ORA User's Guide 2013

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14. ABSTRACT

ORA is a network analysis tool that detects risks or vulnerabilities of an organization?s design structure. The design structure of an organization is the relationship among its personnel, knowledge, resources, and tasks entities. These entities and relationships are represented by the Meta-Matrix. Measures that take as input a Meta-Matrix are used to analyze the structural properties of an organization for potential risk. ORA contains over 100 measures which are categorized by which type of risk they detect. Measures are also organized by input requirements and by output. ORA generates formatted reports viewable on screen or in log files, and reads and writes networks in multiple data formats to be interoperable with existing network analysis packages. In addition, it has tools for graphically visualizing Meta-Matrix data and for optimizing a network?s design structure. ORA uses a Java interface for ease of use, and a C++ computational backend. The most current version of ORA (3.0.8.5) software is available on the casos website: http://casos.cs.cmu.edu/projects/ora/

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Abstract

ORA is a network analysis tool that detects risks or vulnerabilities of an organization's design structure. The design structure of an organization is the relationship among its personnel, knowledge, resources, and tasks entities. These entities and relationships are represented by the Meta-Matrix. Measures that take as input a Meta-Matrix are used to analyze the structural properties of an organization for potential risk. ORA contains over 100 measures which are categorized by which type of risk they detect. Measures are also organized by input requirements and by output. ORA generates formatted reports viewable on screen or in log files, and reads and writes networks in multiple data formats to be interoperable with existing network analysis packages. In addition, it has tools for graphically visualizing Meta-Matrix data and for optimizing a network's design structure. ORA uses a Java interface for ease of use, and a C++ computational backend.

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Glossary

A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

A | Top

Action : driving to the mall, eating lunch. Used as a verb.

Adjacency Matrix : A Matrix that is a square **actor-by-actor (i=j)** matrix where the presence of pair wise links are recorded as elements. The main diagonal, or **self-tie** of an adjacency matrix is often ignored in network analysis.

Aggregation : Combining statistics from different nodes to higher nodes.

Algorithm : A finite list of well-defined instructions for accomplishing some task that, given an initial state, will terminate in a defined end-state.

Agent : An agent, is an information processing entity that can take agent. The most common agents are people. For some research questions, however, it may be useful to make these agents decision entities characterized by role, e.g., registered nurse and doctor. For other research questions, it make make sense to treat the agents as decision making units, like alpha=unit. For other research, the agents might be specific animals, or robots, or other types of actors. Researchers disagree as to whether all agents in the same entity class should be at the same level, e.g., all people, or whether different levels can be mixed such as people and decision units. The key is that an agent is an actor that can act in isolation and is not, for the purpose of the resesrch, subdividable into parts nor has members.

Agent-Generic : Agent-generic are general classes of agents. These can represent the role or an attribute by which an agent is characterized. Examples include american, girl, child, nurse, president.

Agent-Specific : Agent-specific are specific agents. They are generally names entities representing a unique actor. Examples include George_Washington, Red_Deer_0001012.

Asymmetric Networks : Asymmetric are also called Directed Networks where there can be a link e_{uv} is not necessarily equal to link e_{vu} and infact this second link need not even exist.

Attribute : Indicates the presence, absence, or strength of **a particular connection** between nodes in a Matrix. It can also be information about the specifics of the agents. These are usually traits that agents have in common, each can be slightly different (e.g. visible traits like hair colour or intangible traits like religious beliefs).

B | **Top**

Betweenness : Degree an individual lies between other individuals in the network; the extent to which an node is directly connected only to those other nodes that are not directly connected to each other; an intermediary; liaisons; bridges. Therefore, it's the number of nodes who an node is connected to indirectly through their direct links.

Betweenness Centrality : High in betweenness but not degree centrality. This node connects disconnected groups, like a Go-between.

Bimodal Network : A network most commonly arising as a mixture of two different **unimodal networks***.

Binarize : Divides your data into two sets; **zero or one**.

Binary Network : A binary network is constructed by binary values (either 1 or 0) in its network matrix and contains only information whether a link between two entities in the network exists.

Bipartite Graph : Also called a bigraph. It's a set of nodes decomposed into two disjoint sets such that no two nodes within the same set are adjacent.

C | **Top**

Caesar III : An application for the design of information processing and decision making organizations. An application for the design of

decision making organizations at the operational and tactical levels; it takes into consideration cultural differences in coalitions and of adversaries. This tool is under development by George Mason University.

Categorical : An Attribute Type used primarily used for grouping nodes.

Centrality : The nearness of an node to all other nodes in a network. It displays the ability to access information through links connecting other nodes. The closeness is the inverse of the sum of the shortest distances between each node and every other node in the network.

Centralization : Indicates the distribution of connections in the employee communication network as the degree to which communication and/or information flow is centralized around a single agent or small group.

Characteristic Path Length : The median of the average shortest distances (number of links) connecting each employee to all other employees.

> **Interpretation :** Characteristic path length gives a insight into how information spreads. It reflects the communication performance of the entire network and is important for diffusing information and routing information to the right people. A small average path length results in fewer "hops" where individuals or groups don't get information.

Classic SNA density : The number of links divided by the number of possible links not including self-reference. For a square matrix, this **algorithm*** first converts the diagonal to 0, thereby ignoring self-reference **(an node connecting to itself)** and then calculates the density. **When there are N nodes, the denominator is (N*(N-1))**. To consider the self-referential information use general density.

Clique : A sub-structure that is defined as a set of nodes where every node is connected to every other node.

Clique Count : The number of distinct cliques to which each node belongs.

Closeness : node that is closest to all other nodes and has rapid access to all information.

Clustering coefficient : Used to determine whether or not a graph is a small-world network.

Cognitive Demand : Measures the total amount of effort expended by each agent to do its tasks.

Column Degree : see **Out Degree***.

Complexity : Complexity reflects cohesiveness in the organization by comparing existing links to all possible links in all four networks **(employee, task, knowledge and resource)**.

Complementarity : The idea that people seek others with characteristics that are different from and complement their own, aka the idea that opposites attract.

Concor Grouping : Concor recursively splits partitions and the user selects n splits. **(n splits -> 2^n groups)**. At each split it divides the nodes based on maximum correlation in outgoing connections. Helps find groups with similar roles in networks, even if dispersed.

Congruence : The match between a particular organizational design and the organization's ability to carry out a task.

Construct : A reduced form of Construct is found in ORA in the **Near Term Impact Report**.

Continuous : A Attribute Type primarily used for values that are numerical so that statistical analysis can be be performed (Average, Minimum, Maximum, and Standard Deviation).

Count : The total of any part of a Meta-Network **row, column, node, link, isolate, etc.**

CSV : File structure meaning **Comma Separated Value**. Common output structure used in database programs for formatting data.

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Degree : The total number of links to other nodes in the network.

Degree Centrality : a node with the most connections. **(i.e. In the know)**. Identifying the sources for intel helps in reducing information flow.

Density :

- **Binary Network :** The proportion of all possible links actually present in the Matrix.
- **Value Network :** The sum of the links divided by the number of possible links. **(i.e. the ratio of the total link strength that is actually present to the total number of possible links)**.

Disconnected Network : If subsets of nodes are arranged in a way that all nodes of group A are unreachable from all nodes from group B and vice versa, the network is disconnected. Therefore, there is no link connecting any pair of nodes between the subsets of nodes.

Dyad : Two nodes and the connection between them.

Dyadic Analysis : Statistical analysis where the data is in the form of ordered pairs or dyads. The dyads in such an analysis may or may not be for a network.

Dynamic Network Analysis : Dynamic Network Analysis (DNA) is an emergent scientific field that brings together traditional **Social Network Analysis*** (SNA), **Link Analysis*** (LA) and multi-agent systems (MAS).

DyNetML : DyNetML is an xml based interchange language for relational data including nodes, ties, and the attributes of nodes and ties. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools.

E | **Top**

Edge : See **Link**.

Eigenvector Centrality : Node most connected to other highly connected nodes. Assists in identifying those who can mobilize others

Entity Class (same as Ontology class) : The group of nodes that exist in the same domain and are connected to one another. It's a simplified wat of viewing the information.

Event : Something that happens, especially something of importance. Events are usually thought of as a public occasions but they can also be clandestine meetings. The number of agents can range in the thousands or as few as two agents (e.g. Christmas in Times Square or dinner with friends).

Event-Generic : Something that occurs periodically [i.e. Summer]

Event-Specific : One particular instance which may, or may not, be re-occuring. [i.e. Christmas 2011 or the 9/11 attacks].

F | **Top**

FOG : (F)uzzy (O)verlapping (G)roups. Gives a better understanding of individuals spanning groups. Fuzzy groups are a more natural and compelling way of thinking of human social groups.

G | **Top**

General density : The number of links divided by the number of possible links including self-reference. For a square matrix, this **algorithm*** includes self-reference **(an node connecting to itself)** when it calculates the density. When there are N nodes, the denominator is (N*N). To ignore self-referential information use classic **SNA*** density.

Geodesic Distance : A generalization of the notion of a **straight line** to **curved spaces**. In presence of a metric, geodesics are defined to be (locally) the shortest path between points on the space.

Gini coefficient : The measure of inequality of a distribution of income. Uses a ratio with values between 0 and 1: the numerator is the area between the Lorenz curve of the distribution and the uniform (perfect) distribution line; the denominator is the area under the uniform distribution line.

Graph Level Metric : A metric defined for, and gives a value for, the network as a whole. The metric is calculated once for the network. **Examples are Centralization, Graph Hierarchy, and the maximum or average Betweenness.**

GraphML : GraphML is a comprehensive and easy-to-use file format for graphs. It consists of a language core to describe the structural

properties of a graph and a flexible extension mechanism to add application-specific data.

Group : a collection of things (entities, nodes, ties, networks). A group might at times be represented as a meta-node. Nodes may be classified in to groups on the basis of a shared attribute, type, id-range, label, user selection, etc. For example, if you have a set of people and know their gender, then their might be two groups - men and women. In addition the nodes representing those people could be displayed as a meta-node for men and a meta-node for women. Nodes may be classified in to groups on the basis of a grouping algorithm. For example, if you have a network showing connections among members of an organization and you run a grouping algorithm it will return clusters of nodes that fit together on some mathematical criteria. This cluster is a group and can be represented as a meta-node.

H | **Top**

Hamming Distance : Number minimum number of substitutions required to change one string into another string of equal length. (i.e. "**t**o**n**e**d**" and "**r**o**s**e**s**" is 3.)

Heidarian Balance : A motivational theory of attitude change proposed by Fritz Heider, which conceptualizes the consistency motive as a drive toward psychological balance. (Also known as Balance Theory)

Heuristics : Problem-solving by trial and error: a method of solving a problem for which no formula exists, based on informal methods or experience, and employing a form of trial and error iteration.

Homophily : (i.e., love of the same) is the tendency of individuals to associate and bond with similar others.

- **Status homophily** means that individuals with similar social status characteristics are more likely to associate with each other than by chance.
- **Value homophily** refers to a tendency to associate with others who think in similar ways, regardless of differences in status.

HTML : Hyper**T**ext **M**akup **L**anguage.

I | **Top**

In-Degree : The sum of the connections **leading to** an node **from** other nodes. Sometimes referred to **row degree**.

Influence network : A network of hypotheses regarding task performance, event happening and related efforts.

Interstitial : An interstitial (something "in between") is a node situated within but not restricted to or characteristic of a particular group. It provides extra information to the analysis.

Isolate : any node which has no connections to any other node

K | **Top**

Knowledge : Information learned such as a school lecture or knowledge learned from experience (e.g. Excellent knowledge of the periodic table or "I know what you did last summer").

L | **Top**

Latent Semantic Analysis : Latent semantic analysis (LSA) is a technique in natural language processing, in particular in vectorial semantics, of analyzing relationships between a set of documents and the terms they contain by producing a set of concepts related to the documents and terms.

Lattice Network : A graph in which the links are placed at the integer coordinate points of the n-dimensional Euclidean space and each node connects to nodes which are exactly one unit away from it.

Least Squares : The minimum of the sum of the squared deviations from the observed value, for a set of sums.

Link : These are the connections among nodes. An example is a connection between Deetee and United States indicating that she is a citizen of the country.

Link Analysis : A scientific area focused on the study of patterns emerging from dyadic observations. The relationships are typically a form of co-presence between two nodes. Also multiple dyads that may or may not form a network.

Link Class : A set of Links of one type. A set of links of one type can be represented as a meta-link.

Link Confidence : This is a second number associated with the link that specifies the degree of confidence in the presence of the link.

Link Direction : This defines whether the link implies a a source-sink relation between the nodes, or is considered a simple link.

Link Type : This is the name given to this type of link. Link type is specified at the network level. An example of a type if **friendship.** A link type is defined by the two Node classes, the Name of the node classes, whether the links are directional or not.

Link Value : The strength of the link.

Location : An actual physical place. This could be a room in a building, a city, or a country (e.g. Pittsburgh, PA or my living room).

Location-Specific : A Named Entity which is a location [i.e. The Empire State Building].

Location-Generic : A location without a specific reference [i.e. a beach].

Lossy Intersection : Full intersection means that a node/link needs to be in 100% of the networks to be in the resulting network. Lossy intersection at X% percent means that a node/link needs to be in at least X% of the networks to be in the resulting network. Thus, Lossy intersection is a generalization of full intersection.

M | **Top**

Main Diagonal : in a square matrix this is the conjunction of the rows and cells for the same node.

Math Terms

These mathematical terms and symbols are used: Let S be any set:

- card(S) = |S| = the cardinality of S (the cardinality of the node-sets is represented as |A|, |K|, |R|, |T|)
- $\Re$ denotes a real number
- Z denotes an integer

Matrix Algebra : The part of algebra that deals with the theory of matrices.

Maximum Likelihood Estimation [MLE] : An analytic maximization procedure for selecting what probability distribution best fits the observed data by selecting the parameters for a model so as to maximize the model likelihood. **NOTE :** The larger the sample, the more powerful and precise the method.

Method of Moments [MOM] : A computational method to obtain an approximation to the maximum likelihood estimation (MLE), by matching the mean and central moments of the fitted distribution to the mean and central moments of the observed distribution. Moments are used starting with the lowest order as lower moments are more stable. The order of moments is mean, variance, skewness, and finally kurtosis. (Pearson, 1985)

Measure : A measure is a function that maps one or more networks to R^n. Measures are often scalar (n=1) or vector valued with n=|V| or n=|U|.

Member Node : A node with a link to a meta-node.

Meta-Link : The representation of a Group of Links.

MetaMatrix : See Meta-Network

Meta-Network : The representation of a Group of Networks.

Meta-Node : this is a collection of nodes that can be treated as a node for purposes of visualization or analysis. For example, Deettee and Zebadiah could be combined into a single meta-node that we might label as **friends.** A meta-node can include all the nodes in a node class, in which case the meta-node and node-class will in a sense be indistinguishable.

Method of Least Squares [MLS] : The method of least squares assumes that, given a set of observations, the best fitting curve is the curve that has the minimum sum of the deviations squared from the observations; i.e., the least squared errors. This method is typically used in regression analysis.

Monte Carlo : A random optimization of your organization

MRQAP - This describes a report in ORA. See **Reports** for more information. For multivariate cases, if your dependent variable is continous or count data (like in a negative binomial case), you should use MRQAP. If your dependent variable is binary, you should use ERGM (P*) which is forthcoming in ORA. One can perform MRQAP on data that have a dichotomous dependent variable (basically, this is equivalent to using a linear probability model). You do need to interpret your results accordingly.

Multi-Agent System : A loosely coupled network of problem-solver nodes that work together to find answers to problems that are beyond the individual capabilities or knowledge of each node

Multi-node : More than one type of node **(people, events, locations, etc.)**.

Multi-plex : Network where the links are from two or more relation classes.

Multimode Network : Where the nodes are in two or more node classes.

N | **Top**

Neighbors : nodes that share an immediate link to the node selected.

Network : The representation of a set of nodes (including meta-nodes) of one type and the links (including meta-links) of one type between them.

A network N is a triple consisting of two sets of nodes, called U and V, and a set of links $E \subset U \times V$. Thus, we write $N=(U,V,E)$. An element $e = (i,j)$ in E indicates a relationship or tie between nodes $i \in U$ and $j \in V$. A network where U=V and therefore $E \subset V \times V$ is called **unimodal***; otherwise the network is **bimodal***. We write $G=(V,E)$ for **unimodal*** networks. For our purposes, unimodal networks will not contain self loops, which means that $(i,i) \notin E$ for $i \in V$.

Network Class : A set of Networks on one type. This can also be represented as a Meta-Network.

Network data format : usually comes in the form of NodeSet 1 listed vertically in column A starting in row 2 and NodeSet 2 listed

horizontally in row 1 starting with column B. All the intersecting cells are the links between each of the nodes.

Newman Grouping : Finds unusually dense clusters, even in large networks.

Node : A representation of a real-world node (a who, what, where, how, why item.

people, agents, organizations, beliefs, expertise, resource, tasks, events, or locations. Node the representation of a single node (a who, what, where, how why item).

Node Attribute : Nodes can have a number of attributes. The possible attributes are specified at the Node Class level. For each attribute the user needs to specify a name, a mathematical type, and and the possible values. As an example for the Node Class Agent the user specifies the Attribute Gender, and the possible values of Male, Female, Mixed, Unknown. Then for the Node Amy, the value for the Attribute Gender is Female.

Node Class : This is the ontological category into which the associated node falls. ORA and AutoMap use these primary ontological categories - Agent, Organization, Location, Event, Task, Knowledge, Resource, Belief.

Node-Generic : Generic entities are ones for which there are multiple instantiations; i.e., they represent a class.

Node ID : This is the unique to AutoMap/ORA ID of a node. This is usually not changed as it is used by ORA internally.

Node Level Metric : is one that is defined for, and gives a value for, each node in a network. If there are x nodes in a network, then the metric is calculated x times, once each for each node. Examples are **Degree Centrality***, **Betweenness***, and **Cognitive Demand***.

Node Name : This is the label that the user assigns to a Node.

Node Set : A set of nodes consisting on one Node Class.

Node Set Name : This is the label that the user assigns to a Node Set. The default is just to use the name of the node class. For

example, the user could assign the name people to the node class agent.

Node-Specific : Specific entities are ones for which, within the bounds of the research project, there is exactly one entity that can be associated with that name.

Node Type (meta-type) : This is the ontological level of the entity within its ontological category. There are ONLY two node types - **specific and generic**. This type applies only to the following categories - Agent, Organization, Location and Event. An entity is specific if there is one of those entities in the domain of study, otherwise it is generic. So Amy is a Node, of Node Class Agent, of Node Type Specific.

Normalized Sum : Otherwise known as the Average.

Notation:

The following matrix notation is used throughout the document for an arbitrary matrix X:

- X(i,j) = the entry in the i^{th} row and j^{th} column of X
- X(i,:) = i^{th} row vector of X
- X(:,j) = j^{th} column vector of X
- sum(X) = sum of the elements in X (also, X can be a row or column vector of a matrix)
- dich(X) = dichotomize (make binary) X, so that dich(X)(i,j) = 1 iff X(i,j) > 0
- X' = the transpose of X
- ~X = for binary X, ~X(i,j) = 1 iff X(i,j) = 0
- X@X = element-wise multiplication of two matrices (e.g. Z=X@Y => Z(i,j) = X(i,j)*Y(i,j))

O | **Top**

ODBC : (O)pen (D)ata (B)ase (C)onnectivity is an access method developed by the SQL Access group in 1992 whose goal was to make it possible to access any data from any application, regardless of which database management system **(DBMS)** is handling the data.

Ontology : "The Specifics of a Concept". The group of nodes, resources, knowledge, and tasks that exist in the same domain and are connected to one another. It's a simplified way of viewing the information.

Ontology Class (same as entity class) : The group of nodes that exist in the same domain and are connected to one another. It's a simplified wat of viewing the information.

Organization : A group of agents working together for a common cause (e.g. The Red Cross or the local chess club).

Organization-Specific : A Named Entity which is an organization [i.e. The Red Cross].

Organization-Generic : An organization without a specific reference [ ].

Out-Degree : The sum of the connections **leading out from** an node **to** other nodes. This is a measure of how influential the node may be. Sometimes referred to as **column degree**.

P | **Top**

Pajek : A visual tool for analyzing large networks (networks having thousands of vertices).

Path : A set of nodes and links that form a single unbroken chain, such that no node or link is repeated. **i.e. A ⇒ B ⇒ C ⇒ D ⇒ E**

Pendant : Any node which is only connected by one link. They appear to **dangle** off the main group.

Percolation Theory : The behavior of connected clusters in a random network.

Pythia : Program used to create Influence Nets. Pythia is a timed influence net application. This tool can downloaded at the following URL: **http://sysarch.gmu.edu/main/software/**.

Q | Top

QAP Correlation : Calculates measures of nominal, ordinal, and interval association between the relations in two matrices, and uses quadratic assignment procedures to develop standard errors to test for the significance of association.

QAP is designed as a bivariate test (only two variables). Generally, QAP is perfectly fine for almost any bivariate network problem.

R | Top

Random Graph : One tries to prove the existence of graphs with certain properties by assigning random links to various nodes. The existence of a property on a random graph can be translated to the existence of the property on almost all graphs using the famous **Szemerédi regularity lemma***.

Reciprocity : The percentage of nodes in a graph that are bi-directional.

Redundancy : Number of nodes that access to the same resources, are assigned the same task, or know the same knowledge. Redundancy occurs **only** when more than one agent fits the condition.

Regression Analysis : This is used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. The depend and the independent variables can be either network measure or numerical attributes of nodes. Used in Visualization/Measure Charts

Relation : The way in which nodes in one class relate to nodes in another class.

Resource : Can be either a physical or intangible object. Anything that can be used for the completion of a job. (e.g. Use a car to drive

from point A to point B or use money from a bank account to fund something).

Robustness : Two different definitions:

- **Networks :** Concerned with the reliability (Kim & MÃ©dard, 2004) and continued functioning of a network following an intervention. The robustness of a network is particularly relevant in communication-type and flow-oriented networks. The purpose for understanding robustness of a network has more of a management of the network connotation.
- **Measures :** This meaning has more of a statistical connotation. Studying the robustness of a measure of a network can also be referred to as conducting a sensitivity analysis on the measure. In keeping with the terminology of the most-recently published research in this area, in lieu of using the term sensitivity, we too will use the robustness term, although the terms can be used interchangeably.
  A measure is robust if a slight perturbation in its input produces a slight change in its output.

Role : An agents role can be defined as their job for their employer or the part they serve during an event.

Row Degree : see **In Degree***.

S | **Top**

Scale-Free Network : Some nodes act as **highly connected hubs (high degree)**, although most nodes are of low degree. Scale-free networks' structure and dynamics are independent of the system's size N, the number of nodes the system has. A network that is scale-free will have the same properties no matter what the number of its nodes is.

Self-Loop : An node with a connection to itself.

Self-Looped Network : Self-Loops are links from a node to itself. A self-looped network has therefore non-zero diagonal elements in the network matrix.

Shapefile : The GIS Visualizer can view overlay a Meta-Network over a map. The map is a shapefile: a digital vector storage format for storing geometric location and associated attribute information. A "shapefile" commonly refers to a collection of files with ".shp", ".shx", ".dbf", and other extensions on a common prefix name (e.g., "lakes.*"). For example, Shapefiles could represent water wells, rivers, and lakes, respectively. Each item may also have attributes that describe the items, such as the name or temperature.

Simmelian Ties : Two nodes are **Simmelian Tied** to one another if they are reciprocally and strongly tied to each other and strongly tied to at least one third party in common. It's a tie embedded in closed triples.

Simulated Annealing : A method of finding optimal values numerically. It's a search method as opposed to a gradient based algorithm. It chooses a new point, and (for optimization) all uphill points are accepted while some downhill points are accepted depending on a probabilistic criteria.

The term **Simulated Annealing** draws its inspiration from metallurgy, where atoms within a metal are heated thereby dislodging them from a metal's internal structure transforming the metal into another atomic state. In this way, your organization is **heated** changing its components in the attempt to arrive at an optimized state.

Slow Measures : As the name implies these measures generally take longer to run.

Small-World Network : Small-World Networks will have sub-networks that are characterized by the presence of connections between almost any two nodes within them.

Social Network Analysis : The term Social Network Analysis (or SNA) is used to refer to the analysis of any network such that all the nodes are of one type **(e.g., all people, or all roles, or all organizations)**, or at most two types **(e.g., people and the groups they belong to)**.

Sphere of Influence : One node's direct relationship with one of it's neighbors as a function of specified path length.

Standard Deviation : The square root of the variance where variance is the average of the squared differences between data points.

.stl file format : This file format is native to the stereolithography CAD software created by 3D Systems. STL files describe only the surface geometry of a three dimensional object without any representation of color, texture or other common CAD model attributes and can us both ASCII and binary representations

Symmetric Networks : Any link in a network will have a reciprocal link **If there's a link from A to B then there will also be a link from B to A**. Symmetric Network have symmetric values about its diagonal.

Szemerédi's Regularity Lemma : A fundamental structural result in extremal graph theory due to Szemerédi (1978). The regularity lemma essentially says that every graph can be well-approximated by the union of a constant number of random-like bipartite graphs, called regular pairs.

T | **Top**

Table data format : Table data usually contains a column with referencing IDs and headers denoting column names.

Task : A task is part of a set of actions which accomplish a job, problem or assignment. Task is a synonym for activity although the latter carries a connotation of being possibly longer duration (e.g.)

Tie : see **Link**

Time : Referring to time or circumstances. Can be as broad as a year or as pinpoint as the exact time of a particular day (e.g. Last year or 2:33 PM on March 1st, 2009).

Topology : The study of the arrangement or mapping of the elements (links, nodes, etc.) of a network, especially the physical (real) and logical (virtual) interconnections between nodes.

Total Degree Centrality : The normalized sum of an node's row and column degrees.

Trail : A set of nodes and links that form a single unbroken chain that can revisit nodes but not links. **i.e. A ⇒ B ⇒ C ⇒ A ⇒ D**

Transpose : In linear algebra, the transpose of a matrix A is another matrix A^T (also written A^{tr}, ${}^tA$, or A') created by any one of the following equivalent actions:

- write the rows of A as the columns of A^T
- write the columns of A as the rows of A^T
- reflect A by its main diagonal (which starts from the top left) to obtain A^T

See **The Transpose Wikipedia Entry** for formulas, examples and more information.

Tuple : An ordered list of elements. Therefore ***n*-tuple** is an ordered list of *n* elements. There is also a **0-tuple** which is an empty sequence.

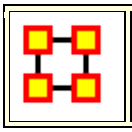
U | **Top**

Unimodal networks : These are also called square networks because their **adjacency matrix*** is square; the diagonal is zero diagonal because there are no **self-loops***.

W | **Top**

Walk : A set of nodes and links that form a single unbroken chain that can revisit both nodes and links. **i.e. A ⇒ B ⇒ C ⇒ B ⇒ D**.

Weighted Network : If the weights of the links are different we use the term weighted network. Every link will be represented by a real number running continuously from -∞ to +∞. It contains not only whether a link exists but also the numerical information about that link. 0 indicates there is no link between two nodes.



Getting Started

Welcome to ORA's Help File system! The ORA Help and examples contained herein are written with a specific data set in mind, mostly designed specifically for a particular section.

How to use ORA help

If you are not familiar with **Social Network Analysis** we encourage you to read through the beginning sections of the help set. The ORA help set is broken up into seven primary parts, which are designed for varying levels of user expertise.

Getting Started : Provides an overview of Social Networks and how they pertain to ORA.

General Content : Information that applies to many parts of ORA in many different ways.

The Main Interface : Details working with the data within the Networks. This includes loading, saving, merging, performing various math functions on the Networks, generating a variety of networks, and running reports.

The Visualizer : Takes these Meta-Networks and turns them into graphical representations. There are tools for creating / deleting nodes and links, displaying information in different formats, and helping to analyze the data.

GeoSpatial/Loom : Describes the parts of ORA specically designed with location functions.

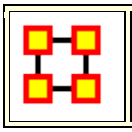
Measures : Explains the various measures used in ORA. They contain a short explanation. It also describes the **type, input, and output**.

Reports : Contains a description of what each report is and what it will tell you about your data.

Lessons : Designed to teach specific functions and how to carry out many types of useful network analytical tasks that can be accomplished by using ORA.

Student Version

NOTE : The student version is for academic use only. The student version is limited to 2000 nodes, certain reports are not available, and batch mode is not available



What is ORA?

An Overview

ORA is a statistical analysis package for analyzing complex systems as **Dynamic Social Networks**.

Many complex systems such as organizations, intra-state alliances, food webs, etc. can be represented as an ecology of interlinked networks. Within ORA any complex system is represented as a Network. What follows is a general description of ORA's primary capabilities. Specific instruction is provided under the correlating folders in this help system.

*See **Basic Terms** for additional definitions relating to Social Networks.*

The ORA Visualizer

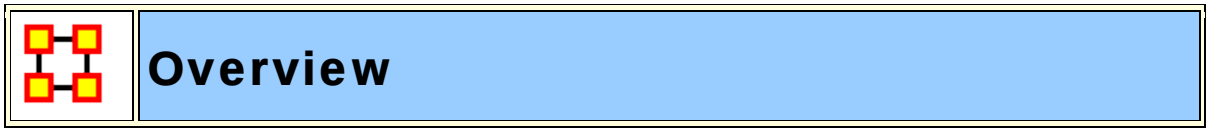
The ORA Visualizer renders conceptual images of social networks. **Nodes** represent real-world **Entities** like the president of a company, driving to the airport, or how to wash your clothes. Nodes which share the same attributes can be further grouped together creating Nodesets. **Links** connect nodes that share a direct relationship. Such relationships are derived from the **Network**. ORA's single unit of data input, and are referred to as graphs. The ORA visualizer is interactive. You can **zoom, rotate, isolate, add and remove Nodes**, and much more.

Reports

ORA can run many reports: **Centrality, Correlation, and Sphere of Influence** to name a few. Multiple organizations can be compared against each other, network structure can be optimized, subgroups within a network can be identified, and scenarios involving the removal of nodes or links can be examined. Reporting capabilities are constantly being refined and updated.

Charts

Four chart types are available: **Bar Chart, Scatter Plot, Histogram, and Heat Map**. Each one in turn presents a different statistical profile of a selected Nodeset. Examples of these reports and how to access them can be found under Basic Usages.



Overview

Contact Information

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ORA

ORA is an analysis tool designed to help the user evaluate one or more networks. It can be used to assess the nature of, features of, change in, and determinants of complex networks. A large variety of networks can be assessed including, but not limited to, social networks, activity networks, task networks, knowledge networks, supply chains, and communication networks. Using ORA questions such as the following can be addressed: what is critical, are there groups of interest, are there patterns of interest, how might

interventions impact the network, who is critical, are there emerging groups, how is the network changing.

What is a network? In any data there are relations among things such as two people are cousins, or a set of people are all members of the same club. These networks might be psychological or cultural as when two people share the same belief. They might be physical as in two resources being in the same location or two computers being connected by a line, or they might be social as in people being related. There are many reasons why networks exist. Networks are ubiquitous. Everyone and everything is constrained and enabled by the networks in which they are embedded. Everyone and everything is embedded in multiple networks; e.g. you are connected to some people due to work, others due to school, others due to your kids, and so on. ORA lets you visualize, assess, and reason about these networks.

What kinds of networks?

ORA can assess any type of network. Anything that can be represented as a set of nodes and relations can be assessed. Typical networks are: social networks (who interacts with whom), financial networks (who lends money to whom); gant charts (what task needs to be done before what), supply chains (what resources are needed to build what other resources)., semantic networks (what ideas are linked to what ideas), proximity networks (what states border on what states), and so on. ORA can assess any data that can be represented as nodes and relations regardless of what the nodes are or what the relations are.

What if there are many networks?

ORA can be used to assess the interlocks among networks. For examples, imagine that the following networks exist: who works with whom; who has what skills, what skills are needed for what tasks, who is doing what tasks then ORA can assess whether in fact the right people have been assigned to those tasks or where there are problems because there is insufficient skills available for the task. ORA can assess "multi-mode multi-link" data.

What if the networks change?

ORA can be used to assess change in networks over time. Over time, the shape or topology of a network might change; e.g., start up companies move from a collaborative to a hierarchical structure, terrorists change what weapons they use to attack sites, scholars cite different papers, and so on. Consequently, over time, who or what is critical in a network might change. ORA can assess change in networks, and forecast possible ways in which the network might change in the future.

What if information is incomplete?

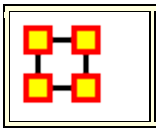
ORA can assess networks even when information is incomplete. ORA has been built to gracefully degrade so that it calculates all and only those metrics for which there is information.

Illustrative applications

ORA has been applied in numerous settings. Examples include the following. Assessment of team-x leadership structure at NASA. Comparison of terror networks. Identification of vulnerabilities in insurgency and terror networks. Assessing change in political elite structures in Korea and early identification of emergent leaders. Designing teams for wargames. Assessing the impact of turnover and retirement on public health organizations in Duchess County, NY. Identifying reports with AIS data. Organizations where ORA has been used include: AFIT, SOCOM, USMA, CIA, many universities.

Tool Evolution

There are still many challenges in the area of dynamic network analysis. Key challenges include handling streaming data, locating confidence intervals for metrics, uncertainty assessment, and so on. As these challenges are met, new algorithms are implemented, tested and added to ORA thus further meeting the user's needs.



Social Network Analysis (SNA)

Social Network Analysis is a scientific area focused on the study of relations, often defined as social networks.

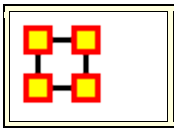
In its basic form, a social network is a network where the people (**entities**) and the relations (**links**) are a form of connection such as friendship. Social Network Analysis takes graph theoretic ideas and applies them to the social world.

The term **social network** was first coined in 1954 by J. A. Barnes **(see: Class and Committees in a Norwegian Island Parish)**. Social network analysis is also called network analysis, structural analysis, and the study of human relations. SNA is often referred to as the science of **connecting the dots**.

> Today, the term Social Network Analysis **(or SNA)** is used to refer to the analysis of any network such that all the entities are of one mode **(e.g., all people, or all roles, or all organizations)**, or at most two mode **(e.g., people and the groups they belong to)**. The metrics and tools in this area, since they are based on the mathematics of graph theory, are applicable regardless of the type of nodes in the network or the reason for the connections.
>
> For most researchers, the entities are actors. As such, a network can be a cell of terrorists, employees of global company or simply a group of friends. However, entities are not limited to actors. A series of computers that interact with each other or a group of interconnected libraries can comprise a network also.

Where to find out more on SNA

- *Scott, John*, 2000, Social Networks, Sage (2nd edition)
- *Wasserman, S. & K. Faust*, 1994, Social Network Analysis: Methods and Applications



Dynamic Network Analysis

Dynamic Network Analysis (DNA)* is an emergent scientific field that brings together traditional **social network analysis (SNA)**, **link analysis (LA)** and **multi-agent systems (MAS)***. There are two aspects of this field. The first is the statistical analysis of DNA data. The second is the utilization of simulation to address issues of network dynamics. DNA networks vary from traditional social networks in that are larger dynamic multi-mode, multi-plex networks, and may contain varying levels of uncertainty.

DNA statistical tools are generally optimized for large-scale networks and admit the analysis of multiple networks simultaneously in which, there are multiple types of nodes **(multi-nodes)*** and multiple types of links **(multi-plex)***. In contrast, SNA statistical tools focus on single or at most two mode data and facilitate the analysis of only one type of link at a time.

DNA statistical tools tend to provide more measures to the user, because they have measures that use data drawn from multiple networks simultaneously. From a computer simulation perspective, nodes in DNA are like atoms in quantum theory, nodes can be, though need not be, treated as probabilistic.

Whereas nodes in a traditional SNA model are static, nodes in a DNA model have the ability to learn. Properties change over time; entities can adapt: A company's employees can learn new skills and increase their value to the network; Or, kill one terrorist and three more are forced to improvise. Change propagates from one entity to the next and so on. DNA adds the critical element of a network's evolution and considers the circumstances under which change is likely to occur.

Adequate Survey Response Rate

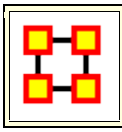
Often people try to get 100% response when the full network is collected - however, anything above 85%-90% is considered good. For ego network data - standard response rate guidelines are followed.

Where to learn to more:

Kathleen M. Carley, 2003, Dynamic Network Analysis" in Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, Ronald Breiger, Kathleen Carley, and Philippa Pattison, (Eds.) Committee on Human Factors, National Research Council, National Research Council. Pp. 133-145, Washington, DC.

Kathleen M. Carley, 2002, Smart Agents and Organizations of the Future" The Handbook of New Media. Edited by Leah Lievrouw and Sonia Livingstone, Ch. 12, pp. 206-220, Thousand Oaks, CA, Sage.

Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat, 2005-forthcoming, Toward an Interoperable Dynamic Network Analysis Toolkit, DSS Special Issue on Cyberinfrastructure for Homeland Security: Advances in Information Sharing, Data Mining, and Collaboration Systems.



ORA and DNA

In general, you may want to use ORA in conjunction with other computational tools to advance DNA theory. The **CMU CASOS tools** that work with ORA to form tool chains are **AutoMap** (extracts networks from texts) and various DNA simulators including both **Construct and DyNet**. These tools are often used in a number of real world applications, including the following areas:

- Designing adaptive teams for Command and Control Networks
- Estimating the impact of organizational downsizing
- Estimating the effectiveness of new structures
- Evaluating risk in organizational designs
- Examine impact of IT effectiveness
- Impact analysis of actions in asymmetric warfare simulation
- Impact analysis of weaponized biological attacks on cities

ORA is interoperable with a number of other SNA and link-analysis tools: **UCINET, KeyPlayer, and Analyst Notebook**. Additional information is listed under data import and export.

Where to learn more about CASOS tools and this tool chain:

Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat, 2004, An Integrated Approach to the Collection and Analysis of Network Data, In Proceedings of the NAACSOS 2004 Conference, Pittsburgh, PA

Kathleen M.Carley, 2004, Estimating Vulnerabilities in Large Covert Networks Using Multi-Level Data, In Proceedings of the NAACSOS 2004 Conference, Pittsburgh, PA

Kathleen M. Carley, 2003, Dynamic Network Analysis in Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, Ronald Breiger, Kathleen Carley, and Philippa Pattison, (Eds.) Committee on Human Factors, National Research Council, National Research Council. Pp. 133-145, Washington, DC.

Kathleen M. Carley, Jana Diesner, Jeffrey Reminga, Maksim Tsvetovat, 2005-forthcoming, Toward an Interoperable Dynamic Network Analysis Toolkit, DSS Special Issue on Cyberinfrastructure for Homeland Security: Advances in Information Sharing, Data Mining, and Collaboration Systems.

CASOS: Center for Computational Analysis of Social and Organizational Systems
(**http://www.casos.cs.cmu.edu/index.html**)

System Requirements

ORA performs best on machines that meet or exceed the following specifications:

Spec	Windows	Mac (running XP)
System	XP	OSX 10.4.x
RAM	256 MB	1GB
Processor	Pentium 4	Intel Core 2 Duo
Speed	1.0 GHz	2.0 GHz
Java	6.0	6.0
Extra		Parallels for Dual Booting

NOTE : When working with extremely large data sets, increasing processing speed and RAM is highly recommended.

Files Formats

ORA can read in a multitude of file formats. Below is a list, with examples of the code, of those formats.

DyNetML – **.dl** – **UCINET** – **comma delimited (.csv)** – **text files (.txt)** – **Pajek (.net)** – **GraphML** – **GMU model (.stl)** – **Pathfinder (.lo)**.

DyNetML (the native ORA xml format): DyNetML is an xml based interchange language for relational data including nodes, ties, and the attributes of nodes and ties. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools.

```
<node id="col_jack_o'neill">
  <properties>
    <property name="ally" type="string" value="yes"/>
    <property name="gender" type="string" value="male"/>
  </properties>
</node>
<graph sourceType="Agent" source="Agent"
targetType="Agent" target="Agent" id="agent x agent"
isDirected="true">
  <edge source="A01" target="A11" type="double"
value="1"/>
  <edge source="A02" target="A01" type="double"
value="1"/>
</graph>
```

.dl: DL (for "data language") is a very powerful and (fairly) simple language that allows the creation of quite complex and large UCINET data sets with minimal data entry. DL language files are plain ASCII text files that can be created with any editor (be sure to store the results as plain text).

```
dl n=9, format=edgelist1
labels:
    A,B,C,D,E,F,G,H,I
data:
    1    1    1
    1    2    1
    1    6    1
          .
          .
          .
    8    7    1
    9    9    1
```

.##h and ##d (UCINet): UCINET datasets are stored in a special (Pascal) format, but can be created and manipulated using both UCINET's and other software tools (text editors and spreadsheets). Each UCINET dataset consists of two separate files that contain header information (e.g. myfile.##h) and the data lines (e.g. myfile.##d). Because of this somewhat unusual way of storing data, it is best to create data sets with the internal spreadsheet editor or

DL language tools, or to import text or spreadsheet files and save the results as UCINET files.

.CSV (comma separated values): The CSV ("Comma Separated Value") file format is often used to exchange data between disparate applications. The file format, as it is used in Microsoft Excel, has become a pseudo standard throughout the industry, even among non-Microsoft platforms. File most commonly created from an Excel spreadsheet using the **Save As...** option

- Each record is one line... but — A record separator may consist of a line feed (ASCII/LF=0x0A), or a carriage return and line feed pair (ASCII/CRLF=0x0D 0x0A)... but — fields may contain embedded line-breaks (see below) so a record may span more than one line.
- Fields are separated with commas.
- Leading and trailing space-characters adjacent to comma field separators are ignored.
- Fields with embedded commas must be delimited with double-quote characters.
- Fields that contain double quote characters must be surrounded by double-quotes, and the embedded double-quotes must each be represented by a pair of consecutive double quotes.
- A field that contains embedded line-breaks must be surrounded by double-quotes
- Fields with leading or trailing spaces must be delimited with double-quote characters.
- Fields may always be delimited with double quotes.
- The first record in a CSV file may be a header record containing column (field) names

```
,A01,A02,A03,A04
A01,0,0,0,0
A02,1,0,0,0
A03,1,0,0,0
A04,1,0,0,0
```

.txt (text files): Otherwise referred to **ASCII files** which contain no extemporaneous formating.

.raw:

.net (Pajek): The file format accepted by Pajek provides information on the vertices, arcs (directed edges), and undirected edges. A short example showing the file format is given below:

```
*Vertices 3
1 "Doc1" 0.0 0.0 0.0 ic Green bc Brown
2 "Doc2" 0.0 0.0 0.0 ic Green bc Brown
3 "Doc3" 0.0 0.0 0.0 ic Green bc Brown
*Arcs
1 2 3 c Green
2 3 5 c Black
*Edges
1 3 4 c Green
```

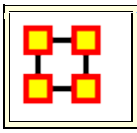
.graphml: GraphML is a comprehensive and easy-to-use file format for graphs. It consists of a language core to describe the structural properties of a graph and a flexible extension mechanism to add application-specific data. Unlike many other file formats for graphs, GraphML does not use a custom syntax. Instead, it is based on XML and hence ideally suited as a common denominator for all kinds of services generating, archiving, or processing graphs.

```
<xs:annotation>
  <xs:documentation
    source="http://graphml.graphdrawing.org/"
    xml:lang="en">
    Simple type definitions for the new graph attributes.
  </xs:documentation>
</xs:annotation>
```

.stl (GMU model): This file format is native to the stereolithography CAD software created by 3D Systems. STL files describe only the surface geometry of a three dimensional object without any representation of color, texture or other common CAD model attributes and can us both ASCII and binary representations

```
An ASCII STL file begins with the line:
solid {name}
where name is an optional string. The file continues with
any number of triangles, each represented as follows:
facet normal n1 n2 n3
  outer loop
    vertex v11 v12 v13
    vertex v21 v22 v23
    vertex v31 v32 v33
  endloop
endfacet
where n1-n3 and v11-v33 are floating point numbers in
sign-mantissa'e'-sign-exponent format and concludes with:
endsolid {name}
```

.lo (pathfinder):



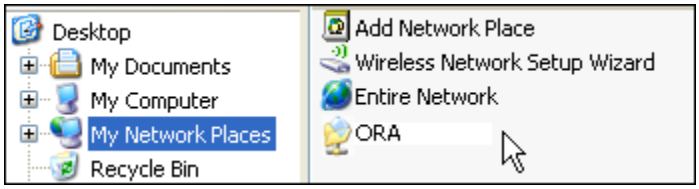
Network Drives

If you are running on a network drive then the help system needs a drive letter in order to work correctly. There are 2 possible solutions to this:

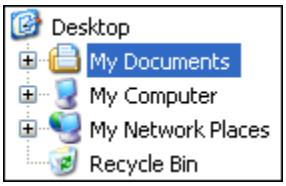
1. Copy the ORA folder to each local machine.
2. If at all possible Map a Network Drive. Right click on the shared folder and select Map Network drive.

Mapping a Network Drive

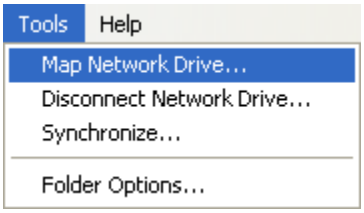
In an Explorer window select **My Network Places**. Find the name of the network which contains ORA.



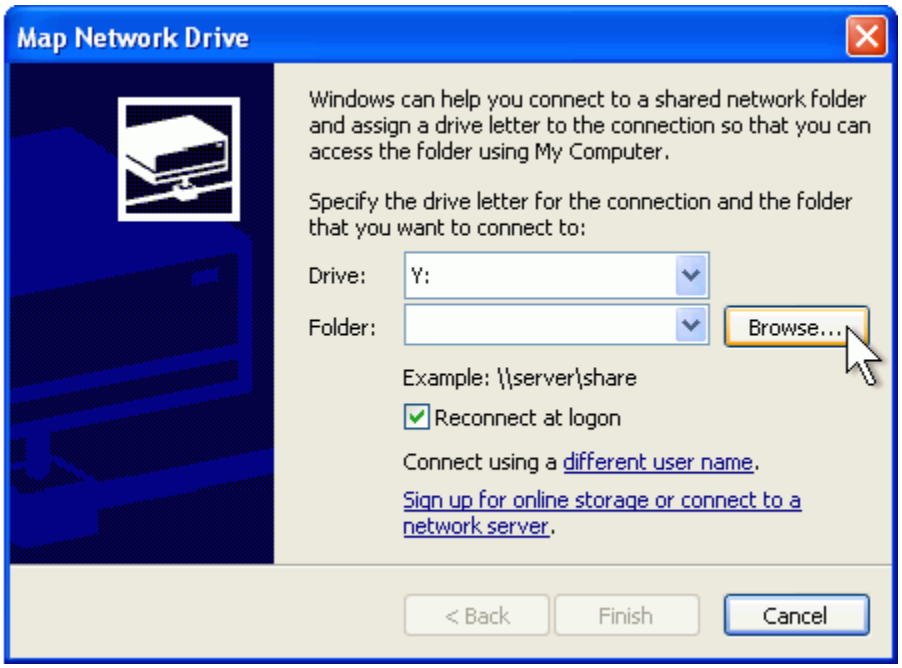
Go back to **My Document**.



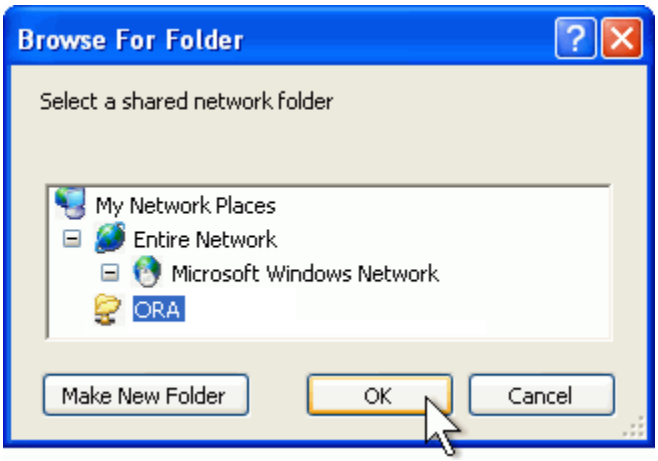
From the menu select **Tools ⇒ Map Network Drive**. This brings up the dialog box below.



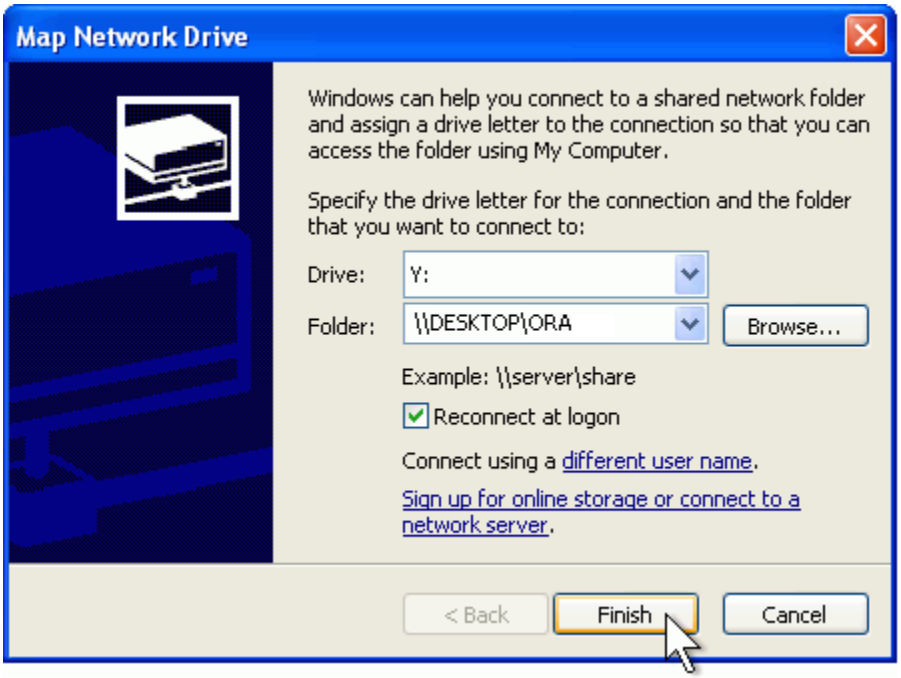
Select the **[Browse]** button in order to select the network drive.



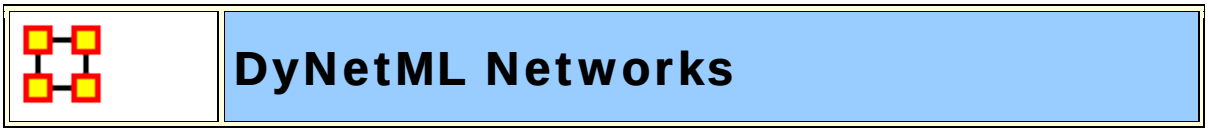
Select the correct network drive and press **[OK]**.



Select **[Finish]**.



Your computer now has the Network drive with ORA mapped on the desktop.



DyNetML

DyNetML is an xml based interchange language for relational data including nodes, links, and the attributes of these nodes and link. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools

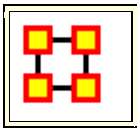
Uni-Modal Networks

Uni-modal networks are not changed (e.g., an Agent x Agent network is NOT symmetrized), but bi-modal networks are **symmetrized** in that the links from two or more networks are combined using the maximum method.

Bi-Modal Networks

Bi-modal networks are combined. e.g., if there is an Agent x Knowledge and a Knowledge x Agent network, then the Knowledge x Agent is transposed to Agent x Knowledge (2) and then Agent x Knowledge and Agent x Knowledge (2) are unioned with the Maximum link weight from each (a,k) or (k,a) being used.

Network names are normalized to reflect their Node Class, i.e., agent x agent, agent x knowledge, etc.



ORA QuickStart

1.0 GENERAL

1.1 WHAT IS ORA:

ORA is a network analysis package that helps the user enter, analyze, visualize, and forecast changes in networks using graph based and statistical based techniques.

ORA consists of two parts: The Editor, which allows you to work on loaded Meta-Networks and the Visualizer, which allows you to see a graphic depiction of the Meta-Network.

1.2 INSTALLATION:

This is the procedure to install ORA on your computer:

Go to http://casos.cs.cmu.edu/projects/ora/software.php

Click the **Download** link

Select the [**Yes**] button to agree to terms and click [**Continue**]

Insert your Information and click [**Continue**]

Choose your platform.

Click the link for your system [**32-bit or 64-bit**]

After the program is downloaded double click the ORA icon to install. Follow installation instructions.

2.0 EDITOR

2.1 EDITOR GUI

The ORA interface is organized into three sections which are placed in resizable and dockable panes. Each pane will have one or more individual parts. On each tab are two buttons: **undock and close**. In the upper right corner of each pane are three buttons: **undock, maximize, and close**. This will allow you to arrange the interface to suit your needs.

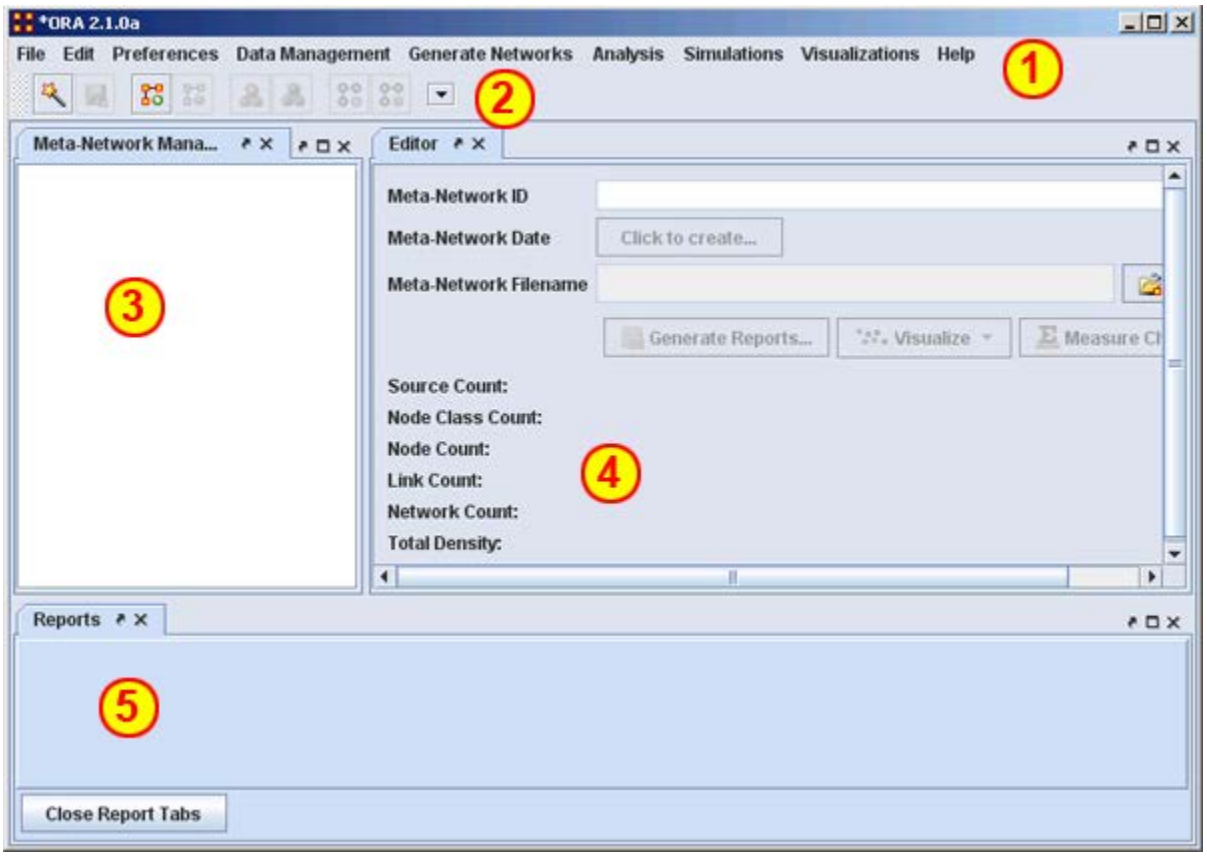


fig - The ORA Editor Interface

1) **Menu :** Source for performing the majority of tasks. The Menu Items are separated into categories each with their own functions.

2) **Toolbar :** Buttons for main functions to work with Meta-Networks, Nodesets and Networks.

3) **Toolbar Button Adder :** Allows you to add menu functions to the toolbar.

4) **Meta-Network Manager :** This pane displays all currently open Meta-Networks.

5) **Editor :** This pane displays in multiple tabs information on Nodesets and Networks.

6) **Reports :** This pane display reports run on Meta-Networks.

2.2 WHAT'S IN A META-NETWORK:

Meta-Network : A representation of a Group of Networks.

Node : A representation of a real-world item (a who, what, where, how, why item).

Nodeset : A collection of nodes.

Nodeset Name : Name for a Nodeset which the user can change.

Node Class : Nodes can be classified as "agent, resource, knowledge, task, organization, location, event, action, belief, or role."

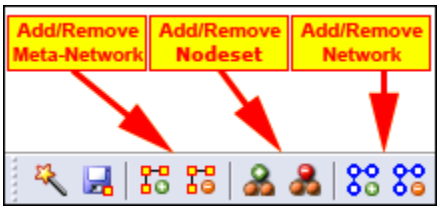
Link : A representation of a connection, or relation between any two nodes.

Network : A representation of a set of nodes (including meta-nodes) of one type and the links (including meta-links) of one type between them.

Attribute : Additional information about a node. The most common agent attributes are age & gender although it can be anything you choose.

2.3 META-NETWOKS, NODE CLASS, AND NETWORKS BUTTONS

ORA contains tools to Add or Remove **Meta-Networks, Nodesets, or Networks**. The **Plus** sign denotes adding and the **Minus** sign denotes removing.



To add a **Meta-Network, Nodeset, or Network** click the appropriate button. The new item will appear in the Meta-Network Manager.

To remove a **Meta-Network, Nodeset, or Network** highlight the item and click the appropriate button.

NOTE : When in the actual program only the applicable buttons will be active e.g. if a network is highlighted then only the Network buttons are active. All others would be greyed out.

2.4 CREATING A NETWORK AND NODESET FILE

A Nodeset or Network can be created either in ORA or in an external program such as a text editor [NotePad or NotePad++] or a spreadsheet program [Excel].

Using a Text Editor

To create a Network in a Text Editor all information will be separated by commas. The lefthand column consists of the **FROM** nodes and the top row consists of the **TO** nodes. A **“"0"”** at an intersection means there is no link while a **non-zero number** means there is a connection.

```
,A01,A02,A03,A04,A05

A01,0,0,0,0,1

A02,1,0,0,0,0

A03,1,0,0,0,1

A04,1,0,0,0,1

A05,0,0,0,0,0
```

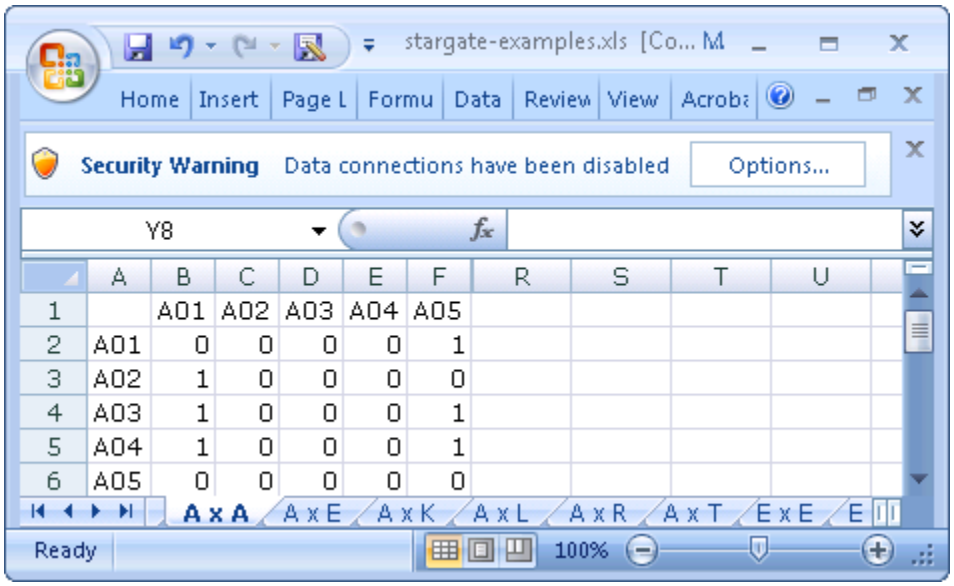
NOTE :

In the text file above notice the **empty value** in the top row just to the left of the top comma. This corresponds to the empty cell in the Excel spreadsheet **Column A--Row 1**.

To create csv files save them as a text file (.txt) but change the extension name to **.csv**.

Using Excel

In an **Excel Spreadsheet** you would place each set of nodes in a separate row or columns with each piece of information in a separate intersecting cell. To create a csv file select **File > Save As……** and save it as a comma-delimited file.



Excel with the SG-1 Network data

Links will run from the node in **Column A** to the node in **Row 1**. For example there is a link from A02 > A01 [cell B3] but there is no link from A01 > A02 [cell C2].

Again note that the cell **[A1]** is blank. This is common in all network files created in this manner.

2.5 IMPORT CSV FILES INTO ORA TO CREATE NODESET AND NETWORK:

With Nodesets and Networks created it is time to import them into ORA. For this we use the Data Import Wizard.

Select **Import existing data? > Table Data from Excel of delimited formats > Rectangle of link weights (a Matrix)**. Click [**Next >**].

Click **Create a new neta-network with ID:**

Replace **Meta Network** with the name for your new MetaNetwork then click [**Next >**]

The Import Data Interface

Click [**Browse**] and locate the csv file of the agents.

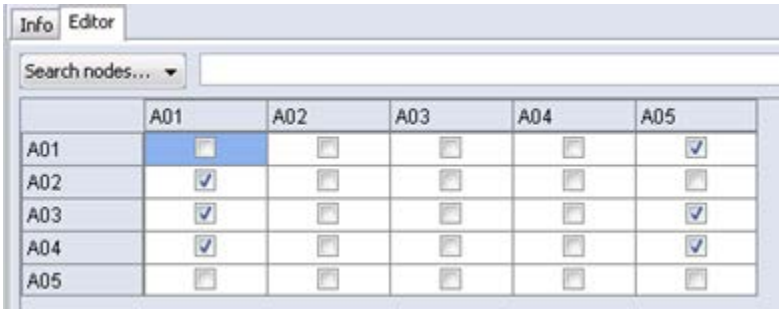
Set **Source type** and **Target type** to agent.

NOTE : For this Network both are set to agent. Depending on the data you are importing these may be set to different Nodesets.

NOTE : Clicking on the **Click to import from another file** allows you to import additional networks.

Click [**Finish**].

To import additional files into the Meta-Network choose **Add to the existing meta-network** instead of **Create a new Meta-Network with ID:**. Then select the Meta-Network to add.



The ORA Editor with the SG-1 network loaded

2.6 CREATING A NODE TITLE/ATTRIBUTE FILE

CSV files are used to create Nodesets and Network files. These can be created in either a text editor or a spreadsheet program.

In a **Text Editor** you would place each node on a separate line with all information separated by commas. To create csv files same them as a text file (.txt) but change the extension name to .csv. For this example the file will create Node Titles. This could be used to import any attribute. The top row contains the names of the fields that will be imported.

id,title

A01,col_jack_o'neill

A02,maj_samantha_carter

A03,daniel_jackson

A04,teal'c

A05,gen_hammond

In an **Excel Spreadsheet** place each node name or attribute into a separate row with each piece of information in a separate cell. The juxtaposition of the various cells on a row code the relations of interest To create csv files **Save As……** a comma-delimited file.

In a **Text Editor** place each node on a separate line. Save as a text file with the .csv externsion.

NOTE : Only rows with ids which match up to existing nodes will be imported unless the Create new nodes option is checked.

2.7 IMPORT ATTRIBUTES INTO ORA:

Select **Import Excel or text delimited files > Table of node attributes**. Click [**Next**].

Select the Meta-Network to add information. Click [**Next** >].

Click **Browse** and navigate to your attribute file.

Select from the drop down which column to use to identify your node IDs.

For each column a box will appear allowing you to chose which attributes to import. Place a check mark next to each attribute you want and give it a Type: Text Category, Text, URI, Number Category, Number, or Date. An attribute without a check mark will not be imported.

Select the Nodeset to add the attributes. This drop down will contain multiple entries if your Meta-Network contains more than one Nodeset.

Click [**Finish**].

The A01, A02, etc will be replaced with the titles in the attribute file.

NOTE : Only the attributes you check mark will be imported. All others will be ignored.

2.8 ADD/REMOVE NODES IN THE EDITOR:

Nodes can be added or removed to any Nodeset through the Editor. Highlight the Nodeset then use the buttons on the right side of the Editor to manipulate the nodes. Some of the functions require that you place a check mark next to the node you are working with [i.e. deleting a node].

Create: Insert new nodes into meta-network

Move : Move node(s) from one Nodeset to another.

Delete : Remove node from Node Class

Merge : Combine two or more nodes into one

Clean : Condense all references of one person into a single node.

2.9 CHANGE DISPLAY TO BINARY OR NUMERICAL

The grids in the Editor can display link data as numeric or check marks. Binary data is usually done with check marks as it is simply on or off. Numerical data [for weighted links] can show a ink as 0 of a positive/negative number.

Click **Display Options** near the bottom right of the Editor interface.

Select **Binary link values** to display data as check marks.

Select **Numeric link values** to display data as numbers.

2.10 ADD/REMOVE LINKS IN THE EDITOR TAB [BINARY]

Click the [**Options……**] button in the lower right of the Editor.

Highlight a **Network** in the Meta-Network panel

Select the **Editor Tab**.

In the grid find the intersection of the column node and row node.

To **create a link** place a **check mark** in the cell. This can be done by clicking the box of pressing the spacebar while the cell is active.

To **remove a link** deselect a cell by removing the **check mark**.

2.11 ADD/REMOVE LINKS IN THE EDITOR TAB [NUMERICAL]

Highlight a **Network**

Select the **Editor Tab**.

In the grid find the intersection of the column node and row node.

To **create a link** place a **non-zero number** in the cell.

To **remove a link** place a [**0**] in the cell.

2.12 SAVE A META-NETWORK

It is important to save your work from time to time. If something happens to your computer or ORA then all work done since your last save will be lost. You have two options.

File > Save Meta-Network : Saves your work to the file that was originally open.

File > Save Meta-Network As…… : Saves your work to a new file. Give the file a new file name when ORA asks. This can be useful if you are experimenting with different ideas and do not want to affect your original data.

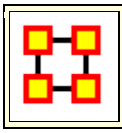
2.13 PREFERENCES

Every user will have their own way they want ORA to perform. The preferences allow for tweaking those functions. There are many parameters that can be set but the important ones to a new user are listed for the individual tabs.

General : Preferences for the look and feel of ORA such as whether tooltips are shown when hovering over items and the size of the toolbar icons.

Data Sets : As a new user concentrate on the three radio buttons near the bottom. These allow you to specify what files you want to load whenever you restart ORA. To start make sure it is set to **Restore previously loaded workspace files at startup**. This can be changed as you learn more about the workings of ORA.

NOTE : Reports and Custom Reports are for advanced users.

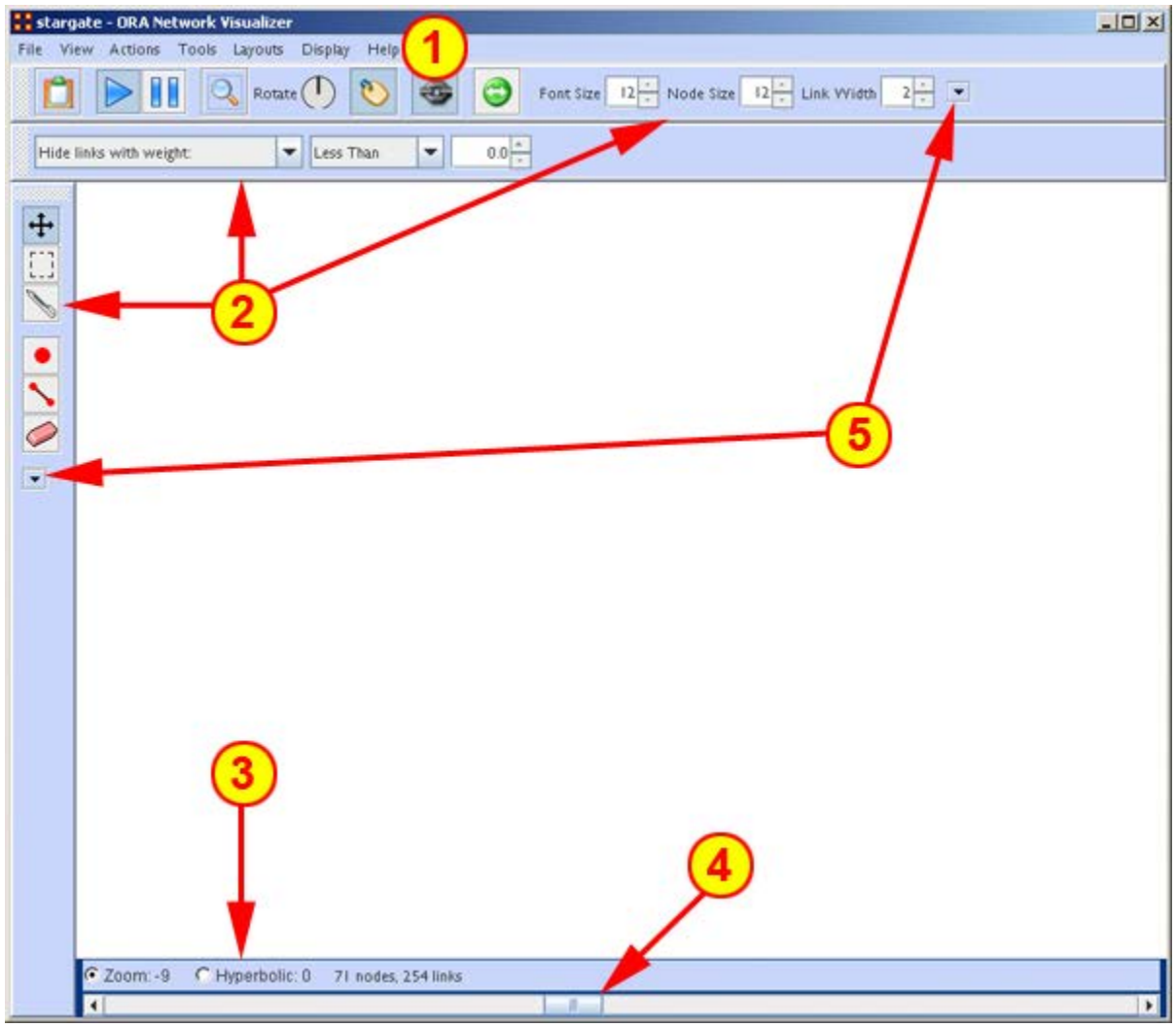


QuickStart Visualizer

3.0 VISUALIZER

3.1 VISUALIZER GUI:

Contains the visual representation of your Meta-Network.



The ORA Visualizer Interface

1) Menu : Source for performing the majority of tasks.

2) Toolbars : Main functions for working with displayed Meta-Network.

3) Zoom / Hyperbolic selector : Select the radio button for the either the sizing or fish-eye view

4) Zoom / Hyperbolic controller : Controls degree of function.

5) Toolbar Button Adder –: Allows you to add menu functions to the toolbar.

3.2 DISPLAYING META-NETWORK IN EDITOR:

Meta-Networks can be visualized in many ways.

Highlight a Meta-Network. Note we are back in the main ORA interface, not the Visualizer.

Click the Visualizer button.

Or from the Editor Menu select **Visualizations > View Networks > 2D Visualization**.

NOTE : The Visualizations menu also contains other display functions for your Meta-Networks. Many of which are advanced functions.

3.3 ADD/REMOVE NODES WITH THE VISUALIZER MENUS:

Actions > Add Node(s) : Allows you to add nodes to existing or new Nodesets.

Tools > Node Status : Displays all the information about the selected node.

Tools > Node Locator : Selecting a node from the dialog box will reveal the location of the node in Visualizer.

Display > Node Shaper : Use this tool to change the size and shape of the selected node.

3.4 ADD NODE IN VISUALIZER WITH NODE CREATOR

- The **Node Creator** button is in the left toolbar. **NOTE :** [2] on The ORA Visualizer interface.

In the drop down menu select a **Nodeset**.

Place a **check mark** in the box. ORA will ask for a name for each new node

Click in the Visualizer to create a new node.

3.5 ADD LINKS IN VISUALIZER WITH LINK CREATOR

 The **Link Creator** button in the left toolbar. **NOTE :** [2] on The ORA Visualizer interface.

Select the **Network** from the dropdown menu to add a link.

Select the weight for new links created.

Click and hold on the **source node**.

Drag the mouse to the **target node**

Release the mouse to create a new link.

3.6 REMOVE NODES OR LINKS IN VISUALZER WITH LINK ERASER

 Click **Node/Link Eraser** is in the left toolbar. **NOTE :** [2] on The ORA Visualizer interface.

Removes node(s) and link(s) from the Visualizer display. Click on a **node or a link** to remove it from the display and Meta-Network.

If the **Permanently Delete** check box is empty ORA will remove the node(s) ro link(s) from the display only. The node(s) or links(s) will be retained in the Meta-Network.

If the **Permanently Delete** check box contains a check mark the node(s) or links(s) will be permanently deleted from the Meta-Network as well.

3.7 SHOW/HIDE VISUALIZER LABELS, LINKS, & ARROWS:

In the display various items can be shown or hidden. **NOTE :** [2] on The ORA Visualizer interface.

 Toggles the display to **show / hide** the node labels.

 Toggles the display to **show / hide** the links.

 Toggles the display to **show / hide** the node arrows.

3.8 CHANGE Nodeset COLOR:

You can change the color of an entire Nodeset in the Visualizer.

If the **Legend** is not visible, open it by selecting **Tools > Legend**.

Click on the color node for a Nodeset.

In the color selector dialog box select a new color.

Click [**OK**].

3.9 DATA REDUCTION STRATEGIES

At times the Visualizer display can be difficult to read. There are multiple ways to reduce unneeded information temporarily from the display.

3.9.1 HIDE ISOLATES

You can remove Isolates from the display without permanently removing them from the Meta-Network.

From the Visualizer menu select **Actions > Isolates > Hide Isolate Nodes**.

3.9.2 REMOVE ISOLATES

You can permantly remove Isolates from a Meta-Network in two ways:

From the Visualizer menu select **Actions > Delete Isolates > Delete Currently Visible Isolates**. This will remove from the Meta-Network only those nodes that are visible.

From the Visualizer menu select **Actions > Delete Isolates > Delete Underlying Isolates**. This will remove all Isolates from the Meta-Network.

3.9.3 HIDE PENDANTS

You can remove Pendants from the display without permanently removing them from the Meta-Network.

From the Visualizer menu select **Actions > Hide Pendant Nodes**.

3.10 ADD ICONS OR PICTURES

Nodes can be replaced by icons or pictures [50 x 50 pixel max] for easier identification.

Icons

Right-Click a node and select **Appearance Submenu > Set Picture**.

From the drop down menu select a category then click and highlight your icon.

Click [**OK**] when finished, The node will then display the icon

3.11 CHANGE SIZE/COLOR NODES BY METRIC

Node Appearance > Size Node by Attribute or Measure.

This will scale the size of all nodes by using the attribute or measure selected.

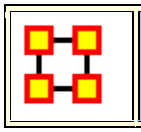
Numbers for each node value are user adjustable.

Node Appearance > Node Color > Color Node by Attribute or Measure

This will color all nodes by using the attribute or measure selected.

Colors for each node value is adjustable.

To reset color and size select **Node Appearance > Reset Node Color and Size**.



QuickStart Reports

4.0 REPORTS

Reports give you information about your Meta-Networks. These are the four most important reports. The other reports are more specialized.

Key Entity : Identifies key entities and groups who, by virtue of their position in the network, are critical to its operation.

> **Networks :** agent x agent, agent x knowledge, agent x resource, agent x task, agent x event, agent x location, all knowledge networks, any resource networks, task x event, task x task.

Standard Social Network Analysis : Calculates the standard network analysis measures.

> **Networks :** Any square Network [e.g., agent x agent].

Sphere of Influence : For each individual, identifies the set of actors, groups, knowledge, resources, etc. that influence, and are influenced, by that actor.

> **Networks :** agent x agent, agent x knowledge, agent x resource, agent x task, agent x location.

Locate Sub-Groups : Identifies the subgroups present in the network using various grouping algorithms. Most algorithms only work on a single network at a time.

> **Networks :** Networks selected by the user.

These reports are run from the Editor menu.

From the menu select **Analysis > Generate Report > [type in name of specific report]**.

In the searchbox at top type in the name of the report.

You can type in the entire name or select the report from the drop down menu.

Place a check mark next to the Meta-Networks to process and click [**Next >**].

Place a check mark next to the Nodesets and Networks to process. Click the box to remove unwanted check marks.

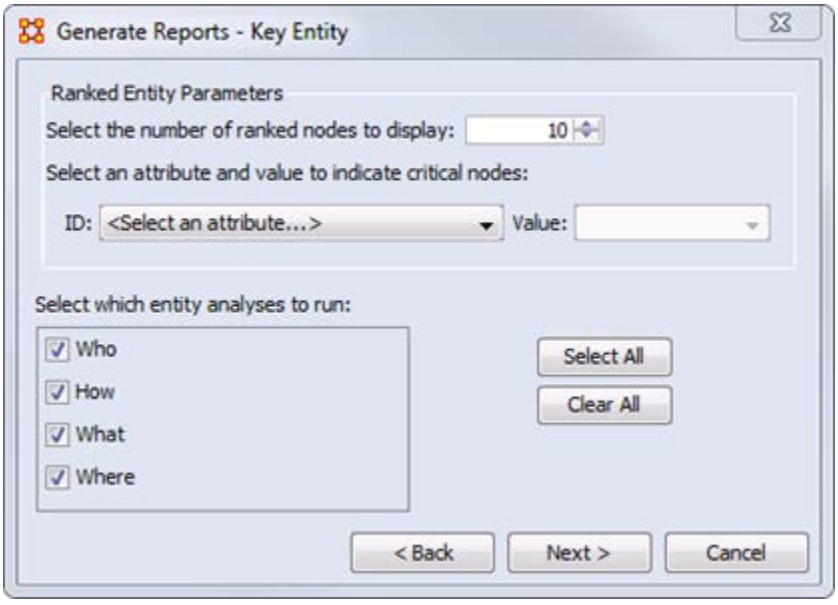
Select the number of nodes to display and click [**Next >**].

Select the location to save the files and the filename for the report and click [**Finish**].

The reports will open in the Report tab of the editor in a text format. They will also open your browser and display with animated graphics.

4.1 FOCUS ON ACTOR

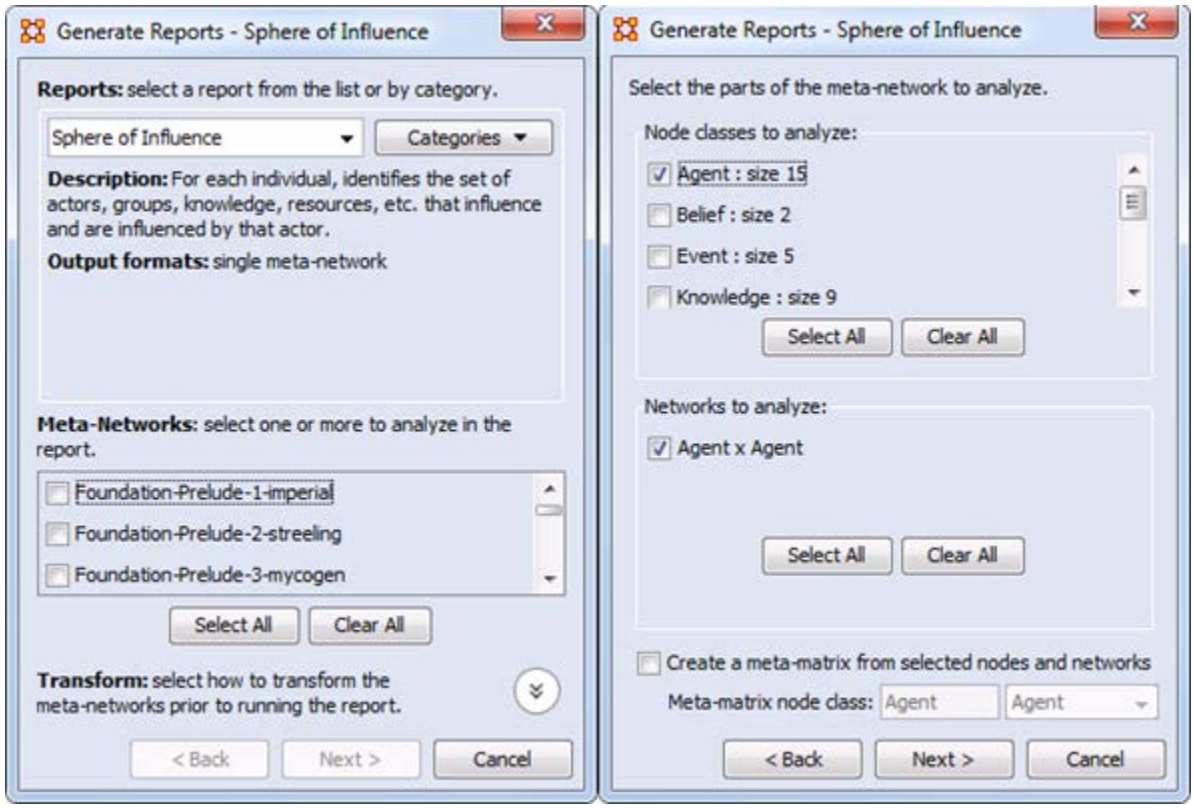
One item you need to discover is who is important in a Meta-Network. To obtain this information you can run the **Key Entity report**. Go to **Analysis > Generate Reports > Locate Key Entities > Key Entity**.



The report will ask you for the number of nodes to display and if you want to use a particular attribute in the calculation. But the most

important selection is the **Who, How, What, and Where**. When focusing on actors place a check mark in the **Who only**. By default the report lists the top 10. This can be changed when running the report.

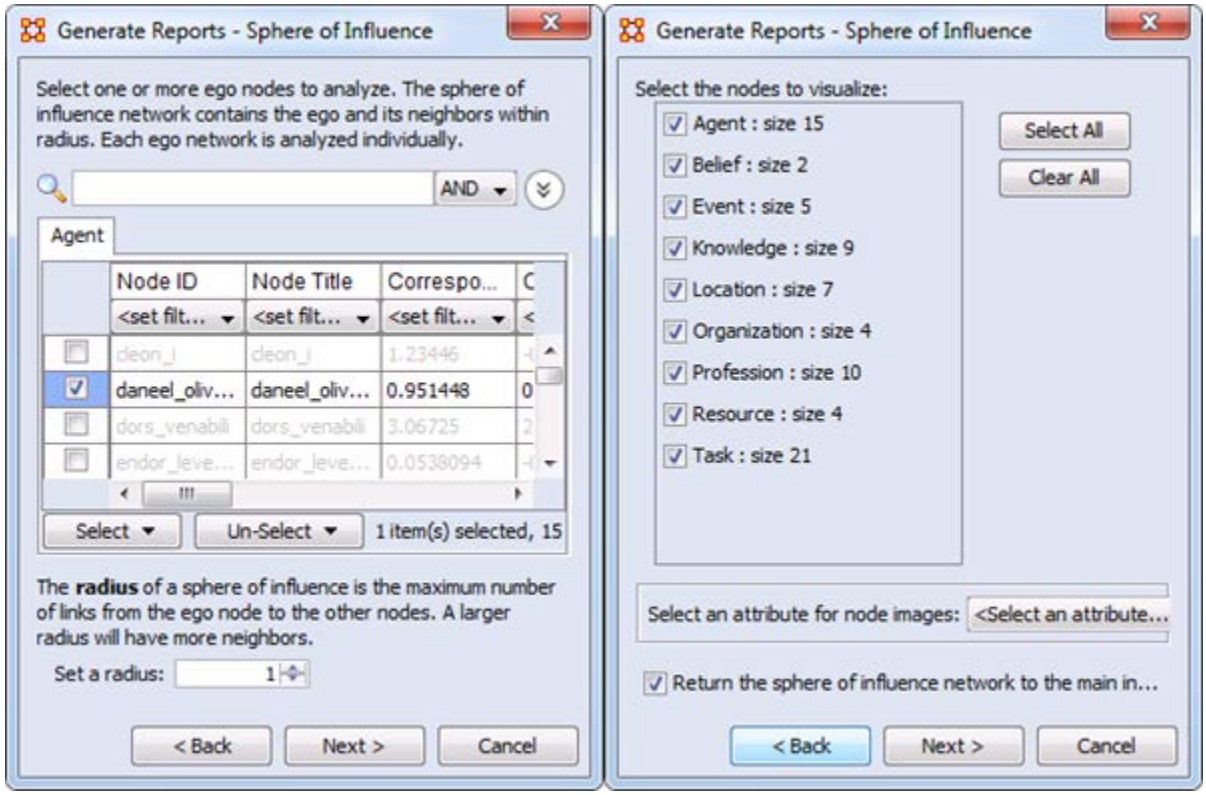
To find out how a particular person is connected run the **Analysis > Generate Reports > Locate Key Entities > Sphere of Influence** report.



Begin with placing a check mark next to one or more a Meta-Networks from the list. Then click [**Next >**].

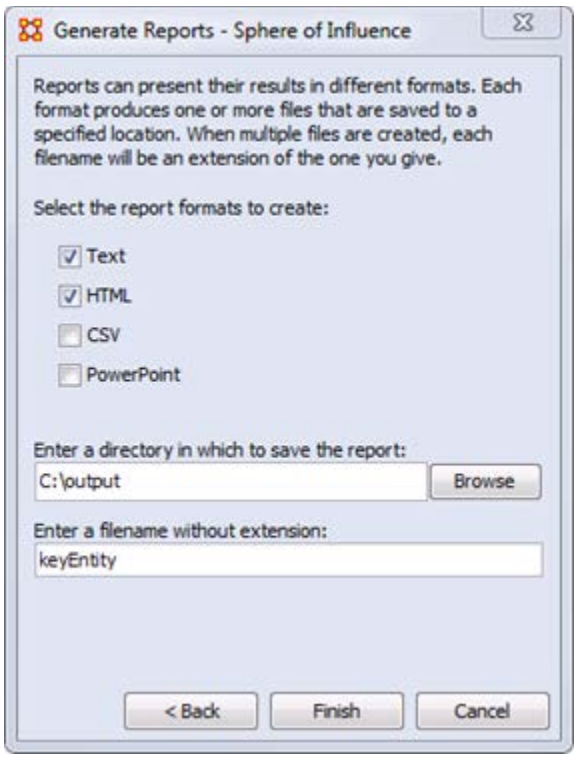
In the second window place a check mark next to the **Nodeset(s)** to analyze. In this case choose **Agent**.

All networks which contain any of the Nodesets selected appear in the bottom pane. Having only choosen **Agent** only the **Agent x Agent** Network appears. Place a check mark next to **Agent x Agent**. Then click [**Next >**].



Next place a check mark next to the agent(s) to track. Then click [**Next >**].

Finally place a check mark next to all the nodes to visualize. Then click [**Next >**].



The final screen allows you to choose where to sent the results. The two most common choices are: **Text** will display it in the **Report Tab** in ORA. **HTML** will open a file in your browser. The browser version is usually best for presentations as it contains more visual elements.

4.2 FOCUS ON REGION

In addition to finding out who the important agents are in a Meta-Network the Key Entity report can also show you the important locations.

As with **Focus on Actor** above the check mark should be placed in the **Where** box only.

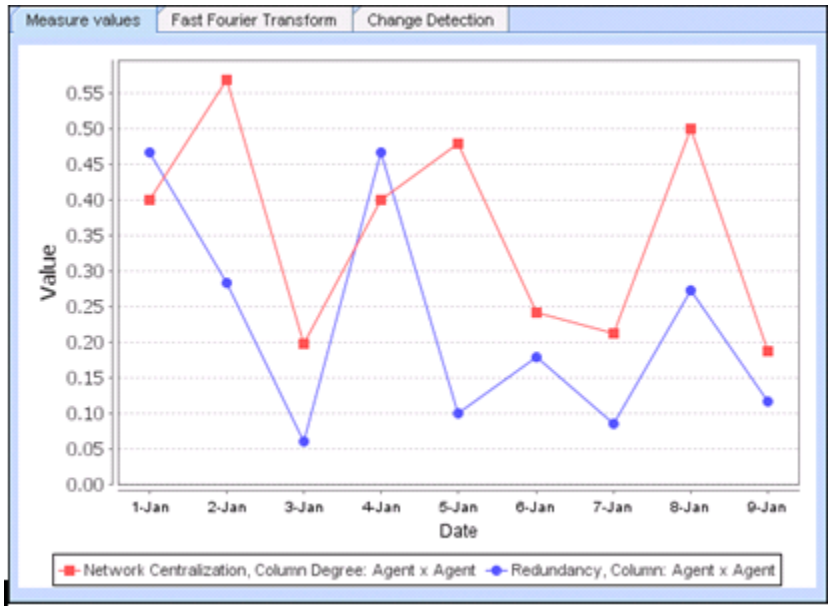
Once the key locations are discovered agents connected to that location can be analyzed. In time marked data it will also show **When** those agents were in those locations.

4.3 FOCUS ON TIME

In the Editor the **Measures Over Time** allows you to see how a network measures changes over multiple time periods.

This requires your data to have **time data**. Highlight a Meta-Network and in the Editor pane to **Date:**. If the area is blank your Meta-Network does not have time data and the function will not run. You can click the [**Click to create…**] button to assign a data to each time slice.

Below is an example of the type of display viewing two meaures over nine time periods.



Any Networks included in a Meta-Network can be displayed in the fashion.

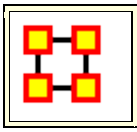
In the Visualizer the **View Networks Over Time** allow you to see how Networks change over the specified time periods.

Each Meta-Network included should contain nodes and networks named the same. This is necessary in order for ORA to assess how individual items have changed for each time period. If a node has a slightly different name then ORA will assume they are not the same node.

The animated sequence will display the selected networks for each Meta-Network.

This display is the normal Visualizer display.

Refer to the User's Guide for more information.



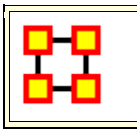
QuickStart Other

5.0 MEASURES

A measure is a function that takes as input a Meta-Network and outputs a single value or a vector of values. For more information on the measures see the User's Guide.

6.0 GEOSPATIAL, LOOM & TRAILS

These are advanced topics and you should refer to the ORA Users Guide for more information



QuickStart Information

7.0 ORA INFORMATION

7.1 CONTACT INFORMATION

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7.2 QUESTIONS, BUGS, AND COMMENTS

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7.3 COPYRIGHT NOTIFICATION

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General Content

These are pages for information on ORA which is general in nature and does not pertain to any particular ORA section.

1, 2, or n Mode Data

Actions vs Tasks vs Event

Beliefs

Change Format

Delimited Files

Dynamic Network

Fast Fourier Transform

Large Meta-Networks

Monte Carlo

Multiple Links in Imported Data

Network Basics

Ontology

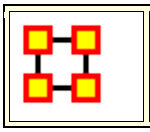
Parts of Speech

Reduced Form Network

Regression

Simulated Annealing

Synchronization



Multi-Mode Data

Ora can handle 1,2 or n mode data. A mode is a set of nodes, i.e., a Nodeset. Typical social network analysis handles one mode data (e.g. a people to people network). In this case, the metrics identify which node in the network are critical. The grouping algorithms cluster the nodes, (e.g., the people, into groups). Sometimes you have two mode data such as people by events, (e.g. the classic Southern Women Study [1]). In this case, you can ask questions like who was at the most events or what events were attended by most people to create two different one mode networks people to people and events to events. With these one mode networks you can again calculate all the standard metrics.

In ORA, however, there are additional special metrics such as redundancy, that can be calculated on two mode data.

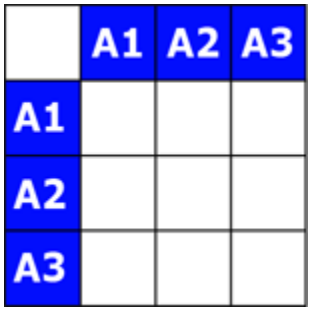
With N mode data, you can do all the above, and in ORA there are additional special metrics such as cognitive demand that calculate a nodes position based on multiple matrices.

In ORA, Nodesets can be cross indexed as being related to agents, organizations, locations, tasks, events, resources, knowledge, beliefs, roles. If you do this there are some additional metrics that rely on knowing what Nodesets you have that you can take advantage of (e.g., with locations you can run the locations reports).

In general, all metrics that run on agents also run on organizations and roles. For tasks and events - there are other special temporal metrics. All metrics that run on resources also run on knowledge and beliefs. The standard social network measures run on any square one mode network - however in ORA - some guidance is provided on how to interpret this based on the type of nodes.

One-Mode

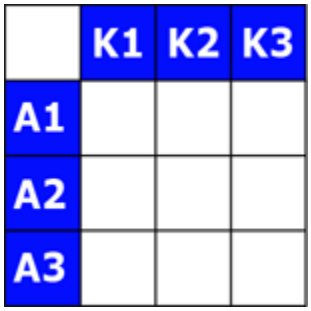
A One Mode dataset uses the same Nodeset as source and target such as an **Agent x Agent** network.



	A1	A2	A3
A1			
A2			
A3			

Two-Mode

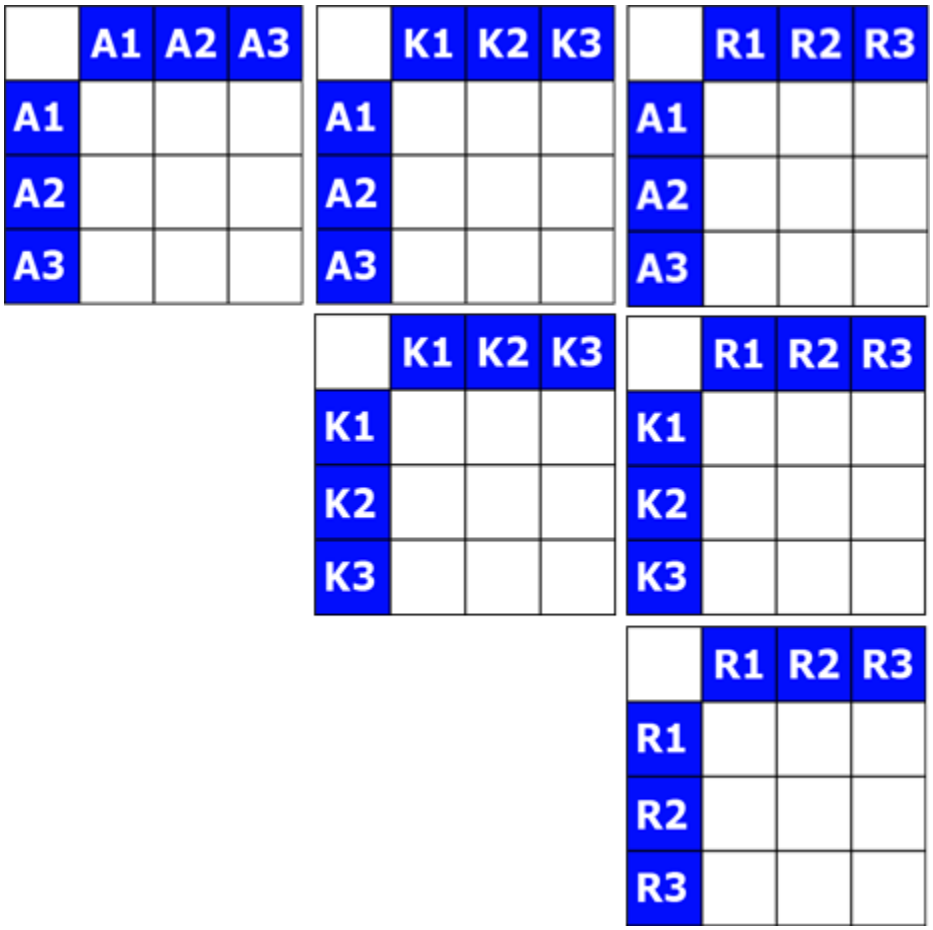
A Two Mode dataset uses two different Nodesets as source and target such as **Agent x Knowledge**.



	K1	K2	K3
A1			
A2			
A3			

Multi-Mode

An N Mode dataset uses multiple Nodesets set in multiple Networks and is represented as a DyNetML file. The example below consists of three Nodesets: Agent, Knowledge, Resource, etc. with subsequent Networks for each. The blanks are where the opposite Network would exist if needed [i.e. the knowledge x agent]. These are usually omited as the information already exists in the first Network. But they can be included if there is a need.



Measures and Their Modes

Measure	Mode
Access Redundancy	**Two-Mode**
Actual Workload	Multi-Mode
Agent Knowledge Needs Congruence	Multi-Mode
Agent Knowledge Waste Congruence	Multi-Mode
Agent Resource Needs Congruence	Multi-Mode
Agent Resource Waste Congruence	Multi-Mode
Agent Socio Economic Power	Multi-Mode
Assignment Redundancy	**Two-Mode**
Authority Centrality	**One-Mode**
Average Communication Speed	**One-Mode**
Betweenness Centrality	**One-Mode**
Betweenness Centrality Spatial	Multi-Mode
Betweenness Network Centralization	**One-Mode**
Biological Diversity Index	**One-Mode**
Bonacich Power Centrality	**One-Mode**
Burt Constraint	**One-Mode**
Burt Effective Network Size	**One-Mode**
Capacity	**Two-Mode**
Characteristic Path Length	**One-Mode**
Clique Count	**One-Mode**
Closeness Centrality	**One-Mode**
Closeness Centrality Spatial	Multi-Mode
Closeness Network Centralization	**One-Mode**
Clusterinf Coefficient	**One-Mode**
Cognitive Demand	Multi-Mode
Cognitive Distinctiveness	**Two-Mode**

Cognitive Expertise	**Two-Mode**
Cognitive Resemblance	**Two-Mode**
Cognitive Similarity	**Two-Mode**
Column Breadth	**Two-Mode**
Column Count	**Two-Mode**
Column Degree Centrality	**Two-Mode**
Column Degree Network Centralization	**Two-Mode**
Column Redundancy	**Two-Mode**
Commmunication	Multi-Mode
Communication Congruence	Multi-Mode
Communicative Need	**One-Mode**
Complexity	Multi-Mode
Connectedness	**One-Mode**
Correlation Expertise	**Two-Mode**
Correlation Distinctiveness	**Two-Mode**
Correlation Resemblance	**Two-Mode**
Correlation Similarity	**Two-Mode**
Degree Centrality Spatial	Multi-Mode
Density	**Two-Mode**
Density Classic SNA	**One-Mode**
Diameter	**One-Mode**
Diffusion	**One-Mode**
Edge Betweenness Centrality	**One-Mode**
Efficiency	**One-Mode**
Eigenvector Centrality	**One-Mode**
Eigenvector Centrality Spatial	Multi-Mode
Exclusivity	**Two-Mode**
Exclusivity Complete	**Two-Mode**
Fragmentation	**One-Mode**

Geodesic Distance	**One-Mode**
Global Efficiency	**One-Mode**
Hierarchy	**One-Mode**
Hub Centrality	**One-Mode**
In-Degree Centrality	**Two-Mode**
In-Degree Network Centralization	**Two-Mode**
Information Centrality	**One-Mode**
Interdependance	**One-Mode**
Interlockers	**One-Mode**
Inverse Closenness Centrality	**One-Mode**
Isolate Count	**One-Mode**
Knowledge Actual Workload	Multi-Mode
Knowledge Based Access Index	**Two-Mode**
Knowledge Task Completion	Multi-Mode
Knowledge Diversity	**Two-Mode**
Knowledge Exclusivity	**Two-Mode**
Knowledge Load	**Two-Mode**
Knowledge Negogiation	Multi-Mode
Knowledge Omega	Multi-Mode
Knowledge Potential Workload	Multi-Mode
Knowledge Redundancy	**Two-Mode**
Knowledge Under Supply	Multi-Mode
Lateral Link Count	**One-Mode**
Link Count	**Two-Mode**
Local Efficiency	**One-Mode**
Location Relevance	Multi-Mode
Minimum Speed	**One-Mode**
Network Levels	**One-Mode**
Node Count	One-Mode

Node Levels	One-Mode
Organization Agent Knowledge Needs Congruence	Multi-Mode
Organization Agent Knowledge Waste Congruence	Multi-Mode
Organization Agent Resource Needs Congruence	Multi-Mode
Organization Agent Resource Waste Congruence	Multi-Mode
Organization Task Knowledge Needs Congruence	Multi-Mode
Organization Task Knowledge Waste Congruence	Multi-Mode
Organization Task Resource Needs Congruence	Multi-Mode
Organization Task Resource Needs Congruence	Multi-Mode
Organizational Availability	Multi-Mode
Out-Degree Centrality	**Two-Mode**
Out-Degree Network Centralization	**Two-Mode**
Overall Role Based Availability	Multi-Mode
Overall Task Completion	Multi-Mode
Performance as Accuracy	Multi-Mode
Personnel Cost	Multi-Mode
Pooled Link Count	**One-Mode**
Potential Boundary Spanner	**One-Mode**
Potential Workload	Multi-Mode
Radials	**One-Mode**
Reciprocal Link Count	**One-Mode**
Relative Cognitive Dinstinctiveness	**Two-Mode**
Relative Cognitive Expertise	**Two-Mode**
Relative Cognitive Resemblance	**Two-Mode**
Relative Cognitive Similarity	**Two-Mode**
Relative Expertise	**Two-Mode**
Relative Similarity	**Two-Mode**
Resource Actual Workload	Multi-Mode
Resource Based Access Index	**Two-Mode**

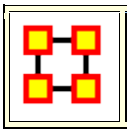
Resource Based Task Completion	Multi-Mode
Resource Diversity	**Two-Mode**
Resource Exclusivity	**Two-Mode**
Resource Load	**Two-Mode**
Resource Negogiation	Multi-Mode
Resource Omega	Multi-Mode
Resource Potential Workload	Multi-Mode
Resource Redundancy	**Two-Mode**
Resource Under Supply	Multi-Mode
Role Based Knowledge Availability	Multi-Mode
Role Based Resource Availability	Multi-Mode
Role Based Knowledge	Multi-Mode
Role Resource Availability	Multi-Mode
Row Breadth	**Two-Mode**
Row Count	**Two-Mode**
Row Degree Centrality	**Two-Mode**
Row Degree Network Centralization	**Two-Mode**
Row Redundancy	**Two-Mode**
Sequential Link Count	**One-Mode**
Shared Situation Awareness	Multi-Mode
Simmelian Ties	**One-Mode**
Skip Link Count	**One-Mode**
Social Technical Congruence	Multi-Mode
Span of Control	**One-Mode**
Strict Knowledge Congruence	Multi-Mode
Strict Resource Congruence	Multi-Mode
Strong Component Count	**One-Mode**
Task Exclusivity	**Two-Mode**
Task Knowledge Needs Congruence	Multi-Mode

Task Knowledge Waste Congruence	Multi-Mode
Task Resource Needs Congruence	Multi-Mode
Task Resource Waste Congruence	Multi-Mode
Total Degree Centrality	**One-Mode**
Total Degree Network Centralization	**One-Mode**
Triad Count	**One-Mode**
Transivity	**One-Mode**
Upper Boundedness	**One-Mode**
Weak Boundary Spanner	**One-Mode**
Weak Component Count	**One-Mode**
Weak Component Memebers	**One-Mode**

References

[1] Davis, A et al. (1941). Deep South. Chicago: University of Chicago Press.

[1] Breiger R. (1974). The duality of persons and groups. Social Forces, 53, 181-190.



Actions, Tasks, and Event

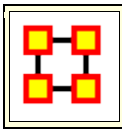
There are three Node Classes in ORA where you can depict what a particular node might be doing. They might seem a little confusing at first. Below are basic explanations of the three. But depending on your situation you may find it necessary to alter the definitions to suit your needs.

Action : Small activities, e.g. the employee makes coffee.

Task : Designed activities, e.g. it is part of the job description of the employee to make coffee.

Event : One time happening, e.g. the employer made coffee on December 12th, 2011.

These definitions are not set in stone but they can be used as a good starting point for your Meta-Network.



Aggregation

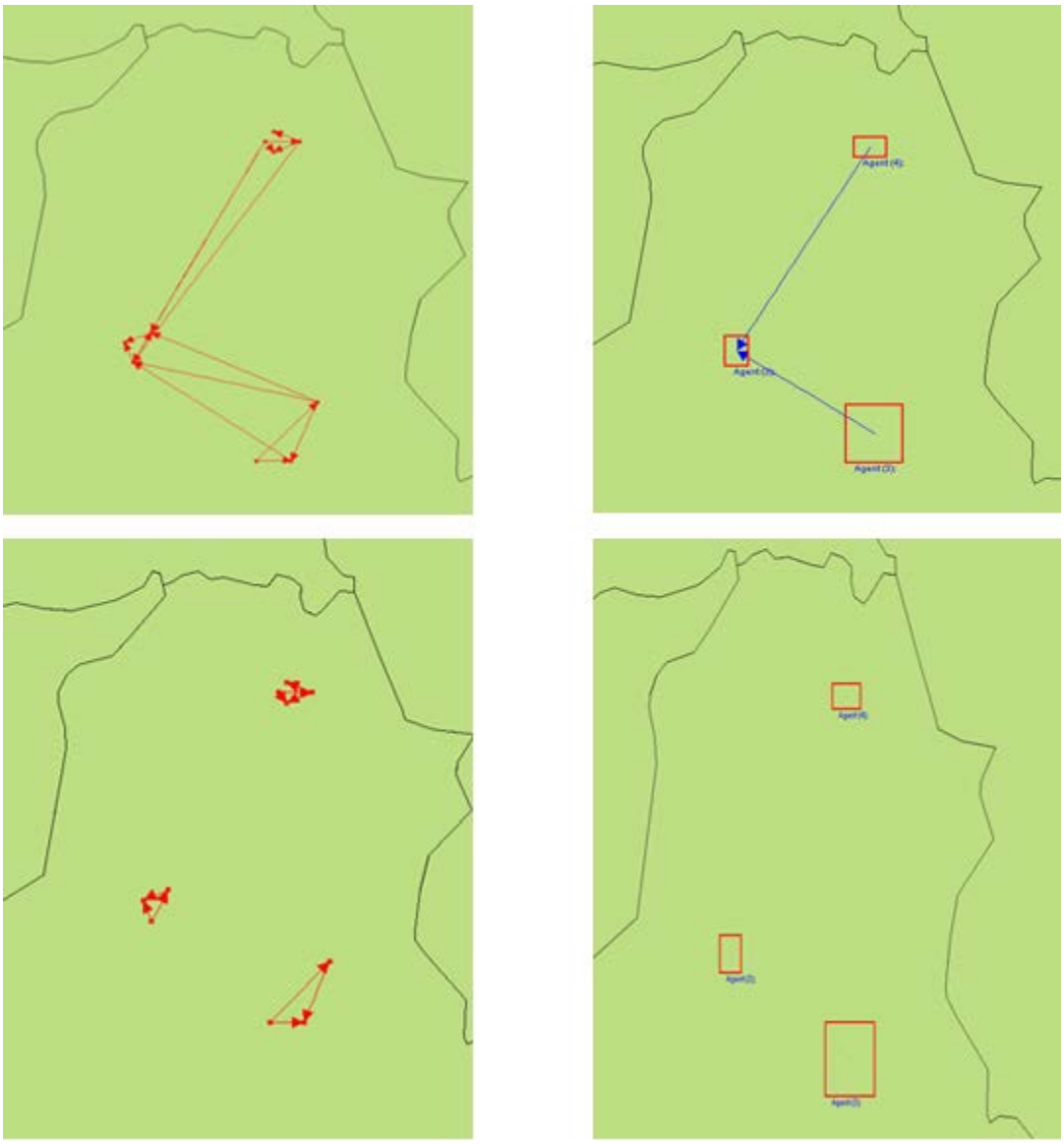
Space is continuous and distances can be arbitrarily large or small. Networks can contains relations between discrete entities or vast neighborhoods. Space, like time, can be discretized to produce networks, but you can't forget about it.

Consider a scientific collaboration network. It could be aggregated by the researchers in each city. But there no way to distinguish between the researchers at individual universities in Pittsburgh. You could have collaborations of Pitt-CMU, Pitt-Pitt, and CMU-CMU. Then there are collaboration between Pittsburgh researchers and Boston researchers. Again, which university might it be.

NOTE : You need to remember that in aggregation, order doesn't matter. All events happen more or less at the same time.

Aggregation Issues

You need to disconnect between space and networks. Locations are continuous. Networks are defined between discrete entities. Are two locations ten meters apart the same location?



Aggregation Can Lose Information

Original Dataset

2	5	6	2
3	5	5	1
4	5	2	3
7	4	1	2

Some Information Loss

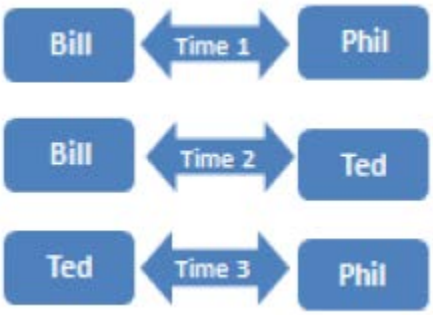
2.5	5.0	5.5	1.5
5.5	4.5	1.5	2.5

Extreme Information Loss

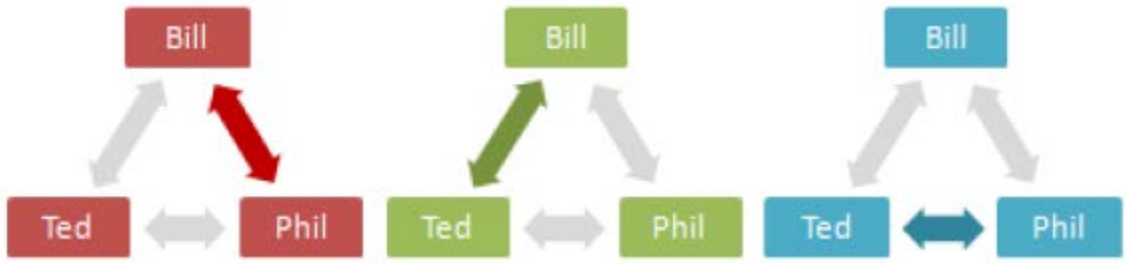
4.0	4.75	3.5	2.0

What To Do?

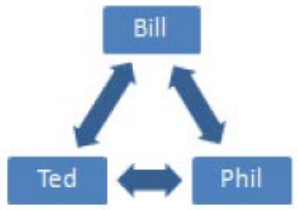
You can explore many different aggregations or quantify the risk of false conclusions. But how much information is not being shown? Is there information entropy from Information Theory. The example below contains links occurring in three separate time periods [top image].



Below shows these links in a network over time.

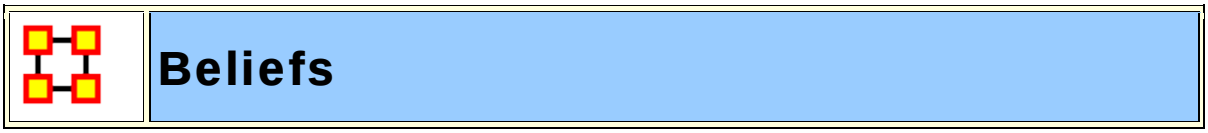


Aggregated, all three people appear to have links to each other simultanously.



Before aggregation, the sequence of actions is clear, but not the overall connections. After aggregation, the total network is clear, but it's unclear when these things happen.

NOTE : Aggregation works well with information that is not time sensitive. Total links rather than the sequence of events.



Belief Diffusion is the change in beliefs of actors in a social group over time. Beliefs cannot be evaluated for truth. Knowledge can contribute to or deny a belief.

Example 1

Belief : Cats are better house-pets for a family than dogs.

> **Supporting Evidence :** Cats tend to live longer than most breeds of dog.
>
> **Contrary Evidence :** Most cats must have explicit socialization training early if they are going to be as affectionate as most breeds of dogs.

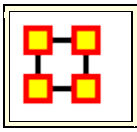
Example 2

Fact 1 : Cats damage furniture.

Fact 2 : Cats are passive aggressive.

Fact 3 : Cats leave trophies.

=> I don't want a cat!



Change Format

Description

NOTE : The first thing to remember is the Change List is for modifying Nodes, not Links.

The **Change Format** is used when you want to:

Delete : Remove a node entirely from the Nodeset.

Split : Split a concept into two or more new concepts. i.e., laptop_computer could be split into two concepts: **laptop** and **computer**. The original concept would remain unaffected

Add : Create a new node in a Nodeset.

Merge : Take the information from two separate nodes and combine it into one node. Used to clean up nodes with similar, but not exact, names.

Move : Move a node from one Nodeset to another.

The Columns

Action : Dictates the action to take on the row. Includes **delete** remove a node from a Nodeset, **split** create multiple entries from one node, **add** create a new node in a Nodeset, and **merge** combine node names into a single entity.

Total Degree :

Frequency : Number of occurrances of a concept.

TF-IDF : Reflects how important a word is to a document in a collection or corpus.

Current Node Name : Contains the text as it appears in the original node.

New Node Name : Contains the text you want to use as a replacement for the text in the **Current Node Name** column. If the New Node Name is blank that means that it remains the same as the Old Node Name.

Current Node Class : Contains the class as it appears in the original node.

New Node Class : Contains the class you want to use as a replacement.

Current Nodeset Name : Contains the **Nodeset Name** as it appears in the original node.

New Nodeset Name : Contains the **Nodeset Name** you want to use as a replacement.

Current Node Type : Used to denote whether the concept is **specific** item [i.e. President Obama] or a **generic** item [i.e. American] or leave blank.

New Node Type : Allows the user to change the Node Type of a node

NOTE : ONLY agent, organization, location, event can have a type.

Generic and Specific Type

The generic and specific are the two allowed Node Type values. They provide the users with some additional information on whether this is a universal or general concept or a specific concept. The difference between Specific and Generic can be simply put as the difference between **a and the**.

Specific : Concepts which reference a specific agent, location or organization. For example: John Doe is a specific agent, CASOS is a specific organization, and USA is a specific location.

Generic : concepts which are universal and do not point to a specific agent, location or an organization. For example: man is a generic agent, health fund organization is a generic organization, and my room is a generic location.

Where To Use This File

This file is used in the **Data Management > Meta-Network Clean...** function.

New Change List Support

Integration of ORA and Automap formats are improved by use of the Change Format. Deleting, Merging, and Moving nodes is greatly simplified. ORA and Automap both use this format.

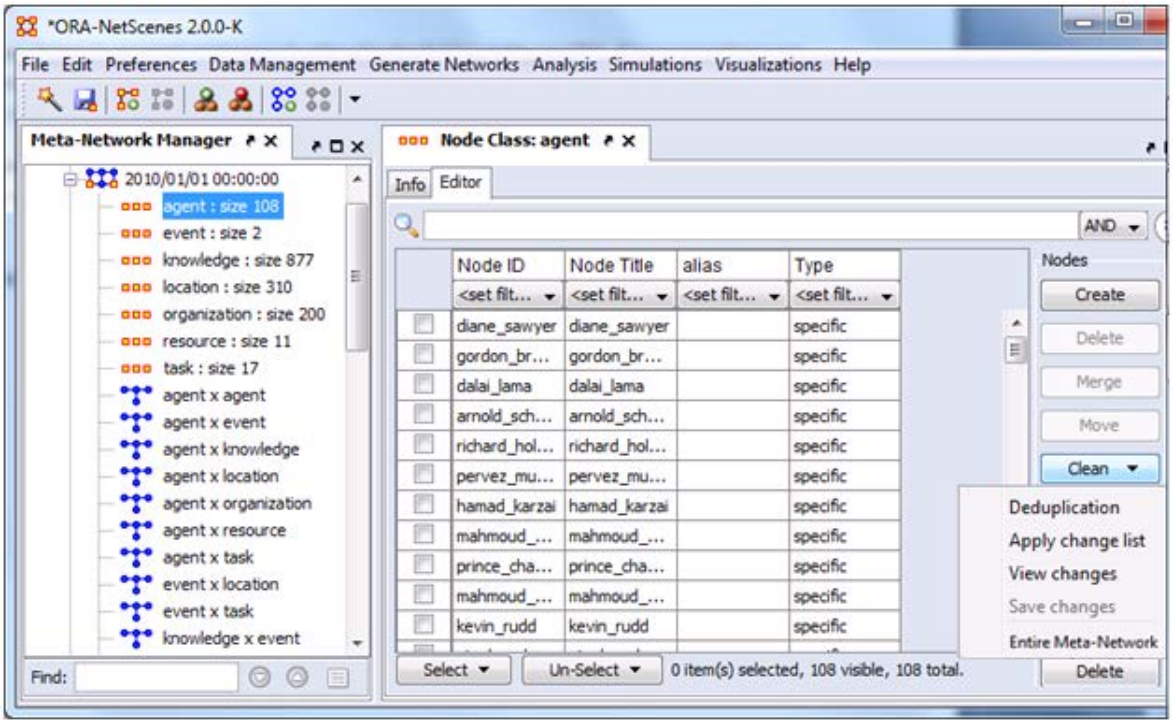
How Is It Used?

When nodes are deleted, merged, and moved within the Node Editor in ORA, these operations are recorded internally in a Change List that can then be exported. Also, existing change lists can be loaded and applied to the Node Class within the editor.

There is one change list per meta-ontology. For example, editing the **Agent : Friends** Node Class will modify the change list for the Meta-Ontology Agent. If you move to another meta-network and edit its **Agent : Enemy** Node Class, then it will also modify the Agent change list. You need to manually clear the change list, as otherwise the changes are just accumulated.

Here is the support in the GUI:

Select a meta-network, expand it in the Meta-Network pane, select a Nodeset, and click on the Clean dropdown arrow:



These are the different options:

Deduplication : Opens a dialog that has existed for a while and that lets one find nodes that are duplicates based on the similarity of their IDs or Titles. The nodes can then be easily merged.

Apply change list : Prompts for a change list file and applies it to the Node Class.

View changes : View the record of the node Merge, Move, Delete operations performed to the current meta-ontology. From within this dialog, one can clear the list.

Save changes : Exports the current changes to the Change List format, and this can then be used in Automap or applied later in ORA.

Entire Meta-Network : Opens up the **Text Analysis Cleaner** and allows you to work on the whole Meta-Network.

NOTE : The Delete, Merge, and Move buttons have been made simple buttons. These otherwise have not been changed.

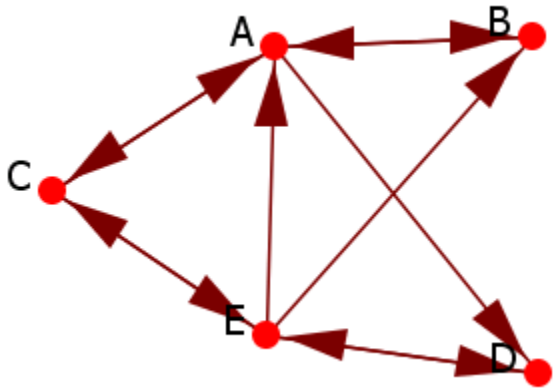
You can think of the Change List as simply a log of the operations performed on the Node Class during the ORA session.

Correlation

Correlation can be found in the **QAP / MRQAP Analysis** report.

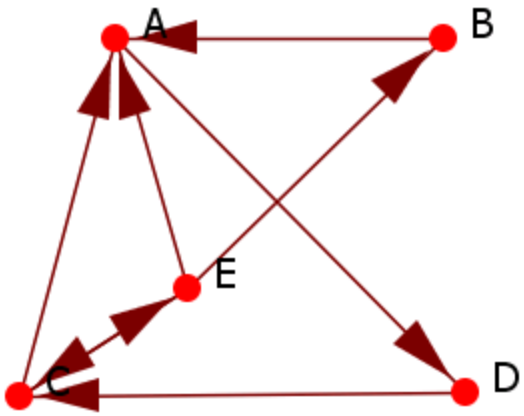
Below are two networks which contain the same nodes but different links. Correlation wshows what needs to be changed to go from one network to the other. Then the **mean** and the **standard deviation** will be presented.

Network 1



	A	B	C	D	E
A	0	1	1	1	0
B	1	0	0	0	0
C	1	0	0	0	1
D	0	0	0	0	1
E	1	1	1	1	0

Network 2



	A	B	C	D	E
A	0	0	0	1	0
B	1	0	0	0	0
C	1	0	0	0	1
D	0	0	1	0	0
E	1	1	1	0	0

String

Both networks are converted into strings. The table shows the differences between the two strings.

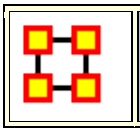
0**11**10100001000100**0**0**1**111**1**0

0**00**10100001000100**1**0**0**111**0**0

Calculation

The report will give the results for their differences.

Mean	Std. Dev.	Correlation
0.44	0.51	0.60
0.32	0.48	



Cube Analysis

Cube Analysis of communicative power: Concept Embedding

Communication depends on asking questions about how different people use words. It is a way of locating Common Ground.

- Do people use same words
- Do people use same words in same way
- Do people evoke the same concepts
- Do people link the same concepts in the same way
- Are the same disciplines employed
- Are the same journals, trade magazines, etc. read

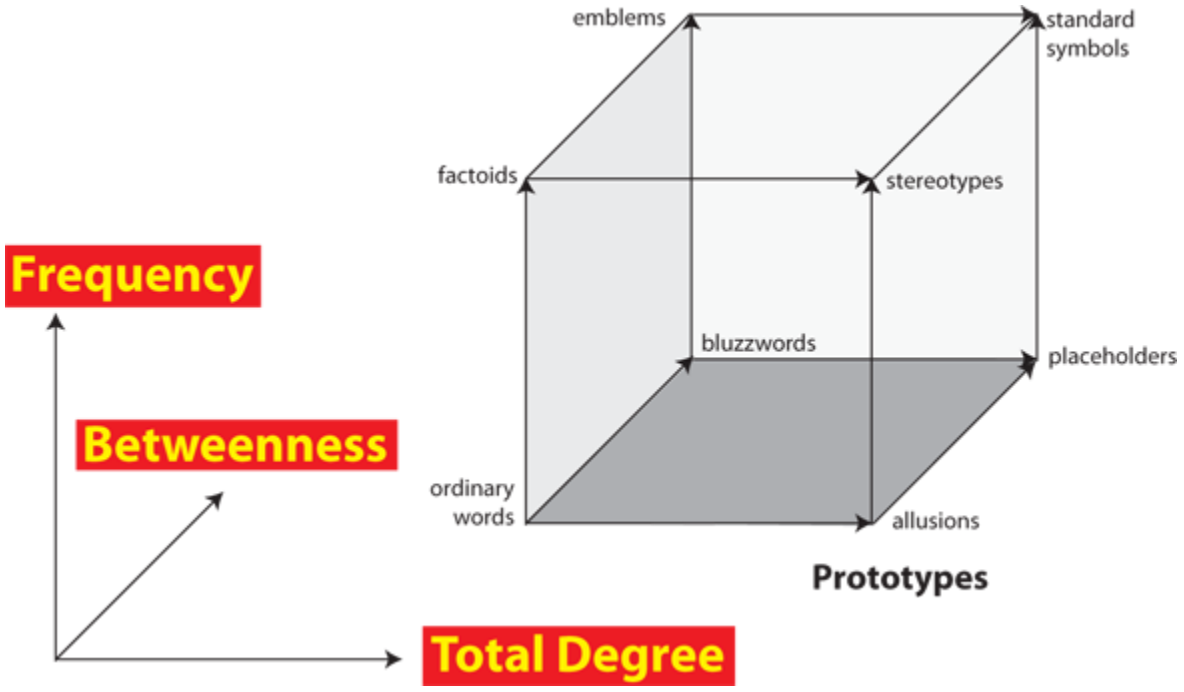
Three key communicative dimensions.

Intensity/consensus : Weighted degree or number of graphs of individual's mental models or number of reports the tie is present in.

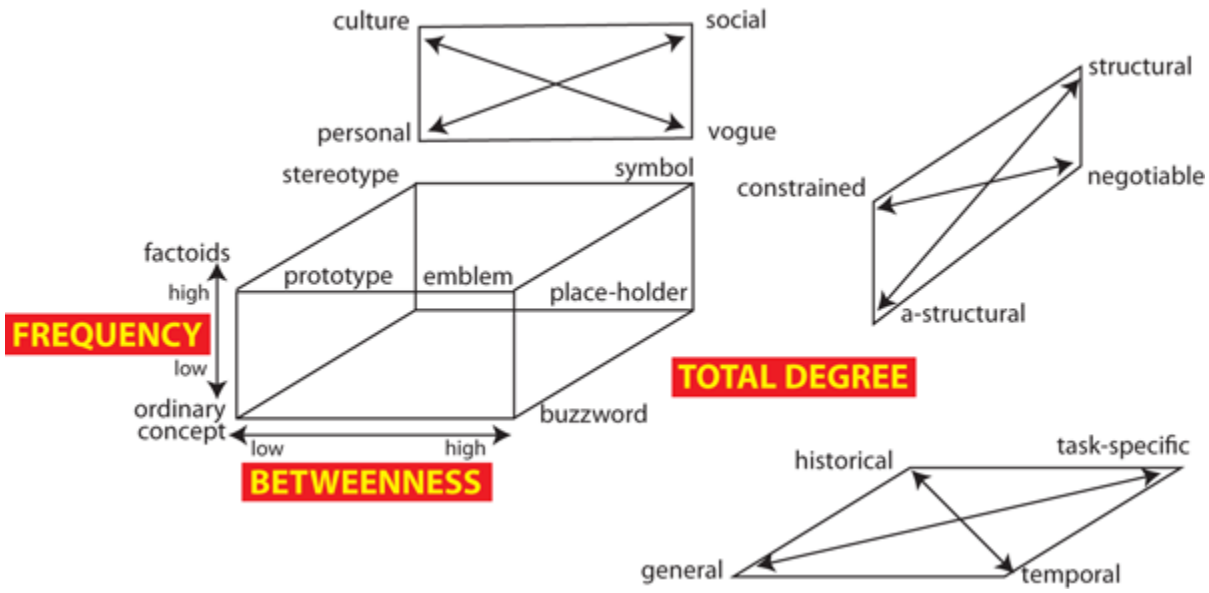
Conductivity : in-degree*out-degree or betweenness

Density : degree

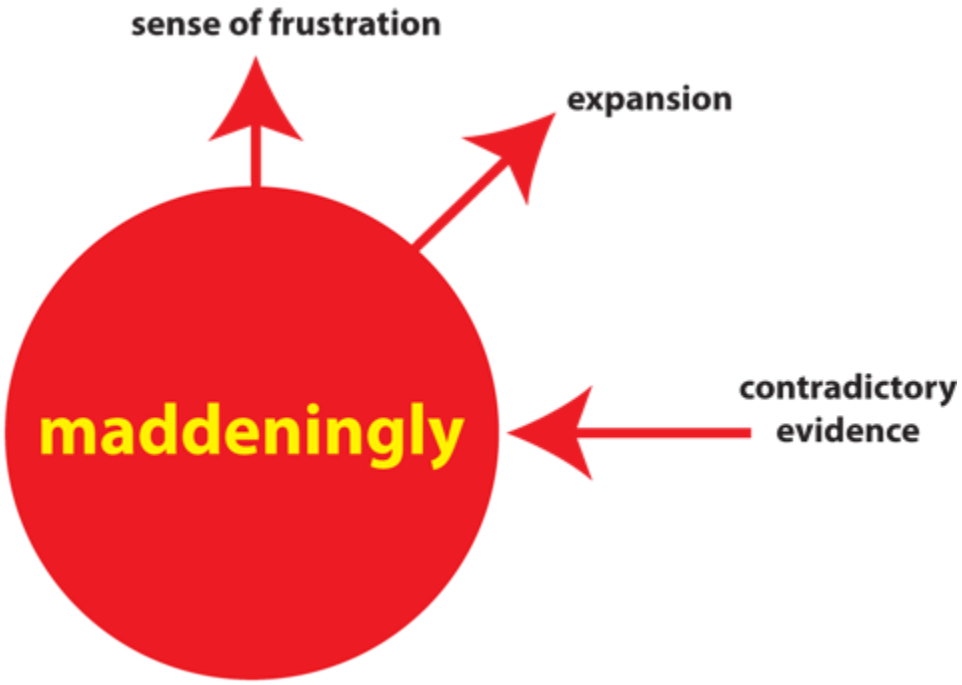
Most words will be low on all three dimensions. Words that stand out on any one dimension will have extra communicative power. Messages containing such words will be more persuasive.



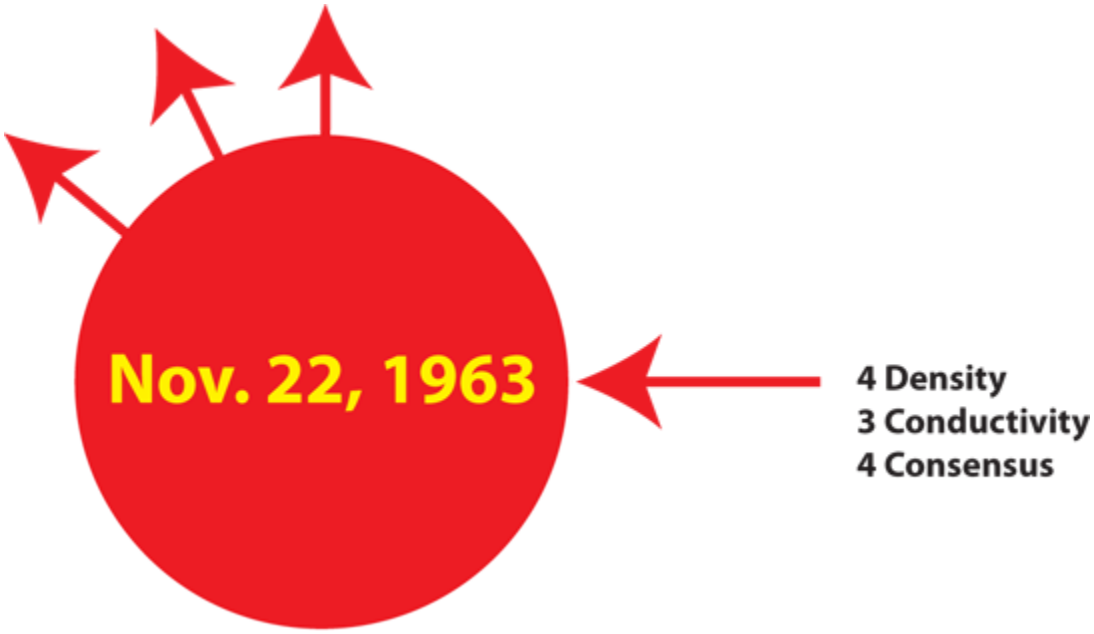
The Cube



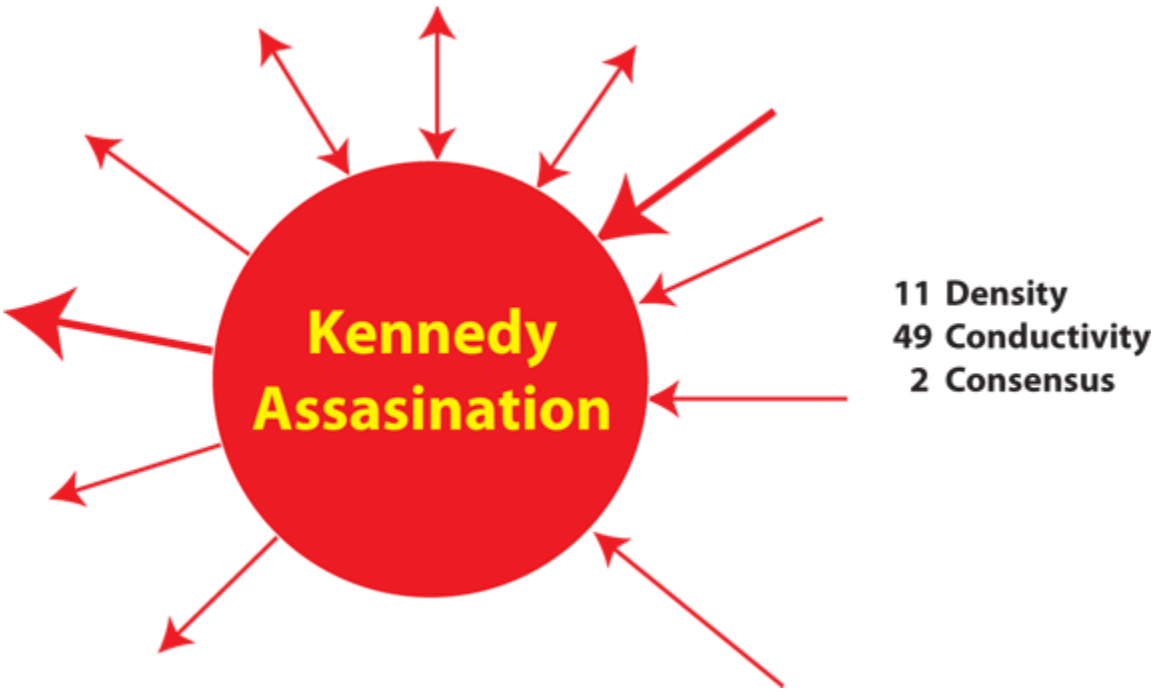
General: Ordinary Word



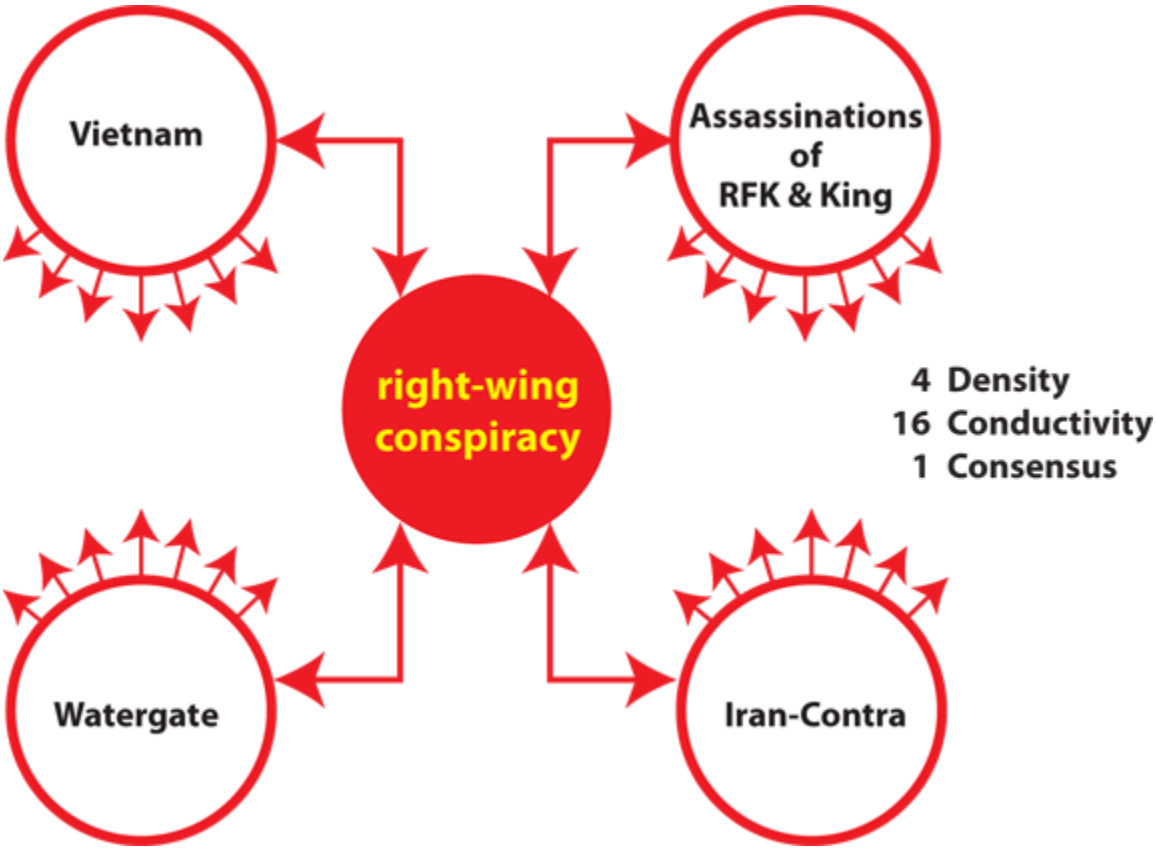
Factoid



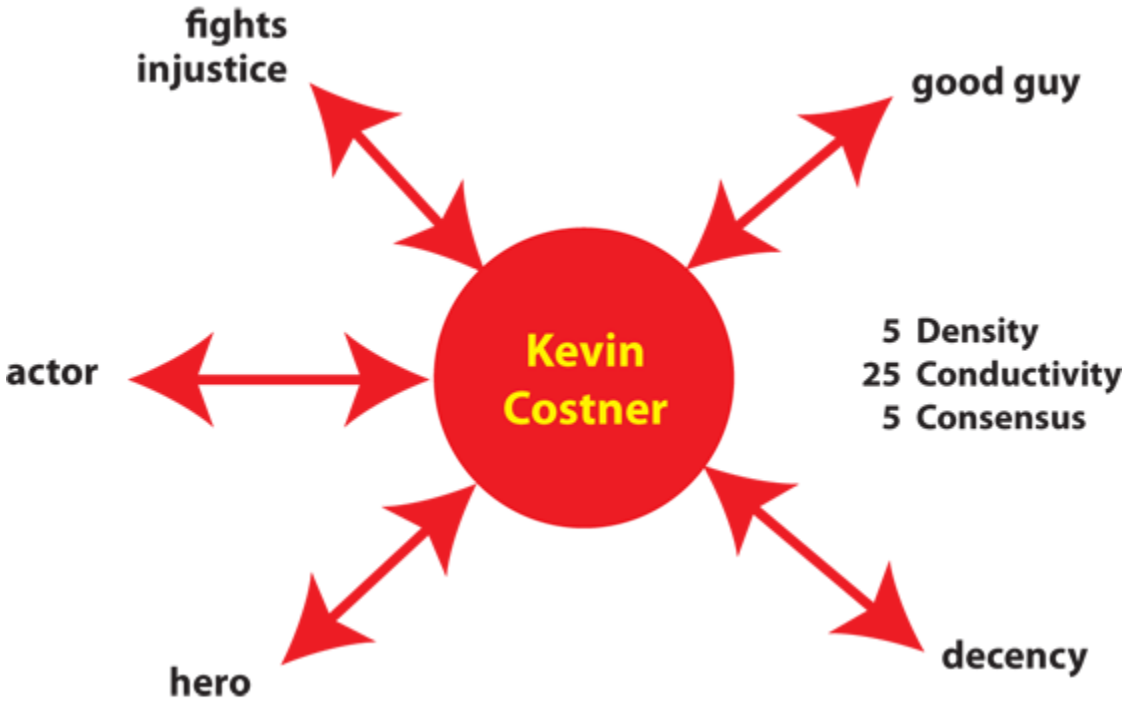
Placeholder


Kennedy
Assasination
11 Density
49 Conductivity
2 Consensus

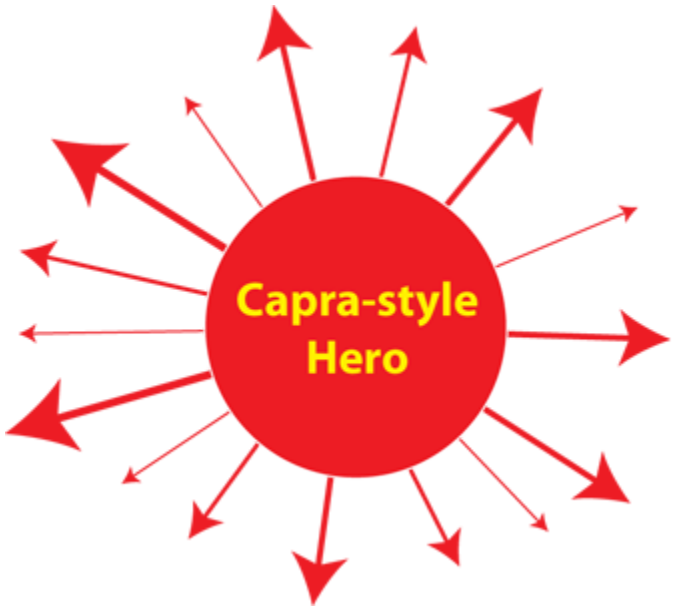
Buzzword


Vietnam
Assassinations
of
RFK & King
right-wing
conspiracy
4 Density
16 Conductivity
1 Consensus
Watergate
Iran-Contra

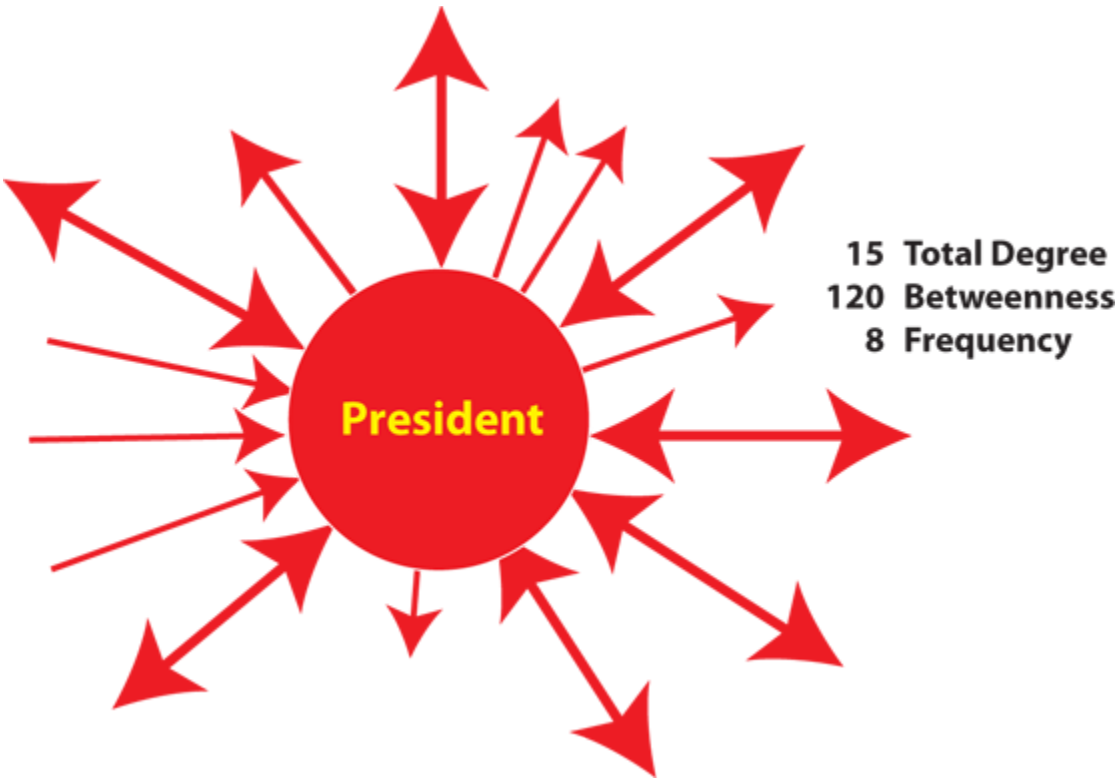
Emblem



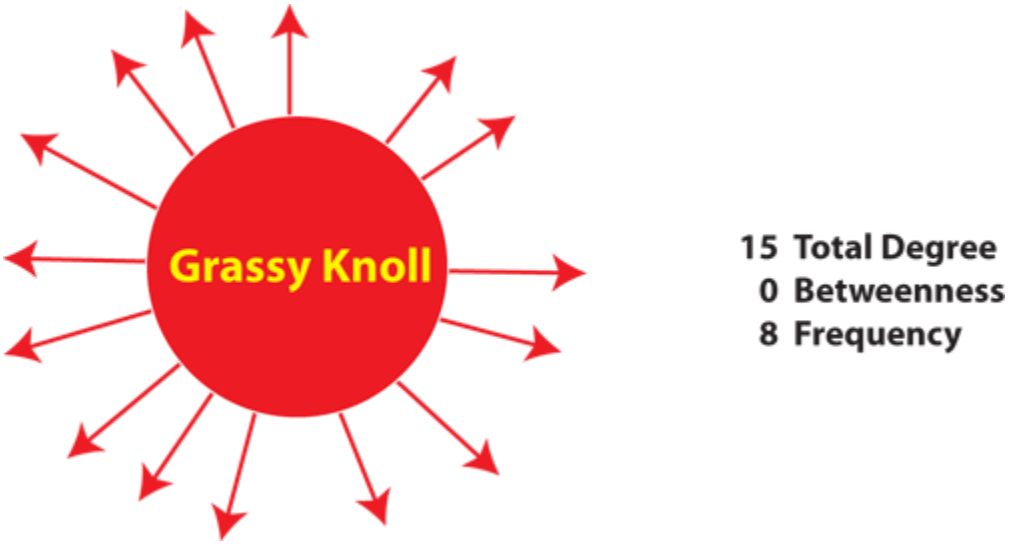
Stereotype



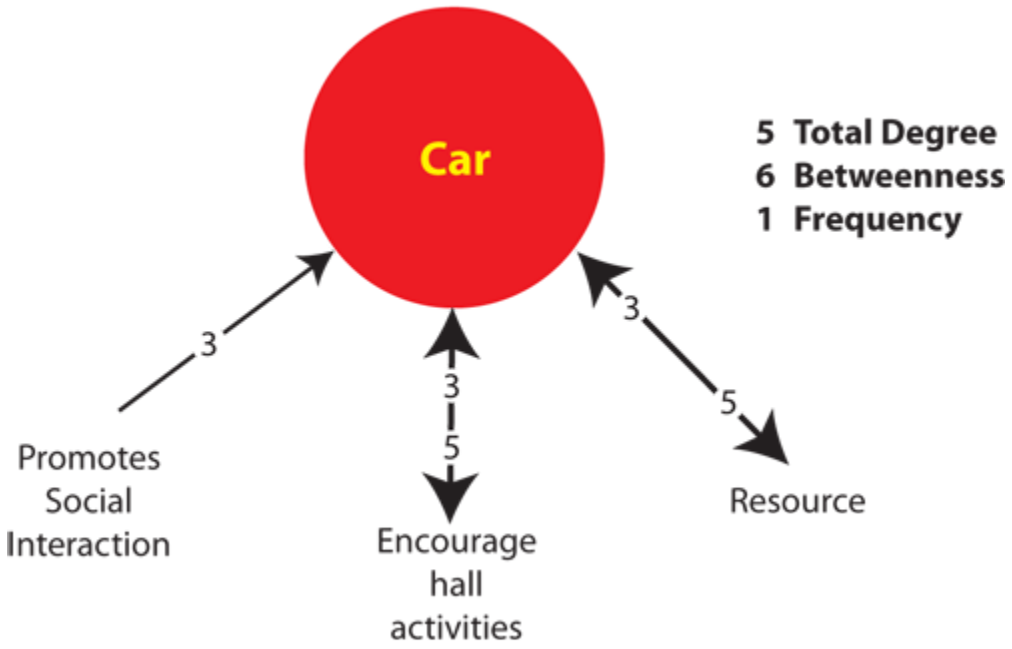
Standard Symbol



Allusion



Illustrative Concept



Summary of Cube Analysis

- Texts can be coded as networks
- Networks represent the mental model
- Coding texts as mental models focuses on meaning
- Concepts have position in texts
- Examining positions focuses on communicative power

Delimited Files

Excel, when reading in a flat file (i.e. txt or .csv), is sensitive to the kind of delimiter used. In the American version of excel, it assumes that a comma or tab is used to separate columns. In other versions, it often assumes that a semicolon or tab is used to separate columns. This is because in many other languages the comma is used as a period in showing the price of items.

AutoMap and ORA export data as comma separated and can import comma separated. This means if you are reading into or reading from a non-American version of excel you may have problems.

Reading in the.csv file into Excel that uses something other than commas will cause the data to appear as a set of text in column A. There are two ways to fix this.

NOTE : And if you data contains commas change to another character before changing the delimiting characters to commas.

First read the file into a text editor and globally change all the delimiting characters to commas.

Second read the file into excel and use the **Text to Columns** function and use a different delimiter.

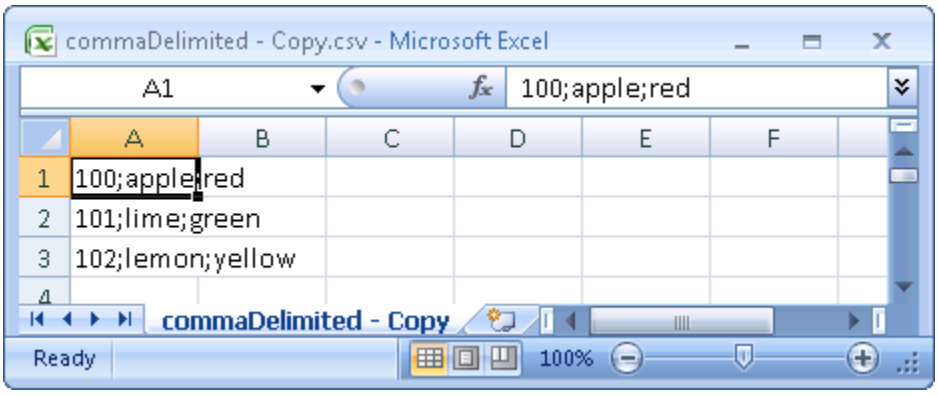
Excel Example

Let's start with a simple three line file using semicolons as delimiters.

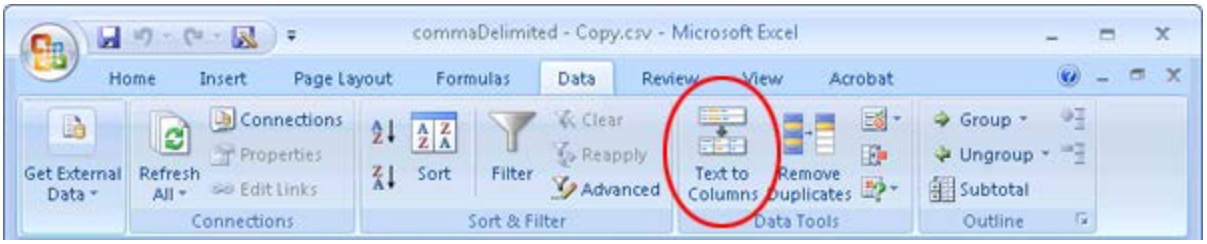
NOTE : Remember, data can be separated with a variety of characters. This procedure allows you to import data with any of them.

```
100;apple;red
101;lime;green
102;lemon;yellow
```

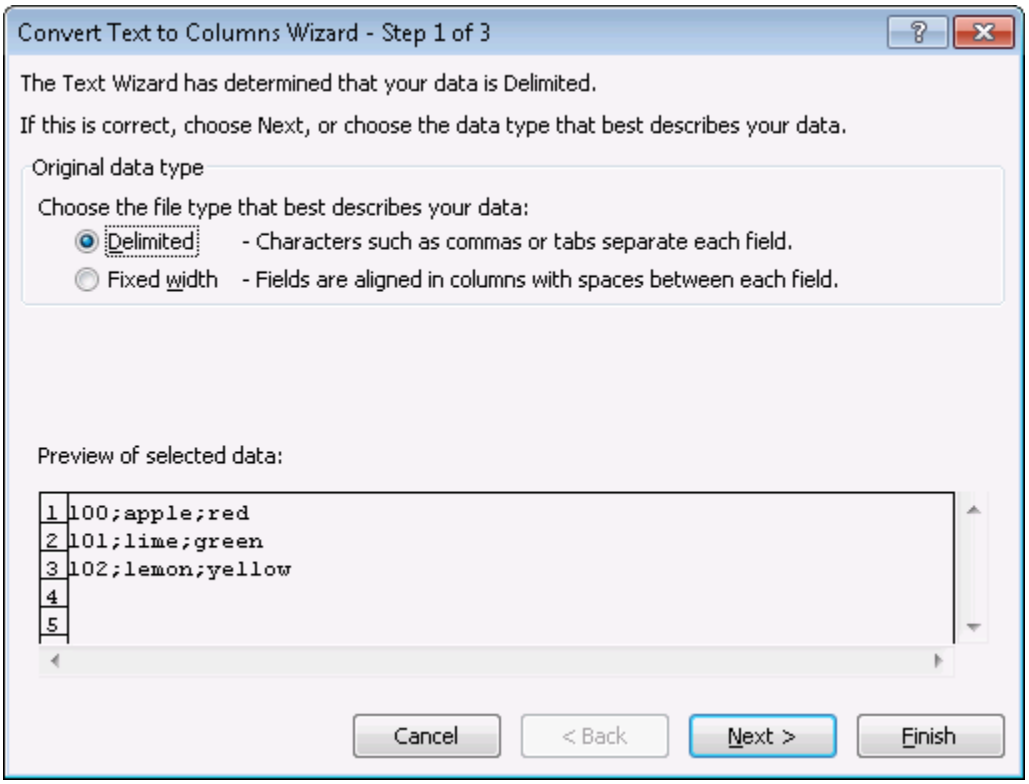
Opening this file in Excel will place each line of text into a single cell. You need to separate this into individual columns.



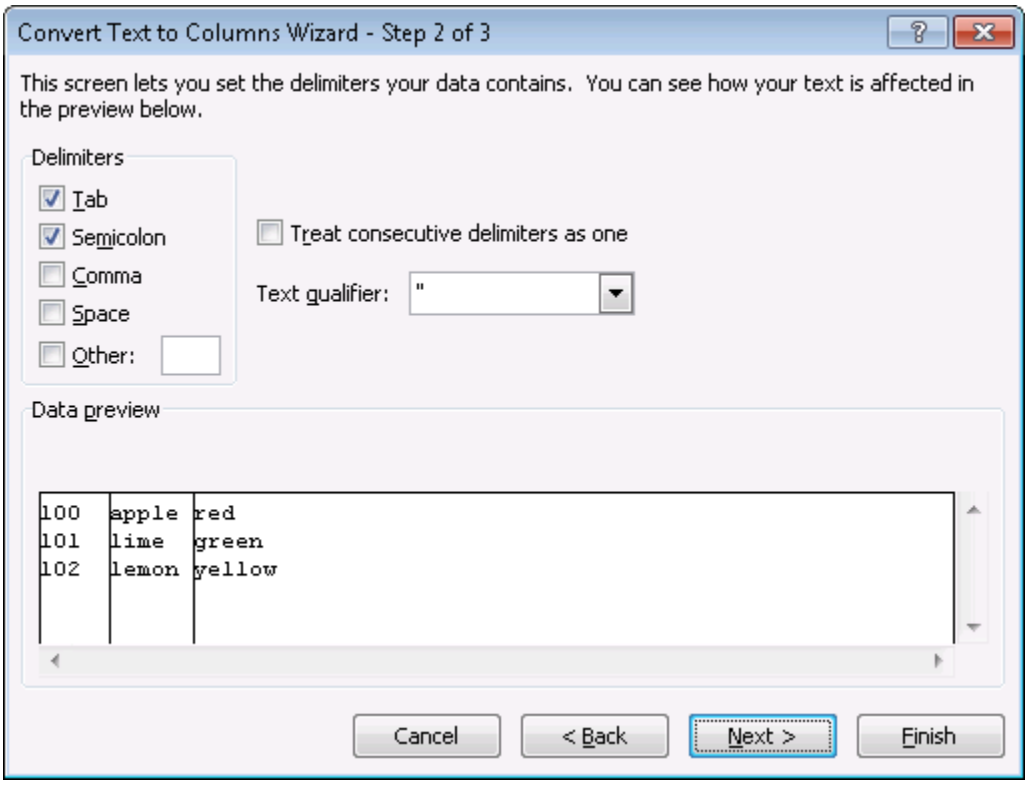
Select the cells you want to convert then click the Data tab. Click the **Text to Columns** function.



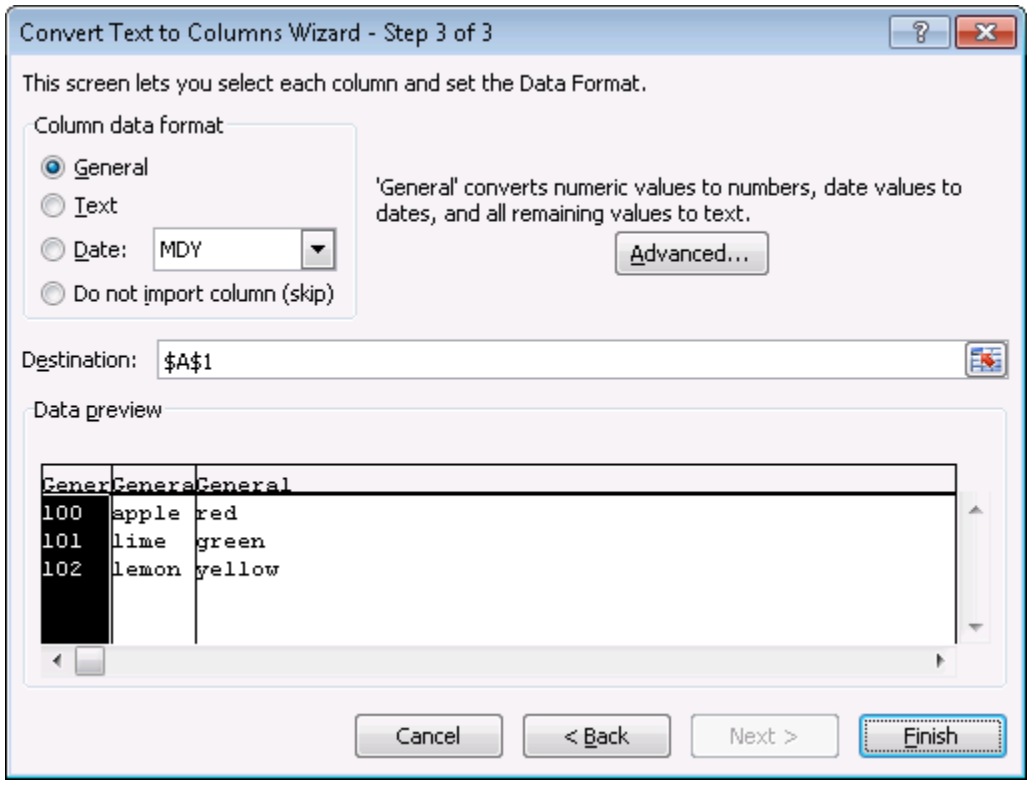
This brings up the **Convert Text to Columns Wizard**. Make sure the **Delimited** radio button is selected. Then click [**Next >**].



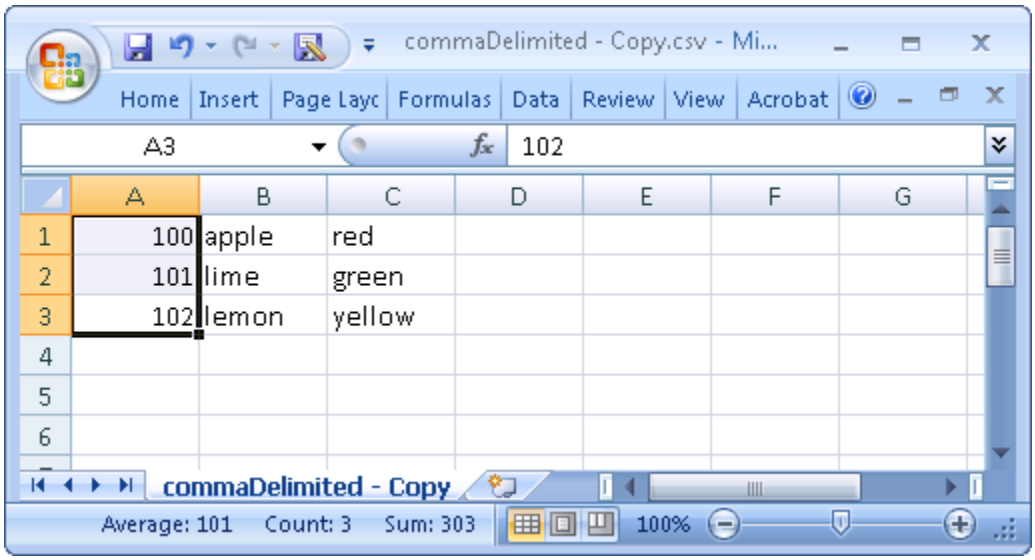
Under the **Delimiters** header make sure the **Semicolon** box contains a check mark. In the **Data preview**area it will show you what your data will look like after the conversion. Click [**Next >**].



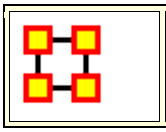
Lastly you can do some final tweaks to how your data will be converted if you want such as your data format or a different destination. In this example we want the data to be inserted back into the original starting cell. Click [**Finish >**].



Each piece of data now resides in a separate cell.



The new file can now be imported into ORA through the Data Import Wizard.



What Is A Dynamic Network

Networks are ways of connecting the who, what, where, why, how and when. Each type of who, what, where, why, how and when is called an entity class. The items within them are called nodes or entities. The set of networks for three or more of these entity classes is called the Meta-network. The entire field of Dynamic Network Analysis is based on the concept of the Meta-Network.

Node

A **Node** can literally be anything you can think of; on an abstract level, an Entity may be merely a dot in a visual network model. It is what we are networking and connecting our ties to and thus looking at in detail visually.

Nodeset

A **Nodeset** is a group of similar nodes [i.e. people, places, knowledge]

Network

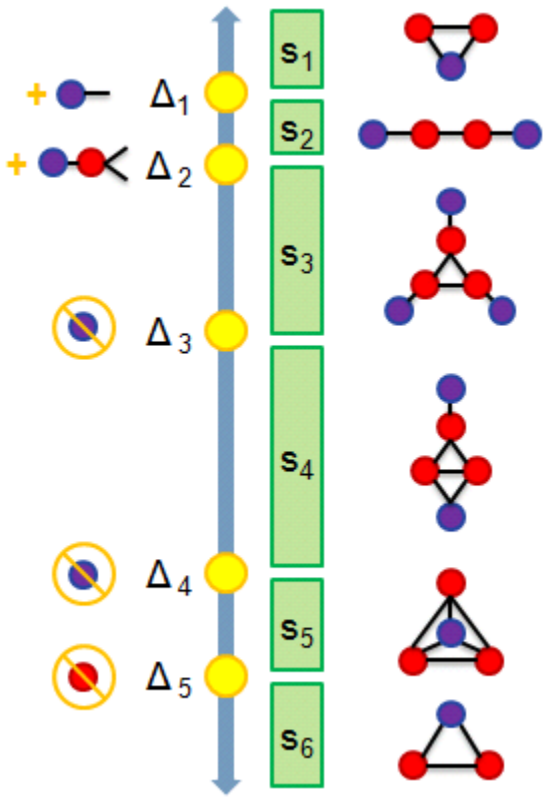
A **Network** shows how the nodes connect to each other.

Meta-Network

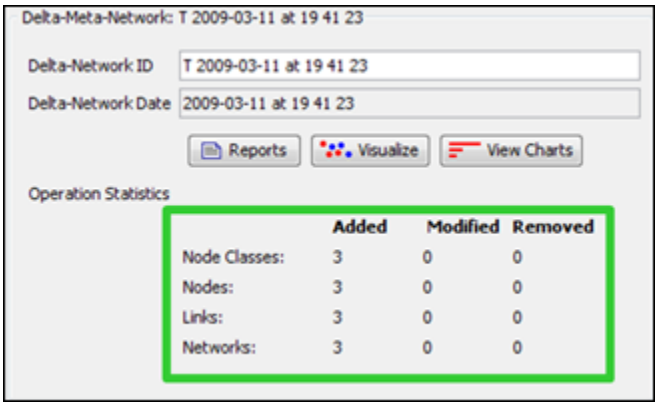
A Meta-Network incorporates different Nodesets and allow you to perform an analysis on the model that way. Such a model is called a MetaNetwork.

A Meta-Network is network composed of multiple networks. A MetaNetwork is the sum of all networks we are considering. The Meta-Network is the foundation for Dynamic Network Analysis;

Dynamic Networks



- **S1 :** 2 agents share 1 location
- **S2 :** They move apart to separate locations
- **S3 :** A 3rd connected agent is detected at its own location
- **S4 :** 2 of the agents meet
- **S5 :** The 3rd joins at same locale
- **S6 :** One agent disappears



The **Operational Statistics** indicate the number of additions, modifications, and removals to the Network.

Manipulating Keyframes / Deltas

You can **Convert Keyframes to Deltas, Deltas to Keyframes, or Aggregate by Day / Week / Month / Year**.

Over-Time Visualizations

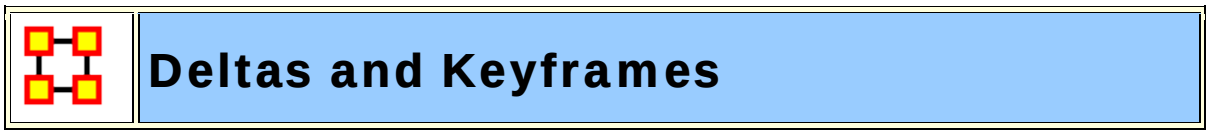
Visual Comparisons, Animating over time, and Plotting changing centrality.

Qualifications

If you are attempting to create a Dynamic Network ORA will check for incompatibilities between the files. If there are incompatibities between different Nodesets which have the same Nodeset Name [e.g., **knowledge : skills and resource : skills**] it will stop the process. Also if there's incompatibility in the nodes in identically named Nodesets.

Retrieving KeyFrames from Dynamic Meta-Network

If you want the individual KeyFrames to use as regualr Meta-Networks then **1)** Select the Keyframes; **2)** Press Control-C to copy those KeyFrames; **3)** Close the Dynamic Meta-Nework; and **4)** Press Control-V to copy them into the Meta-Network Manager pane.

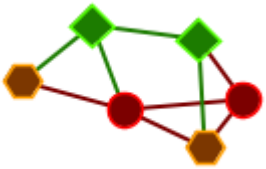
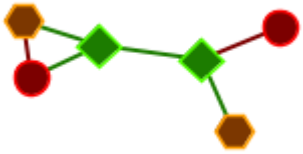
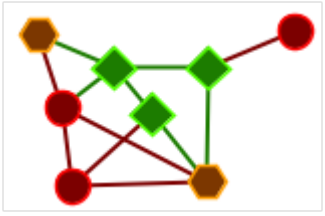


`

The difference between Deltas and KeyFrames

The **Keyframe** acts as a starting point, or a snapshot of what the Meta-Network looks like at any given time. It doesn't care what came before or will occur after.

The **Delta** is a set of instructions on how to change the Meta-Network. It reviews what came before it, applies a set of changes, and displays the revised Meta-Network.

Initial State : Nothing		Initial State : Nothing
KeyFrame : 3 nodes, 3 links		Delta : +3 nodes, +3 links
KeyFrame : 6 nodes, 9 links		Delta : +3 nodes, +6 links
KeyFrame : 6 nodes, 6 links		Delta : -3 links
KeyFrame : 8 nodes, 12 links		Delta : +2 nodes, +6 links

The biggest advantage of Deltas is it requires less information than KeyFrames. KeyFrames are a screenshot of every node and like in every time slice. Deltas, on the other hand, require only the information about individual changes.

NOTE : Change in the first KeyFrame do not affect proceeding KeyFrames. But with Deltas changes in the initial KeyFrame are taken into account by each Delta.

Importing Delta key Frame Data

The easiest way to create a dynamic Meta-Network is to first create a number of regular Meta-Networks. Next, import all these neta-networks into ORA. Select all the Meta-Networks in the Meta-Network pane you want to merge and right-click. From the contextual menu select **Create a Dynamic Meta-Network**. This brings up a Dynamic Meta-Network importer dialog with all your selected Meta-Networks.

Next you need to select which Meta-Networks you want to act as keyframes. This can be as few as the first Meta-Network or as many as all. Then click the [**Import**] button. You have now created a Dynamic Meta-Network.

Delta KeyFrame and Loom

The question arise as to whether you need a Delta KeyFrame to run this in Loom. No, a Delta KeyFrame Meta-Newwork in not a necessity for Loom as long as the Locations/Node Set/node id's match in every Meta-Network.

How can you show only some time periods or some locations

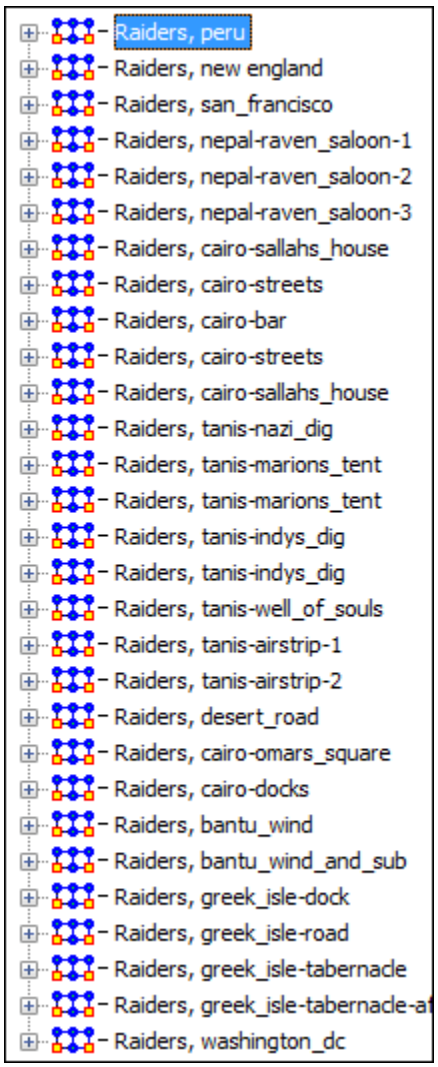
In Loom, only the locations that have entities currently moving through them are displayed. Locations with entities moving through them **cannot be hidden**.

Similarly, there's no way to currently turn off individual time periods. The work-around would be to just not include that time-periods Meta-Network whenever you load up loom.

Create Dynamic Network

A Dynamic Meta-Network is made up of multiple Meta-Networks.

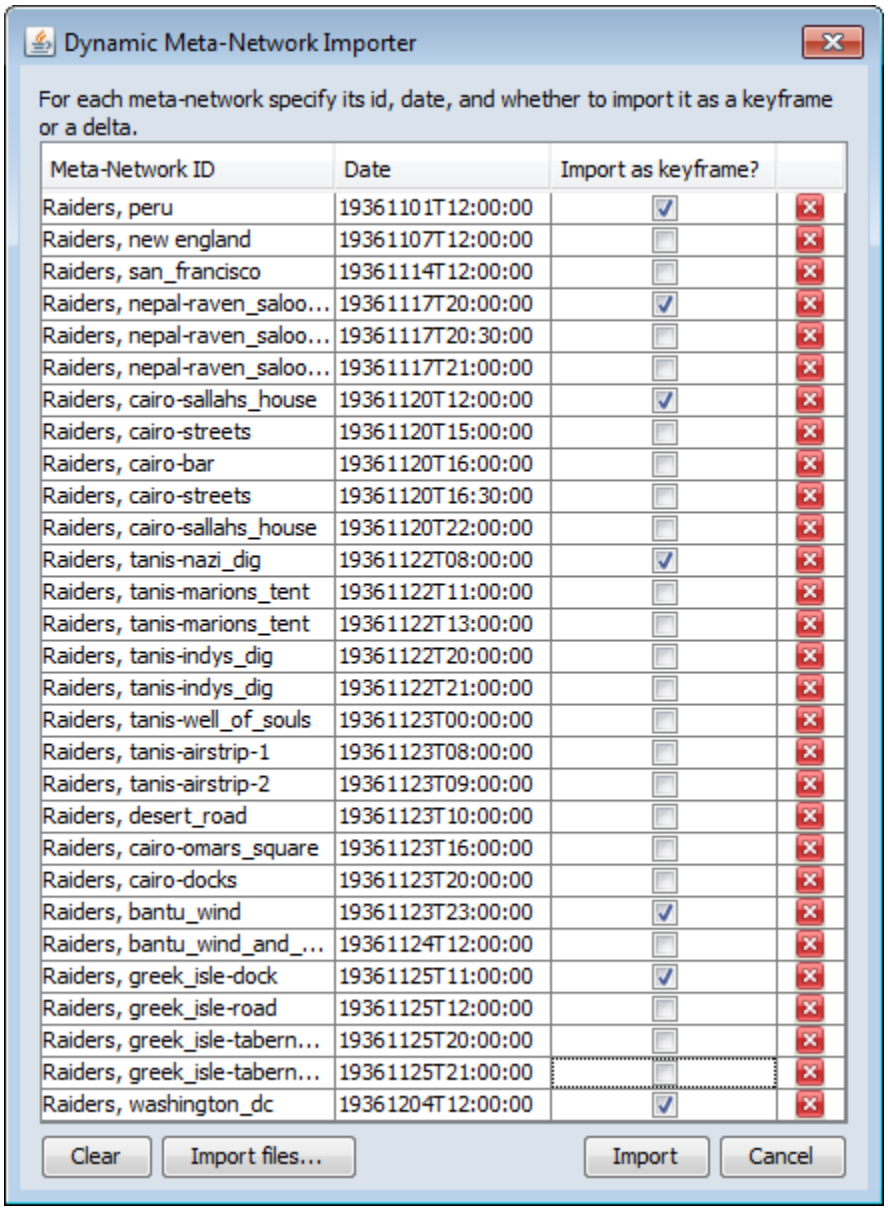
28 Raiders of the Lost Ark Meta-Networks



I split up The Raiders of the Lost Ark into 28 parts and created a Meta-Network for each. These contain Nodesets for agent, locations, resources, knowledge, and tasks. The Nodeset Names contained in each Meta-Network are identical but only appear in Meta-Networks where they have active links.

Example : Belloq, the evil archaeologist, appears in **Raiders, peru** but is absent until eight Meta-Networks later in **Raiders, cario-bar**.

To create a Dynamic Meta-Network highlight all the Meta-Networks you want to include. Right-Click on any of them and select **Create Dynamic Meta-Network**.



In the **Dynamic Meta-Network Importer** it lists each Meta-Network, the date, and whether you want it to be a Meta-Network [check mark] or a Delta [no check mark].

An important item about the date is there can not be any duplicate dates. Also the Dynamic Meta-Network will look at each in chronological order.

The far right column is used if you find the need to remove a Meta-Network before you move on to the creation process. Click the [X] to delete a Meta-Network before importing.



When finished you will see an new Meta-Network in the Manager pane. This icon has the clock overlay signifying it is a Dynamic Meta-Network.

The **Keyframe** Meta-Networks carry the standard Meta-Network icon [the items check marked in the Importer window]. In the main editor page the statistics will be displayed: Source count, Nodeset count, Node count, Link count, Network count, and Total density.

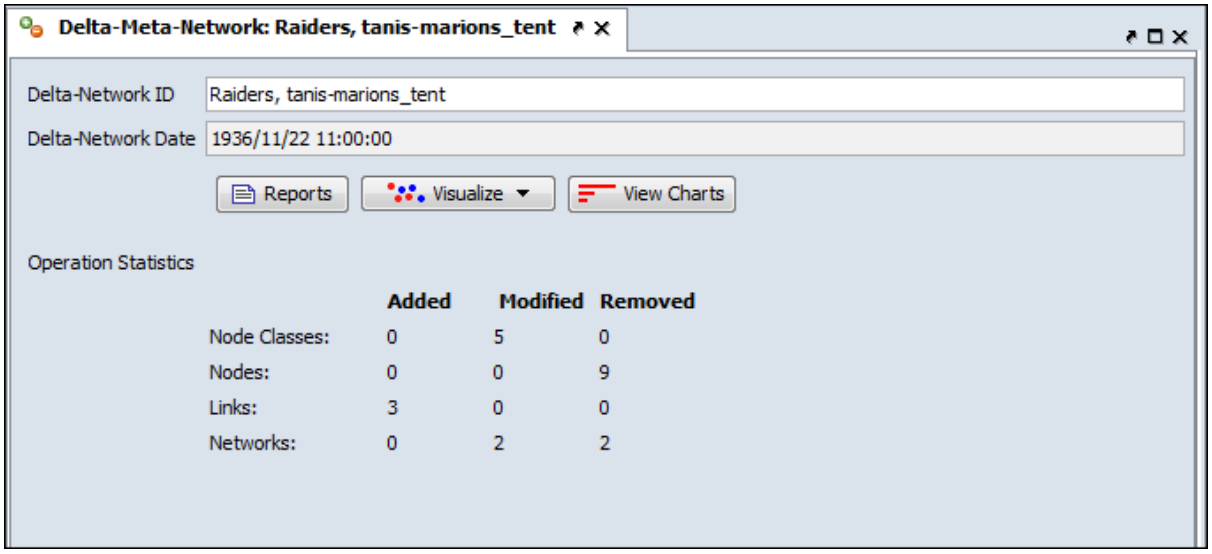
The **Deltas** carry the green and orange circle icons. In the main editor page the **Operation Statistics** will be displayed This consists of additions, modifications, and deletions of Nodesets, Nodes, Links, and Networks.

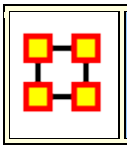
The Info Tab

When you highlight either a Meta-Network or a Delta you will see different information in the Info Tab. A Meta-Network will display the exact count of nodes, links, and other network information.



The Delta, on the other hand, will display only the changes that occurred between itself and the previous Meta-Network/Delta. Displayed are the number of items Added, Modified, and removed.





Exponential Random Graph Models [ERGM]

Exponential Random Graph Models, also known as p* models, are a family of statistical models that help analyze the structure and properties of social and other networks. There are other well known techniques to describe the structural properties of a network such as centrality, density etc. As opposed to these techniques which describe only the network for which they are measured, ERGM's try to describe all possible networks with the same statistical properties as the current one. The other alternative networks may or may not have the same structure, but the underlying statistical model that generates them is the same as the observed network.

The networks that are being studied today are substantially larger in structure for example, the World Wide Web, Internet, communication networks, food web networks, etc which have millions and even billions of nodes. It is very hard to visualize the shape and structure of such networks, even with modern advances in computing technology. In absence of reliable visualization techniques, statistical modeling techniques can provide an answer by quantifying large networks. Networks with similar properties will have similar statistical models. This change in scale also makes traditional questions like, which node's removal will affect the connectivity in the network the most, largely irrelevant. For large scale networks a question which makes more sense is what percentage of nodes when removed would significantly affect network connectivity? [1]. Statistical modeling of networks will allow us to answer this question.

ERGMs were initially introduced to study social networks but since then have found their application to networks generated from several different domains such as epidemiology, telecommunications, political science etc. One point to remember while using ERGM models is that a network is modeled as a single multivariate observation which limits them from being used for modeling networks over time. In addition the modeling by ERGM is limited to networks with binary edges only. Hence networks with non binary edges should be converted to binary valued edges before using ERGM. The coding rule for the conversion may not always be obvious. The other major limitations of ERGM models are that they are very sensitive to missing data and suffer from degeneracy problems. Degeneracy occurs when the derived model is highly unlikely to have generated

the network hence the ERGM cannot be computed. In many cases degeneracy can be circumvented by carefully specifying the components of the model to be estimated as opposed to using ERGM with the default set of controls.

Exponential random graph models have the following form:

$$P_\theta(X = x) = \frac{exp\left\{e^t s(x)\right\}}{c(\theta)} \qquad (1)$$

Where X is a random graph consisting on n nodes and x is the observed graph. The assumption of this model is that the structure of the observed graph x can be derived from a known vector of graph statistics, s(x) and the associated vector of model parameters θ. The parameter c(θ), is a normalizing constant where

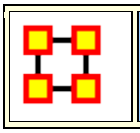
$$c(\theta) = \sum_{\text{all possible graphs } x} exp\{\theta^t s(x)\}$$

All exponential random graph models are of the form in equation (1), which describes a general probability distribution of graphs with n nodes. The particular probability for observing the graph x is dependent on its statistics s(x) and on θ^t for all configurations in the model. Configurations include ties, triads and are these dependence assumptions are important because they pick different configurations as relevant to the model and also because they constrain the possible configurations possible in the model [2]. The simplest dependence assumption is the Bernoulli random graph distributions where the edges are assumed to be independent whereas more complex ERGMs incorporate node level effects in the configurations. This flexibility in dependence assumptions allows for greater variability in the statistical modeling depending on the requirements and needs of the end user using the ERGM technique.

References

1. M. E. J. Newman, *The Structure and Function of Complex Networks*, SIAM Review, Vol. 45, No. 2 (Jun., 2003), pp. 167-256.

2. G. Robins, P. Pattison, Y. Kalish, D. Lusher, *An introduction to exponential random graph (p*) models for social networks*, Social Networks, Volume 29, Issue 2, May 2007, Pages 173-191.



Fast Fourier Transform

What does the Fourier Transform do? Given a color swatch, it finds the base colors.

How? Run the color swatch through filters to extract each base color.

Why? A list of colors are easier to analyze, compare, and modify than the swatch itself.

How do we get the swatch back? Blend the base colors.

In essence The Fourier Transform extracts each "cycle ingredient" from a time-based signal (the cycle strength, delay & speed), resulting in a final "cycle recipe". It changes it from one large amount of a mixture to a list of individual ingrediants.

Filters

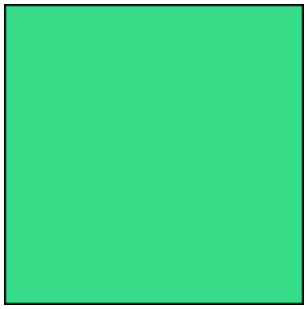
This is a change of persepctive. You change from the notion of a single quantity to the amount of of **something in something else**. It changes from **What are you looking at?** to **How was it made?**

In other words, **What are the component Parts?**

And why do it this way? Because it is easier to categorize, compare, modify, and replicate than the original object in question.

Let's take a look at a color swatch. You can't tell what colors go into making this particualr swatch. You could guess, but it probably

wouldn't be accurate. You'd have to guess about the amounts of Red, Green and Blue in the swatch.



But if you had a way of filtering out each of the colors used to make that swatch, then you could determine exactly what colors went into creating it in the first place. Then you could run the original color first through the red filter [to reveal the amount of units of red are used], then the green, then the blue.

Filters	Red Filter		54 units of red
	Green Filter		220 units of green
	Blue Filter		136 units of blue

Now that you have the breakdown of the three colors used, you could successfully recreate that swatch color.

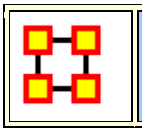
Things To Remember

Even though this sound simple enough, there are a few things that you need to keep in mind.

Filters must be independent : The red filter will only find the red parts. Adding more green or blue will not affect the amount of red it finds. That would only change the starting color.

Filters must be complete : You need a filter for each part. If the blue filter was left out, the resultant colors from the red and green filters would combine to create a different color.

The individual parts must be combineable : Once separated, the colors can be re-combined to create that color again with no issues. But a cookie run through a set of filters to determine it's ingrediants could not be readily re-combined to make a cookie as there are other processes that are needed to make the cookie.



Folding Math

Folding a Network means multiplying the network by its transpose. And that when one folds a two-mode network (e.g., agent x organization) the diagonal gives the number of [organizations] each agent has. The off-diagonal contains the organizations which the agents have in common.

NOTE : A network can be folded by highlighting the network in the Meta-Manager pane. Right-Click on the network and select **Fold Network**.

Here is a simple two-mode network agent x organization I have the following values:

Original Network

	Club A	Club B	Club C
Izy	0	2	10
Jane	5	0	3
Karl	4	6	0

Folded Network

	Izy	Jane	Karl
Izy	104	30	12
Jane	30	34	20
Karl	12	206	52

The question people will have is, "**How can Izy have a self loop of 104, Jane Self Loop of 34, and Karl Self Loop of 52?**"

Tranpose of Original Network

First you need the transpose of your original network.

	Izy	Jane	Karl
Club A	0	5	4
Club B	2	0	6
Club C	10	3	0

And finally, the math.

Linear Algebra

It's part of a the linear algebra operation called the **inner-dot product of the first row and column vector**.

For Izy at row 1 col 1, the value after folding is [0 2 10] * [0 2 10]', or 0 * 0 + 2 * 2 + 10 * 10 = 0 + 4 + 100 = 104.

Now let's take a look at the value from Izy to Jane (30), which is the dot product of the 1st row times the 2nd col, or [0 2 10] * [5 0 3]' = 0 * 5 + 2 * 0 + 10 * 3 = 0 + 0 + 30 = 30.

This process continues for all cells.

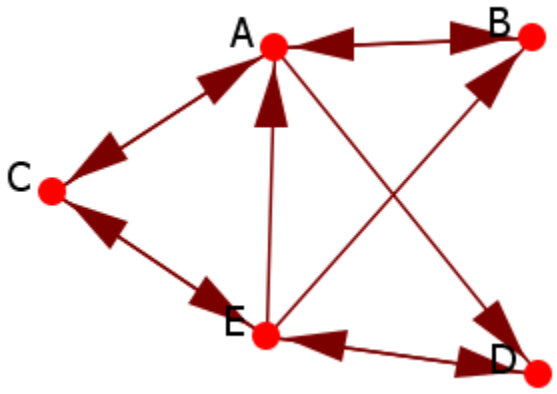
The short of this is, **The self-loop is the sum of the squares of all their ties**.

Hamming Distance

Hamming Distance is the sum of the difference between networks. For binary links, it is how many differences/changes there are between two networks.

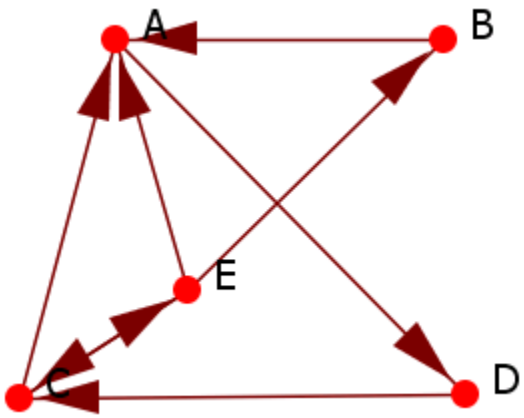
Hamming Distance can be found in the **Key Entity** report.

Network 1



	A	B	C	D	E
A	0	1	1	1	0
B	1	0	0	0	0
C	1	0	0	0	1
D	0	0	0	0	1
E	1	1	1	1	0

Network 2



	A	B	C	D	E
A	0	0	0	1	0
B	1	0	0	0	0
C	1	0	0	0	1
D	0	0	1	0	0
E	1	1	1	0	0

String

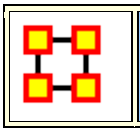
0**11**10100001000100**0**0**1**111**1**0

0**00**10100001000100**1**0**0**111**0**0

Calculation

Distance = 5

5/20. .25, 25%



Inferences Matrices

Questions and Answers about Inference Matrices

Question : You have a matrix defined as [AK x AK^T] and end up with an Agent matrix but with inferences based on the knowledge matrix. What information can you get from this? For example, what if a(ij) = 1. Does that means that agent i and agent j are connected by a common knowledge? Are there any other uses for the inference matrices? Any deeper information we can gather from them? Are there metrics that are applicable to them?

Answer : These often go under two mode metrics. See also Command and Control for more information.

Question : If, in the above example, the AK matrix is not a boolean, but rather has values from 0 -> n, showing the strength of the tie between that agent i and knowledge j. When we look at the inference matrix, some of the values in the matrix are bound to be > 1. Does this imply that the tie between agent i and agent j is greater if there is a value > 1, or should the inference matrix be thought of as a boolean (0, 1) no matter what the value in the matrix after the matrix multiplication?

Answer : It is ok to have cell values greater than 1. It is also ok to binarize it. It just depends on what you want to look at.

Question : Are there any affects that need to be watched for when multiplying a directed and undirected meta matrix?

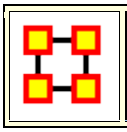
Answer : If you multiply a direct and an undirected it becomes directed.

Question : Do we lose properties, gain them? Is the resultant nectwork directed or undirected (which property is dominant)?

Answer : If you don't want direction to matter you can always symmetrize and tell ora to treat it as undirected.

Question : Directed mean it matters which node is the source and which is the target. Symmetric means that for any network H, $H_{ij}=H_{ji}$. Assymetric means H_{ij} does not necessarily equal H_{ji}.

Answer : An undirected network is symmetric. A symmetric network is not necessarily undirected. A symmetric but directed network that contains H_{ij} and H_{ji} are treated as two different ties just of the same value. If it is symmetric and undirected $H_{ij}=H_{ji}$ and this is treated as a single tie.



Large Meta-Networks

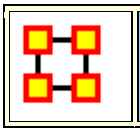
Description

There's always a question as to the maximum size for a Meta-Network in ORA. That depends on a number of items.

First it depends on your machine. Extremely large networks [networks containing 10^6 nodes] have been run successfully on 64-bit multi-core machines.

It is also about the amount of memory in the machine. The more you have the better it is. It helps make very big networks are doable.

Also, if it is taking forever even when running Standard Network Analysis, you may want to go to **Analysis > Measures Manager...** and opt out some of the slow metrics, such as information centrality, if you are not particularly interested in those.



MetaOntology

The Ontology is defined as the group of classes in which almost every concept and phrase can be classified depending on the context in which the concept/phrase is used in a particular sentence or a paragraph. For example: USA can be a location or an Organization, depending on the context of the data.

Standard Node Classes

In detail, the ten Node Classes can be defined as follows:

1. Agents are individual decision makers. The most common type of decision makers is people. However, this category could also be used for other types of actors such as robots or monkeys. A single Agent represents any person: a family member, a Roman soldier, Soothsayer, Calpurnia, Cicero, any historical figure, a terrorist, or a teacher.

2. Resources are products, materials, or goods that are necessary to perform Tasks, Events, and Actions. A Resource could literally be a dagger, a cloak, a crown, a short sword, a computer, money, bombs, tools, or books.

3. Knowledge describes cognitive capabilities and skills. Knowledge could be Trigonometry, History, English, Economics, the science of DNA, or the knowledge about how to perform a surgery or to build bombs.

4. Tasks are well defined procedures or goals. A Task could be any process in a company, e.g., product development or administration, but also the plan to kill Caesar.

5. Organizations are collectives of people that try to reach a common goal. An Organization could be a specific company, the United Nations, or the government of a country.

6. Locations are geographical positions at any aggregation level that describe places or areas. A Location could be 1600 Pennsylvania Avenue in Washington, London, Florida, The Middle East, Earth, or Mars.

7. Events are occurrences or phenomena that happen. An Event could be 9-11, the JFK Assignation, the Super Bowl, a wedding, a funeral, or an inauguration. Specific events are one time occurrences with a specific date.

8. Actions are specific activities done by agents. An Action could be buying a car, writing a letter of recommendation, or flying to Africa.

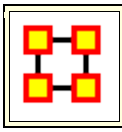
9. Beliefs are any form of religion or other persuasion. A Belief could be to believe that there is a god, or that there are many gods, or that that Earth is flat. Some beliefs are signaled by sentiment such as "war is bad."

10. Roles describe functions of individual decision makers abstracted from specific Agents. A Role could be leader of a group, driver of a car, or mother of an Agent.

Groups, also referred to as **Meta-Nodes**, are any categorization of nodes into a cluster. Groups are defined by one or more of the grouping algorithms.

Example

To repeat the function of these Node Classes are to show their differences as well as give a first impression about how these Node Classes are connected with each other. For example in Julius Caesar, Brutus (Agent) and other senators (Roles) agree that Rome (Location) would be a better place without Caesar (Belief). To kill Caesar (Task) they form a group of assassins (Organization). To accomplish their task they need to know about Caesar's daily routine (Knowledge) and how to get their knives (Resources) into the senate. Finally, the assassination (Event) takes place because somebody actually stabs Caesar (Action).

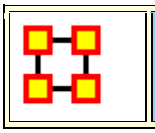


Monte Carlo Network Optimization

Description

Monte Carlo methods (or Monte Carlo experiments) are a class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used in computer simulations of physical and mathematical systems. These methods are most suited to calculation by a computer and tend to be used when it is infeasible to compute an exact result with a deterministic algorithm. This method is also used to complement the theoretical derivations.

In general, Monte Carlo methods are used in mathematics to solve various problems by generating suitable random numbers and observing that fraction of the numbers which obeys some property or properties. The method is useful for obtaining numerical solutions to problems which are too complicated to solve analytically. The most common application of the Monte Carlo method is Monte Carlo integration.



Multiple Links in Imported Data

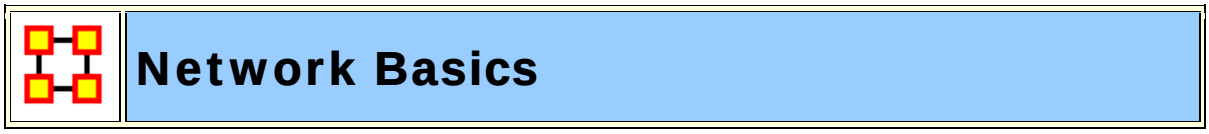
The Problem

There has been a question of what to do when there is the possibility of multiple links between the same nodes in a file to be imported using the **Data-Import Wizard > txt Data > Simple Table > Networks, Nodes and Node Attributes**.

Normally the weight of the links in the final network which contains multiple links will be summed. [**node1 > node2 is 0.4 and node1 > node2, 0.5**]. The expected result would be 4.5 but is in fact summed and becomes 0.9.

The Solution

If you don't know in advance which nodes have multiple links you need to use the Data Import Wizard to create one Network per link type.



Network Basics

Network Basic Terms

Networks are contain information with Weighted/Unweighted, Symmetric/Asymmetric, Connected Networks/Disconnected Networks, and Self Loops. Each makes for a unique network structure. Networks which are directed, weighted, unconnected, and which even contain self-loops are not unusual in social network analysis.

Binary Networks

A binary network is constructed by binary values (either 1 or 0) in its network matrix and contains only the information whether a link between two entities in the network exists or not. In the network matrix, 0 in the cell w_{uv} indicates that there is no links from node u to node v while 1 indicates that there is a link. Because the weights of all links are 1 and therefore equal these networks are also called unweighted networks.

Weighted Networks

If the weights of the links are different we use the term weighted network. In a weighted network every link is represented by a real number w_{uv} (continuously from $-\infty$ to $+\infty$) in its network matrix and contains not only the information about whether there is a link between entities, but also numerical information about the links (e.g., how far two entities are distant geographically or how often agents interact with each other). In the network matrix, 0 indicates there is

no link between two entities while any value other than 0 indicate there is a link between the entities.

Self-Looped Networks

Self-loops (also called self-links or loops) are links from a node to itself. A self-looped network has therefore non-zero diagonal elements in the network matrix. Depending on the weight representation of the network (either binary network or weighted network), these diagonal elements can take the values 1 (in a binary network) or it can take any real number (in a weighted network).

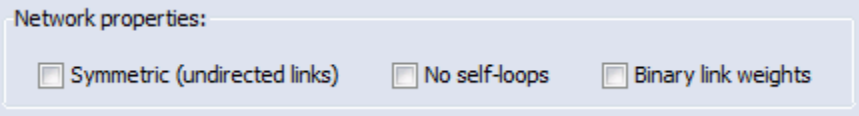
Symmetric/Asymmetric Networks

In a symmetric network for every edge euv there is also an edge evu. All links are therefore reciprocal. In asymmetric networks this is not the case. In its matrix representation, a symmetric network has symmetric values about its diagonal. Asymmetric networks are also called directed networks, while undirected networks are synonymous with symmetric networks. In weighted networks the link values of all paired symmetric matrix elements have to have the same value in order to be symmetric.

Disconnected Networks

A path in a network is a subset of nodes and edges which connects two nodes without repeating a node or an edge. All nodes which can be reached from a specific node using paths are called reachable. If subsets of nodes are arranged in a way that all nodes of group A are unreachable from all nodes from group B and vice versa, the network is disconnected. Therefore, there is no link connecting any pair of nodes between the subsets of nodes. These subsets of nodes are named components. Every component can be interpreted as a single network, but researchers are often interested in treating disconnected networks as a single network. In addition, it is important to know that even if a network is connected, it is possible that there are unreachable nodes for a specific node in case of directed networks.

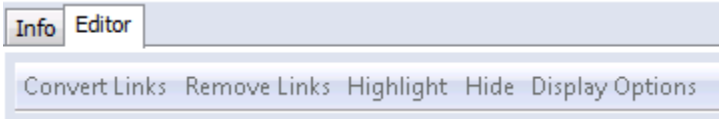
Network Characteristics



Changing any of the characteristics above will affect the working of your network. Normally the creator of a network knows whether a specific network should be directed or undirected when it is created. Changing a weighted network from weighted to unweighted will remove link weight information and you end up with a binary network of 1s and 0s. Changing from a Asymmetric to Symmetric will force ORA to create extra links where the original network had none.

Independently from these network settings ORA offers additional options for treating these characteristics when network measures are calculated. So, your data can have link weights but it is your decision to ignore these link weights when calculating network measures. You will learn more about these options in the following section.

Editor Display Options



Convert Links : This menu item includes different ways to manipulate the line weights of your network. You are able to binarize all links or just links within a specific range (collapse). Negate changes the algebraic sign of the links in the network while absolute value turns all line weights to positive numbers. Row-normalize is a method to weight the importance of a single link with the number of links of a node.

Remove Links : With these methods you can remove specific links, e.g., links with a line value lower or higher than a given value or self-loops. It is also possible to set the self-loops (diagonals) of a network to a designated value. In this menu you can also find ways to symmetrize your networks using different methods (maximum, minimum, sum, average).

Highlight : Input a search parameter and all matching nodes will be highlighted in the matrix.

Hide : Input a search parameter and all matching nodes will be hidden in the matrix.

Display Options : Options for displaying links as binary check boxes or numeric values. You are also given the option to display row or column sums.

Measures

You can add a measure result as an attribute using the Measure button in the Info Tab of a Nodeset. After clicking the button you specify which Network to use, which measure to run and give it a name. The result will display in the Nodeset display under **Editor**. The following are the default settings for measures added.

Treat as symmetric : Symmetrizes the network for the calculation, e.g., if the line weight w_{uv} is larger than w_{vu} than $w_{vu} \leftarrow w_{uv}$.

Ignore self-loops : All diagonal elements are set to 0.

Treat as binary : The link weights for all w_{uv} with $w_{uv} \neq 0$ are set to 1.

Scaling Parameters for Measures

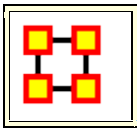
The results of measures is usually within the range 0 and 1 and is the result of scaling. It is used in order to compare networks with different sizes. You can change this to a scale of 0 to 100 under **Preferences > Measures > Scale measures as percentage**.

Network Characteristics on Measures

The characteristics of a network impact the way measures work, i.e. selecting **self-loops** affect the result of degree and eigenvector centrality as well as clustering coefficients. Below is a table with some examples.

Characteristics of Networks and their Impact on Measures				
Measure	Allow/Ignore Self-Loops	Symmetric/Asymmetric	Binary/Weighted	Connected/Disconnected
Degree Centrality	Yes	Yes	Yes	No
Betweenness Centrality	No	Yes	Yes	No
Closeness Centrality	No	Yes	Yes	Yes
Eigenvector Centrality	Yes	(No)	Yes	Yes
Clustering Coefficient	Yes	Yes	No	No

If any option is set to True of False, ORA will add/remove links that the property holds in the network.



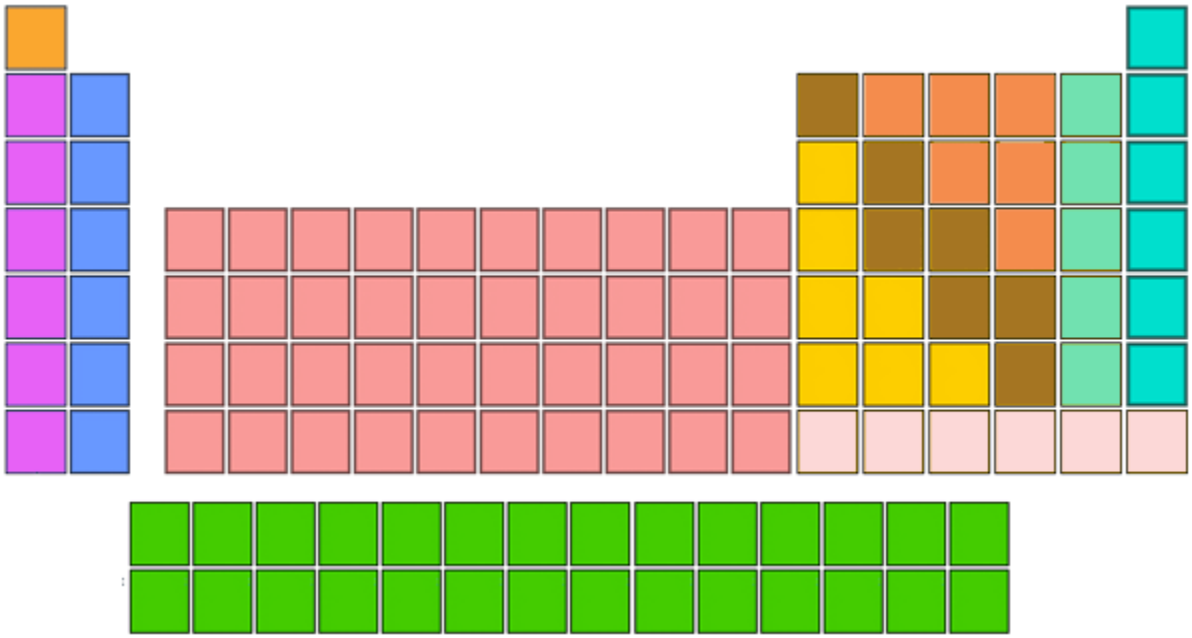
Ontology

What Is Ontology?

Ontology has to do with making clear and explicit statement about entities in a paricular domain. What kinds of things can exist in this world we're trying to explain. What types of relationships do they have with each other. It is concerned with **what is that** and **what is possible**.

Categorization or Classification : Organizing a set of entities into groups based on their essences and possible relations. This assumes that for any new items added to the group a place will already exist.

Below is the **Best Classification** chart and I'm sure you recognize it.



The Periodic Table has the most value, both descriptive and predictive, of any classification chart. The pink column on the right contains the noble gases. It is an odd category, because helium is no more a gas than mercury is a liquid. Helium is just a gas at most temperatures.

Even in a nearly perfect categorization scheme, there are these kinds of context errors, where people are placing something that is merely true at room temperature, and is absolutely unrelated to essence, right in the center of the categorization. And the category 'Noble Gas' has stayed there from the day they added it, because we've all just gotten used to that anomaly as a frozen accident.

If it's impossible to create a completely coherent categorization, even when you're doing something as physically related to essence as chemistry, imagine the problems faced by anyone who's dealing with a domain where essence is even less obvious.

What Makes For A Good List?

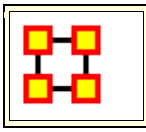
Here are the ideal situations you would like to cleanly classify your domain.

Small corpus
Formal categories
Stable entities
Restricted entities
Clear edges

What Makes For Good Participants?

The other important issue is in regards to who is doing the classifying. Here are a few things that help to job go smoother.

Expert catalogers
Authoritative source of judgment
Coordinated users
Expert users

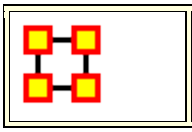


Parts of Speech

Parts of Speech assigns a single best Part of Speech, such as noun, verb, or preposition, to every word in a text. While many words can be unambiguously associated with one tag, (e.g. computer with noun), other words match multiple tags, depending on the context that they appear in.

CC	Coordinating conjunction	**PRP$**	Possessive pronoun
CD	Cardinal number	**RB**	Adverb
DT	Determiner	**RBR**	Adverb, comparative
EX	Existential there	**RBS**	Adverb, superlative
FW	Foreign word	**RP**	Particle
IN	Preposition or subordinating conjunction	**SYM**	Symbol
JJ	Adjective	**TO**	to

JJR	Adjective, comparative	**UH**	Interjection
JJS	Adjective, superlative	**VB**	Verb, base form
LS	List item marker	**VBD**	Verb, past tense
MD	Modal	**VBG**	Verb, gerund or present participle
NN	Noun, singular or mass	**VBN**	Verb, past participle
NNS	Noun, plural	**VBP**	Verb, non-3rd person singular present
NNP	Proper noun, singular	**VBZ**	Verb, 3rd person singular present
NNPS	Proper noun, plural	**WDT**	Wh-determiner
PDT	Predeterminer	**WP**	Wh-pronoun
POS	Possessive ending	**WP$**	Possessive wh-pronoun
PRP	Personal pronoun	**WRB**	Wh-adverb



Reduced Form Network

Description

This is what Reduced Form does and does not do:

Uni-modal networks are not changed (**e.g. an AA is NOT symmetrized**), but bi-modal networks are **symmetrized** in that the links from two or more networks are combined using the maximum method.

Bi-modal networks are combined: For example, if there is an AK and a KA network, then the KA is transposed to AK2 and then AK and AK2 are unioned with the Maximum link weight from each (a,k) or (k,a) being used.

Network Names are normalized to their Node Classes, e.g., agent x agent, agent x knowledge, etc.

NOTE : The original networks are changed into their reduced network forms. If you want to maintain the originals, you need to work on a duplicate of the meta-network.

How and Where ORA does Reduced Form

Remove self loops : Removes all links that connect a node to itself.

Symmetrize by method : Turns directed or asymmetric network data into undirected or symmetric data. All three methods use a pair of values from the upper and lower portions of the table (e.g. cell 1, 3 is compared to cell 3, 1). If a network had a link from A to B but not from B to A then symmetrizing the network would create a reciprocal link from B to A.

Combine networks of the same type using method: : See descriptions below.

Tranpose networks according to node precedence : Tranposes bimodal networks to ensure that certain Node Classes appear first. The order is: Agent, Organization, Knowledge, Resource, Belief, Event, Task, Location.

Combine networks of the same type using method: : See descriptions below.

Combination Methods

Maximum : Compares the values and uses the larger of the values. This is called using the strongest value.

Minimum : Similar to Maximum only it uses the lower, or weaker, value. Average takes the two values and averages them.

Sum : Adds weights of links from all combined networks.

Binary : Sets link to [1] if there is a link an any two nodes or [0] if no network contains a link for two nodes.

Average : Adds all links and divdes by the number of links found.

Order of Node Classes

The Node Classes will be placed in the following order:

Agent
Organization
Knowledge
Resource
Belief
Event
Task
Location.

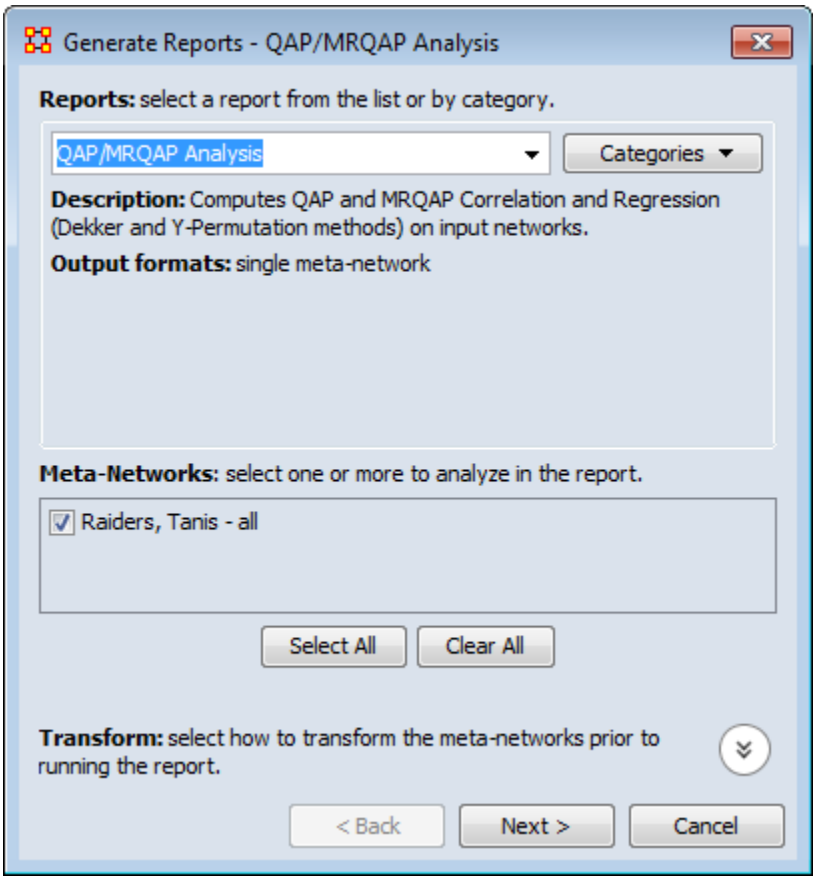
Regression Technique

Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables.[1] The dependent and independent variables can be either network measure or numerical attributes of nodes.

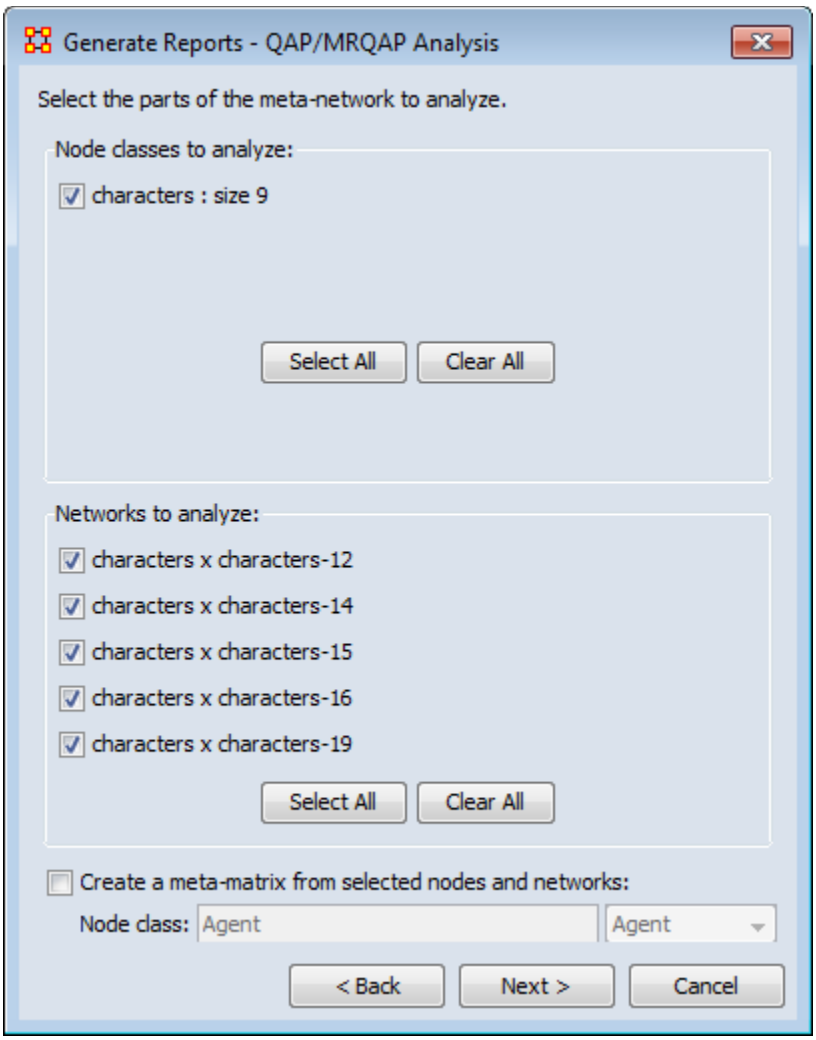
To test the shape of the distribution or normality of the variables use ...

Procedure

From the main menu select **Analysis > Generate Reports... > Statistical Procedures and Diagnostics > QAP/MRQAP Analysis**. Place a check mark next to the Meta-Network(s) to analyze. Click [**Next >**].



In the top section select the Nodesets to analyze. In the bottom section select the Networks to analyze. Place a check mark in the box next to **Create a Meta-Network from select nodes and networks** to create a new Meta-Network. Click [**Next >**].

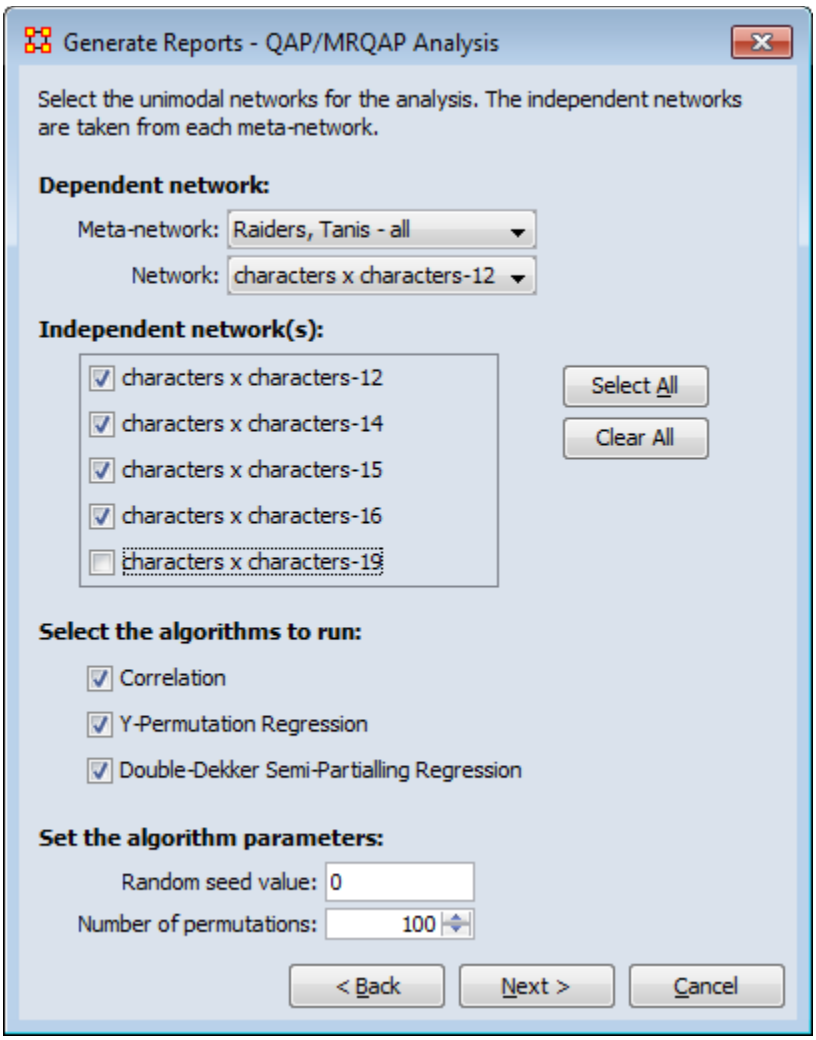


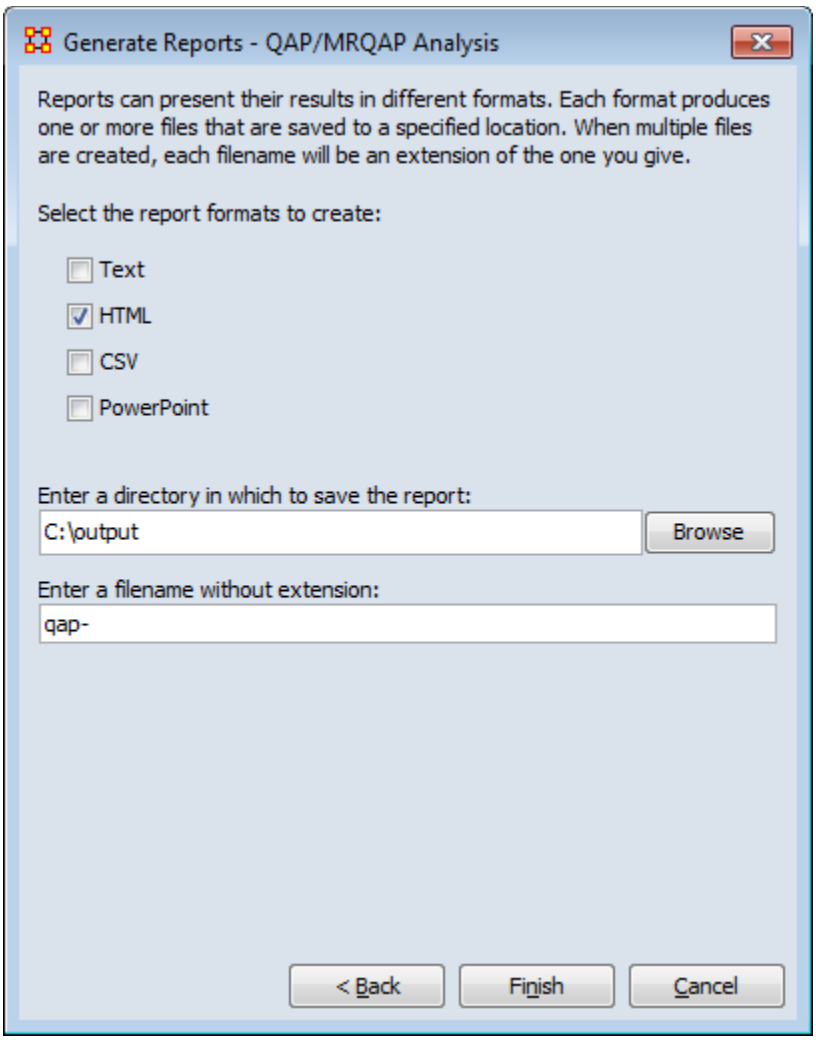
Under **Dependent network:** select the Meta-Network and Network to use.

Under **Independent network(s):** select the Networks to keep independent.

Under **Select the algorithms to run:** select what to use for analysis.

Under **Set the algorithm parameters:** set the set and permutations.


Generate Reports - QAP/MRQAP Analysis
Select the unimodal networks for the analysis. The independent networks are taken from each meta-network.
Dependent network:
Meta-network: Raiders, Tanis - all
Network: characters x characters-12
Independent network(s):
characters x characters-12
characters x characters-14
characters x characters-15
characters x characters-16
characters x characters-19
Select All
Clear All
Select the algorithms to run:
Correlation
Y-Permutation Regression
Double-Dekker Semi-Partialling Regression
Set the algorithm parameters:
Random seed value: 0
Number of permutations: 100
< Back
Next >
Cancel



QAP / MRQAP ANALYSIS REPORT

Input data: Raiders, Tanis - all

Start time: Mon Dec 12 13:59:48 2011

Data Description

Parameters

The random seed is 0

The number of permutations is 100

The dependent network is characters x characters-12 from the meta-network Raiders, Tanis - all

The independent network(s) used from each meta-network:

characters x characters-12

characters x characters-14

characters x characters-15

characters x characters-16

The total number of independent networks is 3

Correlation Results

Network	Correlation	Significance	Hamming Distance	Euclidean Distance
Raiders, Tanis - all : characters x characters-14	0.69	0.01	4	2.00
Raiders, Tanis - all : characters x characters-15	0.30	0.21	8	2.83
Raiders, Tanis - all : characters x characters-16	0.39	0.04	16	4.00

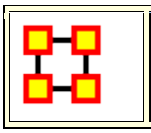
Regression Results

R-Squared: 0.470588

Variable	Coef	Std.Coef	Sig.Y-Perm	Sig.Dekker
Constant	0.00		0.04	
Raiders, Tanis - all : characters x characters-14	0.50	0.69	0.00	0.00
Raiders, Tanis - all : characters x characters-15	0.00	0.00	0.24	0.45
Raiders, Tanis - all : characters x characters-16	0.00	0.00	0.40	0.39

Hanneman & Riddle (2005) argue that predicting and testing hypotheses about a node's non-relational attributes can be done using a mixture of relational (network) measures and non-network measures. This tool allows such tests. An example would be to use the entity class agents - such as specific people, and then regress their performance on a combination of node metrics e.g., degree centrality and non-relational attributes e.g. age and gender. This process computes basic linear multiple regression statistics by ordinary least squares (OLS), and estimate standard errors and significance using the random permutations method for constructing sampling distributions of R-squared and slope coefficients.

[1] Wikipedia



Semantic Network

Semantic Network Union - Input

Automap outputs one Meta-Network per text. A semantic network is a Meta-Network with: **Concept Nodeset, Semantic Network (Concept x Concept), Dynetml <source> element describing Automap processing of the input text.**

You treat Meta-Networks as semantic networks. So you combine all Nodesets into a Node sSet : Concept and also combine all Networks into one Semantic Network.

Semantic Union - Output

Meta-Network called Consolidated. Nodeset : Concept contains special attributes:

Frequency : Sum of the node's frequency attribute across Meta-Networks

Frequency_distinct : Number of Meta-Networks the node was in

Frequency_isolate : Number of Meta-Networks in which the node was an isolate in the semantic network

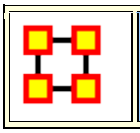
Nodeset : Text with attributes:

One text node per input Meta-Network, corresponding to one text processed by Automap. Attributes describe how Automap processed the text (these are pulled from the <source> Dynetml tag).

Semantic Network

A Union of the Semantic Networks can control how link weights are combined: sum, minimum, maximum, etc..

A Concept x Text network records which texts contain which concepts. Link weights are from the node's frequency attribute (how many times the node occurred in the text).



Simulated Annealing

Decription

Simulated annealing is an optimization heuristic (an algorirthm designed to solve a really difficult problem for which the best answers are computationally difficult to assess). This provides very good answers, but not always the best. You may have heard of other such algorithms, like the genetic algorithm (GA) or hill-climbing or A-star.

The method was independently described by Scott Kirkpatrick, C. Daniel Gelatt and Mario P. Vecchi in 1983,[1] and by Vlado Cerný in 1985.[2] The method is an adaptation of the Metropolis-Hastings algorithm, a Monte Carlo method to generate sample states of a thermodynamic system, invented by M.N. Rosenbluth in a paper by N. Metropolis et al. in 1953.[3]

Source

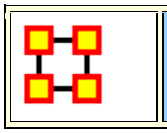
The name and inspiration come from annealing in metallurgy, a technique involving heating and controlled cooling of a material to increase the size of its crystals and reduce their defects. The heat causes the atoms to become unstuck from their initial positions (a local minimum of the internal energy) and wander randomly through states of higher energy; the slow cooling gives them more chances of finding configurations with lower internal energy than the initial one.

---

[1] Kirkpatrick, S.; Gelatt, C. D.; Vecchi, M. P. (1983). "Optimization by Simulated Annealing". Science 220 (4598): 671-680. doi:10.1126/science.220.4598.671. JSTOR 1690046. PMID 17813860.

[2] Černý, V. (1985). "Thermodynamical approach to the traveling salesman problem: An efficient simulation algorithm". Journal of Optimization Theory and Applications 45: 41-51. doi:10.1007/BF00940812.

[3] Metropolis, Nicholas; Rosenbluth, Arianna W.; Rosenbluth, Marshall N.; Teller, Augusta H.; Teller, Edward (1953). "Equation of State Calculations by Fast Computing Machines". The Journal of Chemical Physics 21 (6): 1087. doi:10.1063/1.1699114.



Synchronization

NOTE : This feature available in version 1.9.5.4.5. and above

In ORA you can now work in synchronization between ORA's Main Interface and ORA's Visualizer. If you position a network visualization window in a manner where you can see the ORA main interface and or any of its visualization windows (e.g., Legend), you can then make changes directly into the Main Interface (e.g, such as changing links in the Editor) and that change will be immediately affect the visualization without any further action from the user.

WGS84 Maps

WGS84

WGS84 is based on satelite measurements.

Glossary

DMS : Degrees, Minutes, Seconds. Historicallly, maps have their scales in degrees and minutes. To use this with WGS it must be converted to decilmal form.

WGS : Stands for World Geodetic System

Map Datum : A smooth surface somewhat arbitrarily defined as zero elevation, consistent with a set of surveyor's measures of distances between various stations, and differences in elevation, all reduced to a grid of latitudes, longitudes, and elevations.

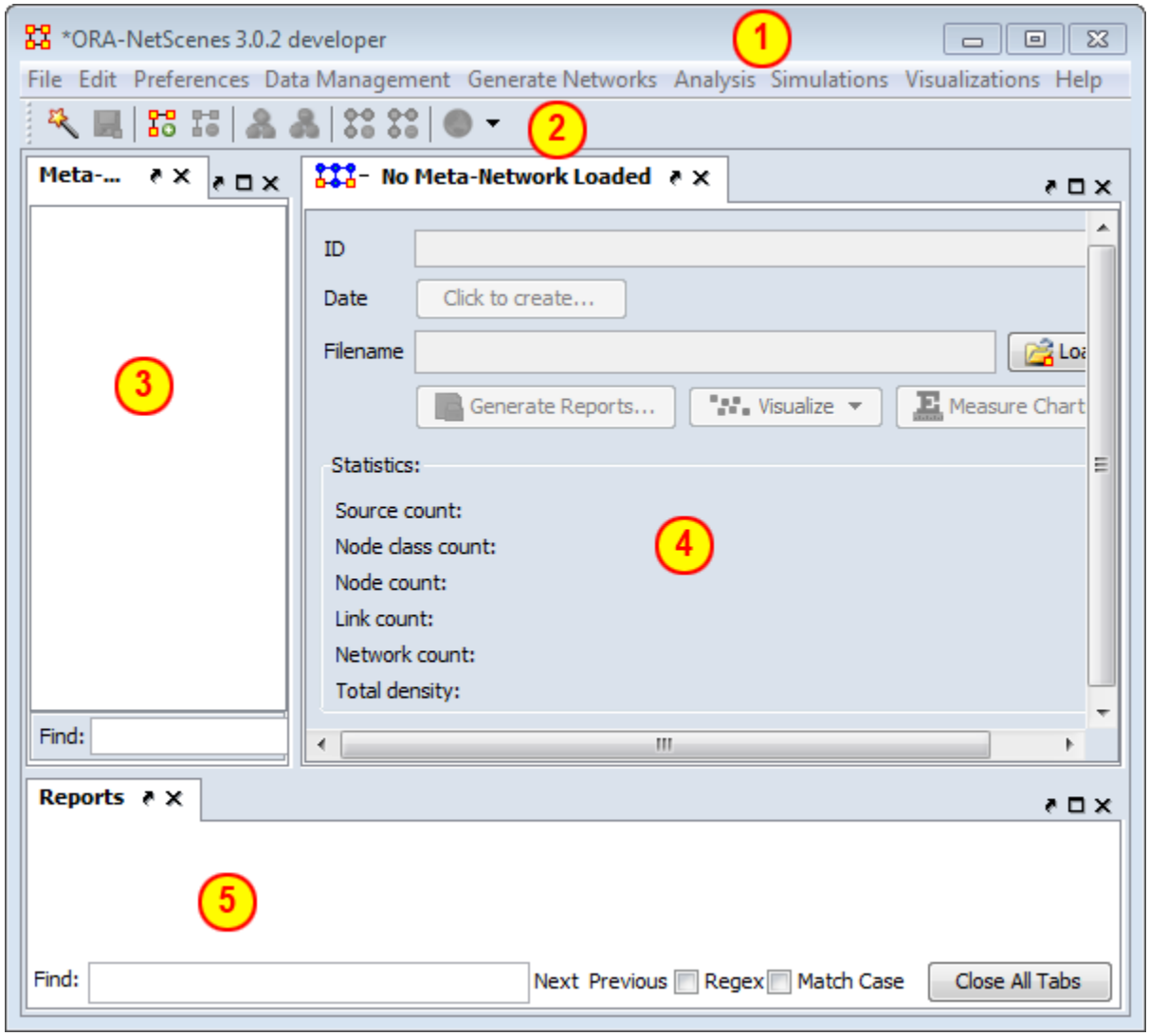
Lat-Long : Stands for **latitude-Longitude**. For example, 50 degrees and 29 minutes north, 123 degrees and 50 minutes west. Latitude-Longitude coordinates are sometimes referred to as the "geodetic grid" which we abbreviate to "Geo". Latitude is written first, followed by the longitude

DMS - Degrees, Minutes, Seconds

As there is no degree symbol [**°**] on the keyboard we use a colon to separate degrees and minutes **50:27.5**. Note can be only one colon. Use a dot is to separate the minutes from the seconds.

ORA's Main Interface

The ORA interface is organized into **five sections**. The menu, the main icons, and three re-sizable panes which are dockable. On each tab are two buttons: **undock and close**. In the upper right corner of each pane are three buttons: **undock, maximize, and close**. This will allow you to arrange the interface to suit your needs.



1 - The Menu

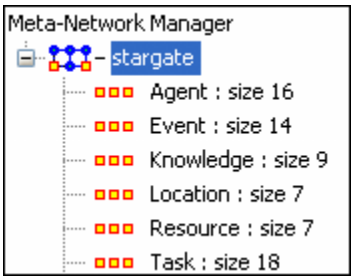
The main source for accomplishing your tasks within the editor. It contains all the functions for managing the Meta-Networks, generating reports and doing analysis.

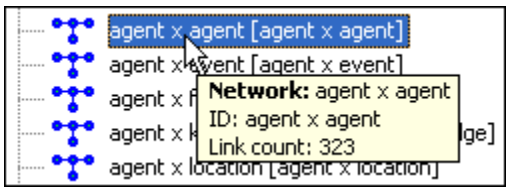
2 - The Icons

Contains the main functions for adding or deleting Meta-Networks, Nodesets, and Networks and importing existing Meta-Networks. Clicking the down-facing triangle brings up a window which allows you to add buttons to the GUI for the functions you use the most.

3 - Meta-Network Manager Pane

This pane contains a tree directory of the current Meta-Network(s) loaded into ORA. This contains the Meta-Networks currently active plus all their Nodesets and Networks. Clicking on the **plus** icon will expand the Meta-Network showing all the Nodesets and Networks and clicking on the **minus** icon condenses the Meta-Network. Hovering the pointer over a graph it will display information about that Network.





4 - Editor Pane

Contains the basic information about the highlighted Meta-Network such as how many nodes are represented. This panel also allows quick access to ORA's Visualizer, Reports and Chart tools. By selecting the Visualize button, the currently loaded Network will render in the ORA Visualizer, which will load in a separate window.

With the Meta-Network selected panel 2 displays the information regarding the Meta-Network itself. The Meta-Network name and pathway at the top. In the bottom, under statistics, are information

regarding the actual Meta-Network including source, node, link, and network counts.

When a Meta-Network is expanded it reveals Nodesets and Networks. Highlighting any of these will reveal information these items.

The Info Tab : Display relevant information whether a Nodeset or Network is highlighted.

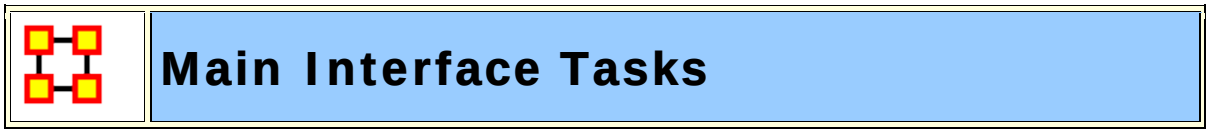
The Editor Tab : Displays the information in a matrix which can be edited in either binary or numeric mode. The data can be directly manipulated in the grid. Nodes, links, and attributes can be added, removed, or edited.

With the **Nodes** and **Attributes** buttons you create, delete, or merge nodes and attributes. The **Find** box assists you in locating particular nodes and attributes.

5 - Reports Pane

This pane is initially empty when ORA is first started up. As reports are run they will be contained within this panel.

NOTE : All three panes can be resized to your preference.



There are a number of tasks that are performed from within the Main Interface to assist in controlling your Meta-Networks, Nodesets, and Networks. These are mostly functions not associated with any of the Menu Items.

Attributes : Adding or Deleting an Attribute and the uses of Attributes.

Attributes Buttons : Controls in the Editor for Attributes.

Clean Button : Helps combine nodes into a single node with slight variances.

Contextual Menus : Right-Clicking of several items brings up a contextual menu of additional functions for various items.

Contextual Menus/Multi-Files : Selecting multiple Meta-Networks and Right-Clicking.

Contextual Menus/Network : Selecting Networks and Right-Clicking.

Contextual Menus/Dynamic Meta-Networks : Selecting a Dynamic Meta-Network and Right-Clicking.

Creating New Meta-Networks : A brief overview of creating a Meta-Network.

Create From Excel : Create a Meta-Network using Excel

Dating Meta-Neworks : Attaching a date to your Meta-Network

Document/URI Attributes : Using Links as Attributes.

Duplicate Items : How to duplicate a Meta-Network, Nodeset, or Network.

Editor Tab-Networks : Description of items and functions in the Editor Tab

Editor Toolbar : Description of the Editor Toolbar functions..

Filters : Setting Filter parameters for searching Nodesets.

Fold Network : How and Why to Fold a Network

Hovering ToolTips : A brief overview of the information given in the tooltips.

ID Names : Description of ID Names and why they are important.

Info Tab-Nodeset : Editor Tabs for Nodesets.

Info Tab-Networks : Editor Tabs for Networks.

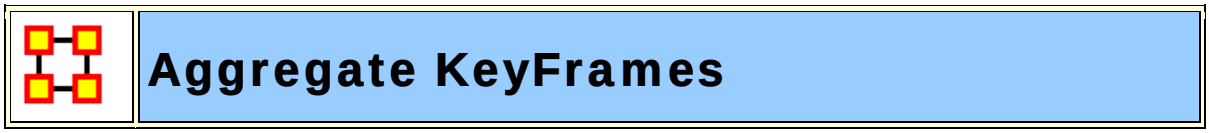
Info Tab-Networks-Statistics : Description of the statistics pane.

Network Editor : Working with the Editor tab with a Network.

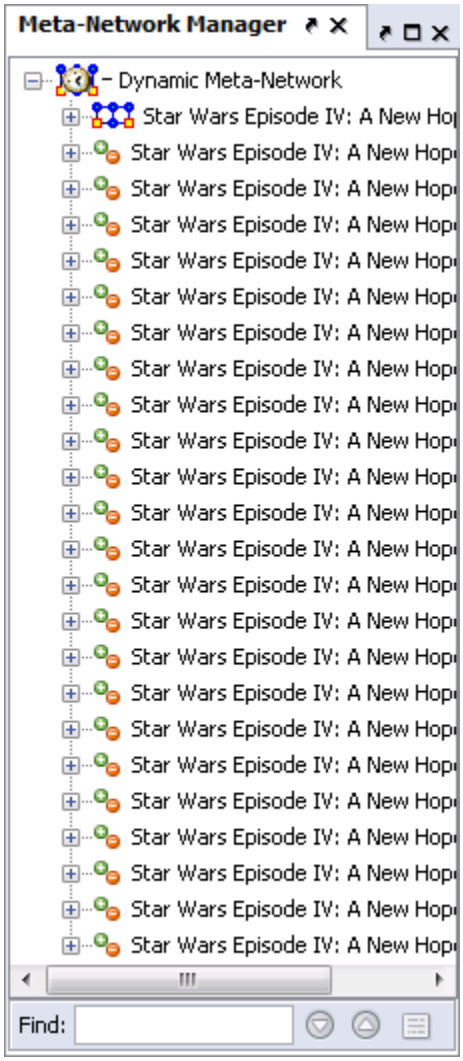
Node Buttons : Description of the buttons in the Editor GUI to work with nodes.

Search : Finding information within the Editor.

Visualize Buttons : The difference between **Visualize this Network** and **Visualize Only this Network** button.



Aggregate KeyFrames

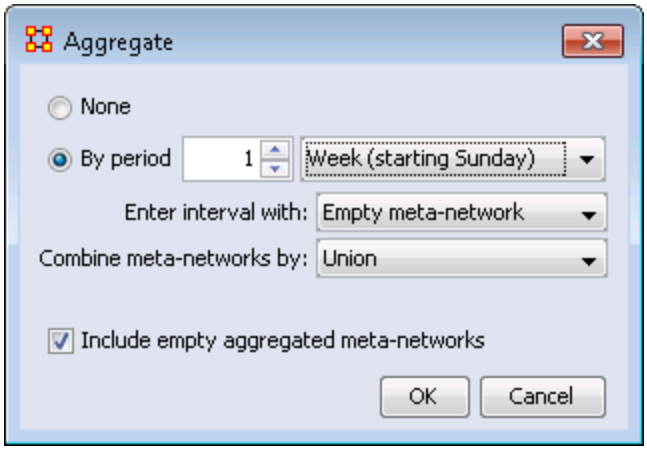


I start out with the Star Wars dataset which consists of 1 keyframe and 23 deltas. Measures can not be run on this in its present form.

The dates for this dataset run from the arbitrary dates **10 NOV 2009 to 21 DEC 2009**. This gives up a choice on how to aggregate the data. The most obvious would be in either weeks or months.

In this example we'll do it by months.

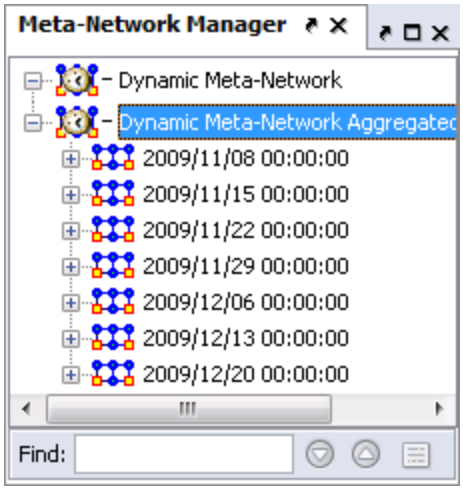
Right-click on the icon with the clock to bring up the contextual menu and select **Aggregate** which brings up the Aggregate dialog box.



Select the radio button **By period**, make sure it says **1** then from the drop down select **Week** [your choice of starting day].

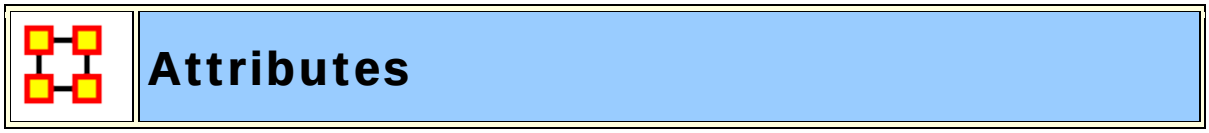
We want to combine by **Union** so all links will be retained.

Click [**OK**].



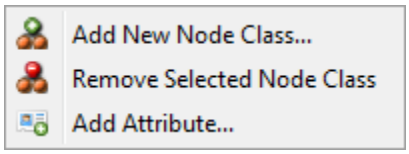
A new Meta-Network will be created containing two KeyFrames each containing one week of data as instructed.

Now each of these KeyFrames can be analyzed individually with any measure.

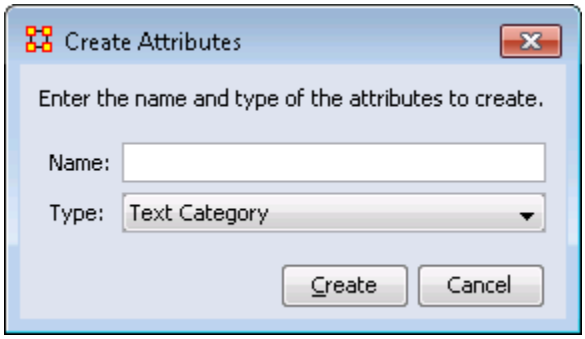


Attributes are extra **containers** that can be attached to an nodes in a Node Set. You can add a **value** to this container. To add an attribute to an Node Set **right-click** on the Node Set Name. This will bring up the contextual menu below.

Add Attribute

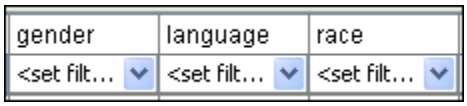


Hightlight a Node Set the right-click to bring up the menu. Then select **Add Attribute...**



Type in the name for your new attribute and select the **Type** form the drop down menu. Your choices are **Text, Text Category, URI, Number Category, Number, or Date**.

Then click [**OK**]. Let's say we want to add other languages spoken by the nodes.



The attribute you added will be inserted **alphabetically** in the editor.

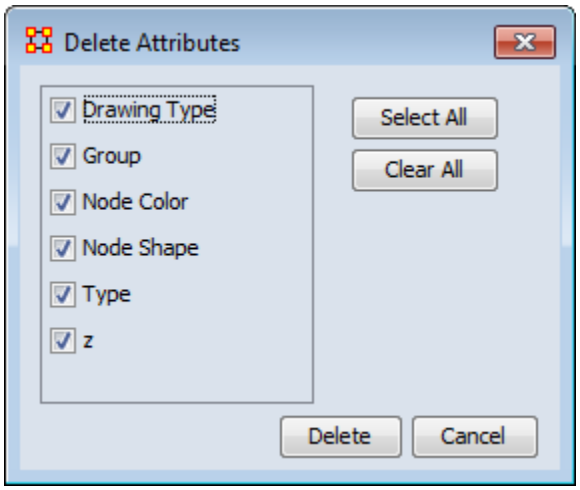


You can now assign any text to this attribute for any of the rows in the Network which can be used later to help define your Network.</td

Edit Attribute

Click the downward triangle to bring up the filter/edit functions. Click the **Edit Attribute** tab. From here you can edit the **Attribute name** and **Attribute type**.

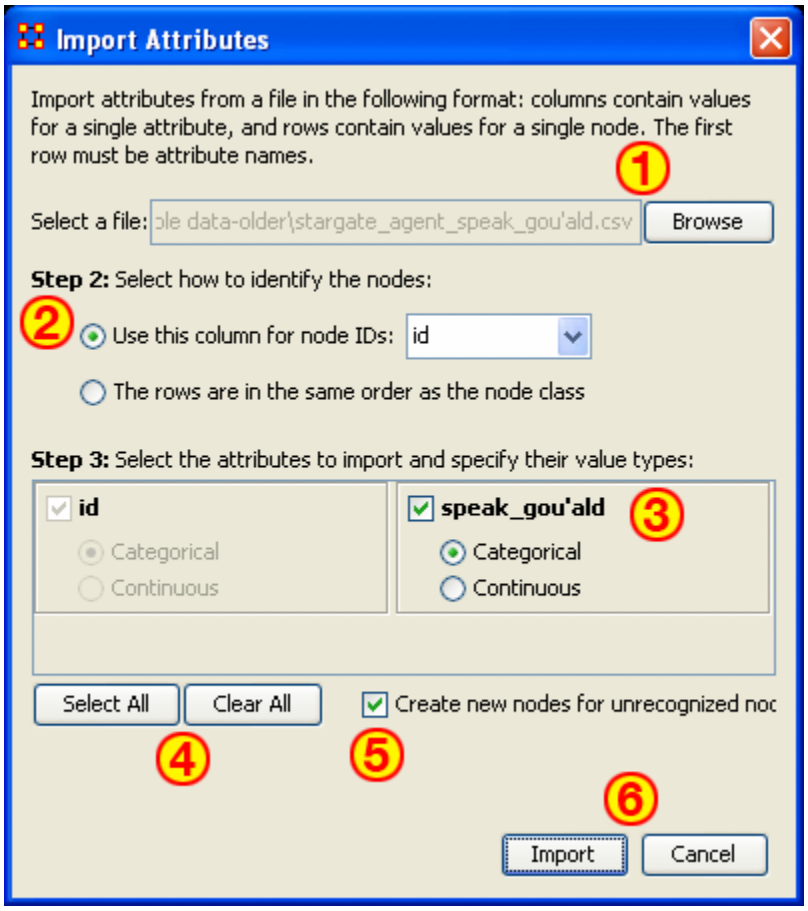
Delete Attribute



And attributes can be removed just as easily by pressing the **Delete** button. The dialog box will present you with a list of attributes. Any attribute with a check mark next to it will be deleted from Meta-Network.

Import Attribute

The **[Import]** button allows for the quick importing or an attribute(s) through the Editor panel. Use a **.csv** file with rows as nodes and columns as attributes. This can be done with, or without, an ID column.



1. Use the Textbox and Browse button to navigate to the csv file with the new attribute(s).
2. Select the radio button to use either **1)** an ID column, or **2)** a file in the same order as Node Set.
3. This section contains all the attributes in the file. If one was chosen to identify the Node Set then it will be greyed out. For attributes NOT greyed out you can chose to make then **Categorical*** or **Continuous***.
4. **Select All / Clear All** buttons places a checkmark in all columns or removes same.
5. Placing a checkmark in the **Create new nodes for unrecognized nodes** creates new nodes into the select Node Set if no node for an attribute currently exists.
6. **Import / Cancel** tells ORA to begin the import or cancel the operation.

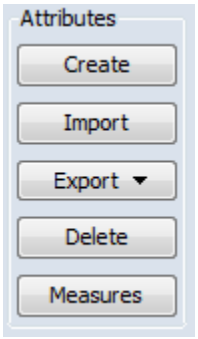
Note: Whenever you set a Node Display Attribute for a Nodeset, the info is also set as an attribute of the nodeset. In other words, Node Display Attributes are now encoded in the data, allowing it to be retained from session to session.



Attribute Buttons

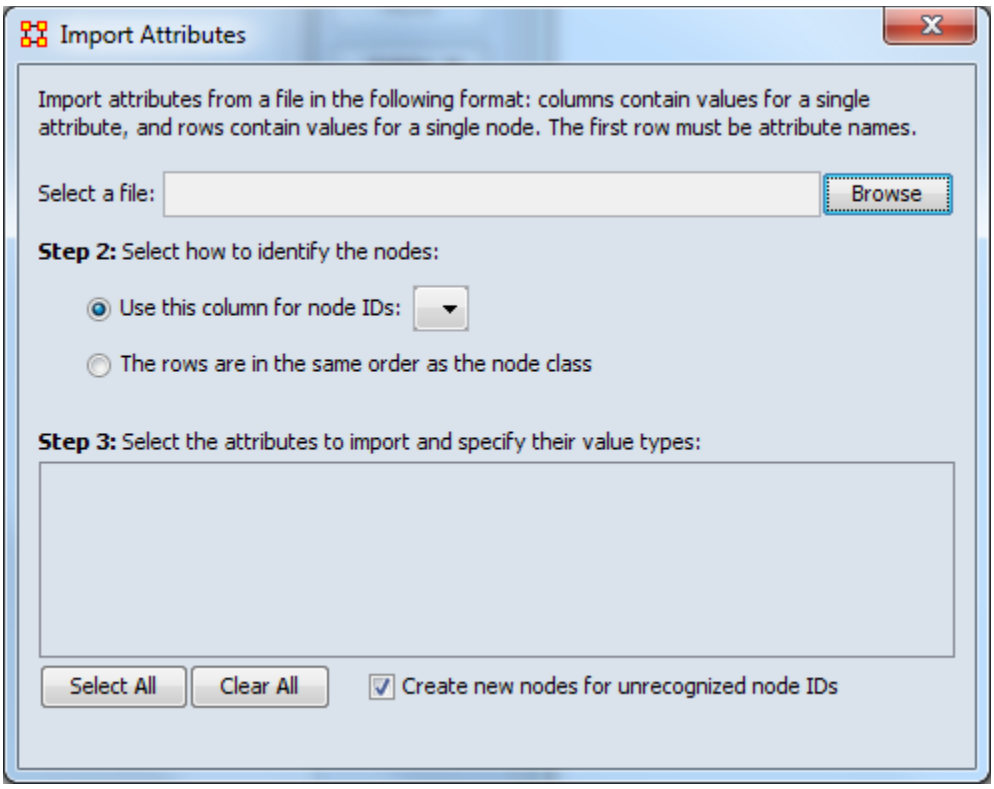
Attribute Buttons

Used within the Editor to manipulate the attributes of a Nodeset.



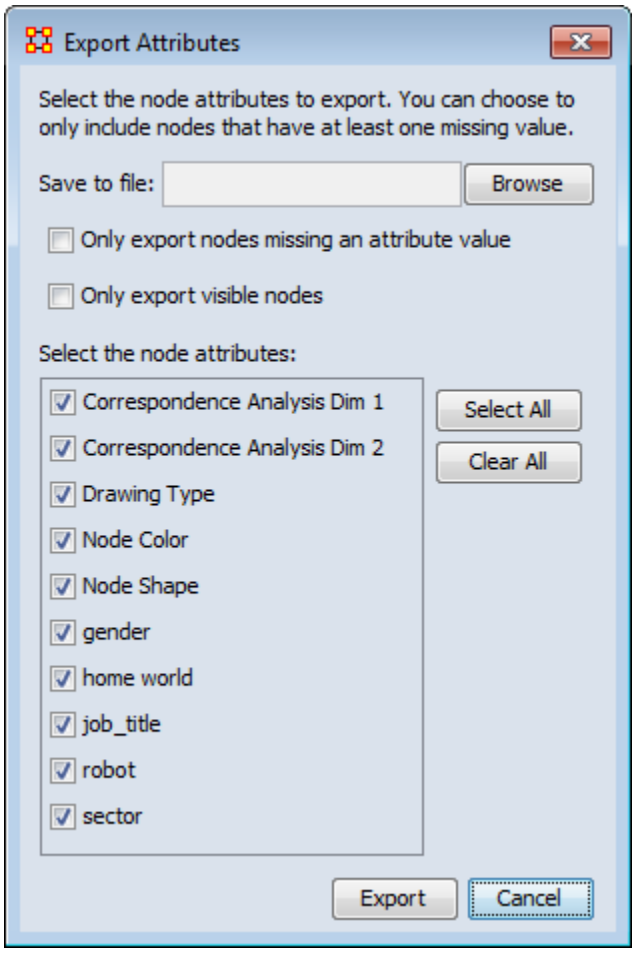
Create : You will be asked for the name of the new attribute as well as the Type: **Text, Text Category, URI, Number Category, Number, Date**.

Import : Import attributes from a file in the following format: columns contain values for a single attribute, and rows contain values for a single node. The first row must be attribute names.

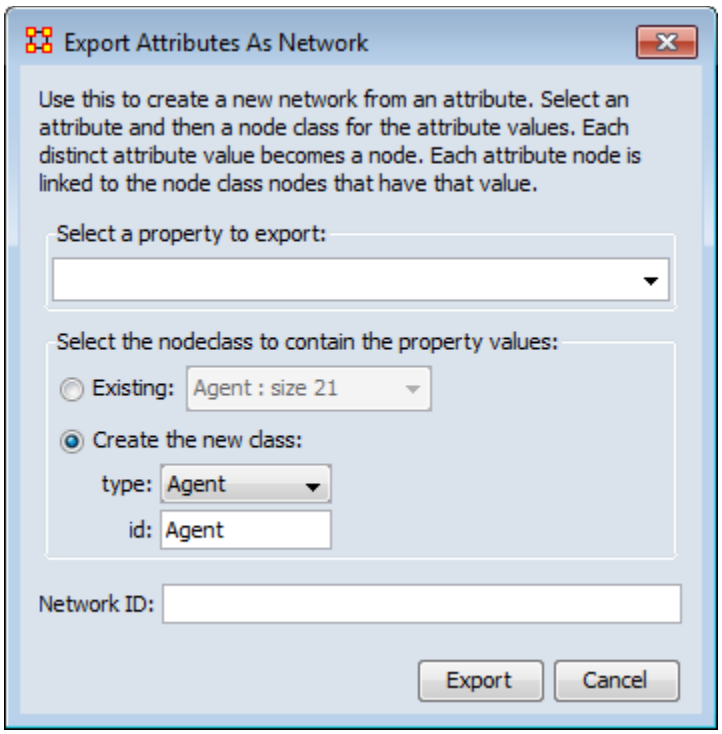


Export :

To a file : Click the [**Browse**] button and select a place to save the file. Place a check mark for the parameters **Only export nodes missing an attribute value** or **Only export visible nodes**. The attributes which have a check mark next to them will be exported to the file.

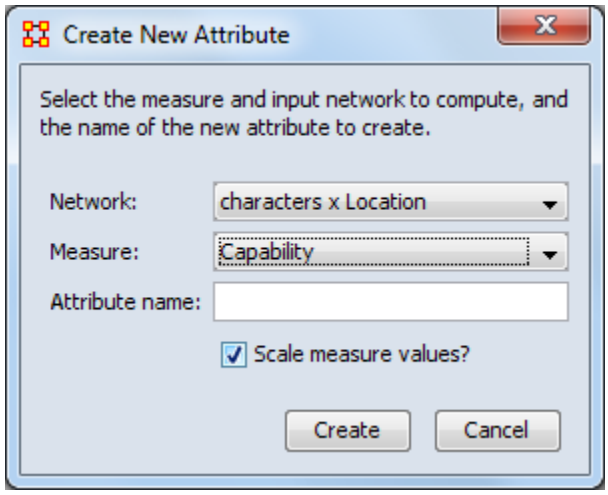


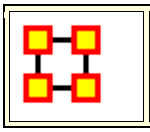
To a network : This allows you to create a new network. Select a property. Next you can either **1]** select an existing Nodeset; or **2]** select a new Node Class. Lastly give this a new Network Name.



Delete : Ora will list the attributes. Place a check mark next to the attributes you want to delete and remove the check mark from attributes you want to keep.

Measures : Select the measure and input network to compute and the name of the new attribute to create.

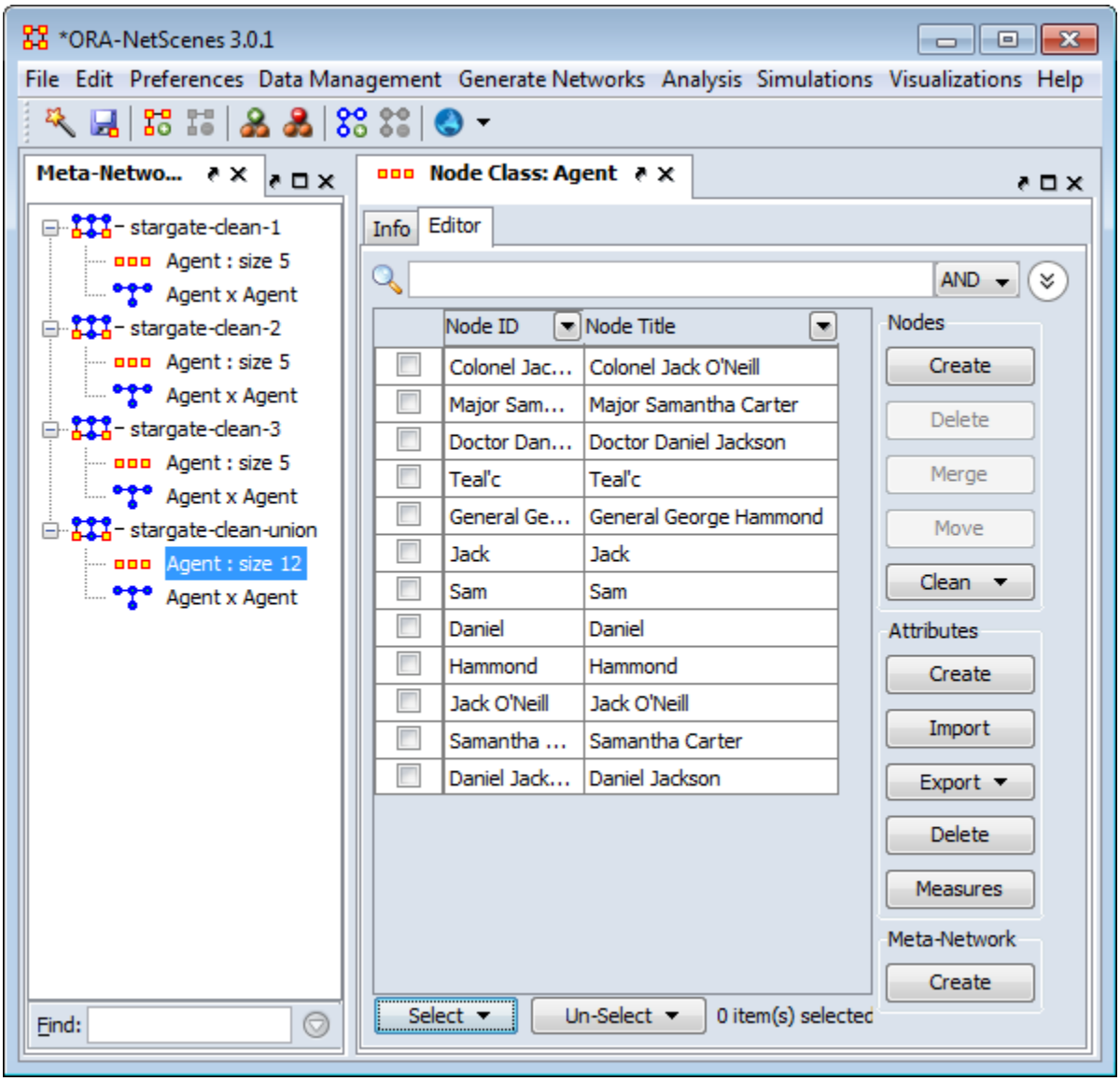




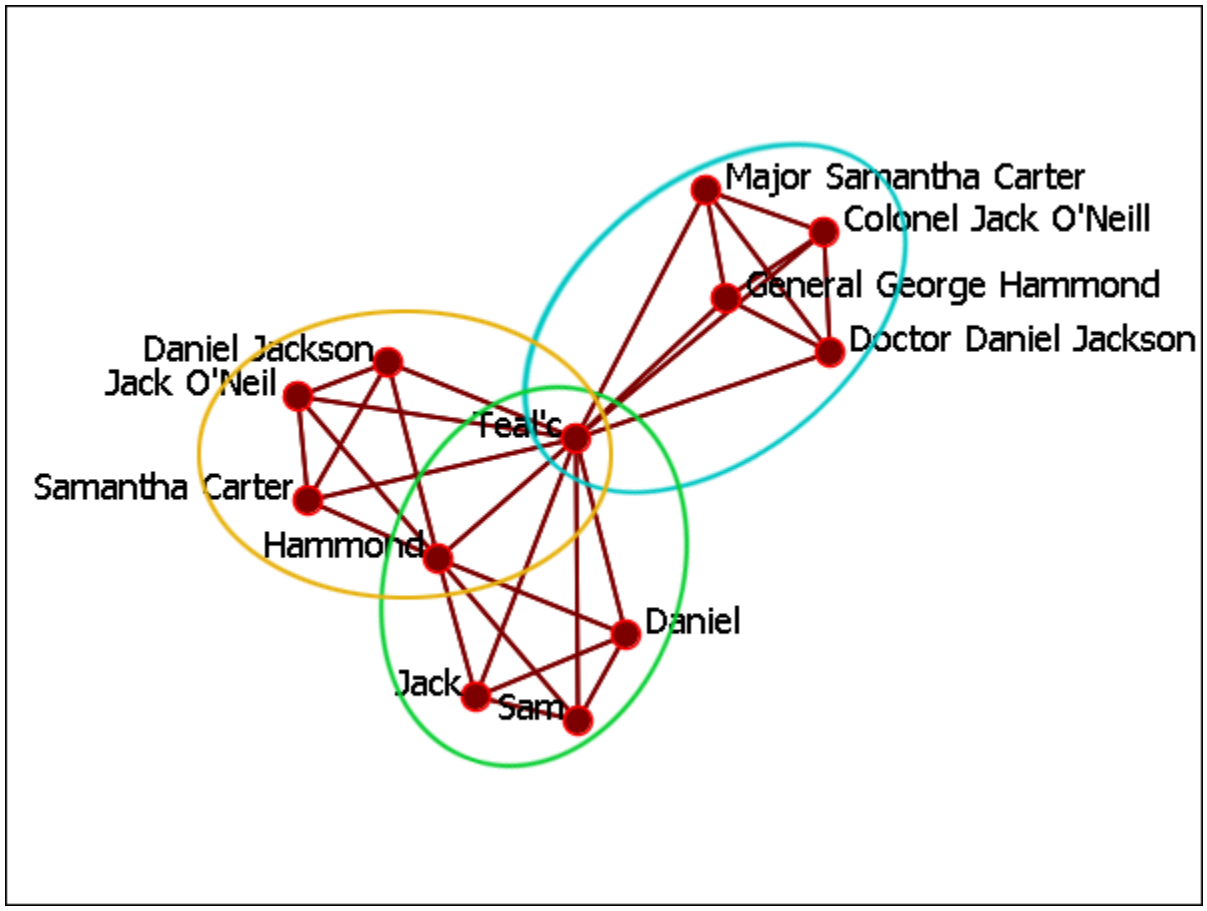
Clean Button

When large datasets are created people's names are after written differently through many different documents. For example you could see someone referred to as **John** in one documents, **John Smith** in another doucments, and **John W. Smith** in yet another document. All three of the these names refer to the same person but in ORA they would be considered different individuals.

The [**Clean**] function is used to condense all the different referenes of one person into a single node. In the example below there are three instances for Colonel Jack O'Neill (Colonel Jack O'Neil, Jack O'Neil, and Jack), three instances for Major Samantha Carter (Major Samantha Cater, Samantha Carter, and Sam), Two instance for Doctor Daniel Jackson (Doctor Daniel Jackson and Daniel Jackson) and finally two instance for General George Hammond (General George Hammond and Hammond).



Visualizing this network makes it appear there are quite a few more people there actually are in the network (12 as opposed to 5).

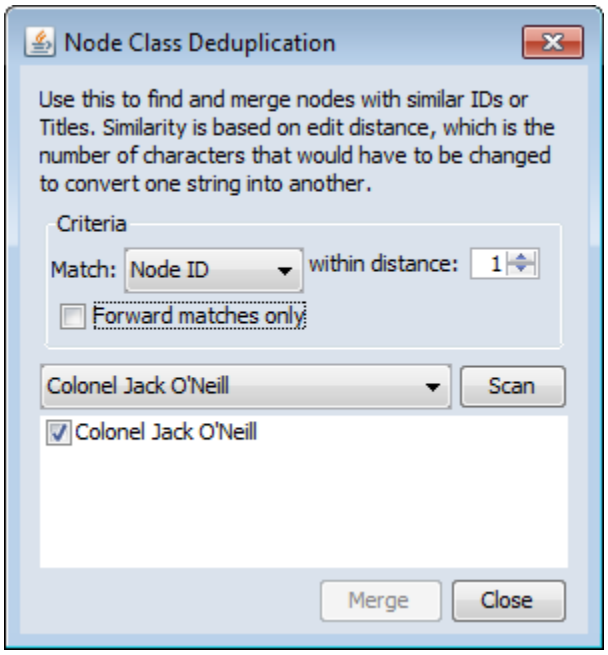


The Clean Button

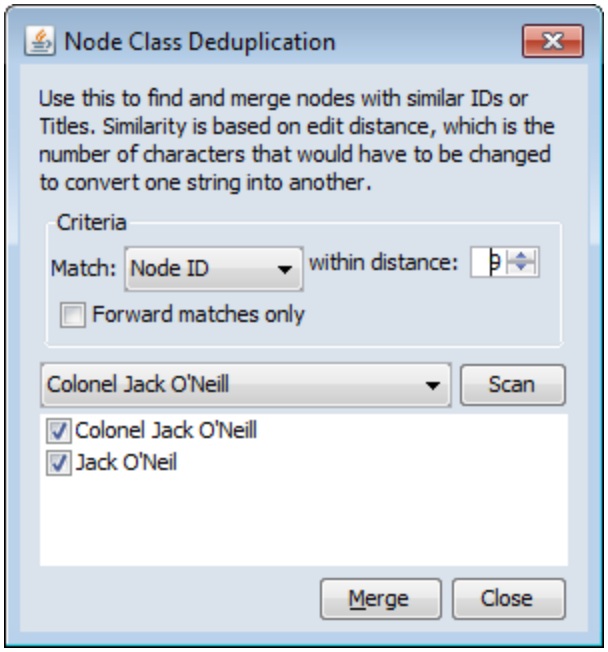
The clean button has multiple functions. Clicking the downward triangle will reveal the menu.

Deduplication

Find and merge nodes with similar IDs or Titles. Similarity is based on edit distance which is the number of characters that would need to be changed to convert one string to another.



From observing in the Editor there are three instances of the agent Jack : **Colonel Jack O'Neill, Jack O'Neil, & Jack**. With the **distance** set to 0 the only agent visible is **Colonel Jack O'Neill**



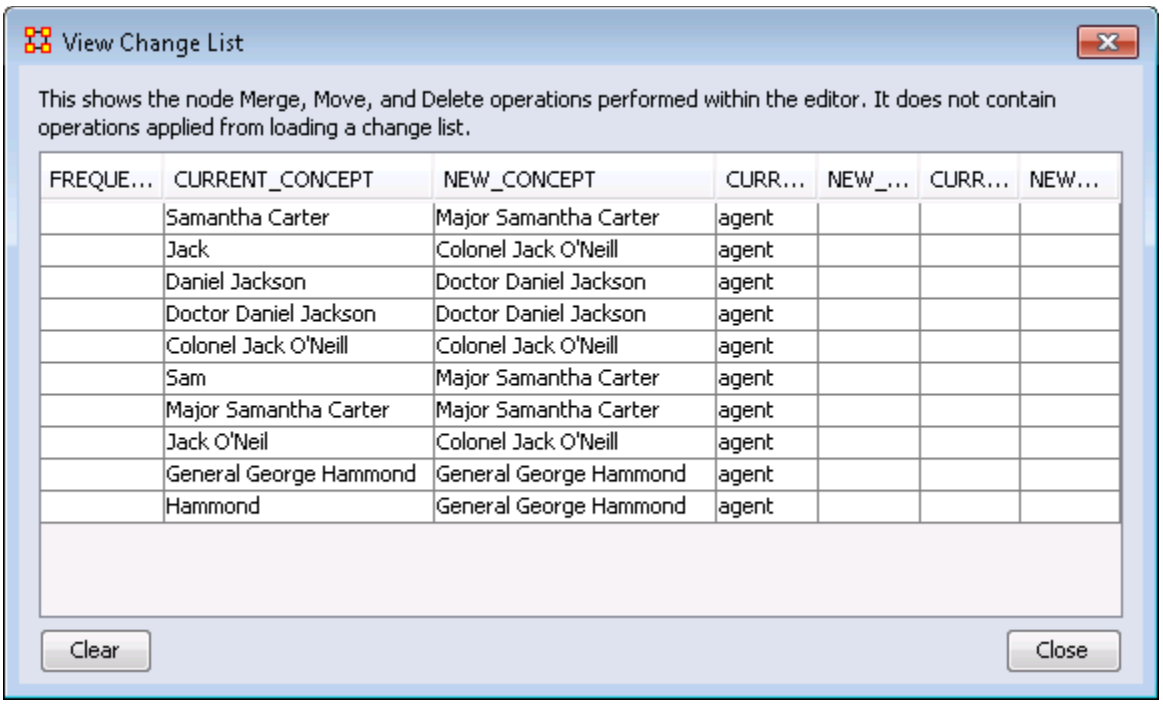
Increasing the Min-Edit to 9 makes visible a second agent, **Jack O'Neil**. The difference between the two agents in the spelling of the surname (one (l) as opposed to two (l)s) and the rank. Clicking the [**Merge**] button will combine these two together into a single node.

Apply Change List

Apply a previously created Change List to the selected Meta-Network.

View Changes

View the current Change List. Click the [**Clear**] button to clear all changes.



NOTE : The Change File can be edited in either Excel or a text editing program.

Save Changes

Allows you to save any modifications that have been done to the current Change List.

Entire Meta-Network

Opens up the Clean Function found on the main menu **Data Management > Meta-Network Clean...** from where you can work with all Nodesets.

The Merge Button

After running the deduplication and merging any duplicates possible the final stage is to use the merge to combine any that may not, for various reasons, be caught by the deduplication process. Place a check mark in the tickybox next to each node to merge then click [**Merge**].

When merging nodes you will be asked for a new ID and Titles and also how to handle the links. There are four options for combining the links of merged nodes.

- **Sum :** Add the weights of all nodes.
- **Minimum :** Examines the link weights and uses the smaller number found.
- **Average :** Examines the link weights and uses the average of all the link weights.
- **Maximum :** Examines the link weights and uses the largest number found.
- **Binary :** If any link is a non-zero then the link becomes a [**1**]. Else it uses [**0**].

There is also an option to record the merged nodes as aliases

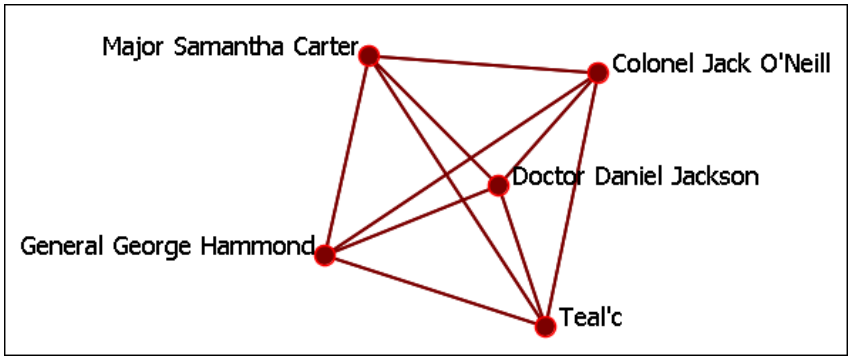
After The Clean And Merge

When you are finished with the **Clean & Merge** your editor grid will reflect the changes. Plus you will see a new columns, **alias**. This will contain all the node Titles/IDs that were eliminated during the process.

	Node ID	Node Title	alias
☐	Colonel Jack O'Neill	Colonel Jack O'Neill	Jack;Jack O'Neil
☐	Major Samantha Carter	Major Samantha Carter	Samantha Carter;Sam
☐	Doctor Daniel Jackson	Doctor Daniel Jackson	Daniel Jackson;Daniel
☐	Teal'c	Teal'c	
☐	General George Ham...	General George Hammond	Hammond

Final

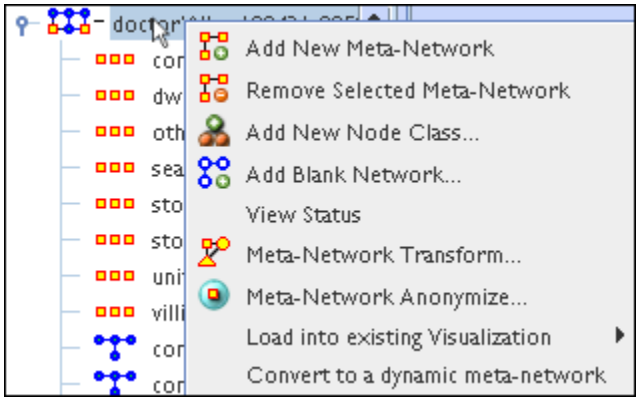
After going through the entire Meta-Network and merging all the same people into single nodes I have ended up with a total of five nodes instead of 12 nodes.



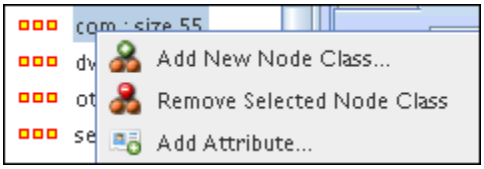
Contextual Menus-Meta-Networks

Right-clicking on any Meta-Network, Nodeset, or Network brings up a contextual menu with the functions available such as add or delete. And within each contextual menu are specialty functions for Meta-Networks, Nodesets, and Networks.

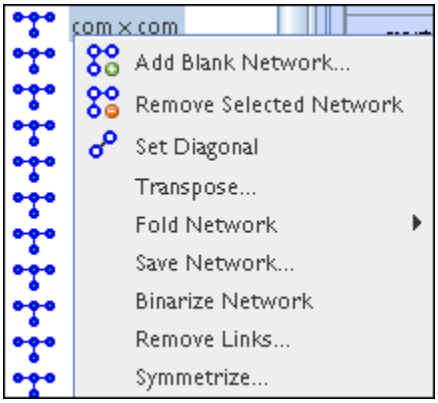
The first four are self-explanatory. Transform… opens up the **Meta-Network Transform…** dialog box.



The first two are self-explanatory. The **Add Attribute …** item opens up the **attribute function** in order to add attributes to a Nodeset.

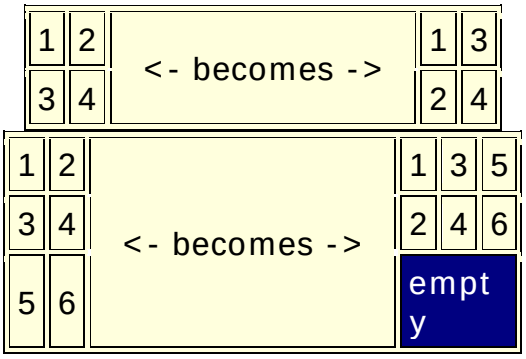


Adding and Removing a Network are fairly self-explanatory. Below is a description of the other functions.



- **Set Diagonal… :** Used on a square network to set cells 1,1 through x,x to the same value. In binary view the choice are **1: True (+1) 2: True (-1) 3: False (0)**. In Numeric view you can put any value into the diagonal.

- **Transpose :** Rotates axis **X** 90 degrees clockwise and mirrors the image horizontally.



- **Fold Network... :** This function creates a new network using matrix algebra. Below are four variations of a **four x four** network and the results when each is folded.

	T1	T2
Knowledge_1	1.0	0.0
Knowledge_2	0.0	0.0

→

	Knowledge_1	Knowledge_2
Knowledge_1	1.0	0.0
Knowledge_2	0.0	0.0

	T1	T2
Knowledge_1	1.0	0.0
Knowledge_2	0.0	1.0

→

	T1	T2
Knowledge_1	1.0	0.0
Knowledge_2	0.0	1.0

	T1	T2
Knowledge_1	1.0	0.0
Knowledge_2	1.0	0.0

→

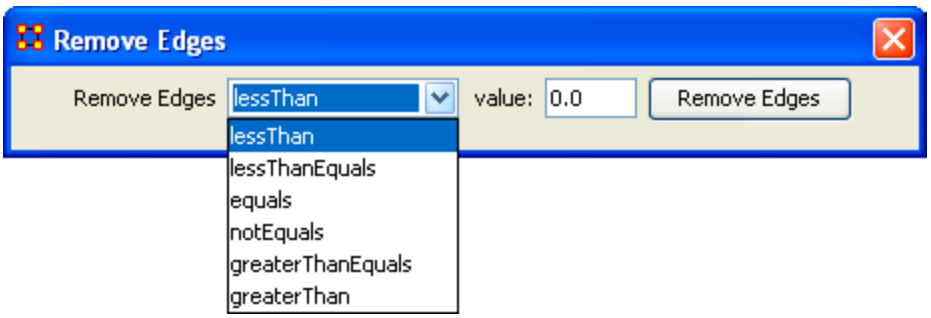
	Knowledge_1	Knowledge_2
Knowledge_1	1.0	1.0
Knowledge_2	1.0	1.0

	T1	T2
Knowledge_1	1.0	1.0
Knowledge_2	0.0	0.0

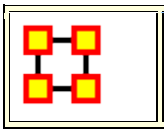
→

	Knowledge_1	Knowledge_2
Knowledge_1	2.0	0.0
Knowledge_2	0.0	0.0

- **Save Network... : (also called Exporting a Network) Any Network can be saved individually to a file in one of the following formats: CSV***, DL, **DyNetML***, or UCINET (.##h). Also check **File Formats** for more information
- **Binarize Network :** Turns all **non-zero numbers** to **[1]** and leaving all **[0]** untouched.
- **Remove Links... :** Removes links in accordance to the selection in the dropdown menu (as seen in the images below).



- **Symmetrize... :**

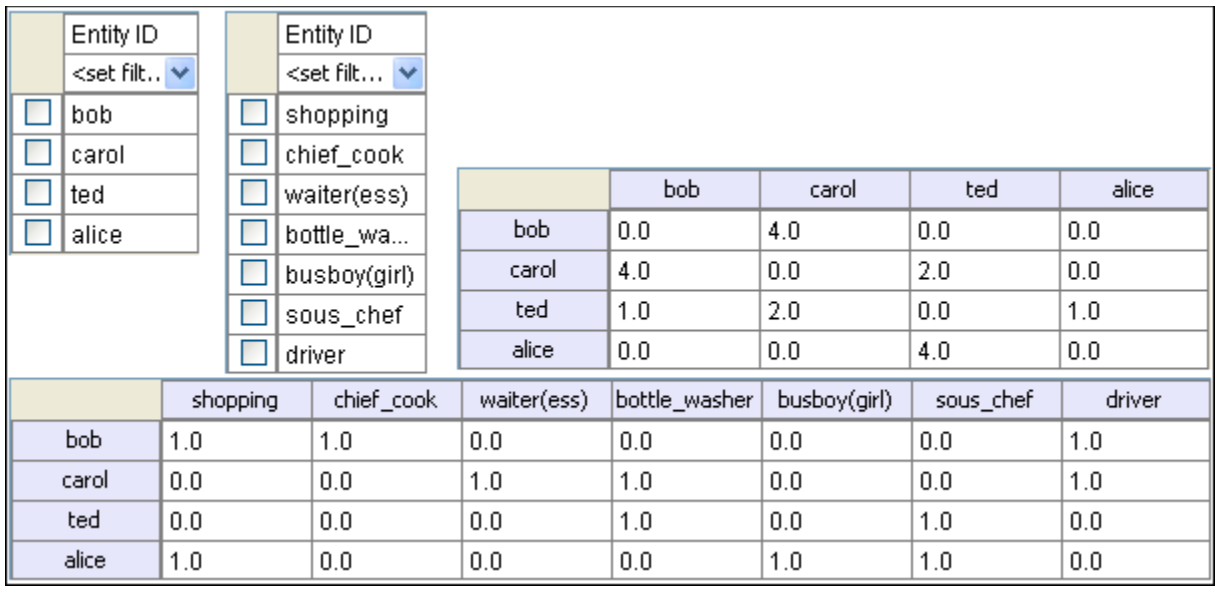


Contextual Menus-Multi Files

Includes: *Union Meta-Networks, Intersect Meta-Networks, Conform Meta-Networks*

There's also a separate contextual menu when you've got two or more Meta-Networks selected. Open up multiple Meta-Networks in the Main Interface. Load two or more files into Panel 1. We'll demonstrate this on two Meta-Networks containing Bob, Carol Ted, & Alice. The agents are identical but the tasks in each are different, except for **driving** which appears in both and has slightly different values. Inbetween the time of cookingIn and eatingOut Alice's feelings for Ted have grown.

CookingIn and



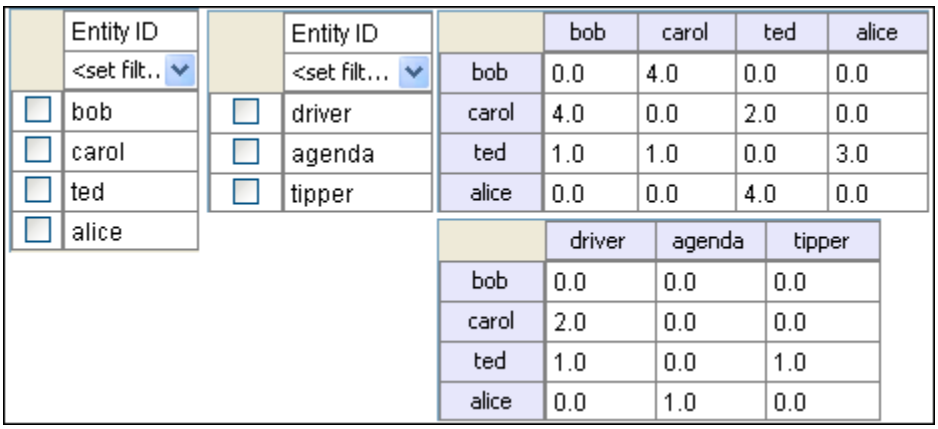
Entity ID <set filt..
bob
carol
ted
alice

Entity ID <set filt...
shopping
chief_cook
waiter(ess)
bottle_wa...
busboy(girl)
sous_chef
driver

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	2.0	0.0	1.0
alice	0.0	0.0	4.0	0.0

	shopping	chief_cook	waiter(ess)	bottle_washer	busboy(girl)	sous_chef	driver
bob	1.0	1.0	0.0	0.0	0.0	0.0	1.0
carol	0.0	0.0	1.0	1.0	0.0	0.0	1.0
ted	0.0	0.0	0.0	1.0	0.0	1.0	0.0
alice	1.0	0.0	0.0	0.0	1.0	1.0	0.0

EatingOut



Entity ID <set filt..
bob
carol
ted
alice

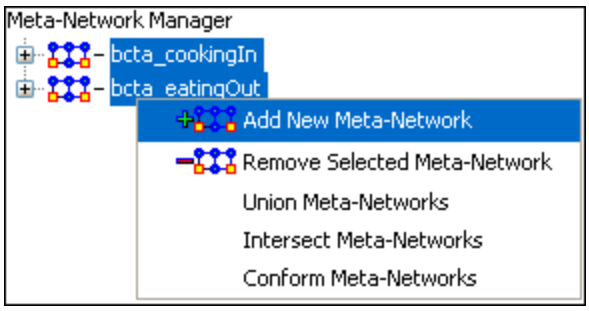
Entity ID <set filt...
driver
agenda
tipper

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	1.0	0.0	3.0
alice	0.0	0.0	4.0	0.0

	driver	agenda	tipper
bob	0.0	0.0	0.0
carol	2.0	0.0	0.0
ted	1.0	0.0	1.0
alice	0.0	1.0	0.0

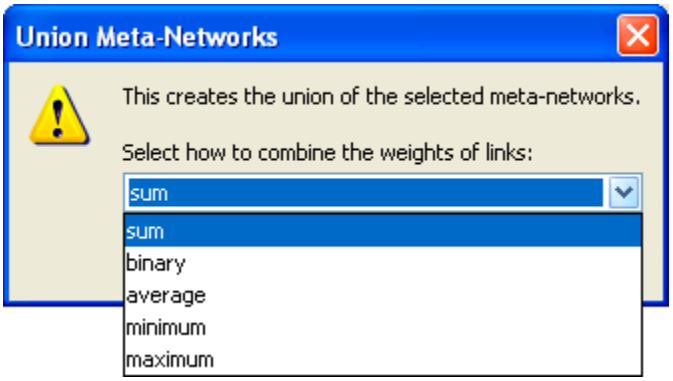


Highlight both of them by holding down the **[Control]** while clicking on each file. Then **Right-click** on one of the files. This brings up the contextual menu.



The **Add New Meta-Network & Remove Selected Meta-Network** are self-explanatory.

The Union Meta-Network will create a **new** Meta-Network using one of five actions: **sum, binary, average, minimum, or maximum**.



- **Sum :** In any identical network **all** values from **all** networks are added together. (i.e. bob's score of 4.0 in both meta-networks are added together for a total of 8.0).

	bob	carol	ted	alice
bob	0.0	8.0	0.0	0.0
carol	8.0	0.0	4.0	0.0
ted	2.0	3.0	0.0	4.0
alice	0.0	0.0	8.0	0.0

- **Binary :** Then in the binary option it doesn't matter what numbers appeared in either meta-network as it uses **only 1 or 0** as a result. If any cell has a **non-zero** it will contain a 1 as a result.

	bob	carol	ted	alice
bob	0.0	1.0	0.0	0.0
carol	1.0	0.0	1.0	0.0
ted	1.0	1.0	0.0	1.0
alice	0.0	0.0	1.0	0.0

- **Average :** This option takes the **sum of all identical cell values and divides them by the number of cells used. In cookingInted x alice** contained a 2 while in **eatingOut** the value for **ted x alice** was a 1. This was averaged out to 1.5.

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	1.5	0.0	2.0
alice	0.0	0.0	4.0	0.0

- **minimum :** This function finds the smallest value in any identical cells and uses that in the final result. (i.e. for **ted x carol** and **ted x alice** both cells use the smaller value of "1" even though they are from different meta-networks.

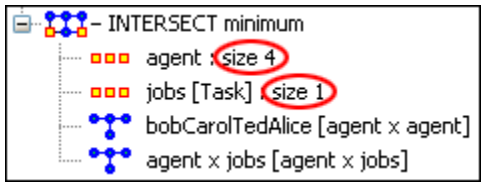
	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	1.0	0.0	1.0
alice	0.0	0.0	4.0	0.0

- **Maximum :** This function finds the largest value in any identical cells and uses that in the final result. (i.e. for **ted x carol** and **ted x alice** both cells use the larger value of "2" and "3" respectively, each taken from a different meta-network.

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	2.0	0.0	3.0
alice	0.0	0.0	4.0	0.0

Intersect Meta-Network works similar to the Union function and has the same five options. But in creating the new Meta-Network only nodes that appear in all Meta-Networks are carried over to the new Meta-Network.

For example: All four agents appear in both Meta-Networks and are brought over into the new Meta-Network. But though there were **six tasks** in the cookingIn and **three tasks** in eatingOut there is only **one task (driver)** in the new Meta-Network created from the intersect function. Only nodes found in all Meta-Networks are brought over.

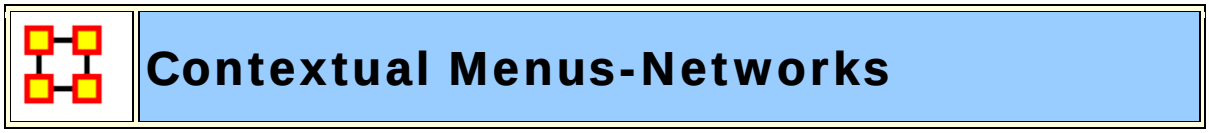


And even though **bob** has a value for driver in **cookingIn** only carol has a value for driver in both Meta-Networks.

	bob	carol	ted	alice
bob	0.0	4.0	0.0	0.0
carol	4.0	0.0	2.0	0.0
ted	1.0	2.0	0.0	1.0
alice	0.0	0.0	4.0	0.0

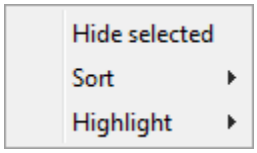
	driver
bob	0.0
carol	1.0
ted	0.0
alice	0.0

Conform Meta-Network alters the selected Meta-Networks and makes them equal. **union** adds nodes that are found in one Meta-Network but not the other. **intersect** removes nodes that are not common to both.



Contextual Menus-Networks

Right-clicking on any network brings up the contextual menu with a set of functions for working with Networks.



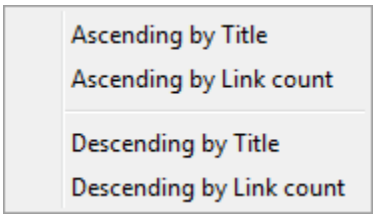
Hide selected

Select one or more rows or columns. Then right-click to bring up the contextual menu. Selecting **Hide Selected** will remove the selected rows or columns from the display.

NOTE : They are hidden for as long as you have the current network viewed. Clicking anywhere else in the Editor then returning back to the previous Network will reveal all rows or columns which were hidden.

Sort

The order which nodes are displayed is the default order they were entered. ORA gives you four different ways to display these same nodes.

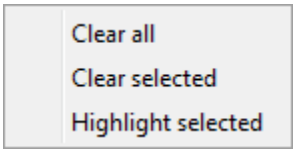


- **Ascending by Title A↓Z :** Arranges nodes in alpha order lowest to highest.
- **Ascending by Link Count :** Arranges nodes in order of number of links from lowest to highest.
- **Descending by Title Z↓A :** Arranges nodes in alpha order highest to lowest.
- **Descending by Link Count :** Arranges nodes in order of number of links from highest to lowest.

NOTE : Nodes will retain their sort order for the duration they are displayed on the screen. Changing this view and returning to a network will place the nodes back in their original order.

Hightlight

Highlights or clears selected nodes.



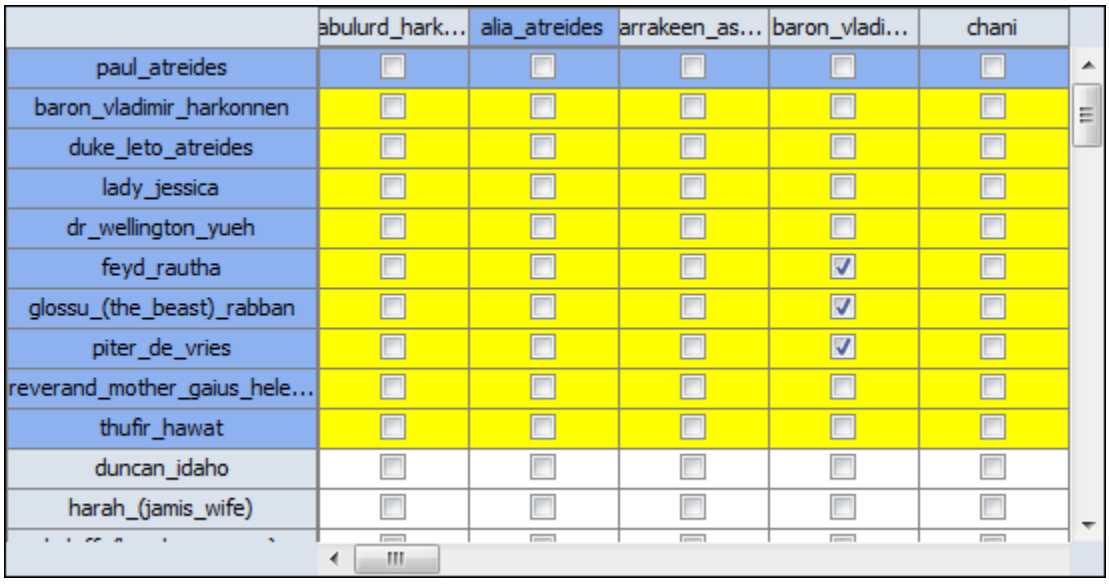
- **Clear all :** Clears the highlight from all nodes.
- **Clear selected :** Clears the highlight from only the selected nodes.
- **Hightlight selected :** Highlights all nodes currently selected.

Example

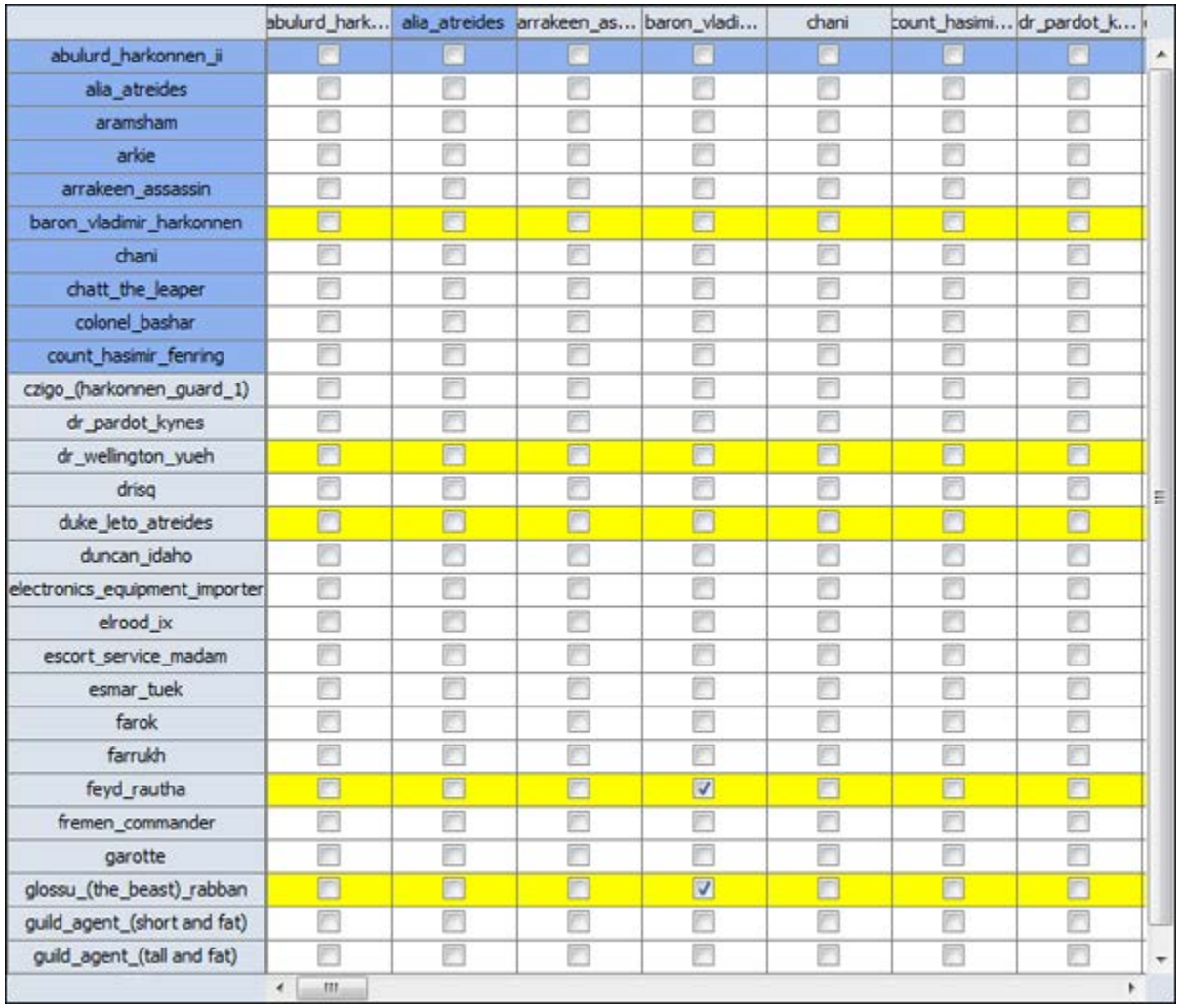
First I sorted the agents by [**Right-Clicking**] on any agent and selecting **Sort > Descending by link count** so the nodes with the highest numbers of links would rise to the top. I clicked on **paul_atreides**, counted down ten agents, and [**Shift-Clicked**] on **thufor_hawat**. This selected the ten agents with the most links.



Hovering over any of the selected agents I [**Right-Clicked**] bringing up the contextual menu. I select **Hightlight > Highlight selected**. This placed a yellow highlight over the top ten agents.

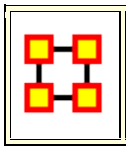


I wanted the list sorted by name again so I [**Right-Clicked**] and selected **Sort > Ascending by title.**



	abulurd_hark...	alia_atreides	arrakeen_as...	baron_vladi...	chani	count_hasimi...	dr_pardot_k...
abulurd_harkonnen_ii	☐	☐	☐	☐	☐	☐	☐
alia_atreides	☐	☐	☐	☐	☐	☐	☐
aramsham	☐	☐	☐	☐	☐	☐	☐
arkie	☐	☐	☐	☐	☐	☐	☐
arrakeen_assassin	☐	☐	☐	☐	☐	☐	☐
baron_vladimir_harkonnen	☐	☐	☐	☐	☐	☐	☐
chani	☐	☐	☐	☐	☐	☐	☐
chatt_the_leaper	☐	☐	☐	☐	☐	☐	☐
colonel_bashar	☐	☐	☐	☐	☐	☐	☐
count_hasimir_fenring	☐	☐	☐	☐	☐	☐	☐
czigo_(harkonnen_guard_1)	☐	☐	☐	☐	☐	☐	☐
dr_pardot_kynes	☐	☐	☐	☐	☐	☐	☐
dr_wellington_yueh	☐	☐	☐	☐	☐	☐	☐
drisq	☐	☐	☐	☐	☐	☐	☐
duke_leto_atreides	☐	☐	☐	☐	☐	☐	☐
duncan_idaho	☐	☐	☐	☐	☐	☐	☐
electronics_equipment_importer	☐	☐	☐	☐	☐	☐	☐
elrood_ix	☐	☐	☐	☐	☐	☐	☐
escort_service_madam	☐	☐	☐	☐	☐	☐	☐
esmar_tuek	☐	☐	☐	☐	☐	☐	☐
farok	☐	☐	☐	☐	☐	☐	☐
farrukh	☐	☐	☐	☐	☐	☐	☐
feyd_rautha	☐	☐	☐	☑	☐	☐	☐
fremen_commander	☐	☐	☐	☐	☐	☐	☐
garotte	☐	☐	☐	☐	☐	☐	☐
glossu_(the_beast)_rabban	☐	☐	☐	☑	☐	☐	☐
guild_agent_(short and fat)	☐	☐	☐	☐	☐	☐	☐
guild_agent_(tall and fat)	☐	☐	☐	☐	☐	☐	☐

NOTE : Highlighting works in the same manner with regards to columns.



Contextual Menus - Dynamic Meta-Networks

The Meta-Network with a Clock signifies a special type of Meta-Network.

In the Meta-Network Panel click the [**+**] button to the left of the icon to expand the contents. Clicking on any of the just revealed icons will display te contents of the individual components. The first one (with the regular Meta-Network icon) contains the general data. Each of the other components are the individual timeslices within the dataset which also contain the same number of Nodesets and Networks.

Right-clicking on any Meta-Network with the clock icon brings up the contextual menu to work with these types of files.

Contextual Menu for Dynamic Meta-Network

Remove Selected : Remove selected Meta-Networks from ORA.

Import Keyframes... : Merges the new Keyframe into the Selected Meta-Network based on the new date. If the new Keyframe has no date it will be placed at the beginning of the Dynamic Meta-Network.

Import Keyframes as deltas... :

Create a new delta... : Add new delta either at the end of the all time periods or inserted after a specific date.

Aggregate... : Combine data from individual parts of Meta-Network determined by parameters.

MetaNetwork Transform... : Use to transform each keyframe in the Dynamic Meta-Networlk according to the parameters selected.

Contextual Menu for Keyframe

Add New Meta-Network : Create Blank Meta-Network

Remove Selected Meta-Network : Remove Selected Meta-Networks from ORA.

Add New Node Class... : Create Blank Node Class in Selected Meta-Network.

Add Blank Network... : Add blank Network to Selected Meta-Network

View Status :

Meta-Network Transform... : Use to transform each keyframe in the Dynamic Meta-Networlk according to the parameters selected.

MetaNetwork Anonymize... :

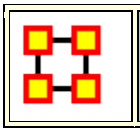
Contextual Menu for Other Deltas

Insert Keyframe : Inserts new KeyFrame after Selecte Delta. This Keyframe will containall the information from the previous Delta which can then be modified by additions, Deletions, and modifications.

Convert to Keyframe : Converts a Delta into a Keyframe.

NOTE : You can not convert a Keyframe into a Delta.

Create New Delta : Create a new Delta. You can choose to add one to the end of the time by various increments or use the **Custom date** function to insert it into the list. The new Delta will contain all the information from the previous Delta or Keyframe.



Create a New Meta-Network

What follows are procedures for creating a new Meta-Network.

There are times you need to run measures on or visualize only part of an existing Meta-Network. This section will show you the easy way to create sub-sets of an existing Meta-Network.

First **duplicate the Meta-Network**. Highlight the Meta-Network then from the main menu select **Edit > Copy Meta-Network**. Then from the main menu select **Edit > Paste Meta-Networks**. It would be a good idea to rename this new Meta-Network immediately so as to not get it confused with the original. You can do this in the Editor tab, see **Renaming**.

Next, expand the Meta-Network you want by clicking the **[+]** if it isn't expanded already. Highlight the Nodeset with the nodes you want to remove.



In panel 2 select the **Editor tab** which brings up the matrix with nodes on the vertical and attributes on the horizontal. Below each attribute is a **<set filter>**. Below left is the **stargate_summit** meta-network along with the **ally** attribute. I wish to make a new meta-network of the **good guys** only. In the dropdown menu under ally I select **no**. These are the nodes I want to remove.

	Entity ID	Entity Title	ally
	<set filt..	<set filt...	<set filt..
☐	A01	col_jack_...	yes
☐	A02	maj_sam...	yes
☐	A03	daniel_jac...	yes
☐	A04	teal'c	yes
☐	A05	jacob_cart...	yes
☐	A06	lt_elliott	yes
☐	A07	ren'al	yes
☐	A08	aldwin	yes
☐	A09	janet_frazier	yes
☐	A10	maj_man...	yes
☐	A11	gen_ham...	yes
☐	A12	lantash	yes
☐	A13	narim	yes
☐	A14	travell	yes
☐	A15	osiris	no
☐	A16	yu	no

ally
<set filt...
<set filter>
yes
no

	Entity ID	Entity Title	ally
	<set filt..	<set filt...	no
☐	A15	osiris	no
☐	A16	yu	no

Place a checkmark in the box of each node. Below the matrix in the section called **Nodes** are three buttons. Click the **[Delete]** button. The Nodeset now contains only the nodes that had **yes** in the attribute **ally**.



With this same procedure I created a Meta-Network of only the **allies**.

Create Meta-Network from Excel File

If you don't have a Network, you can create one from scratch. Below is step-by-step instruction on how to do this in Excel.

We will create an square, agent-by-agent Network. We say it is **square** because all row headings correspond directly to column headings. This is important as it relates to specific measures ORA can run on a graph. If the graph is not square, some measures will not work.

Open a blank Microsoft Excel work book. In **column A** we will enter the name of all the nodes that make up our social network or organization.

NOTE : When creating your spreadsheet, do not add any additional titles, notes, or other headings, which will interfere with the "square" properties of the Network.

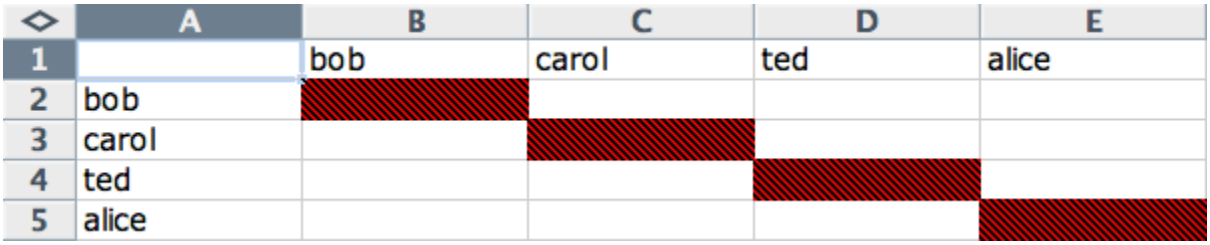
	A	B	C	D	E
1					
2	bob				
3	carol				
4	ted				
5	alice				

Next, create column headings using the correlating names as they appear in row headings. Again, this will ensure that our Network will be square.

	A	B	C	D	E
1		bob	carol	ted	alice
2	bob				
3	carol				
4	ted				
5	alice				

Next we will create **links** between each agent. We do this by entering a **1** if a direct connection or relationship exists and a **0** if it does not. Please note that headings that cross-reference themselves are considered redundant and thus are left blank or **0**.

In the example below, **Redundant cells** [i.e., the diagonel] are filled in with red strips to illustrate the self-loops. This redundancy should continue as a smooth diagonal line from the top left corner of your Network to the bottom right.



NOTE : If you don't end up with a diagonal line then your graph is not square.

Using **1**s and **0**s to establish link, complete your spreadsheet.

In the Network example, we have assigned links randomly. Within your organization or network, however, you can describe any direct connections or relationships you are interested in analyzing. For instance, you may determine that a direct connection exists if agents within your network consult with each other at least once a month; literally, it can be anything you decide.

Below is our completed Network (The red fill illustrates cells that do not require input due to their **redundancy***).

	A	B	C	D	E
1		bob	carol	ted	alice
2	bob		1	0	0
3	carol	1		1	0
4	ted	1	1		1
5	alice	0	0	1	

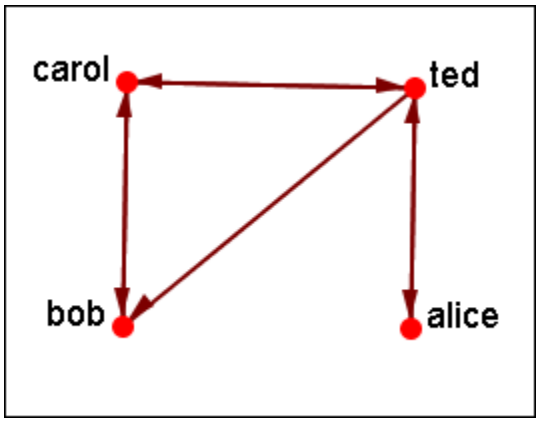
Now that we have essentially built a Network from scratch using Excel, the next step is to save it in a compatible file format ORA can interpret. For Excel spreadsheets this will be the **CSV*** file format.

From the main menu select **File ⇒ Save As**

Make sure you save this file as a **CSV (comma delimited)**

You have now created a Network from scratch which can be loaded into ORA.

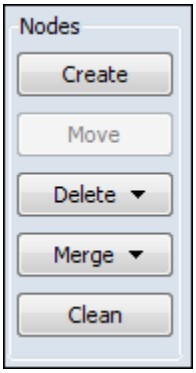
Now return to ORA and load up your new Network. Below is a our new Network rendered in the ORA Visualizer. Notice the arrows only point from one node to another if there is a 1 in the column for a particular node. **i.e. There is a "1" in the bob column for ted but a "0" in the ted column for bob. So an arrow points from ted to bob but NOT from bob to ted**.



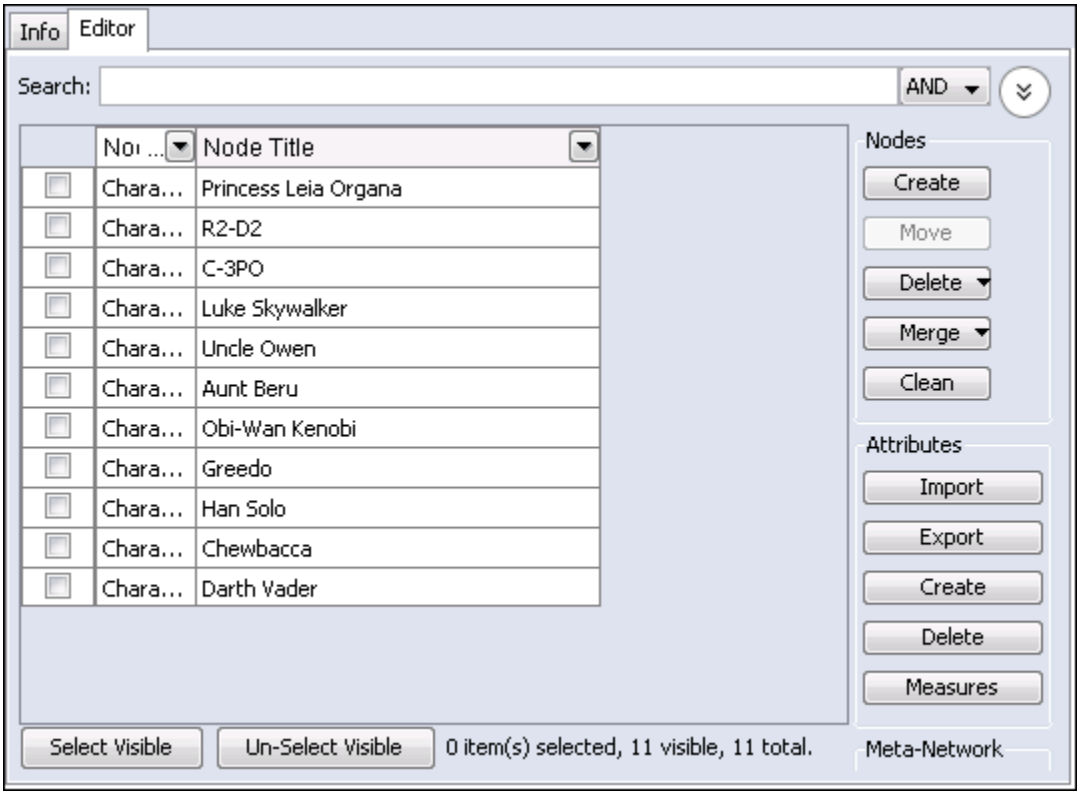
For a more in-depth explanation for creating Meta-Networks see the **lessons section under Meta-Network**.

Create New Node

With the [**Create**] button in the editor you can create any number of nodes at one time. But there are times you only need to insert a single node into a Nodeset. Such as while building a dataset you forgot to include it in the original construction. ORA gives you a quick method of adding a single node.



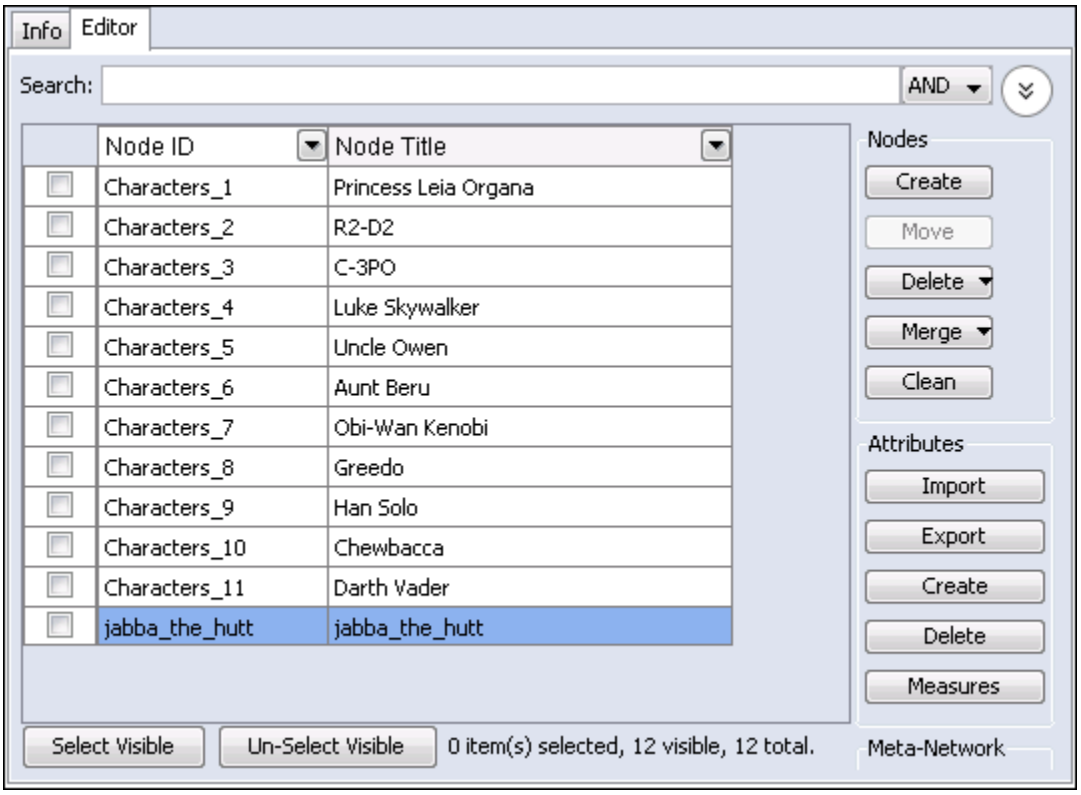
Below is the small Star Wars set containing 11 agents. And for some reason you needed to include a 12th agent, say Jabba the Hutt.



I typed **jabba_the_hutt** into the Search box and since he's not in this set ORA display no nodes. But notice to the right of the Search box a [**Create a new node**] button has appeared. If the node you want does not exist this allows you to instantly add it to the Node Class.

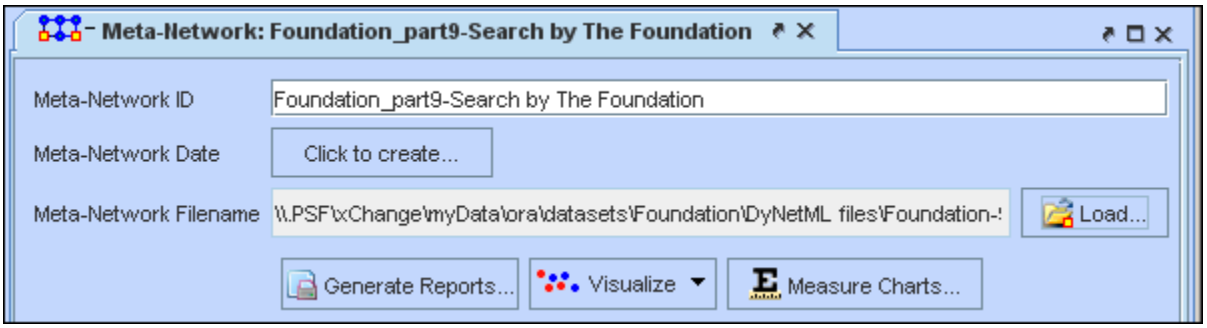


Upon click the [**Create a new node**] button the Jabb_the_hutt node is added to the bottom of the list.



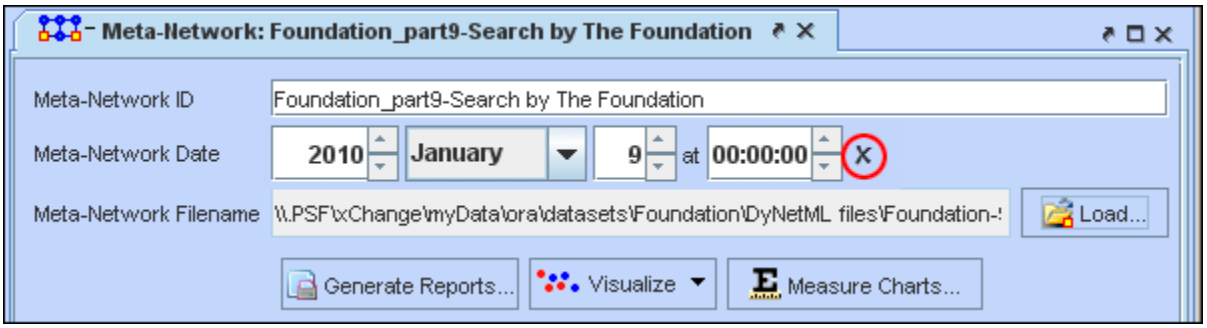
Dating Meta-Networks

Certain functions require a Meta-Network to have a date attached to it. These include: Measures Over Time, Networks Over Time, and Loom. To add a date first highlight the Meta-Network. In the Editor pane find **Meta-Network Date**. Click on the [**Click to create...**].



Now you can set the parameters for the date which include year, month, day, and time.

Remove Meta-Network date



If, at any time, you need to remove the date from a Meta-Network click on the [**X**] to the right of the date.

Delimited Files

Excel, when reading in a flat file (i.e. txt or .csv), is sensitive to the kind of delimiter used. In the American version of excel, it assumes

that a comma or tab is used to separate columns. In other versions, it often assumes that a semicolon or tab is used to separate columns. This is because in many other languages the comma is used as a period in showing the price of items.

AutoMap and ORA export data as comma separated and can import comma separated. This means if you are reading into or reading from a non-American version of excel you may have problems.

Reading in the.csv file into Excel that uses something other than commas will cause the data to appear as a set of text in column A. There are two ways to fix this.

NOTE : And if you data contains commas change to another character before changing the delimiting characters to commas.

First read the file into a text editor and globally change all the delimiting characters to commas.

Second read the file into excel and use the **Text to Columns** function and use a different delimiter.

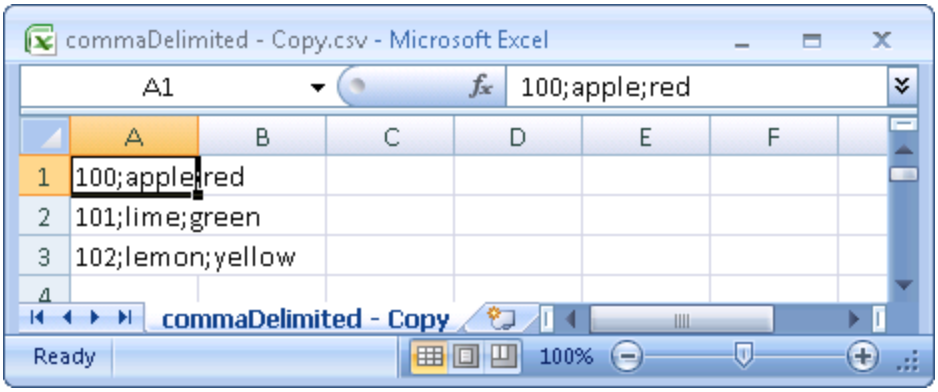
Excel Example

Let's start with a simple three line file using semicolons as delimiters.

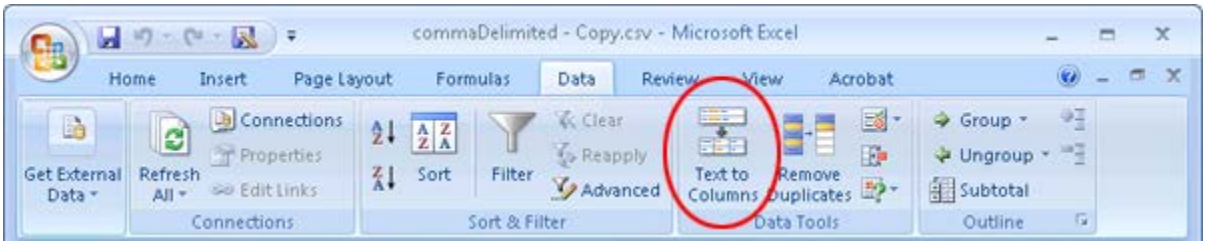
NOTE : Remember, data can be separated with a variety of characters. This procedure allows you to import data with any of them.

```
100;apple;red
101;lime;green
102;lemon;yellow
```

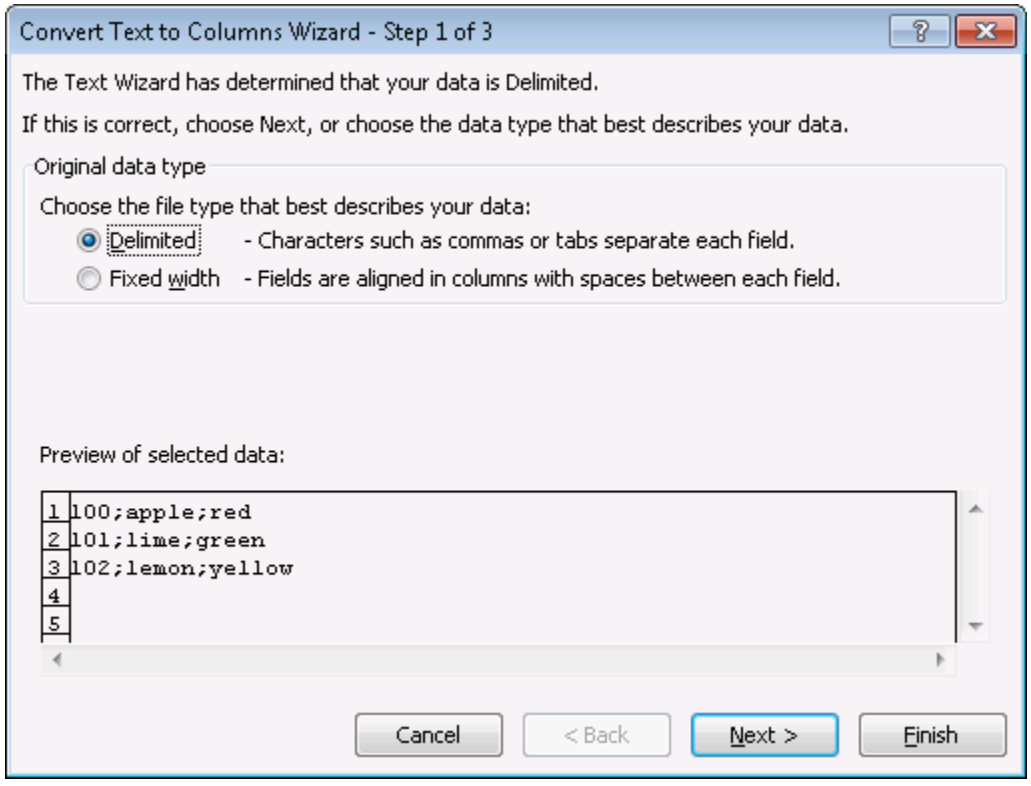
Opening this file in Excel will place each line of text into a single cell. You need to separate this into individual columns.



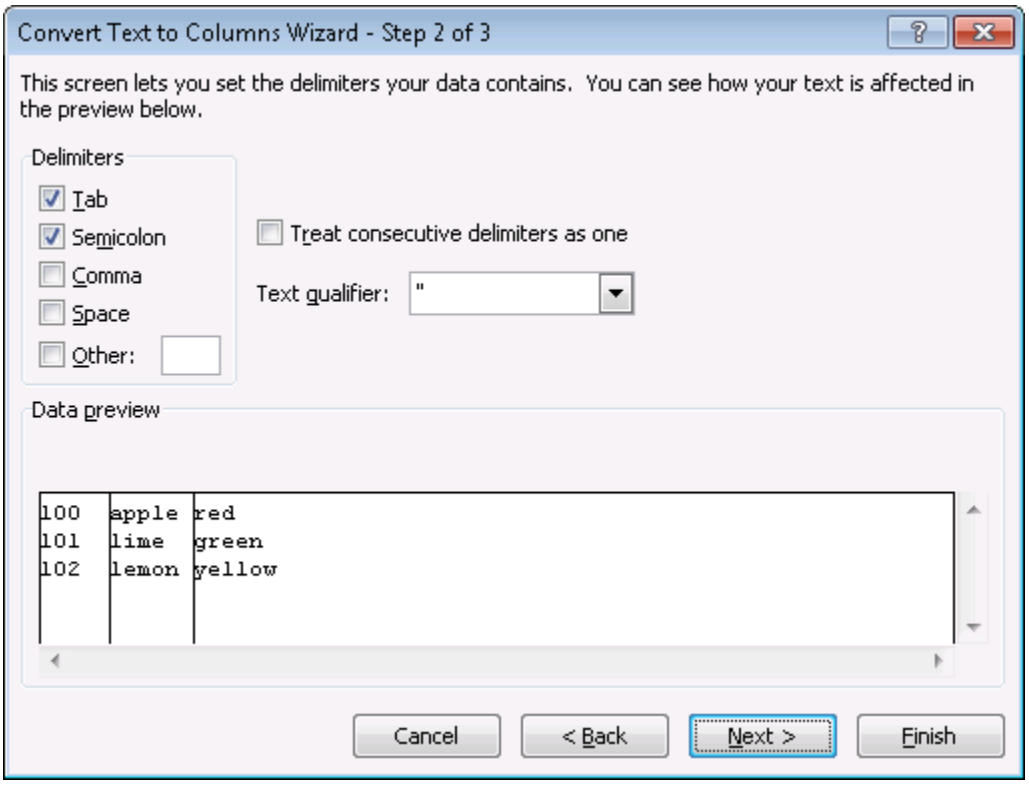
Select the cells you want to convert then click the Data tab. Click the **Text to Columns** function.



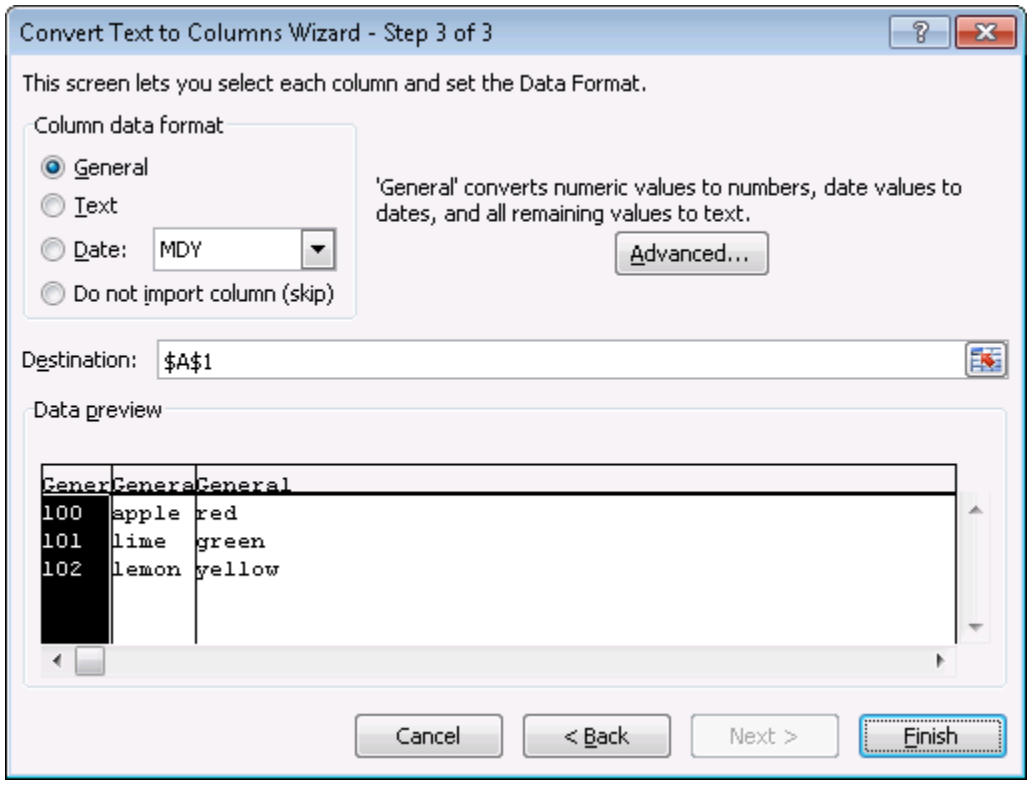
This brings up the **Convert Text to Columns Wizard**. Make sure the **Delimited** radio button is selected. Then click [**Next >**].



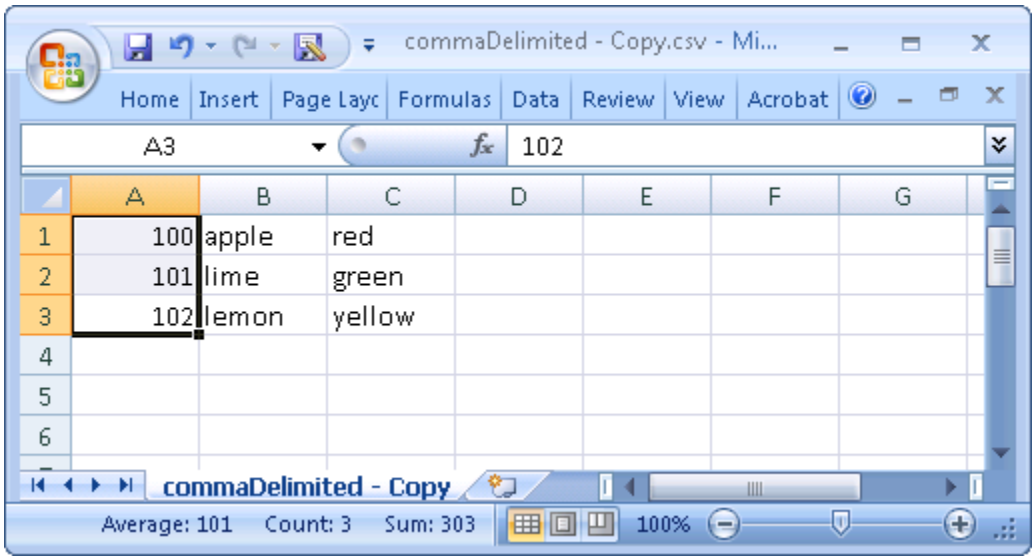
Under the **Delimiters** header make sure the **Semicolon** box contains a check mark. In the **Data preview**area it will show you what your data will look like after the conversion. Click [**Next >**].



Lastly you can do some final tweaks to how your data will be converted if you want such as your data format or a different destination. In this example we want the data to be inserted back into the original starting cell. Click [**Finish >**].



Each piece of data now resides in a separate cell.



The new file can now be imported into ORA through the Data Import Wizard.

Document/URI Attributes

The following instruction demonstrates how to add a **document attribute** or a **URI** to a Node.

Adding a document links in the Editor

Load a Meta-Network into ORA. Then expand the Meta-Network using the [+] icon to display all the Nodesets and Networks in the Meta-Network. Then right-click on a Nodeset and this will access the contextual menu. From here, select **Add Attribute**. Give the new attribute a name.

In Pane 2 click the Editor tab to display the matrix and find the new attribute just created. All cells will be empty. A new pathway can be inserted in the cell at this time.

Once the node title has been changed, you can now enter a URI directly inside the corresponding blank field. This can either be an absolute pathway to a document on the user's hard drive or a web URL.

Adding a URI in the Visualizer

Visualize a Meta-Network, select a node, and right-click to access it's contextual menu. From the contextual menu select, choose **URI submenu > Attach URI**. This brings up the **Add URI** box where the new URI can be entered.

When viewing the Meta-Network in the Editor a new column appears with the title you inserted in the field **Name:**.

NOTE : When using a absolute path to a document the link will not work if the Meta-Network is opened on another computer. It's much safer to use URIs from the internet to connect documents.

The same document pathway can be used for multiple nodes.

When the Meta-Network is displayed in the Visualizer the document URI will appear in the Node Status tooltip. You can go to this URI by right-clicking a node and use the URI submenu to **Go To URI**. A new

explorer window will be launched showing the location of the document file. It can then be opened with the appropriate program.

Multiple URIs/URLs

A node can have multiple URIs and you can still launch from the URI SubMenu. The preferred method for launching URIs is through the **Node Status** dialog where you can choose an individual URI to launch.

There's a new URI tab that allows you to view URI's, launch them, and add new ones. When adding new ones, the current convention is to create a new Attribute with name URI-X, where X is the earliest number that doesn't already exist. So, adding a URI to nodes will create results such as URI-1, URI-2, etc. Currently, when finding URI's to \launch, only those that follow the above convention are included, but it will be expanded to include any attribute with URI or URL in it anywhere.



Duplicate Items

ORA allows for the quick duplication of Meta-Networks, Nodesets, and Networks. It uses the **Copy and Paste** commands but some aspects work in a different manner than most users are familiar with.

Meta-Network

Duplicating a Meta-Network can be done with the menu, **Edit > Copy Ctrl+C** then **Edit > Paste Ctrl+V**. This will create a duplicate of the highlighted Meta-Network. And as the menu items show you can also use the keyboard shortcuts, **Crtl+C and Ctrl+V**

There is also a method for duplicating two or more Meta-Networks simultaneously. Hightlight all the Meta-Networks you need to duplicate. Press and hold the [**Alt**] key. Place the mouse cursor over one of the highlighted Meta-Networks then **Click and hold**. Drag the cursor into an unused area of the Meta-Network Manager pane and release the mouse button. All highlighted Meta-Networks will be duplicated.

Nodesets and Networks

Using the Menu items **Edit > Copy Ctrl+C** and **Edit > Paste Ctrl+V** work differently with Nodesets and Networks. This can be used to either create new Meta-Networks or duplicate Nodesets and Networks in existing Meta-Networks.

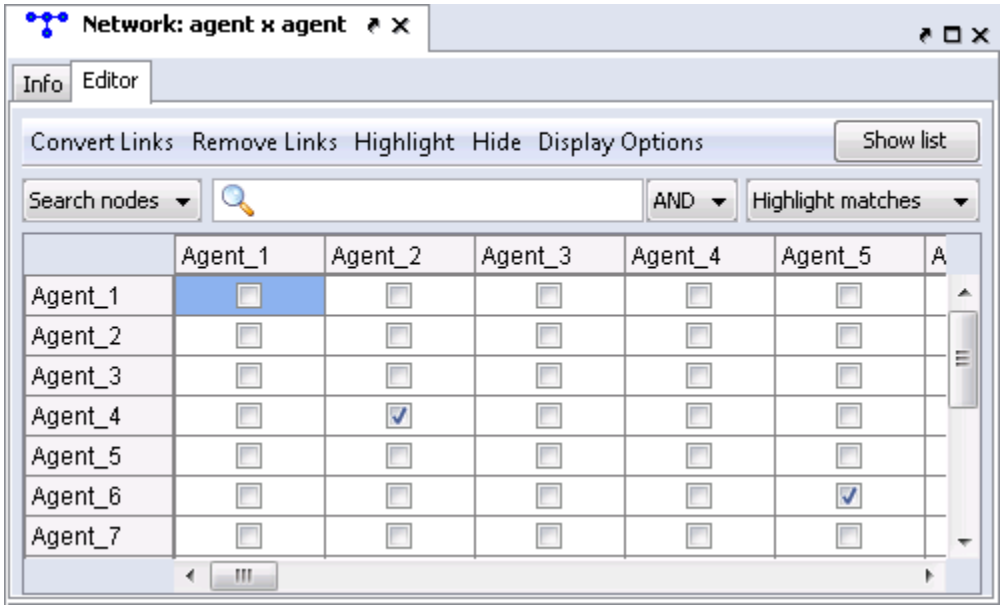
This leads to an interesting side benefit. You can highlight Nodesets and Networks from different Meta-Networks, Copy, and Paste. This will create a new Meta-Network with all the highlighted items.

Create new Meta-Network : As with Meta-Networks click, hold and drag a Nodeset(s) or Network(s) to an unused space in Meta-Network Manager pane. Upon releasing the mouse button ORA will create new Meta-Networks containing those Nodesets and Networks.

NOTE : If you highlight two Nodesets or Networks with the same name ORA will ask you to give the second one a different name.

Add to existing Meta-Network : Dragging a Nodeset or Network to an existing Meta-Network will add that Nodeset or Network to the new Meta-Network. If that Nodeset name is currently in use ORA will as you to rename the Nodeset or Network you want to append.

Editor Tab-Network



Convert Links :

This allows you to manipulate the line weights of your network.

Binarize link weights : ($x \neq 0 \Rightarrow x = 1$)

Collapse link weights : ($a \leq x \leq b \Rightarrow x = 1$)

Negate link weights : ($-x$)

Invert link weights : ($1/x$)

Logorithm of the link weights : ($\log10(x)$)

Absolute value of the link weights : ($|x|$)

Scale the link weights : ($c * x$)

Row-Normalize the link weights : (x/OutDegree)

Increment the link weightsSubtract the link weights : ($c + x$)

Subtract link weights : ($c - x$)

Remove Links :

Remove all links : As it states, all links will be removed from the Network.

Remove links by value : Allows you to choose a value then the method in which to remove links which match.

Remove self-loops (diagonal) : Removes all links from a node to itself. **NOTE :** Only works on symmetric Networks.

Highlight :

Clear all : Clears all highlights from editor.

Hightlight Isolates : Highlights on yellow any nodes not connected to any other nodes in the Network.

Hide :

Show all : Displays all hidden nodes and links

Hide highlighted rows : Any rows that are highlighted yellow will be hidden.

Hide highlighted columns : Any columns that are highlighted yellow will be hidden.

Display Options

Binary link values : Changes the grid to display check boxes. If a link exists, regardless of the weight, a check mark will appear in that cell.

Numeric link values : Changes the grid to display cells. The weight of the link will be display as a negative value, 0, or a positive value.

Display row sums : Creates a column to the right of the row names and displays the sum of all links in that row.

Display column sums : Creates a row below the columns names and displays the sum of all links in that column.

Show List / Show Matrix

Toggles between displaying the matrix of links with the list of links.

Search nodes... drop down:

Search nodes... : Using the **AND / OR** drop down you can search for **ALL** or **ANY** of the terms in the box.

Search nodes... : This doubles the capacity for searching and gives you two search boxes and AND/OR options. It allows you to make a finer tuned search.

Find a link... : Select a node from each drop down box and ORA will locate the cell corresponding to that link.

Results drop down :

Highlight Results : Highlights in yellow the results of your search

Show Results : Shows only the results of the search. All other nodes will be hidden.

Hide Results : Hides the results of a search showing only nodes and links that do not match.

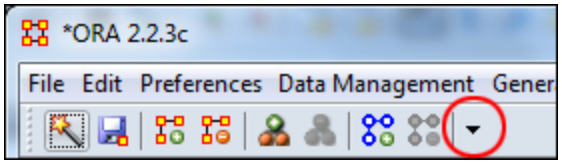
Highlight Matches

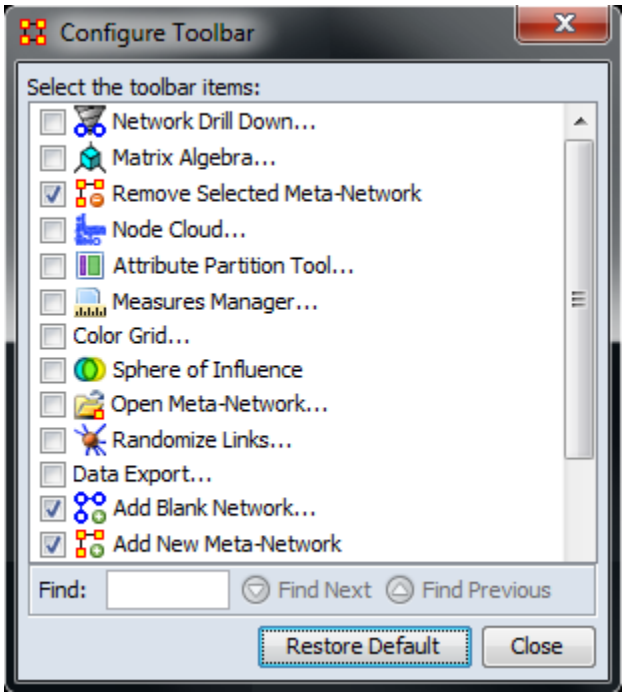
Highlight Matches highlights the row or column in a pale yellow tint.

Show only matches hides any node which **does not match** the search parameters.

Hide matches hides any node which **does match** the search parameters.

Editor Toolbar





To help facilitate your workflow ORA allows you to mount/unmount tool buttons in the Editor's toolbar (and also in the Visualizer toolbar). Click the down-triangle to open the dialog box.

The **Configure Toolbar** dialog box will appear. You will notice that some items are already checked. These correspond to the buttons already present. Placing a check mark next to any tool instantly mounts it on the toolbar. Removing the check mark from a button instantly removes the button.

When you are finished click [**Close**].

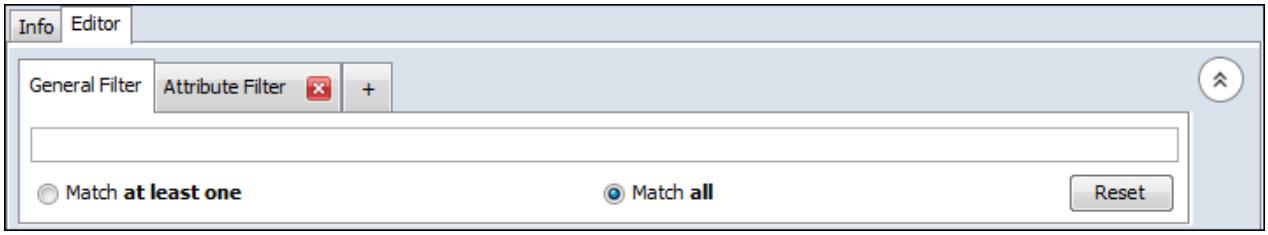
If at any point you can select the [**Restore Default**] button which will remove all the changes you made and restore the toolbar to the buttons found in the image at the top.

NOTE : The buttons appear from left to right in the order you select them. You can not re-arrange buttons once they are placed on the toolbar.

Filters

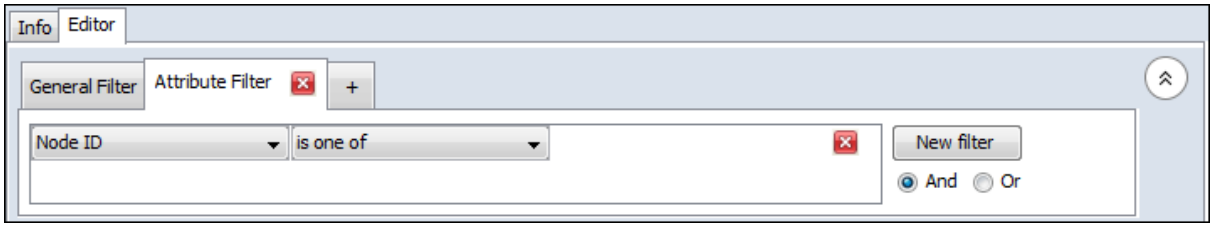
Use of this function allows you to reduce the number of nodes that appear in the Editor. By clicking the double up-pointing arrows in the top right of the Editor pane you will reveal the filtering tabs. Using the [**+**] you can add additional filtering parameters. Likewise you can remove filters by using the **[X]**

General Filter



The General Filter works across all columns. Think of it as a **blunt force** filter. The terms you are searching for are either **In or are not in** the dataset.

Attribute Filter



With the Attribute Filter you can do finely tuned searches specifying whether a term is foun, or not, within a specific attribute.

NOTE : At any point you need to backtrack or start over select the **General Filter** tab and click the [**Reset**] button.

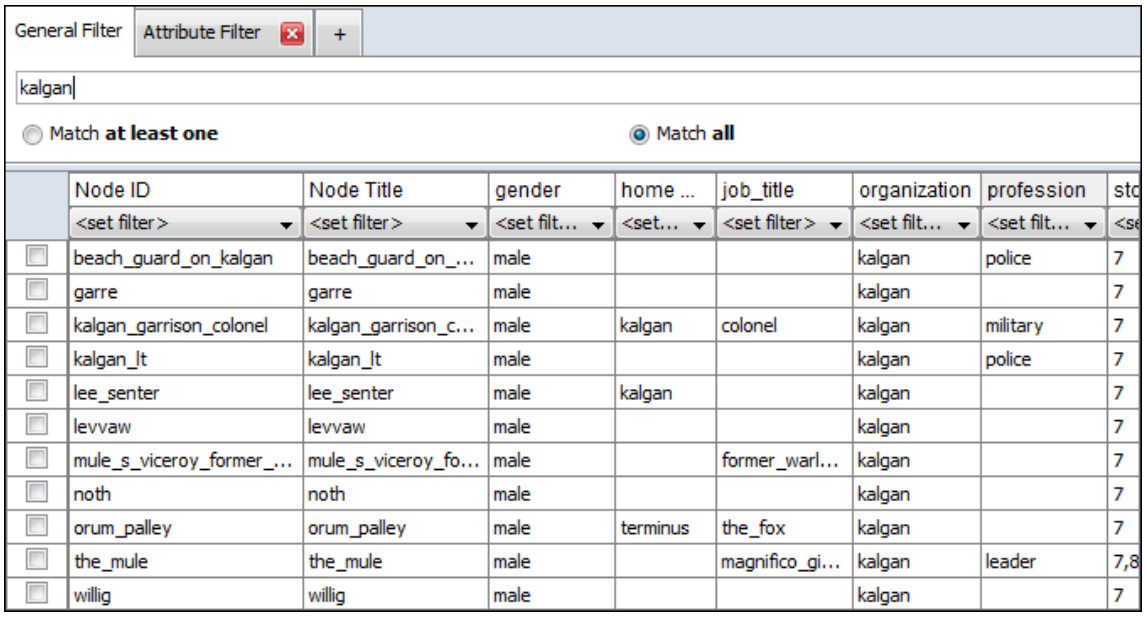
General Filtering

Here is the character Nodeset from part 7 of the Foundation dataset.

	Node ID	Node Title	gender	home ...	job_title	organization	profession
	<set filter>	<set filter>	<set filt...	<set...	<set filter>	<set filt...	<set filt...
	anonymous_conspirator	anonymous_consp...	male	terminus	worker		spy
	bayta_darell	bayta_darell	female	terminus		foundation,...	spy
	beach_guard_on_kalgan	beach_guard_on_...	male			kalgan	police
	bureau_chief_of_produc...	bureau_chief_of_...	male	haven	bureau_chief	bureaucrat	bureaucrat
	captain_han_pritcher	captain_han_pritcher	male	locris	war_depart...	foundation,...	military
	captain_inspector_of_fili...	captain_inspector...	male				military
	dagobert_IX	dagobert_IX	male	trantor	emperor	empire	royalty
	ebling_mis	ebling_mis	male		the_scientist	foundation	psychologist
	filian_soldier_1	filian_soldier_1	male				military
	filian_soldier_2	filian_soldier_2	male				military
	filian_soldier_3	filian_soldier_3	male				military
	filian_soldier_4	filian_soldier_4	male				military
	filian_soldier_5	filian_soldier_5	male				military
	filian_soldier_6	filian_soldier_6	male				military
	foundation_tax_collector	foundation_tax_c...		terminus	tax_collector	foundation	finance
	franssart	franssart	male		toran_s_father	trader	trader
	garre	garre	male			kalgan	
	general_sammin	general_sammin	male		general		military
	gilmer	gilmer					
	governor_jord_commason	governor_jord_co...	male		governor	empire	bureaucrat
	hella	hella	female	haven	worker	trader	worker
	inchney_(dagobert_X)	inchney_(dagober...	male	neotrantor	crown_prince	empire	royalty
	indbur_s_chamberlain	indbur_s_chamberl...	male	terminus		faoundation	servant
	iwo_lyon	iwo_lyon	male			trader	trader
	juddee	juddee	female	haven	worker	trader	worker
	kalgan_garrison_colonel	kalgan_garrison_c...	male	kalgan	colonel	kalgan	military
	kalgan_lt	kalgan_lt	male			kalgan	police
	lee_senter	lee_senter	male	kalgan		kalgan	
	levvaw	levvaw	male			kalgan	
	mangin	mangin	male	iss		trader	trader
	mayor_indbur_the_third	mayor_indbur_the...	male	terminus	mayor	foundation	politician
	mule_s_viceroy_former_...	mule_s_viceroy_fo...	male		former_warl...	kalgan	
	new_girl	new_girl	female	haven	worker	trader	worker
	noth	noth	male			kalgan	
	orum_palley	orum_palley	male	terminus	the_fox	kalgan	
	ovall_gri	ovall_gri	male	mnemon		trader	trader
	porfirat_hart	porfirat_hart				foundation,...	spy
	randu	randu	male		toran_s_fat...	trader	trader
	secretary_to_the_mayor	secretary_to_the_...	male	terminus	secretary	foundation	civil_servant
	the_mule	the_mule	male		magnifico_gi...	kalgan	leader
	toran_darell	toran_darell	male	haven		trader	trader

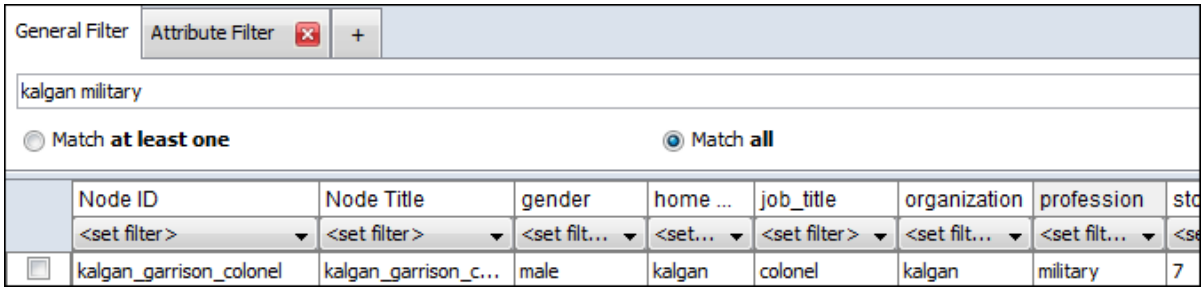
Using the General Filter on the Foundation dataset we'll use it to find the military officers on the world Kalgan. Note that Kalgan is in the attribute HomeWorld and police is in the attribute profession. After

typing **kalgan** into the search box ORA filters out all entries which **do not** contain the world kalgan.



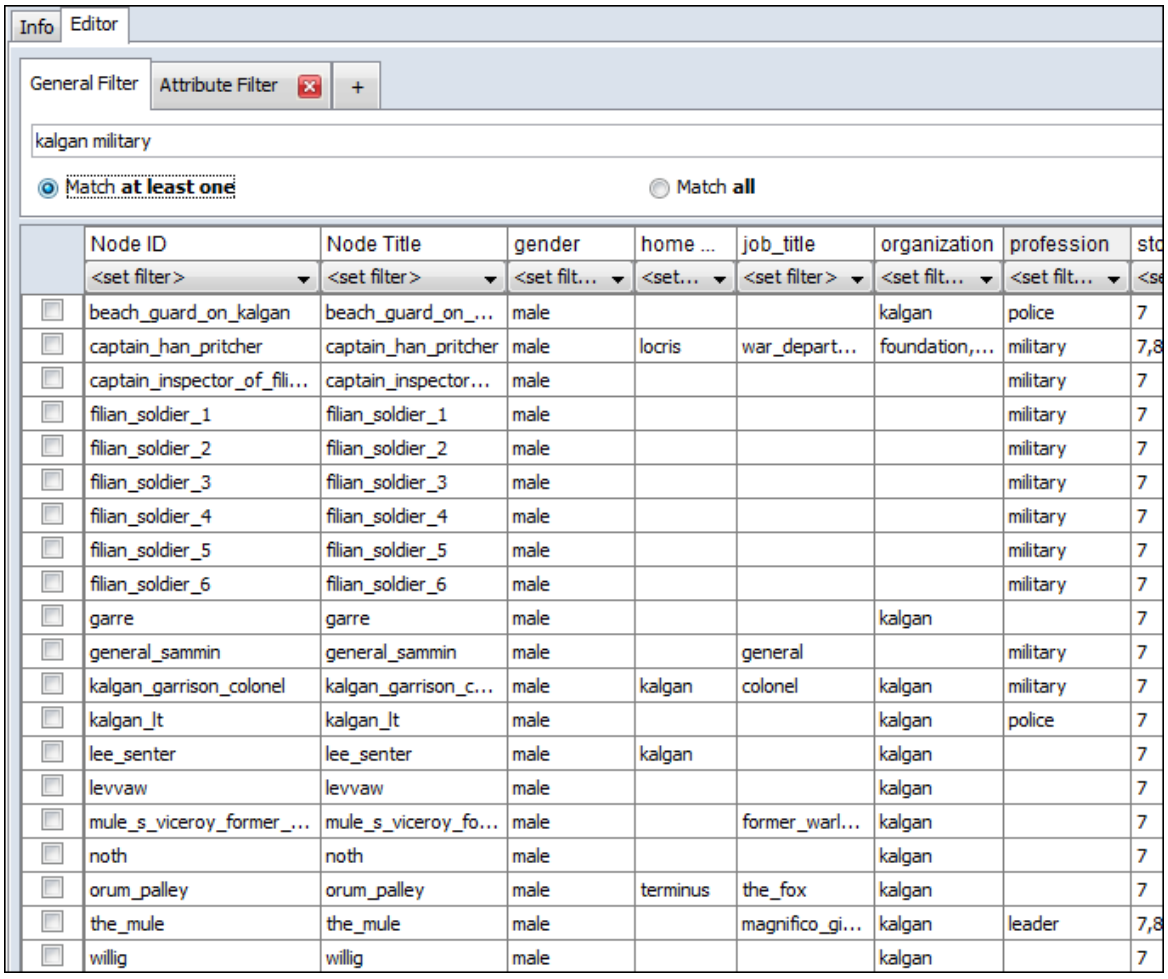
	Node ID	Node Title	gender	home ...	job_title	organization	profession	sto
	<set filter>	<set filter>	<set filt...	<set...	<set filter>	<set filt...	<set filt...	<se
	beach_guard_on_kalgan	beach_guard_on_...	male			kalgan	police	7
	garre	garre	male			kalgan		7
	kalgan_garrison_colonel	kalgan_garrison_c...	male	kalgan	colonel	kalgan	military	7
	kalgan_lt	kalgan_lt	male			kalgan	police	7
	lee_senter	lee_senter	male	kalgan		kalgan		7
	levvaw	levvaw	male			kalgan		7
	mule_s_viceroy_former_...	mule_s_viceroy_fo...	male		former_warl...	kalgan		7
	noth	noth	male			kalgan		7
	orum_palley	orum_palley	male	terminus	the_fox	kalgan		7
	the_mule	the_mule	male		magnifico_gi...	kalgan	leader	7,8
	willig	willig	male			kalgan		7

Next **military** is typed into the search box. Remember to leave a space in-between each word. And since **Match all** is selected ORA filters out all entries with do not include **BOTH** kalgan and military. Only one entry corresponds to both.



	Node ID	Node Title	gender	home ...	job_title	organization	profession	sto
	<set filter>	<set filter>	<set filt...	<set...	<set filter>	<set filt...	<set filt...	<se
	kalgan_garrison_colonel	kalgan_garrison_c...	male	kalgan	colonel	kalgan	military	7

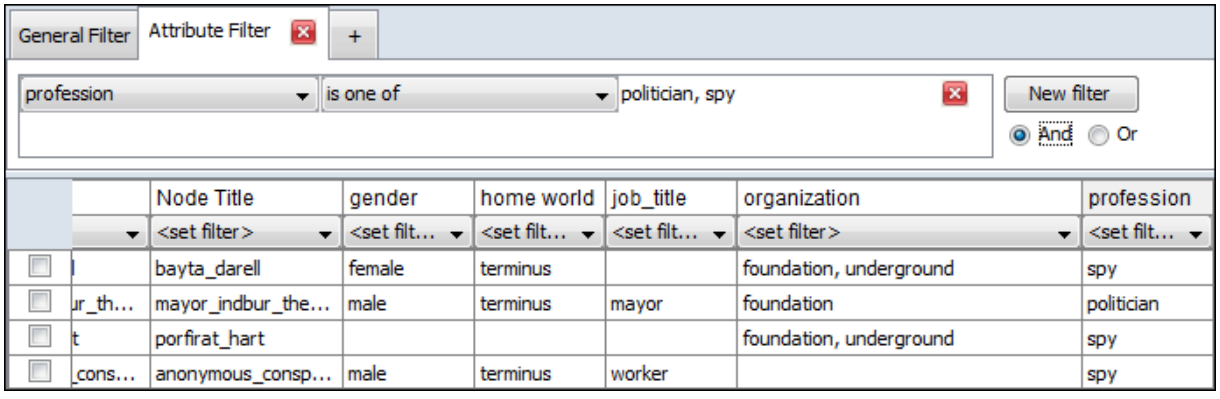
Now let's change the conditions from **Match all** to **Match at least one**. Now every entry which has **either** kalgan -OR- military shows up.



	Node ID	Node Title	gender	home ...	job_title	organization	profession	sto
	<set filter>	<set filter>	<set filt...	<set...	<set filter>	<set filt...	<set filt...	<se
☐	beach_guard_on_kalgan	beach_guard_on_...	male			kalgan	police	7
☐	captain_han_pritcher	captain_han_pritcher	male	locris	war_depart...	foundation,...	military	7,8
☐	captain_inspector_of_fili...	captain_inspector...	male				military	7
☐	filian_soldier_1	filian_soldier_1	male				military	7
☐	filian_soldier_2	filian_soldier_2	male				military	7
☐	filian_soldier_3	filian_soldier_3	male				military	7
☐	filian_soldier_4	filian_soldier_4	male				military	7
☐	filian_soldier_5	filian_soldier_5	male				military	7
☐	filian_soldier_6	filian_soldier_6	male				military	7
☐	garre	garre	male			kalgan		7
☐	general_sammin	general_sammin	male		general		military	7
☐	kalgan_garrison_colonel	kalgan_garrison_c...	male	kalgan	colonel	kalgan	military	7
☐	kalgan_lt	kalgan_lt	male			kalgan	police	7
☐	lee_senter	lee_senter	male	kalgan		kalgan		7
☐	levvaw	levvaw	male			kalgan		7
☐	mule_s_viceroy_former_...	mule_s_viceroy_fo...	male		former_warl...	kalgan		7
☐	noth	noth	male			kalgan		7
☐	orum_palley	orum_palley	male	terminus	the_fox	kalgan		7
☐	the_mule	the_mule	male		magnifico_gi...	kalgan	leader	7,8
☐	willig	willig	male			kalgan		7

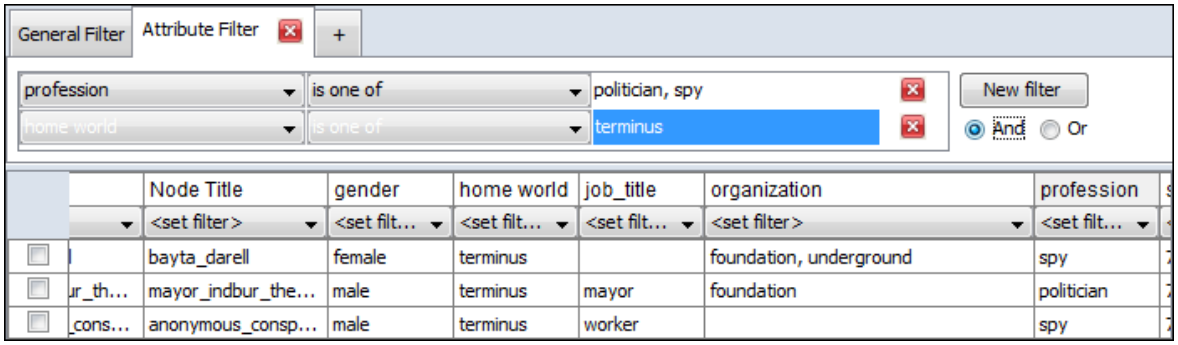
Attribute Filtering

Single Attribute Filter : Click the leftmost drop down and select **profession**. Click the middle drop down and select **is one of**. Type **politician or spy** into the textbox. Four characters fit this filter and are displayed in the Editor.



		Node Title	gender	home world	job_title	organization	profession
		<set filter>	<set filt...	<set filt...	<set filt...	<set filter>	<set filt...
☐		bayta_darell	female	terminus		foundation, underground	spy
☐	ur_th...	mayor_indbur_the...	male	terminus	mayor	foundation	politician
☐	t	porfirat_hart				foundation, underground	spy
☐	_cons...	anonymous_consp...	male	terminus	worker		spy

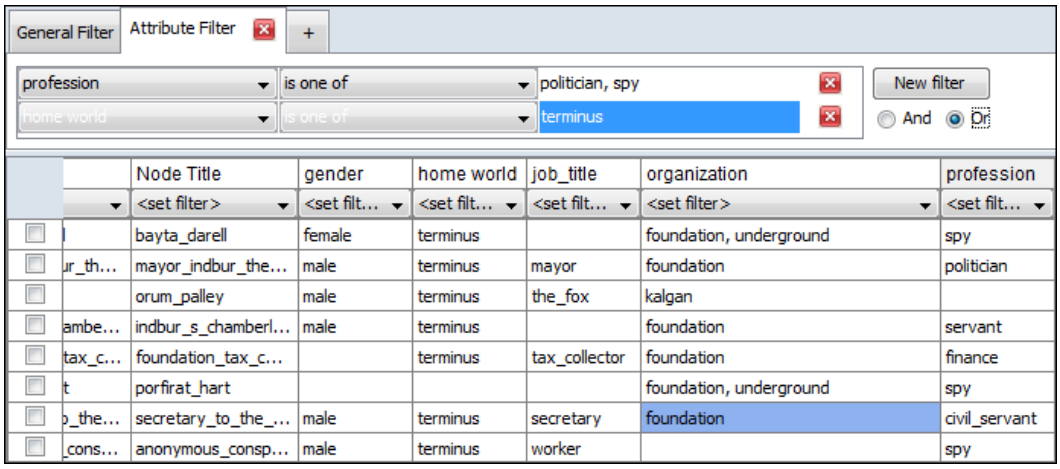
Multiple Filters using AND : The search can be further refined by adding additional parameters. Click the [**New filter**] button to create a second filter parameter. It will appear directly beneath your first filter. Click the leftmost drop down and select **home world**. Click the middle drop down and select **is one of**. Type **terminus** into the textbox. This eliminates the character **portirat_hart** from the search as there is no home world specified for that character.



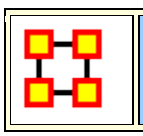
	Node Title	gender	home world	job_title	organization	profession
	<set filter>	<set filt...	<set filt...	<set filt...	<set filter>	<set filt...
	bayta_darell	female	terminus		foundation, underground	spy
ur_th...	mayor_indbur_the...	male	terminus	mayor	foundation	politician
_cons...	anonymous_consp...	male	terminus	worker		spy

Multiple Filters using OR :

Leaving the filter parameters the same we'll now change the condition from **AND** to **OR**. This means that a character will be displayed in the Editor if **either** the profession or home world match.



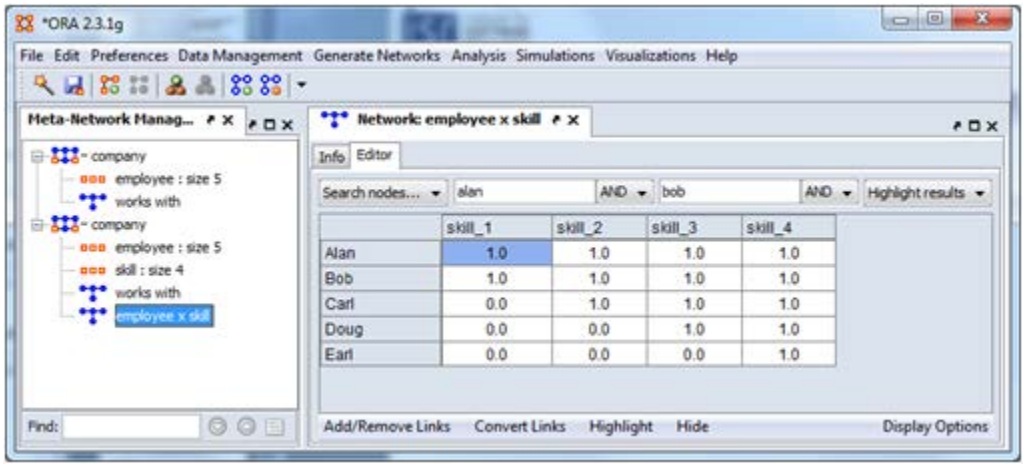
	Node Title	gender	home world	job_title	organization	profession
	<set filter>	<set filt...	<set filt...	<set filt...	<set filter>	<set filt...
	bayta_darell	female	terminus		foundation, underground	spy
ur_th...	mayor_indbur_the...	male	terminus	mayor	foundation	politician
	orum_palley	male	terminus	the_fox	kalgan	
ambe...	indbur_s_chamberl...	male	terminus		foundation	servant
tax_c...	foundation_tax_c...		terminus	tax_collector	foundation	finance
t	porfirat_hart				foundation, underground	spy
o_the...	secretary_to_the_...	male	terminus	secretary	foundation	civil_servant
_cons...	anonymous_consp...	male	terminus	worker		spy



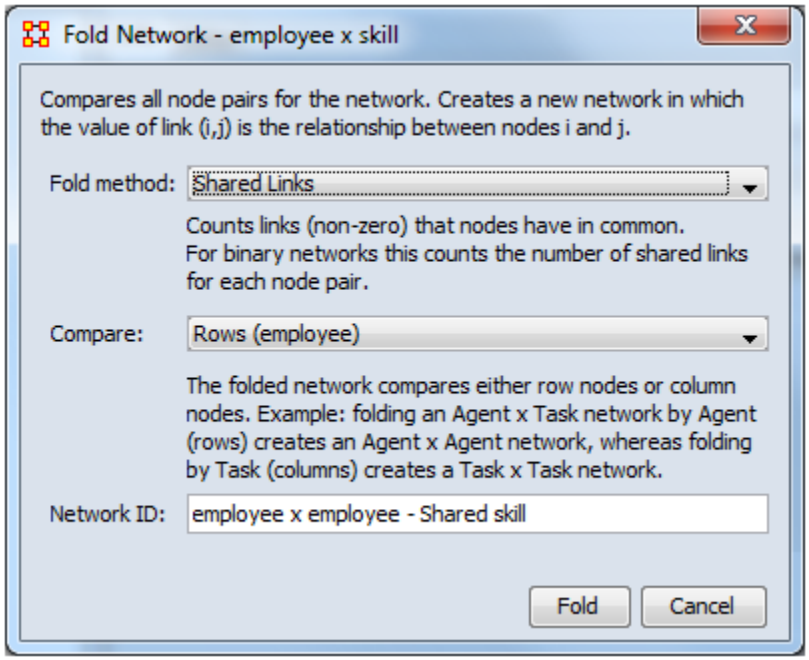
Fold Network

Folding a Network can answer questions about a Network such as which agents have the most common knowledge. **Folding a**

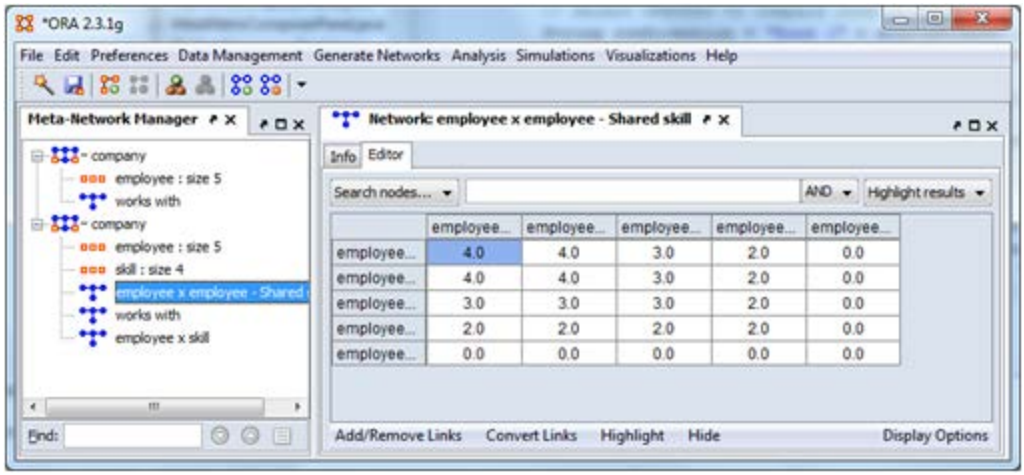
Network multiples the network by its transpose. The result is an **agent x knowledge network** whose links are the number of knowledges in common for the agents.



Fold a network select the Network in the Meta-Network Manager Pane and right-click. From the contextual network select **Fold Network**. From the dialog box select the **Fold Method and Compare** options. In the Network ID give the new Network a unique name.



The new Network is **agent x knowledge - Shared Knowledge**. This will appear in the Meta-Network Manager pane.



Examining the Network in the Editor will show the diagonal gives the number of knowledges each agent has. The off-diagonal contains the knowledge agents have in common.

Creating a transpose and then doing the multiplcation could also be done manually in the **Matrix Alegbra tool** under Data Management.

Hovering - Tooltips

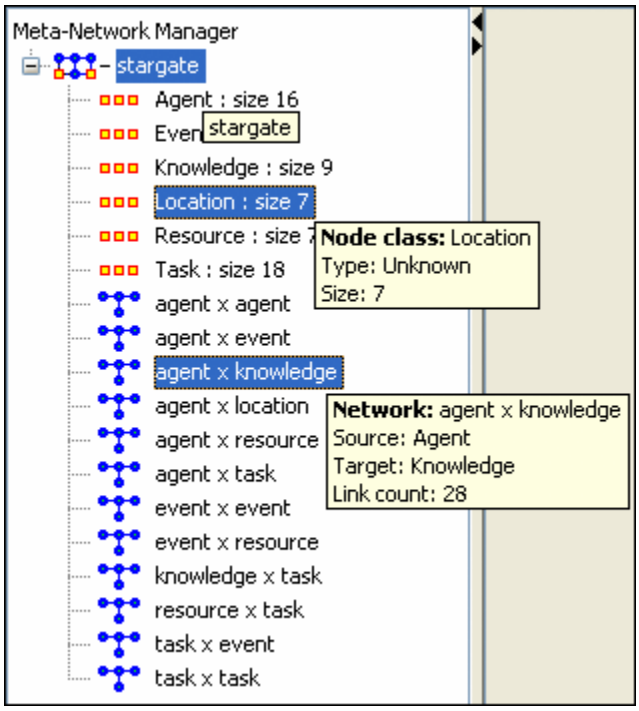
Hovering the pointer over various parts of the panels will reveal information about the Meta-Network.

Hovering over the parts in Panel 1 will reveal different information about the **Meta-Networks, Nodesets, and Networks**.

Hovering over the Meta-Network reveals the name.

Hovering over a Nodeset Name reveals the Node Class and size.

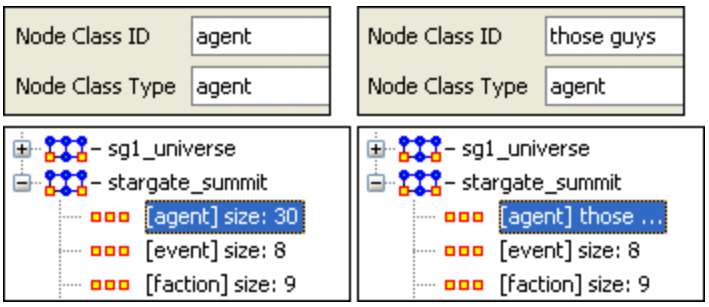
Hovering over a Network reveals the network's source and target and the link count.



Names

Working with Names

Each Meta-Network, Nodeset, and Network can be given a distinct **Name**. At times this can be very helpful when working with multiple Meta-Networks it can also cause problems with certain functions.



Here I renamed one of the Nodesets to **those guys**. It is also reflected throughout all of Meta-Network Panel. You can rename any Meta-Network, Nodeset, or Network for better readability.

Areas where it's important to maintain Name ID integrity

View Measures Over Time : This function allows an analyst to see how a network measures change over multiple time periods. So in order to track measures over time it is necessary that the ID Names of the Networks are the same in all instances.

View Networks Over Time : This function allows you to set up multiple Networks that encompass various time frames and view them in succession. Since you want to see what happens over the same Network Over Time it becomes virtually important to make sure the ID Names of these Networks are all the same. Else ORA will not be able to analyze them correctly.

Comparing Networks : When ORA runs measures on Networks it's sometimes necessary to do have identical Network names. This will be listed in the Measures section.

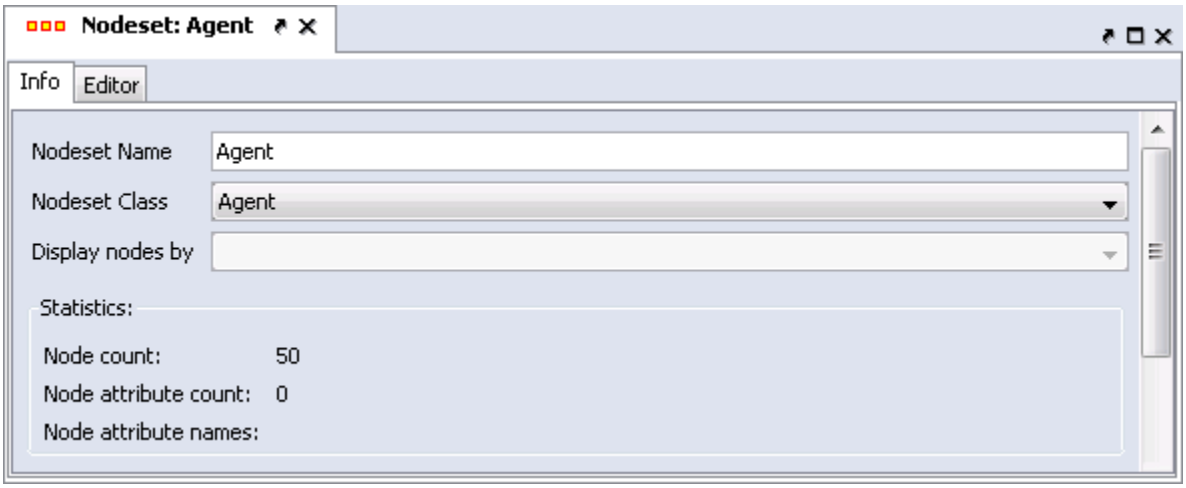


Panel 2 contains two tabs, **Info and Editor**. The Info tab is mainly designed to display information regarding the Meta-Networks, Nodesets, and Networks. But this is the area where you can rename the **Nodeset Name** and change the **Nodeset Class** to a different MetaOntology. To rename a Nodeset place the cursor in the box, make sure the entire name is highlighted, and type in your new

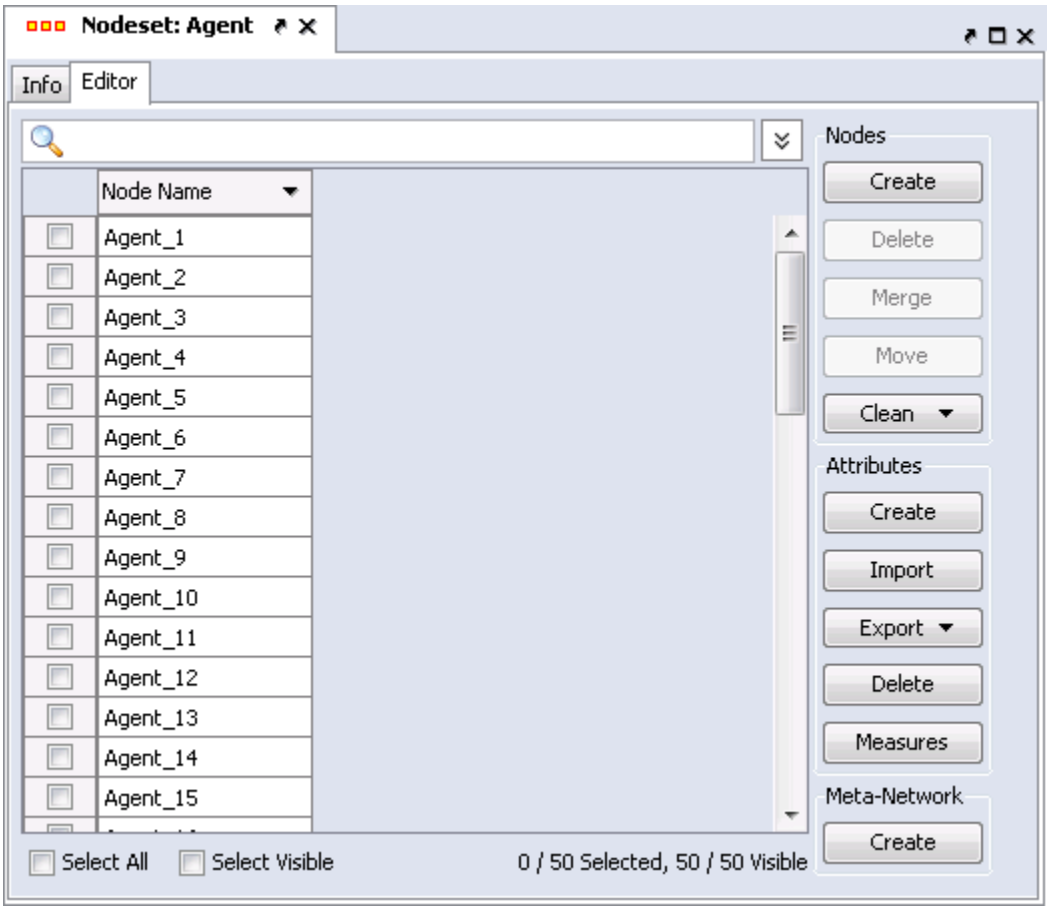
name. The **Display nodes by** function determines what attribute will be displayed when visualized.

This area also gives you the **Node Count** of the selected Nodeset as well as the **Attribute Names** contained within the Nodeset.

The **Display nodes by** dropdown allows you to select the text that will be display for the nodes of this Nodeset in the Visualizer. Each Nodeset can be set individually.



The **Editor tab** contains most of the editing functions.



The **Search box** (with the magnifying glass) is for finding particular node(s) in a Nodeset.

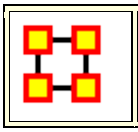
The **Set filter** (the downward facing triangle) is for displaying only a particular sub-set of node(s).

The **Check boxes** to designate which nodes to Delete or Merge.

The **Nodes buttons** are to Create, Delete, Merge, Move, and Clean nodes in a Nodeset.

The **Attributes buttons** allow you to Create, Import, Export, Delete, and add measure values to a Nodeset.

The **Meta-Network Create button** will create a blank Meta-Network based on the nodes in the Editor. You can select either or both **Visible nodes and Selected nodes**. This is noted near the bottom of the frame.



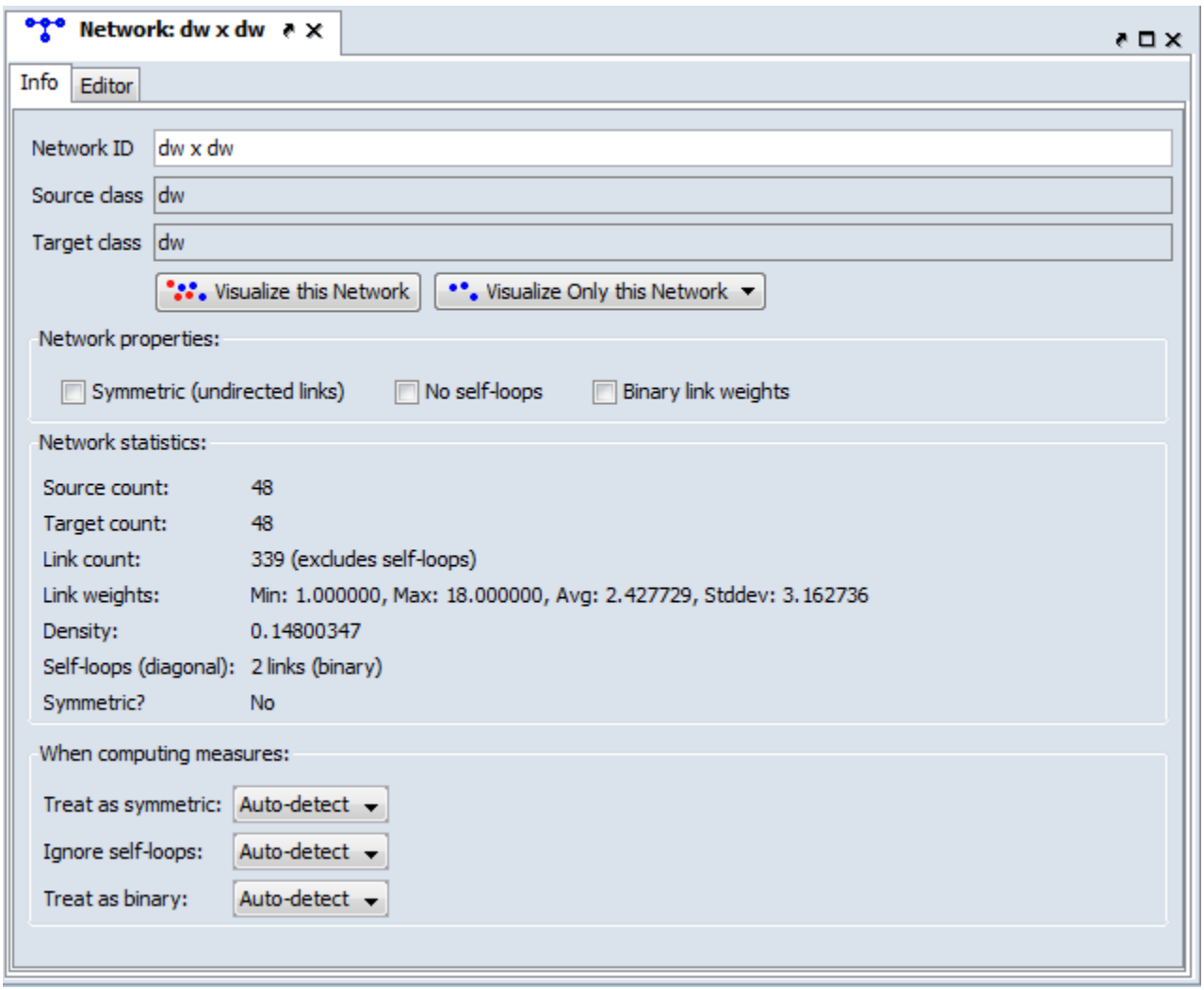
Info Tab - Network

When a Network is selected there are also two tabs, **Info and Editor**.

The Info tab contains a textbox, **Network ID** in which you can change the name of any network, The Source and Target Nodesets, and whether this network is directed or not, the Link Count, and the Density.

The two buttons underneath allow the choice of **Visualize this Network** which will send the entire Meta-Network to the visualizer or **Visualize Only this Network** which display only the currently selected Network.

Below is an image of InfoTabs and Editor Tabs in ORA.



Network ID : Allows you to rename the network.

Source class : Displays the source Nodeset i.e., the leftmost column in the graph.

Target class : Displays the target Nodeset i.e., the topmost row in the graph.

Network Properties: Symmetric, No Self-loops, and Binary link weights

Place a check mark in the box(es) which you want to include.

Network Statistics

Gives information regarding the selected network.

When computing measures:

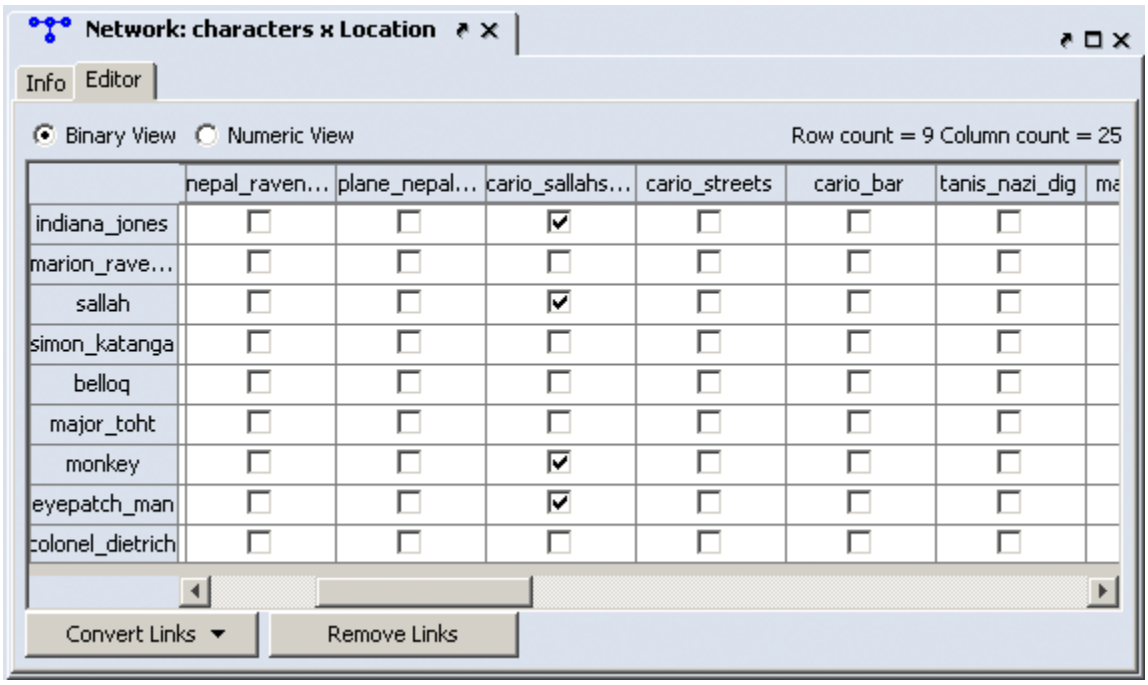
The purpose of this is to let the user tell ORA what links should be used and how they should be interpreted when computing measures, as this affects the results. The areas are: Symmetric/Or Not, Self-loops/Or Not, and Binary/Weighted.

If you want ORA to treat the data as symmetric if it is symmetric, then use Auto-Detect. This option will test if the network is symmetric, record the result, and use that result when computing measures. The same goes for binary and self-loops. If all the links in the network are of weight one, then the network assumed to be binary (but if there is a link with a weight other than one, then it is assumed weighted). Lastly, if the network has no self-loops, then it is assumed it cannot have any.

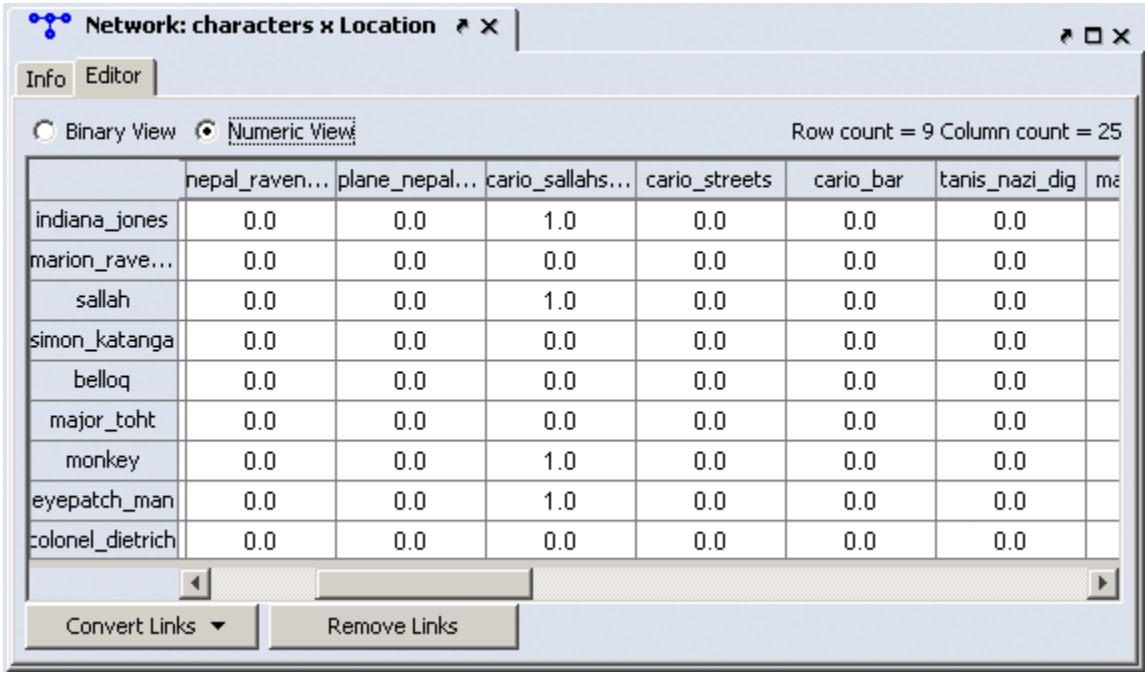
If, for example, there just happens to be no self-loops, but there could be, and the user wants the measure to take that into account, then the user would select TRUE. On the other hand, if are self-loops and they should always be ignored, then the user can choose FALSE. Note that FALSE does not change the network data in any way, but the measures just ignore the loops.

The Editor tab has two views: **Binary and Numeric.**

Binary view is used when you only need to establish a connection between two nodes with no weights. It's a simple **Yes or No** arrangement.



The Numeric view allows you to treat links between various nodes with more or less importance. Notice that all the **row nodes** have a check marked connection to the **column containing [yu]** in the binary mode. This denotes they know one another. But in the numeric mode this value is a 0.5 which is used to denote previous acknowledgement but is an adversary.



The **Convert Links** button contains options for converting links in a Network.

Binarize link weights (x 0 -> x = 1)

Collapse link weights (a=x=b -> x = 1

Negate link weights (-x)

Invert the link weights (1/x)

Logorithm of the link weights (log10(x))

Absolute value of the link weights ((|x|)

Row-Normalize the link weights (x/OutDegree)

Increment the link weights (c + x)

The **Remove Links** buttons deletes all links for the selected condition and the value of the links you wanted removed.



Less than

Less than of equal to

Equal to

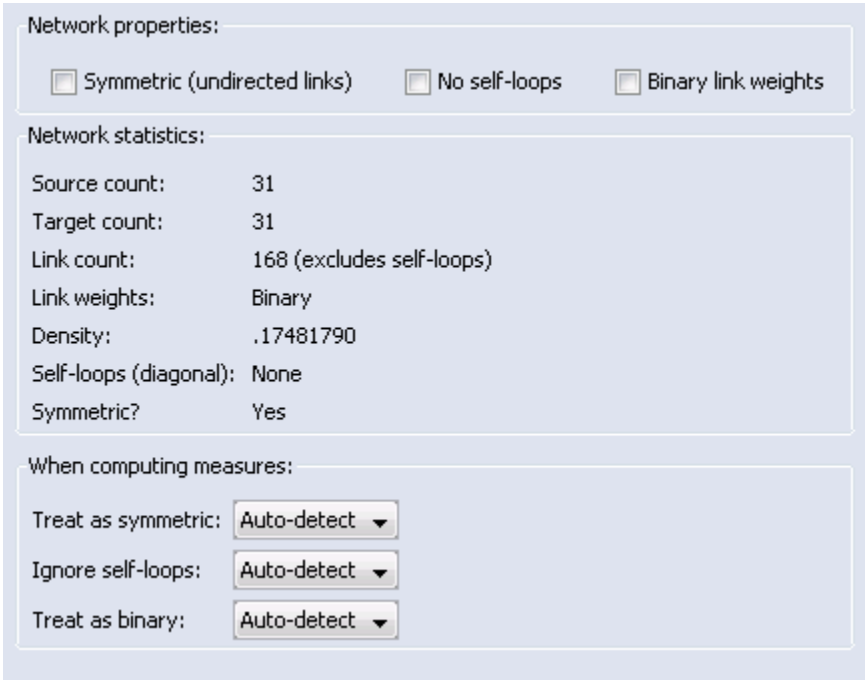
Not equal to

Greater than or equal to

Greater than

Info Tab-Network-Statistics

The Info Tab : Display relevant information whether a Nodeset or Network is highlighted.



Network Properties

Symmetric (undirected links) : Create additional links to maintain symmetry of the Network. [e.g. you create a link **A > B** and ORA would automatically create the link **B > A** of the same weight.

No self-loops : Disallows a link to be set back to node to itself.

Binary Link Weights : This will set all link weights that are not [**0**] to [**1**]

NOTE : Changing these options for existing networks can have huge impact to your data. Changing a network from **weighted** to **unweighted** will set all link weights w_{uv} to 1.0. These options also have implications for the editor. If the option is set to **directed network** then changing the value w_{uv} in the matrix will automatically change the value w_{vu}.

Select how to treat links when computing measures:

You can use this to control how Links and Properties are handled for each individual Network when measures are run on the networks.

NOTE : These options are "temporary" version of the network properties. They do not affect the actual Meta-Network.

Under **Select how to treat the links when computing measures:** you can select between **True, False, and Auto-detect**.

Treat as symmetric : Symmetrizes the network for the calculation, e.g., if the line weight w_{uv} is larger than w_{vu} then w_{vu} -> w_{uv}.

Ignore self-loops : All diagonal elements are set to 0.

Treat as binary : The link weights for all wuv with wuv ? 0 are set to 1.

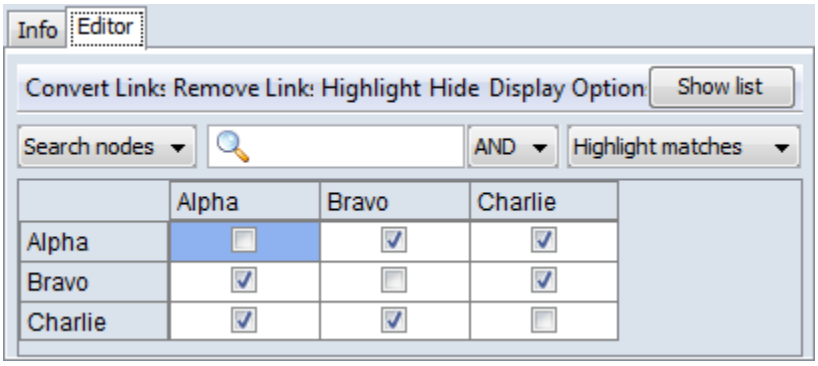
The default setting for these is **Auto-detect**. If the network is symmetric, then when computing measures the network is considered as symmetric. Similarly, if the network has only binary link weights, then when computing measures the network is considered binary. The user can also explicitly set to **True or False** whether the network should be treated as symmetric, without self-loops, or binary.

To change the settings, select the network and change one or more of the three controls in the info window of a network in the section **Select how to treat the links when computing measures**.

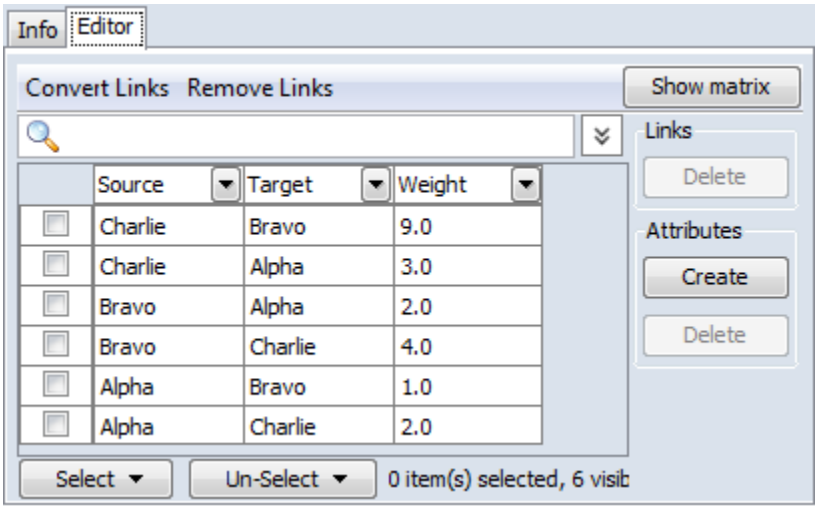
Whenever ORA calculates a measure (independent from which measure calculation you select) a network will be pre-prepared based on the settings of these primary measure parameters. These setting do not change the original data but the way ORA handles the data when calculating measures. To actually convert the data you can change the network parameters (see section 2) or use other procedures to have more detailed options (e.g. symmetrize by minimum value). You can find an introduction into these procedures in section 2.7.

Link Attributes

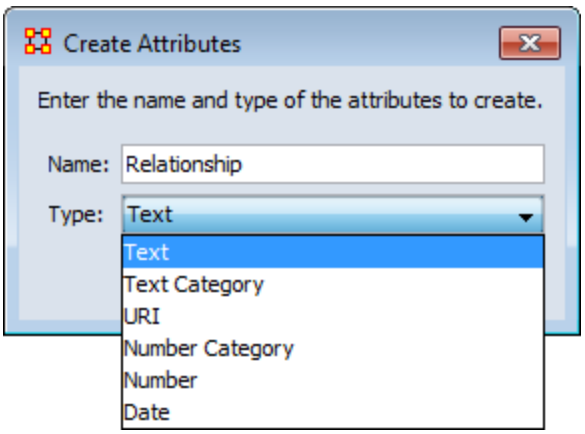
Nodes can have various attributes like their location, gender, or other specialized information. Links can also have attributes. When you highlight a Network this reveals the Matrix of links.



Click the [**Show list**] button at the top right to reveal information on those links.



Click the [**Create**] button under Attributes. You can select the **Type** of attribute from the drop down menu. Give your attribute a name then select the type of attribute.



In the Editor you will see a new column. You can now enter in attributes for each link in the Network.

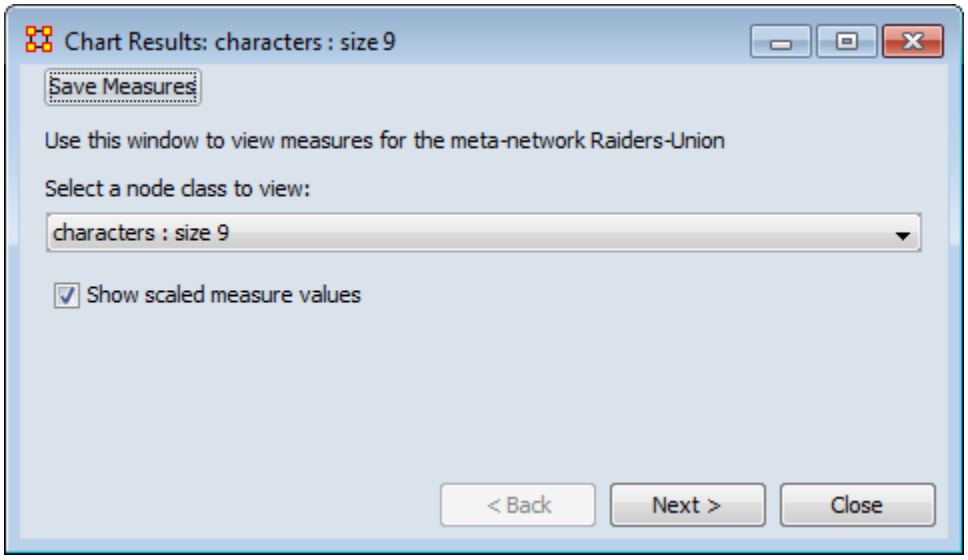
	Source	Target	Weight	Relation...
	Charlie	Bravo	9.0	Friendly
	Charlie	Alpha	3.0	Causal
	Bravo	Alpha	2.0	Causal
	Bravo	Charlie	4.0	Friendly
	Alpha	Bravo	1.0	Cold
	Alpha	Charlie	2.0	Causal

Measure Charts

Below are examples of each type of ORA charts: **Bar Chart, Scatter Plot, Histogram, and Regression.**

NOTE : The measures run can be changed by select from the main menu **Analysis > Measures Manager**.

Save Measures



Use this button to save results measures to a text file. This file can be opened in either Excel or a text editor. ORA will not attach an extension to this file and it is suggested to give it either a **.txt or .csv** extension.

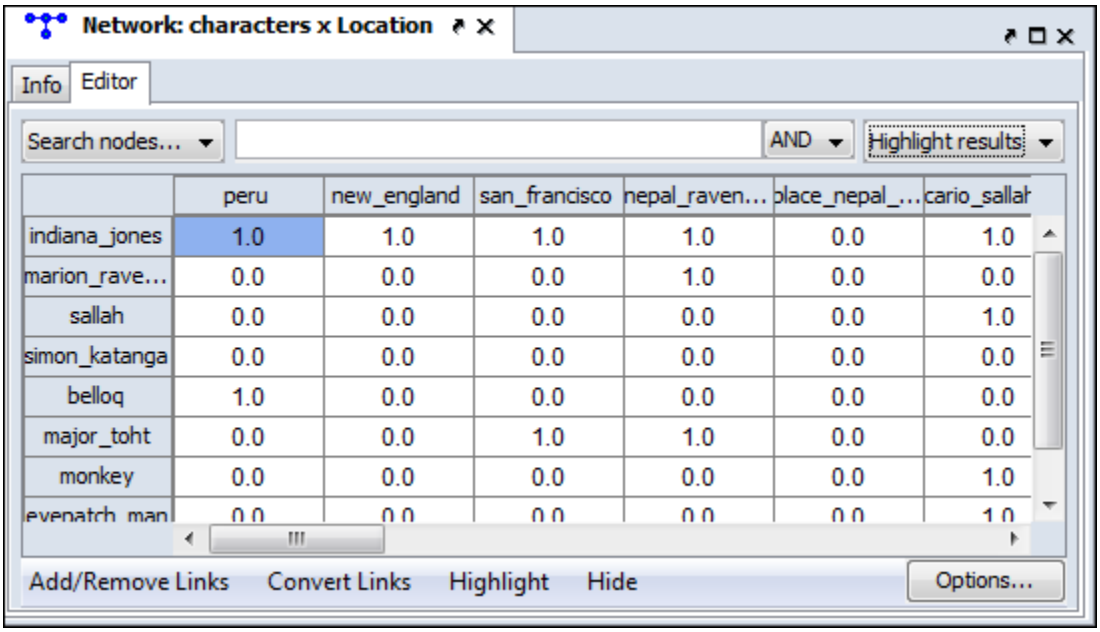
Opening the File

Opening this file in Excel, making sure to import it as a delimited file, will give you the measures it can use and the values associated with each node in the Nodeset chosen. You will notice that the names of the characters are **characters_1, characters_2, and so forth**. In this particular Nodeset the **Node ID** contained the text **Character_** plus a number and the **Node Title** contained the actual name of the character. This function used the Node ID when it exports this information.

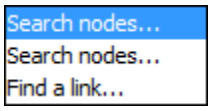
	A	B	C	D	E	F	G	H
1	Measure	Input networks	Input node classes	Input parameters	characters_1	characters_2	characters_3	characters_4
2	capability	characters x Location			0.9933072	0.9338295	0.2926904	0.0378589
3	cognitiveDistinctiveness	characters x Location			0.42	0.33	0.29	0.37
4	cognitiveExpertise	characters x Location			0.015625	0.1041667	0.2291667	0.3352273
5	cognitiveResemblance	characters x Location			0.58	0.67	0.71	0.63
6	cognitiveSimilarity	characters x Location			0.3860295	0.4101945	0.3309044	0.0890994

Network Editor

With a Network highlighted and the Editor tab displayed ORA has many functions for working with nodes and links in a network.

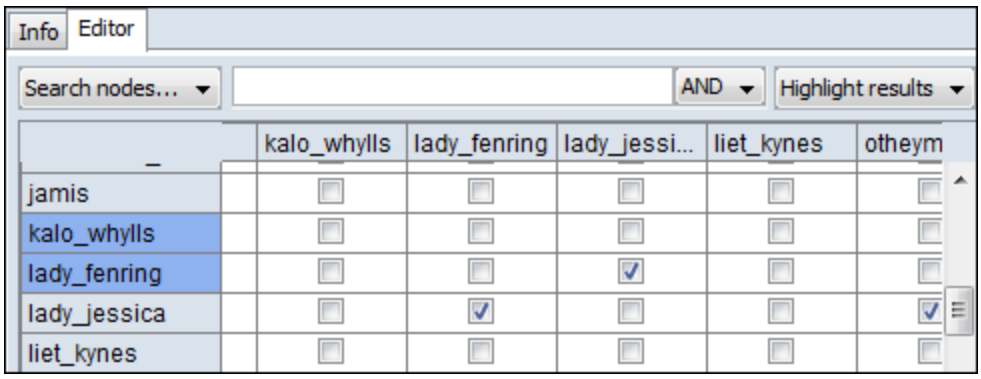


Search Nodes...

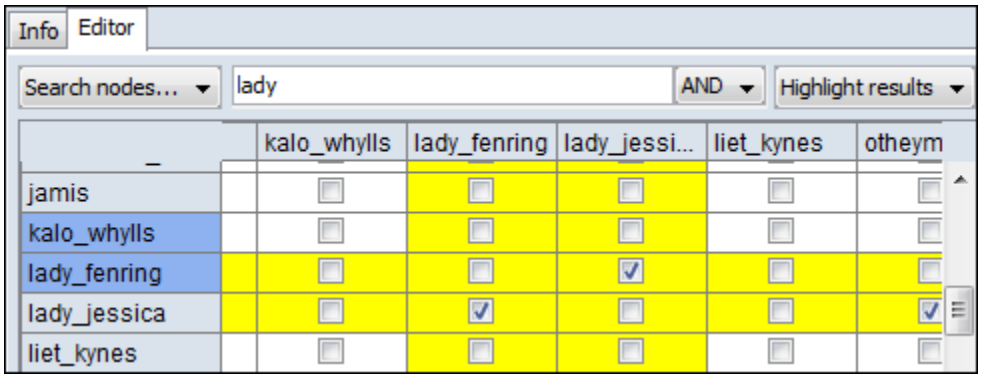


Search type 1

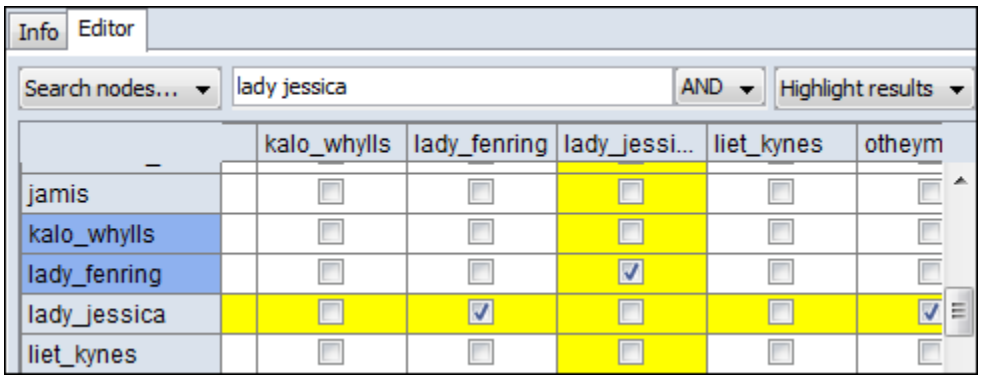
Using the Search box and the [**AND / OR**] selector you can refine a search on a Network.



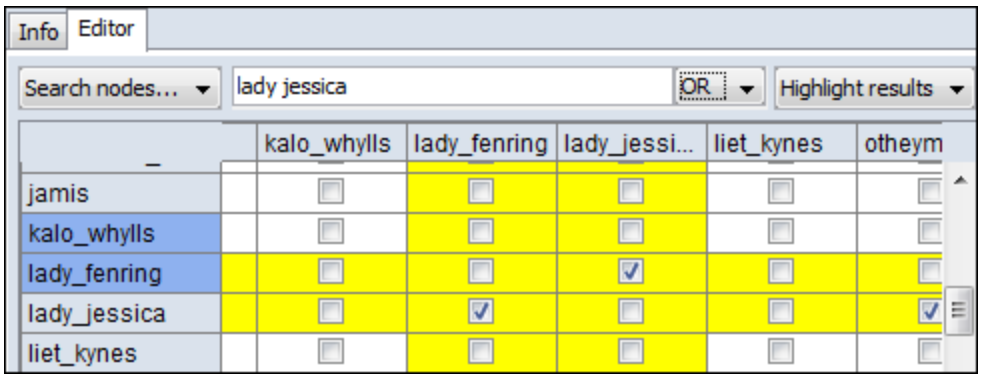
With the [**AND/OR**] selector set to AND I type **lady** into the Search box. This results in two rows/columns being highlighted, **lady_jessica** and **lady_fenring**.



To refine the search I type **jessica** into the Search box (making sure to place a space between the words). This eliminates **lady_fenring** leaving only **lady_jessica** highlighted.



Without changing anything in the Search box I change the **AND** to **OR** in the [**AND/OR**] selector and it now reveals any node with either **lady** OR **jessica**.



NOTE : Idential search results were achieved with different parameters.

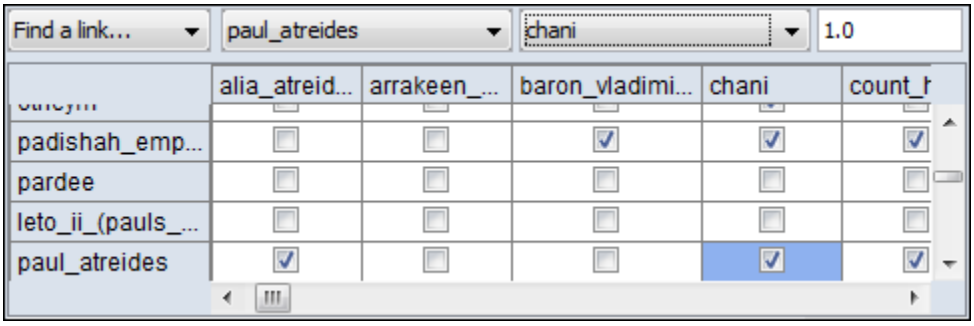
Search type 2

This search is similar as the primary search but with two Search boxes for added refinement.

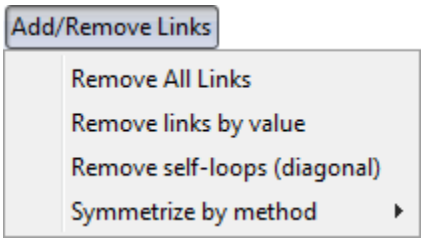


Find a link...

Chosing two nodes in the two dropdown menus will locate the link in the matrix.



NOTE : The box to the right of the node dropdowns is for setting the weight of the link.

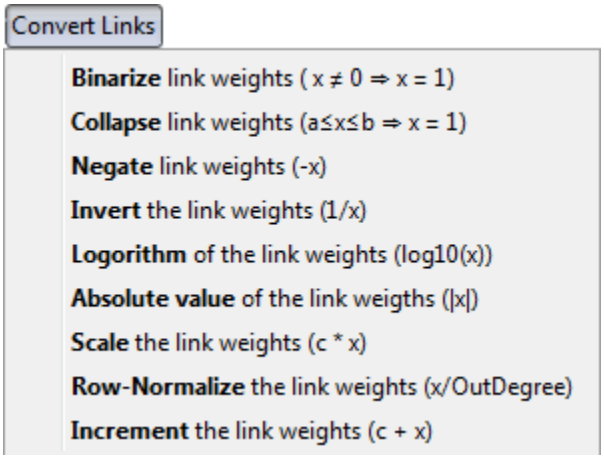


Remove All Links : Removes all links from Network.

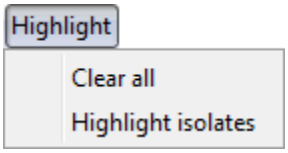
Remove links by value : Allows you to set parameters for the values of links which you want to remove.

Remove self-loops (diagonel) : Removes links connecting a node to itself/

Symmetrize by method : Gives for options : Maximum, Minimum, Sum, and Average.

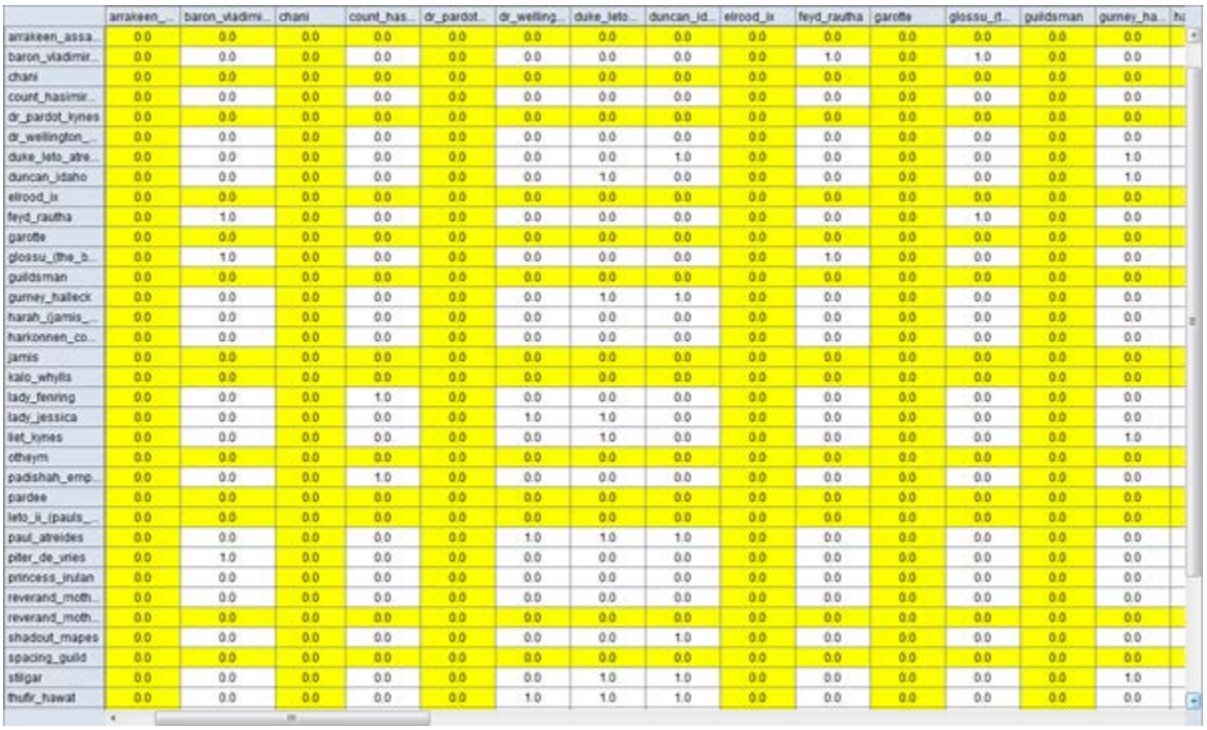


Convert Links : Gives options for changing the value of links in a Network.

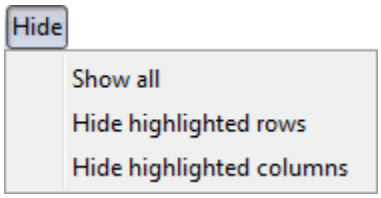


Clear all : Clears all highlighting from rows and columns.

Highlight isolates : Highlights rows and columns of any node with has no connections to any other nodes in the network.



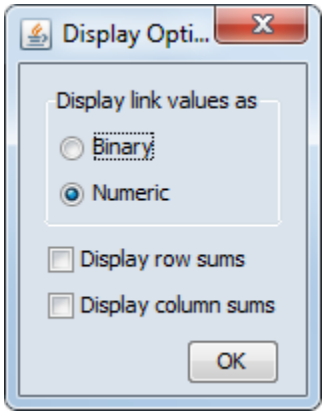
	arrakeen_...	baron_vladimi...	chani	count_has...	dr_pardot...	dr_welling...	duke_leto...	duncan_id...	elrood_ix	feyd_rautha	garotte	glossu_(t...	guildsman	gurney_ha...	h
arrakeen_assa...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
baron_vladimir...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	
chani	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
count_hasimir...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
dr_pardot_kynes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
dr_wellington_...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
duke_leto_atre...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	
duncan_idaho	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	
elrood_ix	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
feyd_rautha	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	
garotte	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
glossu_(the_b...	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	
guildsman	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
gurney_halleck	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
harah_(jamis_...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
harkonnen_co...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
jamis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
kailo_whylls	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
lady_fenring	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
lady_jessica	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
liet_kynes	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	
otheym	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
padishah_emp...	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
pardee	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
leto_ii_(pauls_...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
paul_atreides	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
piter_de_vries	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
princess_irulan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
reverand_moth...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
reverand_moth...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
shadout_mapes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	
spacing_guild	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
stilgar	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	
thufir_hawat	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	



Show all :

Hide highlighted rows :

Hide highlighted columns :



Node Buttons

Node Buttons

Used within the Editor you can manipulate nodes in a Nodeset.

NOTE : Any changes done to a Nodeset are permanent. There is no Undo.



Create : Inserts a new node(s) into the Nodeset. You will be asked for the number of new nodes to create and a node ID. If multiple nodes are to created then a number will be appended to each new node.

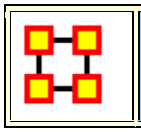
Delete : Removes node(s) and all associated link(s) from the Meta-Network. There are four sub-options viewable by clicking the downward triangle. The nodes deleted are kept in a log which is used for creating a delete list.

Merge : Removes all selected nodes and replaces them with a single node with all previous links and attributes. This is used primarily when data needs to be consolidated. **Example :** A Nodeset contains two nodes, **jack** and **col_o'neill**. These are actually the same person. Merge could combine their information into one which could be named **col_jack_o'neill**.

Move : Move all check marked node(s) to another designated Nodeset. ORA will prompt you for the movement of links to other Networks that are associated with these node(s).

NOTE : Information on both deleted nodes and merged nodes is kept in a log file which ORA used to create a Change List.

Clean : finds all nodes whose IDs are within the edit distance of the selected node. An edit is a change of a single character.



Search

Sub-Set of a Nodeset

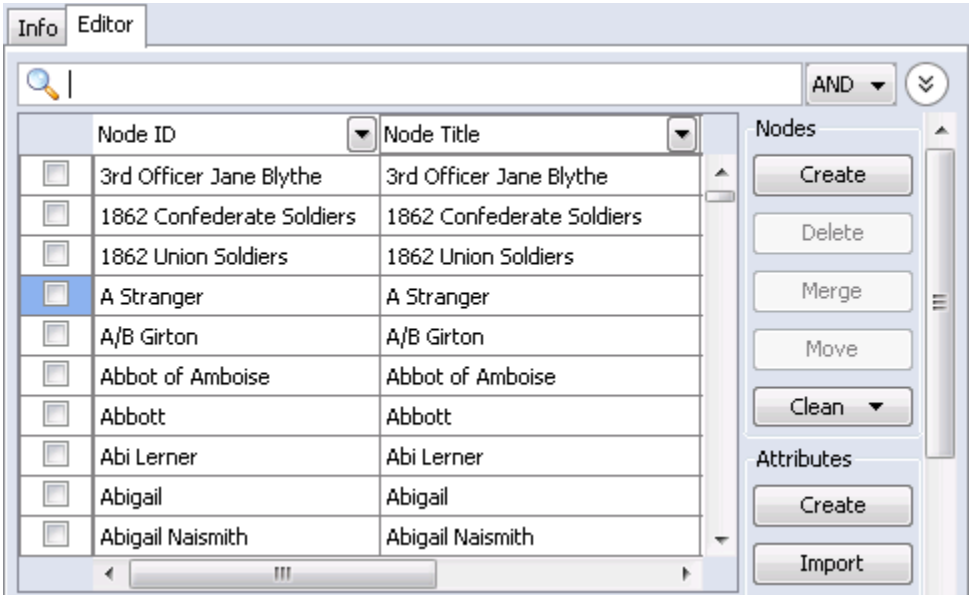
With the **Search** feature you can quickly locate specific nodes. Typing a term into the Search box will display all nodes with that term in their name or attributes.

To the right of the Search box is the **AND/OR** selector. This is a boolean search tool. **AND** requires all terms in the Search box to be present in every node. **OR** will display all nodes with **any** of the Search terms present.

NOTE : Be aware of how **sub-strings** work in searches. A search for **male** will find all values of **male** as well as **female** because **male** is a sub-string of **female**.

Example

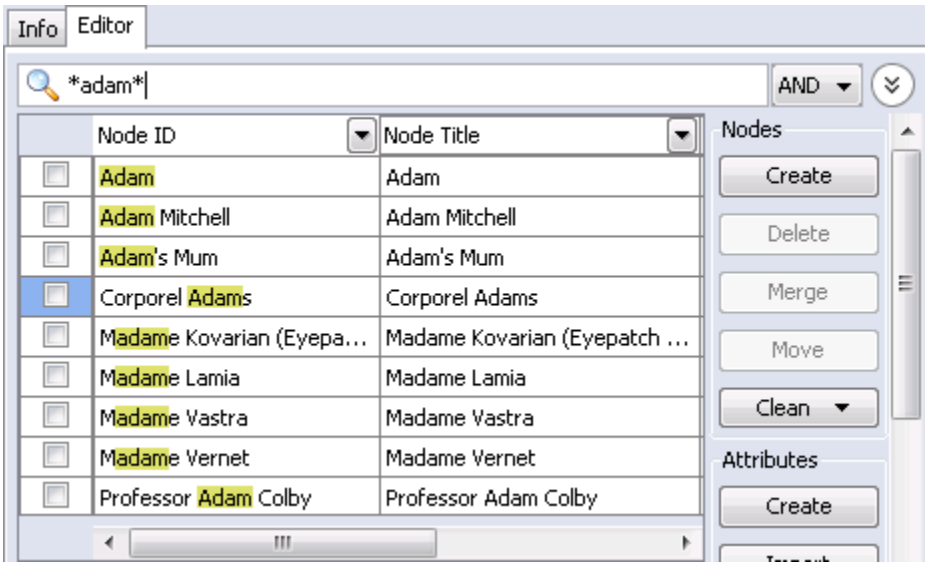
When you start, all nodes will be visible in the Editor. Using the wildcards you can reduce and control what is displayed.



The [*] wildcard

The use of the [*] tells ORA to find all nodes with the string enclosed by the astericks. That string can occur anywhere in the name.

NOTE : Search requires the use of the **wildcard** character [*] both before and after the search term.

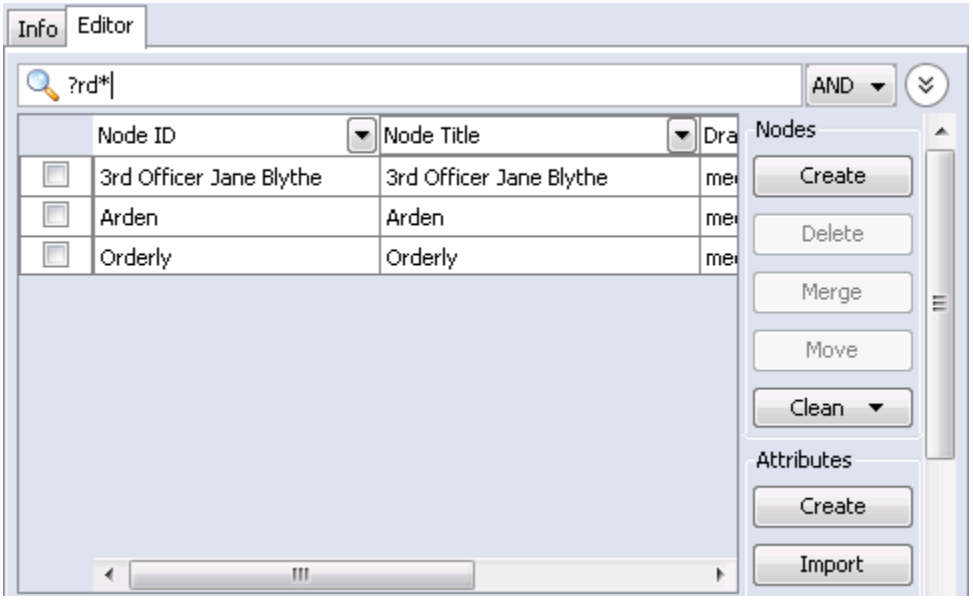


NOTE : Highlights done to emphasize the search. ORA does not highlight these in the actual program.

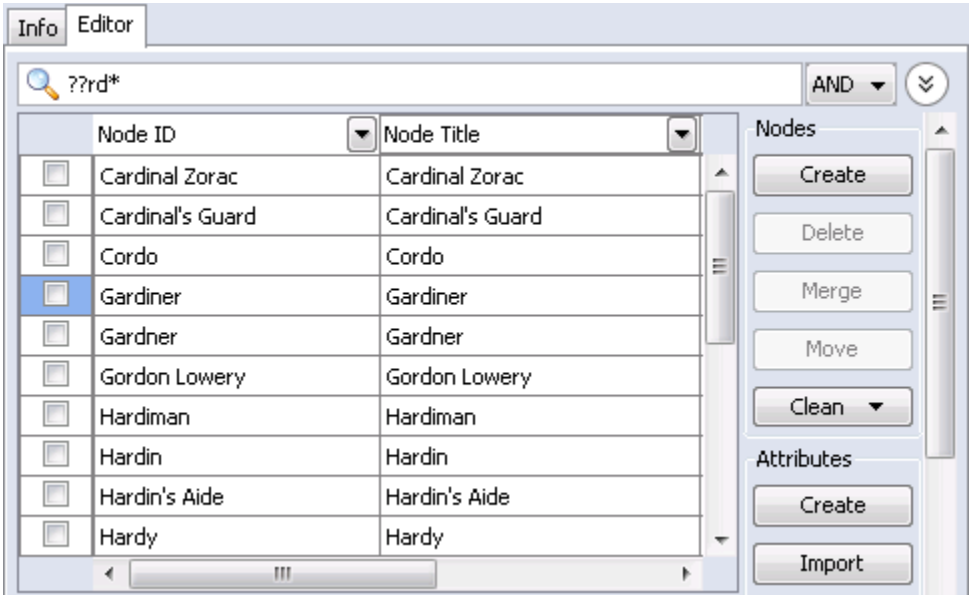
NOTE : The Search functions works on the Nodeset as a whole meaning there's no selecting one single attribute to search. A term found anywhere marks that node to be displayed.

The [?] wildcard

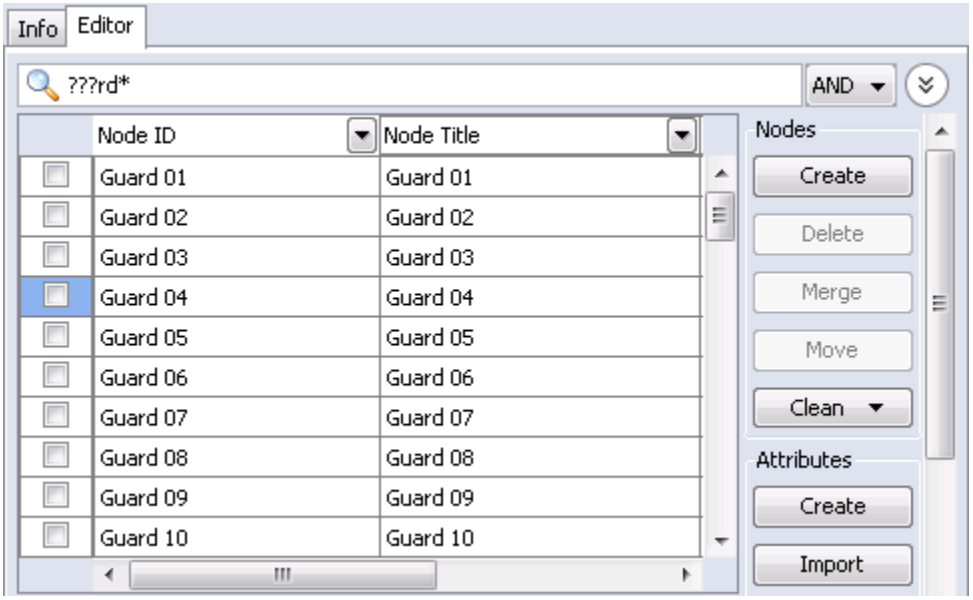
Unlike the asterick the question mark substitutes for only a single character. In the example the first node is **3rd Officer Jane Blythe**. Typing **?rd*** tells ORA to search for the string **rd** which contains any one preceeding character and any amount of trailing characters. It locates three nodes which match



Adding a second **?** tells ORA to search for the string **rd** which contains any two preceeding character and any amount of trailing characters. **3rd Officer Jane Blythe** is no longer found as there is only one character preceeding the **rd** string.



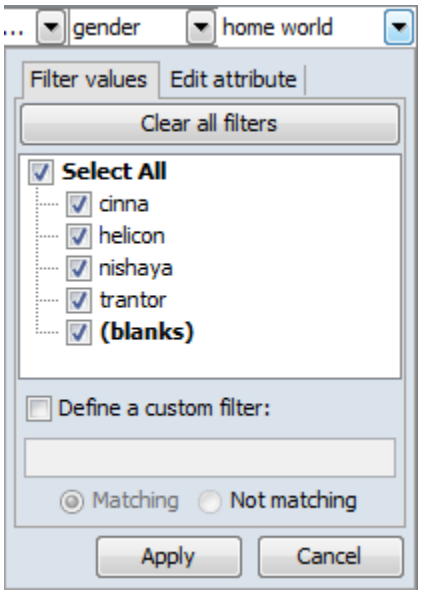
Adding a third **?** to the search produces a third set of results.



Filters

Filtering allows you to select specific nodes to display in the Editor. A check mark tells ORA to display a node with an equal value.

The [**Clear all filters**] button removes the filter parameters from that particular column only. It does not affect any other filters you have set elsewhere.



Deselecting all except **(blanks)** will display any node which has a null value. This is useful when you need to fill in attributes for blank nodes.

With **Define a custom filter** you can specific a filter in greater detail. If there were three nodes with attributes of **city-1, city-2, and city-3** defining ***city*** as the filter would display all three. This also contains the **Matching** [shows only what matches the filter] and **Not matching** [which shows only what does not match the filter].

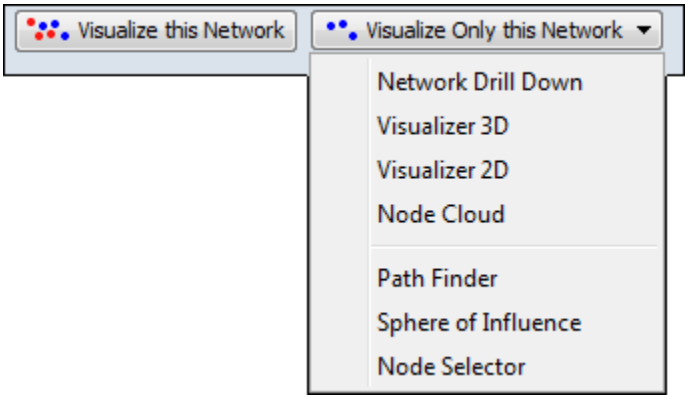
When finished click the [**Apply**] button activate the filter.

You can also set filtering to multiple columns to better define your search. This search required the **home world to equal trantor** and also **sector to equal dahl**. Only nodes with both attributes are displayed.

Node Title	Corr...	Corr...	home world	job_title	sector
yugo_amaryl	0.0498787		trantor		dahl
gambol_deen_namarti	0.18136	male	trantor	docto	dahl
raych	0.30	male	trantor		dahl

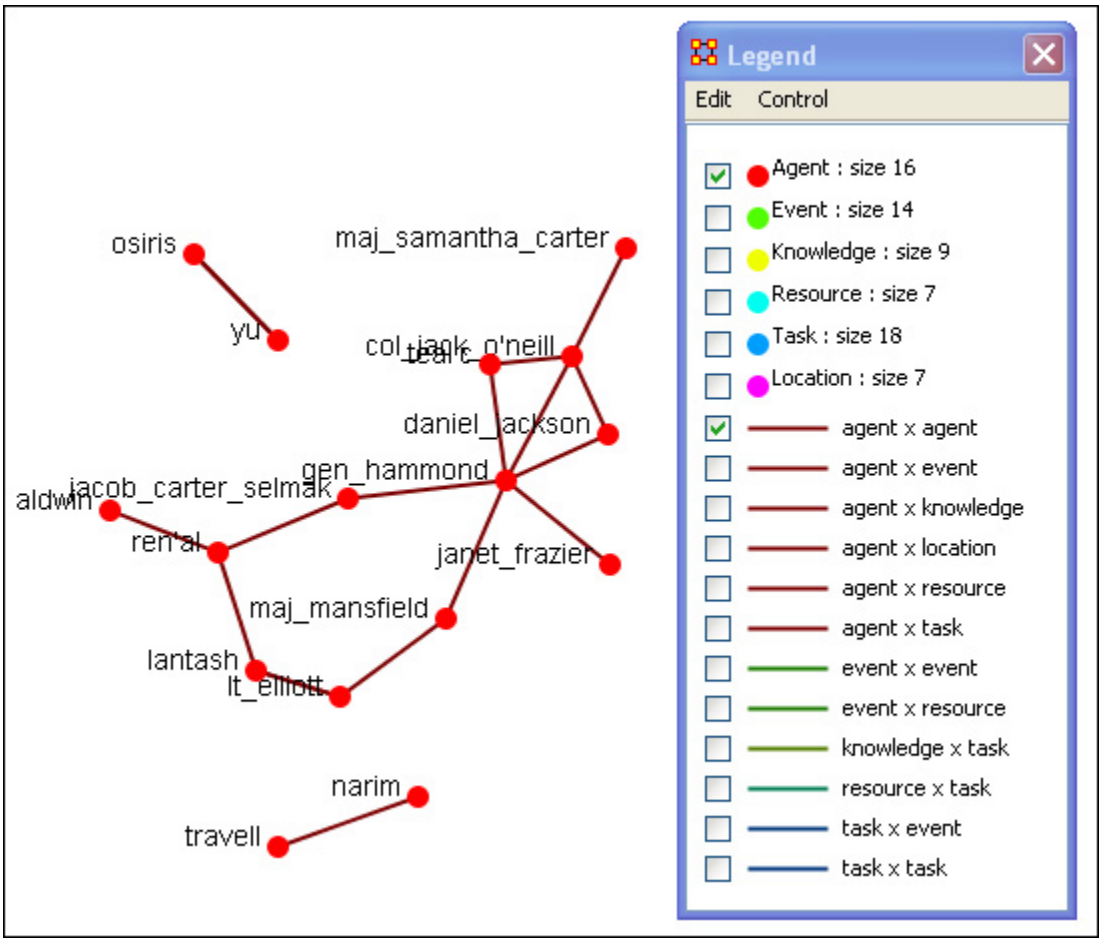
Visualize Buttons

There are two **Visualize** buttons and they work slightly different.



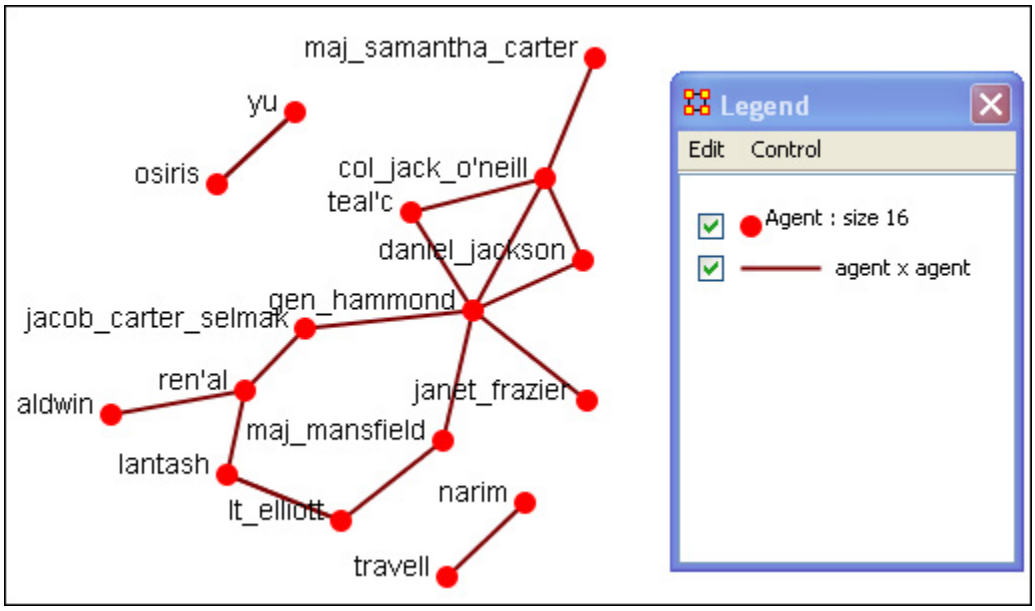
Visualize this Network

The **Visualize this Network** visualizes the chosen Network. In the **Legend** dialog box all Nodesets and LinkSets are available.



Visualize Only this Network

The **Visualize Only this Network** visualizes the chosen Network. But in the **Legend** only the Nodesets and Link Sets chosen are displayed. This is a much quicker means to display a Network. ORA only makes computations for the chosen Network.



Clicking on the downward triangle brings up the dropdown menu with additional options for visualizations: **Network Drill Down**, Visualizer 3D, **Visualize 2D**, **Node Cloud**, **Path Finder**, **Sphere of Influence**, and **Node Selector**

File Menu

Below is an image of the File Menu accessible from ORA's main title bar menu. Further below are descriptions of the various tools accessible through the File Menu.



Open Meta-Network : opens a single Network with the following formats: DyNetML* (the native ORA xml format), .dl, .##h (UCINet), .csv* (comma separated values, Excel spreadsheet out), .txt (text files), .raw, .net (Pajek), .graphml*, .stl* (GMU model), and .lo (pathfinder).



Data Import Wizard : Contains additional options for importing Networks such as multiple file importing. See **Lessons** for more comprehensive information regarding this function.

Data Export... : Allows you to export a Meta-Network into a different format: **CSV, UCINET-Binary, UCINET-DL, Netdraw VNA, Text, Pajek, DyNetML, or C3Trace**.

Manage CASOS Database.....

NOTE : This function only available in the full version.



Open Workspace... Allows you to open an entire workspace that you were previously using. A workspace consists of a set of Meta-Networks that were all open at the same time, and saved as a workspace.

CEMAP... Opens up the CEMAP Parser.

CEMAP3... Opens up the CEMAP3 Parser.



AutoMap... Opens up the program AutoMap.

Pile Sort... allows a user to load a series of entities such as concepts which can then be organized into a piles. The output will be a network in DyNetML format.

Data to Model Wizard



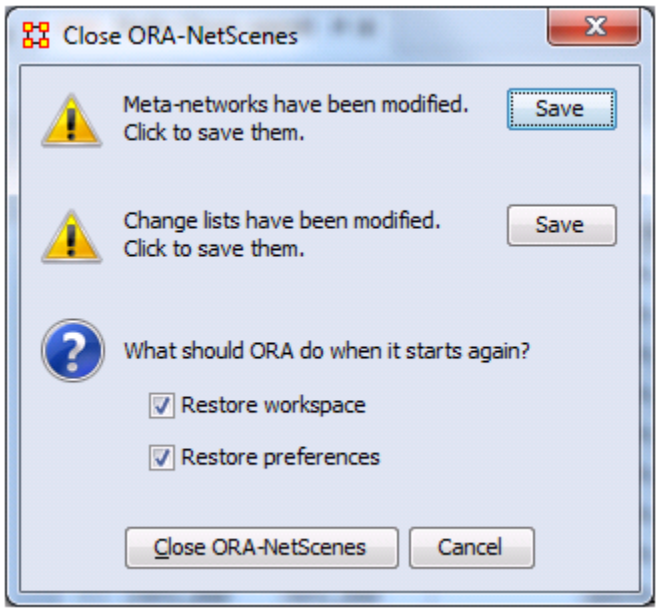
Save Meta-Network : This item is initially greyed out. It only becomes active when you've made a change to a Network. You can use it as an indicator whether you've made a change to the active Meta-Network. Notice as you highlight each Meta-Network the icon in the toolbar will be greyed out (no changes) or colored (changes made to that Meta-Network).

Save Meta-Network As... : Allows you to save the changes in a Meta-Network under a new filename.



Save Workspace : Saves the active Meta-Networks into a **Workspace** which can be opened up at a later date.

Exit : Closes the program and gives you two options for the next time you open up ORA.



- **Meta-Networks have been modified :** If you have any Meta-Networks with unsaved changes you can save them by clicking [**Save**]
- **Change lists have been modified :** If you have any Change Lists with unsaved changes you can save them by clicking [**Save**]
- **Restore workspace :** If checked, the next time ORA is started

it will load any Meta-Networks currently open when it was last closed.

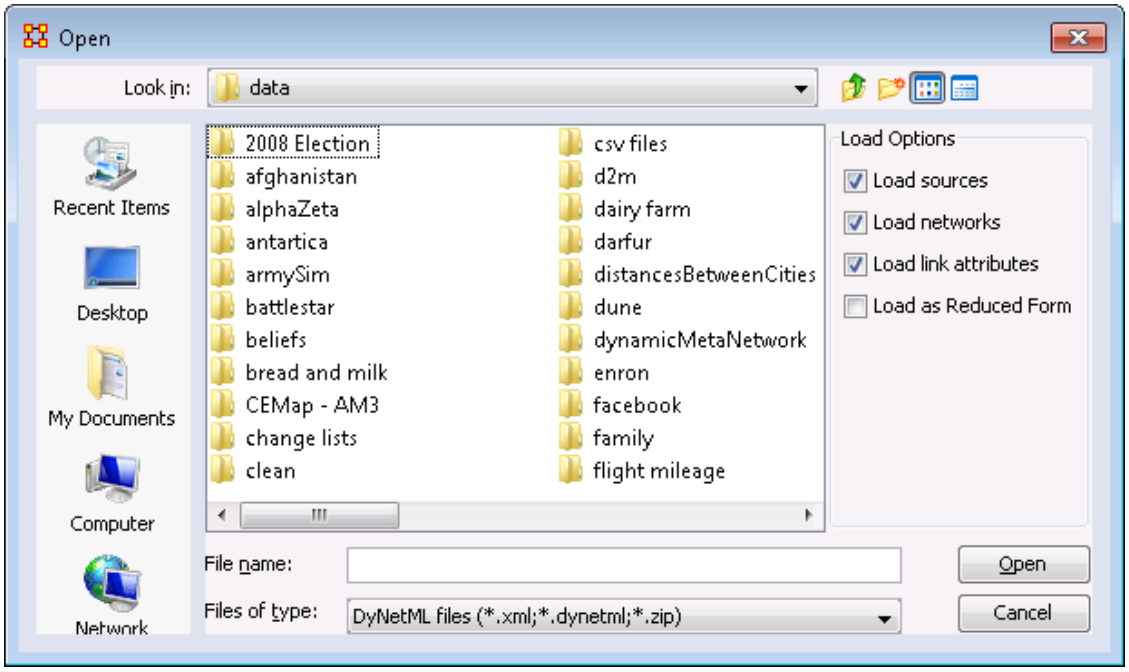
- **Restore preferences :** If checked, all preferences from **Edit > Other...** will remain in effect. If not then ORA will resort back to it's defaults..

Open Files in ORA

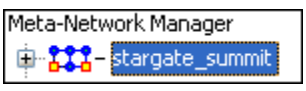
ORA is designed to work with **DyNetML** files. However, data in a format other than DyNetML can be imported and converted.

Open Meta-Network

From the Main Menu select **File > Open Meta-Network.** to bring up the initial open dialog box. Navigate to the folder with your DyNetML file and click **[OK]**.



There are four **load options** available. After selecting your files, they will appear in the Meta-Network Manager pane.



Data Import Wizard

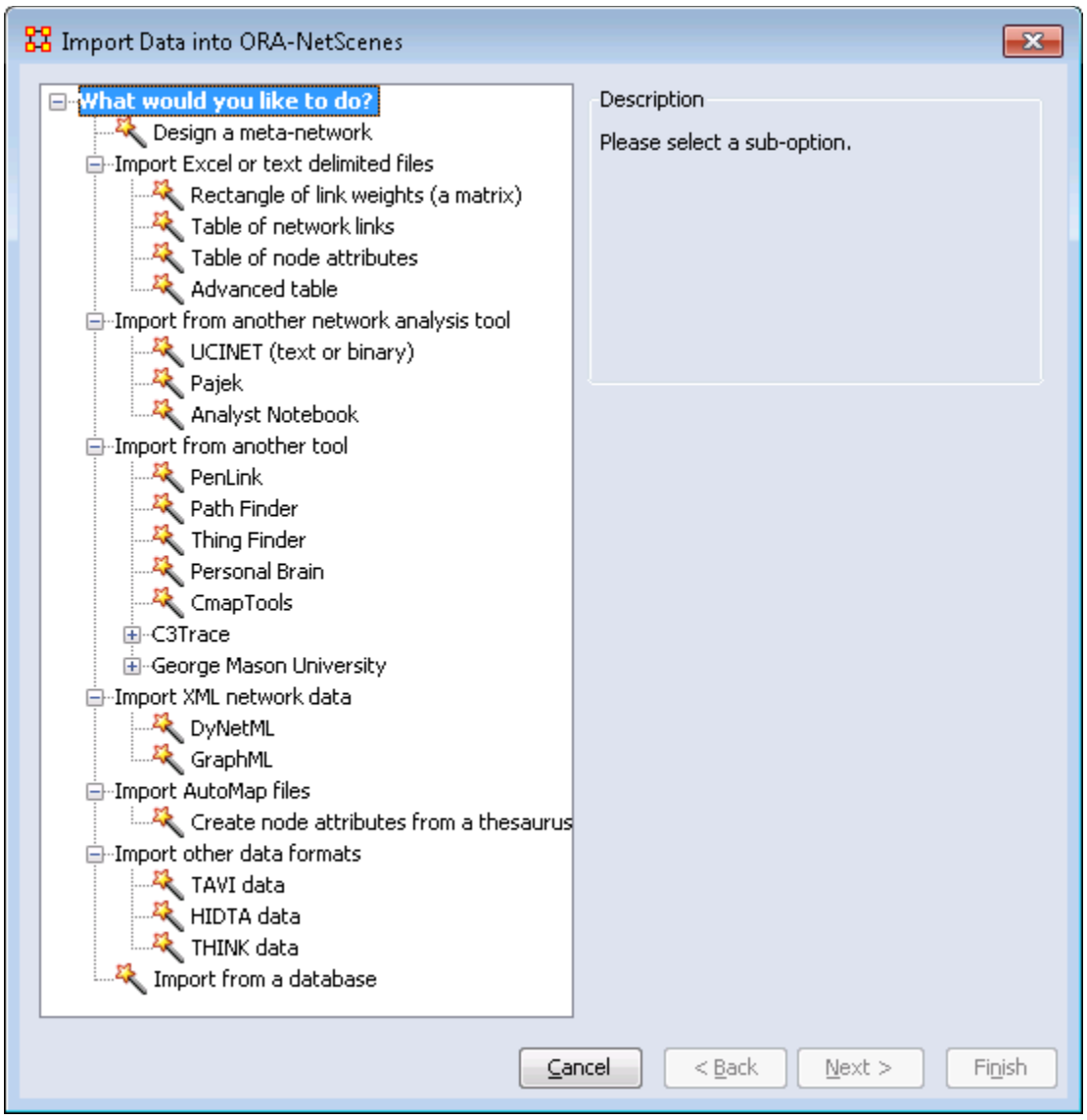
The **Data Import Wizard** imports files in a variety of File Formats. The idea behind the data import wizard is that users come to ORA with a variety of file formats from various different network analytical tools. Very rare is it that an analyst has a Meta-Network ready to load. Moreover, network data may exist in a separate file or in a variety of file formats, which then need to be merged together.

The Data Import Wizard is used to convert the user data from their native format and separate files and convert it into Meta-Networks and then into a DyNetML file.

The files can be in any of the following formats: **CSV, UCINET, GraphML, or Pajek**. ORA uses the file extension to determine the native file format to assign to your network. Therefore, if you change a file extension from its native extension **(e.g., GraphML file such as "example.gml" to "example.dot" ORA will not recognize the data format).**

This section will review the basics of the Data Import Wizard. See the lesson **Creating a Meta-Network** for more comprehensive information on importing.

Data Import Wizard is accessed either **File > Data Import Wizard** or the icon in the toolbar. You are presented with a dialog box showing all the file format options to import. Each contains a description on the right-side of the box.



Other Functions Besides Importing

- **Create a meta-network from separate network files:** Use this option to select multiple networks in one of the several native file formats indicated above and pull them into ORA. The file formats don't have to match. ORA will then combine all the network files into one Meta-Network, which will then be saved as a **DyNetML*** file (ORA's native file format).
- **Create a meta-network from table data:** Text files in the form of **rows of Nodes and columns of Attributes** will be used to populate existing Nodesets.

- **Import node attributes from table data:** Text files used to import Attributes to a Node.



Data Import

The Data Import function contains many methods for creating new Meta-Networks or importing data into pre-existing Meta-Networks.

This section instructs you how to:

Designing a blank Meta-Network.

Importing Network matrix data to create a new Meta-Network.

Importing Attributes into an existing Meta-Network.

Importing KeyFrame data

Importing a Simple Table

Importing data from an Arbitrary Database

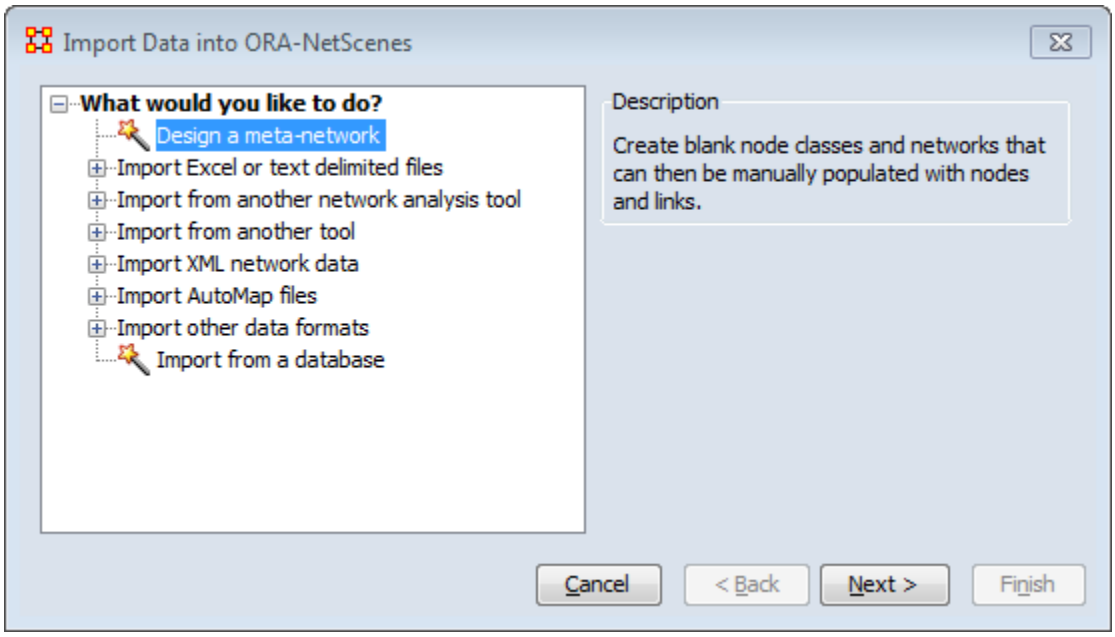
Importing from SQL



Create Blank Meta-Network

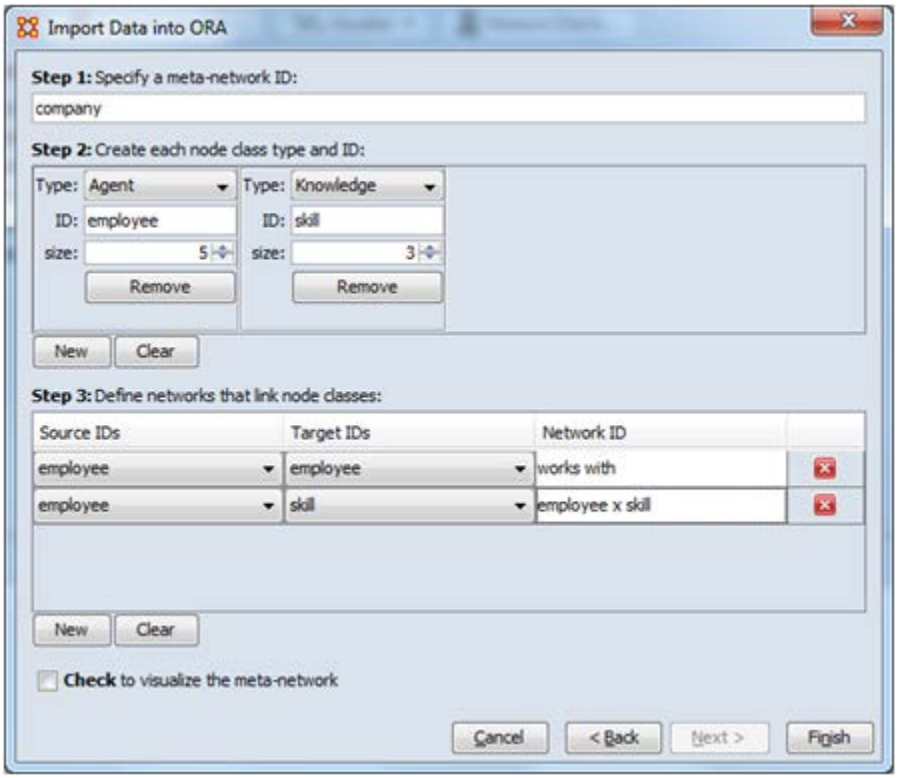
ORA allows you to create a blank Meta-Network from the **Data Import Wizard**. This Meta-Network will contain Nodesets and Network which can be populated with information either manually or by importing csv file data.

Select the Import Wizard with **File > Data Import Wizard**



In the left box select **Design a meta-network** Then click [**Next >**].

This brings up the dialog box for creating a blank Meta-Network.



Following the three steps you can create a blank Meta-Network with any number of **Nodesets** and **Networks**.

Step 1: Specify the name for your new Meta-Network.

Step 2: Click the [**New**] button to insert a new **Nodesets**.

1. Select a **Type** from the drop down menu.

2. Give it a unique ID name.

3. Specify the size you want your new Nodeset to be.

NOTE : In the above image two Nodesets were created, **Agent and Knowledge**.

NOTE : The [**Remove**] button will remove that particular Nodeset from the screen. It will not affect any other Nodesets.

Continue creating all necessary Nodesets.

Step 3:

As with Nodesets this step is for creating all necessary Networks. Click the [**New**] button to insert a new **Network**.

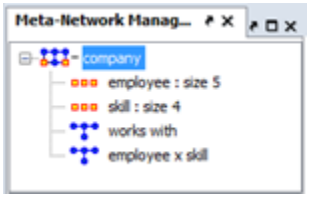
1. Select a **Source ID** and a **Target ID** from the drop down menus.

2. Give it a unique Network ID name.

NOTE : The employee x employee network was called **works with** while the employee x skill was called **employee x skill**.

NOTE : The [**X**] button will remove that particular Nodeset from the screen. It will not affect any other Nodesets.

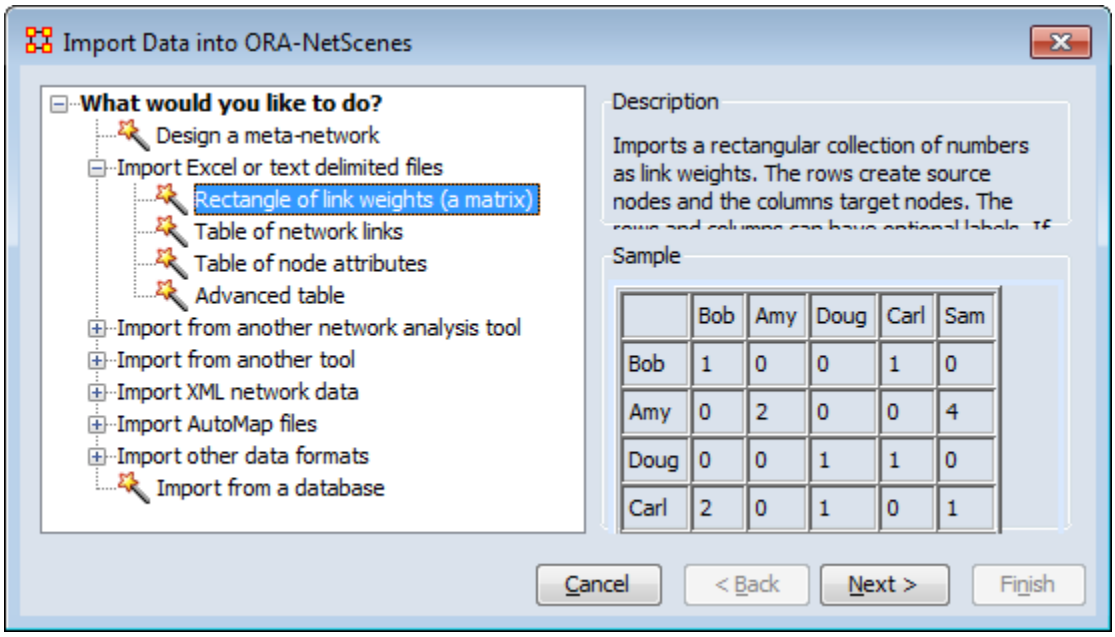
Continue creating all necessary Networks. When you are done click the [**Finish**] button. You will see you newly created Meta-Network in the **Meta-Network Manager Pane**



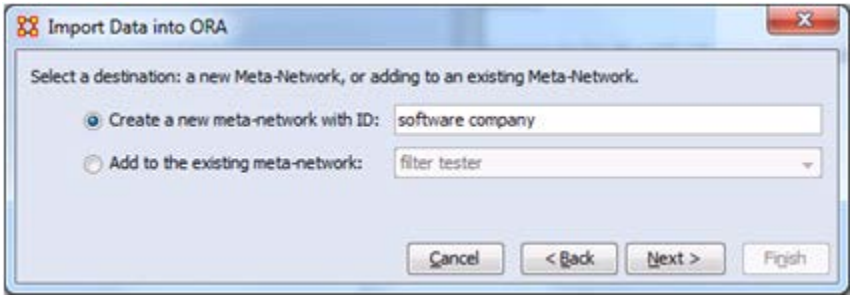
When you are finished you can use the ORA Editor to type in information of use the Data Import Wizard to import information from externally created CSV files.

Import Matrix Data

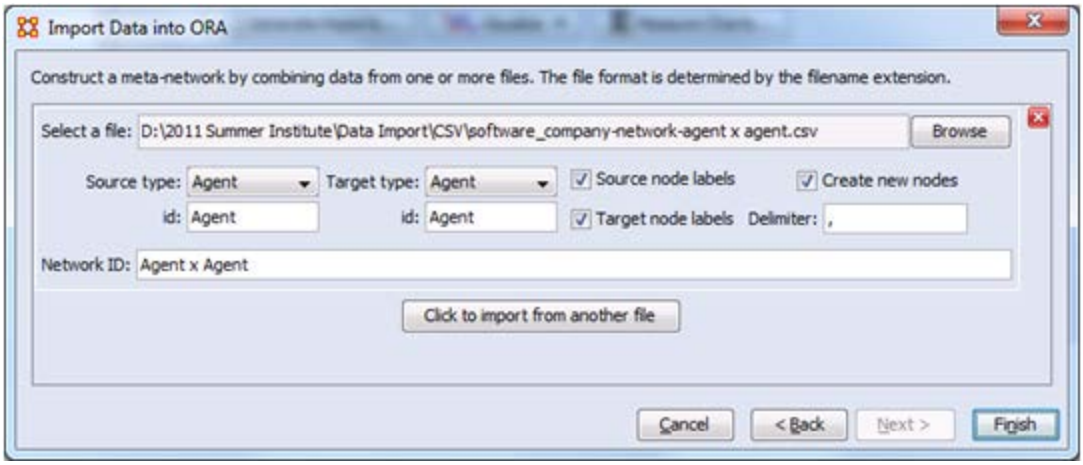
Data in a Matrix form (**In excel or text delimited format**) can be imported via the Data Import Wizard. Open the wizard by selecting **File > Data Import Wizard**.



Select **Rectangle of link weights** option then click [**Next >**].



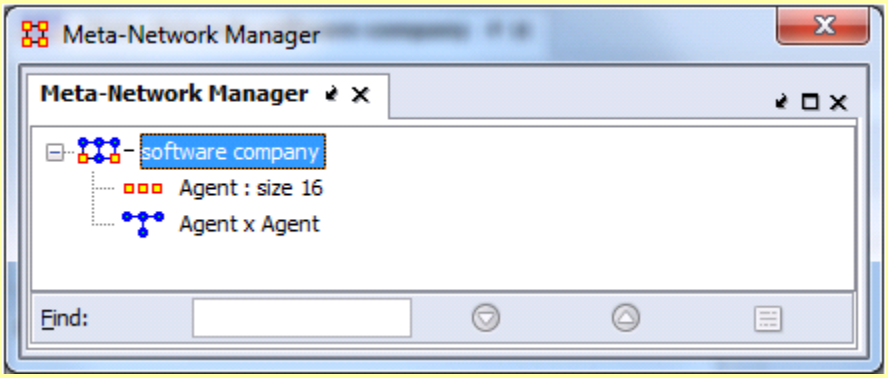
Select the **Create a new meta-network with ID:** and give it a new name. Then click [**Next >**].



The data in the example is an **agent x agent** type so the **Source Type** and the **Target type** are set to **Agent**. ORA will automatically fill in the **Network ID** as **Agent x Agent**. You can change this name if you want.

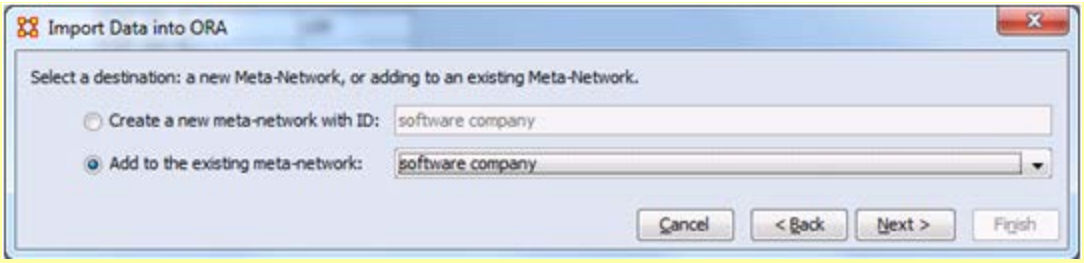
NOTE : The field, **Delimiter:** can be use to specify the character for a delimited file. It defaults to the [**,**].

Click [**Finish**].

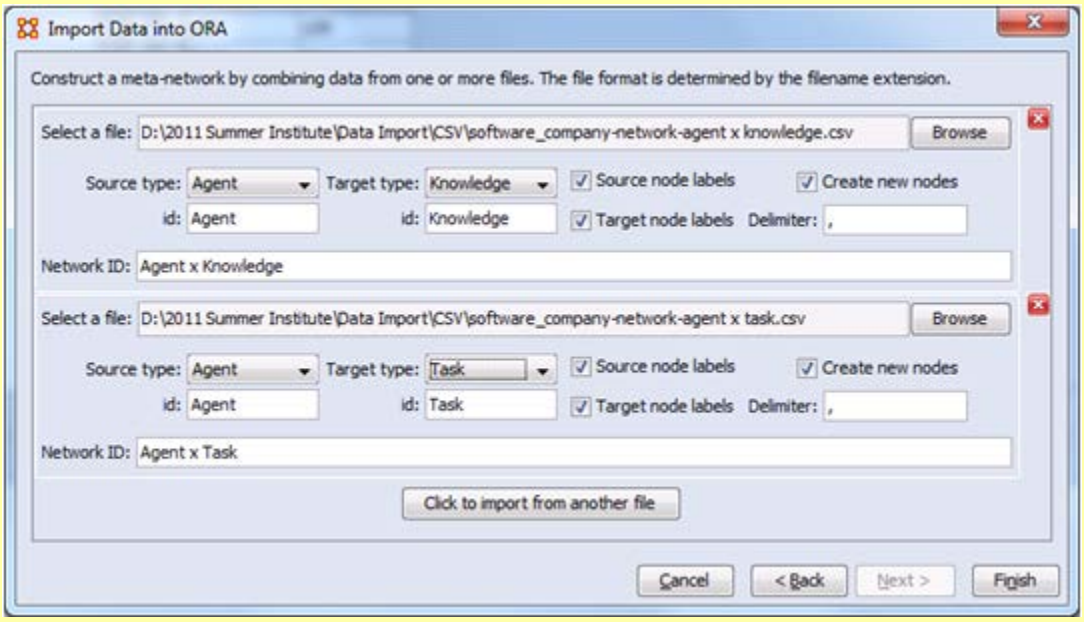


The **Meta-Network Manager Pane** now contains a new Meta-Network with the imported Network and in the process has created a new Nodeset Set. You can examine these in the Editor. For now the **Nodeset ID and the Nodeset Title** will be identical. This can be adjusted when additional attributes are imported.

NOTE : To import additional matrix files follow the above procedure except use the **Add to the existing meta-Network** option as shown below.



Click the [**Browse**] button to select the file{s) to import. Set the **Source type** and the **Target type** for each file imported. To add more Networks click the [**Click to import from another file**] button to add another Network.

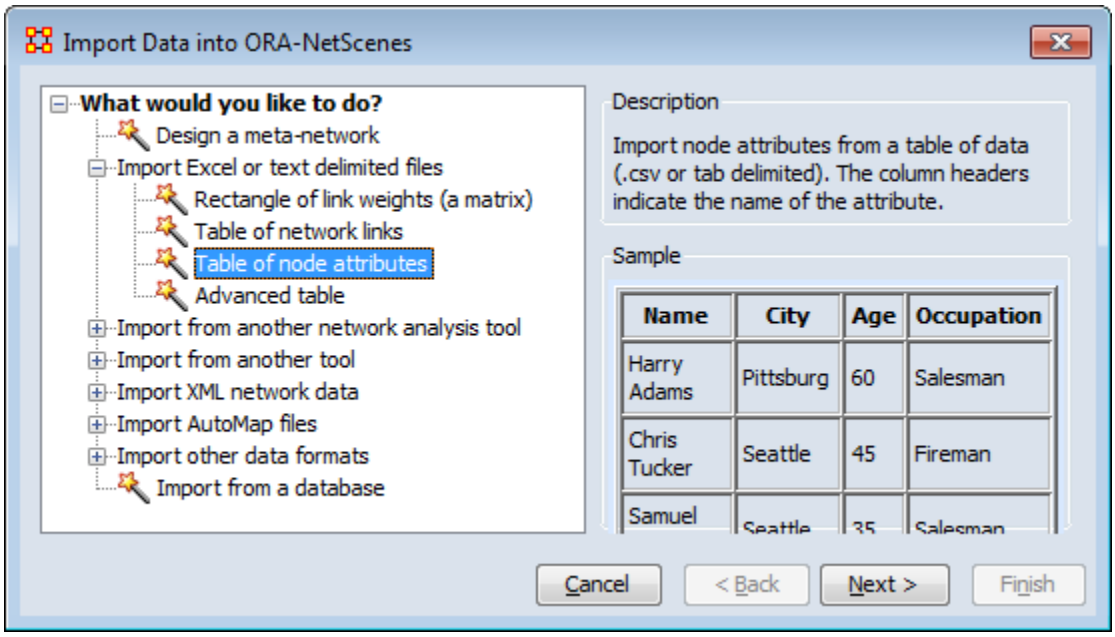


When you have imported all your Networks click the [**Finish**] button. You modified Meta-Network can be viewed in the **Meta-Network Manager Pane**.



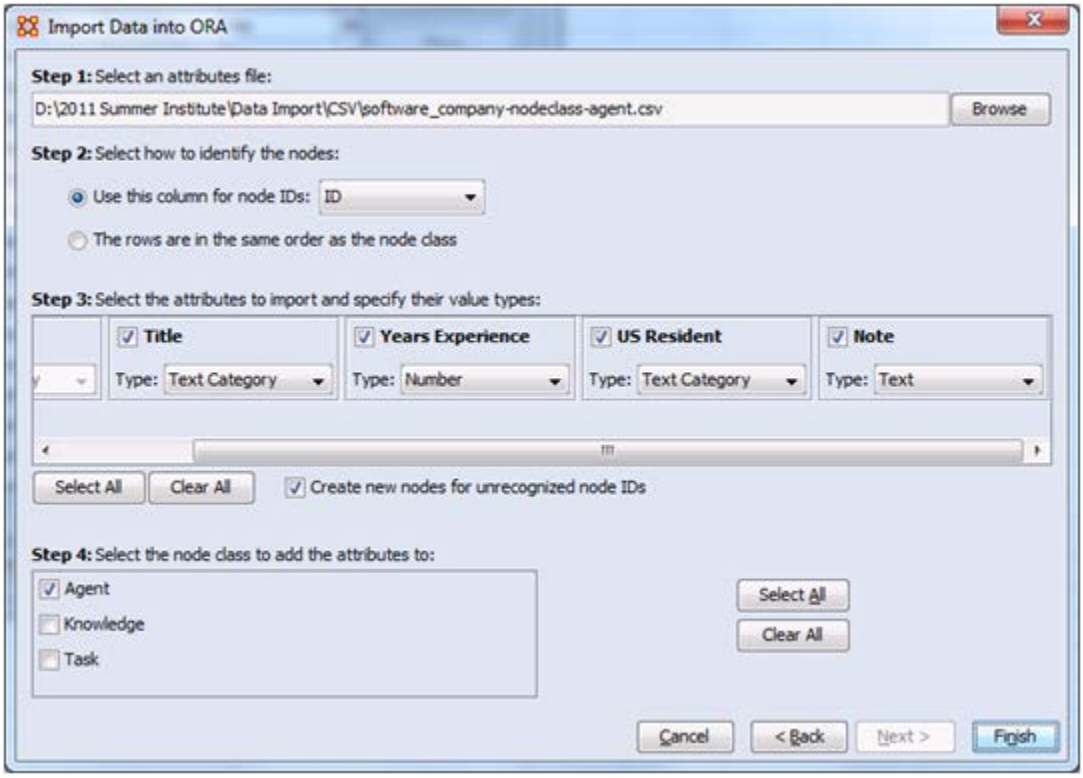
Import Attribute Data

After a Meta-Network is created and Networks have been imported it's time to import **Node Attributes**. Select **File > Data Import**. From the dialog box select **Import existing data? > Table data from Excel or text delimited formats > Simple table > Node attributes**. Click [**Next >**].



On the next screen click the Meta-Network to add attributes to. Then click [**Next >**].

This brings up the next screen for adding the attributes.



Step 1: Click [**Browse**] and select the file with the attributes for the Meta-Network.

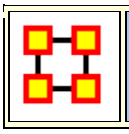
Step 2: Select the **Use this column for node IDs**. The data file should contain a first column of **node IDs** for Agents. Each row should contain the attributes for those agents.

Step 3: Select the attributes to import by placing a check mark next to the attribute's name. Next select the **Type** for each attribute.

Step 4: Place a check mark next to the Nodesets to add attributes to.

Click [**Finish**] to import.

After the import the nodes in the selected Nodeset will contain new attributes.

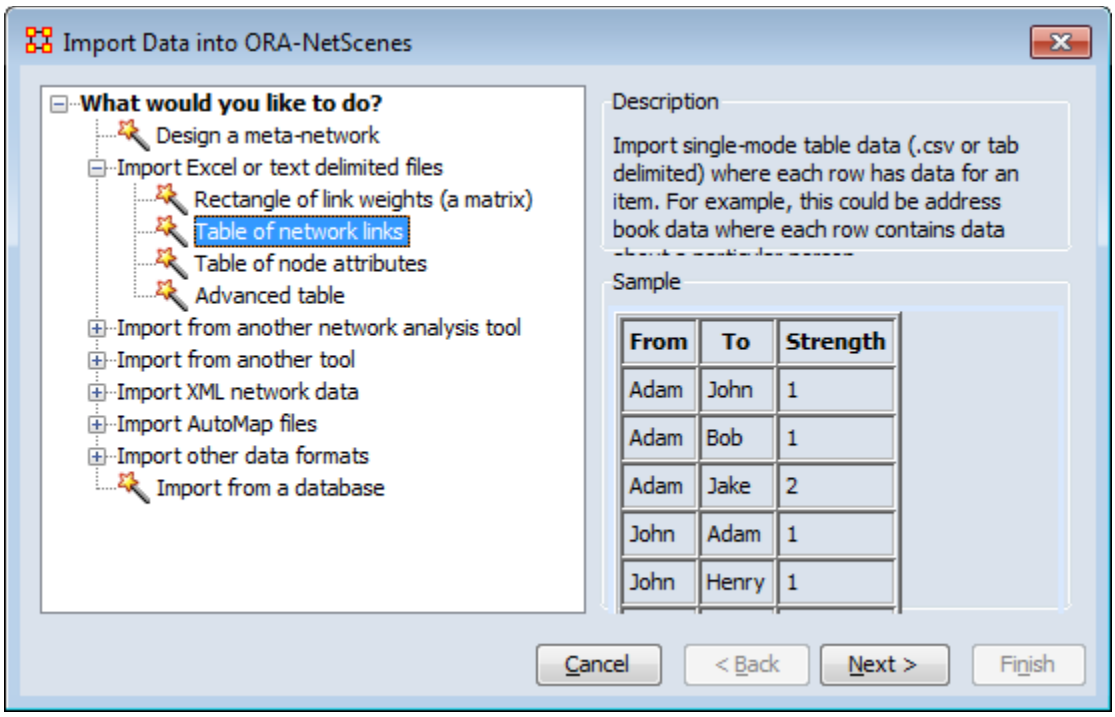


Import Keyframe Data

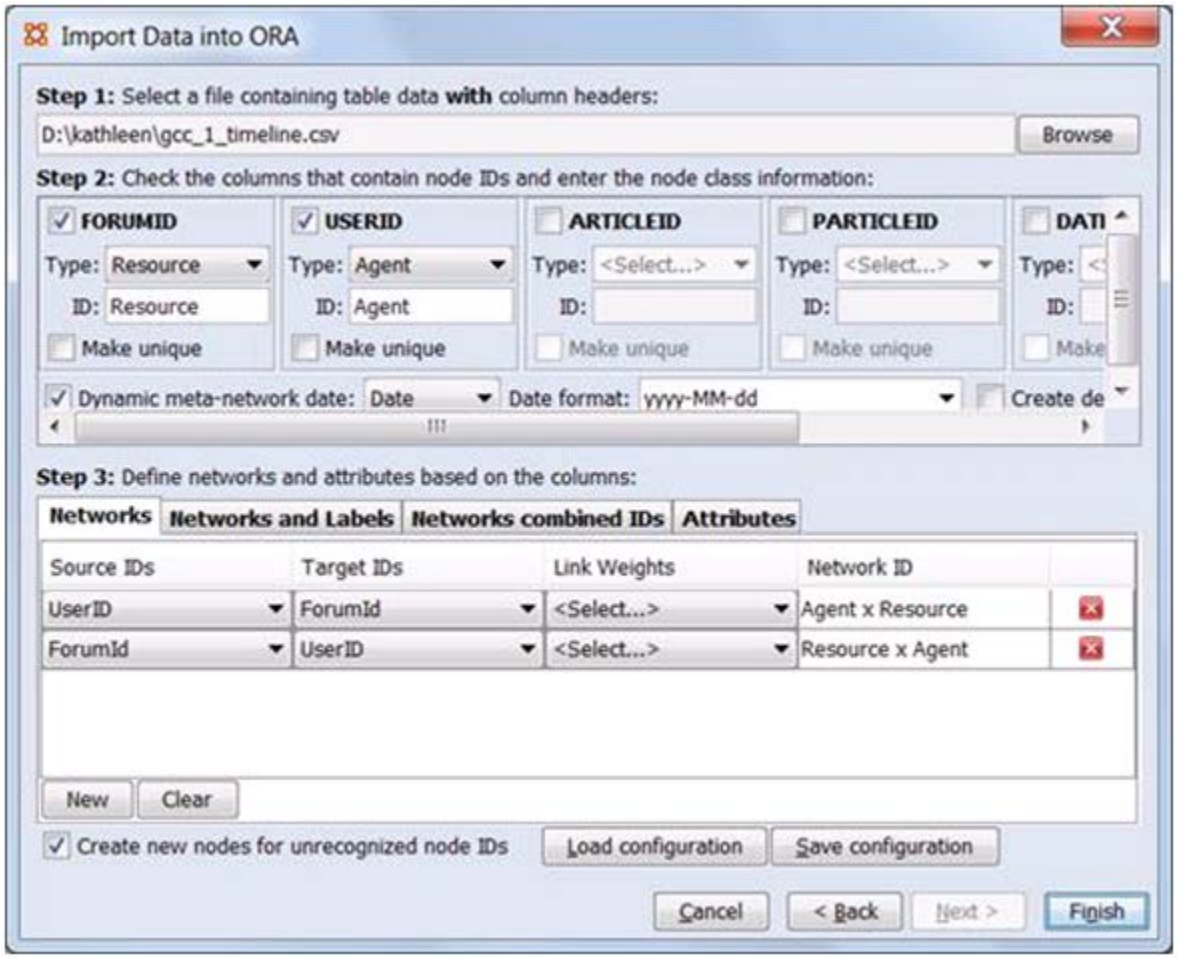
Importing GCC Timeline data into ORA

ORA can import data from a CSV file into a Dynamic Meta Network of keyframes. In this example each has an **Agent x Resource** and an **Agent x Agent** network. The AA = AR * RA network computed using the **Matrix Algebra Tool**.

Open the Data Import Wizard using **File > Data Import Wizard** [**Ctrl + W**]. Then select the option below.

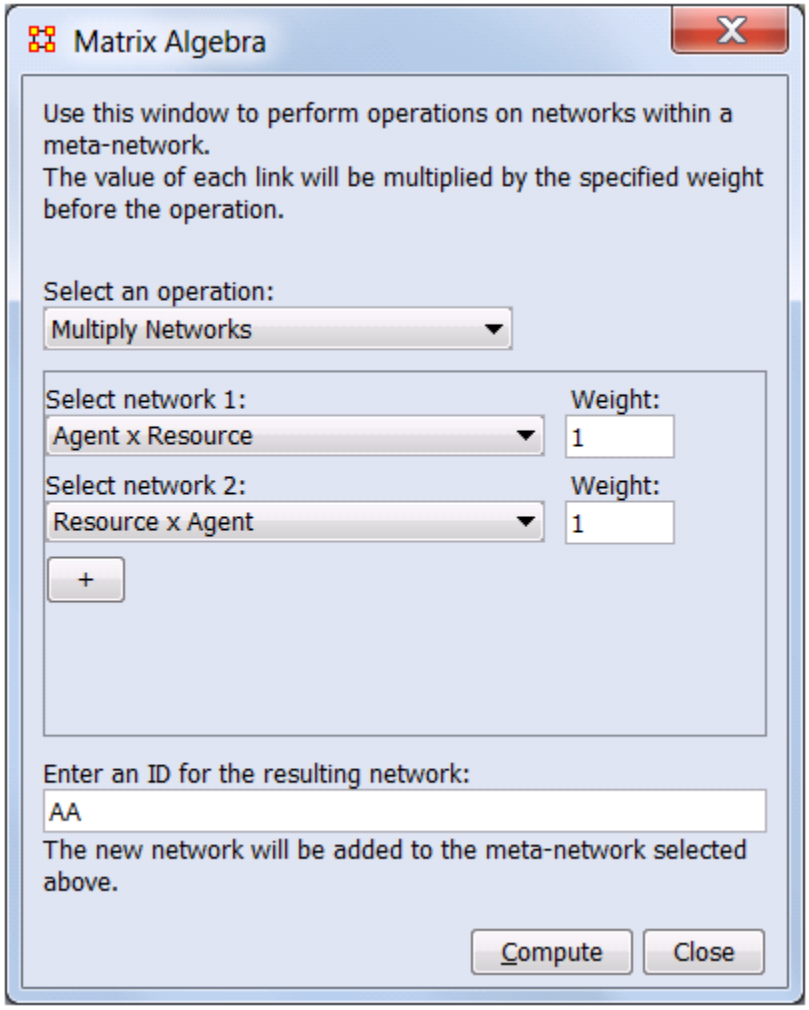


Configure the final Data Import Wizard page per the picture below:

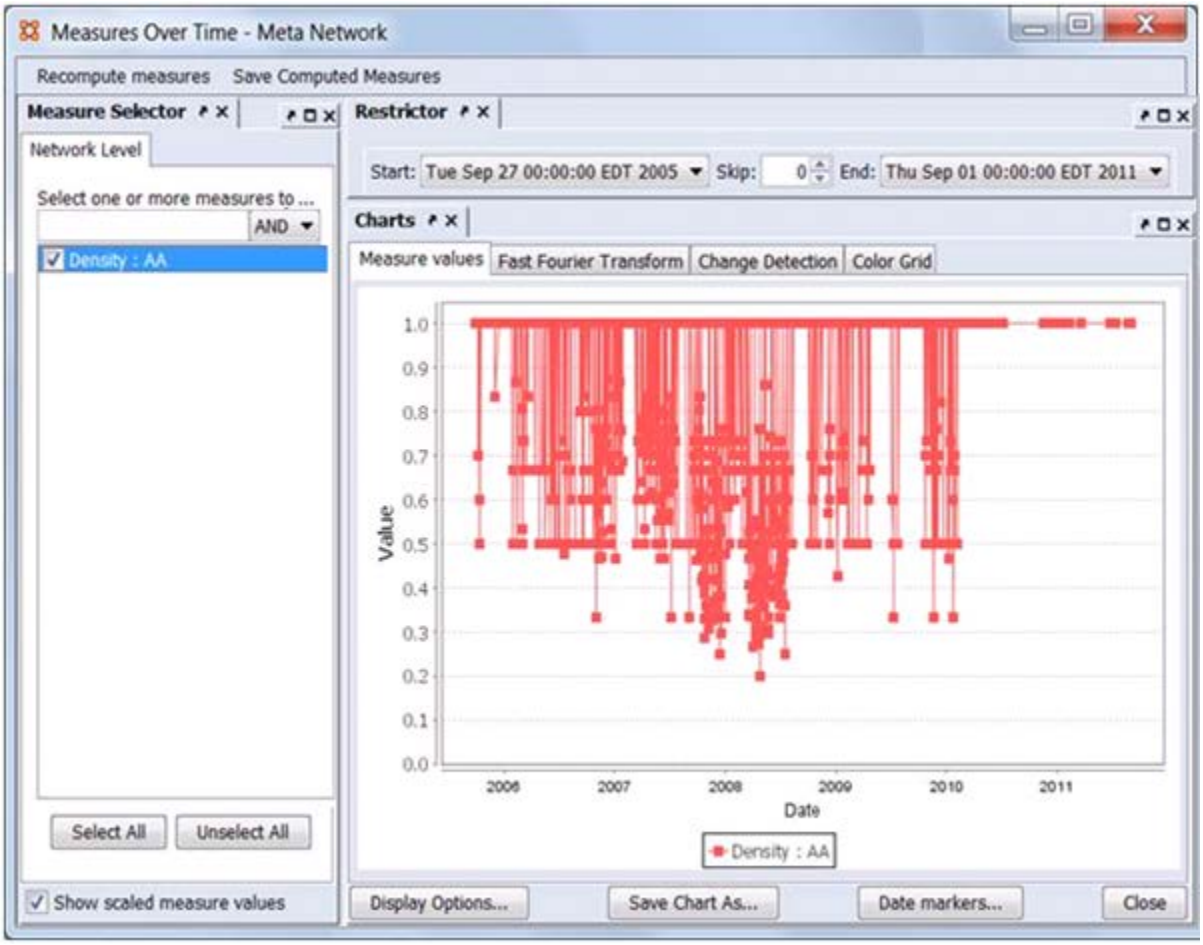


I import **AR and then RA**, which contain the same links but transposed so that I can then easily multiply to get AA = AR*RA. This is how the Matrix Algebra Tool in ORA functions. To multiply by a transpose you must create an intermediate transposed matrix.

Select **Data Management > Matrix Algebra** menu open the Matrix Algebra Tool. Select the options below for each keyframe in the AxA network.

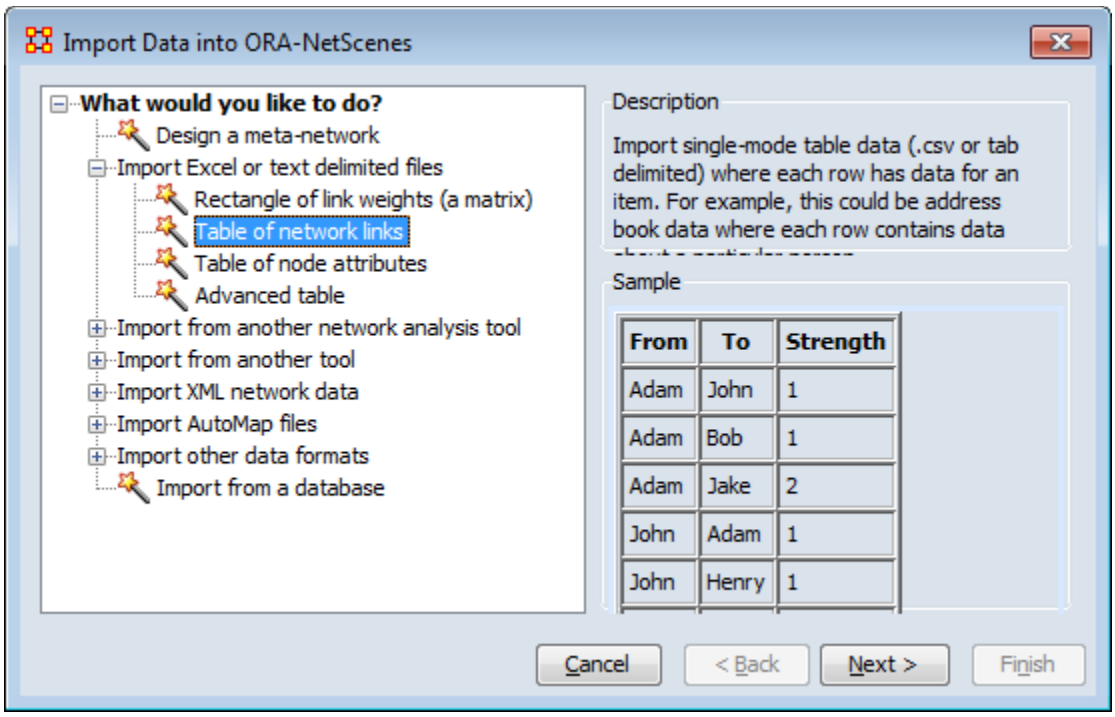


Select **Visualization > Measures Over Time**. Plot the density of the AA network to see that the networks are not all empty.



Import Simple Table Data

Select **File > Data Import Wizard**. Then select **Import existing data? > Table data from excel of text delimited formats > Simple Table > Networks, nodes, and node attributes**.



Import Arbitrary Database

ORA can import data from other databases such as MySQL. This is done through the **Data Import Wizard**. You will need to configure your database via an ODBC[1] connection, and place the jODBC driver into the requisite ORA JRE installation folder.

If you want to write a dynetml file to a database, such as one in MySQL, then you would use **File Manage CASOS Database.**

The jODBC installer deploys the following files:

jodbc.dll	jBASE ODBC Driver Library
libjODBCSetup.dll	jBASE ODBC Setup Library
jODBCManager.exe	jBASE ODBC Manager
ACE.dll	ACE (Adaptive Communication Environment) Libraries
ACE_SSL.dll	

libeay32.dll	OPENSSL Libraries
ssleay32.dll	
icuuc40.dll	ICU (International Components for Unicode) libraries
icudt40.dll	

NOTE : The ODBC installer copies the ODBC driver and setup libraries under the Windows\System32 directory.

ODBC Setup library is a separate library implementing the ODBC Setup API required by the driver manager to display graphical components such as connection dialogs. Connection dialogs enables users to configure DSNs inside Windows' ODBC Manager (odbcad32.exe) or input connection details when requested by the driver.

jBASE ODBC Manager is a small console application used to register the ODBC libraries with the system, create/remove DSNs or test a connection to a remote jBASE instance. Please run **jODBCManager -h** to obtain more information on how to use this utility.

Installing the driver

The ODBC installer will automatically register the ODBC driver and ODBC Setup libraries. The registration process is required to inform the ODBC Manager about the location of the ODBC driver libraries. The ODBC installer will also add the installation directory to the global user environment variable PATH. This is necessary since the jBASE ODBC driver depends on other shared libraries as e.g. ACE, etc.

When installing on Windows 7 x64, the following extra steps are required:

Start a command shell as Administrator.

Navigate to the directory where you installed the driver then run the following 'jodbcmanager' command.

```
C:\Program Files (x86)\jBASE ODBC Connector>jodbcmanager -i -
driver="C:\WINDOWS\system32\jodbc.dll" -
setup="C:\WINDOWS\system32\libjODBCSetup.dll"
```

Configuring DSNs

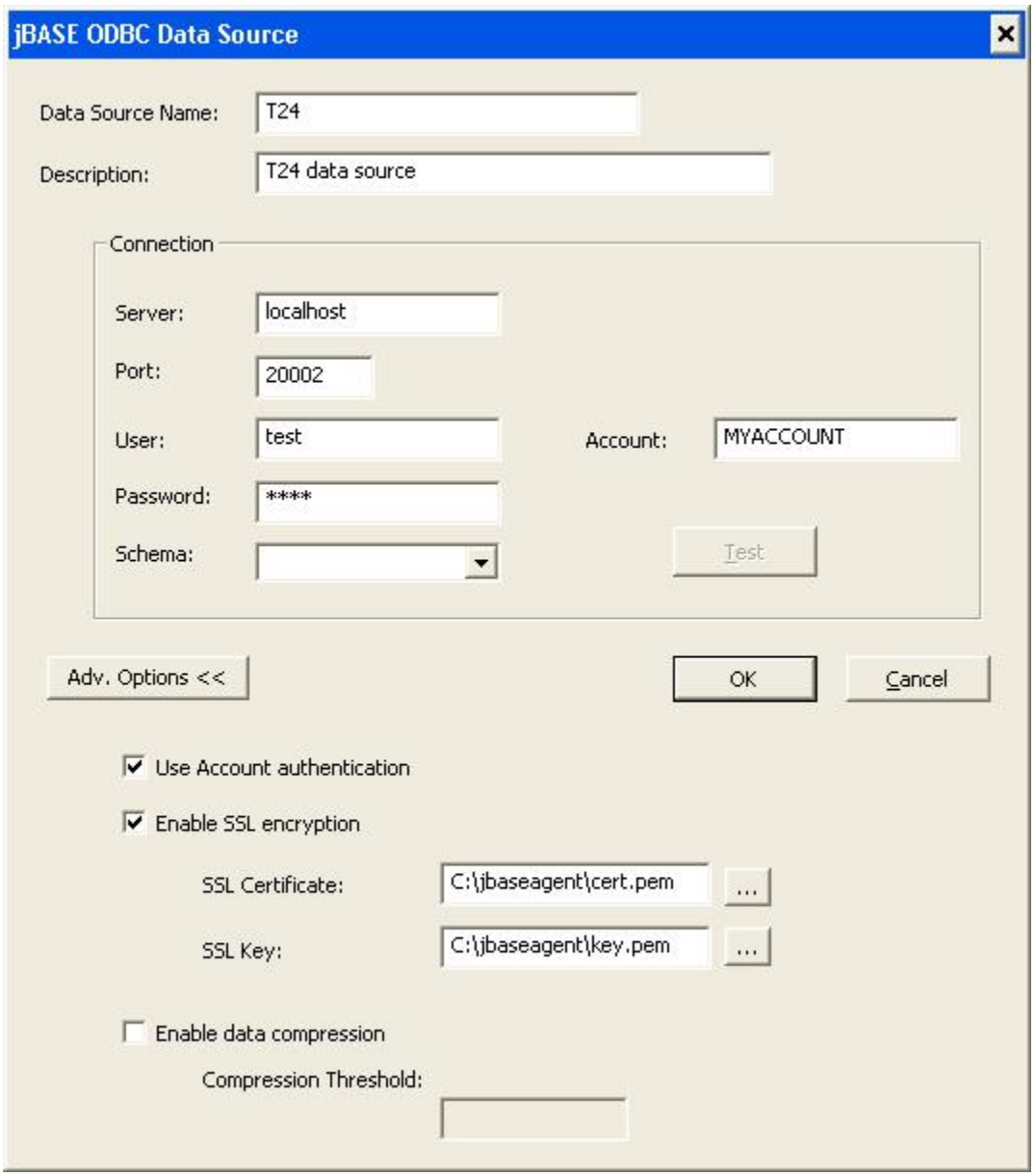
ODBC applications usually obtain the connection details from DSNs which may be configured via Microsoft's ODBC Data Source Administrator (also known as ODBC Manager / odbcad32.exe or Control Panel > Administrative Tools > Data Sources (ODBC))

When installing on a 64 bit client, the version of ODBCAD that should be used is the version in **c:\windows\syswow64**

If the installation has been successful, the following driver should appear in the list of available ODBC drivers:

jBASE ODBC Driver

Adding a DSN for this driver will present the following dialog:

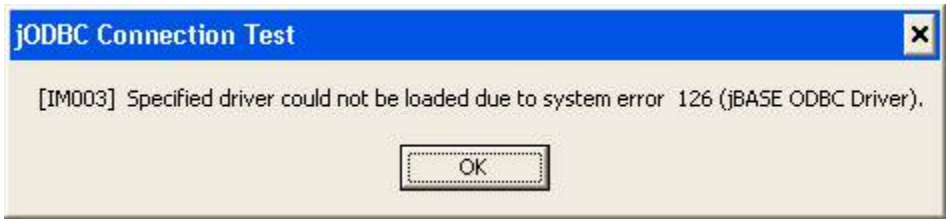


Most of the parameters shown in the previous picture refer to the connection details required by the remote **jAgent** instance. Server specifies the IP/machine name and Port specifies the TCP port of the remote **jAgent** instance.

Please refer to the **jAgent** user guide for more information about the available options.

Pressing the test button will attempt to establish a connection to the server using the provided user/account credentials. If the driver is not correctly registered with the system or the PATH environment variable does not

contain the path to the installation directory, the following message box will appear:



Connection strings

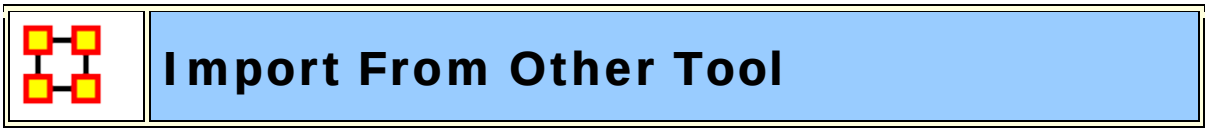
Connection strings, as defined by the ODBC SQL CLI, specify the connection parameters supplied to the server when attempting to establish a connection. All connection attributes are defined in a single string separated by semicolons. jBASE ODBC Connector accepts the following attributes:

DSN	Data Source Name
DRIVER	Name of ODBC Driver. Must be jBASE ODBC Driver
DESCRIPTION	DSN Description
SERVER	Server Address
PORT	jAgent Port Number
UID	User ID
ACCOUNT	jBASE Account. User Authentication will be used if this field is blank
PWD	User/Account Password
SCHEMA	Schema Name. used. Reserved for future yse
SSL	Enable SSL Encryption (1 = Enable SSL, 0 = Disable SSL [default])
SSL_CERTIFICATE	Path to SSL Certificate File
SSL_KEY	Path to SSL Public Key File
COMPRESSION	Enable Data Compression (1 = Enable comp., 0 = Disable comp. [default])
COMP_THRESHOLD	Compression Threshold. Default = 1024 byte

DSN, DRIVER, UID and PWD are attributes defined by the SQL CLI, all other attributes are jBASE ODBC Connector specific attributes. Attributes highlighted in bold are mandatory attributes.

Example:

DSN=T24;SERVER=127.0.0.1;PORT=20002;UID=test;PWD=test



Import From Other Tool

UCINET

UCINET has been supported for many years, both import and export.

There are different data formats grouped under term UCINET.

The DL protocol is a flexible language for describing data and itself encompasses a number of different formats. Three of these formats - nodelist, edgelist and fullmatrix. **nodelist** is a file with node desccriptions. **edgelist** is a file with link descriptions. **fullmatrix** is a file which contains both.

NOTE : The Italicized text is for reference only.

```
DL
FORMAT = FULLMATRIX  The type of data
N = 3  The Number of Nodes
NM = 1  The Number of Matrices
LABELS:  Node Names
ALPHA
BRAVO
CHARLIE

MATRIX LABELS:  Matrix names
FRIENDS

DATA:  The Actual Data
0 0 1
1 1 0
1 0 1
```

VNA - NetDraw format

Note that the values do not need to be numeric. They should all be **separated by a comma, space or tab**. Values that contain spaces should be enclosed in quotes as in "Bill Smith").

VNA files are ordinary text files. They consist of sections called **star sections**. Not every file has to have every possible star section, and sections can be in any order. At the moment, there are 3 possible star sections (soon to be 6). They are:

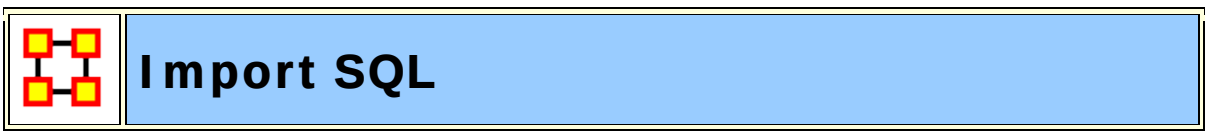
- ***node data :** Describes the actors in a network
- ***node properties :** Descrubes the display characteristics of the node
- ***tie data :** Contains dydadic data among pairs of nodes

```
*node data
id gender role age
Alpha male leader 56
Bravo female follower 22
Charlie male follower 34

*Node properties
ID x y color shape size
Alpha 1094 415 255 1 10
Bravi 84 742 255 1 10
Charlie 1224 996 255 1 10

*tie data
from to friends advice
Alpha Bravo 1 3
Bravo Alpha 0 1
Alpha Charlie 1 2
Bravo Charlie 0 6
```

These formats can be imported via the **Data Import Wizard > Data from another network analysis tool**, and exported with the Data Export tool.



Configure an SQL Server database

1. Download the JDBC driver for SQL Server from **http://msdn.microsoft.com/en-us/sqlserver/aa937724**.

2. Install the JDBC driver (which just unzips the file).

3. Go to the installation JDBC folder and get these two JAR files:

sqljdbc.jar and sqljdbc4.jar

4. Place these two jar files (or the equivalent thereof based on his install) in location **C:\Program Files\ORA\jre\lib\ext**

In Addition

You can directly connect to an SQL database via an ODBC connection using the Data Import Wizard. You then issue a query against the database, and then create node classes and networks directly from the query result set.

NOTE : This assumes that the data returned from the SQL query is exactly what you want to input into ORA. Some intermediary processing in Python might be necessary.

Another option is to generate intermediary CSV files that can easily import into ORA (rather than directly creating dynetml) if you want to import the data into other software tools. In addition, separating the two steps 1) pulling from the database using Python, and 2) importing into ORA - by an intermediary CSV file might make it easier to validate the correctness of the overall process.

NOTE : Having an intermediary format can introduce human errors.

NOTE : There is a Relax-NG spec of dynetml on our website that serves the same purpose as a DTD. It's purpose is to completely describe dynetml. Working from example dynetml files, however, might be sufficient.



A text file can be imported directly into ORA but a few things needs to be understood before performing this funtion.

What Is Needed

1] The file needs to be in a **Tab Delimited** format.

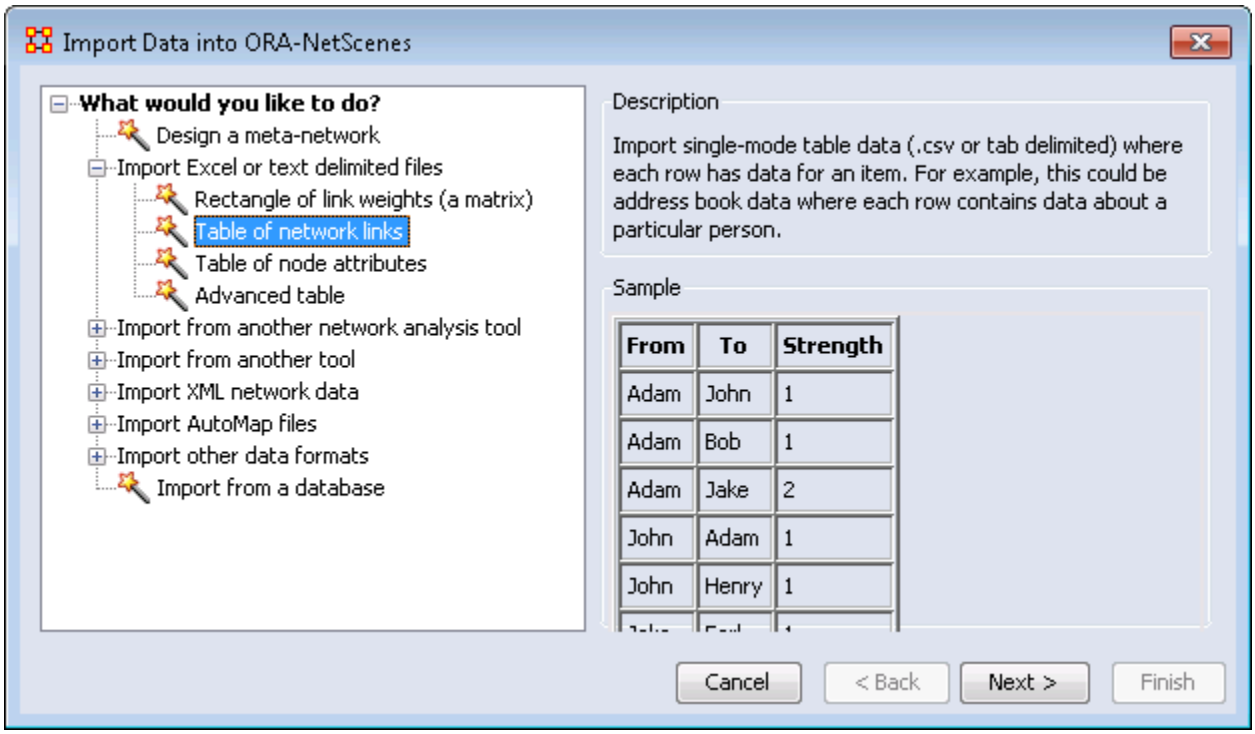
2] At least one column needs to be in the date format and this date format meeds to contain **month, day, and year**. Without all three it will not import as a Dynamic Network.

File Format

```
AUTHOR PUB DATE ALBUM ARTIST LABEL YEAR SCORE SNM
Ian Cohen 2010-03-15 00:00:00 Fang Island Fang Island Sargent
House 2010 8.3 1
```

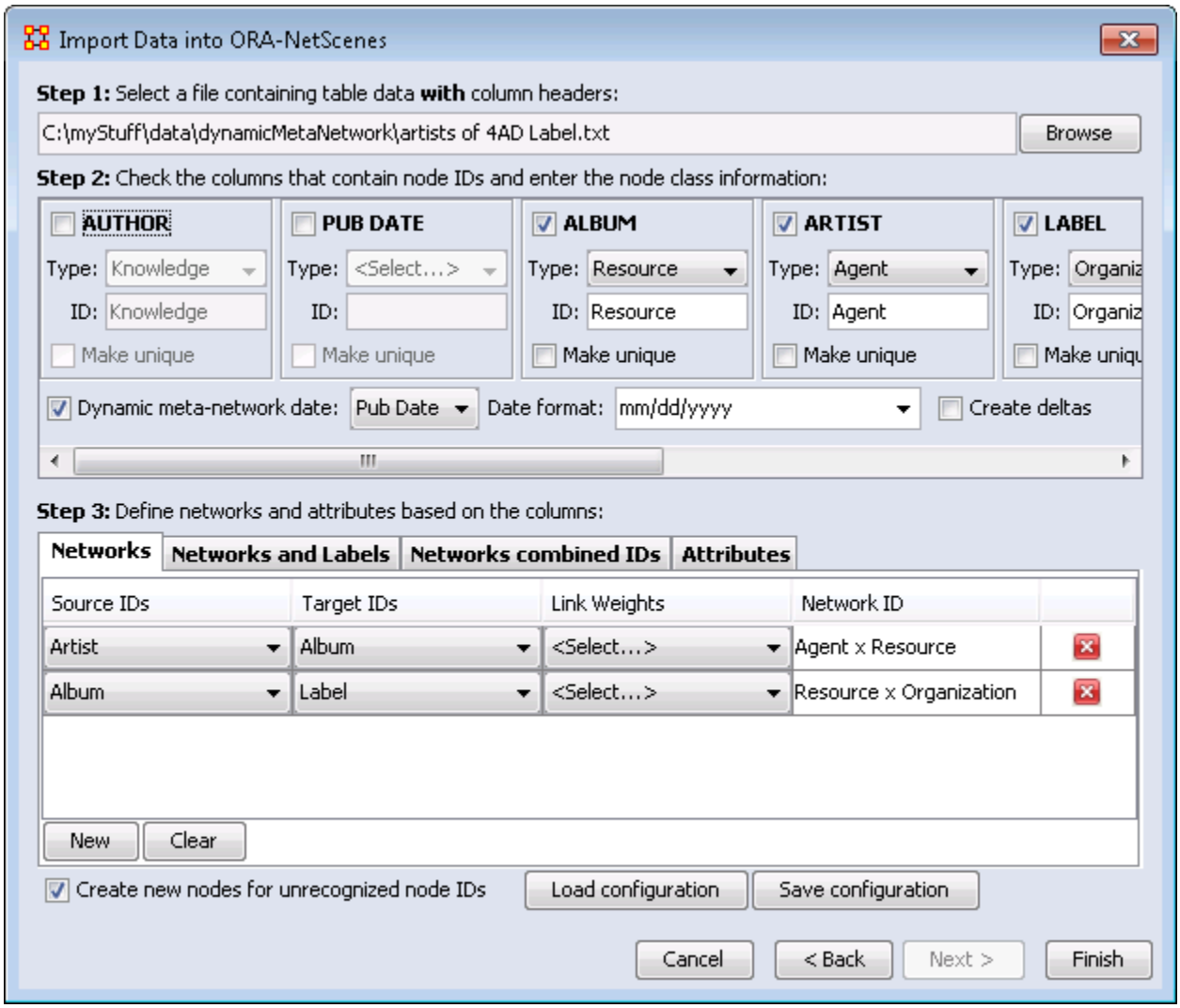
A good way to create this type of file is to place your data into Excel and export it as a **Text (Tab delimited) (*.txt)** format. This assures all the data is in the correct format.

Procedure



Start by opening the **Data Import Wizard** by hitting **Control-W**, clicking the button on the toolbar, or from the menu **File > Data Import Wizard**. Select **Table of network links** and click [**Next >**].

On the next dialog box select the **Create a new meta-network with ID:** and type in a new name and click [**Next >**].



Step 1: Click the [**Browse**] button and navigate to your text file. This will bring up all the node IDs in the next section.

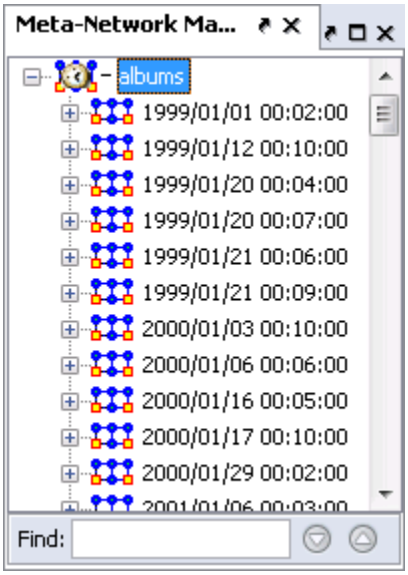
Step 2 : Place a check mark next to all attributes you want to import then select a **Type** and give it an unique ID:.

To create a Dynamic Network the check box **Dynamic meta-network date:** must be checked and one attribute is selected which contains the date.

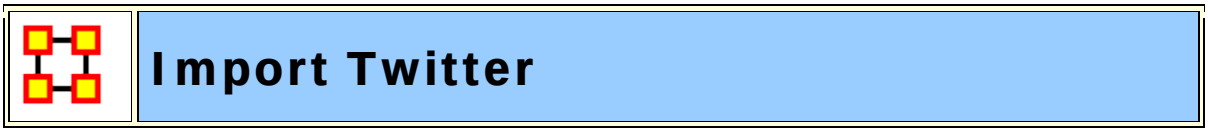
NOTE : Make sure that the **Date format** in the dialog box matches the format of the date in your file.

Step 3 : Select the **Networks** tab. Click the [**New**] button which brings up a new line in the window above. Use the drop down menus to select your

source and target IDs. If you file has a weight attribute select that in the **Link Weights** column. When you are finished click the [**Finish**] button.



A Meta-Network will be created in the Meta-Network pane. Clicking the [+] reveals the individual Meta-Networks, one for each **PUB_DATE** contained in the original file.

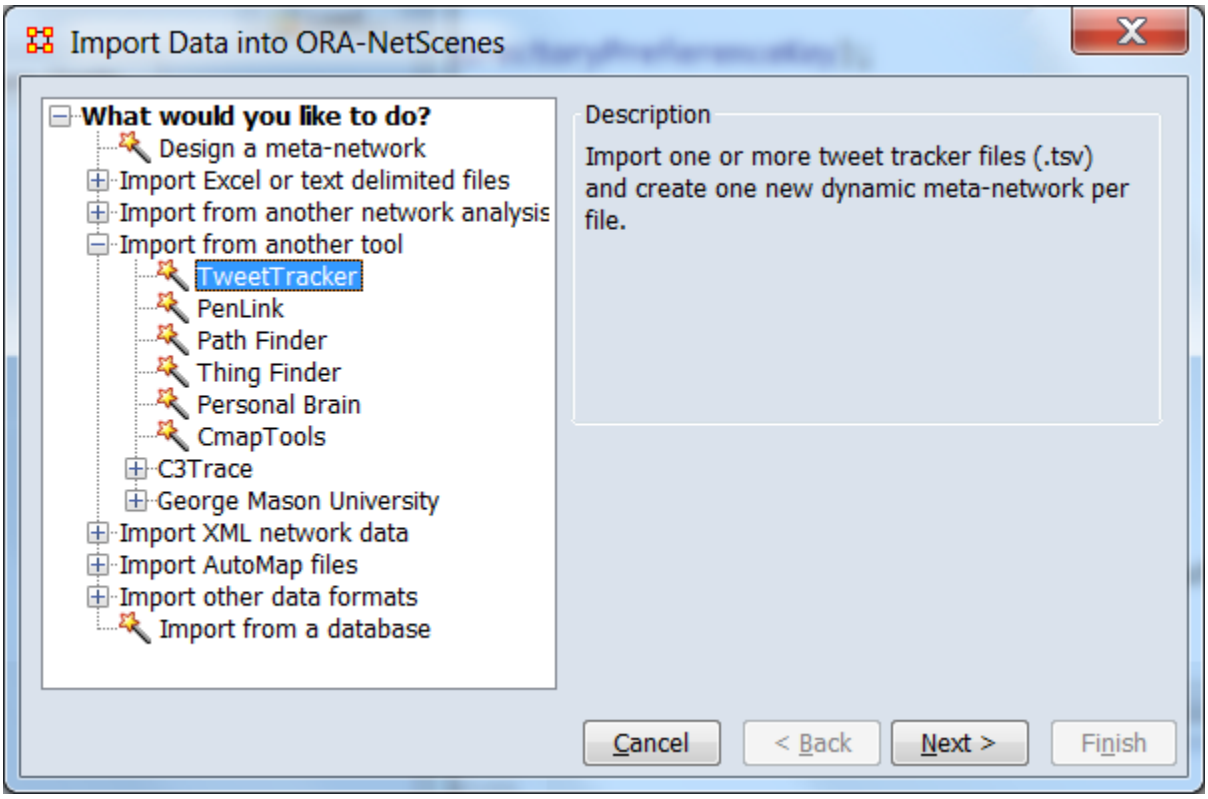


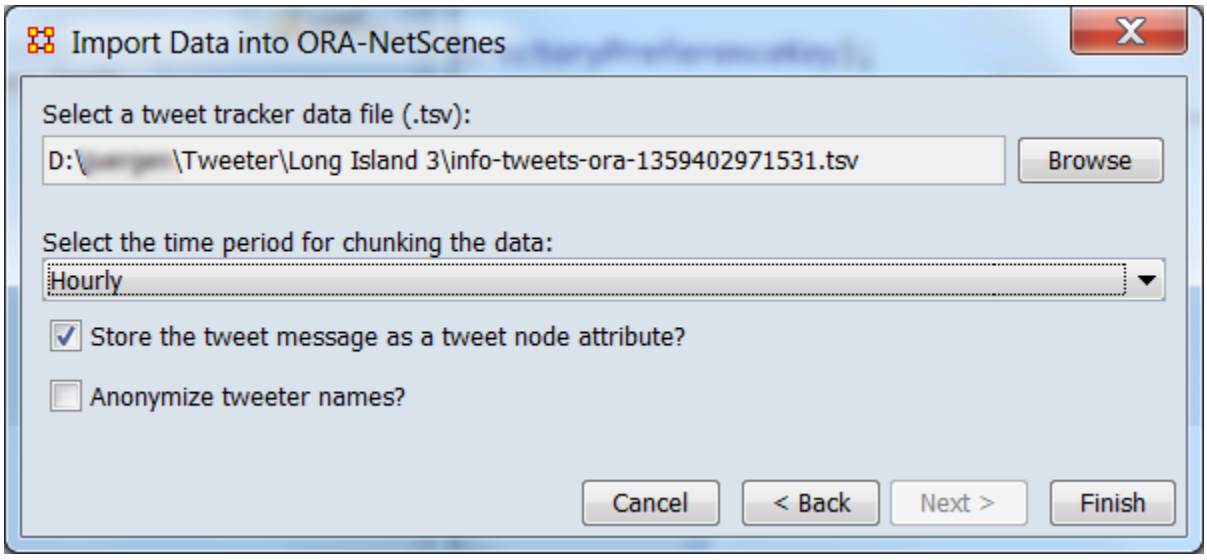
Import Twitter

The **TweetTracker** creates Meta-Networks from Twitter data.

Twitter Company records all tweets sent by anybody in the world, and for a price anybody can get access to these tweets. A tweet has a sender, a timestamp, one or more hashtags, the number of followers that the tweeter had when he sent it, and the actual tweet message, and zero or more other tweeters explicitly mentioned.

TweetTracker is a software from Arizona State that converts these tweet data from Twitter Company into CSV files that ORA then can import via this:



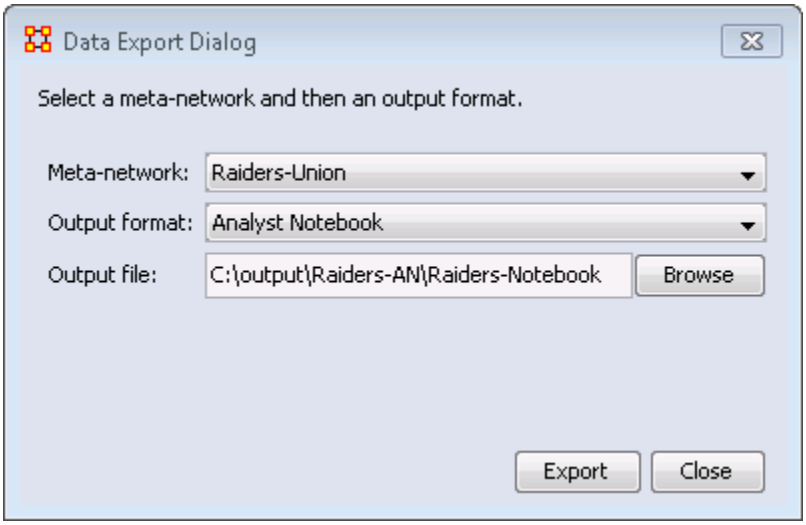


And the resulting meta-network is in ORA.

After this, the Twitter Report can be used to analyze this imported meta-network.

Data Export

ORA can export your Meta-Networks to a variety of formats. **1]** Select a Meta-Network. **2]** Select an Output Format. **3]** Click the [**Browse**] button to select the destination. When finished click the [**Export**] button.



NOTE : Some of these are all proprietary formats and can only be opened with the proper program.

Analyst Notebook : Exports two .CSV files. One for Entities, and one for Links.

C3Trace : Exports one **.xls** file. This spreadsheet will contain multiple sheets depending on the amount data in your original Meta-Network.

CMapTools : Exports a single file in the **.CXL** format

CSV : Exports one **.CSV** file for each Nodeset and Network.

Pajek : Export one file in the .net format for Pajek.

UCINET - Binary : Exports files int **##d and ##H** format for use in UCINET. Creates two files for each Nodeset and Network.

UCINET - Text : Exports one **.dl** file for each Nodeset and Network.

Saving Your Files

Save Meta-Network

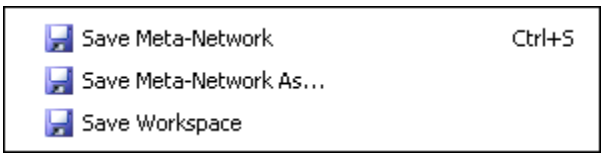
This option is initially **grayed** out when you first load a Meta-Network. This signifies that the Meta-Network is currently unchanged. Whenever you make **ANY** change within he Meta-Network the option will become full-color indicating it is time save changes.

After clicking the icon in the toolbar, or selecting the menu item, it will become grayed out again till you change your Meta-Network once again.

No change needs saved in the Meta-Network



Changes made to Meta-Network and need saved



Save Meta-Network As...

If you need to save a Meta-Network under a different name use select **File > Save Meta-Network As...**. This will leave the original file intact and create a new Meta-Network with the new file name.

Save Workspace

While working with multiple Meta-Networks you may want to retain the information of what files you had open for later use. Saving your workspace creates a file which can be opened later and will recreate your workspace as before.

From the Main Menu select **File > Save Ora Project**. After selecting **[OK]** on the initial dialog box the **Save Ora Project** dialog box will appear. Navigate to the folder where you want to save your workspace.

This Workspace can then be called up with the Load Workspace in a future session.



CASOS Email Parser

CEMAP belongs to the family of **Extract, Transform, and Load** software. It is designed to extract data from electronic sources in their native formats and make it possible to load into the target software system.

CEMAP can be used in either Interactive mode or Hands-off Batch mode. In the interactive mode, users can design the output datasets in a repetitive fashion with minimal effort—the software is designed with the realities of the analytic workflow in mind. As a batch process, CEMAP can be set up to execute in an automated fashion, for example, to extract one's email network every night at midnight.

CEMAP separates much of the technical detail from the analytic detail allowing the user to use the individual parts of CEMAP which they understand.

The inner workings consist of three vital elements: templates, tablesets, and template/tableset mapping. Brought together they form a **profile**.

A template describes the endprocess, output files that CEMAP is being asked to create for later loading into the downstream or host software.

A tableset describes the technical elements necessary to extract the raw source data.

The tableset-to-template mapping contained with a profile expresses the manner in which the output of the tableset is logically connected to the input of the template. Critically, the output of the tableset is a set of one or more relational data tables (think excel spreadsheet) and the input to the template is a set of one or more relational data tables. The mapping simply describes the connection between the tableset output and the template input. The profile contains all of this information in one logical construct.

CEMAP is an ORA tool that primarily allows you to pull network data in the form of emails into ORA. However, the CEMAP tool could be used to convert any sources of data in the world into DyNetML, ORA's native file format, for analysis.

Setting up CEMAP is similar to setting up a new ISP mail client. What follows are procedures to configure this tool and how to use it.

IMPORTANT NOTE : Before attempting to download emails from Gmail your Gmail account needs to be set up for **IMAP**. Information on that procedure is contained on the Google site.

Email Dates

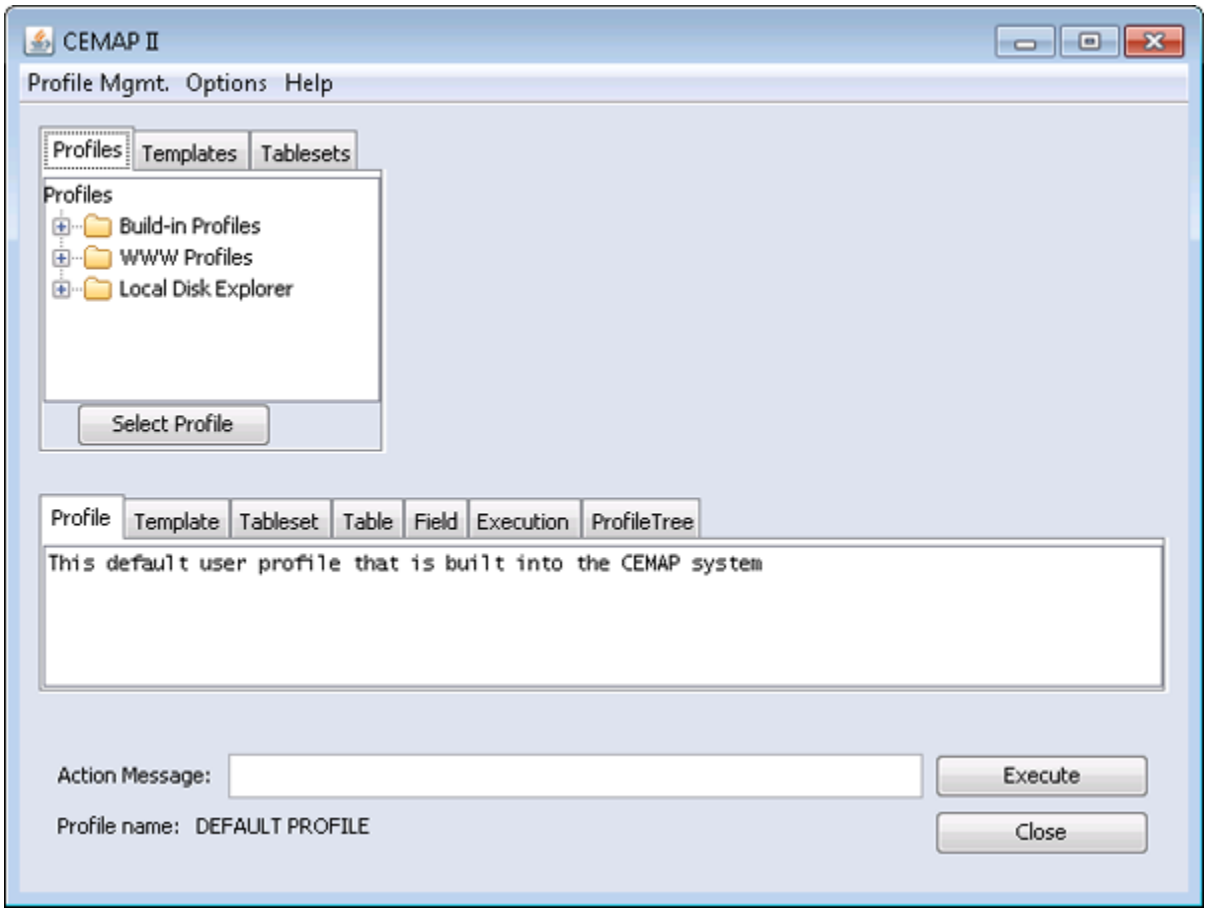
Each email has an identifying number in a long number showing the date, for example: [**20060308**042751s1500bii66e]. The **20060308** is in the **year/month/day** format and says this email was sent on March 8, 2006.

The CASOS Email Parser **(CEMAP)** that is launched through AutoMap/ORA (http://www.casos.cs.cmu.edu/projects/automap/software.html) enables the extraction of different types of network information from emails **(e.g. who exchanges information, who provides what information, etc.)**.



Starting CEMAP

From the main menu select **File > CEMAP...**. The following interface will appear



Profile Mgmt.Menu

Load Profile : Select a Profile from the built-in list.

Save profile to original location : Save the currently loaded Profile back to it's original location.

Save profile to file as... : Save a Profile to a new location.

Reload Active Profile : Not Currently Implemented

Clear Current profile : Not Currently Implemented

Reload user's startup profile : Loads the user's Profile

Load default startup profile : Loads the default Profile

Save active profile to file as... : Saves the currently loaded Profile. User can select new name for this Profile.

Options

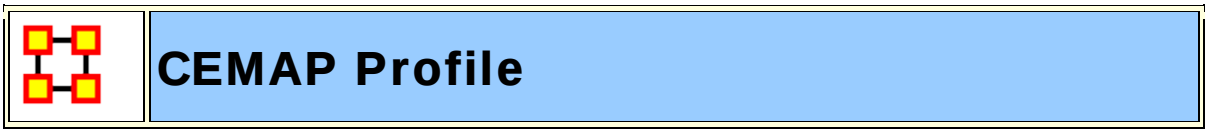
Save your user profile :

Activate CASOS Remote Debugging :

Activate CASOS Remote Execution :

Save passwords in Profile saves :

Help



What is a Profile

CEMAP contains many built-in profiles. These are sets of instructions for extracting data from web site APIs needing onlu minimum information from the user.

Profiles

You will mostly work with the built-in Profiles for extracting emails and other data from web site APIs. CEMAP contains many specialized profiles but also many general profiles which can be customized to suit you needs. Let's concentrate on some of the more useful profiles.

Select the **Profiles** tab. Click the [**+**] next to **Build-in Profiles** then the [**+**] next to **Email**. Here is a list of the most common email types.

EML : Email attachments, **IMAP**

IMAP : Internet message access protocol one of the two most prevalent Internet standard protocols for e-mail retrieval. This allows users to access emails from a remote server.

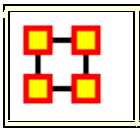
MBOX : A generic term for a family of related file formats used for holding collections of electronic mail messages.

POP3 : Stands for **Post Office Protocol 3** which is used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection.

gmailIMAP : Similar to IMAP except specifically geared toward retrieving emails from the Gmail server.

Microsoft Exchange Server : An e-mail-based collaborative communications server for businesses.

Microsoft Outlook Extract : A personal information manager from Microsoft, available both as a separate application as well as a part of the Microsoft Office suite.



Profile Example of Zachary Dataset

Information on any of the **Built-in Profiles > General** will be found in the **Profile Tab**. This is the exampleof the information in the profile tab for the for the Zachary file.

Background
A network of friendships between the 34 members of a karate club at a US university, as described by Wayne Zachary in 1977.
References: W. W. Zachary, An information flow model for conflict and fission in small groups, Journal of Anthropological Research 33, 452-473 (1977).
History
Original data obtained from: http://www-personal.umich.edu/~mejn/netdata/
SEE:
http://www.casos.cs.cmu.edu/computational_tools/datasets/external/karate/index.php

Loading the **http://www.casos.cs.cmu.edu/computational_tools/datasets/external/karate/index.php** url into your broswer you will get additional information about the Zachary dataset.

Example

Description

The Zachary Dataset.

Standard Network Analysis

SNA Report (**html** | **csv**)

File Downloads

karate.xml (Dynetml)

karate 2.0.xml (Dynetml 2.0)

karate.gml (Original format)

Background

A network of friendships between the 34 members of a karate club at a US university, as described by Wayne Zachary in 1977.

References

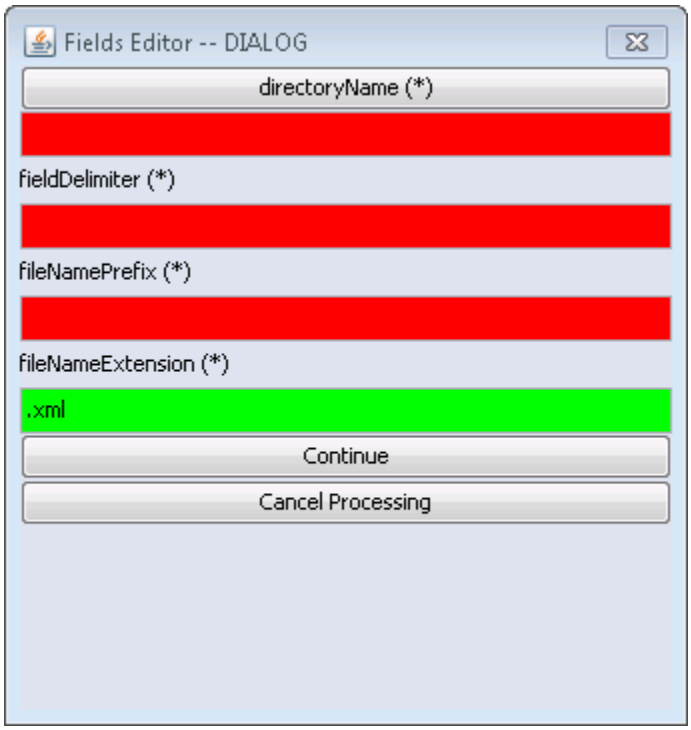
W. W. Zachary, An information flow model for conflict and fission in small groups, Journal of Anthropological Research 33, 452-473 (1977).

History

Original data obtained from: **http://www-personal.umich.edu/~mejn/netdata/**

Procedure

After selecting a built-In profile by highlighting a profile and clicking [**Select Profile**], click the [**Execute**] button. Some profiles will run automatically if no further parameters are needed. Others will display a Fields dialog box.



The **directoryName (*)** is the destination you want for your output file. You can either click the button or type it in directly.

The **fieldDelimiter (*)**

The **fileNamePrefix (*)** allows you to give the file a specific name

The **fileNameExztension (*)** allows you to change the extension of the file.

When you are ready click the [**Continue**] button.

Your new Meta-Network will be loaded into the Manager pane and processing can begin.

CEMAP - Email

Cemap is an email client. If it fails to download emails that means that one or more of these parameters is wrong: (a) the server **imap.gmail.com**, the user id, or the password for the user id. --or-- that the host computer (running cemap) simply could not connect to the Internet to get to the email server, which doeas happen with any email client rather often. Most email

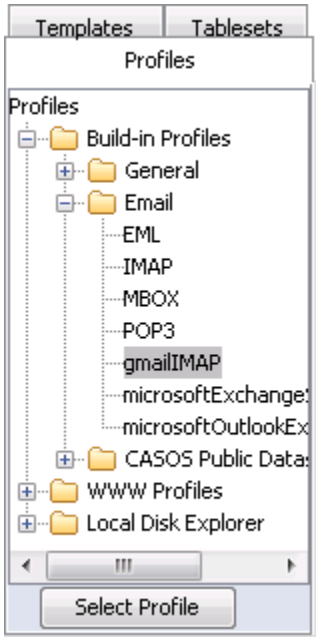
clients will automatically retry this connection process without the human even knowing it. CEMAP will not do the auto-retry.

Procedure

From the main menu select **File > CEMAP...**. This brings up the CEMAP dialog box.

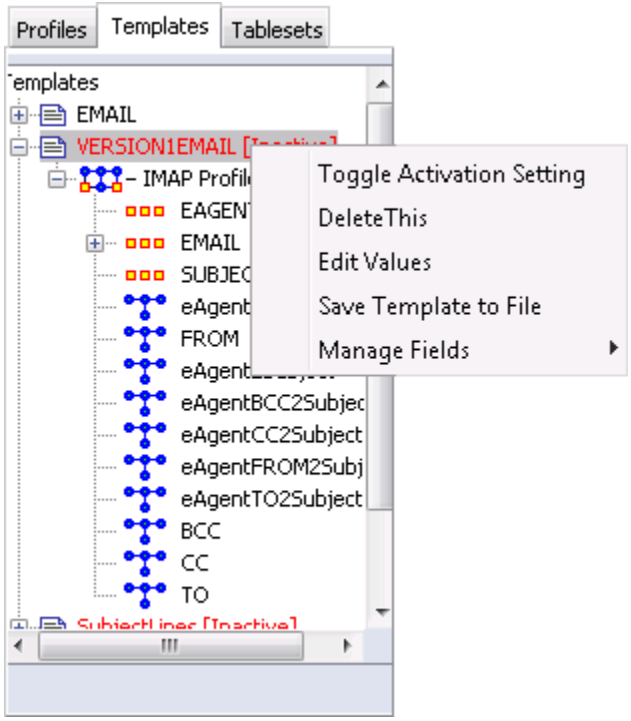
Expand **Build-In Profiles** then expand **Email** then highlight **gmailIMAP**.

Click the [**Select Profile**] button.

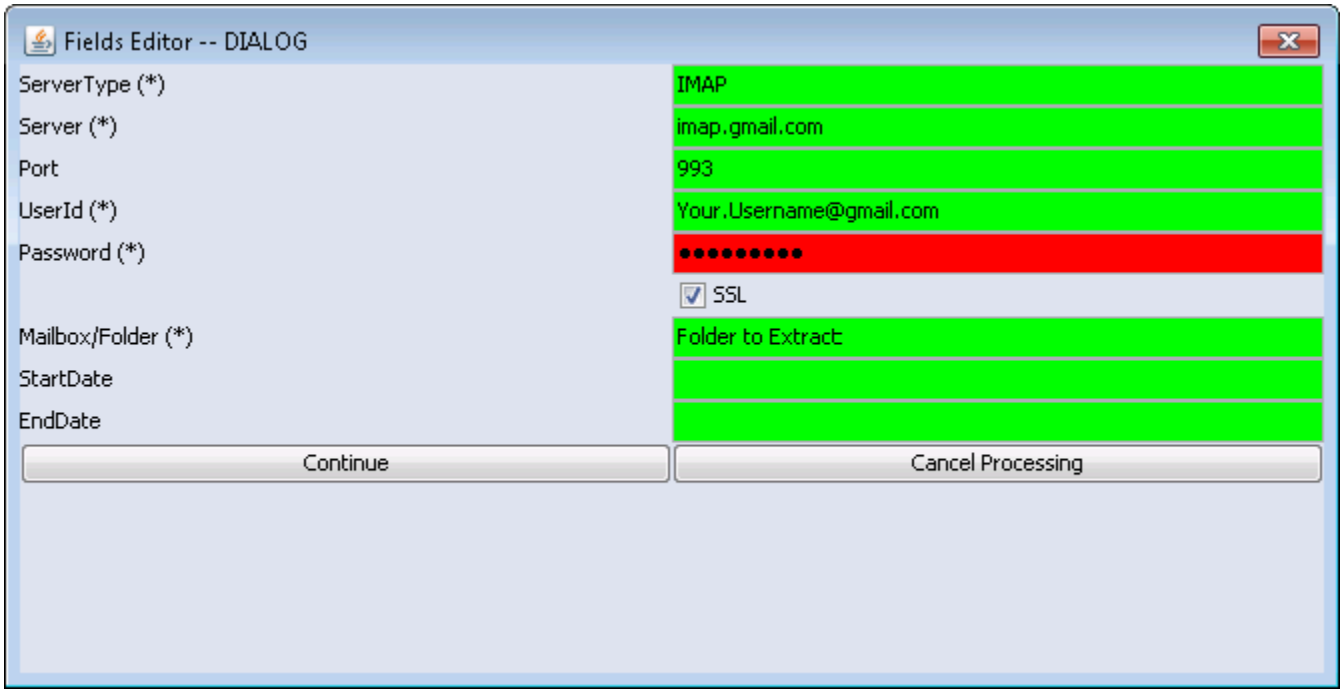


Click the **Templates** tab. Here are the optional material which can be extracted from gmail. To extract this, right-click on any of the **red-colored** entries and select **Toggle Activation Setting**.

Click the [**Execute**] button.



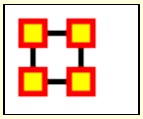
Fill in your **UserID** and your **password**. CEMAP defaults to your INBOX but you can change to any folder. When finished click [**Continue**].



CEMAP will now begin processing. When finished a **Parsing Finished** alert will appear.

NOTE : Depending on the number of emails it needs to extract the process could take a fair amount of time.

The resulting XML file can be opened up directly in ORA.



CEMAP Profile

CEMAP can obtain data from Facebook using APIs from the Facebook platform. With it it can create an **Ego-Network** of the subject's friends. CEMAP's purpose is to transform real-world data into relational network data. You use the interactive interface to create a profile. Then you can tweak that profile for your needs. Finally you can save that profile for future use. The use indicates the source of the data and that is made available to CEMAP to create a **Tableset**.

In Your Browser

Go to the CEMAP Facebook site: **http://cemap4ora.com/facebook/**.

Follow directions to allow permissions:
http://www.cemap4ora.com/facebook/grantAccess.html.

NOTE : This is important for first time CEMAP users. Facebook requires you to grant access first.

NOTE : This does not function in Internet Explorer. You will need to switch to an alternate browser to perform this funtion.

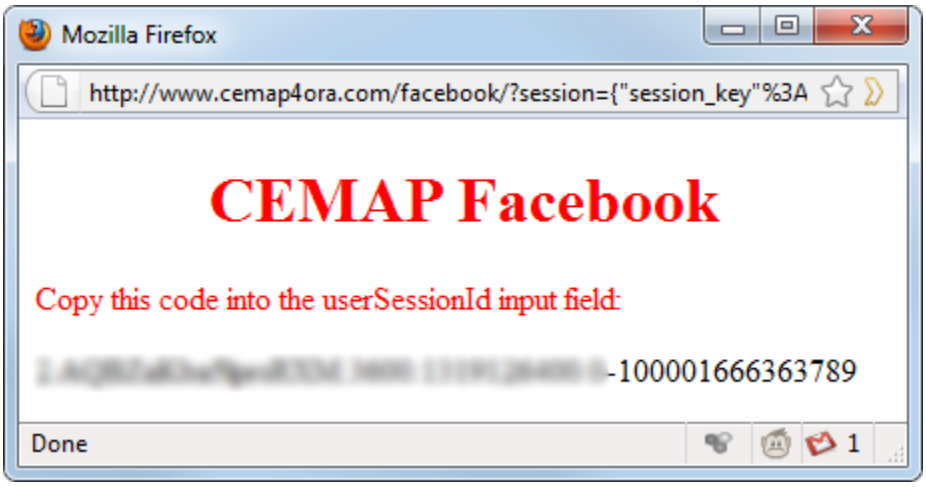
Click the connect button to get your key:



<<<< Click here to obtain your special key

If you are not logged into Facebook a login screen will appear. Type in your Email and Password.

A window will appear with a User Session code [This example has the code blurred on purpose].



Copy this code for use in CEMAP.

In ORA

Open CEMAP in ORA **File > CEMAP...**

In the CEMAP window highlight **Built-In Profiles -> General -> facebook**. Then click the [**Select Profile**] button. To run the function click the [**Execute**] button in the lower right of the window.

Fields Editor -- DIALOG [1]

NOTE : This dialog will appear only the first time you access this function.

Click the [**Location to Store Network File**] button. Navigate to the location you want to store the file and type in a name in the textbox.

NOTE : You need to type in the .XML extension.

Click [**Continue**].

Fields Editor -- DIALOG [2]

Leave both apiKey/secretKey as **default**.

Paste your **userSessionId** you obtained from the web page into the **userSessionID** field.

Click [**Continue**].

CEMAP will start Parsing the data from Facebook. When it is finished a new Meta-Network will appear in the Meta-Network Pane titled **Facebook Profile**.

The Meta-Network is ready to be used the same as any other Meta-Network.

Example of a Facebook Network

NOTE : When you click continue, ensure that 1) You have no tab/window open to Facebook; 2) You are logged in; and 3) The window with the session key is open.



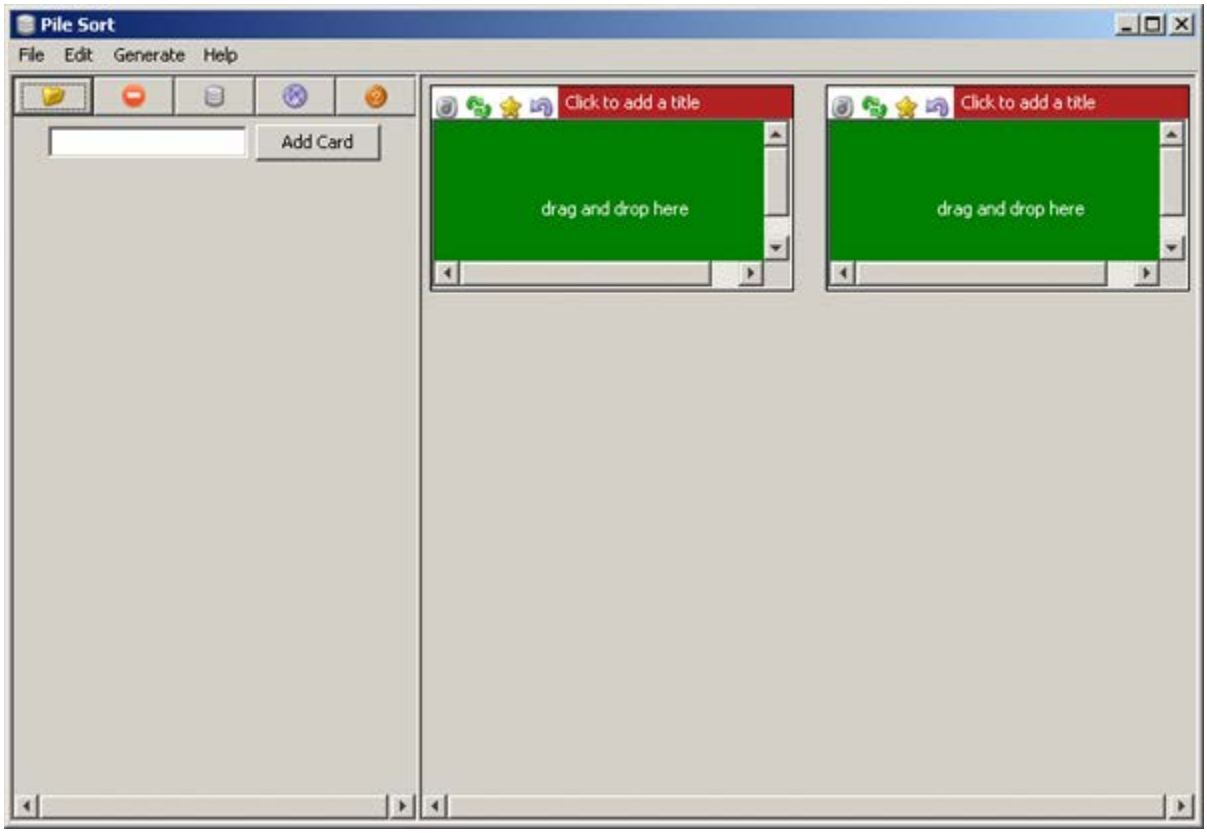
Pile Sort

The PileSort module allows a user to load a series of entities such as concepts or people's names. These entities are displayed in a deck, which can then be organized and grouped into a pile, which will contain entities that are similar to one another. The output of the PileSort module will be a network in DyNetML format.

The user can use either a text editor of a spreadsheet to create a two-column comma-separated file **(i.e. a .csv file)**. The first column contains the concept and must not be blank. The second column is **optional** and can contain metadata.

NOTE : Concepts can not contain embedded commas.

Pile Sort GUI



Pile Sort Interface : consists of two panes: The Side Deck and the Canvas. **The Side Deck** displays cards that have not been organized into piles, such

as initially when the input file in read. **The Canvas** contains the piles where the cards are placed from the Side Deck.

Pile Sort Menus

File > Load a File : Navigate to a directory with a new Pile to Sort.

File > Exit : Leave the Pile Sort program.

Edit > Add an Empty Pile : Creates an additional empty pile on the canvas.

Generate > Create a Network DyNetML File : Creates a DyNetML file from the current state of organization. All cards in a pile are fully connected and cards remaining in the deck are isolates.

Help > Show Help Topics : Accesses the ORA Help files

Other Functions

Add Card : takes the concept that has been filled into the text field next to the **[Add]** button and creates a card with that name at the end of the card deck.

Transfer All Cards to Another Pile : Click and hold the icon of a pile and drag it to another pile. All cards in the first pile will be transfered to the new pile.

Cycle Through the Cards in the Pile : Rotates the cards in a pile that the card currently beneath the currently highlighted card becomes highlighted. The newly highlighted card becomes the pile's representative.

Return Cards to the Side Deck : Removes all cards from a pile and returns them to the side deck.

Mark a Card as a Pile's Representative : marks the currently highlighted card as a pile's representative.

Move Card to Another Pile : Click and hold a card in a pile and drag it to another pile.

Click to Add a Title : allows the entire pile to be given a name. Either click on the title bar or use the drop down menu item.

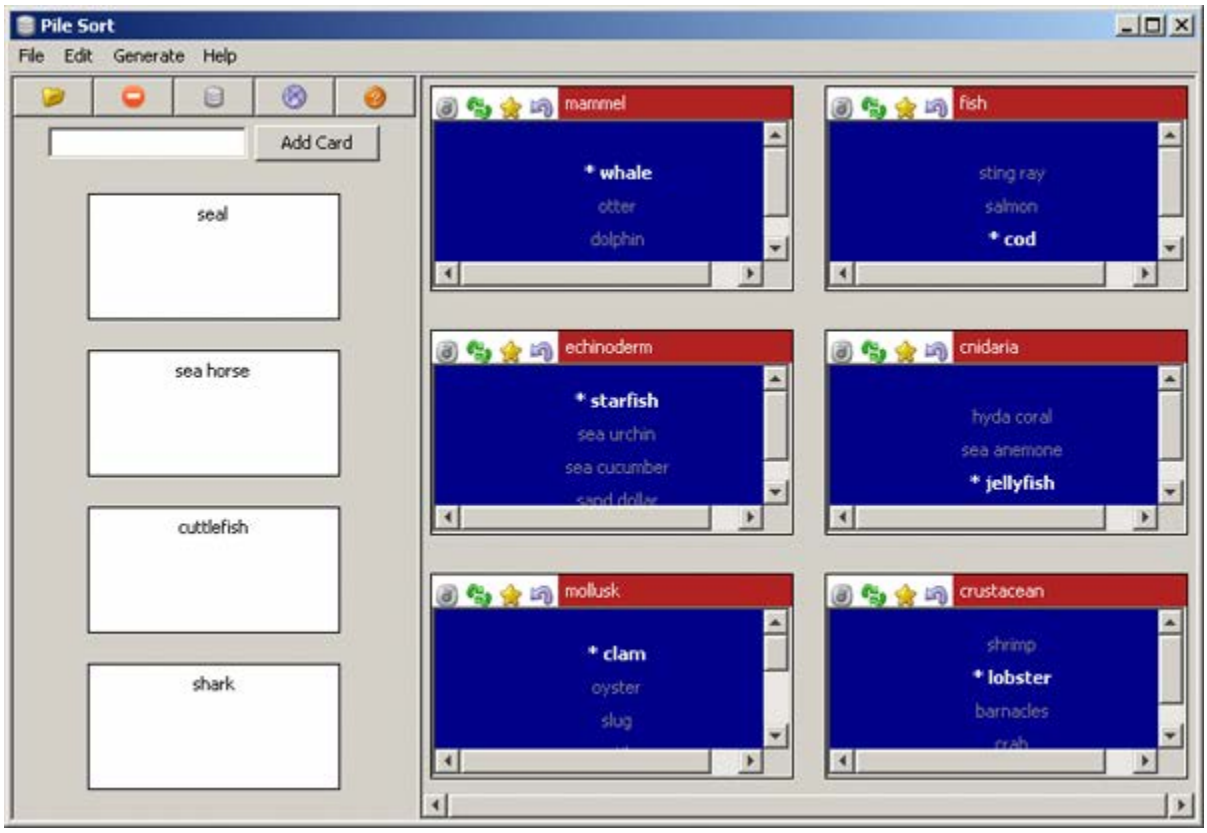
Drag and Drop Here : allows the user to drag cards from the side deck onto a pile.

Loading a list of concepts :

All piles are initially empty. The concepts appear in the side deck to the left. A scrollbar will appear if the number of concepts is greater than the screen length. An empty pile contains the banner **drag and drop here** signifying an empty pile. Once a concept is placed in a pile it will all concepts will be displayed in it's window.

NOTE : To have duplicate concepts in more than one pile requires the creation of duplicate cards.

NOTE : You can leave cards in side deck. Any card not so placed will become an isolate in the resulting network.



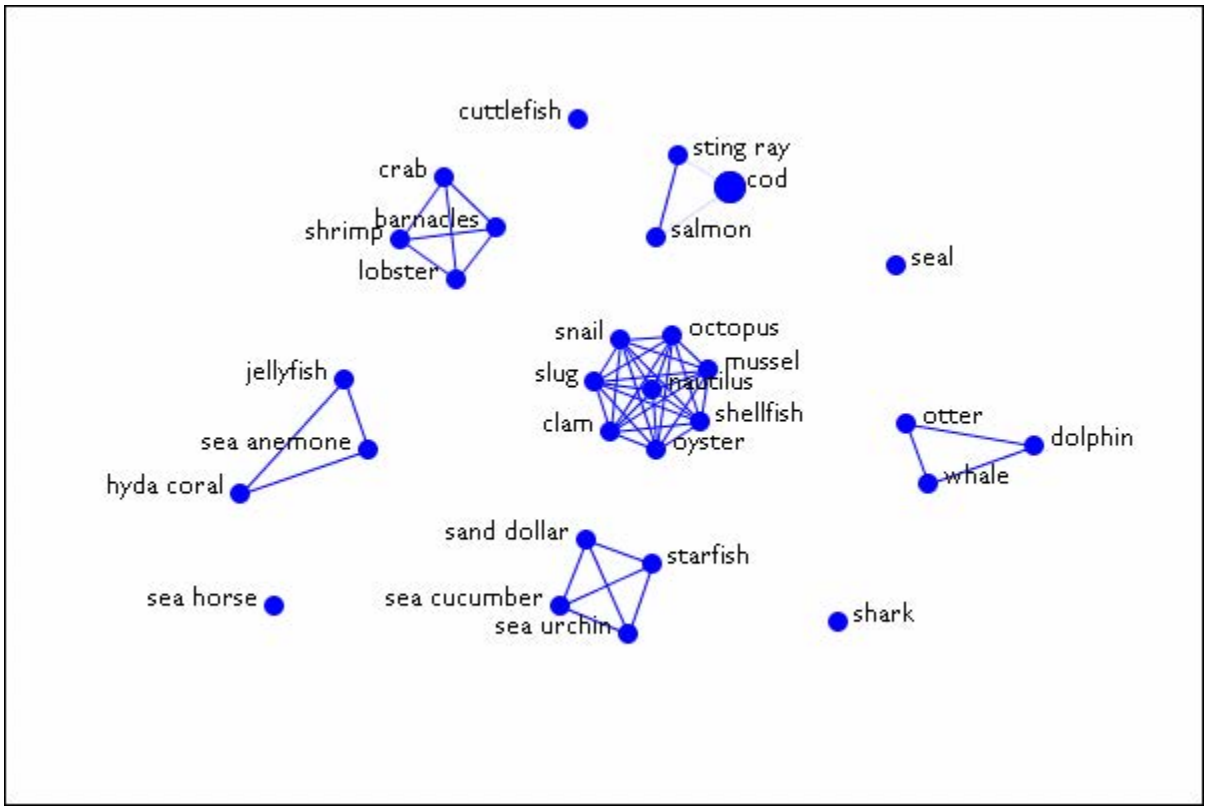
Viewing in ORA

Saving a sorted Pile : Sorted piles are saved to the DyNetML format. Networks are formed from the individual piles which include the metadata from each card.

Viewed in the Editor you can see all the saved information from Pile Sort. The column **containing_pile** is the name you gave the pile into which a card was placed. **meta-information** is the optional second column from the .CSV file originally loaded into Pile Sort. If that was empty, then the meta-information cell would also be empty.

	Node ID	Node Title	containing_pile	freq...	meta_information	relative_freq...	seconds_on_t...
	<set f...	<set fi...	<set filter>	...	<set filter>	<set filter>	<set filter>
☐	barnacles	barnacles	crustacean	1	crustacean	1.0	0.90
☐	clam	clam	mollusk	1	mollusk bivalve	1.0	1.43
☐	cod	cod	fish	1	fish	1.0	1.03
☐	crab	crab	crustacean	1	crustacean	1.0	1.56
☐	cuttlefish	cuttlefish		1	mollusk cephaloped	1.0	0.00
☐	dolphin	dolphin	mammel	1	mammel	1.0	0.69
☐	hyda coral	hyda coral	cnidaria	1	cnidaria	1.0	0.90
☐	jellyfish	jellyfish	cnidaria	1	cnidaria	1.0	1.45
☐	lobster	lobster	crustacean	1	crustacean	1.0	0.75
☐	mussel	mussel	mollusk	1	mollusk bivalve	1.0	1.08
☐	nautilus	nautilus	mollusk	1	mollusk cephaloped	1.0	0.95

Clicking the **[Visualize this Network]** button displays your Pile in the ORA Visualizer. How networks are formed is based upon the cards placed in each pile. The four cards not placed into a pile (cuttlefish, seal, sea horse, and shark) became isolates in the Visualizer.



Data-to-Model

What is Data-to-Model?

Data-to-Model (D2M) is a heuristic procedure for extracting network data from a set of source texts and subsequently analyzing it; source material may include but is not limited to newspapers, magazines, tribune reviews, works of prose, and email. Automap is used to clean and extract the networks from the texts, which can then be analyzed in ORA. (Carley et al., 2010) The analysis made from the report generated by ORA helps identify the influential people, the intervening agents and implicated locations.

In addition, it helps forecast a situation and identify key actors (Carley et al., 2010). This analytical document is important for policy makers and people interested in the social, political and structural evolution of a situation. Data-to-Model has been used in the case of Sudan Conflict, Singapore and Haiti. There are three degrees of modal that can be obtained: **Basic Model, Refined Model and Advanced Model.**

Basic Model

Basic Model (AutoMap)

The first step to construct a model is to develop a basic model from texts. This basic model will use the most appropriate routines and techniques and databases requiring limited interaction from the user. The networks in the basic model include **a concept network and a semantic network**.

To reduce the number of concepts in this network, especially multiple concepts that express an identical meaning, a **depluralization thesauri** is constructed focusing on nouns and verbs to take these concepts to their base form such as present tense and singular form.

Established databases are used to identify and process known entities such as the **names of countries and major cities** as well as the names of current and recent world leaders.

Procedures

Step 1 : Create a Project Directory

Prior to uploading your data, you need to create a workspace (folder) where all your input and output files will be stored. This helps in organizing your files and in preventing any loss. You may copy in some standard files such as Generic Delete File, Standard Thesauri. Information in the Generic Delete List consists of things that have been considered irrelevant in precedent encounters and therefore saved into a Delete List. There may be information that are already pre-existing in our data base that you want to make use of.

Example : CASOS Group has standard thesauri that contains some pre-defined knowledge.

Step 2 : Import your text files into AutoMap

When you click on the **File > Import Text Files** you will be prompted to choose the files you want to upload from your directory. Your files will be uploaded as they are, however you may change the text settings. AutoMap can guess your files encoding but it is not all accurate. It is better to choose your text encoding if you know it before resorting to the automated choice. Other languages settings will require you to change the font to be able to read it. Since your files are from multiple sources, it is certain that your files have different encoding. To facilitate this you can save your files in word as a text file. Due to the huge number of files it takes a lot of time to identify the encoding for each individual text.

Step 3 : Cleaning the Text

There are many concepts and words and structures that are part of your data set but which are not necessary for the purpose of your project. Therefore this need to be deleted from your text. This is selected under **Preprocess > Perform All Cleaning**. This cleaning gets rid of extra whitespace, fixes common typos, coverts British to American spelling, and expands contractions and abbreviations. You can actually perform all this at once but if you do not wish to remove extra space for example you can do the manual cleaning for each step. The individual functions can be found under **Preprocess > Text Cleaning**.

NOTE : This cleaning doesn't affect the meaning of your text.

Step 4 : Generating some thesauri

You are generating these thesauri early because they rely on the **Part of Speech**, thus very important. Before you start manipulating your files it is important to extract the essential knowledge. Proper nouns and verbs have a tremendous importance in your project. For any generation procedures select them from the **Generate Menu** and scroll down to what you want to generate from the menu list.

a) Suggested Names Thesauri

Generate the **Named Thesauri** from the data. This is automatically executed and it is saved in the project folder where the user can review it when necessary. To generate the Names thesauri, select **Generate > Named Entities**. The Named Entities Thesauri consist of **names of agents, organizations and locations**. It will be saved in the project directory in Standard Format. You may open it in Excel or Word to edit. You may delete some entries that you deem irrelevant and add some from other sources.

NOTE : Gazetteer is a source where you can obtain names of locations to expand your thesauri.

You may generate multiple Name Thesauri and compare them. This thesauri has everything that the part of speech has identified as proper noun. There may be inaccurate facts where some parts of speech are mistakenly identified as nouns but that are not. It is important to know that the system is giving you more information instead of less because it is easy to go through and delete what you don't want than add new things. Factual errors stem also from the structure of the text itself. For instance **Sudan Bishop accuses Oil Companies**, which has been identified by the computer as a name because most of it starts with a capital letter and the computer is not able to differentiate nouns from other parts of speech not because of the way it is presented in the text. The system also gives you a guess of ontological classes (organization, location, agents).

In addition, in AutoMap there is a **Location Distillation** that gives you a thesauri based on the location you specify. If you specify the name of the location the system will suggest all synonyms and spelling variants for that location. You may use those to expand your thesauri. In default everything is classified as agent.

b) Generate a Suggested MetaNetwork Thesauri

From the menu select **Generate > Suggested Metanetwork Thesauri**. This assigns an ontological class for each individual concept. It tells whether this concept is an agent, location, source, or any other category. This automatic categorization is not always right, therefore you may find some obvious proper names classified as locations. This may be due to the structure of the text. The good thing is that you, as a user, can access this thesauri from your project folder and change some classification that you think are not right or just for the purpose of this particular project you may want to classify some obvious names of locations as source or agent.

Example : United States of America is a location but it can also be considered as agent in some cases where the United States Government has taken some actions.

c) Depluralization Thesauri

Depluralization is the elimination of plurals forms which consequently reduces the verbs or nouns to its base form. It uses the part of speech. The Depluralization Thesauri is a list of nouns and verbs in their base forms automatically generated by the Data to Model wizard and saved in the project folder where it can be reviewed anytime. This also includes detensying (reducing verbs to their base forms).

From the main menu select **>Generate > Generalization Thesauri > Context- Stemming Thesaurus**. This procedure applies stemming to nouns and verbs. Proper nouns will remain unchanged. Exception has been drawn on proper nouns because the stemming system doesn't work well with proper nouns.

Example : CASOS becomes CASO which really reduces the meaning or may even refer to something else than what was intended.

We also focus on nouns and verbs because they are the most important part of speech you use in your thesauri. Sometimes due to the text there are some irregularities, irrelevant entries can get involved but you can access it and edit from your directory folder.

NOTE : These are in Master format which refers to the four format thesauri. See **Master Format page** for more information.

After generating the Context-Sensitive Thesaurus, apply it to your text. All nouns and verbs except proper nouns will be reduced to their base forms. It will depluralize and detense most nouns and verbs.

Data Preparation

At this stage you have already extracted the thesauri that rely on the part of speech. You can now manipulate your texts knowing that you have already obtained some essential information.

Step 5 : Pronoun Resolution

The pronoun resolution is done from the Preprocess tab>Text Preparation>pronoun resolution. It consists of replacing all pronouns with their relative nouns.

```
Example: John went to the bakery, he bought some bread
```

The **he** will be replaced with **John**.

Some pronouns will still remain after this process; all remaining pronouns will be automatically deleted. It also removes prepositions, verbs of noise (verbs of being, verbs of helping), converts all concepts to lower case except proper nouns and names of Organizations and also converts N-grams (two word concepts that appear meaningfully together). Their separation distorts the meaning.

Example : The terms **civil war, white house, United States** have a commonly known meaning being put together. However, each word taken away will have a completely difference meaning. So by converting n-grams, the wizard associates those concepts.

NOTE : It is important that you lower case your text with caution because it may change the ontological classes of the concepts. Not everything needs to be lower case, especially proper nouns.

Step 6 : Apply the Delete List

To apply Delete List select from the menu **Preprocess > Text Refinement > Apply Delete List**. Applying the Delete List will remove all concepts already in the Delete List and a Filtered List of concepts will be generated. This application should be **Rhetorical** which replaces all deleted concepts with **XXX**. Whereas the **Delete** option will simply apply deletion.

There are cases where you don't want to use the standard delete because some texts are very sensitive. This is not an issue in media files because the idea can still be inferred even after deletion of noise words. However, court documents are very word sensitive, deleting prepositions like **the or a** may drastically change the meaning of that word. A good example is:

```
He shot him with a gun

He shot him with the gun

He shot him with XX gun
```

These sentences have different meaning and may affect the meaning and purposes intended in a court.

Step 7 : Merging

Merge all Depluralization Thesauri, Named Entities Thesauri, and Suggested Thesauri to form a project based thesauri. From the main menu select **Procedures > Master Thesauri procedures > Master Thesauri Merge**. You may also view this list and edit it to fit your project. You are merging them together to have a more expanded knowledge about agents, locations, sources. You will have all this information organized in one file.

Under **Procedures > Thesuari Procedures** you can change your thesauri from Master format to Standard format or visa versa. Under Thesauri Procedures you can also merge thesauri together by specifying the change thesauri and the standard thesauri. You have access to this merged format and may edit it to your liking. Merging the thesauri can also be done manually by copying and pasting them together. At this stage you are the master of your project therefore you can choose to manually modify your thesauri and tailor it your project. However, you can also execute this automatically under Master Thesauri procedures and in case of conflicts the system will identify the conflict and will prompt you to choose one preference.

Step 8 : Generalization Using Name Thesauri (project thesauri)

This procedure is under the drop list of the Preprocessing tab. Go to Preprocess>Text Refinement>Apply Generalization Thesauri. At the prompt, select the name thesauri and apply it. People, locations and things can have various names. Creating general thesauri will consolidate each of these

names into a uniform name (See AutoMap Help). Below is an example: Concept, Key Concept

```
Barack Hussein Obama, Barack_Obama

United States, United_States_of_America

USA, United_States_of_America
```

Step 9 : Generate a Concept List with MetaNetwork Tag

From the main menu select **Generate > Concept List > Concept List with MetaNetwork Tags**. This extracts a list of concept from your data using your Standard Thesauri. From the menu select **Procedures > Thesaurus Procedures > Convert Master Thesauri to MetaNetwork Thesauri**. Use this concept list for any future modifications.

Step 10 : Create an Uncategorized Thesauri

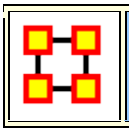
From the main menu select **Generate > Concept List > Concept List (Per Text)**. The Concept List will be extracted from your data. Those concepts have not yet been categorized, in other words there are yet unknown. An ontology will be automatically for each concept found based on part of speech. Merge these concepts to your already existing thesauri. Verbs are classified as tasks and all remaining concepts (except nouns and verbs) as knowledge. You have already classified nouns as agents and location. You can merge this one back to your project thesauri.

Step 11 : Generate DyNetML (Use Metanetwork)

It is now time to generate a DyNetML file. From the main menu select **Generate > Metanetwork > MetaNetwork DyNetML [(Per Text) / (Union Only)]**. The DyNetML is the model you have been aiming for by refining and manipulating your data. You will be prompted to choose a DyNetML from each text or a Union DyNetML which will create one file using concepts from all files. Choose a **window size** based on your average sentence length in order to have an adequate view of your DyNetML. Windows size 8 is often used.

Step 12 : Start ORA

Load these files already saved in your project folder to ORA. Generate key entity report using union. Upon generation of the key entity report, you may review the report. If your report appears to be lacking for the analysis of your project, you may always go back to the thesauri and tailor it to your project purposes. Depending on your satisfaction of the results generated by ORA you can always go back to refine your Project Thesauri and generate a new DyNetML and then a new ORA report. It is the refinement process.

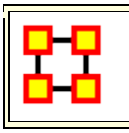


Refined Model

Refined model

The refined model allows the user to evaluate the automated choice selections. For instance, in the depluralization thesauri concepts are taken to their base form. This technique uses part of speech analysis to find only nouns and verbs, specifically excluding proper nouns. However, an occasional proper noun may be identified as a common noun especially in the case of incorrect grammar usage in texts.

The names thesauri use proper names to identify instances of agents. While it is common for the proper names found in a text corpus to refer to an agent, a proper name could refer to an organization. The names thesauri would be reviewed to change the categorization to organization where appropriate. To review the names thesauri you can access it from your project folder. The category agent can be substituted with organization or location. As a user, if you feel that the entry does not correspond to agent, organization, or location, one of the other categories can be used such as event, resource, knowledge, or task. If an entry does not fit any of those categories the entry can be deleted from the thesauri.

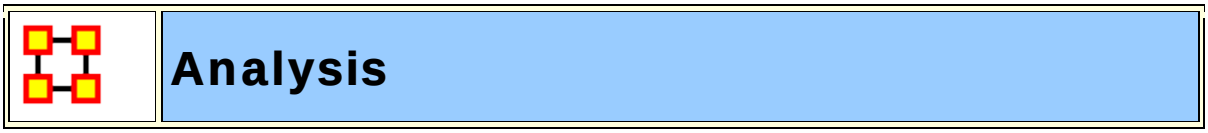


Advanced Model

Advanced Model

In the advanced Model the user is well acquainted with the data and with the procedures. Therefore, you may use more expertise to execute procedures

without the wizard because you now understand the purpose and the under-belly of the data to Model wizard.



Analysis

This steps calls for your knowledge of the subject you are dealing with and also knowledge about the actor's level measures and the network level measures. This includes but is not limited to degree centrality, hub centrality, click counts, authority centrality etc (ORA Glossary, 2010). Prior to the analysis, you have already obtained your Model which is the DyNetML. This is only the analytical part, no more automated procedure is involved, and this should be done after all satisfactory refinements.

References

Carley, K.M., Reminga J., Storrick J., and Columbus D., 2010, “ORA User's Guide 2010,”Carnegie Mellon University, School of Computer Science, Institute for Software Research, Technical Report, CMU-ISR-10-120.

Carley, K.M., Columbus D., Bigrigg M. and Kunkel F., 2010 “AutoMap User's Guide 2010,”Carnegie Mellon University, School of Computer Science, Institute for Software Research, Technical Report, CMU-ISR-10-121.

Carley, K.M; Tambayong. L (2010). Political Networks of Sudan: A two-Mode Dynamic Network Text Analysis. Carnegie Mellon University of Pittsburgh, CASOS group.

Edit Menu

The Copy/Paste functions are **dynamic** in nature. ORA understands what you have highlighted and will copy it onto the clipboard. Whatever is currently in the clipboard can be copied back into ORA any number of times.

The first two options are to Copy/Paste Editor values.



Copy : The copy function will place a copy of whatever is currently highlighted into the clipboard. That will remain until another item is copied.



Paste : The Paste function will create a copy of whatever is stored in the clipboard. This can be repeated as many times as necessary.

NOTE : ORA's menus change as different items are highlighted.. They also change after something has been copied. If a Nodeset had previously been copied the menu item will change to **Paste Nodeset**. If you then copy a Meta-Network the menu item will change to **Paste Meta-Network**.

Find Entities : Search all selected Meta-Networks for named node.

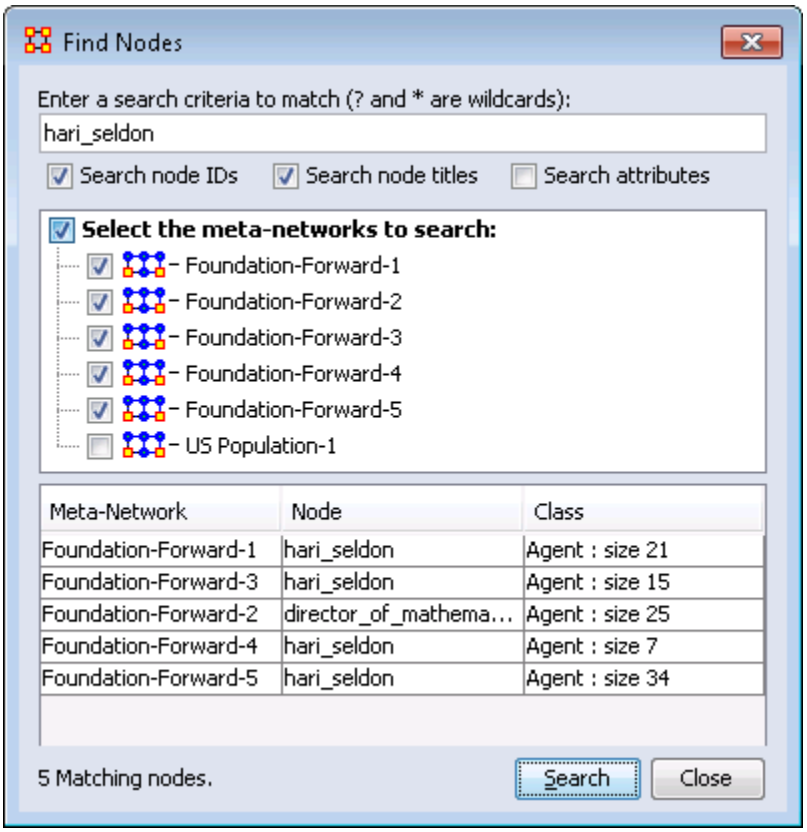
Find Entities

You can do a quick search of any loaded Meta-Network for a name of an individual node. **Remember :** The name must be spelled exact or the search will fail.

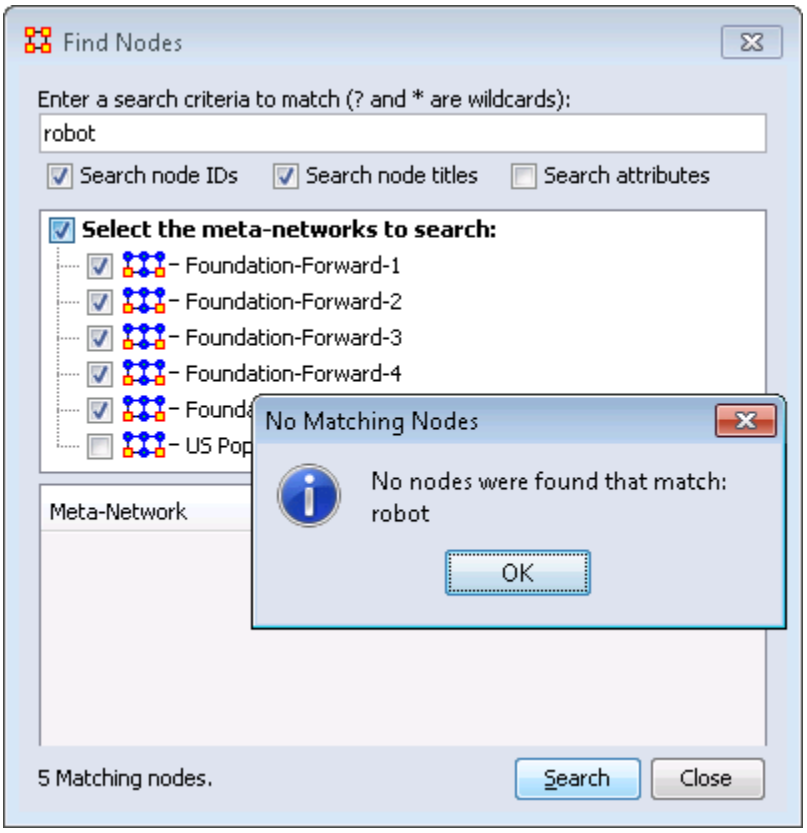
Standard Search

Place a check mark next to the Metwork-Networks to search. Above this box are three check boxes, **Search node IDs, Search node titles, and Search attributes**. First we will srearch only IDs and titles.

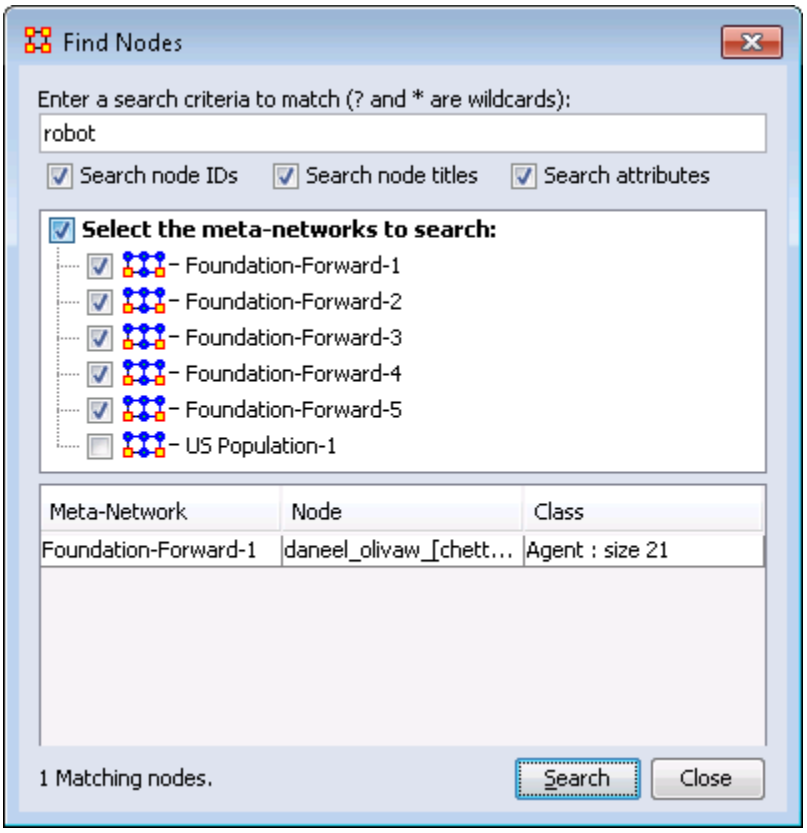
Type in the name of a node to search for. Make sure it is spelled correctly or ORA will find no results. IN the pane at the bottom it display the Meta-Network, name of the node, and size for each occurance.



Next we do a search for **robot**. In this instance ORA finds no match. But knowing this dataset I know it exists. In this case you need to place a check mark in the check box **Search attributes** in order for ORA to search the entire dataset.



And the result is one entry.


Find Nodes
Enter a search criteria to match (? and * are wildcards):
robot
Search node IDs
Search node titles
Search attributes
Select the meta-networks to search:
- Foundation-Forward-1
- Foundation-Forward-2
- Foundation-Forward-3
- Foundation-Forward-4
- Foundation-Forward-5
- US Population-1
Meta-Network
Node
Class
Foundation-Forward-1
daneel_olivaw_[chett...
Agent : size 21
1 Matching nodes.
Search
Close

Preference Menu

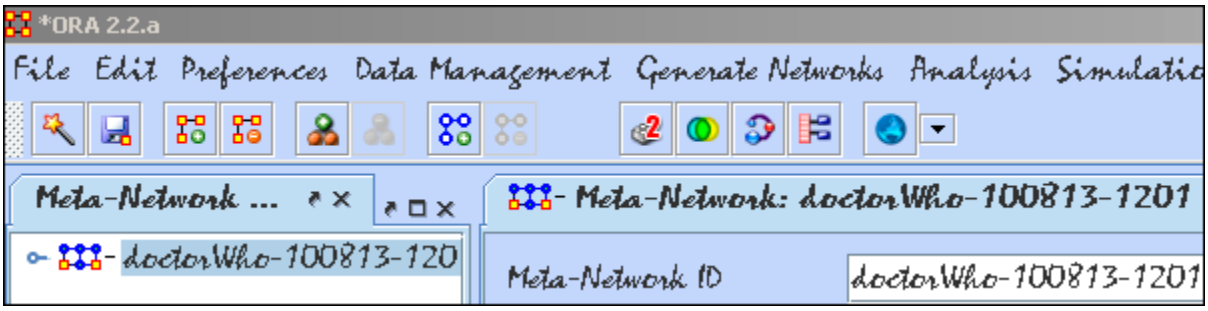
The View Menu shows a log of all activity performed in ORA.

Defaut Layout : Resets the Editor GUI layout to its default panes position.

Change Font : Allows you to change the GUI font to any font on your system. Be careful with the font chosen as some fonts are built more for custom design rather than readability.

Load Font : Add font to use for the ORA display. ORA will ask whether to make this the default font. If **Yes** the the GUI will be displayed with the new font. These loaded fonts can be found in **C:\Documents and Settings\{username}\Ora Fonts**.

NOTE : Some fonts may make reading the GUI difficult. Take note of your previous font before making any changes.



Event Log : The log maintains a list of all actions performed in ORA. This allows you to review steps that were taken during a particular time.

NOTE : The report pane must be visible in the GUI to view the log. This pane can be reinstalled by selecting **View > Default Layout**.

Measure Preferences : Allows you to select the type of measures to run.

Use only fast measures :

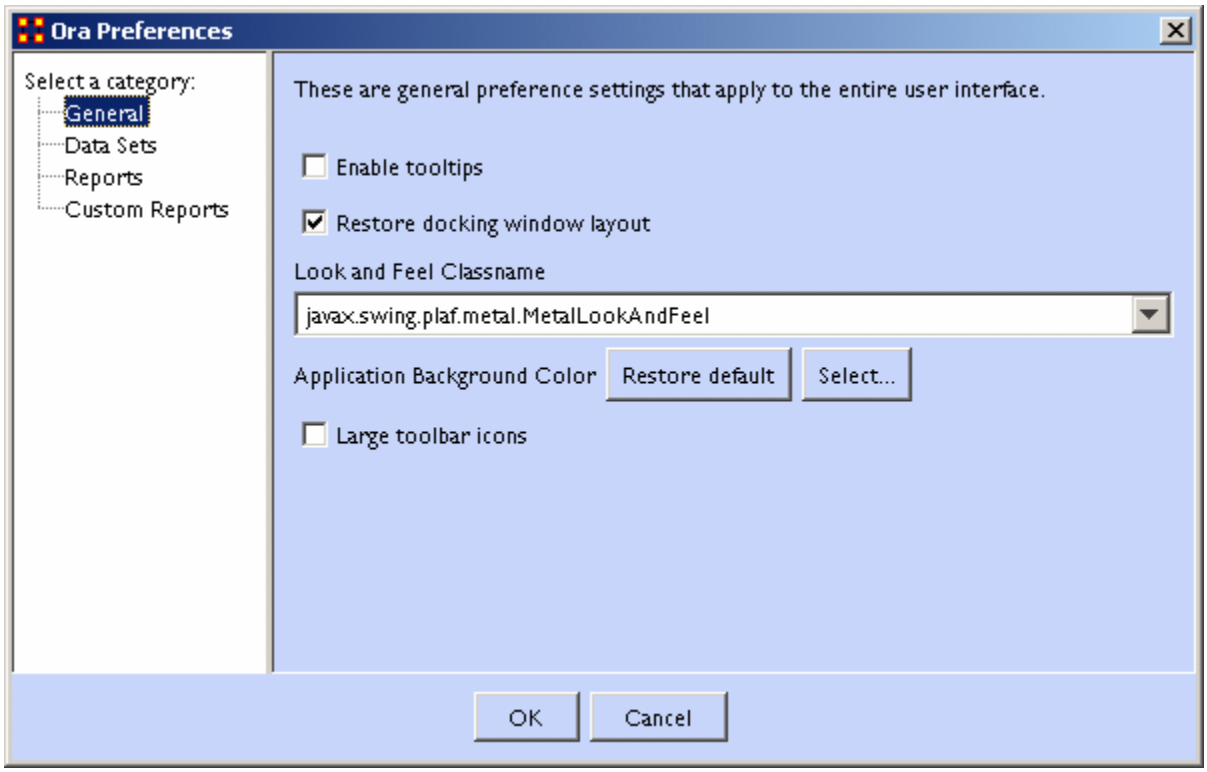
Do not use slow measures :

Scale measures as percentages (like UCINET) :



All Preferences : Contains settings for controlling the environment for working within ORA.

General



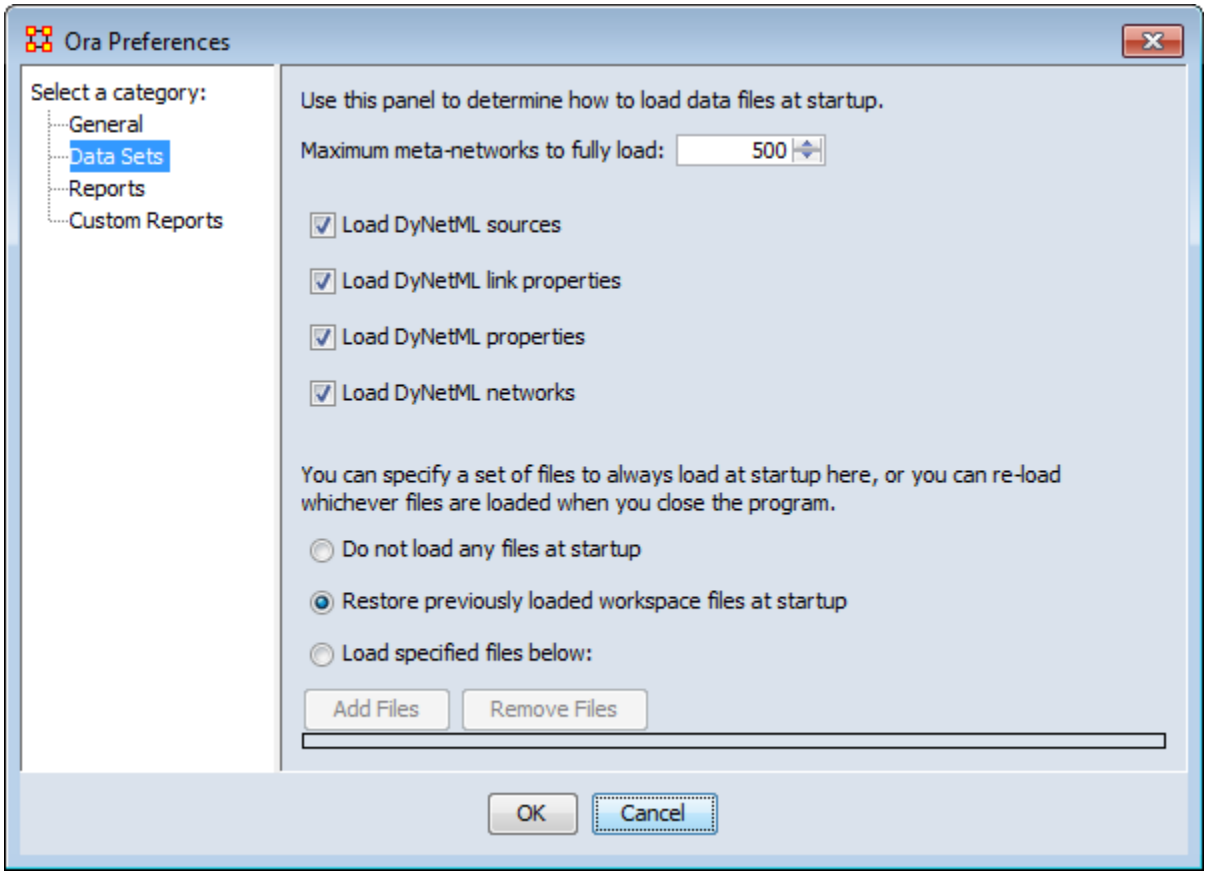
Enable tooltips toggles whether the tooltips are shown when you hover over an object.

Restore docking window layout will restore any changes you've made to the GUI layout. Unchecked at time of closing will result in ORA going back to it's default layout.

Look and Feel Classname

Large toolbar icons

Datasets



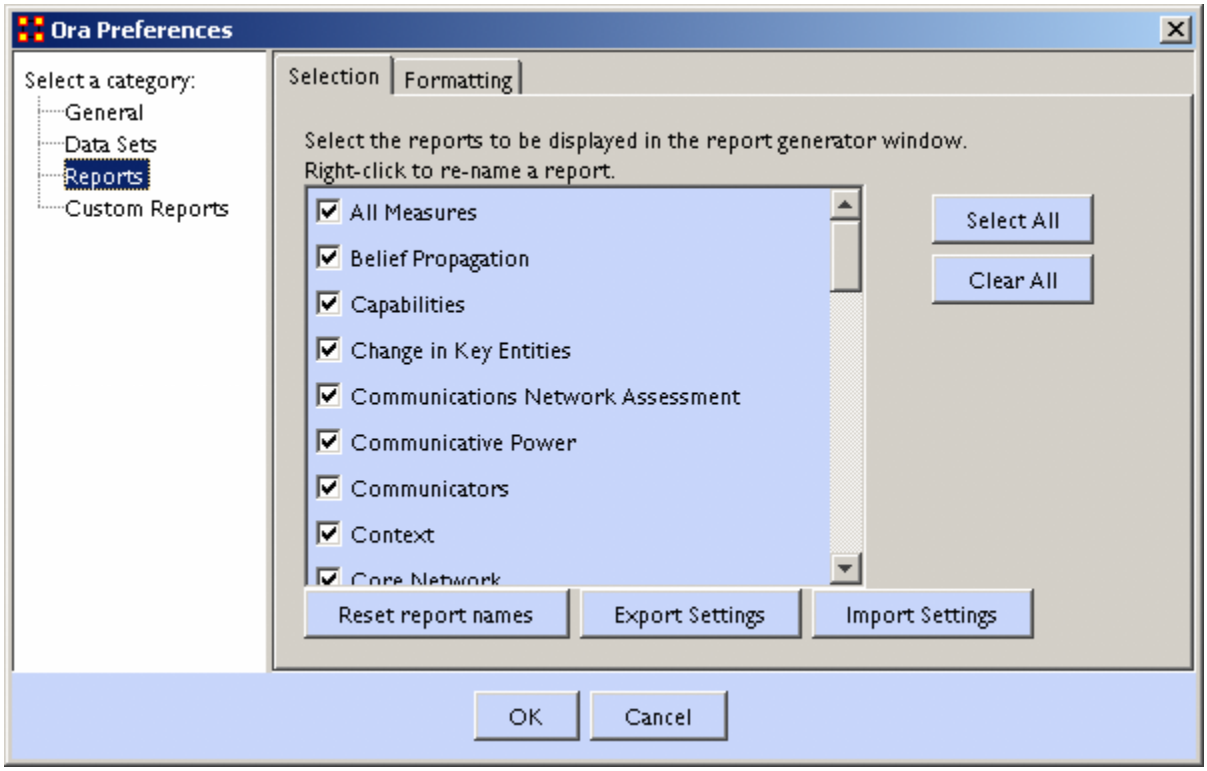
Maximum Meta-Networks to fully load

Load DyNetML sources

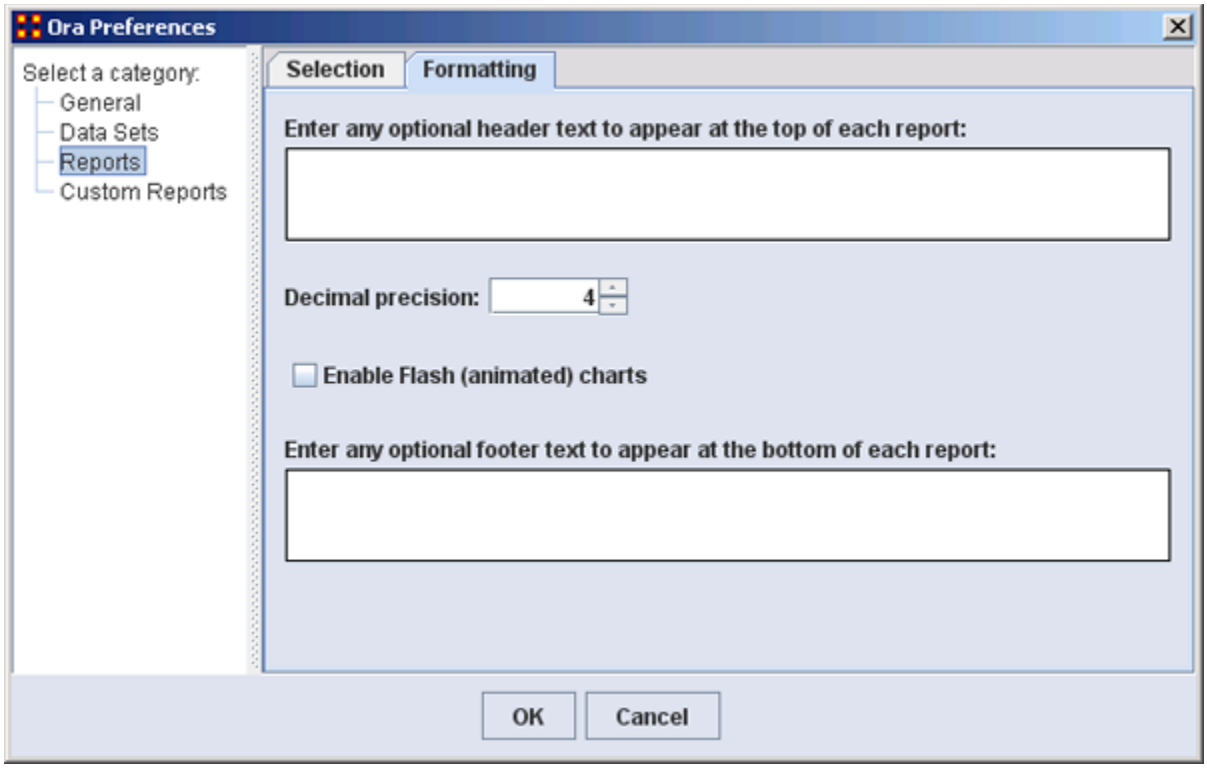
Load DyNetML link properties

Specify set of files to load at startup gives three options. **1) Do not load any files at startup** starts ORA with an empty Meta-Network pane. **2) Restore previously loaded workspace files at startup** loads the files stored in the Workspace file. **3) Load specified files below** allows you to pick which files you want loaded the next time you start ORA.

Reports

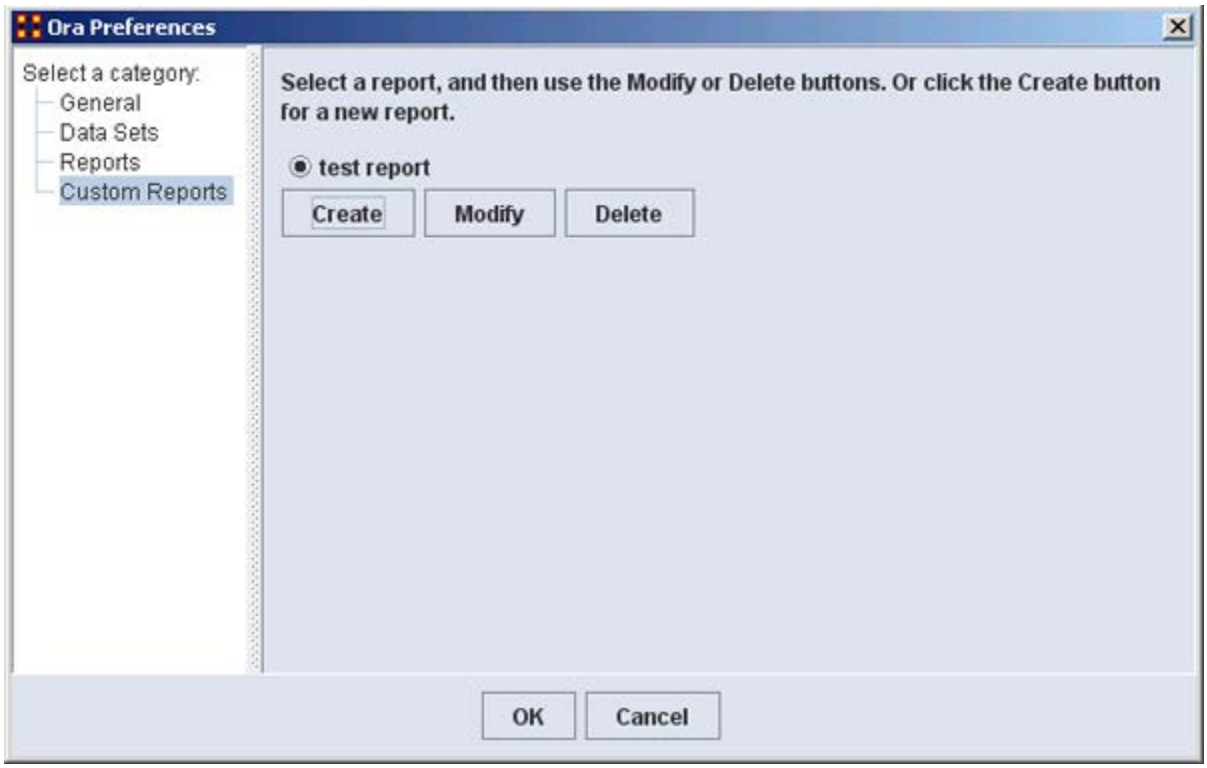


Select reports display as list of all reports available. Check marked reports will be used in the report generator. Report names can be changed by right-clicking a report and typing a new name. There is a **Reset report names** button which changes all names back to their default.



You can type in text for the **header and footer** of your reports. It will appear on all pages. The **Decimal precision** controls the number of decimal places for all numbers.

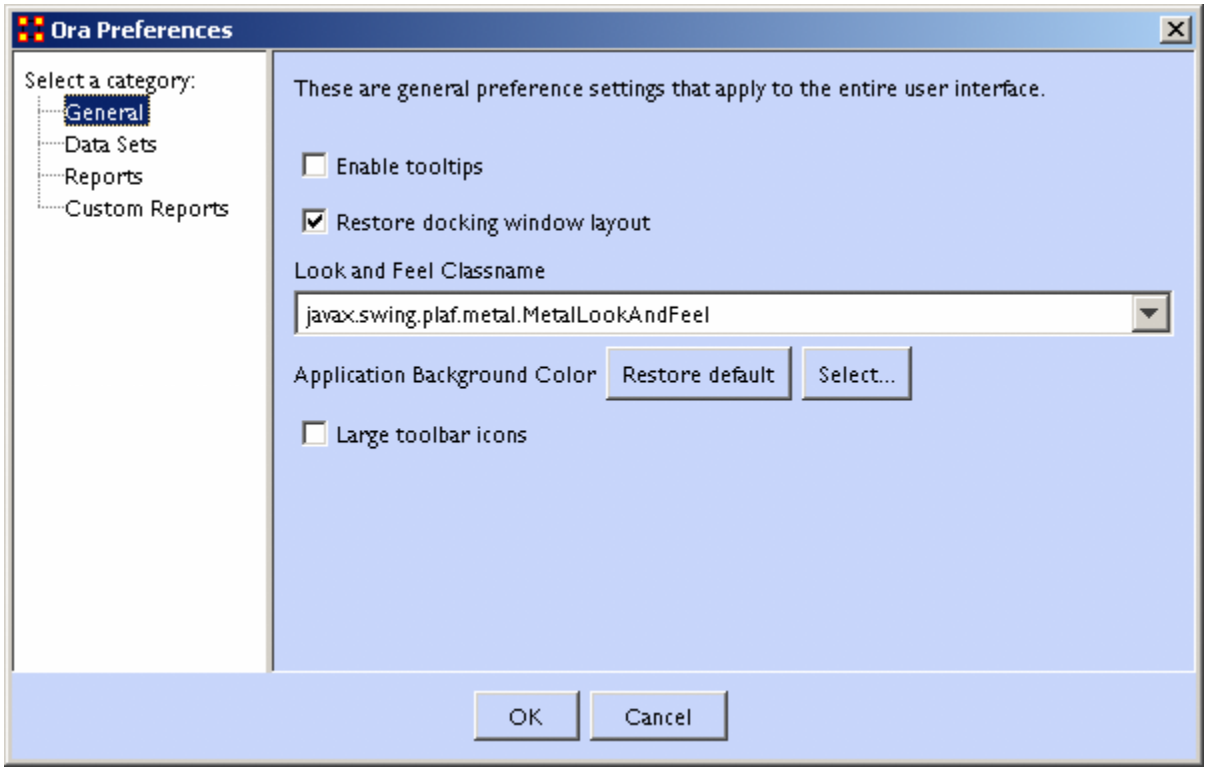
Custom Reports



Allows you to name, describe, and set up the measures to be used. If there are variable parameters for a measure they can be set also. If you have created any previous **Custom Reports** they will appear in this window. This is where they can be Modified or Deleted.

Preferences Panes

Preferences are global variations which control aspects of how ORA works.



General

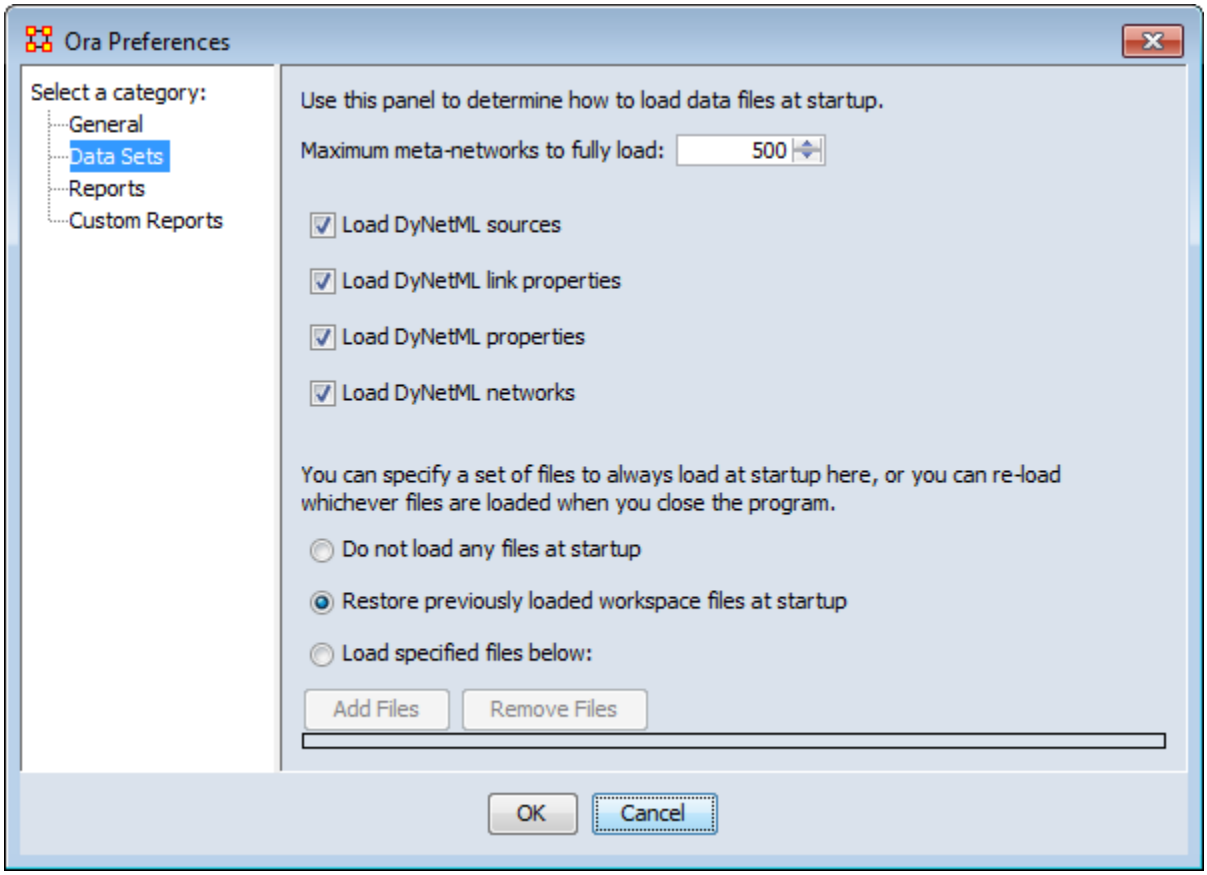
Enable tooltips Toggles whether tooltips are shown when you hover over an object.

Restore docking window layout Restores the layout to the default settings. Any changes you've made to the GUI layout will be removed. If it unchecked at time of closing the program ORA startup in the defulat arrangement.

Look and Feel Classname : Sets the style of the ORA GUI.

Large toolbar icons : Placing a checkmark toggles between using the 16x16 or 24x24 icons.

Data Sets



Maximum Data Files to Load : Tells ORA the maximum number of files to load upon start-up. The checkboxes let you select what to load from the individual Meta-Networks.

Load DyNetML sources :

Load DyNetML link properties : Unchecking will stop ORA from loading in Attributes for all links.

Load DyNetML properties : Unchecking stops ORA from loading in Attributes for all nodes.

Load DyNetML networks : Unchecking stops ORA from loading any Networks.

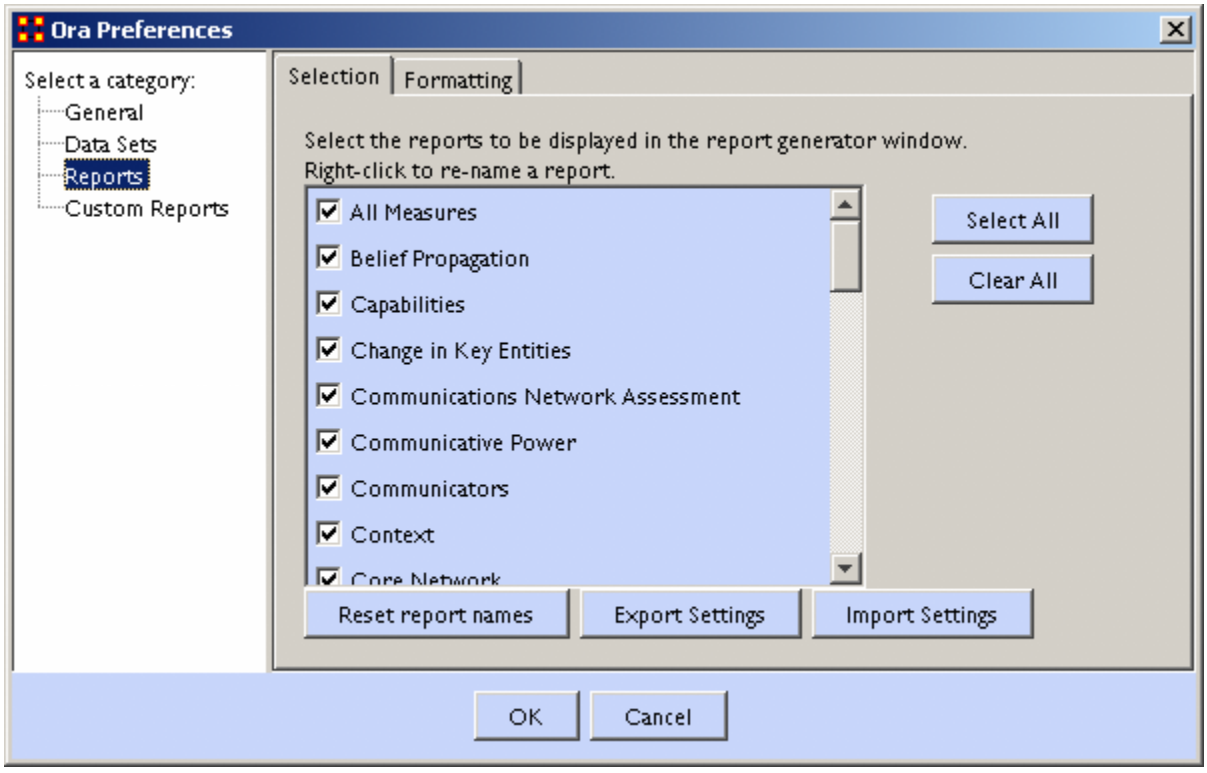
What To Load : You have three options for loading files when ORA is started up.

Do not load any files at startup : Ignores any files that were loaded during the last session.

Restore previously loaded workspace at startup : Loads the files that were current when ORA was last shutdown.

Load specified files below: Loads the files specified in the box below the option.

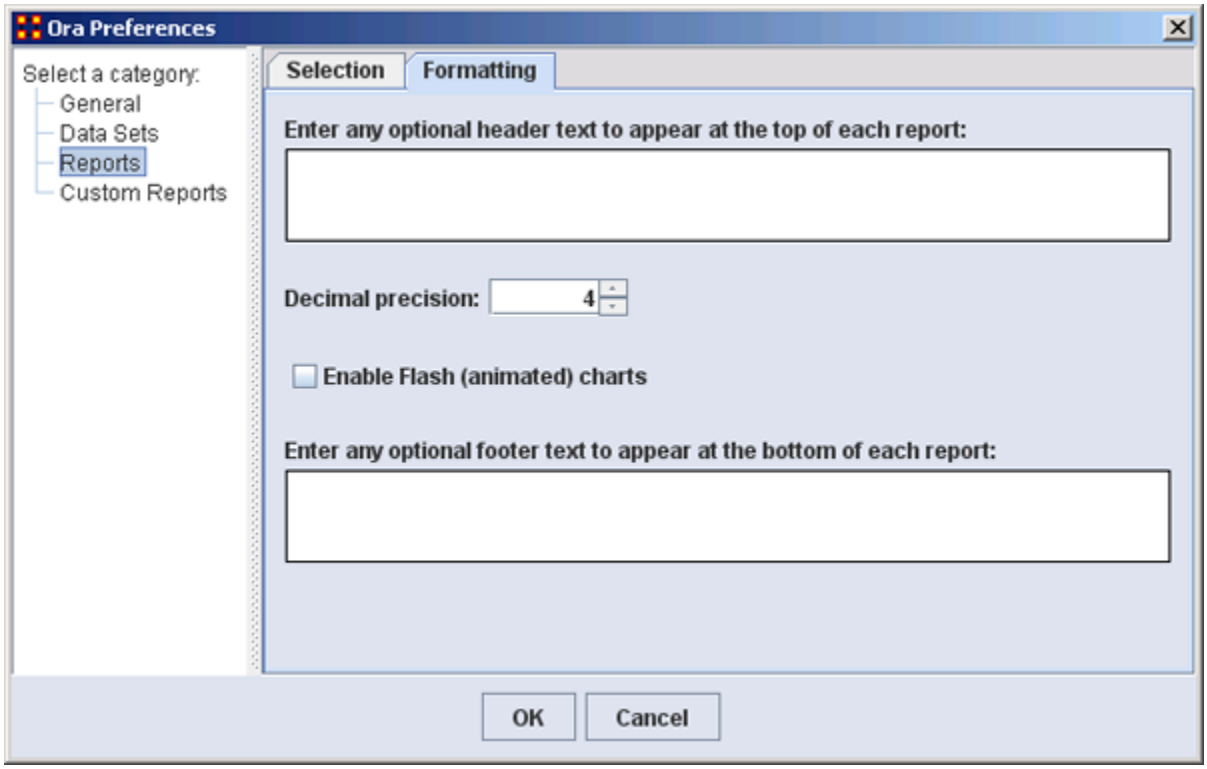
Reports



Selecting Reports to Display : Any reports with a checkmark will appear in the report generator window. Check marked reports will be used in the report generator. Report names can be changed by right-clicking a report and typing a new name.

Reset report names : Resets the names of all reports back to their default names.

Import/Export Settings : These two buttons are used if multiple people work on the same computer. Each individual can use the **Export Settings** button to export the settings they are using at the end of a session then use the **Import Settings** when they return to the computer.

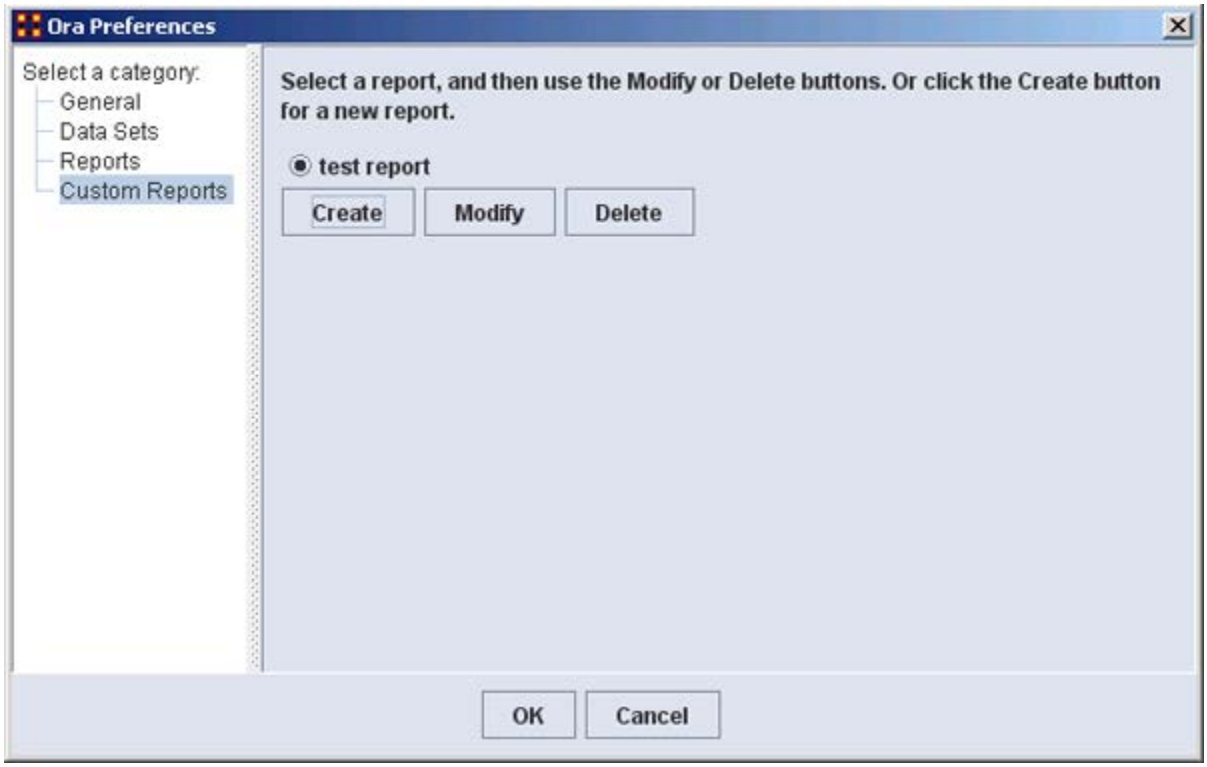


You can type in text for the **header and footer** of your reports. It will appear on all pages. The **Decimal precision** controls the number of decimal places for all numbers.

Decimal Precision : Sets the precision to which results are calculated.

Enable Flash Charts : Toggles whether Flash charts will be rendered in reports.

Custom Reports



The **Create, Modify and Delete** buttons.

Allows you to name, describe, and set up the measures to be used. If there are variable parameters for a measure they can be set also. If you have created any previous **Custom Reports** they will appear in this window. This is where they can be Modified or Deleted.

Data Management

These sets of menu items enable you to control the addition or removal of Meta-Networks, Nodesets, and Networks as well as adding Attributes to a Nodeset.

Matrix Algebra, Meta-Network Transform, and Meta-Network Union... also create new Meta-Networks, Nodesets, and Networks but do it with Mathematical operations.



Matrix Algebra... : Performs mathematical operations on two Meta-Networks.



Meta-Network Transform... : Cleans up a visualizer display making it easier to read.

Meta-Network Clean... :



Meta-Network Anonymize... : Resets the NodeID (and optionally the Node Title) to anonymous values.



Meta-Network Union... : Creates a single Meta-Network from two (or more) existing Meta-Networks.

Meta-Network



Add New Meta-Network Used for adding or removing Meta-Networks from use.



Remove Selected Meta-Network : Removes any Meta-Network which is currently selected.

Nodeset



Add New Nodeset... : Enables you to add, remove Nodesets, as well as, change the size of the Nodeset. You can also add an Attribute to an existing Nodeset. Depending on what you have

selected different options may be greyed out.



Remove Selected Nodeset : Removes all selected Nodeset from the Meta-Network along with any associated Networks.



Add Attribute... : Creates a new attribute in a Nodeset. You need to give the attribute a name and also what type of attribute it is: **Text, Text Category, URI, Number Category, Number, Date**.

Network



Add Blank Network... : Similar to Nodeset in that you can add or remove Networks. This function also enables you to **Set the Diagonal** of a graph to either **-1, 0 or +1**. Useful for setting consistent values on an **agent-by-agent** Network.



Remove Selected Network : Removes all selected Networks from the Meta-Network.



Set Diagonal : Allows user to constant values to the diagonal of a square network. If Binary View is chosen you can pick **True (+1), False (0), or True (-1)**. If Numeric View is chosen you can set the diagonal to any value.



Attribute Partition Tool : Creates new Meta-Networks from existing Meta-Networks using a node attribute.

Infer Links...



Infer Links > Beliefs :

NOTE : This function only available in the full version.



Randomize Links : A new Meta-Network is created with identical Nodesets, and with Networks of the same size and density, but with links distributed randomly according to Erdos-Renyi.

NOTE : This function only available in the full version.

-->

Network Algebra

Network Algebra allows you to perform mathematical operations on two Meta-Networks. The options in ORA are **addition, subtraction, and multiplication**. These functions help spot **strong and weak** connections within a Meta-Network.

NOTE : The term Network Algebra is synonymous with Matrix Algebra in computational parlance. Also, the following images display **Matrix Algebra** in the title bar. This may or may not be the case for the most recent version of ORA.

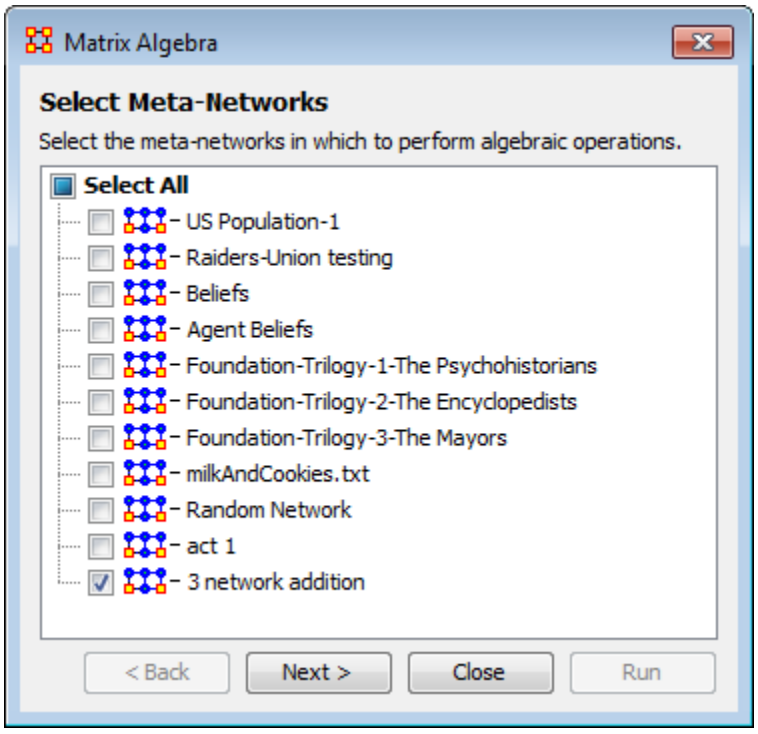
Matrix Algebra Definitions

Matrix Multiply : Technically this is the outproduct.

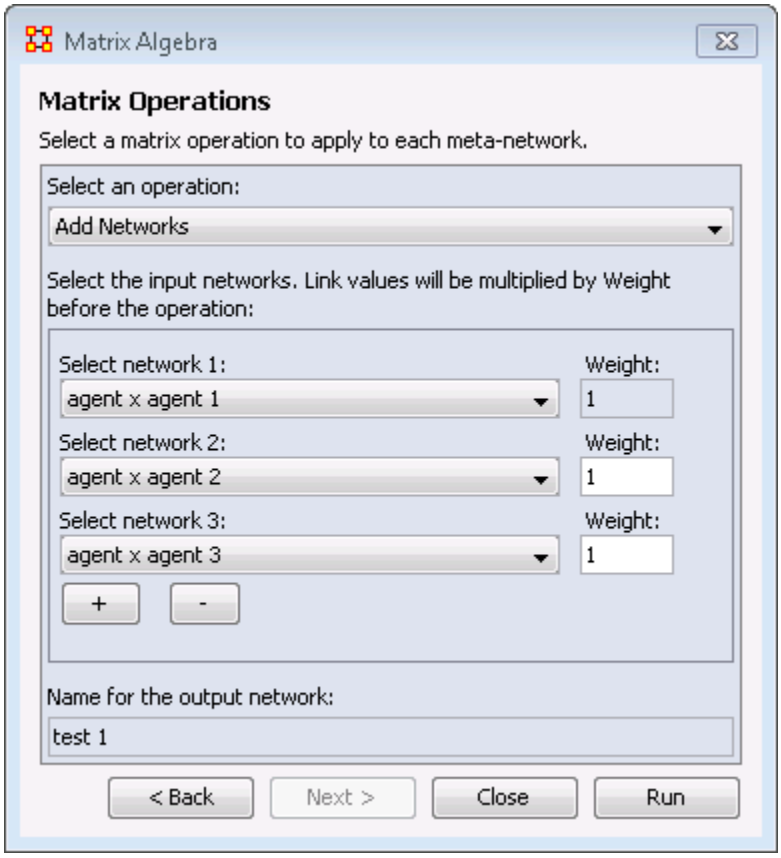
Inner Product : This is a form of matrix multiplication, sometimes referred to as the dot product. Both matrices must be of the same dimensions - e.g, both 10 x 5. The resulting matrix will be of the same dimensions. For the inner product each term is simply multiple by it's corresponding term in the other matrix.

Procedure

In the Meta-Network pan highlight the Meta-Networks to analyze. Then select **Data Management > Matrix Algebra...**. If you want to include any additional Meta-Networks place a check mark next to ehri names. When finished click [**Next >**].



The Network Algebra dialog appears.



The **Select an operation** dropdown menu contains the various ways to manipulate your networks. The **Select the input networks** section allows you to select networks from your Meta-Networks.

NOTE : Only Networks which are the same size will show up in the dropdowns.

- **Add Networks:** Adds together corresponding cells of two different Networks.
- **Subtract Networks:** Subtracts corresponding cells of two different Networks.
- **Multiply Networks:** Multiplication is slightly different than the **add or subtract**. The number of rows in the first Meta-Network must equal the number of columns in the second. A Meta-Network can be multiplied by itself to help reveal specific **strong and weak** areas.
- **Add a Scalar to existing links:**
- **Add a Scalar (dense matrix operation):**
- **Subtract a Scalar from existing links:**
- **Subtract a Scalar (dense matrix operation):**
- **Multiply by a Scalar:**
- **Divide by a Scalar:**
- **Dot Products Networks:**
- **Set the Diagonal:**
- **Transpose:**

Select Network 1:

Next select the first Network you want to work with.

Select Network 2:

Then select the second Network in order to perform the algebra.

Name for the output network:

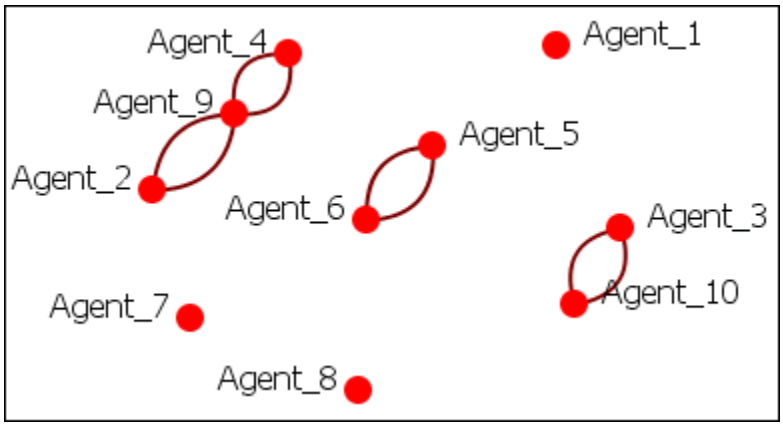
If you wish, you can change the default name for the newly created Network.

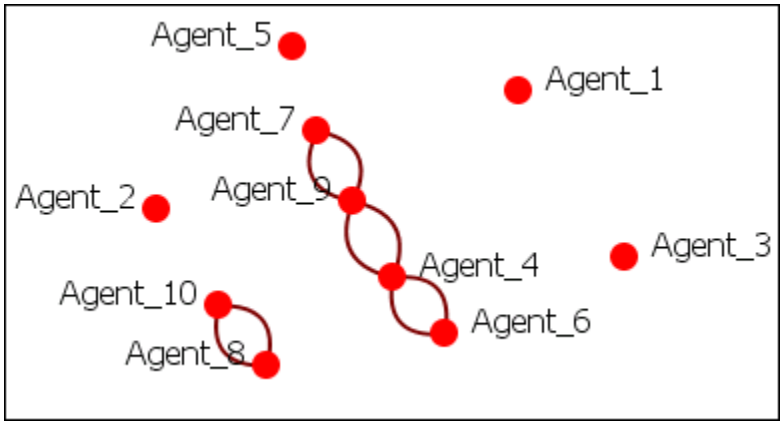
Click [**Run**] to create you new Network. You can then create more Networks if desired. When done, select **[Cancel]** to remove the dialog box from the screen.

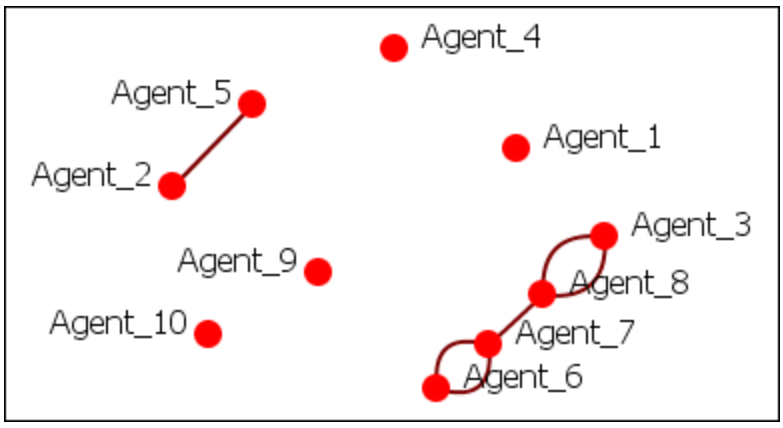
Your new Network will now appear in the box with your Meta-Network. Next highlight the Network you just created.

Visualize The Networks

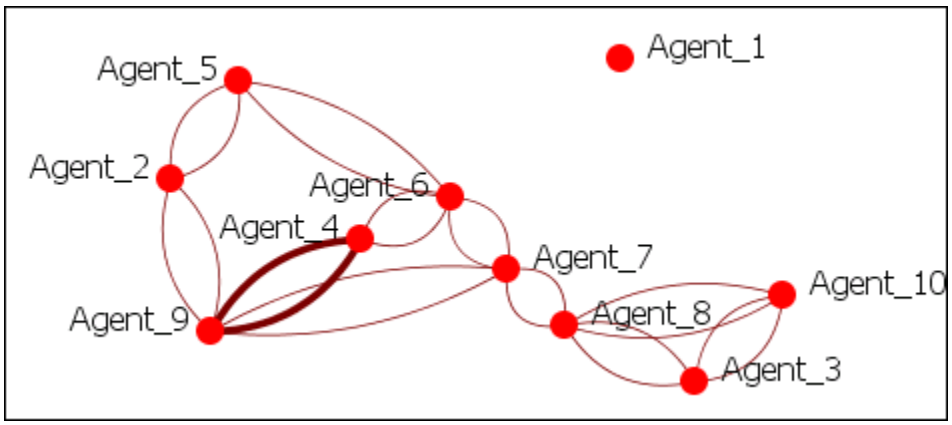
The Meta-Network example has one Agent Nodeset with ten agent nodes. Then three Agent x Agent Networks were generated using Erdos-Reyni. Below are the three networks. The bi-directional links are shown.



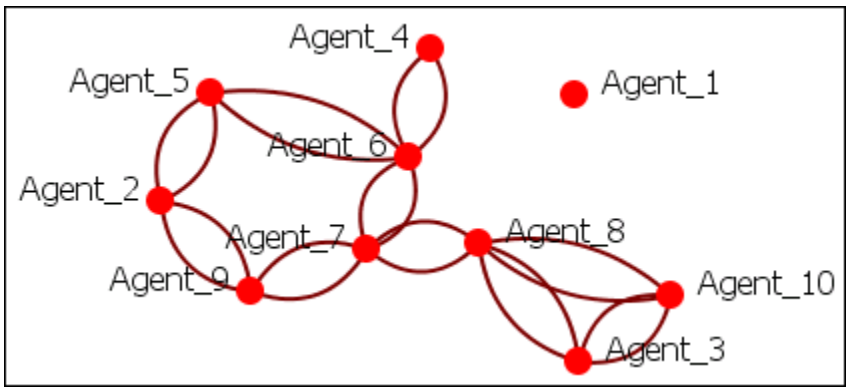




Add



Subtract

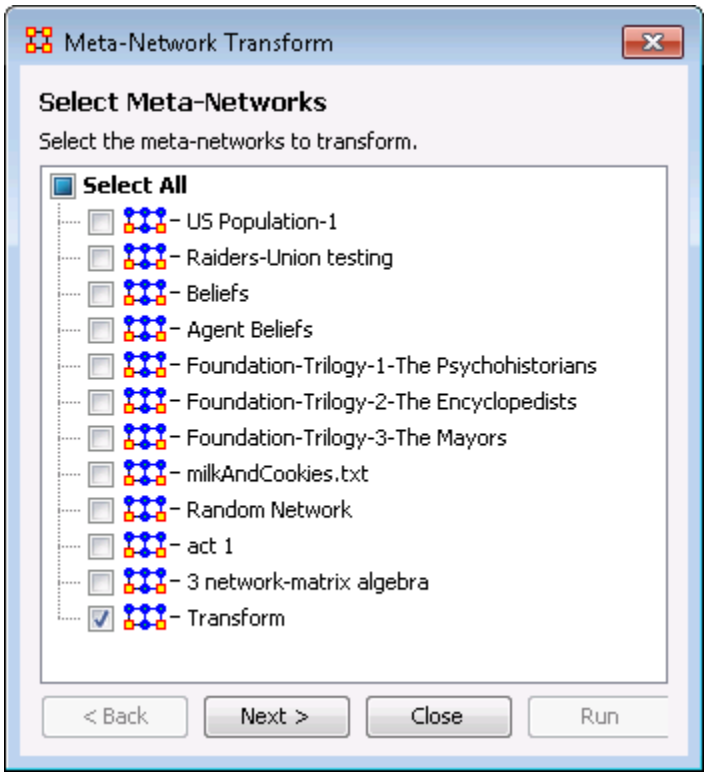


Meta-Network Transform

Select Files

On some occasions the display in the Visualizer is too cluttered to make much sense of your network model. ORA offers a variety of ways to clean up the display in order to make it easier to view your data.

In the main menu select **Data Management > Meta-Network Transform…**.

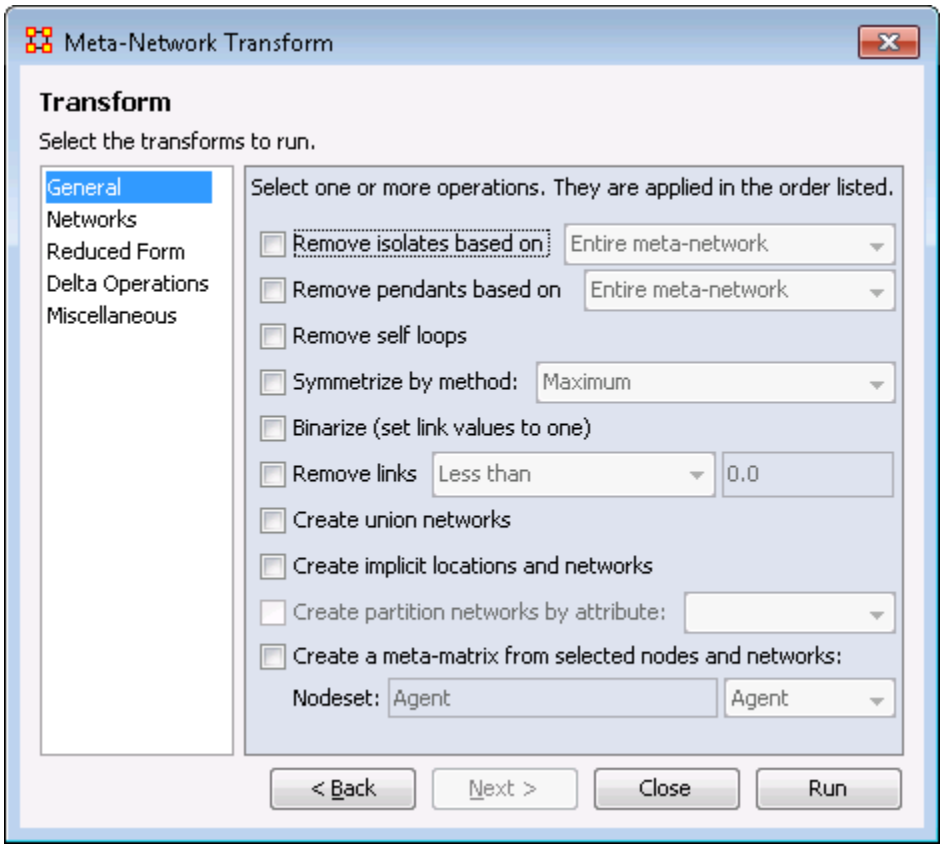


Place a check mark next to the Meta-Networks you want to perform a transformation on.

General

Click the [**General**] button and place a check mark next to any transforms to apply to the selected Network(s) These transformations will be performed in order from top to bottom.

NOTE : To perform transformations in a different order select a transformation then click the [**Apply**] button. Deselct that transformation and click the [**Apply**] button again. Repeat until you have performed all necessary transformation.



The "Whole Meta-Network" tab

This tab contains funtions which work on all Nodesets and Networks.

Remove isolates based on : Remove isolates based on selection of Meta-Network or individual Networks.

Remove pendants based on : Remove pendants based on selection of Meta-Network or individual Networks.

Remove self loops : Remove self loops (diagonal) in Networks

Symmetrize by method : Turns all links bi-directional by adding or removing uni-directional links.

Maximum Compares the values and uses the larger of the values. This is called **using the stronest value**.

Minimum Similar to **Maximum** only it uses the lower, or weaker, value.

Sum Adds all values together

Average Takes the two values and averages them.

Binarize (set link weights to one) : Takes **all** links weighted greater than [**0**] and make them all equal to [**1**]. All links will be either [**1 or 0**].

Remove Links : When using **weighted links** this functions allows for links to be removed based on link weight. You can choose from **six** options for the removal of links.

- **Less Than :**
- **Less than or equal to :**
- **Equal to :**
- **Not equal to :**
- **Greater than or equal to :**
- **Great than :**

Create union networks : Creates new networks that are the union of all networks of the same type. If the Meta-Network had two Agent x Agent Networks, then using this feature would create a new Agent x Agent Network which would contain all the links that were present in the original two Networks.

NOTE : The input networks are **NOT** deleted.

Create implicit locations and networks : For a Meta-Network without a location Node Class but with Agents or Organizations having latitude and longitude attributes this will 1) create a location Nodeset populated with Agents and Organizations and 2) Create Networks linking each Agent and Organization to its location.

Create partition Networks by attribute : This partitions the Nodeset according to the values of the specified entity attribute and then creates a group of new graphs based on the partitioned Meta-Node. This kind of grouping is often done in network analysis to understand how some Meta-Nodes are **embedded** in various social roles or how they interact within

larger Meta-Nodes. The dropdown menu will contain all the attributes in the meta-network.

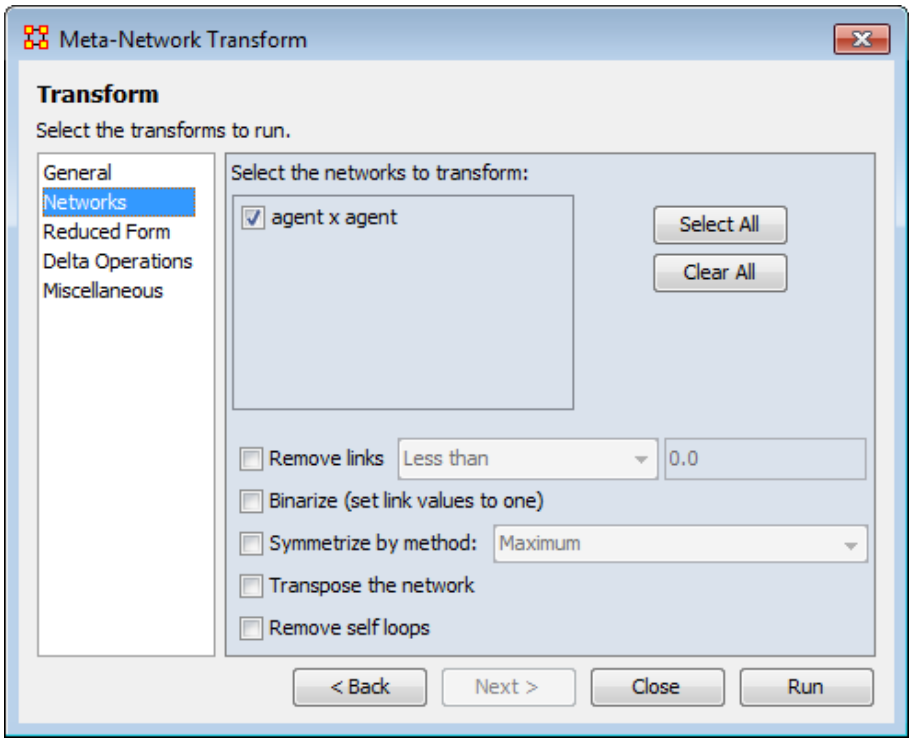
*Example, if you have an Agent Meta-Node that has a **gender** attribute for each node that takes on values **male** and **female**, then using this feature four new Agent x Agent Networks would be created that contained links from males to males, males to females, females to males, and females to females. No new Meta-Node is created and no data is changed.*

Create a meta-network from selected nodes and networks : Creates a new Meta-Network with **a single** Nodeset and **a single** Network. The nodes are prefixed with the name of the Nodeset they were taken from.

> Say you have a network with three networks, **Agent x Agent, Agent by Organization, and Organization x Organization** and you want to combine these into one nodecass and network. Highlight the Meta-Network, place a check mark in this box, and click [**Transform**]. ORA will create a new Meta-Network which conatins all the nodes in a single Nodeset and will combine all the networks. In the Node ID it will preface each with the original nodeclass .

Network

This tab allows you to **Choose one or more networks to transform** by placing a checkmark in the box. All marked netowrks will be processed.



Remove links : removes links based on one of six options.

- **Less Than :**
- **Less than or equal to :**
- **Equal to :**
- **Not equal to :**
- **Greater than or equal to :**
- **Great than :**

Binarize (set link weights to one) : Take all weighted links greater than [**0**] and make them all equal to [**1**].

Symmetrize by method : turns **directed or asymmetric** network data into **un-directed or symmetric** data. All three methods (**maximum, minimum, average**) use a pair of values from the upper and lower portions of the table (**e.g. cell 1, 3 is compared to cell 3, 1**)

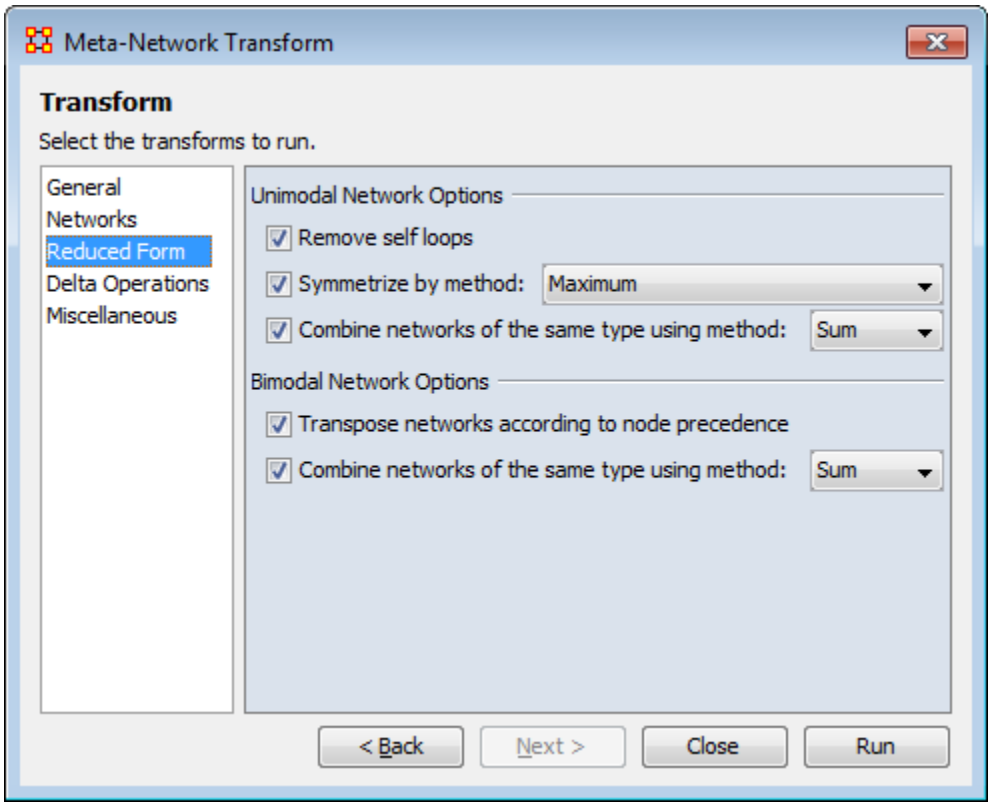
Transpose the network : writes the rows of network [**A**] as the columns of network [$\mathbf{A}^{\mathbf{T}}$] and writes the columns of network [**A**] as the rows of network [$\mathbf{A}^{\mathbf{T}}$]. It literally rotates the network 90° then mirrors the image horizontally.

Remove self loops :

Reduced Form

Used for removing clutter and making sure Nodesets are arranged in proper order.

Transposes networks to their ontological order, i.e.,if there is an **Agent x Location** Network and a Location x Agent Network, then a single Agent x Location Network is created by combining the edges from both Networks.



Unimodal Network Options

Remove self loops : Removes all links that connect a node to itself

Symmetrize by method : Turns directed or asymmetric network data into undirected or symmetric data. All three methods use a pair of values from the upper and lower portions of the table **(e.g. cell 1, 3 is compared to cell 3, 1)**. If a network had a link from A to B but not from B to A then symmetrizing the network would create a reciprocal link from B to A.

- **Maximum** Compares the values and uses the larger of the values. This is called **using the strongest value**.

- **Minimum** Similar to **Maximum** only it uses the lower, or weaker, value.
- **Average** takes the two values and averages them.

Combine networks of the same type using method: :

Sum : Adds weights of links from all combined networks

Binary : Sets link to [**1**] if there is a link an any two nodes or [**0**] if no network contains a link for two nodes.

Average : Adds all links and divdes by the number of links found.

Minimum : Uses the lowest link weight found in any network.

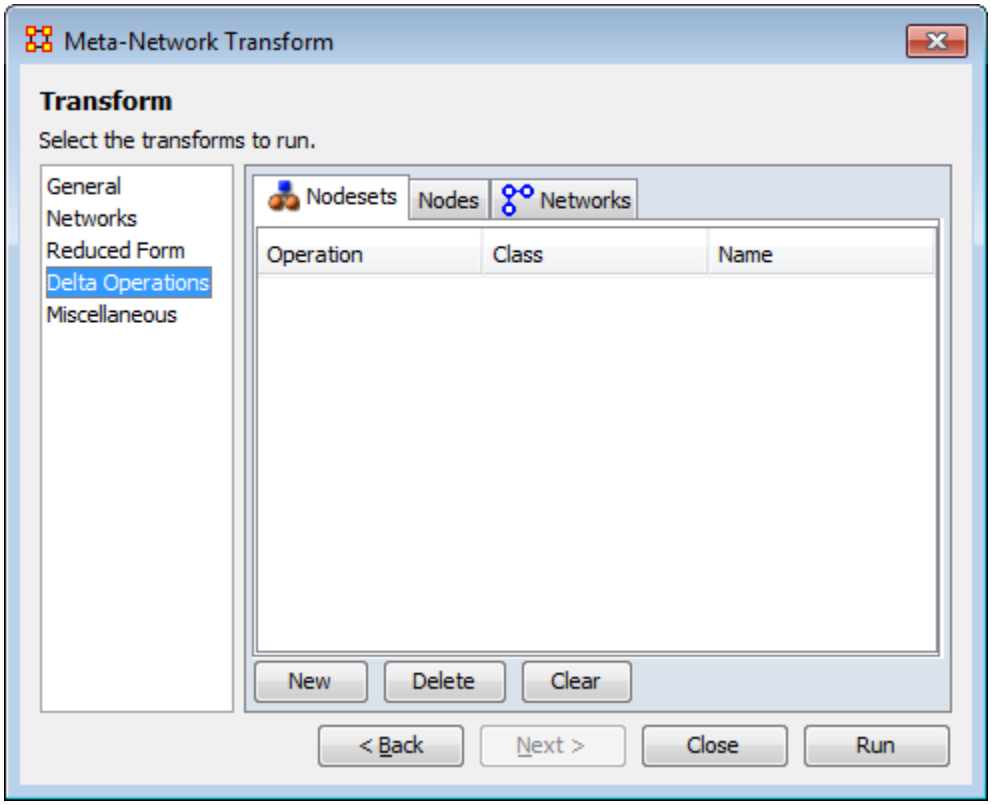
Maximum : Uses the highest link weight found in any network.

Bimodal Network Options

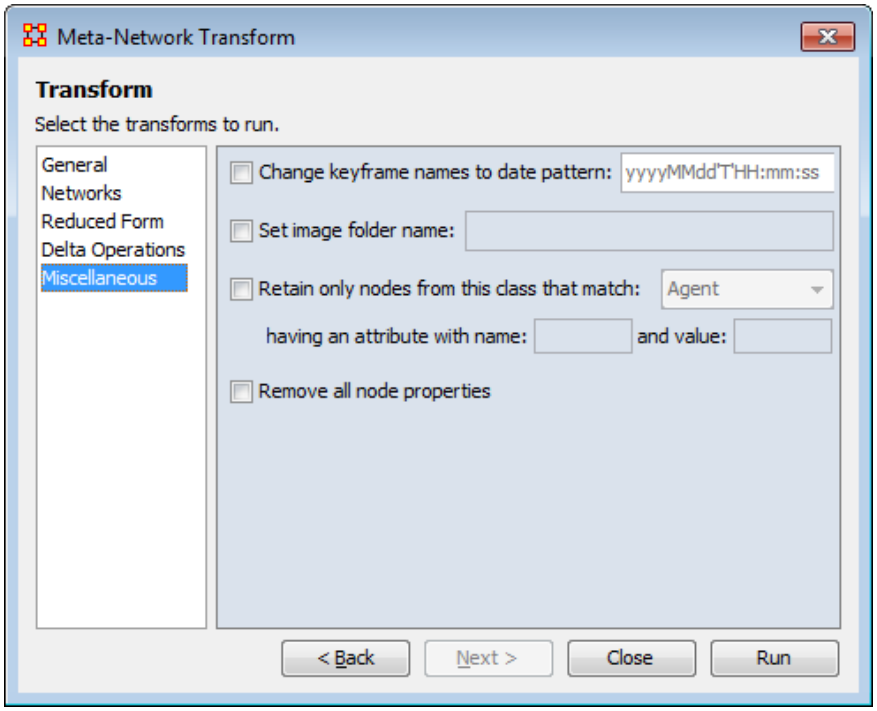
Tranpose networks according to node precedence : Tranposes bimodal networks to ensure that certain nodeclasses appear first. The order is: **Agent, Organization, Knowledge, Resource, Belief, Event, Task, Location**.

Combine networks of the same type using method: : See descriptions above

Delta Operations



Miscellaneous



Change keyframe to date pattern: : Set the format for dates used in your Meta-Network

Set image folder name: : Set location which contains images for nodes.

Retain only nodes from this class that match: : Select the Nodeset to use.

having an attribute with ID: and value: : From the above Nodeset, nodes need to have the particular names and values.

Remove all node properties : Wipe the slate clean of all attributes.

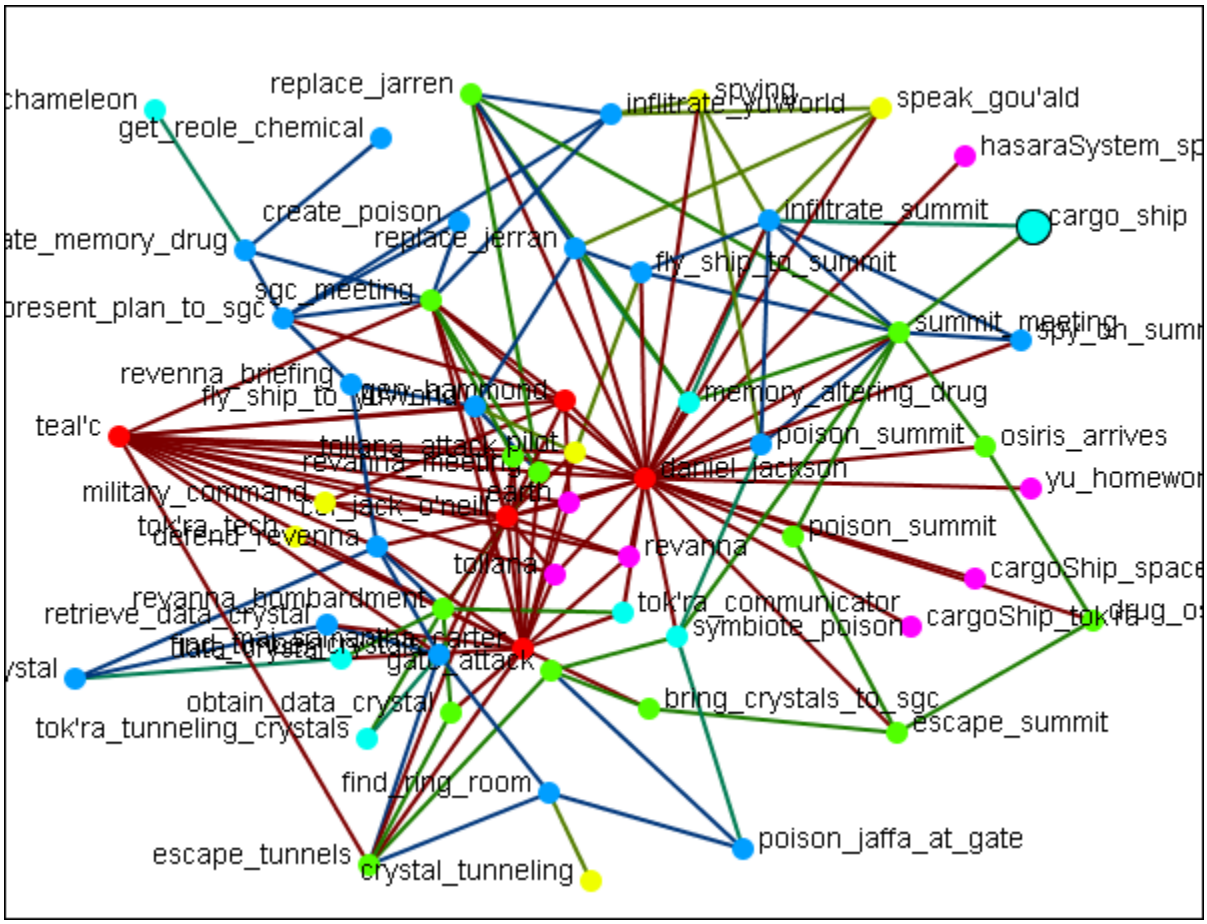


Meta-Network Anonymizer

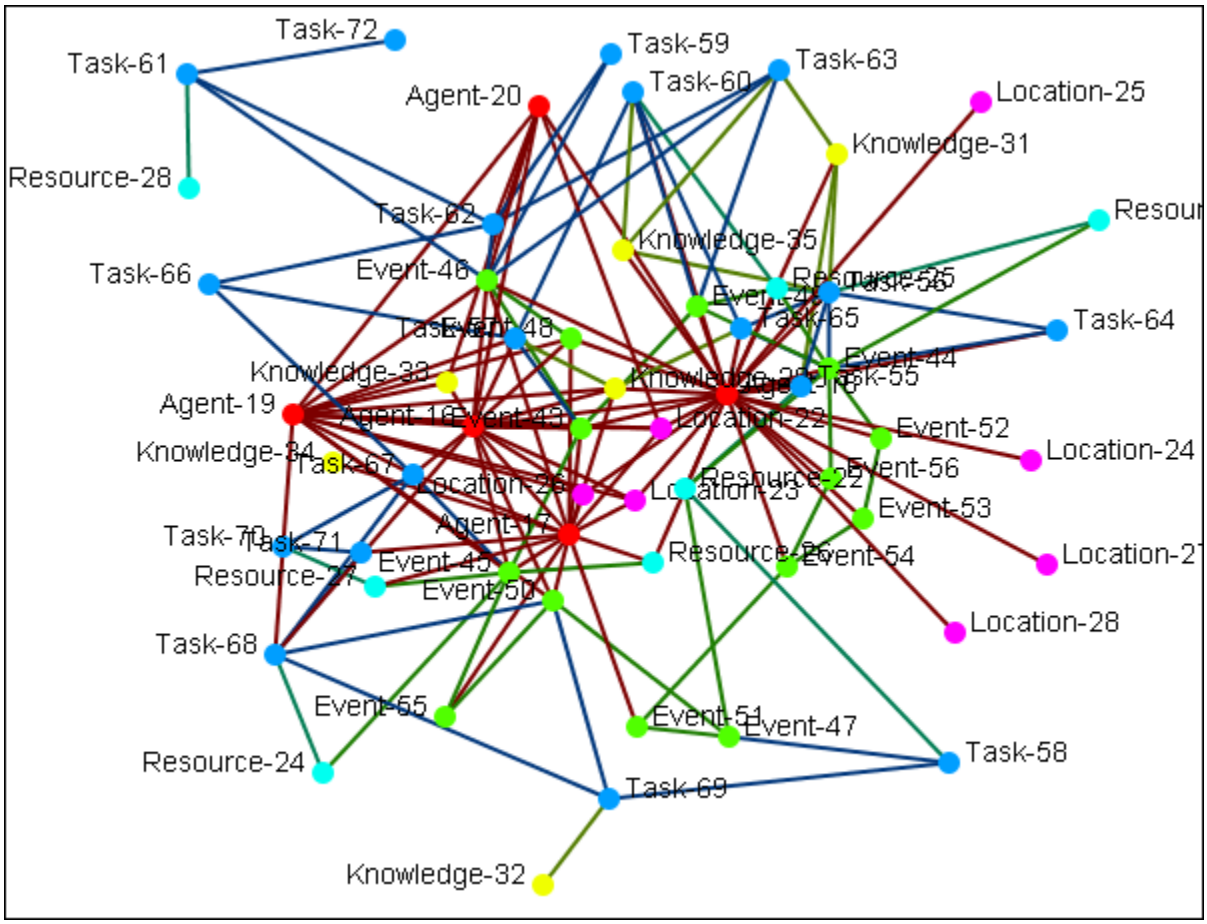
 **Meta-Network Anonymize** tool removes IDs (and optionally Titles) from any chosen Nodeset. This is particularly helpful if you are discussing sensitive network information about real people and wish to remove their names from the network model.

The Visualizer

Visualizer Before Anonymizing : When you load your network model into the Visualizer, you will see (by default) the names of your agents or applicable Nodesets. You may, for a number of confidentiality reasons, wish to hide this information from your audience yet still show them visually what the network can reveal.



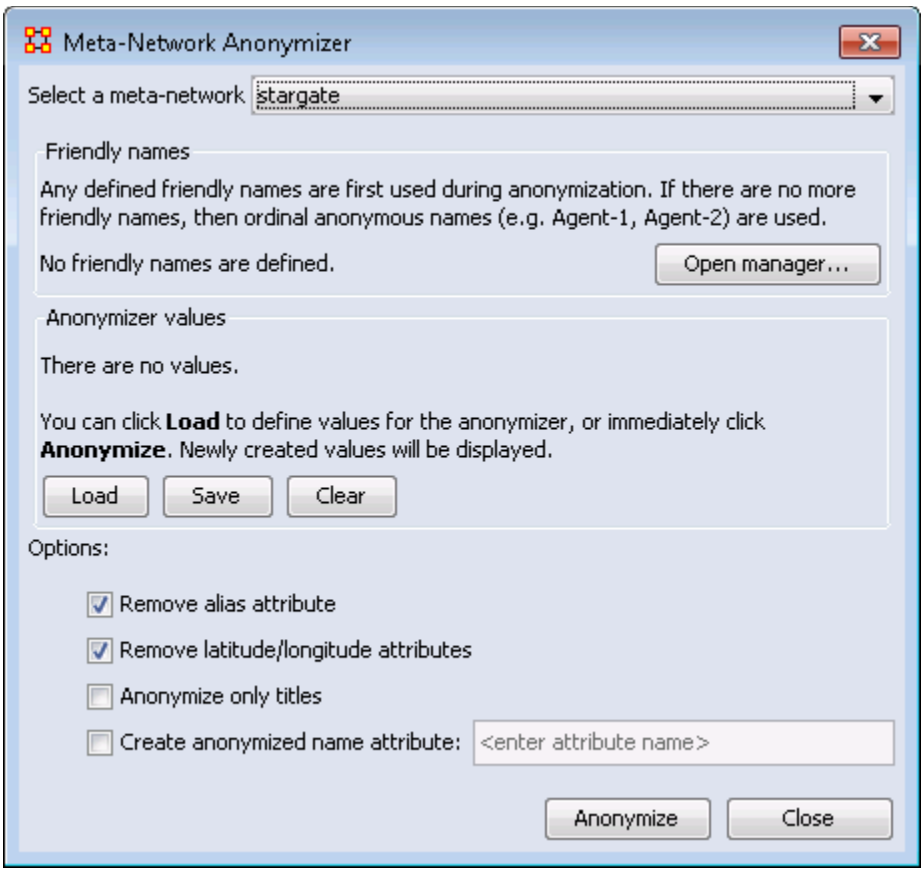
Visualizer After Anonymizing : None of the nodes have recognizable names and only the link and network information is known.



Meta-Network Anonymizer dialog

From the main menu select **Data Management > Meta-Network Anonymize...**.

The Meta-network Anonymizer tool will appear in a pop-up window. Here you can select a number of parameters pertinent to the Nodesets you wish to anonymize.



1. **Select a Meta-Network :** All active Meta-Networks appear in the drop-down menu. Select the Meta-Network to anonymize.
2. **Friendly names :** The user can create a list for each Nodeset of names that will not be anonymized.
3. **Anonymizer values :**
4. **Options :**
    - **Remove alias attribute :**
    - **Remove latitude/longitude attributes :** Removes geospatial attributes from the Meta-Network.
    - **Anonymize only titles :**
    - **Create anonymized name attribute :** If you would like to use descriptions other than Names, you can generate your own terms. This is intended to be used with the friendly anonymizer tool but can be used for whatever reasons you deem fit. To do so, be sure the **create Name Attribute** is checked then enter your own term.

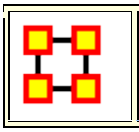
5. **Anonymize button :** Click the button when you are ready to crate an anonymized file.

Writing an Anonymized file : When the **[Anonymize]** button is selected ORA writes a **.CSV** file. The Save box allows the user to navigate to a directory to save the file.

```
Encoded ID,Original ID
A-1,A01
A-2,A02
A-3,A03
A-4,A04
```

Node Title : If the **Anonymize node title** is selected then ORA will also write the original Title to the file.

```
Encoded ID,Original ID,Title
E-1,E01,revanna_meeting
E-2,E02,summit_meeting
E-3,E03,revanna_bombardment
E-4,E04,sgc_meeting
```



Meta-Network Clean

When large datasets are created people's names are after written differently through many different documents. For example you could see someone referred to as **John** in one documents, **John Smith** in another doucments, and **John W. Smith** in yet another document. All three of the these names refer to the same person but in ORA they would be considered different individuals.

This function provides additional cleaning for text analysis. The user can select and operate on multiple meta-networks at once. The new dialog is under the Data Management main menu item. The following functions are available. Select from the main menu **Data Management > Meta-Network Clean...**

Functions

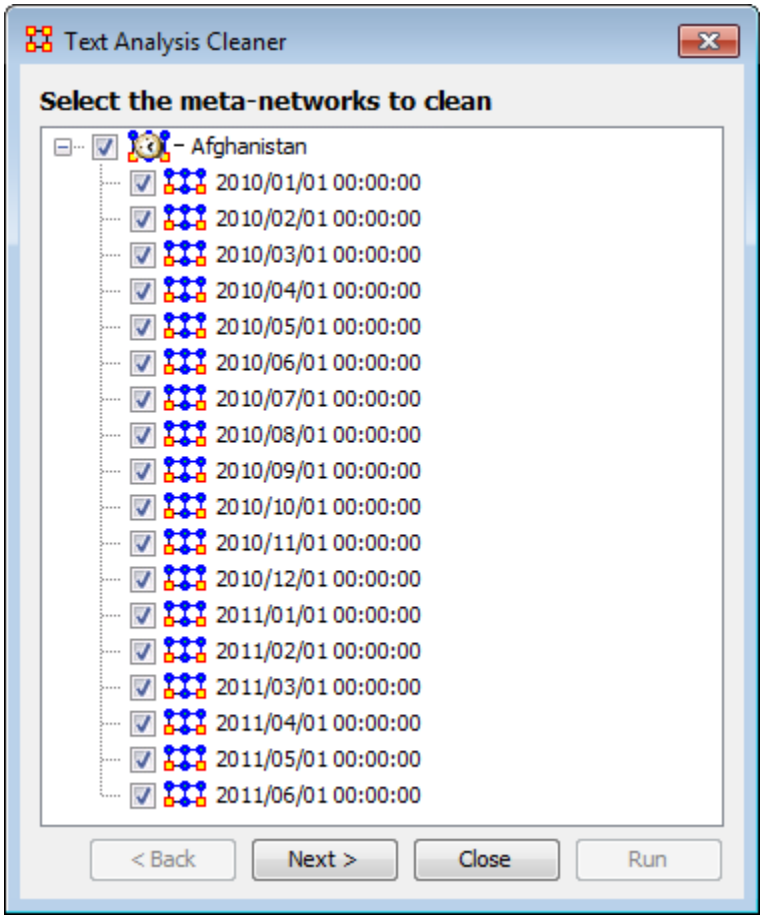
Convert LexisNexis meta-network to our standard meta-ontologies.

Apply **Change Lists**

Create **Blank Change Lists**.

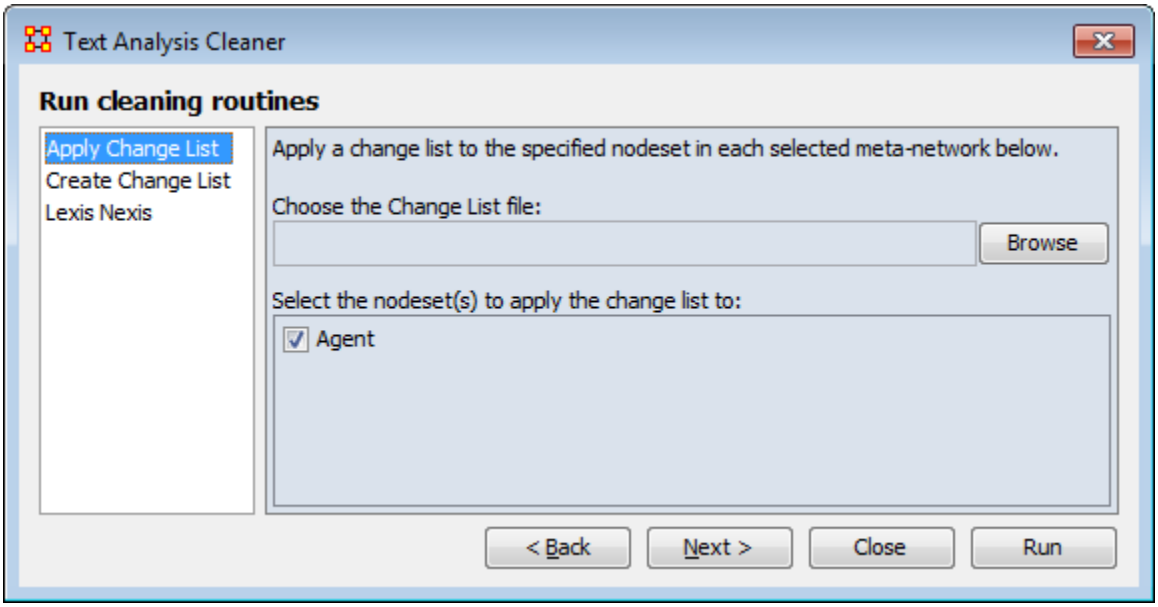
Workflow

Load LexisNexis data called Afghanistan.xml, which is a dynamic meta-network in the LexisNexis format typical from Juergen's analyses. Open the Text Analysis Cleaner dialog. Select all of the meta-networks in the dynamic meta-network. Click [**Next**].



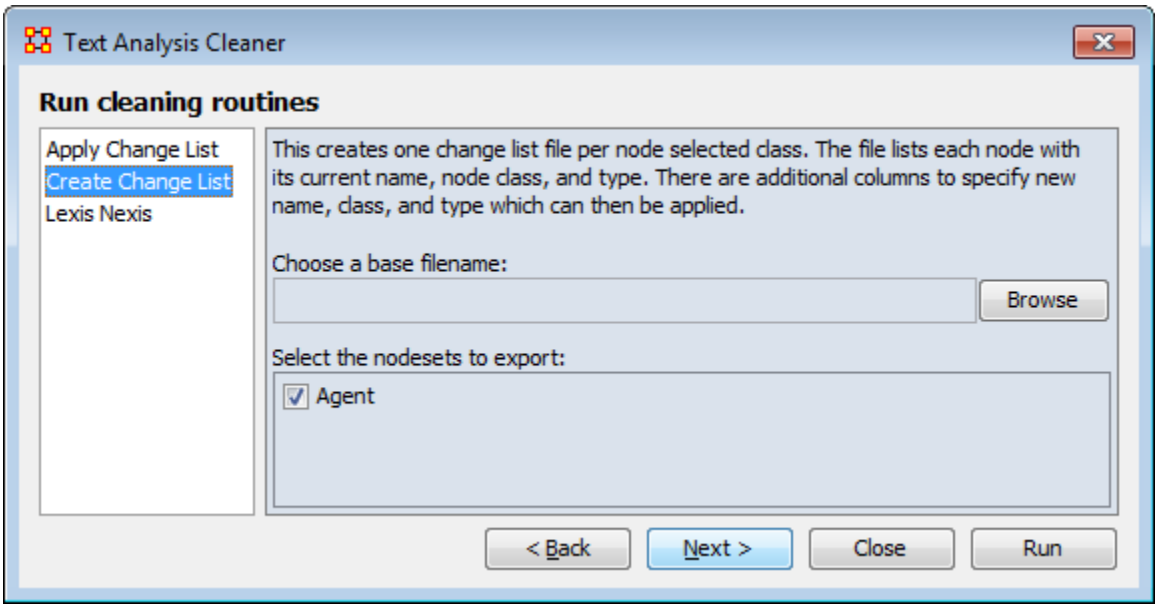
Apply A Change List

Next a Change List is applied to the Agent and Knowledge Node Classes. These meta-ontologies are standard, and the Node IDs are standard. You should expect the Change Lists to apply well. Click on the **Apply Change Lists** tab. Click the [**Browse**] button and navigate to your change list file. Click the [**Run**] button.



Create A Change List

You can now export empty (or blank) change lists that can then be loaded into Excel and edited for an iterative cleaning process. Click the **Create Change Lists** tab and place a check mark next to all Nodesets to export.



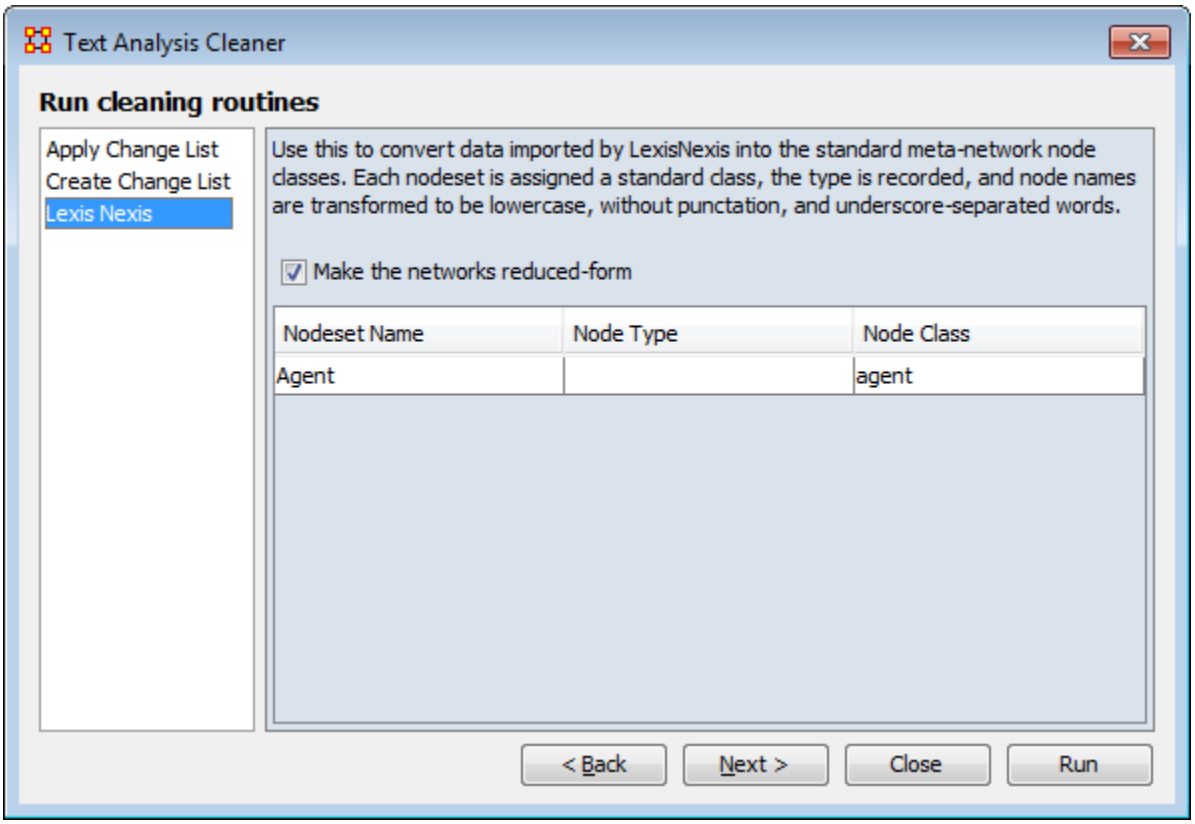
This will create a union all of the selected Afghan meta-networks to create combined Nodesets. It will also create a single file per Nodeset by **appending _agent, _knowledge, _task** to the base filename. The **Frequency column** of the newly created (blank) change lists will be populated according to this rule: if the node has a **frequency** attribute, then its value is used (it will be summed across meta-networks); otherwise the node's total degree is used.

NOTE : This can easily be misleading, for example, suppose a node exists in all the meta-networks, but only in the first one has the "frequency" attribute. This frequency value will be used, even though it is based on only one meta-network.

NOTE : Only CSV files are currently used; Excel (.xlsx) will be supported shortly.

NOTE : This dialog could be combined with the Meta-Network Transform dialog or perhaps that is not a good idea? Suggestions welcome.

Lexis Nexis



Click [**Run**]. The following transformations are made:

1] Node IDs need to be converted to standard node IDs. What happens is:

Nodes are all converted to **Lowercase**.

All **punctuation** is removed.

Spaces converted to **underscores**.

2] Node Class meta-ontologies are changed to those used in Automap.

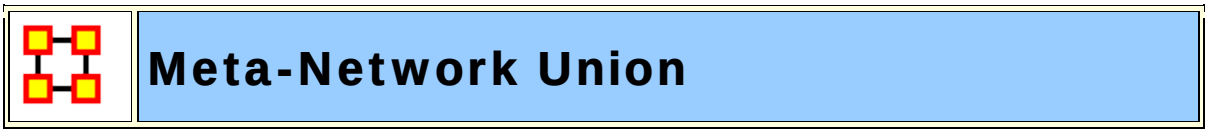
3] The meta-networks are made Reduced Form, which means:

Uni-modal networks are symmetrized.

Bi-modal networks are combined into a single direction (e.g. AK and KA are combined into a single AK. Order is defined by precedence.

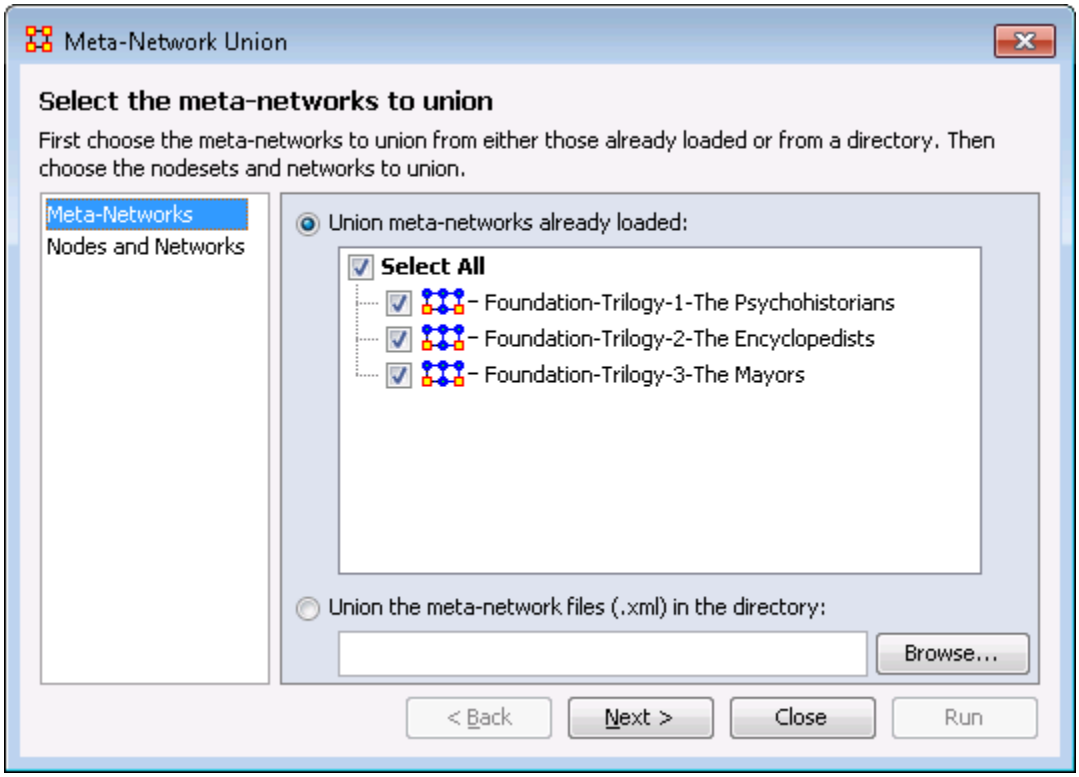
Self-loops are removed

The Results Log of the transformation is available but at this time is not very interesting. This becomes more important when a Change List in applied.



Meta-Network Union is used to combine two or more Meta-Networks together. There are tools to select which Meta-Networks to use or exclude and how to combine the link weights. ORA can save out the result as an entirely new Meta-Network file.

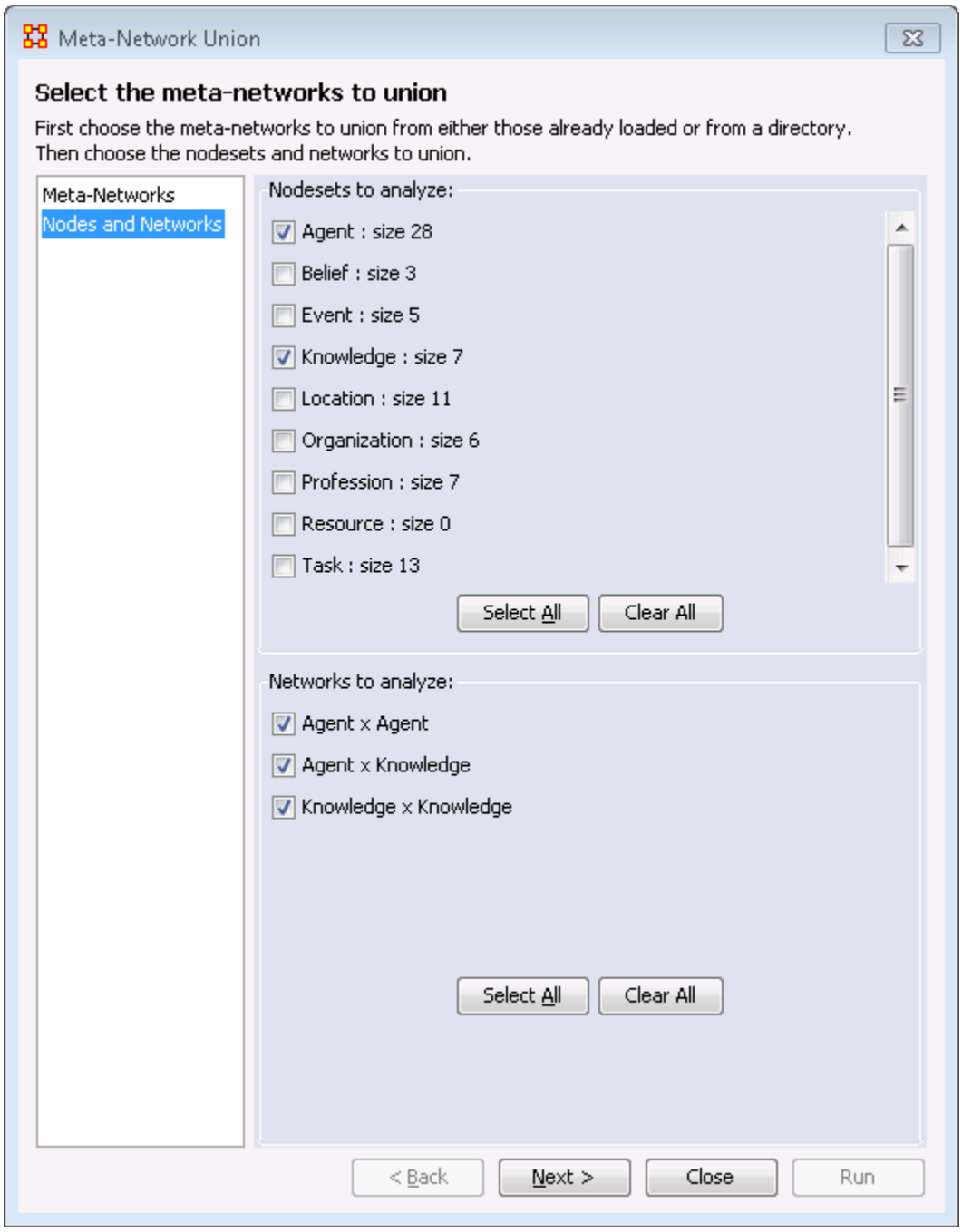
Select Files



Place a check mark next to all Meta-Networks you want to select Networks from for the new Union Meta-Network. You can also select the radio button to **Union the meta-networks files (.xml) in the directory** and navigate to a folder.

Here I selected all three of the current Meta-Networks. You can chose any set to union.

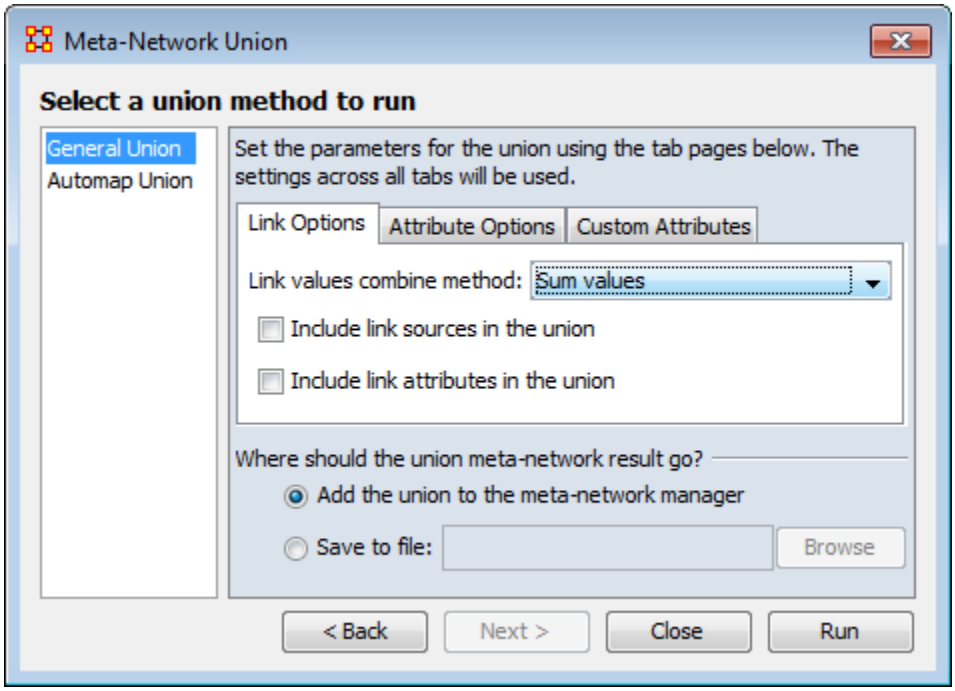
Select Networks



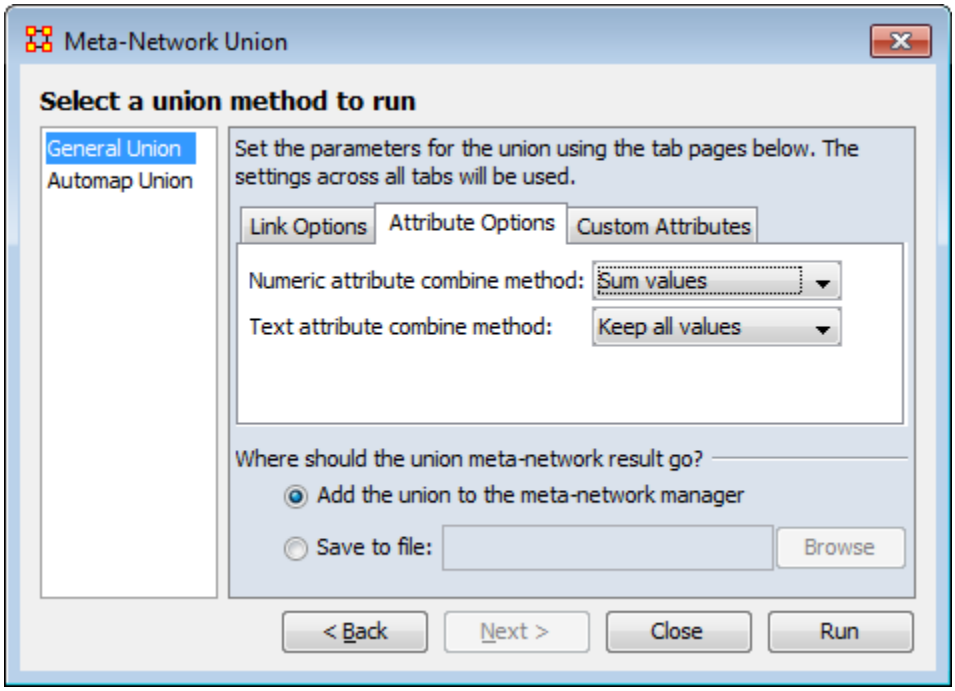
Place a check mark next to all Networks you want to place into the new Union Meta-Network.

I deselected all but the **agent and knowledge** Nodesets. I could have also deselected any of the Networks

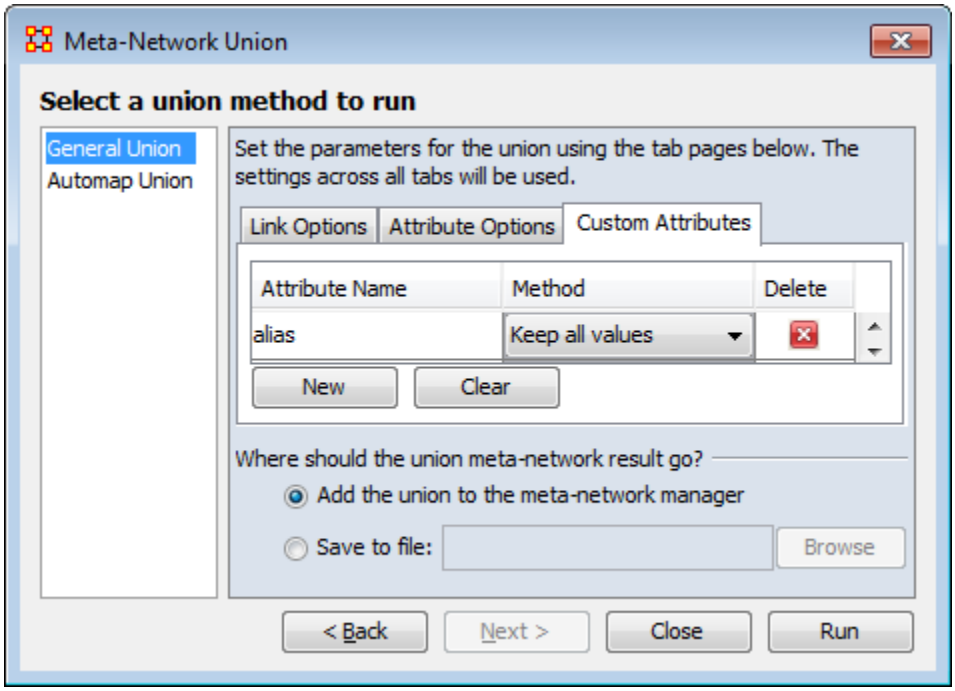
General Union



The **Link Options** allow you to select the meta data that will be ported into the union. You can also select whether to add the new union to the Meta-Network pane or save it out to a file. Choose to combine the link options with: **sum, average, maximum, minimum, and binary values**.

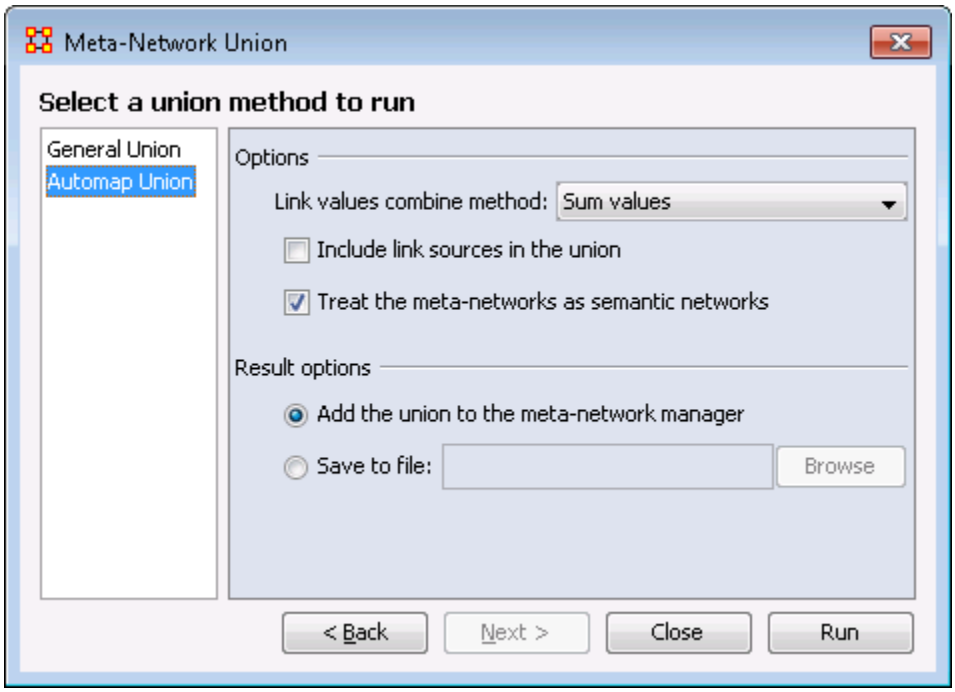


Select how to handle both numeric and text attributes. For numeric attributes chose from **keep first value, overwrite values, keep all values, sum values, average values, keep maximum value, keep minimm value**. For text attributes you can chose from **keep first value, overwrite values, or keep all values**.



For custom attributes select for each one how to transfer their values from **keep first value, overwrite values, keep all values, sum values, average values, keep maximum value, keep minimm value**.

Automap Union



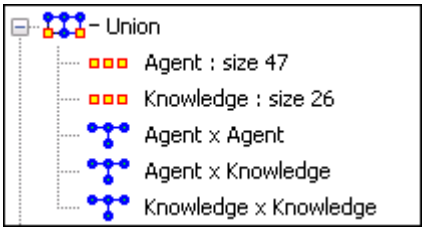
Select how to transfer your link values from the Automap file, **sum, average, maxmum, minimum, or binary** values.

You can also chose to add the union to the Meta-Network pane or save it to a file.

Examples

The Foundation-Union



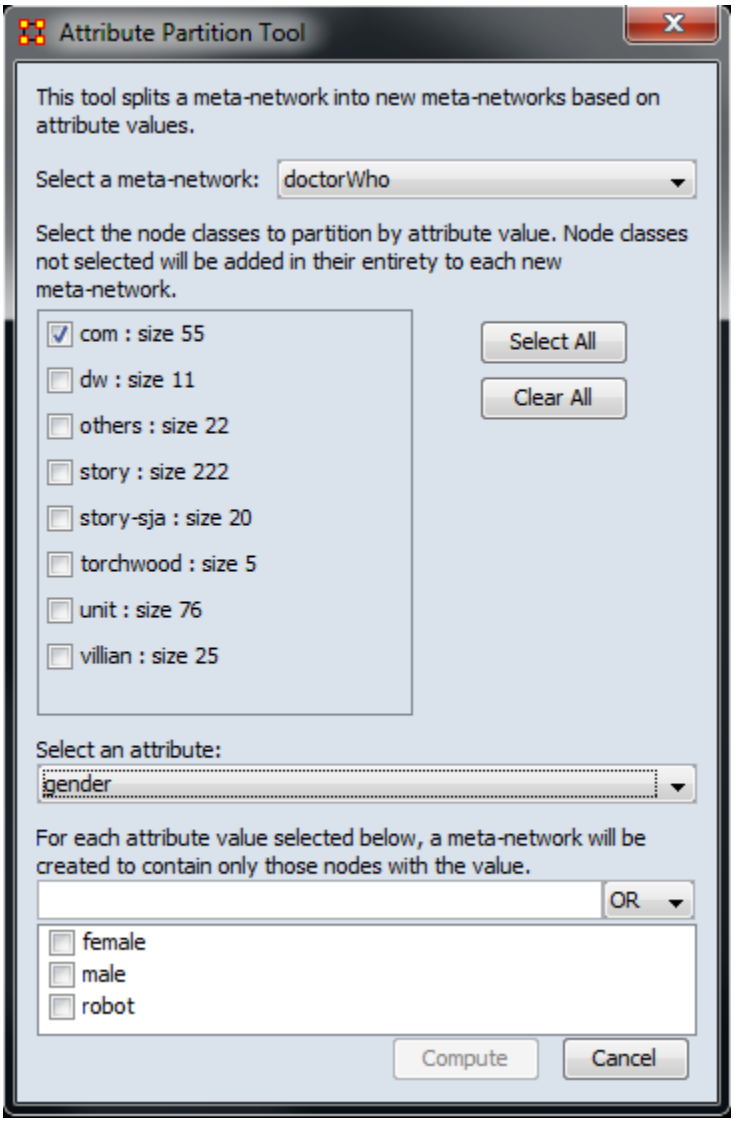


I started out with three Meta-Networks from the Foundation dataset. I selected all three, right-clicked on them and selected **union**. I deselected all the Nodesets except **agent and knowledge**. Then clicked the [**Compute**] button.

ORA combined these three Meta-Networks into one combining only the Nodesets and Networks that were selected.

Attribute Partition Tool

To create new **Meta-Networks** which are a subset of nodes use the **Attribute Partition**. Select a Nodeset(s), select the Attribute set, then select the individual attribute(s) to form a new Meta-Network.



There are four sections to the dialog box:

Select a Meta-Network: The dropdown menu lists all the currently open Meta-Networks

Select Nodeset(s): Place a checkmark in the box(es) of the Nodesets you want included.

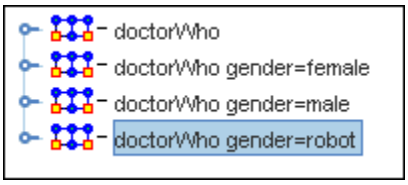
Select an attribute: This drop-down menu shows all the attribute(s) contained within the selected Nodeset(s). If you change the Nodeset(s) the choice of attribute(s) will be reflected in this dropdown.

Attribute Value: Place a checkmark in the box(es) of the attributes you want included in the new Meta-Networks. Each attribute check marked will create a separate Meta-Network.

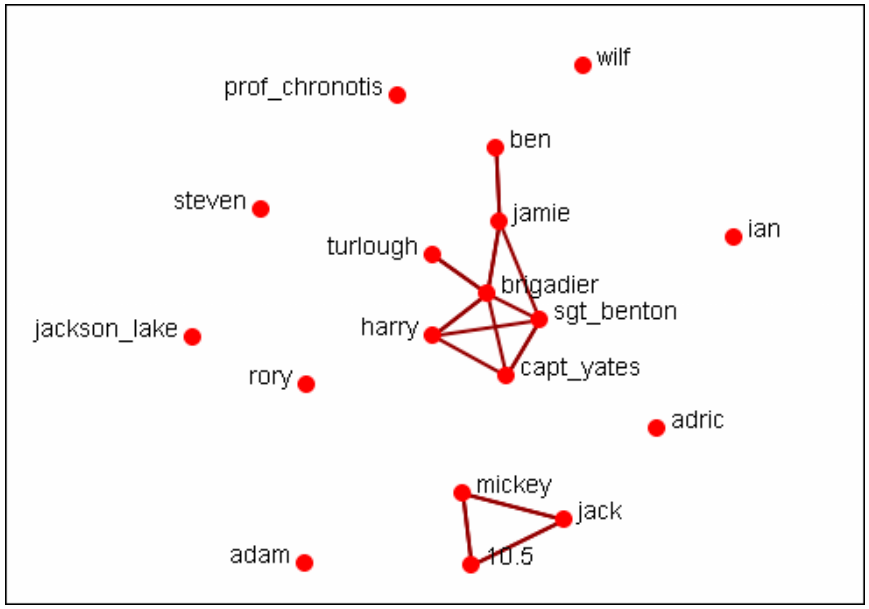
When you click the **[Compute]** button ORA will tell you how many new Meta-Networks were created and you will see them in pane 1 of the GUI.

Create New Meta-Network Example

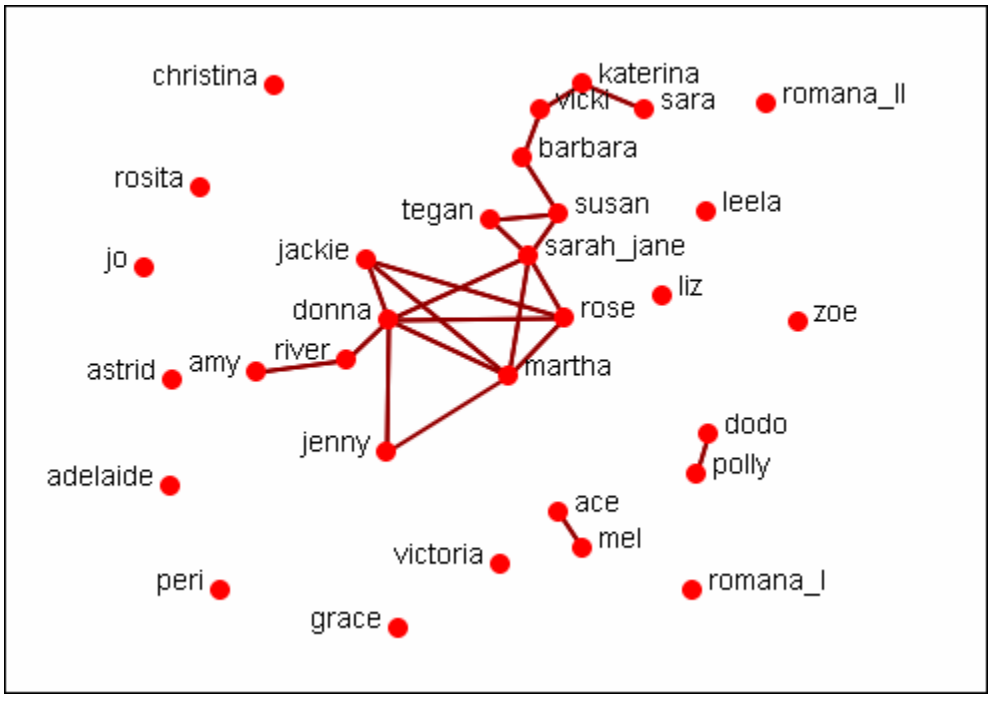
Using the Doctor Who Companion Network I selected the **gender** attribute. In the value section I placed check marks in all three boxes in order to create three new meta-networks. When I click the [**Compute**] button ORA creates three new meta-networks.



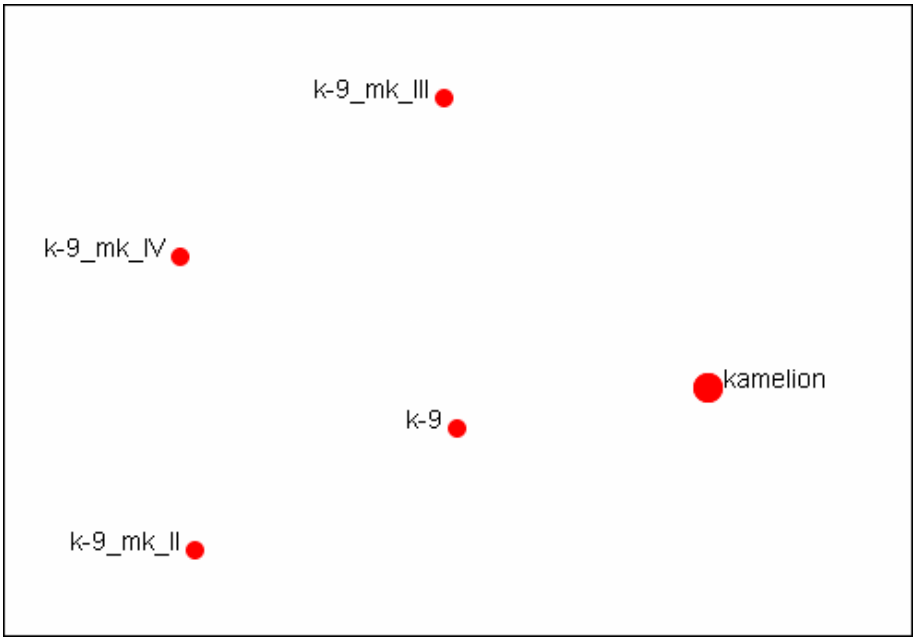
Males



Females



Robots



Randomize Existing Network

NOTE : This function only available in the full version.

Randomizing Links is commonly done to test a hypothesis about a given network. If after conducting experiments, there is no significant difference between a hypothesis and a random graph, the evidence supporting the hypothesis could be weak.

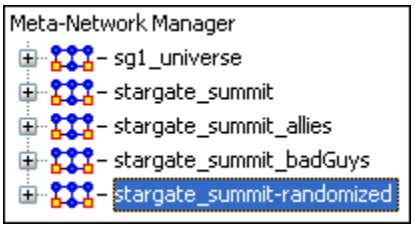
A Random Graph : is obtained by starting with a set of **n nodes** and adding Links between them at random. Different random network models produce different probability distributions on networks.

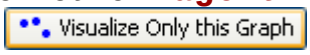
The theory of random networks studies typical properties of random networks, those that hold with high probability for networks drawn from a particular distribution. For example, we might ask for a given value of n and p what the probability is that G(n,p) is connected. In studying such questions, researchers often concentrate on the limit behavior of random networks-the values that various probabilities converge to as n grows very

large. **Percolation theory** characterizes the connectedness of random networks, especially infinitely large ones.

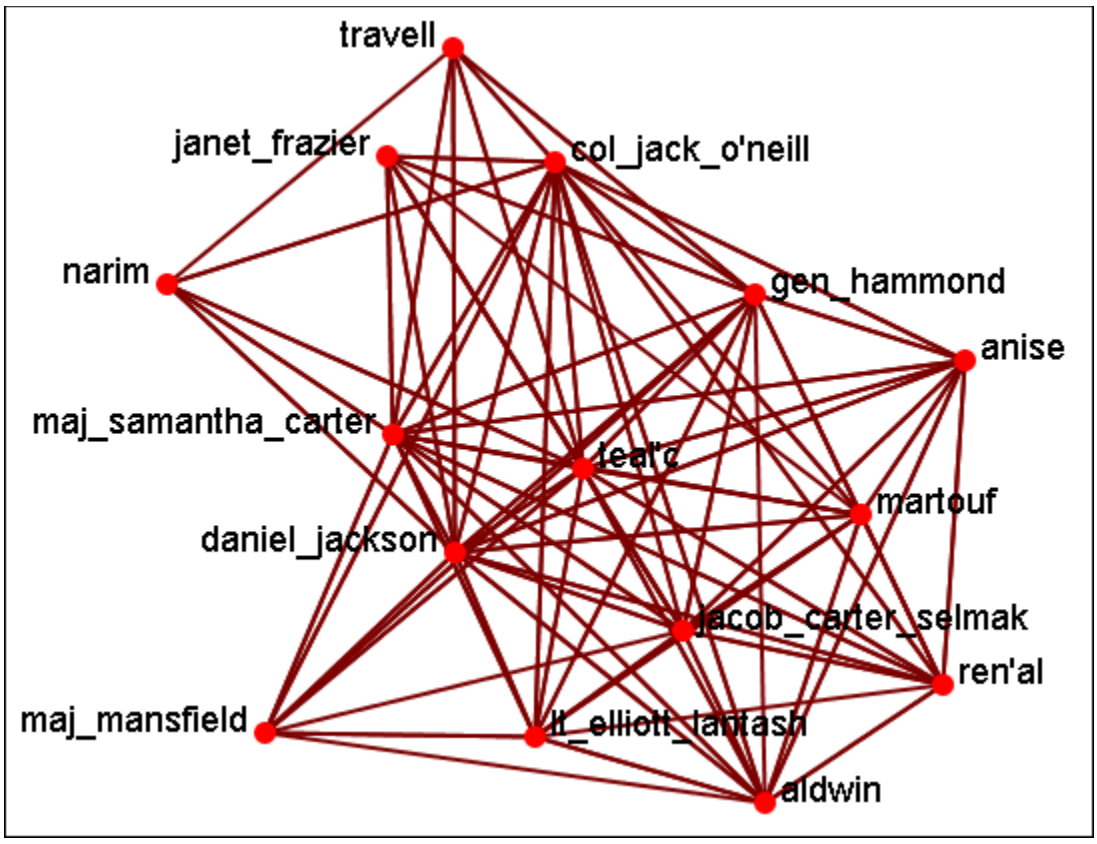
Random networks are widely used in the probabilistic method, where one tries to prove the existence of networks with certain properties. The existence of a property on a random network implies, via the famous **Szemerédi regularity lemma**, the existence of that property on almost all networks.

Creating a Random Graph : is a function which **randomizes** the Links in a Network. From the main menu select **Data Management > Randomize Links**. From the dialog box select from the drop-down menu. A new Meta-Network will appear in Pane 1 and it's name will denote it has been randomized.



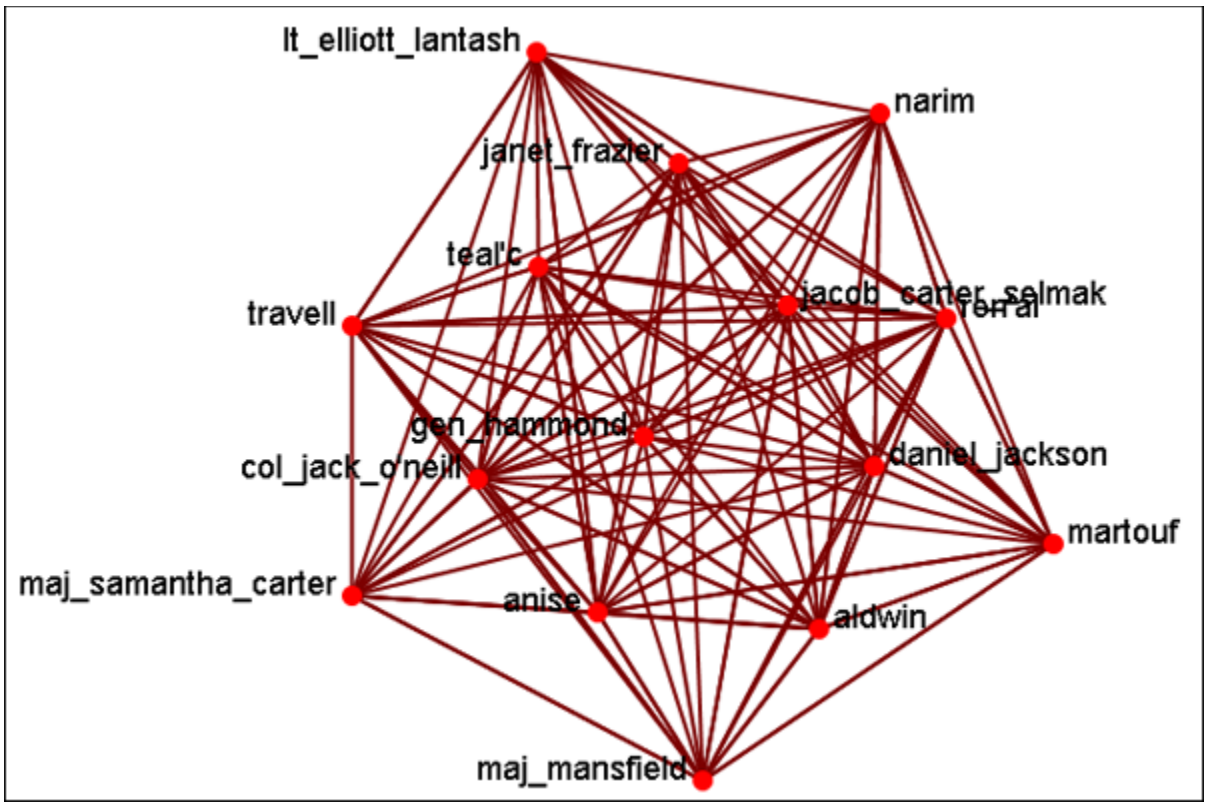
The original Meta-Network is selected and the Network **agent x agent** is chosen. From the **Info Tab** in the Editor the 

button is clicked. This displays the Network as it appears in the original Meta-Network.



Now select the newly created **randomized Network** and select the **agent x agent** Network. From the **Info Tab** in the Editor the Visualize Only this Graph button is clicked. This displays the Network as it appears in the randomized Meta-Network.

As shown in the visualizer the links have been randomized.


lt_elliott_lantash
narim
janet_frazier
teal'c
jacob_carter_selmak
travell
gen_hammond
daniel_jackson
col_jack_o'neill
martouf
maj_samantha_carter
anise
aldwin
maj_mansfield

Generate Network



Create New Meta-Network : Creates a new **blank** Meta-Network.

Influence Network Generator : Creates an Influence Network file for use in the external program Pythia.

NOTE : This function only available in the full version.

Command and Control Structure Generator : Creates Network files for use in the external program Caesar III.

NOTE : This function only available in the full version.



Create New Meta-Network In Visualizer : Creates a blank Meta-Network in the Visualizer which can be populated with Nodesets and Networks from scratch.

Create Stylized Network : Generates new Networks using various Mathematical formulas including Erdős-Rény, Core-Periphery, Scale-Free, Cellular, Lattice, and Small-World Networks

Create Expected Interaction Network : Predicts the expected interaction of a network given known tasks and other available network data. You can create: Expertise Correlation, Similarity Correlation, Distinctiveness Correlation, and Resemblance Correlation

Influence Network Generator

NOTE : This function only available in the full version.

Influence Network : is a hypotheses regarding **tasks, performance, event happening, and related events**. This functions covers how to generate an influence network from a social network using ORA and examines the probability of event happenings based on the state and influence of supporting nodes.

The **Influence Network Generator tool** in ORA takes a Meta-Network and outputs an influence network that is readable by another software program, **Pythia**. Pythia, a software tool developed by George Mason University, has the ability to reason about an influence network's structure extracted by ORA. Therefore, ORA and Pythia can work in conjunction to perform an influence network analysis. Essentially, ORA generates the network and Pythia tells you something about it.

ORA generates influence nets for Pythia from Meta-Networks. ORA can also read in a Pythia influence net and assess its structure. After ORA generates an influence network, the user then has to work with Pythia and a SME (subject matter expert) to get the probability distributions to make sense. The key advantage is by inferring the influence network from the meta-network via ORA you save a lot of the start-up time in performing an influence network analysis.

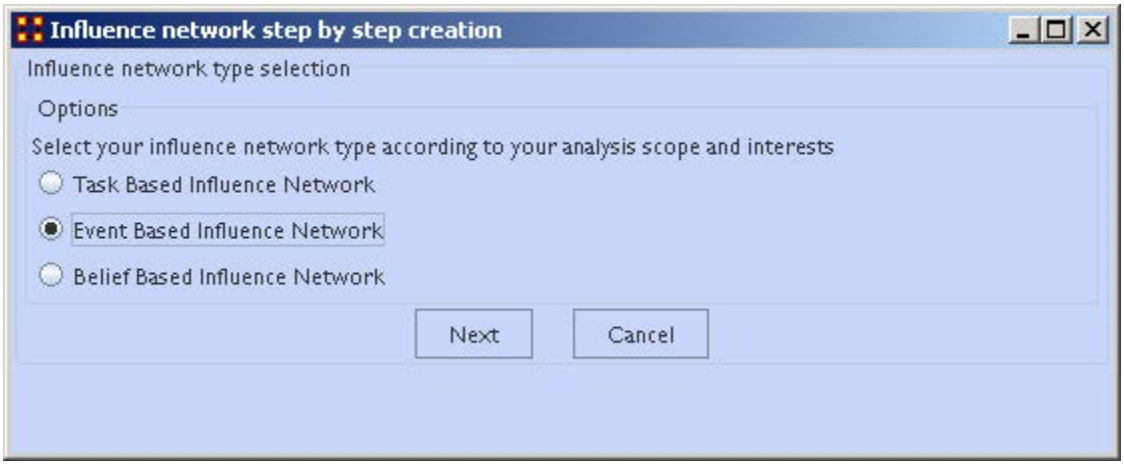
The ORA file generated by this function is directly loadable in Pythia. It is not a complete influence network and the user will need to make adjustments to the generated networks. It uses basic **ontological** interpretations and inferred baseline probabilities where the user specifies positive/negative probability.

We create an influence network based on: Extracting a task network which directs the target task to analyze. Then examine the complexity, importance, personnel/resource/expertise assignment of the tasks.

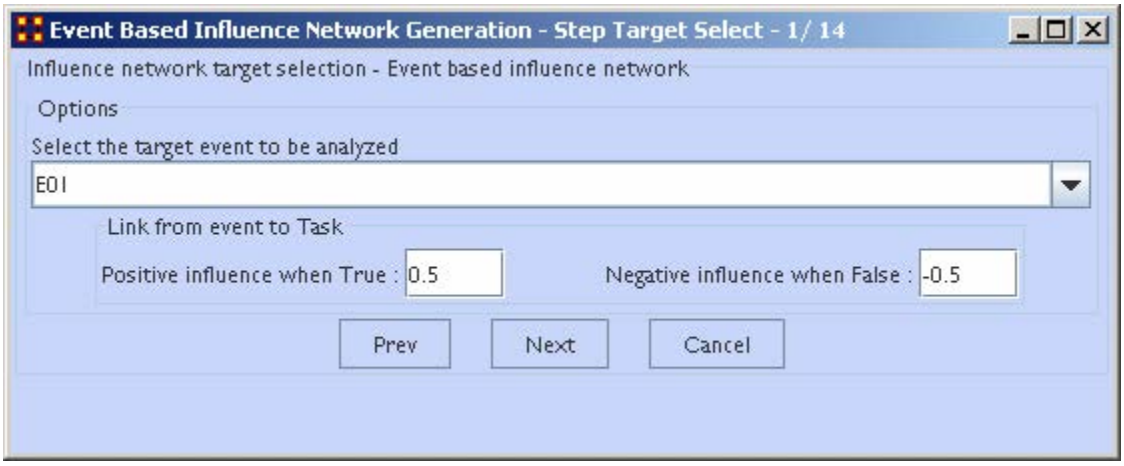
The examinations become influence network nodes containing ontological interpretation when: The task is done — the task is complex — the task is important — there are sufficient actors associated with the task — resources are available — expertise is available.

Then links are created as in the task network and background hypotheses nodes link to a task node.

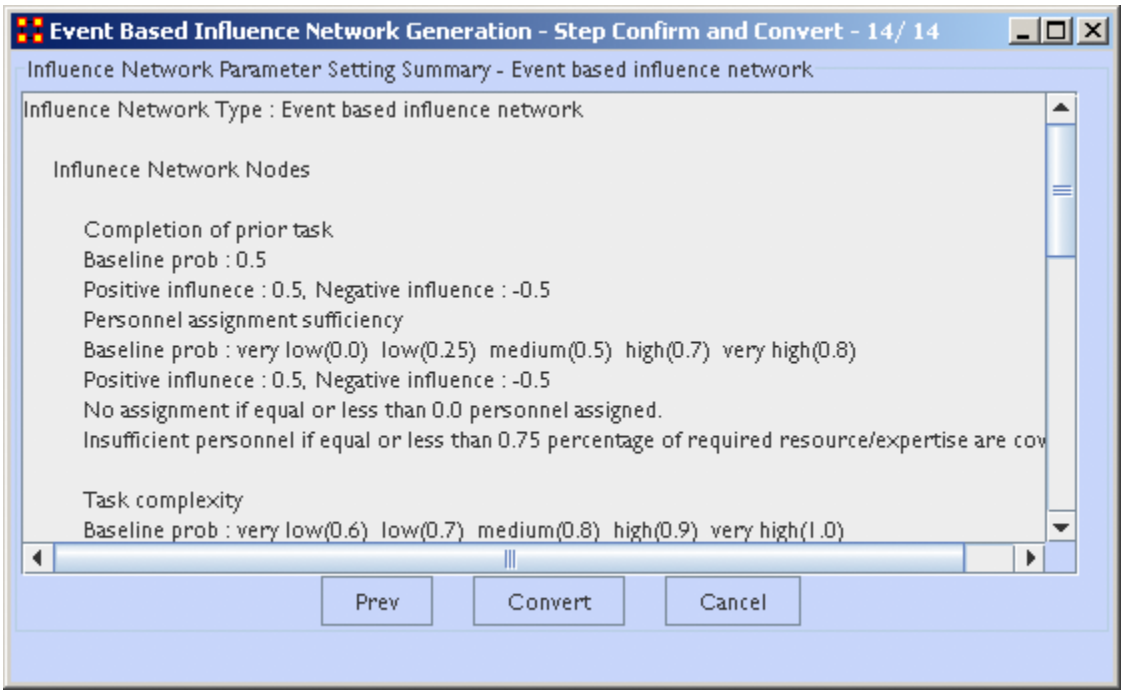
Running the Routine : From the main menu: **File > Influence Network Generator**. This brings up the **Influence network step by step creation** dialog box. There are three options: **Task Based, Event Based, and Belief Based**.



After selecting the creation type and clicking **[Next]** you will be presented with a number of steps depending on what information needs created.



Information on the thresholds you want and other data will be input in the dialog boxes until the final screen is reached.



When all the information is input a dialog box with the results will display. This is the final check before clicking the **[Convert]** button and saving the file.

Il-Chul Moon, *Destabilization of Adversarial Organizations with Strategic Interventions*, PhD Thesis, School of Computer Science, Carnegie Mellon University

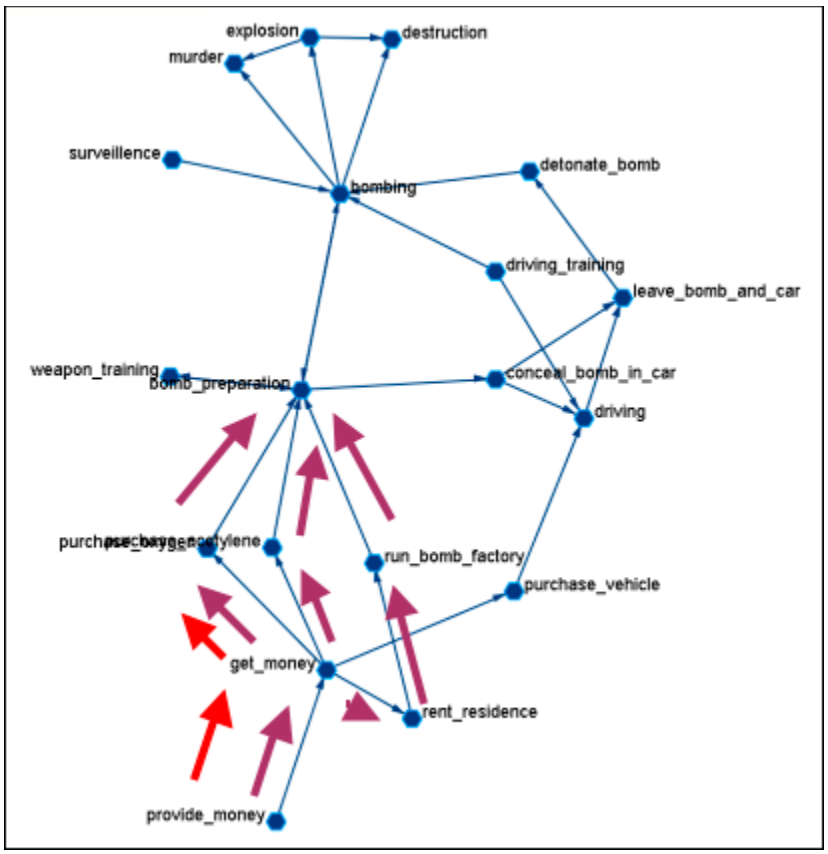


Extracting a Task Network for the Influence Network Generator

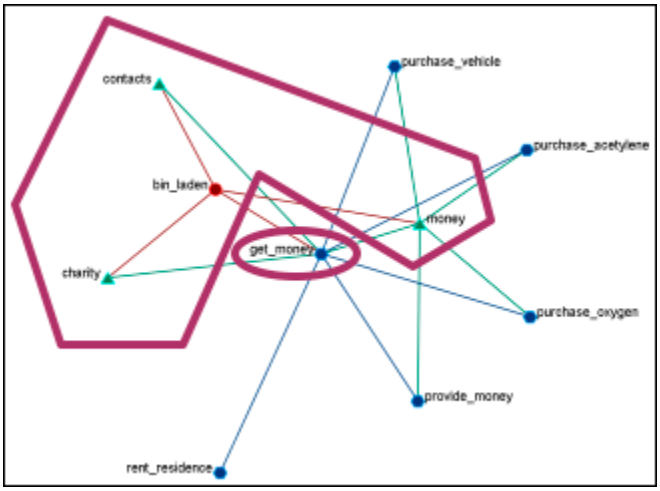
NOTE : This function only available in the full version.

What follows are procedures to extract a Task Network for the Influence Network Generator.

In a Meta-Network there is an *event-to-event* network and a *task-to-task* network. Choose one task to analyze.

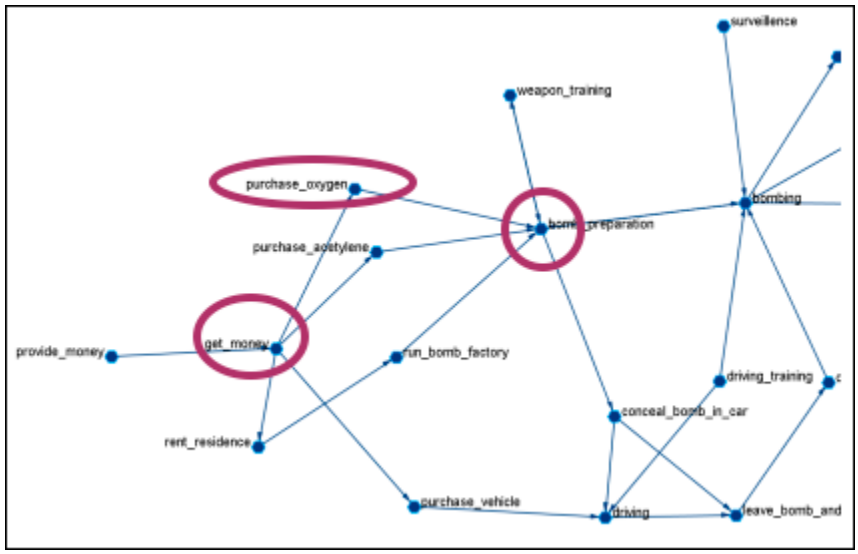


Here we look at **bomb preparation**. Find the tasks that need completed to accomplish the objective. Then trace from **provide_money**, **get_money**, **purchase_oxygen**.



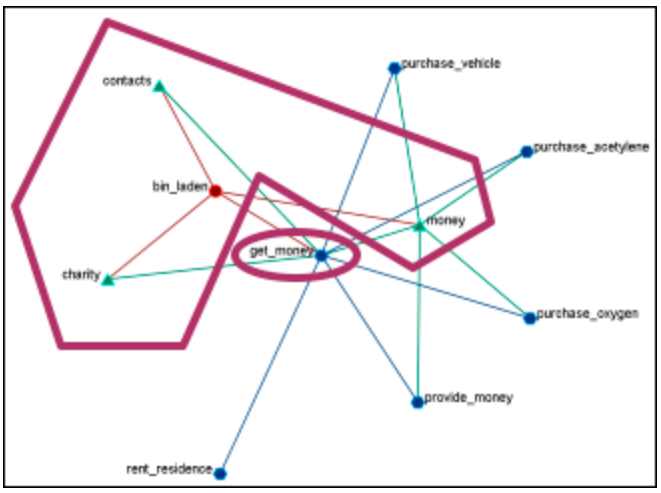
The complexity of the task depends on three items. **Resources / Expertise required and number of person required**.

- **Very Low (default baseline=1.0):** 0 resource/expertise required / 1 person required.
- **Low (default baseline=0.9):** 1 resource/expertise required / Less than 3 persons required.
- **Medium (default baseline=0.8):** Less than 4 resource/expertise required / Less than 4 persons required.
- **High (default baseline=0.7):** Less than 8 resource/expertise required / Less than 7 persons required.
- **Very High (default baseline=0.6):** More than 7 resource/expertise required / More than 6 persons required.



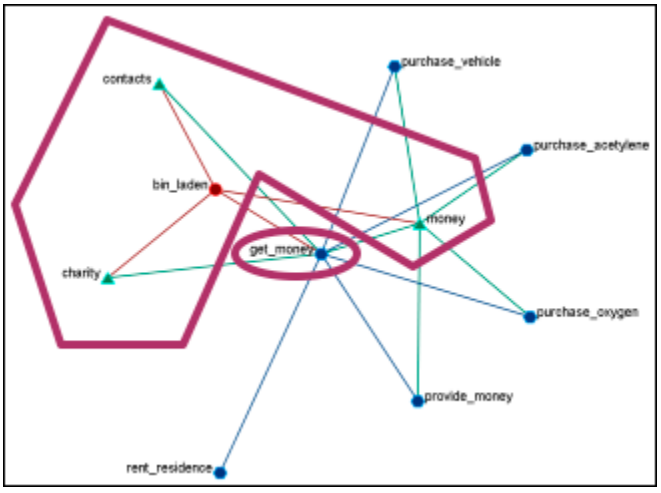
The importance of the task is determined by using **standardized degree centrality** and **betweenness** (ranging (0~1):

- **Very Low (default baseline=0.4):** Not connected to other tasks
- **Low (0.5):** Low out-degree density and low betweenness in task network
- **Medium (0.6):** Medium out-degree density and low betweenness in task network
- **High (0.7):** High out-degree density or medium betweenness in task network
- **Very High (0.8):** High out-degree density in task network



The actor assignment of the task is determined by sufficient actors, which are associated with the task.

- **No personnel (default baseline=0):** No assigned actors
- **Insufficient (0.25):** Only 75% of resources/expertise are covered by assigned actors.
- **Almost sufficient (0.5):** More than 75% of resources/expertise are covered by the assigned actors.
- **Sufficient (0.7):** At most one person associated with each resource and each expertise connected to the task.
- **More than sufficient (0.8):** More than one person associated with some resources and expertise connected to the task.



Resource / Expertise availability

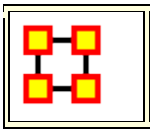
Finds if **Expertise and Resource** are directly accessible. The availability is determined as follows:

- **Redundantly available/accessible baseline probability=0.75):** More than one person with the expertise associated with the task.
- **Available/accessible (0.6):** One person with the expertise/resource is associated with the task.
- **Unavailable/unaccessible (0.25):** No person with the expertise/resource is associated with the task.

Learn more...

Il-Chul Moon, Kathleen M. Carley, and Alexander H. Levis, Inferring and Assessing Informal Organizational Structures from an Observed Dynamic Network of an Organization, Management Science, 2008, Submitted and under review

Il-Chul Moon, Kathleen M. Carley and Alexander H. Levis, Vulnerability Assessment on Adversarial Organization: Unifying Command and Control Structure Analysis and Social Network Analysis, SIAM International Conference on Data Mining, Workshop on Link Analysis, Counter-terrorism and Security, Atlanta, Georgia, Apr. 26, 2008



Pythia

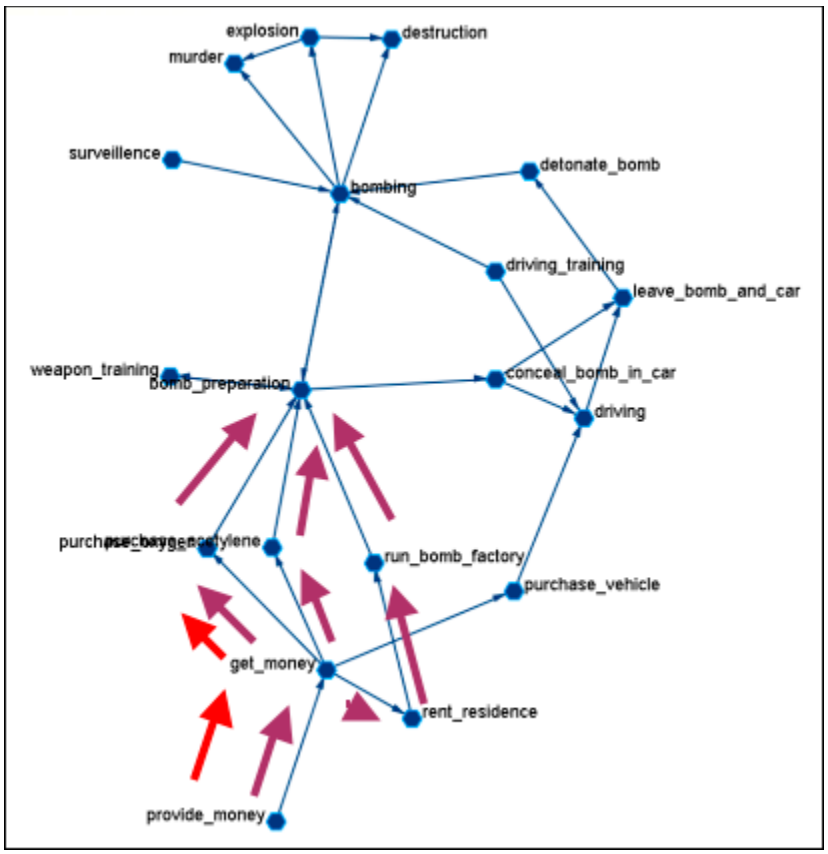
NOTE : This function only available in the full version.

Pythia is a timed influence net application. Conversely, data from Pythia can be loaded into ORA using the **Data Import Wizard**.

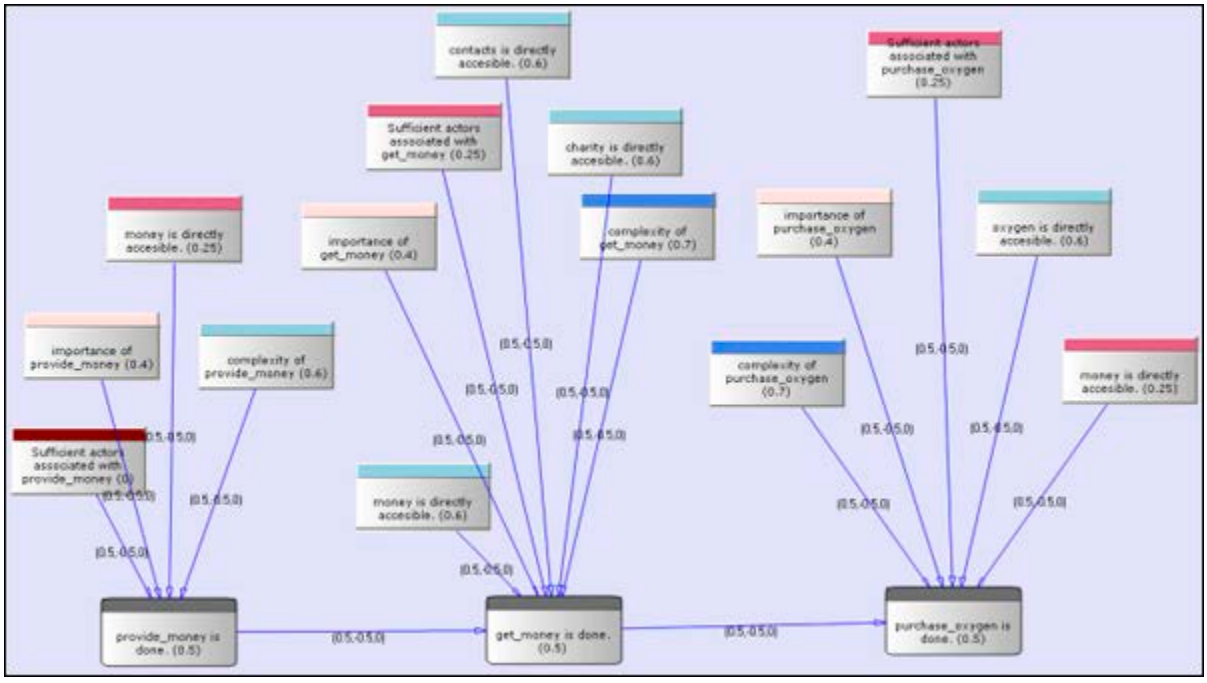
In conjunction with the Pythia application from George Mason University, data from ORA can be loaded into Pythia to create organizational displays.

What follows is a brief example of creating an organizational display using ORA with Pythia.

Start from an ORA **Task Network** (shown below)



The data can be loaded into **Pythia** to create an organizational display.



Reference at the George Mason University web site:
http://sysarch.gmu.edu/main/software/

Contact George Mason at the above URL for instructions on downloading Pythia and additional instructions on how to use the tool.

Learn more...

Il-Chul Moon, Destabilization of Adversarial Organizations with Strategic Interventions, PhD Thesis, School of Computer Science, Carnegie Mellon University

Command and Control Structure Generator

NOTE : This function only available in the full version.

C2 Structure and Meta-Network

A Meta-network is a representation of a complex adaptive system. This system it has agents, expertise, resources and tasks. And inherent in this data are Meta-networks that contain the C2 structure of an organization, which are the links of a social network among commanders represented in the following ways:

- Command chains
- Information sharing relations
- Result/response sharing relations

However, meta-networks may only have one commander-to-commander network without classifying the nature of links. An analyst oftentimes needs a method to infer the nature of relations among commanders based on a given meta-network. That is where this tool can help. ORA uses the task assignment and communication directions to infer the nature of a link.

C2 structure in CAESAR III : Design View and Analysis View can be generated from a series of matrices describing the communications among decision makers (agents). The goal should be producing the matrices out of a social network. The analysis view has cognition aspects The nature of a link is determined by the timing of communication during the decision making process.

Meta-Network : Network among people (, knowledge, resources, tasks, etc). Data for statistical analysis, not exactly an analysis tool. Reveal the organizational structure, influence propagation, command and control structure, etc. Widely used in organizational science, counter-terrorism, structure reformation, etc.

C2 structure extraction in ORA : ORA provides a function, Command and Control Structure Generator. Automatic generation of C2 structure based on a target task and a social network among decision makers. Generated influence network is directly loadable in CAESAR III. It is not a complete C2 structure but a reasonable inference (or approximation).

C2 Structure Generation Procedure

Determine a target task to analyze. Extract the task network of the target task. Extract the related (assigned) agents of the task network. The other agents are aggregated and represented as the outside world (IN and OUT). Regard the agent-to-agent network as a information sharing network. Determine the network level based on the link directions and network topology. Then, extract a command chain from links bridging different network level. Determine the result sharing requirement based on the task network (i.e. the link direction between the two tasks indicate the result sharing requirement) Then, create a result sharing network based on the requirements.



Extracting a Task Network for the Command and Control

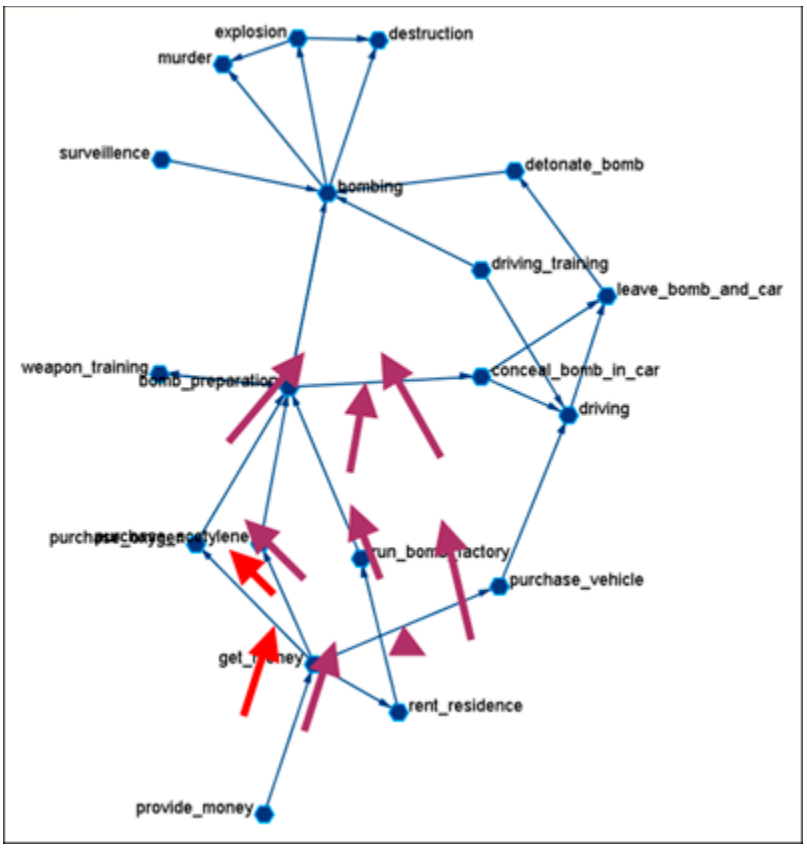
NOTE : This function only available in the full version.

What follows are procedures and an overview of extracting a *task network* for command and control analysis using ORA in conjunction with Caesar III, an external software tool for task network analysis.

In a Meta-Network, there are *event-to-event* networks and *task-to-task* networks contained in most data sets. We select one task to analyze and use ORA's command and control tool to discover the steps needed to complete this task from beginning to completion.

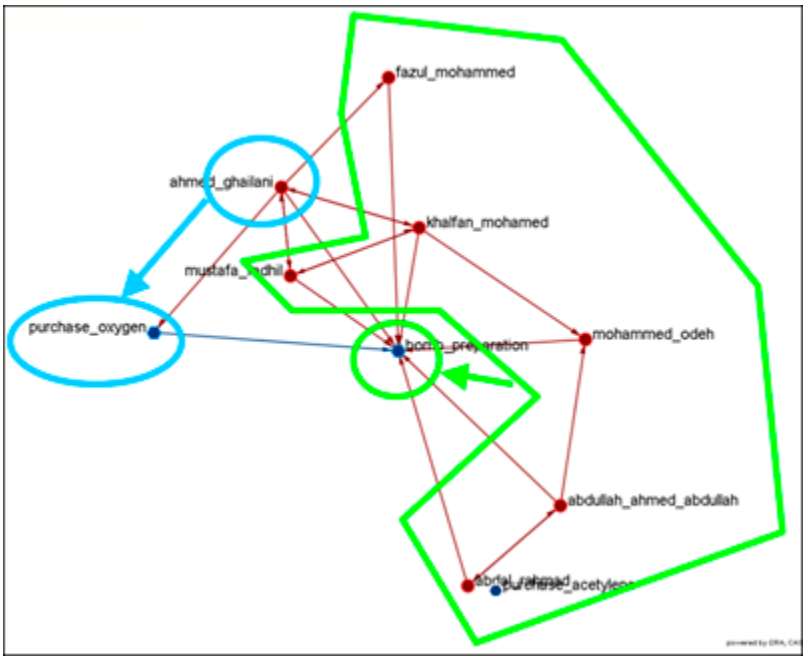
In the images below, we are extracting a task network needed for the bomb_preparation task node.

The idea is to find how tasks should be completed to accomplish the objective, bomb_preparation *(e.g., find the trace to a purchase_oxygen task. Provide_money —> get_money —> purchase_oxygen).*



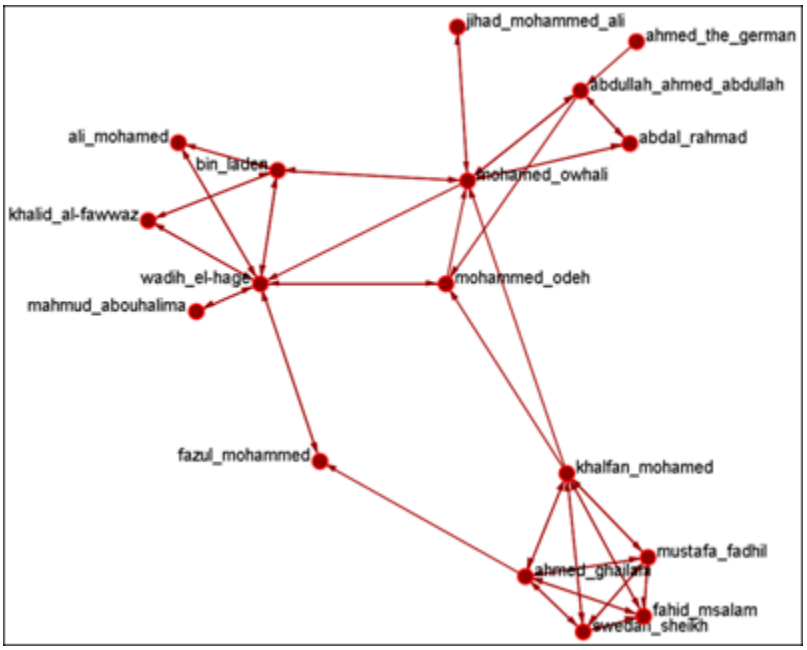
Assigned Agents

Identify the task network. Find all the assigned agents. Agents directly linked to a task in the task network.



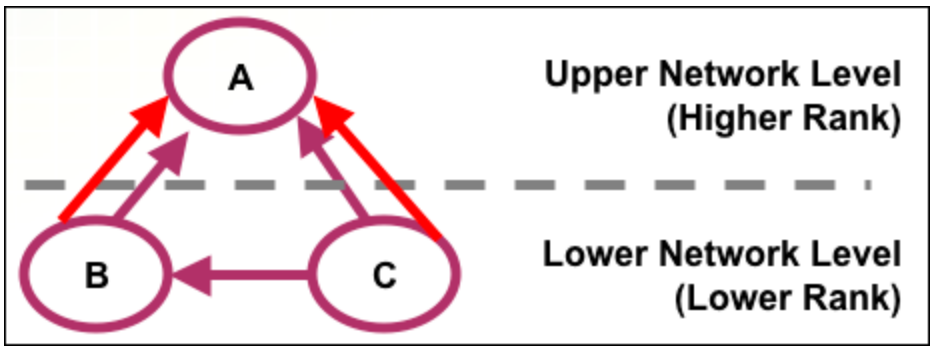
Approximated Information Sharing Network

Just the *agent-to-agent* network in a meta-network.

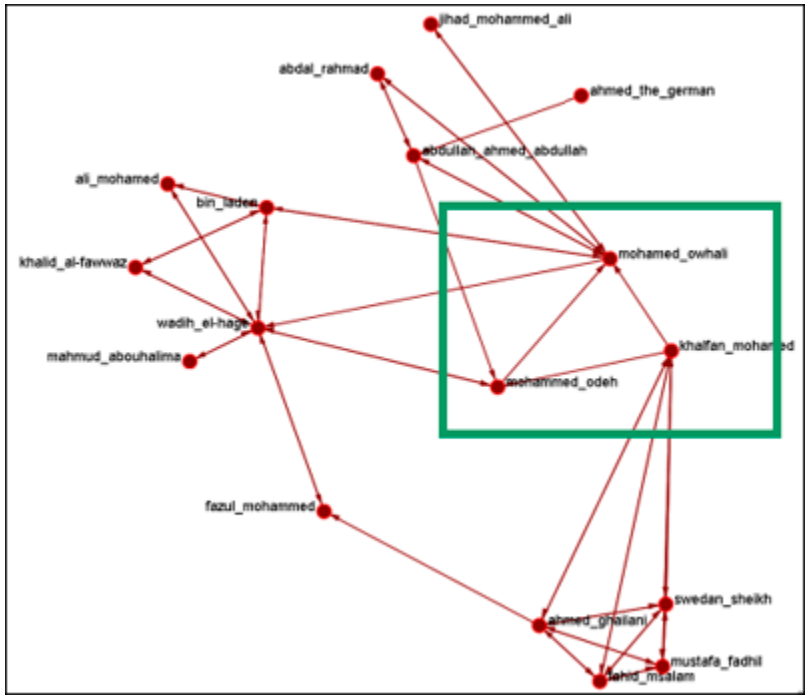


Inferred Command Chain

Determine the network level. Find the inferred hierarchy of the organization. Find the command chain from the hierarchy.

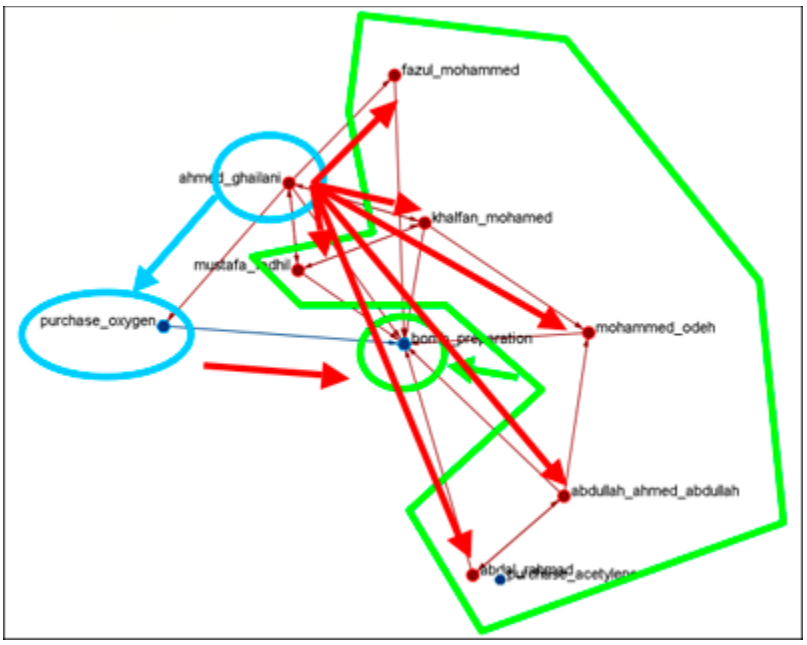


Red arrows are command chains. Purple arrows are social network links.



Inferred Result Sharing Network

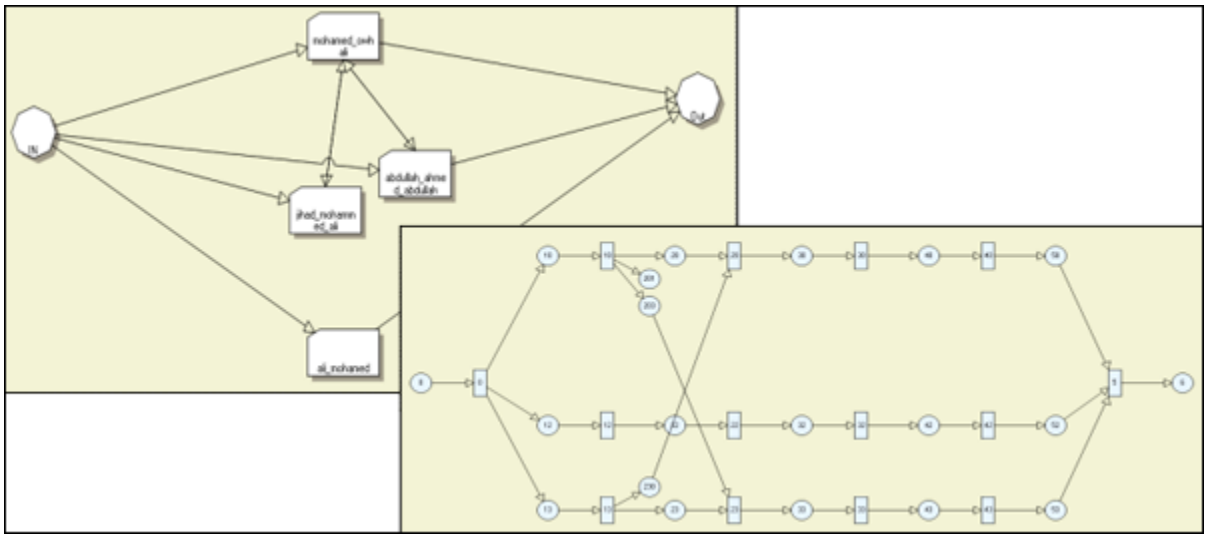
The task network defines the task prerequisites. Then, the result of a task should be informed to the agents doing the next task. Create a result sharing network by using the above inference rule.



Ahmed_ghallani should inform the result of purchase_oxygen to the agents doing bomb_preparation. Purchase_oxygen is a prerequisite of bomb_preparation.

Visualization by CAESAR III

Generated by ORA. Target task : surveillance. Design view and analysis view in CAESAR III.



Learn more...

Il-Chul Moon, Kathleen M. Carley, and Lee W. Wagenhals, Estimating Task Success Likelihood by an Influence Network Generated from an Organizational Structure, Organization Science, 2008, Submitted and under review

Il-Chul Moon, Eunice J. Kim and Kathleen M. Carley, Automated Influence Network Generation and the Node Parameter Sensitivity Analysis, International Command and Control Research Technology Symposium (ICCRTS'08, DOD CCRP conference), Bellevue, WA, Jun 17-19, 2008



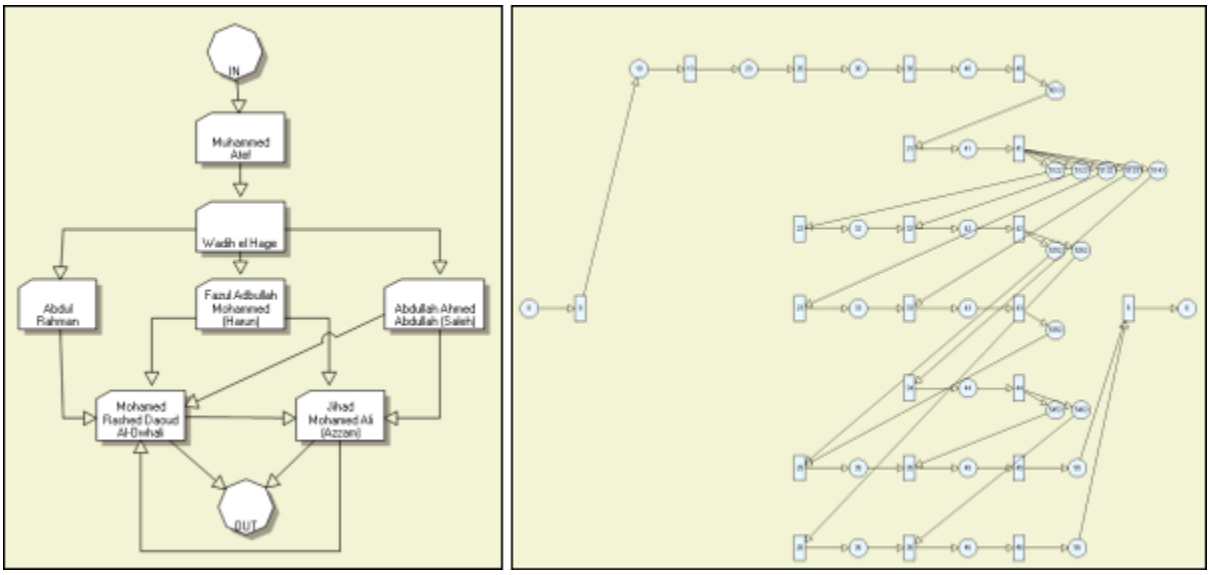
Caesar III

NOTE : This function only available in the full version.

Caesar III is a software application for the design of decision making organizations at the operational and tactical levels; it takes into consideration cultural differences in coalitions and of adversaries. What follows in overview of how Caesar III and ORA can work together.

ORA can import data from Caesar III. See the Data Import Wizard for detailed instructions.

The **Design View and Analysis View** can be generated from a series of matrices describing the communications among decision makers (agents). The goal should be producing the matrices out of a social network. The analysis view has cognition aspects. The nature of a link is determined by the timing of communication during the decision making process.



Meta-Networks are generated by ORA. Then through **Caesar III**'s Design and Analysis Views their structure is analyzed.

Reference at the George Mason University web site:
http://sysarch.gmu.edu/main/software/

Contact George Mason University at the above URL for instruction on downloading Caesar III data.

New Meta-Network in Visualizer

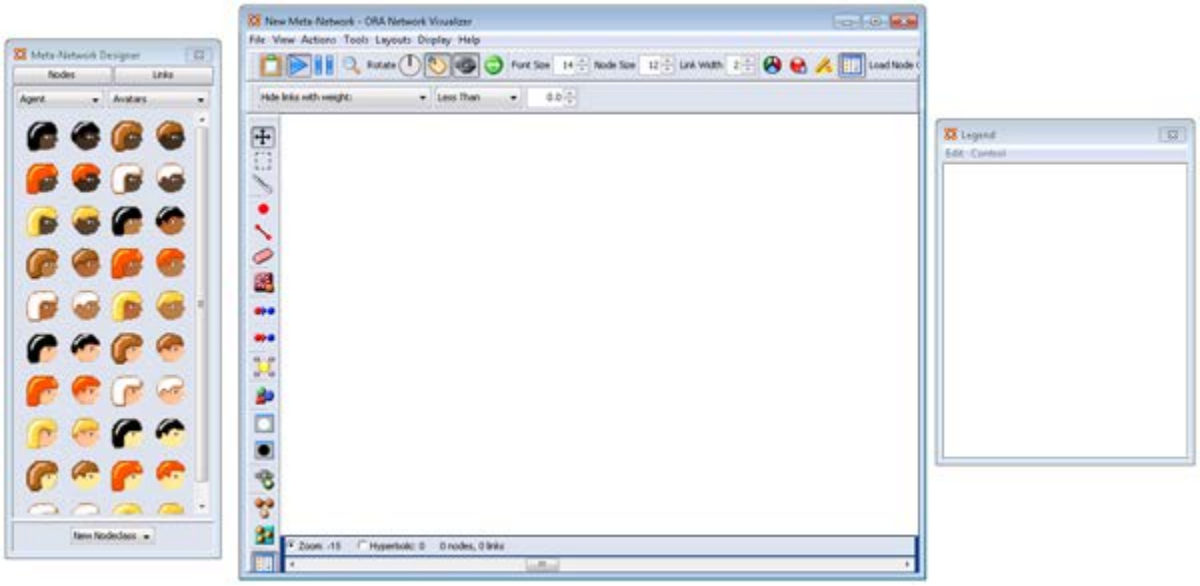
From the main menu select **Generate Networks > Create New Meta-Network in Visualizer**. This does two things:

1) It creates an empty Meta-Network in the Meta-Network Manager Pane.

2) It brings up an empty Visualizer window to create a Meta-Network.

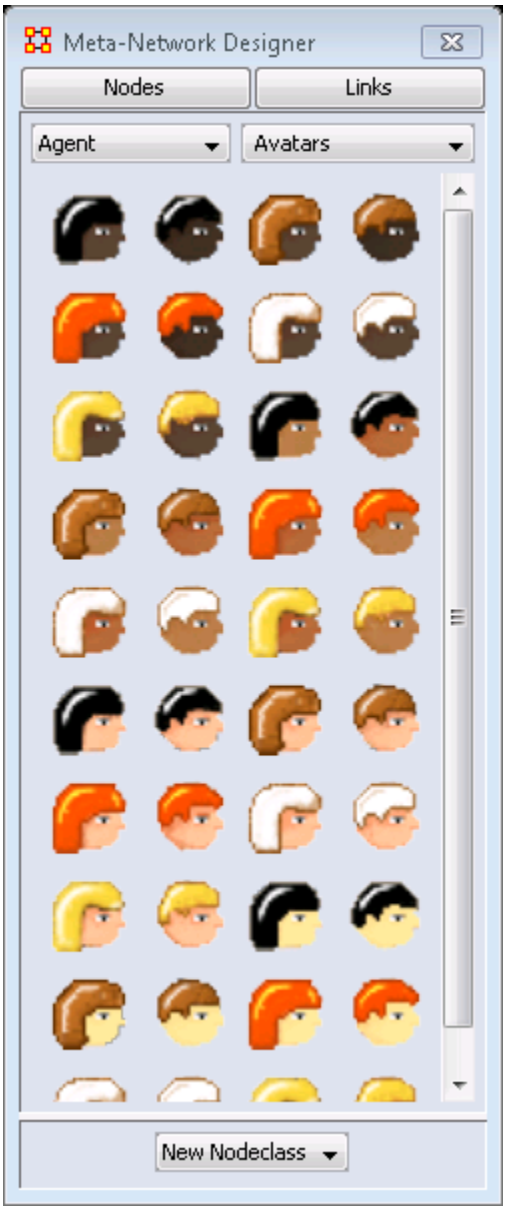
NOTE : The Main Interface and the Visualizer are linked. What you do in one is reflected in the other.

The Windows



Your work area contains, from left to right, **Meta-Network Designer, Visualizer window, and Legend**.

The Meta-Network Designer Window



The Designer box contains four areas.

The **Nodes Button :** Displays the graphic representation of the selected Nodeset

The **Links Button :** Allows you to change the link weight.

The **Agents Drop Down menu :** Used to select a Nodeset for placing a new Node.

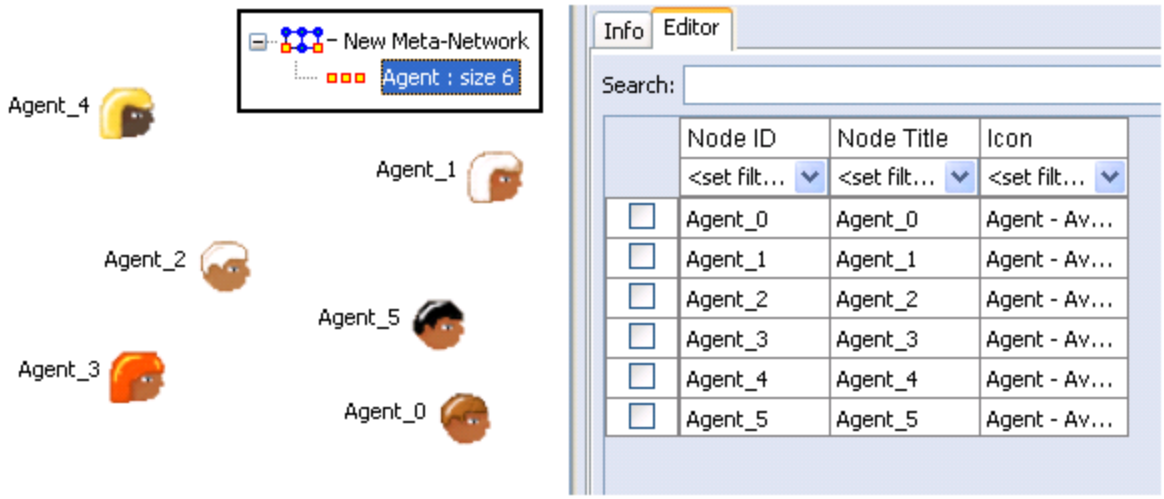
The **Avatars Drop Down menu :**

The **Icon Display Area :** Shows the current group of icons available.

The **New Nodeset Button :** This menu starts out empty until you create u.a Nodeset. Once Nodesets are created they will appear in this men

Creating New Nodes

To create a new node select a Nodeset, select a link weight, then click, and hold, an icon and drag it into the Visualizer window.



Creating New Links



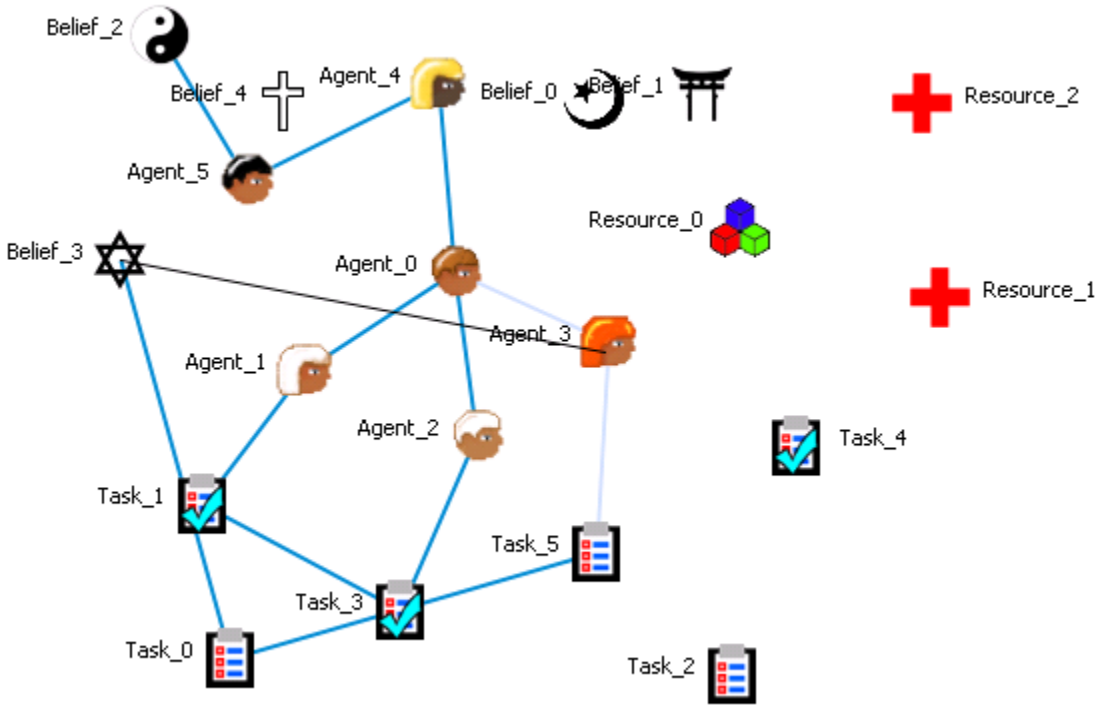
In the Designer window click the [**Links**] button. This brings up buttons to set the weight of new links.

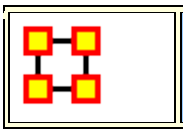
The drop down at the bottom defaults to **Auto-Find and Create Networks**.

If you place a check mark in the **Auto-Create Bidirectional Links** when you create a link. (e.g. You create a link from Node A to Node B) ORA will automatically create a complementary link (e.g. a link from Node B to Node A will be added).

To create links, click and hold the left mouse button on a node. Then drag the cursor to another node and release the button.

Final Network





Create Stylized Networks

Stylized Networks are models built upon common network structures evident in many real world environments.

Erdős-Rényi Network : A model for generating random graphs by setting an Link between each pair of nodes with equal probability, independently of other Links.

Core-Periphery Network : The core-periphery structure of the network has a dense central core of key agents and a large periphery of marginal agents.

Scale-Free Network : Some nodes act as **highly connected hubs (high-degree)**, although most nodes are of low degree. Scale-free networks' structure and dynamics are independent of the system's size N, the number of nodes the system has. In other words, a network that is scale-free will have the same properties no matter what the number of its entities is.

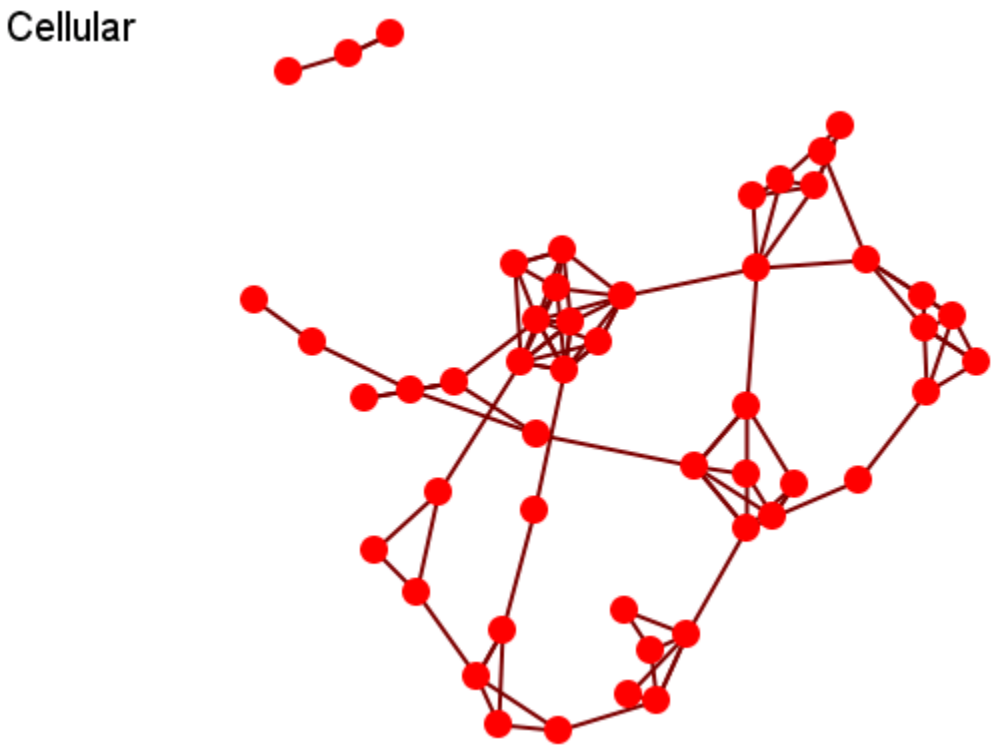
Cellular Network : Highly connected cells connected by a few links.

Lattice Network : A Lattice Network is a large-world network.

Small-World Network : Where most nodes are **NOT** neighbors but can be reached from every other node by a small number of hops or steps.

Fixed Degree-Distribution Network : A random graph is constructed by specifying as input: **(a)** the number of nodes in the network, and **(b)** the number of link for each node. The graph is random according to the input, however it should be noted that not all degree sequences are illogical so this algorithm may produce an empty graph as a result. **read more...**

Cellular Network



General

A small number of tight clusters with few links between clusters.

Properties

Large distances.

High local structure [clustering].

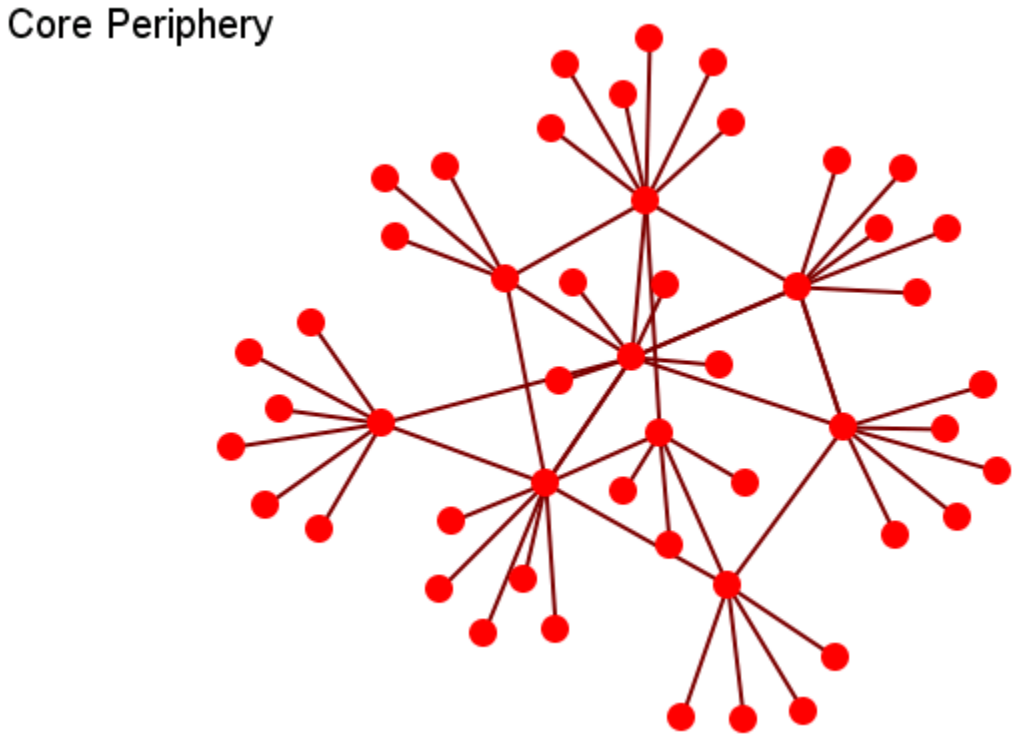
Dialog Box

Number of Cells : How many groups [clusters] for the network.

Inner Density : How dense should the network within each cell be?

Outer Density : How dense should the connections between cells be?

Core Periphery



The core-periphery structure is an ideal typical pattern that divides both the rows and the columns into two classes. One of the blocks on the main diagonal (the core) is a high-density block; the other block on the main diagonal (the periphery) is a low-density block. The core-periphery model is indifferent to the density of ties in the off-diagonal blocks.

When we apply the core-periphery model to actor-by-actor data (Core/Periphery), the model seeks to identify a set of actors who have high density of links among themselves (the core) by sharing many events in common, and another set of actors who have very low density of ties among themselves (the periphery) by having few events in common. Actors in the core are able to coordinate their actions, those in the periphery are not. As a consequence, actors in the core are at a structural advantage in exchange relations with actors in the periphery.

There are Two kinds of nodes

Core of interconnected nodes.

Periphery of pendants with single connection to Core.

Properties

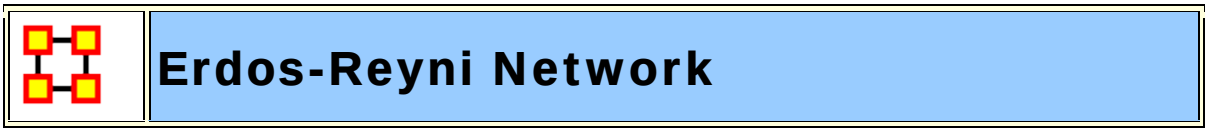
Short distances

Some local structure (core vs non-core)

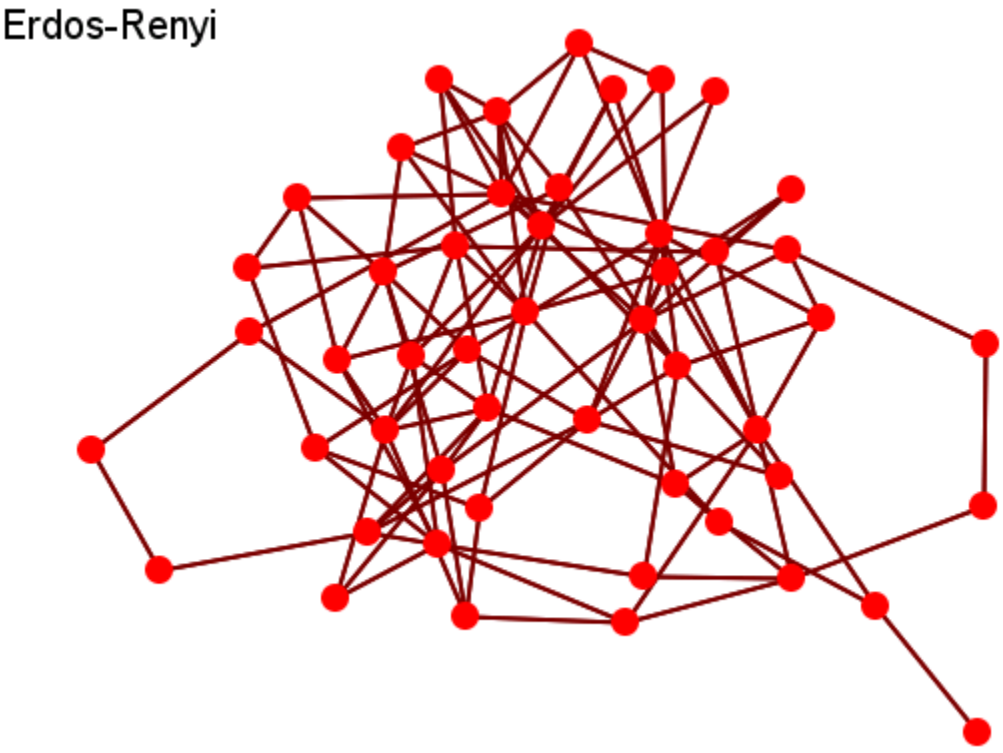
Dialog Box

Proportion of core nodes :

Density of core nodes : How dense should the within-core network be?



Erdos-Reyni Network



General

Networks are purely random

They are the most commonly form studied.

Properties

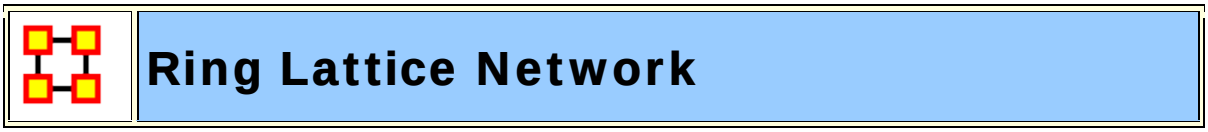
Short distances.

No local structure (clustering).

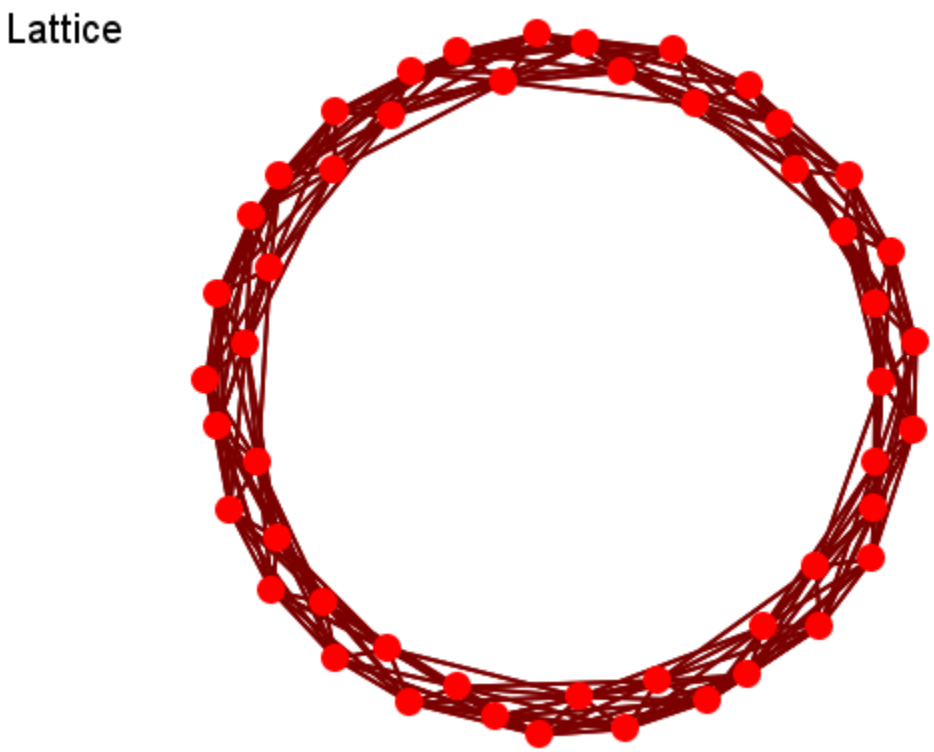
Very different than real-world networks.

Dialog Box

Input : Approximate density of resulting network.



Ring Lattice Network



Nodes are placed at the integer coordinate points of the **n-dimensional** Euclidean space and each node connects to nodes which are exactly one unit away from it. **(i.e. if the lattice is two dimensional and the length of the lattice is 2 along the first and 2 along the second dimension, then it has 4 nodes and they're placed at coordinates (1,1), (1,2), (2,1), (2,2))** The two nodes are connected if the difference of one of their coordinates is one or minus one and all their other coordinates are exactly the same.

General

Nodes laid out in a circle and connected to their K closest neighbors.

Properties

High clustering.

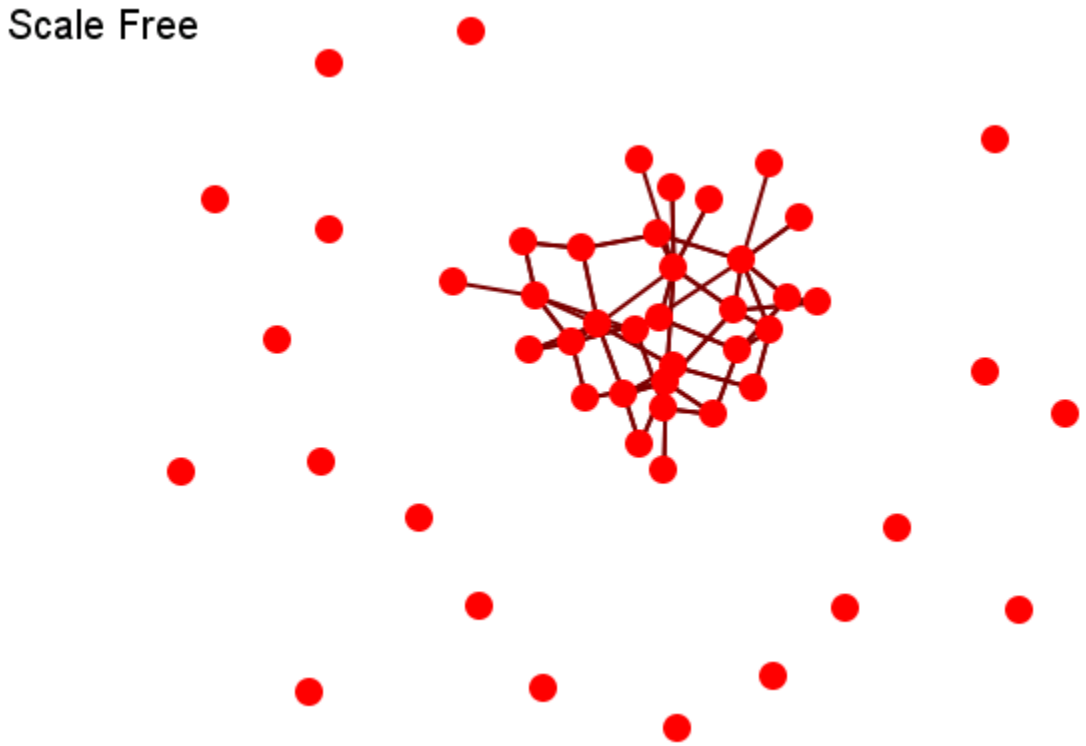
High average path length

Dialog Box

Number of agents : Network size.

Number of neighbors : Number of neighbors each node is connected to

Scale Free Network



Their most distinguishing characteristic is that their degree distribution follows a power law relationship, \mathbf{P(k) \sim k^{- \gamma}},

$$\mathbf{P(k)} \sim \mathbf{k^{-\gamma}},$$

Where the probability P(k) that a node in the network connects with k other nodes was roughly proportional to $k^{-\gamma}$, and this function gave a roughly good fit to their observed data. The coefficient γ may vary approximately from 2 to 3 for most real networks.

Process

New nodes more likely to connect to existing nodes with high degree.

Properties

Short Distances.

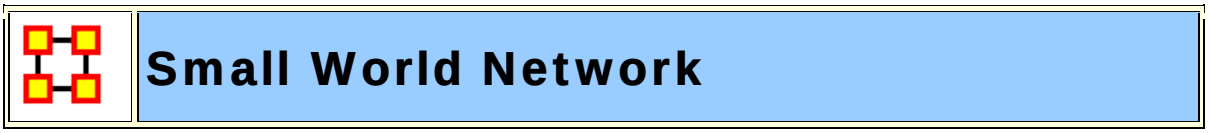
No local structure.

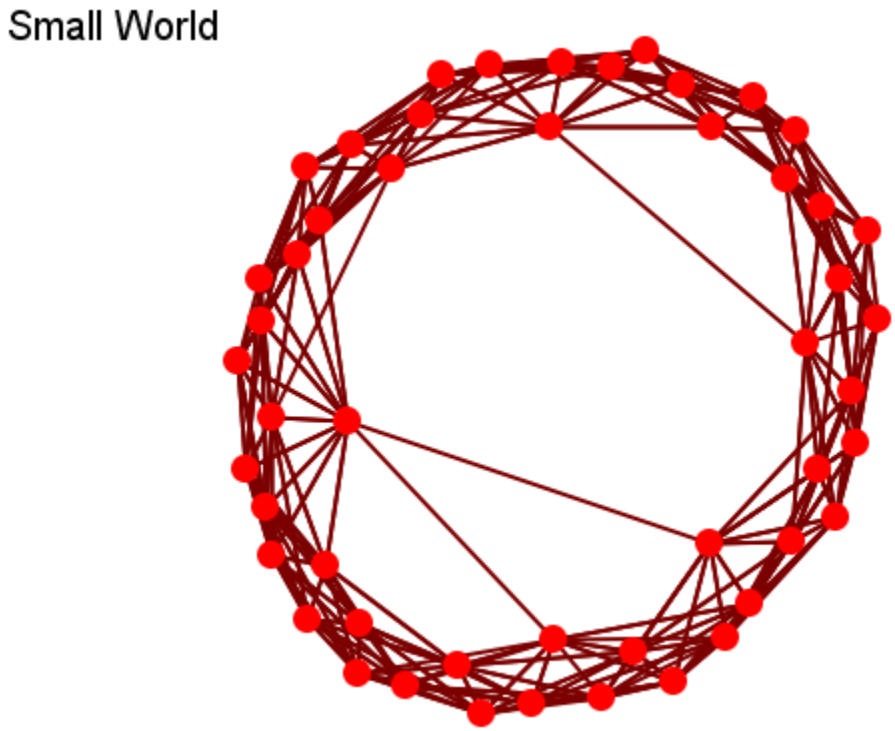
Dialog Box

Density : How dense should the resulting network be?.

Initial network : How big should the simple (erdos-renyi) seed network be?

Initial density : How dense should the simple (erdos-renyi) seed network be?





A type of graph in which most nodes are **NOT** neighbors of one another, but most nodes can be reached from every other node by a small number of hops or steps. A small world network, where nodes represent people and links connect people that know each other, captures the small world phenomenon of strangers being linked by a mutual acquaintance.

The small-world behavior is characterized by the fact that the distance between any two inks is of the order of that for a random network and, at the same time, the concept of neighborhood is preserved.

A Small-World Network is a regular network with a degree of random **long range** connections. It is rarely disrupted by the elimination of one node.

Creation in Three Steps

Begin with a lattice, e.g., 2D grid with k nearest neighbors connected.

Randomly remove connections.

Randomly add long distance connections.

Properties

High local structure (clustering).

Short maximum distances

Dialog Box

Number of neighbors : Dimensionality of embedding space/lattice. Alternatively, average degree.

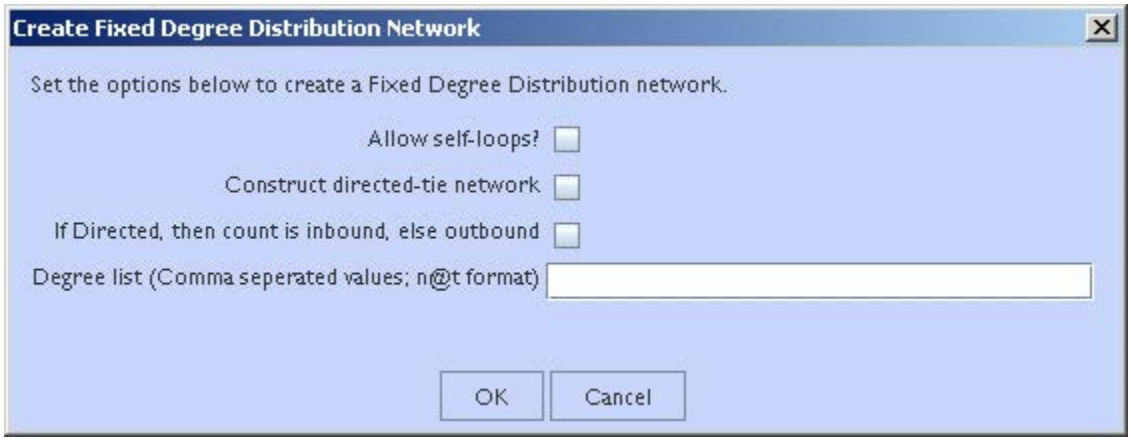
Probability of removing a neighbor : Remove any local structure?

Probability of adding a neighbor : Add long-range connections?

Power law exponent : How much should long-range connections ignore local structure?

Fixed Degree-Distribution Network

Create Fixed Degree Distribution : creates a random graph constructed by specifying as input: **(a)** the number of nodes in the network, and; **(b)** the number of links for each node. The graph is random according to the input, however it should be noted that not all degree sequences are illogical so this algorithm may produce an empty graph as a result.



Allow self-loops : Checked allows the generation of a node tied to itself. **Unchecked** disallows the generation of a node tied to itself

Construct directed-tie network : Checked generates directed network. **Unchecked** generates an undirected network

If directed, then count is inbound, else outbound : Checked the degree list is incoming ties. **Unchecked** the degree list is outgoing ties

Degree list : Enter the degree listing – in the desired node order. The input for the degree sequence is a **comma delimited list** of the number of edges. Correspondingly, the number of nodes is determined by the number of parameters entered.

To facilitate simplified entry, a shortcut can be made by specifying the number of nodes at a specific number of edges. Further, the node id in the generated graph will correspond with the position in the input string.

Degree sequences that are illogical will be impossible to generate, e.g., 2@20 *(two nodes with 20 ties each; impossible because the maximum ties a node can have in this network of size two is 1 tie.)* Further, some networks can be difficult to produce due to the specific degree distribution and the

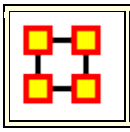
random process used to construct the network, so the algorithm is designed to make up to 10 separate attempts at constructing the exact distribution. After 10 attempts, the algorithm will return the error meta-network. The user may chose to resubmit the same request for another up-to-10 attempts at making the network.

For example, the following are valid input strings (with self-loops off and undirected):

- **1,5,3,0,1** - produces a 5 node network with one isolate and 2 pendants, etc.
- **3@2, 0, 0** - produces a 5 node network with 2 isolates and 3 nodes with 2 edges.
- **10@5,10@3** - will produce a 20 node network

The following are valid input strings **but illogical**:

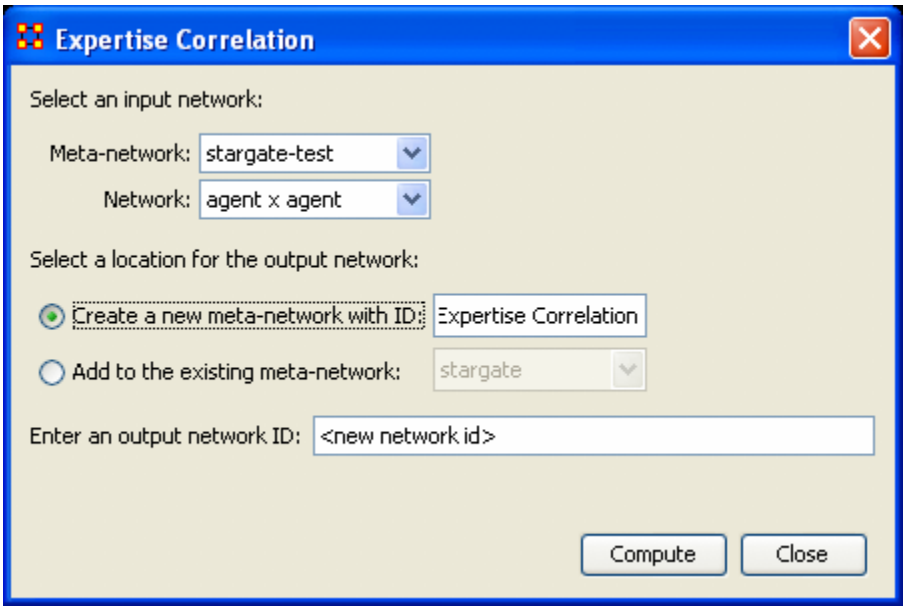
- **100,0,1** - is illogical and will produce a null meta-network named with an error message
- **3@2,1** - is illogical and will produce a null meta-network named with an error message
- **10@5,10@3,1** - is illogical will produce a null meta-network named with an error message



Create Expected Interaction Networks

NOTE : This function only available in the full version.

Below is an image of the Expertise Correlation tool in ORA and procedures on using the various options it contains:



Below are links to the **Measures section** pertaining to each Correlation.

Expertise Correlation... : Measures the complementarity of two agents based on their knowledge.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.14285715	0.2857143	0.0	0.0
maj_samant...	0.14285715	0.0	0.2857143	0.14285715	0.14285715
daniel_jackson	0.16666667	0.16666667	0.0	0.16666667	0.16666667
teal'c	0.0	0.14285715	0.2857143	0.0	0.0
gen_hammond	0.125	0.25	0.375	0.125	0.0

Similarity Correlation

Measures the degree of similarity between agents based on the number of knowledge bits they both have.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	1.0	0.33333334	0.25	1.0	0.5
maj_samant...	0.33333334	1.0	0.25	0.33333334	0.0
daniel_jackson	0.25	0.25	1.0	0.25	0.0
teal'c	1.0	0.33333334	0.25	1.0	0.5
gen_hammond	0.5	0.0	0.0	0.5	1.0

Distinctiveness Correlation... : Measures how distinct are two agents based on the number of knowledge bits they hold oppositely.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.22222222	0.33333334	0.0	0.11111111
maj_samant...	0.22222222	0.0	0.33333334	0.22222222	0.33333334
daniel_jackson	0.33333334	0.33333334	0.0	0.33333334	0.44444445
teal'c	0.0	0.22222222	0.33333334	0.0	0.11111111
gen_hammond	0.11111111	0.33333334	0.44444445	0.11111111	0.0

Resemblance Correlation... : Measures the degree of resemblance between agents based on the number of knowledge bits they both have or both do not have.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	1.0	0.7777778	0.6666667	1.0	0.8888889
maj_samant...	0.7777778	1.0	0.6666667	0.7777778	0.6666667
daniel_jackson	0.6666667	0.6666667	1.0	0.6666667	0.5555556
teal'c	1.0	0.7777778	0.6666667	1.0	0.8888889
gen_hammond	0.8888889	0.6666667	0.5555556	0.8888889	1.0

Analysis Menu



Generate Reports : Top level for all the ORA reports. These are further grouped into similar reporting groups to make it easier to find the particular report you want.



Measures Manager : The option allows you to choose which measures are to be used in generating reports for the selected Meta-Networks. The dropdown menu allows you to chose **measures lists** which divide them up into categories such as: **Slow Measures, Critical Risk Employees, and Resource Allocation Risk**.

Batch Mode Console : Opens a console window that lets the user to type commands and execute in a non-graphical way. It is an advanced menu item.

Topic Analysis : Analysis using the LDA [Latent Dirichlet Allocation] and LSA [Latent Semantic Analysis] Clustering functions.



Correspondence Analysis : Runs a correspondence analysis on the selected network to find patterns in the row and column entries.



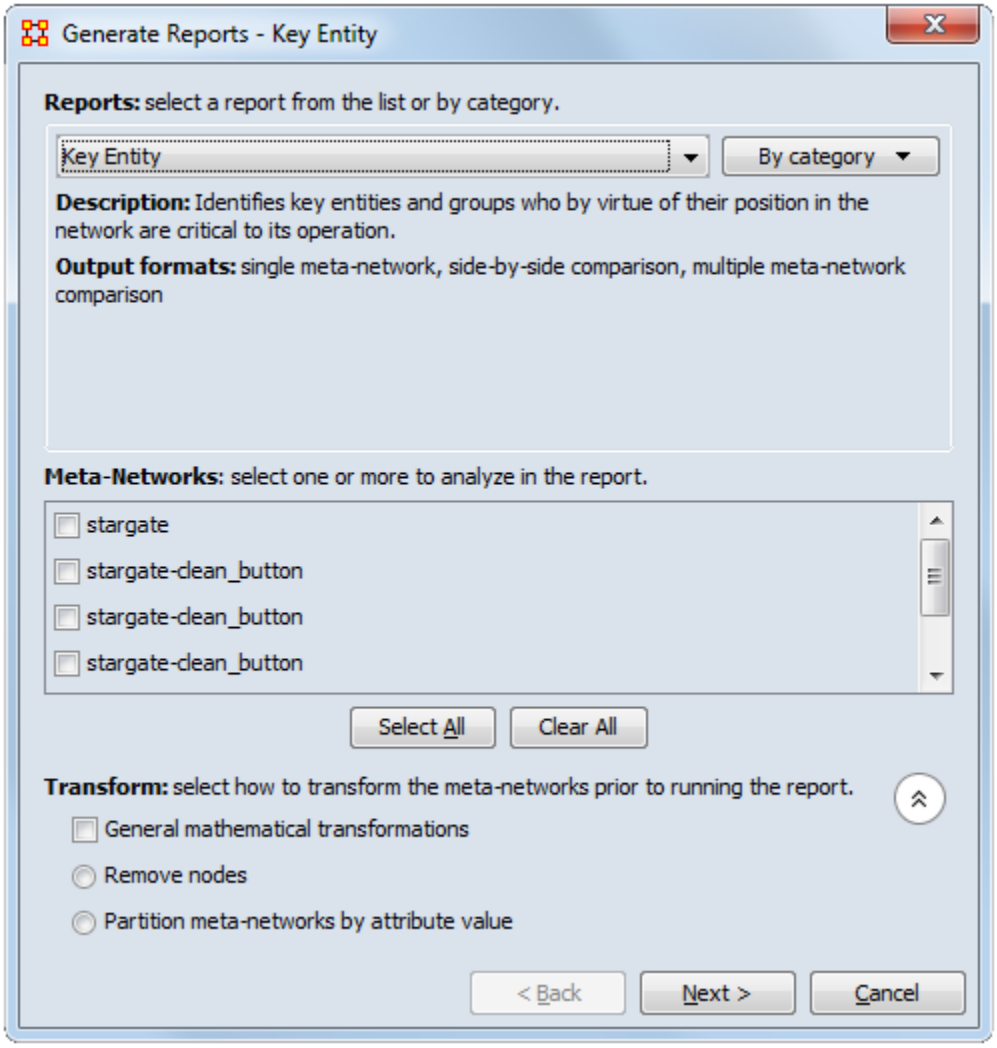
Geary-C & Moran-I Analysis... : This function performs Moran's I test using phylogenetic and spatial link matrix (binary or general). It uses neighbouring weights so Moran's I and Geary's c randomization tests are equivalent.

Generate Reports



Creates reports on the selected Meta-Networks. These reports are detailed in the **Reports Section**.

You can choose an individual report from the drop-down menu or use the **By Category** drop-down menu which forms them into groups by function. All measures are in both drop-downs.



After choosing a report from the drop down menu a description and output format will appear beneath it.

The next section allows you to chose which Meta-Networks to run the report on. Place a check mark next to all reports to use.

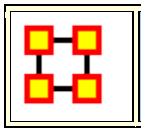
Clicking on the downward poiting double arrow reveals the **Transform section** which allows you to select the method the Meta-Networks are changed prior to running the report.

- **General mathematical transformation :**
- **Remove node :**
- **Partition nodes into separate Meta-Networks by attribute value :**

Click [**Next**]

This next screen will differ depending on which report was chosen. For some reports you will be taken directly to the print screen. For others there will be additional information you need to specify.

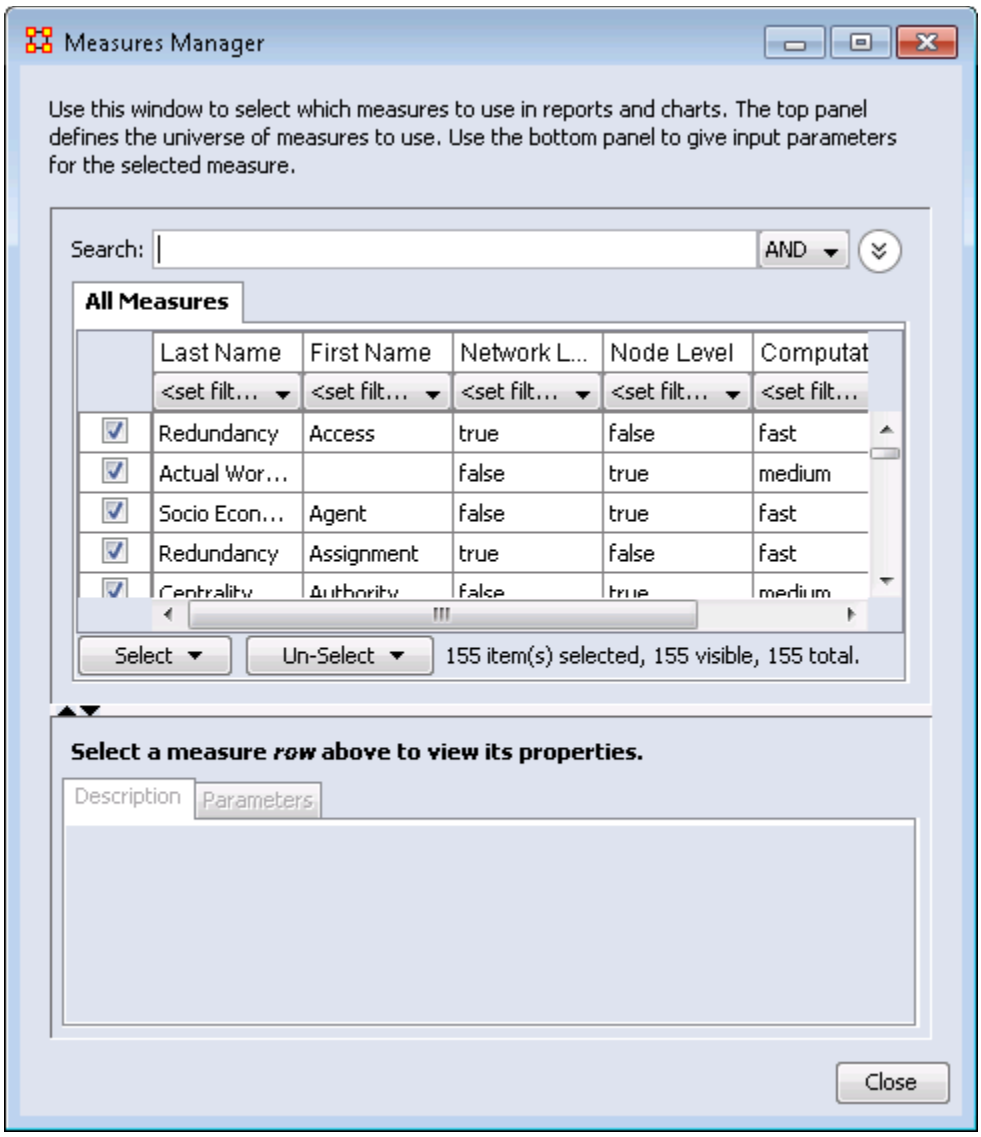
The Final Print Screen : allows you to chose whether to write the file to a **Text, HTML, CSV, or PowerPoint** file and tell ORA where to save it. You can also choose to use a different filename for all the reports written.



All Measures Report

There are several different ways to get network measures in ORA. The normal way is by using reports. Reports are collections of measures based on different research questions. The Standard Network Analysis report includes all measures.

The **All Measures Report** defaults to running all measures in the system. But you can define this report to only run specific measures using **The Measures Manager**. From the main menu select **Analysis > Measures Manager**.



From this box you can **select or unselect all/some** measures. Notice that each measure has a **First and Last name**. This is to assist in finding specific measures. There is also a search filter and drop down **AND/OR** box will also aid in this task.

NOTE : For faster selection you can use the [**Select**] or [**Un-Select**] buttons.

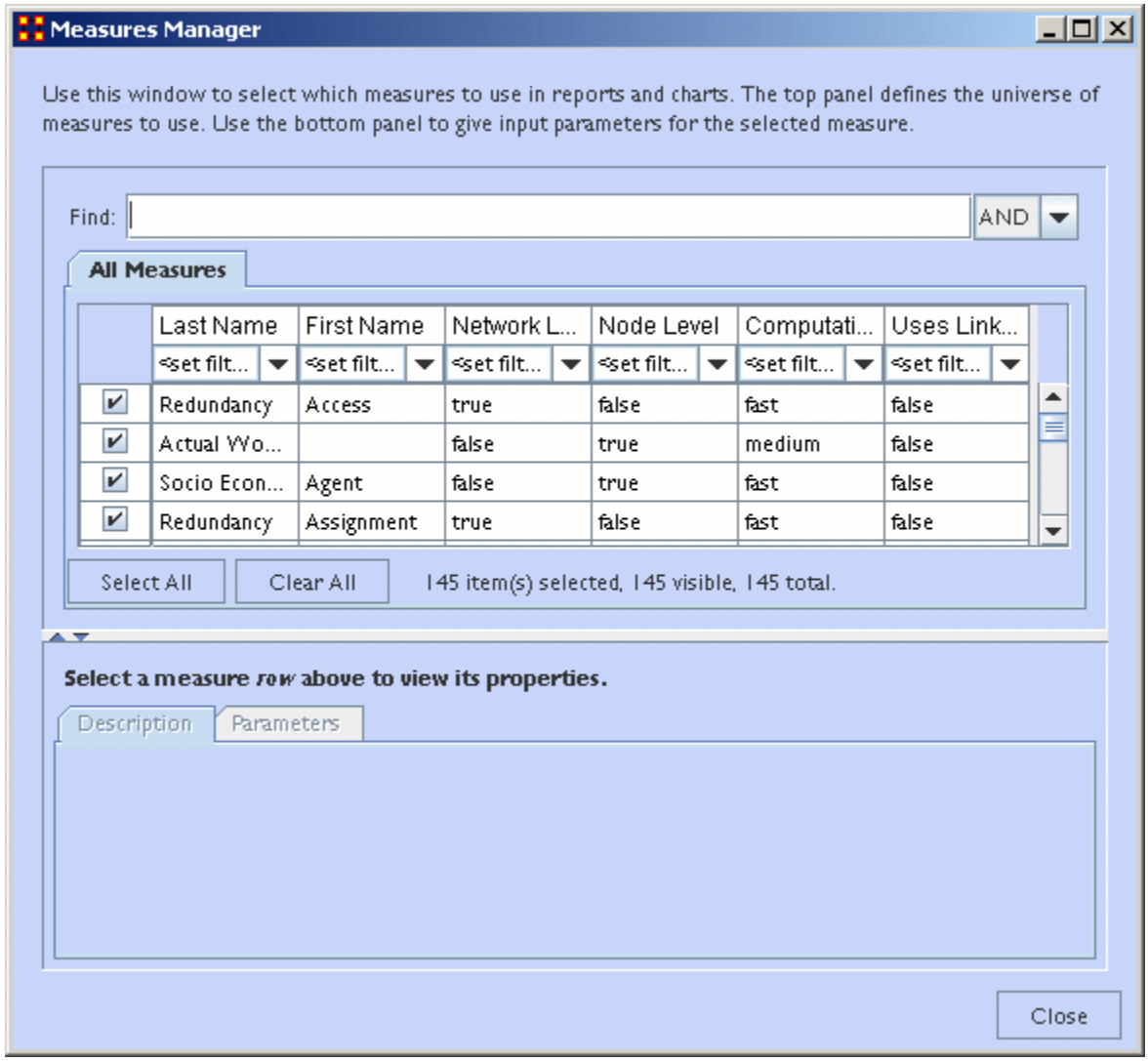
Example : If you want to find **degree** and **betweenness centrality**, we can first select centrality in the last name field and then select degree centrality and betweenness centrality in the window. When you are finished with selecting the measure, close the window to save the options. When next you select the **All**

Measures Report only the measures you selected in the Measures Manager will be calculated.

Measures Manager

Before you run any measures on a **Meta-Network** you can use the **Measures Manager** to set exactly the measures you wish to compute.

Form the main interface menu select **Analysis > Measures Manager.**



NOTE : You can sort the measures by clicking on any of the headers.

The dialog box has multiple sections:

Filter Commands :

This section comprises **two radio buttons** (Match at **least one** filter | Match **all** filters) which allow for complex filtering, a **[Reset Filters]** button, and a **Search text box** used for inputting your search. Whatever searches you input in this section are reflected in the **Tabbed Window** below. It will display only the nodes which match the search(es).

Item(s) Selected | Visible | Total

When first called up the **All Measures** tab defaults to showing every measures available. When started there were **137 item(s) selected, 137 visible, 137 total**.

Selecting the **Slow Measures** tab this changes to **16 item(s) selected, 16 visible, 16 total**.

Typing **Cognitive** into the search text box reduces this to **16 item(s) selected, 8 visible, 16 total** showing that only 8 out of the 16 Slow Measures contain the word Cognitive.

Furthermore you can unselect measures by removing the checkmark next to the measure's name. With each measure deselected the number of **selected** items will reduce by one.

With these tools you can select only the measures you want to run reports on.

Buttons

- **Reorder**
- **Select All :** Selects (puts a checkmark in the box) all **visible** measures
- **Clear All :** De-Selects (removes check marks) from all **visible** measures.

Tabbed Window

This section contains tabs which sort the measures into various categories.

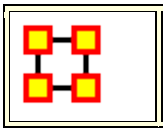
Each of the nine tabs sorts out the measures in different categories. This is very useful for large Meta-Networks when you'd prefer not run, say the **Slow Measures*** cause it would put too much a drain on your machine. By removing the check boxes for the Slow Measures they are taken out of the mix and the reports will effectively ignore them. You can turn them back on when you're finished by placing a checkmark back in the box.

In the **Tabbed Window** there are four columns:

1. **Last Name :** Deals the general type of measure **(Congruence, Exclusivity, Cognitive...)**. Most entries in this column will display one row as they are singular in what they need to show. Others will display two rows as it's nearly the same measure run on both **knowledge and resources**. Then a few **(like Centrality)** will display quite a few rows the types of measures written for that type of measures are somewhat varied.
2. **First Name :** Deals with the category of the measure **(Betweenness, Closeness, Centrality...)**. This is a secondary factoring.
3. **Graph Level : Graph Level*** produces a single number as output.
4. **Entity Level : Entity Level*** produces one number per entity.

Drop-Down Menu

Gives the user the ability to select which currently active Meta-Network to run the measures on, as well as, which individual networks.



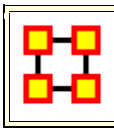
Groupings of Reports

This chart shows the groupings for the reports in ORA

Groups and Which Reports They Contain

Groupings	Reports
Dynamics	Belief Propagation Change in Key Entities Immediate Impact QAP/MRQAP Analysis Statistical Change Detection
Geospatial	Geospatial Assessment Key Entity Trails
Groups	Core Network Local Patterns Locate Subgroups
Knowledge Networks & Network Text Analysis	Communicative Network Assessment Communicative Power Group Talk Hot Topics Large Scale Part of Speech Semantic Network
Locate Key Entities	Change in Key Entities Communicators Critical Sets Key Entity Management Simmelian Ties Analysis Sphere of Influence Standard Network Analysis

Locate Key Relations	**Shortest Path**
Specialty	**Capabilities** **Drill Down** **Influence Net** **Merchant Marine** **Optimizer** **Public Health** **Rules of Engagement** **Tactical Insight** **Trails Analysis**
Statistical Procedures and Diagnosics	**Context** **Missing Links** **Potential Errors** **QAP / MRQAP Analysis** **Statistical Change Detection** **Statistical Distribution**
Show Me Everything	



Reports In Which Group

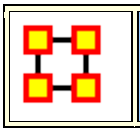
ORA contains many reports for data analysis. The table below shows all the reports and into which groups they fall.

Reports and the Groups In Which They Belong

Report	Group(s)
Belief Propagation	**Dynamics**
Capabilities	**Specialty**
Change in Key Entities	**Dynamics** **Locate Key Entities**
Communicative Network Assessment	**Knowledge Networks & Network Text Analysis**

Communicative Power	**Knowledge Networks & Network Text Analysis**
Communicators	**Locate Key Entities**
Context	**Statistical Procedures and Diagnosics**
Core Network	**Groups**
Critical Sets	**Locate Key Entities**
Drill Down	**Specialty**
Geospatial Assessment	**Geospatial**
Group Talk	**Knowledge Networks & Network Text Analysis**
Hot Topics	**Knowledge Networks & Network Text Analysis**
Immediate Impact	**Dynamics**
Influence Net	**Specialty**
Key Entity	**Geospatial** **Locate Key Entities**
Large Scale	**Knowledge Networks & Network Text Analysis**
Local Patterns	**Groups**
Locate Subgroups	**Groups**
Management	**Locate Key Entities**
Merchant Marine	**Specialty**
Missing Links	**Statistical Procedures and Diagnosics**
Optimizer	**Specialty**
Part of Speech	**Knowledge Networks & Network Text Analysis**
Potential Errors	**Statistical Procedures and Diagnosics**
Public Health	**Specialty**
QAP / MRQAP Analysis	**Statistical Procedures and**

	Diagnosics **Dynamics**
Rules of Engagement	**Specialty**
Semantic Network	**Knowledge Networks & Network Text Analysis**
Shortest Path	**Locate Key Relations**
Simmelian Ties Analysis	**Locate Key Entities**
Sphere of Influence	**Locate Key Entities**
Standard Network Analysis	**Locate Key Entities**
Statistical Change Detection	**Statistical Procedures and Diagnosics** **Dynamics**
Statistical Distribution	**Statistical Procedures and Diagnosics**
Tactical Insight	**Specialty**
Trails	**Geospatial**
Trails Analysis	**Specialty**



Topic Analysis

LSA and LDA come from alternate schools of thought that attempt to link together documents based on shared content, which is construed in aggregate as shared “themes”. To get these themes, both methods use a **bag of words** approach that, unlike the methods described above, does not look at adjacency as the sole definer of context. Rather each document is seen as one indiscriminate context. Correlations between all the words in documents are considered to determine underlying correlations that go beyond immediate context.

Latent Semantic Analysis

Latent Semantic Analysis (LSA) is a technique in natural language processing, in particular in vectorial semantics, of analyzing relationships between a set of documents and the terms they contain by producing a set of concepts related to the documents and terms. It finds correlations between particular words in documents and, from this, particular correlations between the documents by mapping the documents to a vector space of reduced dimensionality, the latent semantic space. After running LSA, an analyst will possess a number of correlations between terms of particular strengths and a number of correlations between documents dependent on the strengths of these term correlations. The method has been applied to a variety of different data; notable examples include looking at the communications of the ICA for information about relations within the discipline, and looking at presidential debates for salient features shared by election winners.

Latent Dirichlet Allocation

Latent Dirichlet Allocation (LDA) is a topic modeling algorithm first introduced in Blei et al, 2003. It takes a collection of Meta-Networks as input and uses a set number of topics to locate. Each Meta-Network models a document and the Nodesets are combined to create a single list of concepts with frequencies determined by an attribute called **Frequency**. The algorithm assigns a probability that a topic belongs to a document and a probability that a concept belongs to a topic. For each topic the ten concepts with the highest probability of belonging to that topic are report. It is a method for attempting to determine the words that make up a set of topics

covered by a corpus of documents. LDA assumes that documents consist of a mixture of topics, and that the constituent words of the document are, individually, each members of particular topics. LSA attempts to find the strongest correlations between particular words. LDA, in contrast, uses probabilistic methods to identify which words are most closely linked in a topic.

Although LDA was invented for document analysis in reality it can be used on any two mode data. Traditionally this was documents by words; however, it can be applied to other data such as people by locations.

LDA is a latent space model that represents the first Nodeset in a much more compact set of hidden variable; e.g., representing a set of documents interms of a set of topics. In a typical LDA model a document is represented as a set of words or concepts, where each concept is assumed to belong to one or more of the hidden topics. Thus, the first Nodeset can be described by considering for each node its connections to nodes in the second Nodeset and the strength of their association to the hidden variables; in turn these variables can be described by the clusters of nodes in the second mode. For example, documents (mode 1 - first Nodeset) can be described by their association to topics (hidden variables) based on the words (mode 2 - second Nodeset) in the document and the topics can be described by the associated words. By considering nodes in the first Nodeset which are highly associated with the same hidden variable, we can begin to understand "clusters" (or groups) of nodes.

A benefit of LDA as a clustering routine is that it supports characterization of nodes in one class by the distribution of their ties to nodes in another set.

A shortcoming of LDA, is that an arbitrary number of hidden variables need be chosen by the user. To do this in ORA, Sensitivity analyses should be run to determine the right number of variables.

Data Pruning

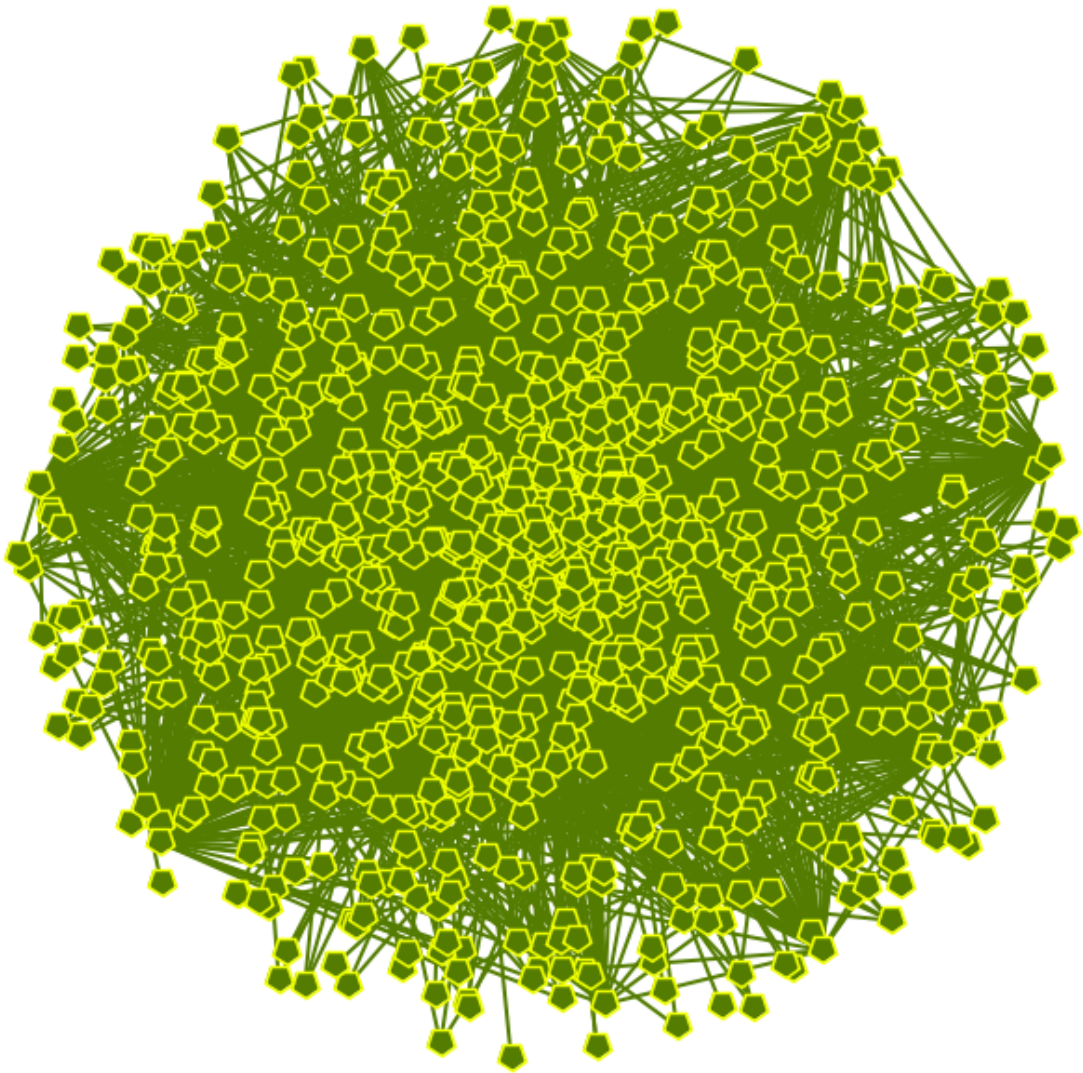
For most clustering routines, especially with two mode clustering routines, common practice is to prune the data. Specifically nodes in mode 1 that are are connected to very few nodes in mode 2 (low out degree) are often removed before the clustering is run. For example, this is typically done with LDA and LSA.

Regarding Your Input Network

The input daya needs to be a **concept by text** matrix if you want to do topic analysis. You can import a .csv file also if you want where the rows are concepts and columns are texts. You can also generate a concept by text matrix when you generate a semantic network from AutoMap.

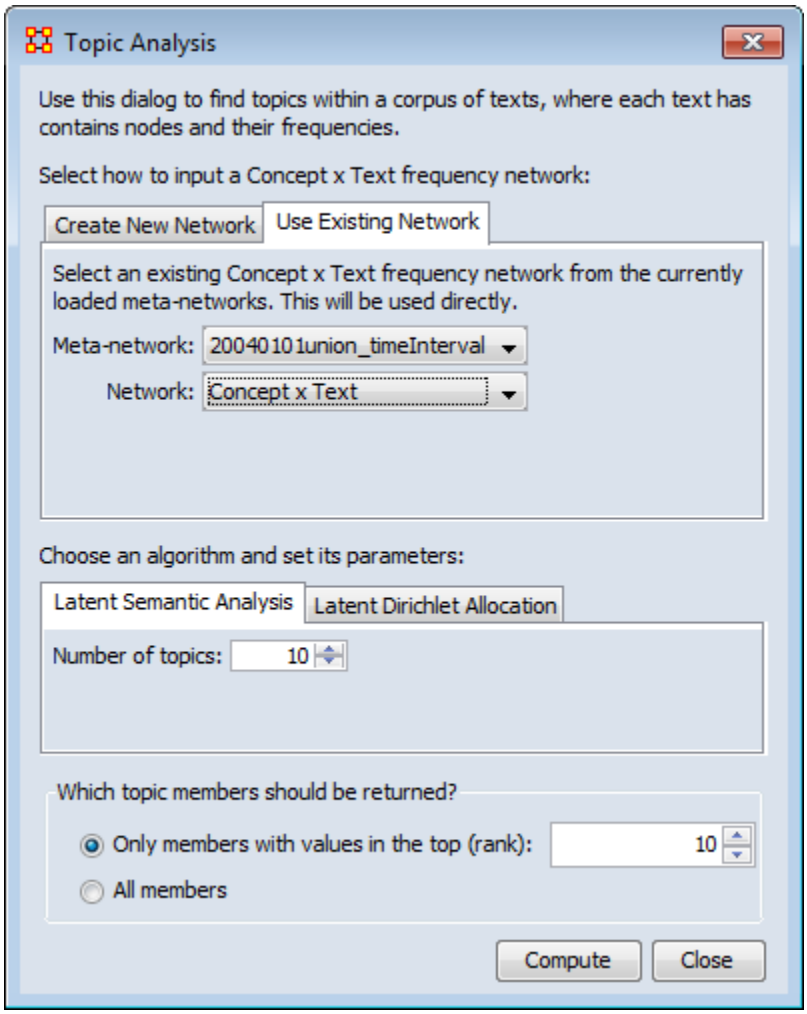
Example

This is the **20040101union_timeInterval** Meta-Network before processing. As you can see it is not very informative.



We will process it with the LSA and LDA functions.

LSA



Number of Topics determines the number of groups of concepts in the final Meta-Network.

From the Editor's menu select **Analysis > Topic Analysis**. This brings up the Topic Analysis dialog. Select the **Use Existing Network** tab and select the Meta-Network. From the Network menu select **Concept x Text**.

In the **CHoose an algorithm and set its parameters:** make sure the **Latent Semantic Network** tab is active. For the number of topics select 10.

In the **Which topic members should be returned?** select the **Only members with values in the top (rank):** and set this to 10.

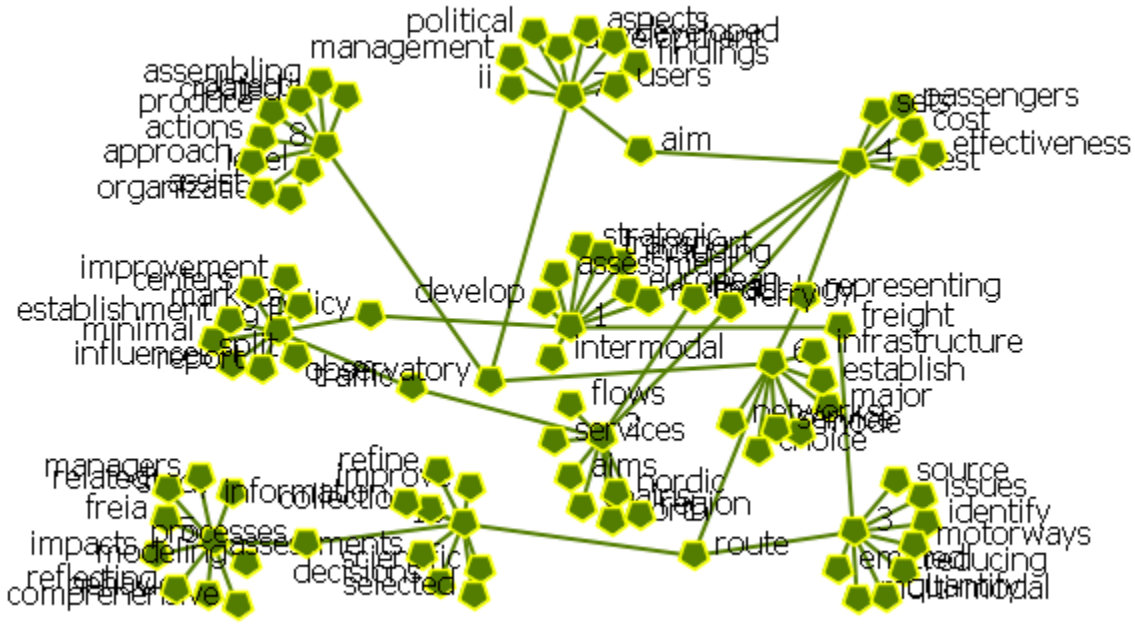
Click the
[**Computer**]

button.

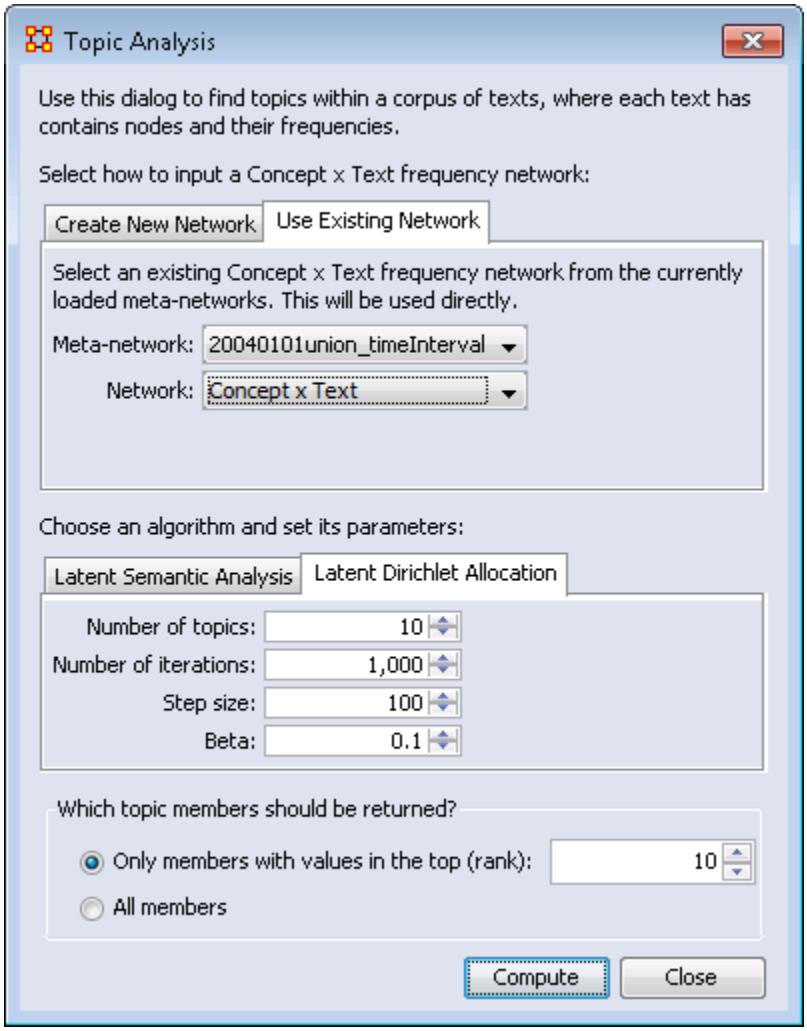
A new Meta-Network will be added to the Manager Pane. Expand this by clicking the [+]. Select the **Topic x Concept** network. The click the [**Visualize**] button.

Network clustered using LSA

Each of the **numbered nodes** represent a group. And in this example each of the groups contains 10 links as per the parameters set.



LDA



The **Select how to input...** and **Which topic members...** sections are the same as in the LSA.

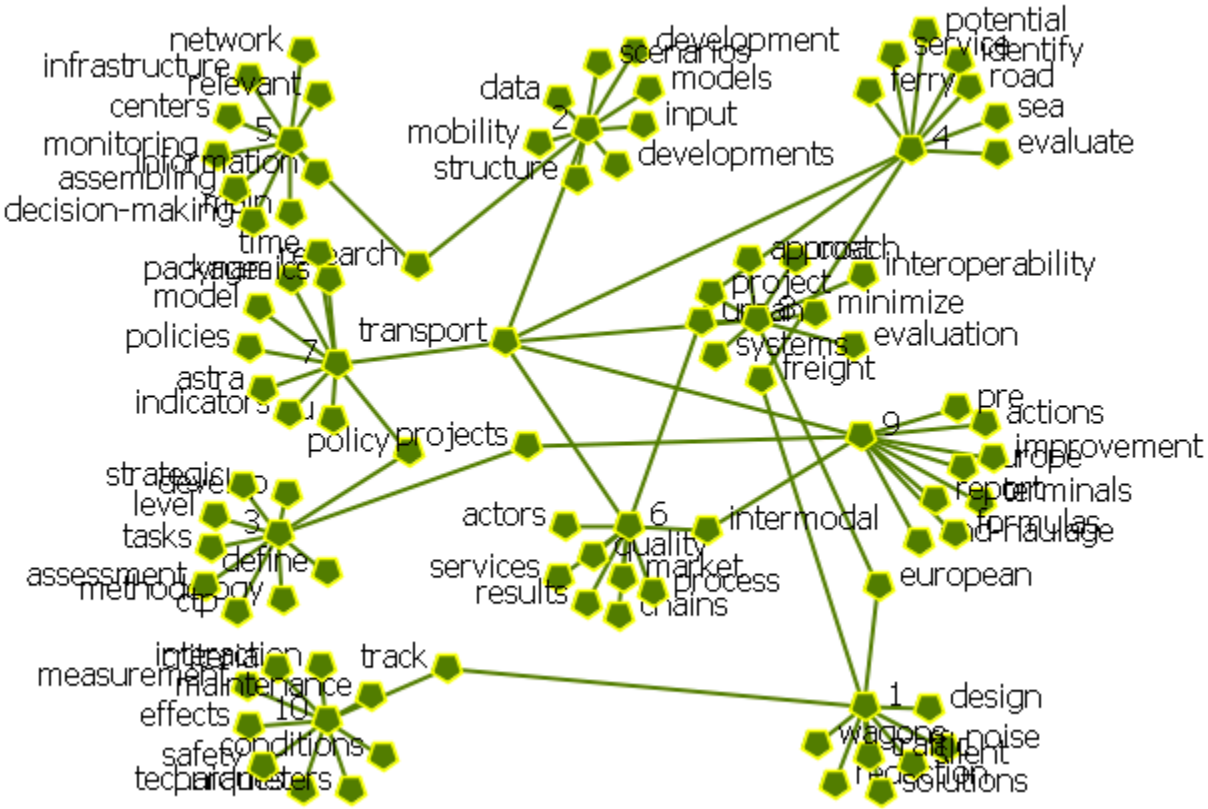
The parameters for the LDA are more indepth than the LSA. You have:

Number of Topics : The number of groups you want in the final display
Number of iterations : The number of runs performed. 1,000 is the minimum. A higher number refines the results but will take longer to compute
Step size : The number of iterations after which the model parameters are recomputed. 100 is the minimum recommened. A higher step size will compute faster but will reduce accuracy.
Beta : determines how heavily the empirical predictive distribution of a

multinomial Dirichlet is smoothed. Its default value is 0.1 and can be altered to give the desired resolution in the resulting distribution.

Network clustered using LDA

Each of the **numbered nodes** represent a group. And in this example each of the groups contains 10 links as per the parameters set.



References

D. M. Blei, A. Y. Ng, and M. I. Jordan. Latent dirichlet allocation. J. Mach. Learn. Res., 3:993-1022, Mar. 2003.

Correspondence Analysis

General Purpose

Correspondence analysis is a descriptive/exploratory technique designed to analyze simple two-way and multi-way tables containing some measure of correspondence between the rows and columns. The most common kind of table of this type is the two-way frequency crosstabulation table. For a comprehensive description of this method, computational details, and its applications (in the English language), refer to the classic text by Greenacre (1984).

Applies to categorical rather than continuous data. It provides a means of displaying or summarising a set of data in two-dimensional graphical form. All data should be nonnegative and on the same scale for CA to be applicable, and the method treats rows and columns equivalently.

	Smoking Category				
Staff Group	(1) None	(2) Light	(3) Medium	(4) Heavy	Row Totals
(1) Senior Managers	4	2	3	2	11
(2) Junior Managers	4	3	7	4	18
(3) Senior Employees	25	10	12	4	51
(4) Junior Employees	18	24	33	13	88
(5) Secretaries	10	6	7	2	25
Column Totals	61	45	62	25	193

Mass : To continue with the simpler example of the two-way table presented above, computationally, the program will first compute the relative frequencies for the frequency table, so that the sum of all table entries is equal to 1.0 (each element will be divided by the total, i.e., 193). You could say that this table now shows how one unit of mass is distributed across the cells. In the terminology of correspondence analysis, the row and column totals of the matrix of relative frequenciesare called the row mass and column mass, respectively.

Inertia : The term inertia in correspondence analysis is used by analogy with the definition in applied mathematics of "moment of inertia," which stands for the integral of mass times the squared distance to the centroid (e.g., Greenacre, 1984, p. 35). Inertia is defined as the total Pearson Chi-square for the two-way divided by the total sum (193 in the present example).

According to the well-known formula for computing the Chi-square statistic for two-way tables, the expected frequencies in a table, where the column and rows are independent of each other, are equal to the respective column total times the row total, divided by the grand total. Any deviations from the expected values (expected under the hypothesis of complete independence of the row and column variables) will contribute to the overall Chi-square.

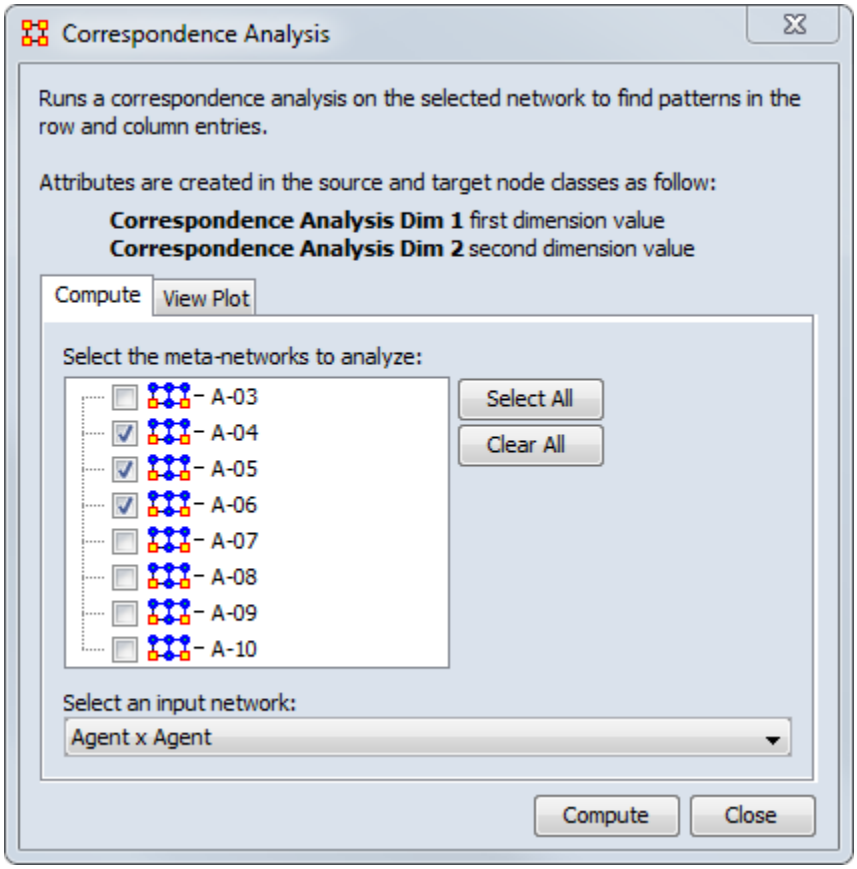
Eigenvalues and Inertia for all Dimensions Input Table (Rows x Columns): 5 x 4 Total Inertia = .08519 Chi^2 = 16.442					
No. of Dims	Singular Values	Eigen-Values	Perc. of Inertia	Cumulatv Percent	Chi Squares
1	.273421	.074759	87.75587	87.7559	14.42851
2	.100086	.010017	11.75865	99.5145	1.93332
3	.020337	.000414	.48547	100.0000	.07982

References

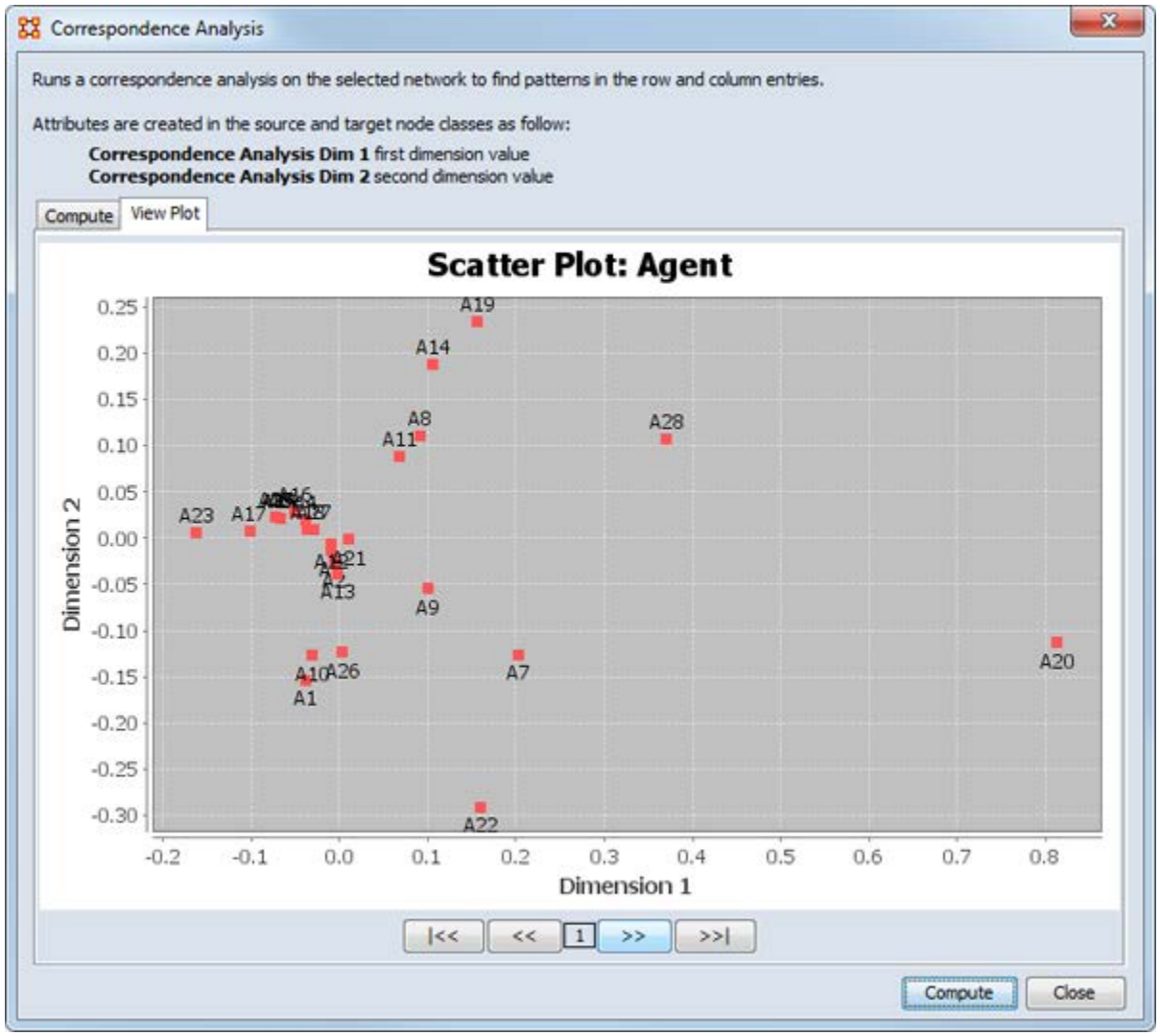
Correspondence Analysis. Retrieved on Spember 27, 2011, from http://www.statsoft.com/textbook/correspondence-analysis/.

Correspondence Analysis Example

From the Editor Menu select **Analysis > Correspondence Analysis**.



The Corresondence Analysis box will appear with a list of all currently loaded Meta-Networks. Place a check mark next to the Meta-Network(s) to analyze. For **Select an input network:** select the network to analyze. When you are finished click [**Compute**]. This brings up the **Scatter Plot**.



The buttons at the bottom are navigation buttons:

[**|<<**] Go To First Graph

[**<<**] Go To Next Graph

[**>>**] Go To Previous Graph

[**>>|**]Go To Last Graph

The number in the middle of the buttons tells you which graph is currently displayed.

Moran-I and Geary-C

Description

Moran's-I : The measure of spatial autocorrelation to study stochastic phenomena which are distributed in space in two or more dimensions. The values of Moran's I range from **+1** meaning strong positive spatial autocorrelation, to **0** meaning a random pattern to **-1** indicating strong negative spatial autocorrelation.

This particular statistic is designed for the measurement of global spatial autocorrelation of ordinal, interval or ratio data.

Geary's-C : Based upon a paired comparison of juxtaposed map values and **ranges between 0 and 2**. Positive spatial autocorrelation is found with values ranging from 0 to 1 and negative spatial autocorrelation is found between 1 and 2. However, values can be found greater than 2 on occasion (Griffith, 1987). As similar values are in juxtaposition the numerator which measures the absolute difference squared between juxtaposed values will tend toward zero. Whereas, as non-similar values become juxtaposed the statistic will tend toward larger values in the numerator and thus toward its maximum value of two.

This particular statistic is designed for the measurement of local spatial autocorrelation of ordinal, interval or ratio data.

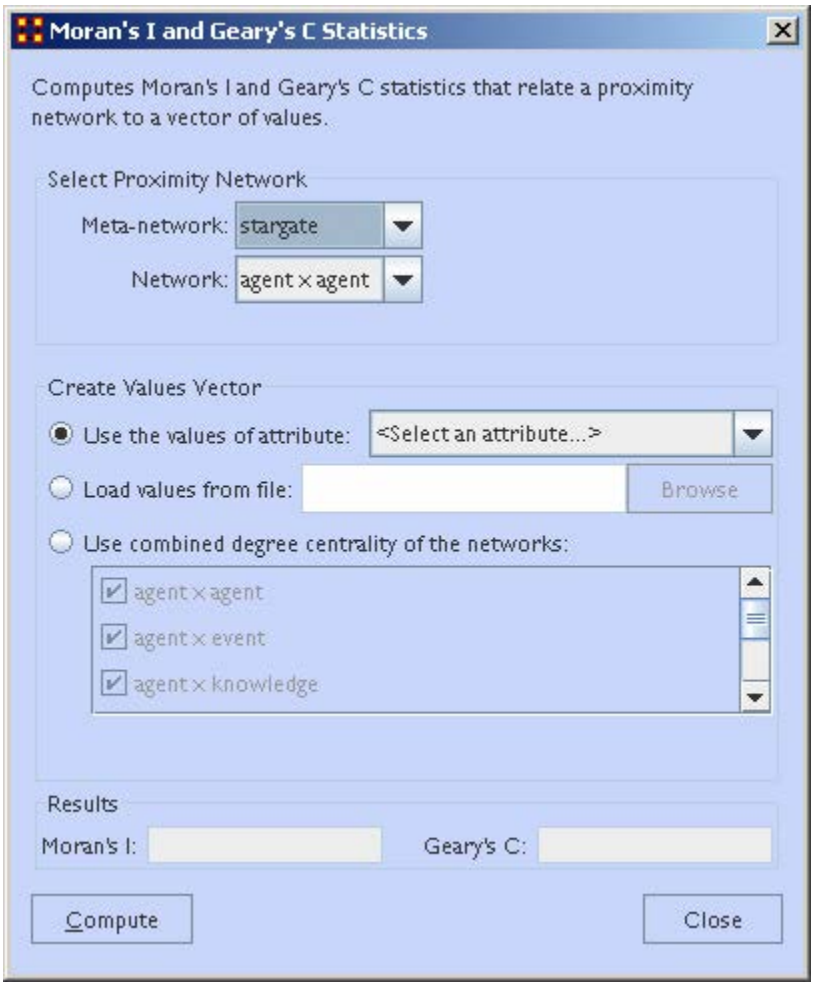
Example

	Moran's I	Geary's C
A	0.9	.04
B	0.2	0.9
C	-.8	1.8

A has positive global spatial autocorrelation and local spatial autocorelation.

B is random with respect to space.

C has negative global and local spatial autocorrelation.



Select Proximity Network : Select a Meta-network from the first dropdown menu. The second dropdown menu will contain all the networks in the selected Meta-Network.

Create Values Vector : There are three ways to select a value

1. **Use the values of attributes :** uses an attribute within the Meta-Network.
2. **Load values from file :** browses for a file previously constructed.
3. **Use combined degree centrality of the networks :** Place a checkmark for one (or more) networks within the selected Meta-network to use. Combines the centrality to use in the formulas.

Results : Displays the **Moran-I and Geary-C** results.

Reference

Geary, R. C. (1954). "The Contiguity Ratio and Statistical Mapping". The Incorporated Statistician (The Incorporated Statistician) 5 (3): 115-145.

Moran, P. A. P. (1950). "Notes on Continuous Stochastic Phenomena". Biometrika 37 (1): 17-23.

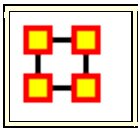
Simulations



Near-Term Analysis : The **Near Term Analysis** (NTA) is a tool that allows for the removal of nodes from a given organizational structure to evaluate how the organization will likely perform as a result.

OrgAhead : OrgAhead is an organizational learning model designed to test different forms of organizations under a common task representation. Each member of the organization receives information from a subordinate or from the environment, makes a decision based on the information and what he or she has learned so far, and provides superiors with an answer to the decision. These decisions are either **yes/no** or **yes/maybe/no**; again, we're dealing with an intellective model.

Micro Simulations : Micro Simulation allows you to run some basic simulations on the curretly loaded visualization. Link weights are important as once they are normalized, they correspond to the probablity of a transmission.



Near Term Analysis

The **Near Term Analysis** (NTA) is a tool that allows for the removal of nodes from a given organizational structure to evaluate how the organization will likely perform as a result. The Near Term Analysis tool uses a multi-agent model as input, **Dynet ML***.

The goal is to provide an answer to the question on how an organization will behave and change after considering a sequence of strategic interventions or personnel loss by way of agent removal. In other words, we want to know what happens when we remove nodes from an organization, be they people, places, resources, knowledge sets or other common Nodesets.

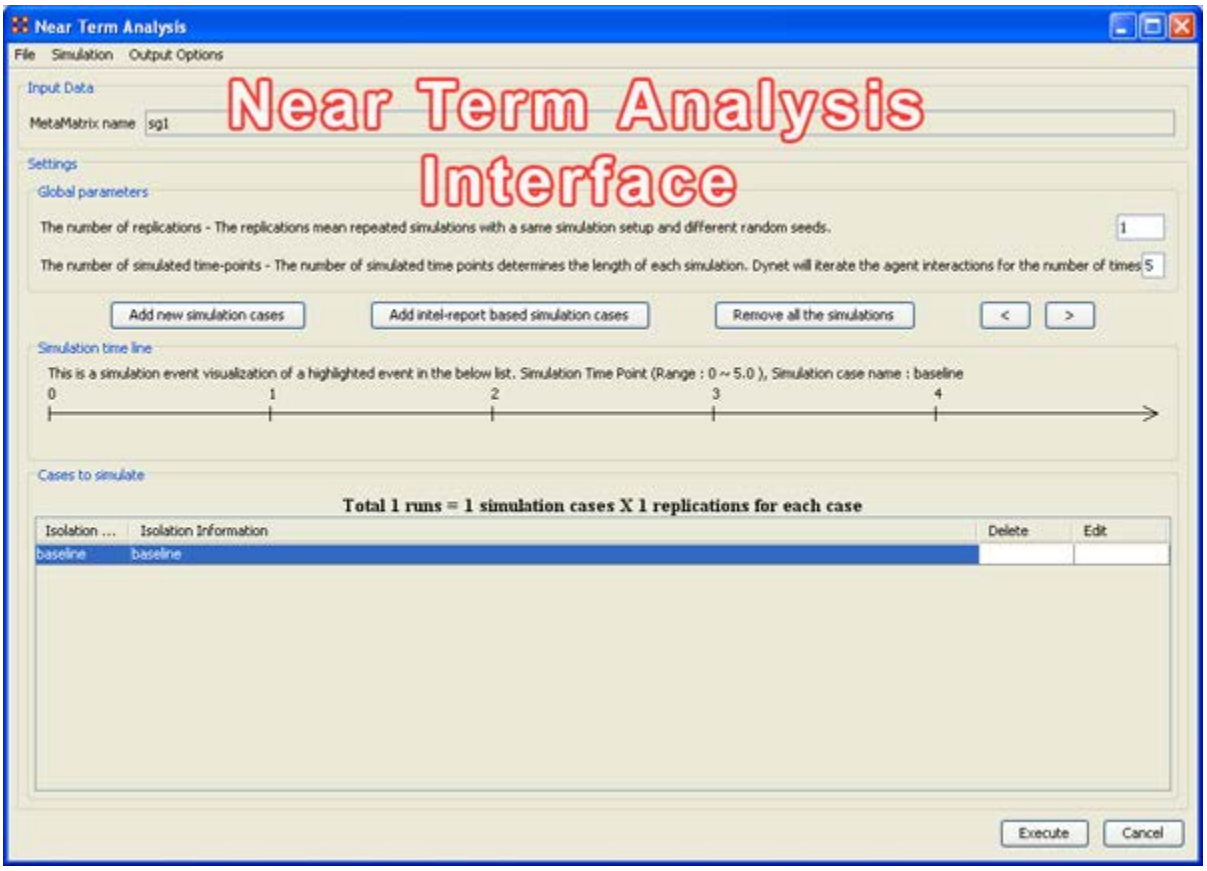
This example will use the **Stargate dataset (SG-1)**. This dataset is included with the version of ORA downloaded and can be found on-line at the following url:
http://www.casos.cs.cmu.edu/projects/ora/sample.php.

From the menu bar select **File > Open Meta-Network** then select SG1.xml.

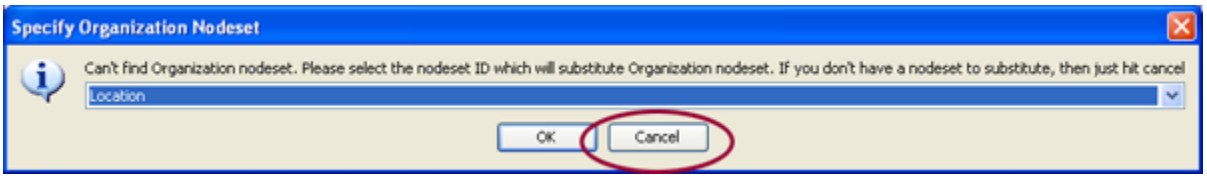
In this example, we will remove two agents: **daniel_jackson** and **maj_samantha_carter**

1. Open the **SG1 Meta-Network** into ORA.
2. Highlight the SG1 Meta-Network **before** starting NTA in the ORA Meta-Network Manager panel.
3. From the main menu select **Simulations > Near-Term Analysis**.

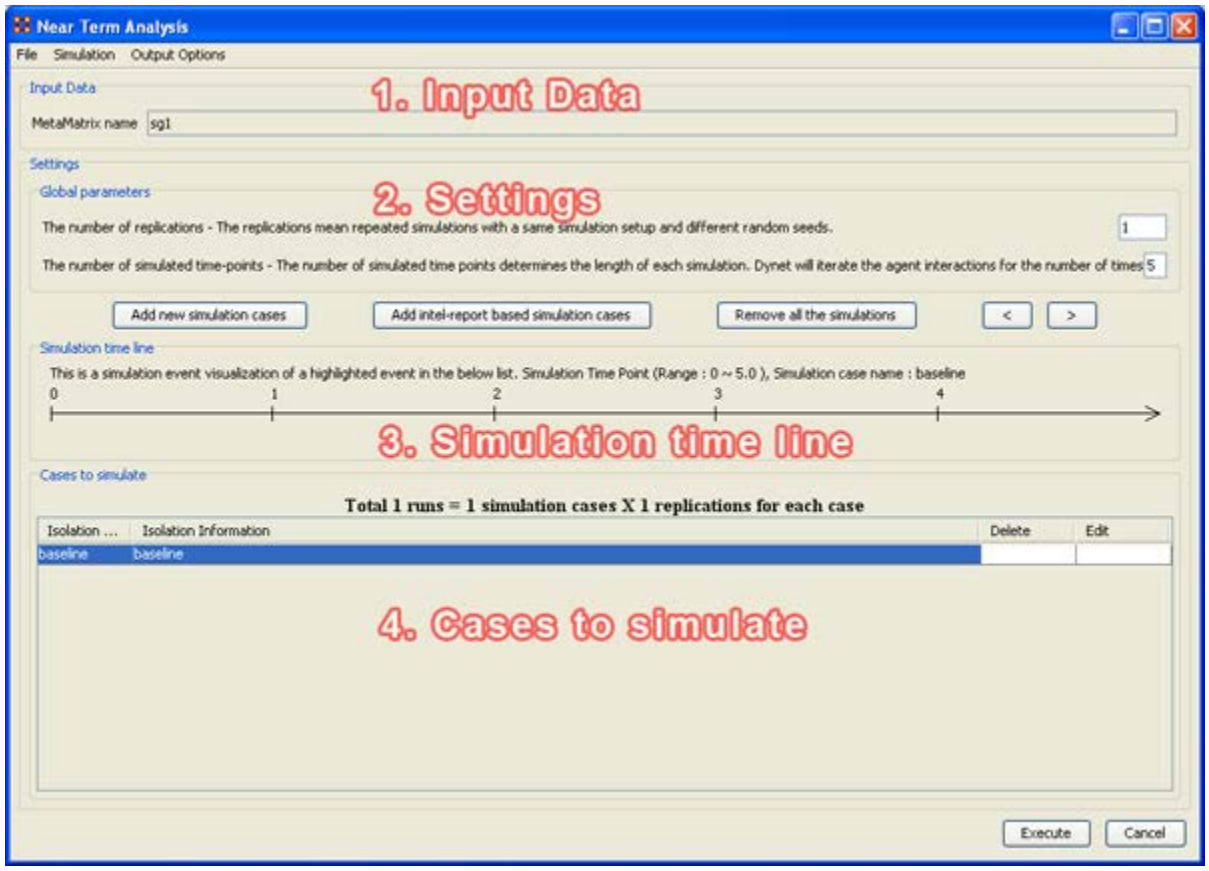
NOTE : If your dataset contains an Organization Node Class ORA will display the NTA main window. If not, it will ask for you to chose a substitute Organization Nodeset.



When a Meta-Network is first loaded into ORA's the Near Term Analysis, a pop-up may appear asking for a **location** node. Select Cancel and proceed with the Near Term Analysis.



The NTA main window consisted of four sub panels: **Input Data, Settings, Simulation time line and Cases to simulate**. Below is a brief description of each panel:



1. Input Data

In this section is the file name of the Meta-Network loaded.

2. Settings (Global Parameters)

In the **Setting** area are two text boxes. The first, **The Number of replications** informs ORA how many times to run the simulation. The second, **The number of simulated time-points** defines the range in the section **Simulation time line**.

In the settings area, there are two critical factors: 1) the **number of replications** and 2) the **number of simulated time points**.

Why is this important?

The number of replications if set at a higher versus lower value, will result in more experiments being conducted on the scenario the tool is presented. Therefore, the more replications the more likely the results will mirror those in a real world example.

The number of time points determines the length of the Near Term Analysis iterations. If this number is also set to a relatively high value, the simulation will take longer.

NOTE : Be mindful of any memory considerations when running high value replications or time points.

3. Simulation time line

This are of the Near Term Analysis tool shows a visual representation of the time points selected in Settings area above.

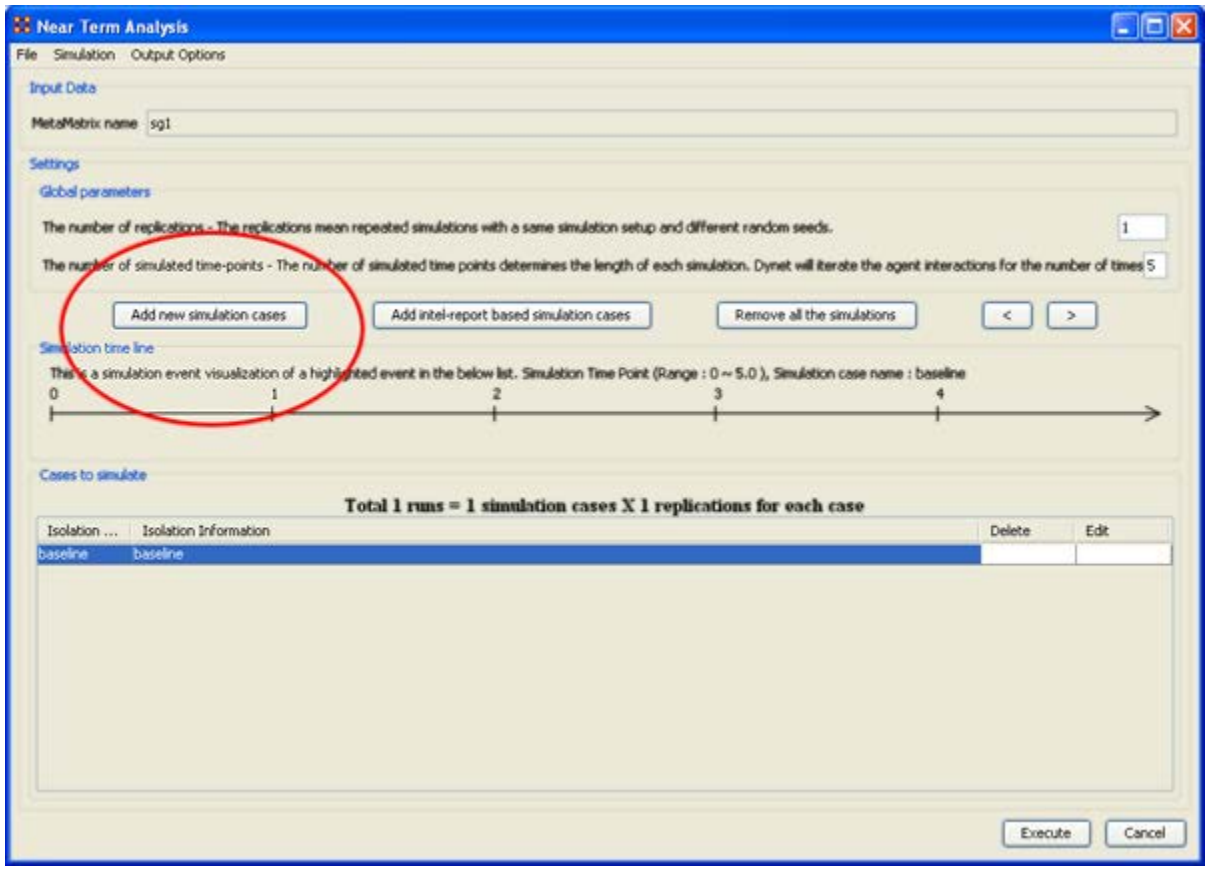
4. Cases to simulate

After the settings **(global parameters)** are set, the virtual experiment cells need set.

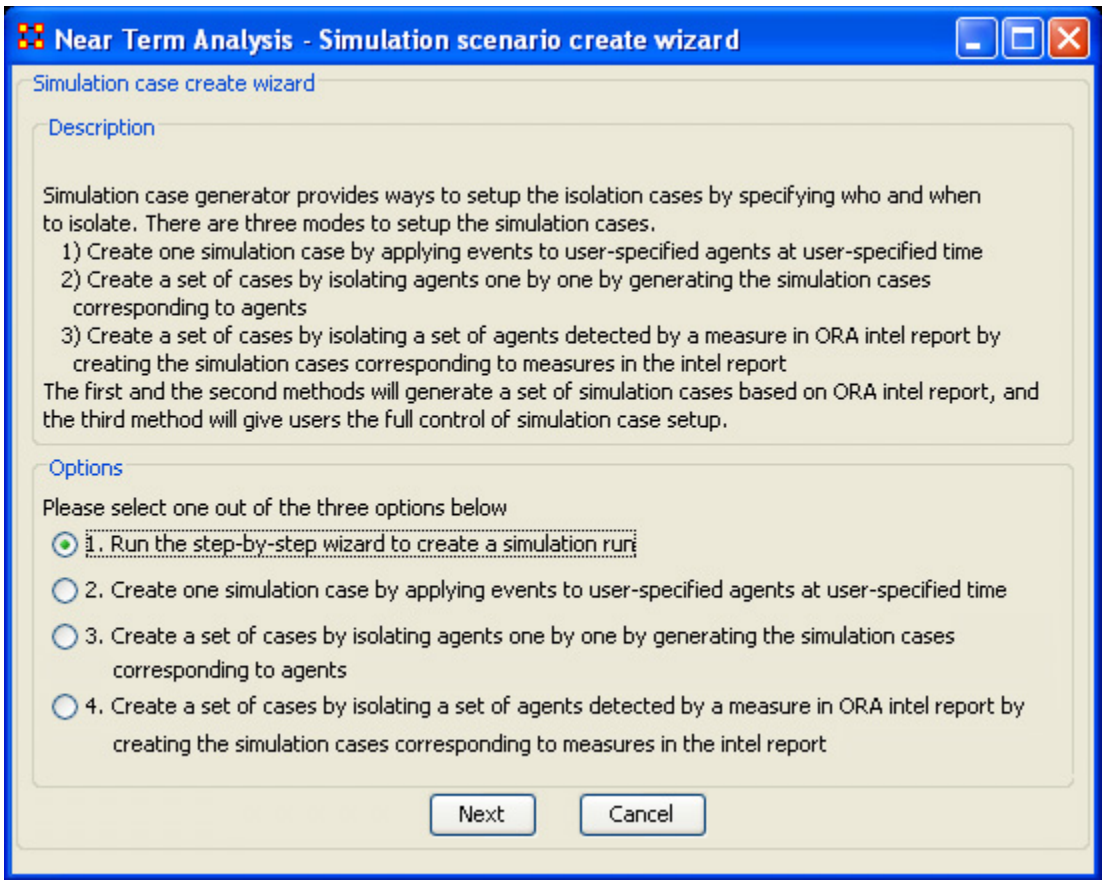
Initially, there is a pre-defined simulation cell, the **Baseline**. The Baseline is the cell without any entities removed as is the control situation when the organization does not experience any interventions. Besides Baseline, any other cells need set up. Start by selected **Add new simulation instances**, the leftmost of the four buttons.

Add new simulation cases

To run a Near Term Analysis, we will begin by selected the **Add new simulations cases** button from the main Near Term Analysis Tool (see area highlighted in red ellipse below).



After selecting **Add new simulation instances** button, a dialog box titled **Near Term Analysis– Simulation scenario create wizard** will appear. This wizard supports the creation of virtual experiment cells in three different ways. The **First** allows for the most freedom of choice. The **second** and the **third** options will ask for a set of criteria for selecting important agents in the network and make experiment cells according to the selection. Therefore, the first option gives full flexibility to users, and the second and the third option provides a systematic analysis setup method. To proceed this demonstration, select the first option and select **[Next]**.



There are four options:

The next section explores all four of the Near Term Analysis Options:

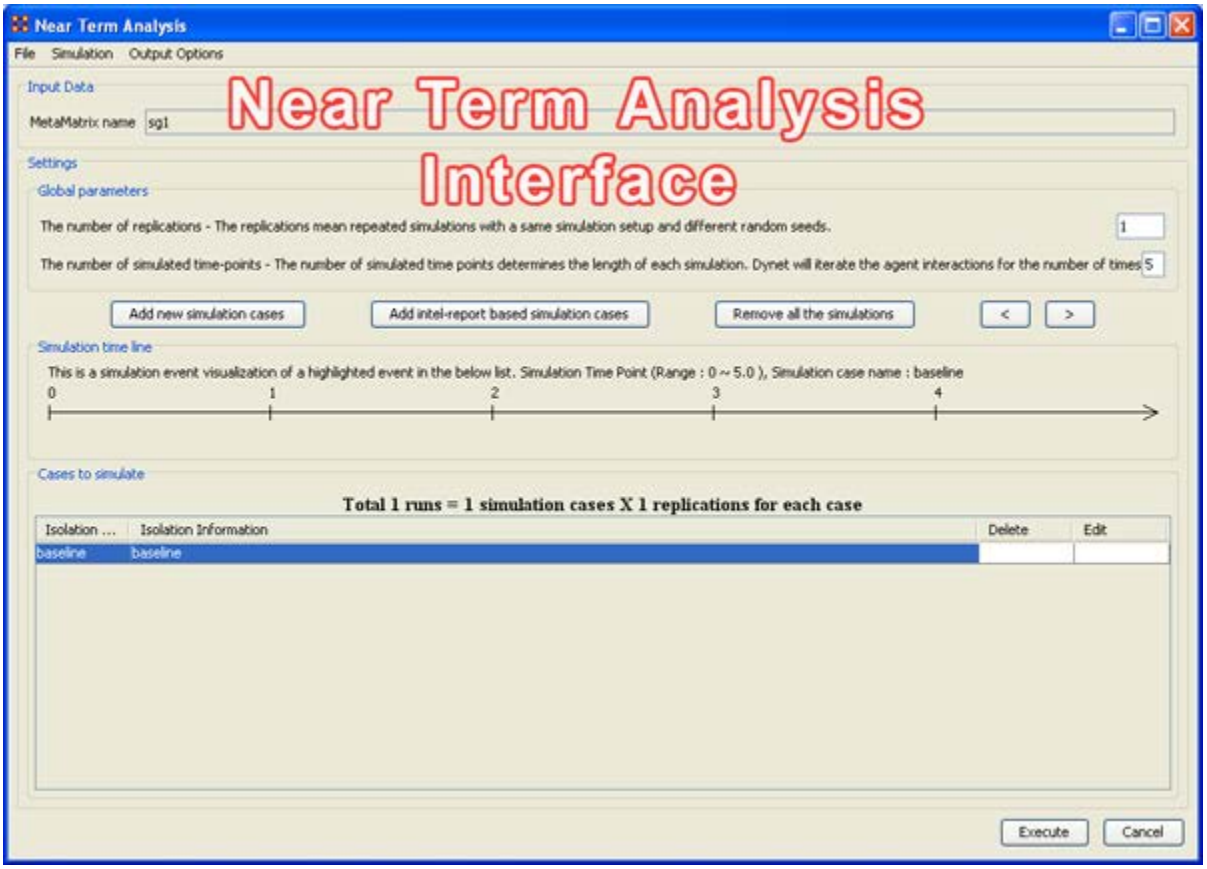
Run the Step-by-Step Wizard – This process will help walk through setting up a near term analysis experiment on the Meta-Network loaded into the Near Term Analysis tool.

Create one simulation case – In this simulation experiment, events and user-specified time can be applied to agents.

Create a set of cases by isolating agents – This scenario isolates one agent and perform an experiment. Then the experiment can be performed again with the agent removed.

Create a set of cases by isolating a set of agents relating to a specific measure. – Based on measures contained in the ORA intel report, a set of agents can be isolated and a simulation case can be created.

Near Term Analysis Menu



File Menu

Save the current simulation setting: Brings up a save box where you can navigate to a directory and save **all** the current simulation settings.

Load a simulation setting from a file: Navigate to a directory to load a previously saved simulation setting.

NOTE : This will remove any settings that are currently active.

Close: Closes the Near Term Analysis window.

Simulation Menu

Execute simulation cases: Begins running the simulation. Same function as the **[Execute]** button at the bottom of the window.

Show the add simulation wizard: Brings up the creation window. same as the **[Add new simulation cases]** button.

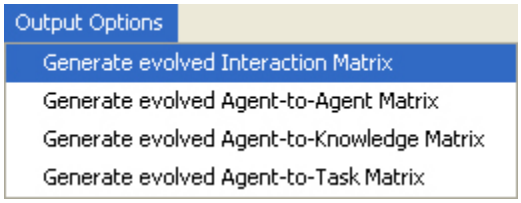
Add ORA-Intel report based simulation cases: Same as **[Add ORA-Intel report based simulation cases]** button.

Edit the highlighted case: Brings up the dialog box to edit parameters for selected event.

Remove the selected cases: Removes selected event from simulations.

Remove all of the cases: Same as the **[Remove all the simulations]** button.

Output Options



These menu items will display in the **Near Term Results** menu:

Generate evolved Interaction Matrix:

Generate evolved Agent-to-Agent Matrix: Displays how agents interact with one another.

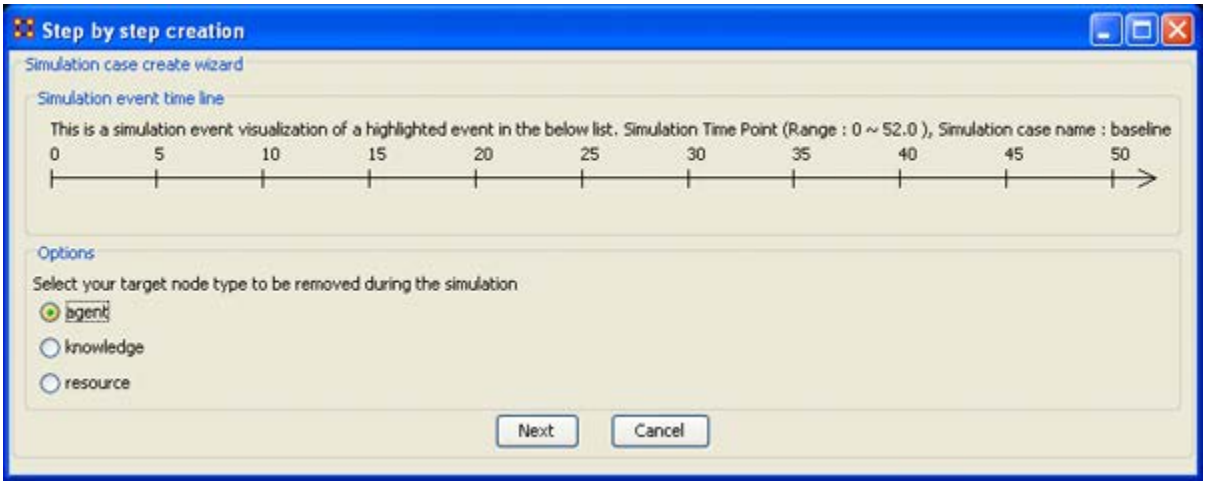
Generate evolved Agent-to-Knowledge Matrix: Displays how knowledge is diffused within the agent network

Generate evolved Agent-to-Task Matrix: Display how tasks are used within a network.

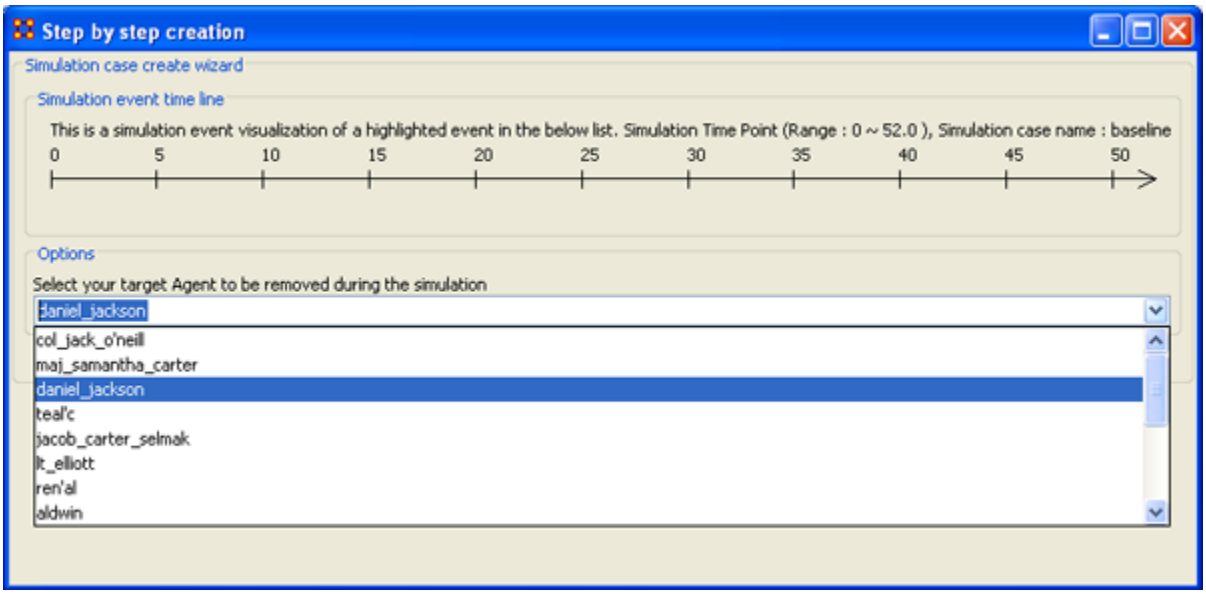
Near Term Impact Option 1

Step-by-Step wizard

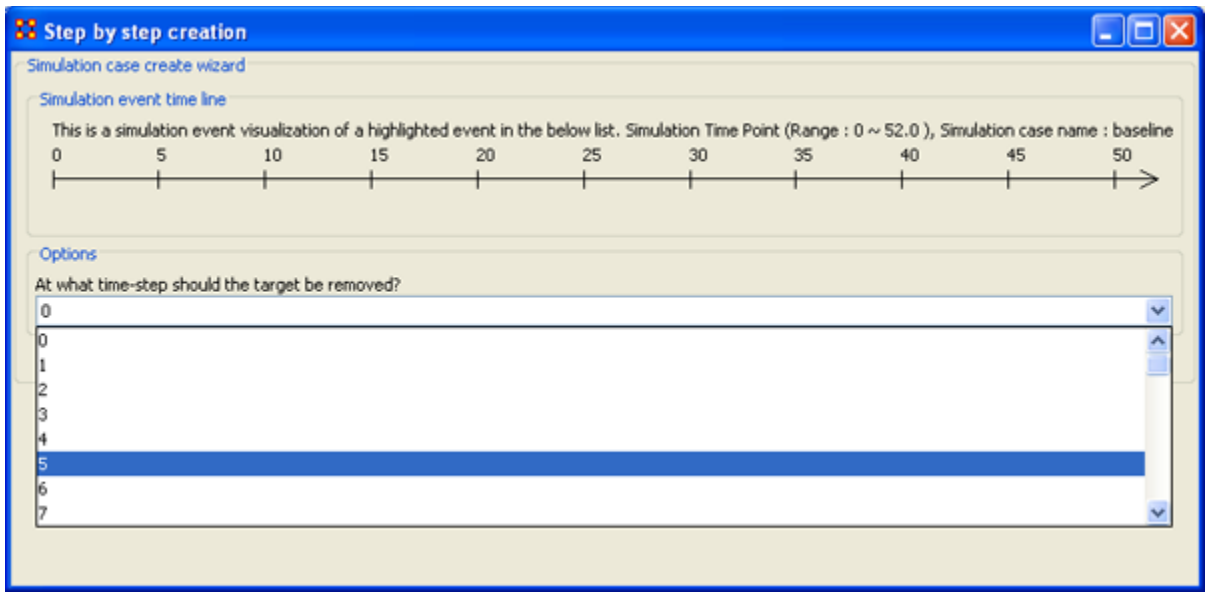
Selecting the first option brings up the **step-by-step creation** dialog box.



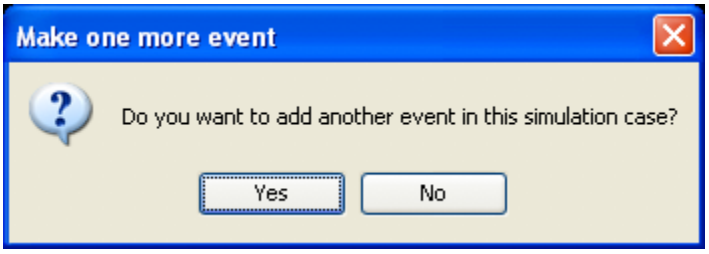
Under **Options** select whether to isolate an **agent, knowledge, or resource**. We'll leave it at agent. Then select the **[Next]** button.



Under **Options** select the agent to isolate. Here we select **daniel_jackson**. The select the **[Next]** button.

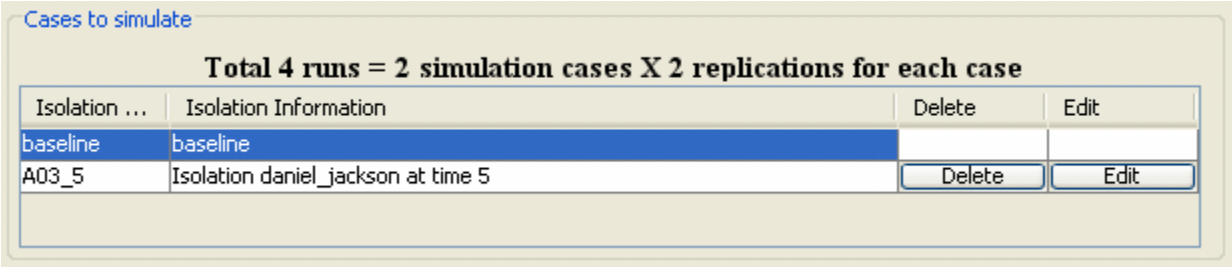


Under **Options** select the time-step to isolate the agent. For this simulation we select **5**. The select the **[Next]** button.

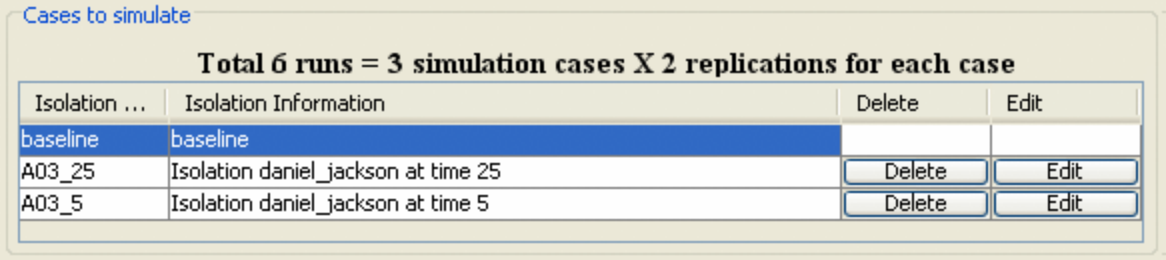


At this point you are asked if you want to add more events to the simulation or not.

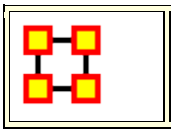
You can add as many **events**as you wish. But for this example we'll only use only one event. Select **[No]** to continue.



Now repeat the steps above and add a **second** simulation. But this time let's remove **daniel_jackson** at time-step 25.



Now proceed to **Analysis Results**.

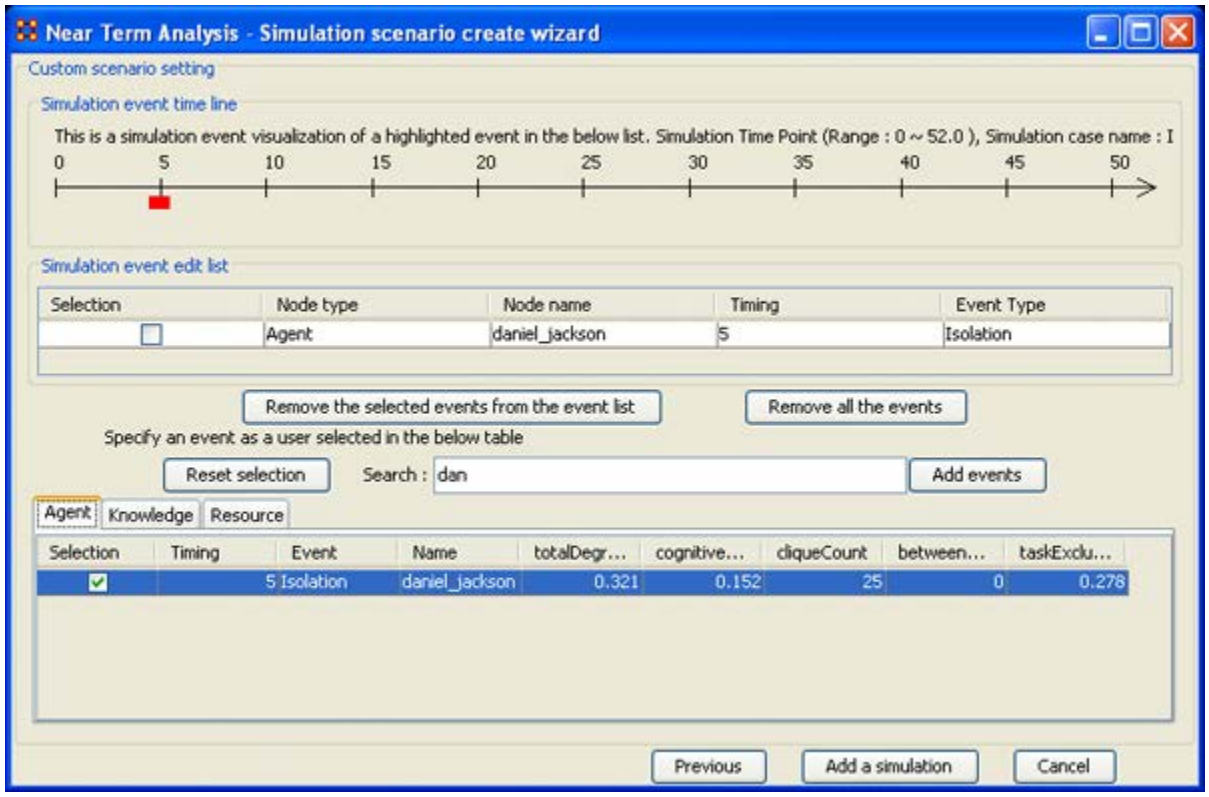


Near Term Impact Option 2

Apply events to specified agents

The second option for creating simulation files is to create one simulation case and apply events to specified agents, knowledge, or resource nodes.

Select the **[Add new simulation cases]** button to bring up the wizard.



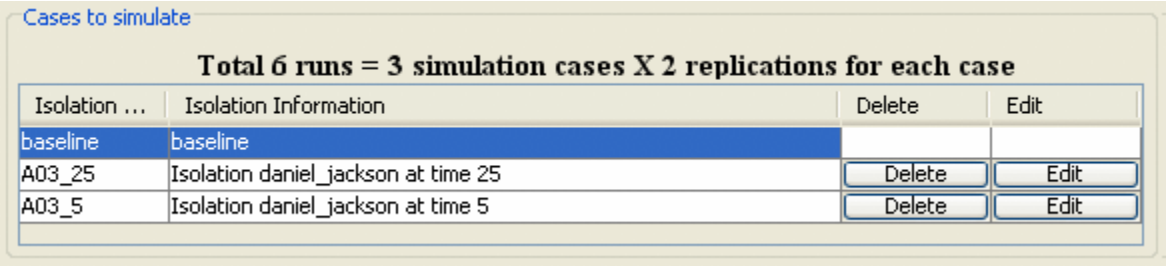
1. Type in a search criteria to highlight only the agents to work with (i.e. typing in **dan** brought up only **daniel_jackson**.
2. Place a checkmark on the line. Notice that when you placed a checkmark in the box the **Event** automatically changed to **Isolation**.
3. Double-click in the **Timing** cell to select it and type in a number from 0 to the highest number you selected for your simulation. In this case we'll repeat with the timing of "5".
4. Select the **[Add events]** button. This places the event in the **Simulation event edit list** section.
5. If there were more events to add you could continue with the same procedure. When you are done, select the **[Add a simulation]** button at the bottom.

The two buttons beneath the **Simulation event edit list** section to remove events from the list. The **[Remove all the events]** button obviously removes everything in the **Simulation event edit list** but the **Remove the selected events from the event list only removes the events with a checkmark beside them.**

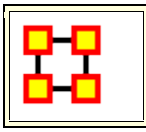
The **[Reset selection]** button removes all check marks placed in the bottom table and sets the Event to **No Event**.

The **[Previous]** button returns to the main Wizard screen.

When you have finished you will have created the same two simulations as in Option 1.



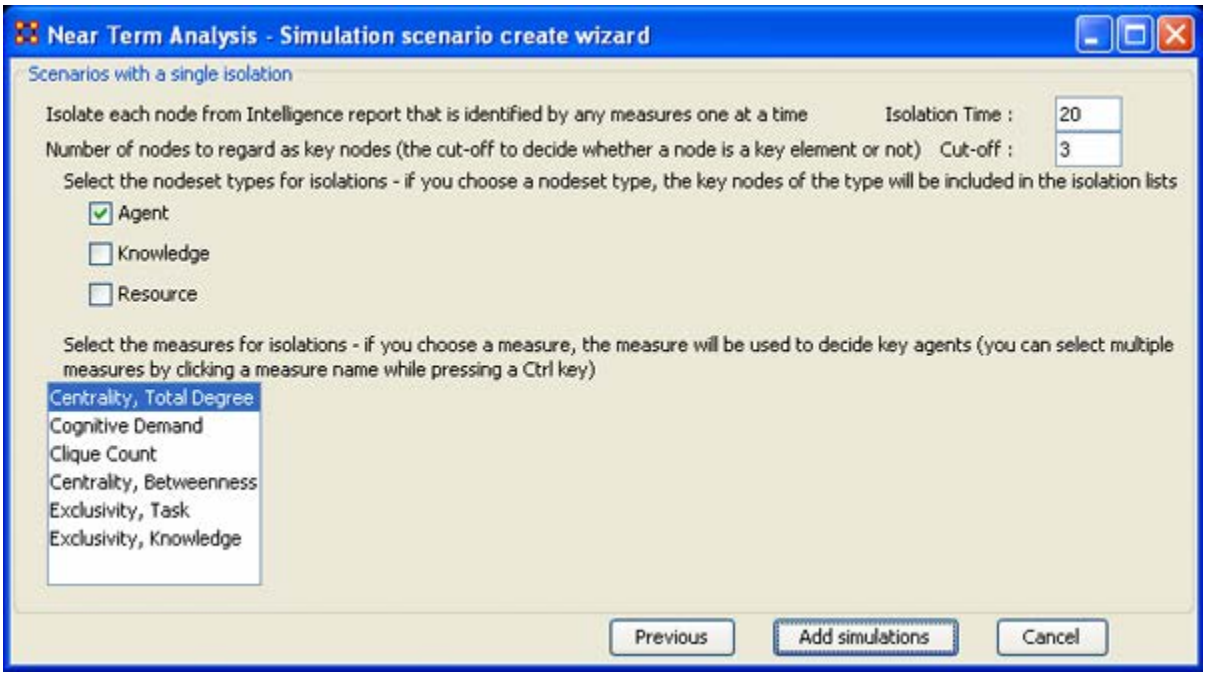
Now proceed to **Analysis Results**.



Term Impact Option 3

Create set of cases using Measures

Option 3 allows for selecting agents/knowledge/resources based on their ranking when certain measures are run on them.



Here are three examples run with the same **Isolation Time and Cut-offs**. Only the measures were changed.

Centrality, Total Degree

Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
daniel_jackson_20	Isolation null at time 20	Delete	Edit
jacob_carter_selmak_20	Isolation null at time 20	Delete	Edit
ren'al_20	Isolation null at time 20	Delete	Edit

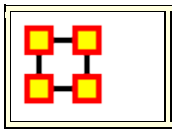
Cognitive Demand

Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
ren'al_20	Isolation null at time 20	Delete	Edit
jacob_carter_selmak_20	Isolation null at time 20	Delete	Edit
daniel_jackson_20	Isolation null at time 20	Delete	Edit

Clique Count

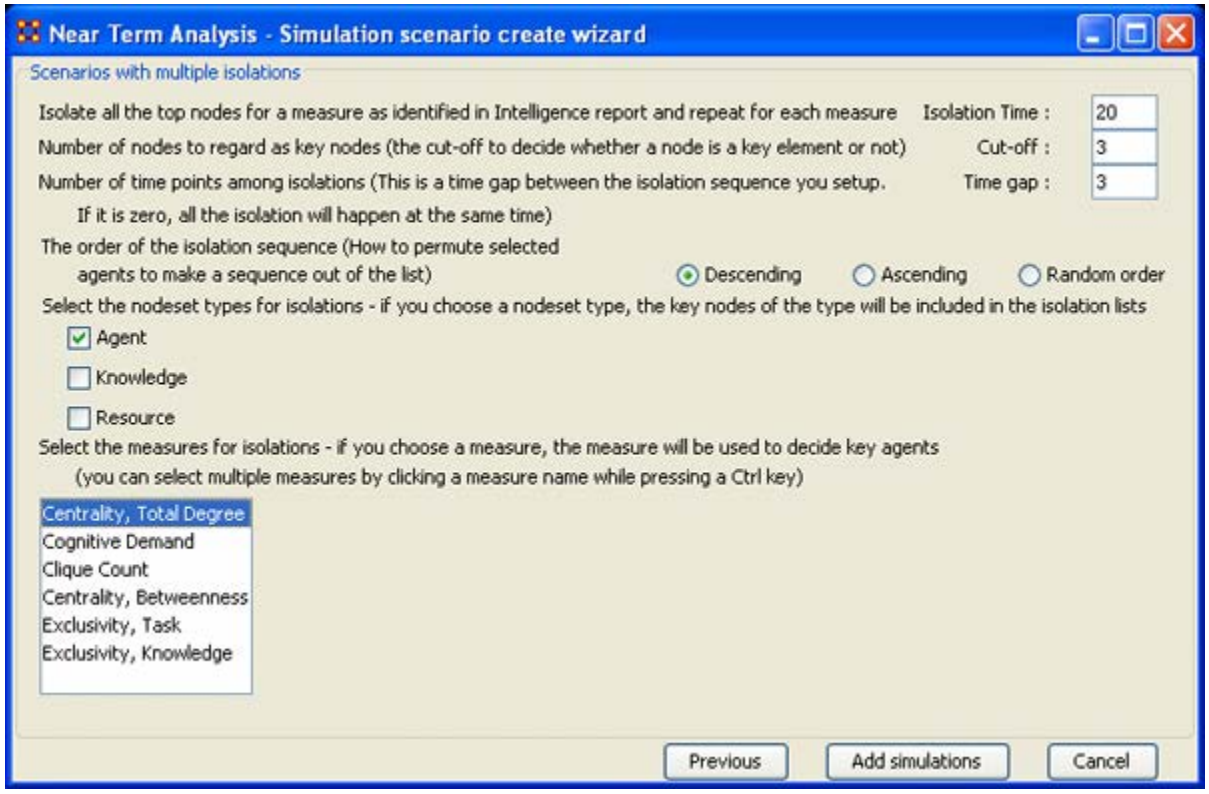
Isolation Case	Isolation Information	Delete	Edit
baseline	baseline		
col_jack_o'neill_20	Isolation null at time 20	Delete	Edit
ren'al_20	Isolation null at time 20	Delete	Edit
daniel_jackson_20	Isolation null at time 20	Delete	Edit

When you have run the measures proceed to **Analysis Results**.



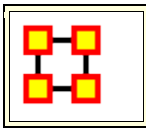
Near Term Impact Option 4

A set of agents by a set of cases by measure(s).



Option 4 allows the addition of adding **Time gaps** between the isolations and whether to isolate them in descending, Ascending, or Random order.

Now proceed to **Analysis Results**.



Near Term Impact Results Menu

Save the Construct launch scripts : Information on Construct can be obtained at the following URL: **http://www.casos.cs.cmu.edu/project/construct/index.html**.

Show text report on the ORA main window : Displays the report in Panel 3 of the ORA Main Interface.

Save the completely evolved Meta-Networks : Will save as an ORA Meta-Network any of the simulation cases with a checkmark in the **Select** column.

Save the html report : Navigate to a directory to save an **html** file that can be displayed in a browser.

Save the text report : Navigate to a directory to save an **text** file.

Save the Knowledge Diffusion line chart : Saves the chart as a **.png** file that can be used in other documents.

Save the Task Accuracy line chart : Saves the chart as a **.png** file that can be used in other documents.

Save the Energy Task line chart : Saves the chart as a **.png** file that can be used in other documents.

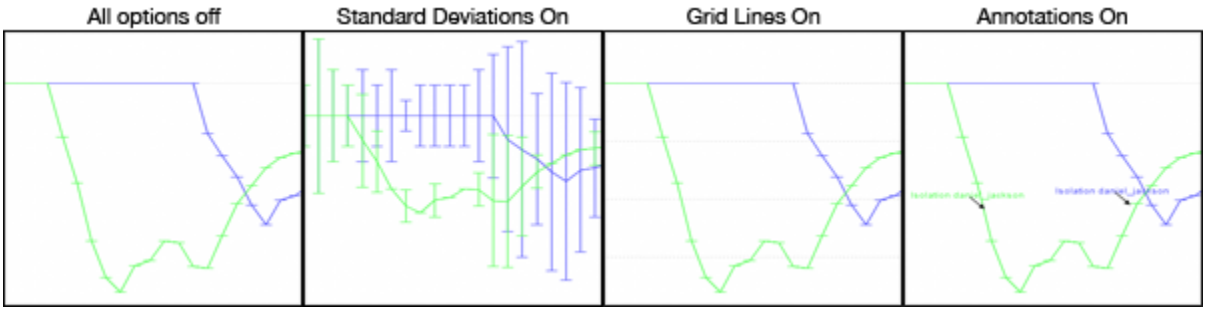
Save the Knowledge Diffusion result CSV file : Saves the results as a **.csv** file that can be used in other programs.

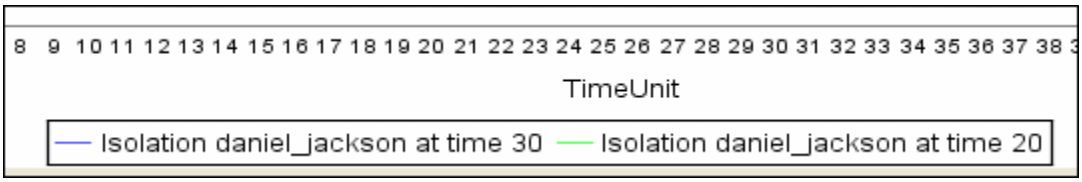
Save the Task Accuracy result CSV file : Saves the results as a **.csv** file that can be used in other programs.

Save the Energy Task result CSV file : Saves the results as a **.csv** file that can be used in other programs.

Close :

Copy the chart in the clipboard : Copies the window to the clipboard that can be pasted into other programs.



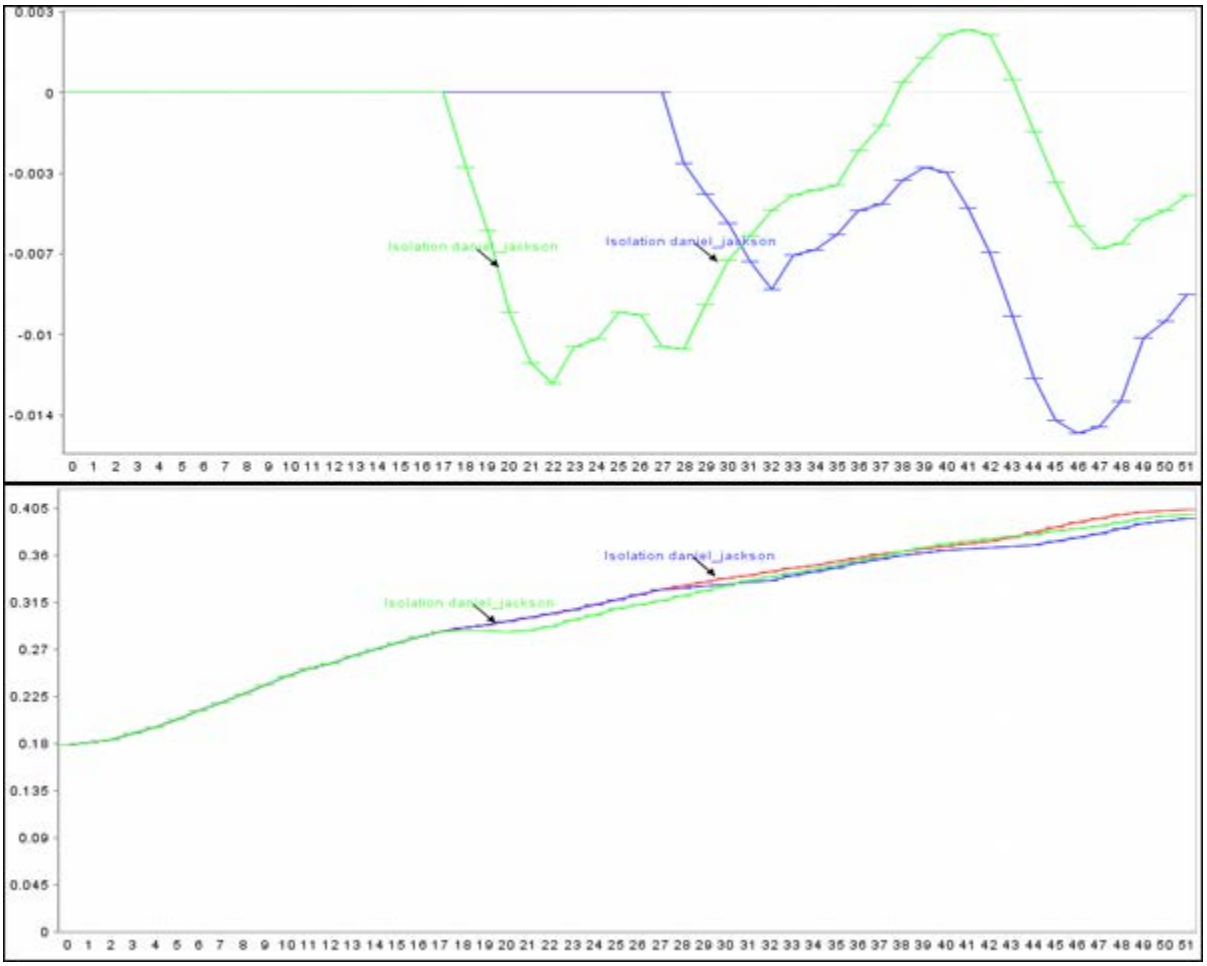


Standard Deviation ranges : **Standard Deviations*** displays the range of values for a particular instance.

Grid lines in the chart : Displays the grid lines for values.

Legends in the chart : Displays the legend underneath the chart.

Event annotations in the chart : Displays the event annotations within the chart.



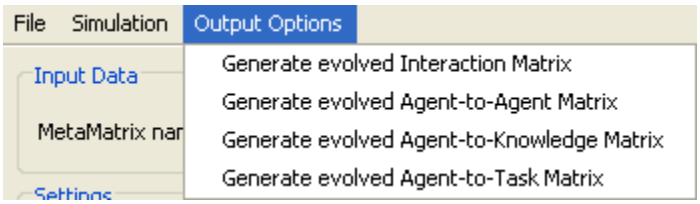
Deviation from the baseline : Using the **baseline** numbers the chart shows the offset for the simulation.

Show actual values : Uses he actual calculated values in the chart.

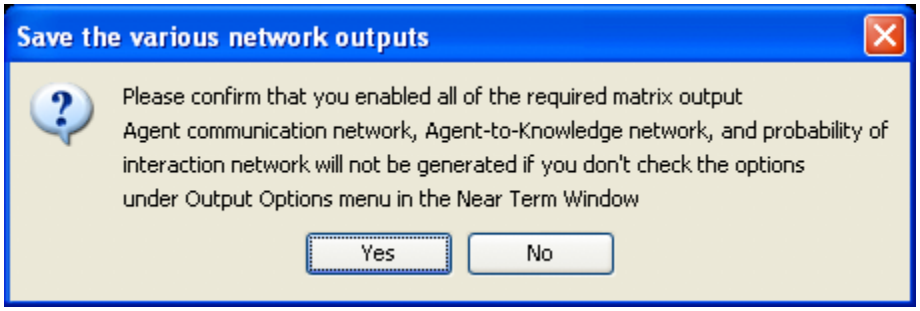
Background color : choose the background color of the chart of either **white or gray**.

Near Term Impact Results

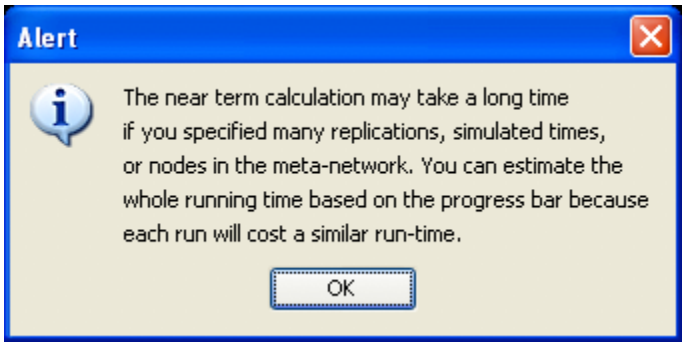
Now we're ready to Execute the simulations. But before that you must select the type of **Output Options** you want. From the Near Term Analysis menu select **Output Options ⇒ {any or all of the four options}.**



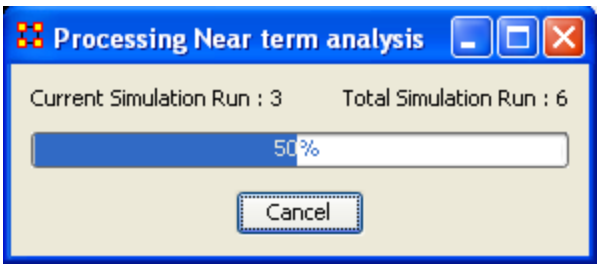
Now select the **[Execute]** button in the bottom-right corner. This will bring up two dialog boxes asking you to confirm you're selected output options and then an alert telling you that, this may take a while with a large Meta-Network and a lot of simulation runs.



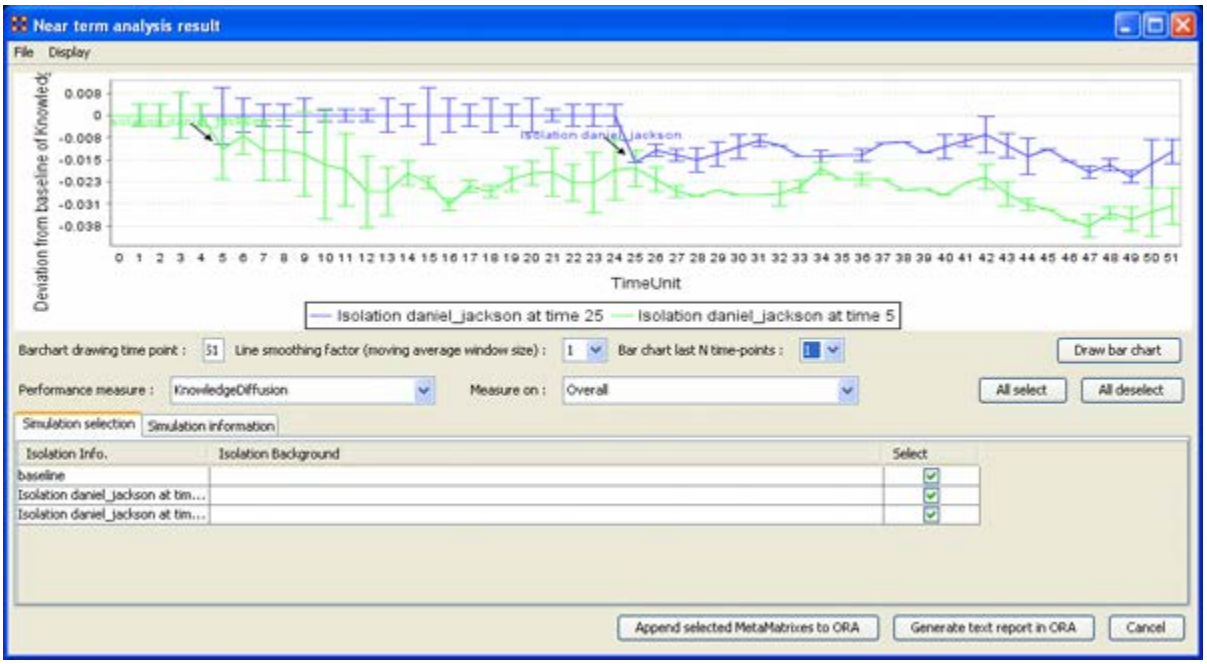
An alert box will display advising you that the near term calculation may take a long time depending on settings of your experiment.



After selected **[Execute]** the **Processing Near Term analysis** dialog will show you the progress.



Next will be displayed the **Near Term Analysis results** window.



The results of the experiment will compare against the baseline data established prior to the removal of any isolated agents. In the example above, we can see how the network was impacted in the time line when we isolated **daniel_jackson** and removed this node from the data set.

Further information can be obtained form the following references:

For knowledge diffusion and energy task

Schreiber, C. (2006) Human and Organizational Risk Modeling: Critical Personnel and Leadership in Network Organizations, PhD Thesis, Carnegie Mellon University, CMU-ISRI-06-120

For binary task accuracy

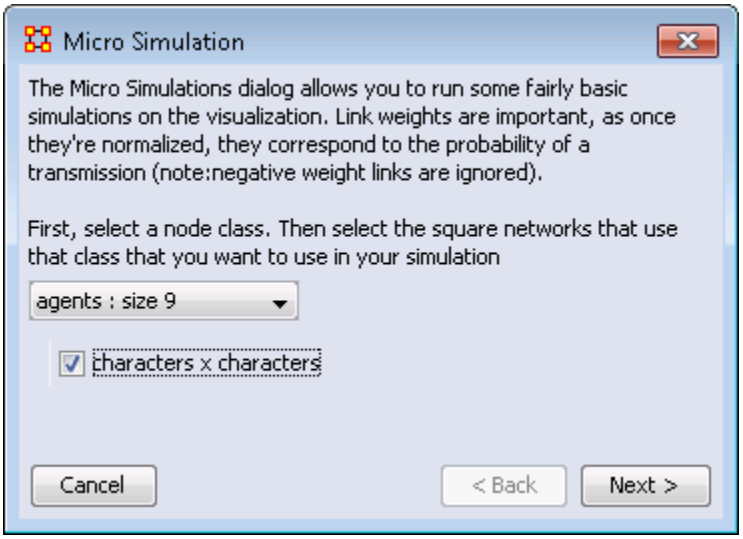
Lin, Z., K. Carley. 1997. Organizational response: The cost performance trade-off. Management Sci. 43(2) 217-234.

Micro Simulations

The Micro Simulation exists in both the **Editor** and in the **Visualizer**. The difference is the Visualizer version is mainly used to visualize **as it happens**. The Editor version is used to create simulation data.

Procedure

The first thing it requests is a Nodeset. After that it will give you a choice the square networks comprised of that Nodeset. This creates a new meta-network consisting of **a single Nodeset** with the same nodes as the input Nodeset, and **a single network** with the same links present in the selected networks. If multiple networks are selected and multiple links from node A -> node B are present, the resulting link from A -> B has a weight equal to the sum of all A -> B links.



Once a new Meta-Network is defined it takes all the links and normalizes them between zero and one. The link weight then corresponds to the probability that a transmission will occur down that link. This means that **both Link Direction and Link Weight** play an important role.

The Simulations

The Simulations are **Disease, Money, Information, and Technology** and are types of flows. At any given timepoint, any node that has one of those things is going to try to give it to someone else. And each flow has its own rules.

Types of Simulation Flows

Disease : An entity can not re-get the disease, and an entity can only give out the disease while it has the disease. The entity can also give out a disease to multiple other entities. After a user-specified number of time periods, the entity loses the disease.

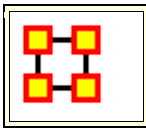
Money : Once an entity gives away the money, he cannot give the money to anyone else. There is no limit on re-getting the money.

Information : Once an entity gets information, they cannot lose it. They also never stop giving out the information.

It's important to understand how these transmissions occur. During the **transmission** phase ORA looks at every node that has a resource. It then iterates through all outgoing links, trying to give that resource through that link (in the case of money, since it can only go through one link, we randomize the order links are tested). When looking at a link, if checks to see if the transmission can occur based on the link weight. Another check is made to see if the transmission can overcome the transmission resistance.

These checks are continued based on the rules outlined above for the user specified number of time periods. Then a dynamic meta-network is generated that shows for any given time period what node was associated with a resource.

Adoption of Technology : is a unique simulation. A node is more likely to adopt a piece of tech if it has many neighbors trying to convince it to adopt the tech. A node is more likely to un-adopt a piece of tech if the node has fewer neighbors also using the tech.



OrgAhead

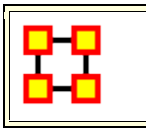
NOTE : This function only available in the full version.

Description

An organization should be capable of estimating its short-range performance. **ORGAHEAD** is an organizational learning model designed to test different forms of organizations under a common task representation. Each member of the organization receives information from a subordinate or from the environment then makes a decision based on the information and what he or she has learned so far. They then provide their superiors with an answer to the decision. These decisions are either **yes/no** or **yes/maybe/no**. ORGAHEAD falls in the class of intellective models; it is not designed to simulate exact behavior, but capture dynamics, important from a theoretical standpoint.

Structure

ORGAHEAD tests a single quasi-hierarchical organization containing up to three levels which run from top to bottom" **CEO, Manager, and Analyst**. The organization does not have to take a pure hierarchical form as the information or reporting **has** to travel upward from the task to CEO. For instance, an Analyst can report directly to the CEO, but can never report to another analyst. Similarly, a CEO can have a direct link to a task bypassing any managers or analysts.



OrgAhead Initial Format

NOTE : This function only available in the full version.

Input Format for Initial Org Arguments

Each of these arguments takes a quote-enclosed string. The string given should consist of words separated by spaces, each word

indicates the resources to give to a person. For example **a 0b cd** means create 3 people, the 3rd gets two resources, and the others each get one.

Each word should consist of characters indicating the resources given to this new person. For example, the string **abc** means the new person gets the first 3 resources of the immediate lower level (i.e. CEO gets managers who get analysts who get tasks). Each character may have a modifying digit preceding it. The modifying digit can be '0' for task, '1' for analyst, or '2' for manager. Case is not important. This indicates that the level of the resource the person sees is not necessarily the default level for the person. For example **0b** indicates the person gets task B, even if the person is a manager or CEO. **a1bc** means the person gets resources A and C of the default level, and analyst B. (Of course, if the person is a manager, saying **abc** would have been the same as **a1bc**.) A **-** indicates a person with no resources (who has to randomly guess at the answer), and a **.** indicates no person (a silly thing to input, but nonetheless, it can be done). Passing an empty string indicates that there shall be no members on the level associated with the argument; however, if all three arguments get empty strings (-analysts, -managers, -ceos), then a random org is created for each simulation.

In addition, the -president switch indicates if the org should have a President, who oversees all CEOs and any unsupervised managers or analysts.

Output format for Organizations (seen if -print_organization is specified)

This format specifies the org's structural hierarchy, who supervises whom. If -print_organization is specified, it is printed once before simulation starts, once at the end, and every time a change to the org is made. Here is what a sample org might look like:

Organizational structure is: President: abc

```
a1a0a b1b0b 1c0c
abcgi defh
a b c d e f g h i
```

The bottom line indicates that the first analyst sees task A, the second analyst sees task B, and so on. The next line up shows 2 managers; the first one supervises the first, second, third, seventh, and ninth analysts, and the second manager oversees the other ones.

The top line depicts three CEOs. The first one oversees the first manager (A), as well as the first analyst (1A) and ask (0A). The second one sees the second manager, analyst and task. The third one oversees the third analyst and task. Finally, the first line indicates that this org has a President, who supervises the three CEOs.

Orgstat reads orgs from a file or stdin in this same format. It only reads orgs whose preceding line reads **Final Organizational structure is**. This way you could pipe output of orgsim to orgstat, and orgstat will ignore initial and intermediate orgs, using only final orgs, one for each simulation performed.

Output format for People (seen if -print_person is specified)

This format specifies the experience of every person in the org. If-print_person is specified, this data is printed for every person after each efficiency check. Here is what a single person's experience might look like:

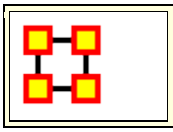
Manager #1 has resources: A1 T2 Eff: 43.00% (Recent: 43%) from 400 tasks. For pattern: 1 1

```
42 = 41 1 0 | 31 0 0 8 0 0 10 0 0 = 49
13 = 12 1 0 | 12 1 0 1 0 0 6 0 0 = 20
3 = 3 0 0 | 3 0 0 1 0 0 0 0 0 = 4
```

For pattern: 1 2

From the top line, we see that the first manager oversees the first analyst and the second task. He has an overall efficiency of 43.00, and a 43% relative efficiency from the last efficiency check. And he's seen 400 tasks. Then we will see a listing of each pattern he may see; only his output for pattern (1 1) is shown above. The data is collected into 4 3x3 matrices, and they indicate his absolute, initial, relative, and old relative experience, from right to left. The rows indicate what the correct answer was (top=1, middle=2, bottom=3), and the columns indicate what he guessed (left=1, middle=2, right=3). So, in the full 400 tasks, where the pattern (1 1) emerged, the answer was 1 42 times, and 41 of those times he guessed 1. However, when he started off (initial experience) there were 31 1's and he guessed correctly every time. Since the last efficiency check, there were 8 1's, and he guessed them all, and in the previous efficiency check, there were 10 1's and he guessed them all correctly

again. The numbers on the left and right sides are sums, the right ones are useful in judging how he will react the next time he sees (1 1) Since the answer was 1 42 times (from the left side), we figure he'd be best to guess 1. That's what he'll do, because the right number (49) isgreatest on the right side.



OrgAhead Output

NOTE : This function only available in the full version.

Output format for Organizations (seen if -print_organization is specified)

This format specifies the org's structural hierarchy, who supervises whom. If -print_organization is specified, it is printed once before simulation starts, once at the end, and every time a change to the org is made. Here is what a sample org might look like:

Organizational structure is: President: abc

```
a1a0a b1b0b 1c0c
abcgi defh
a b c d e f g h i
```

The bottom line indicates that the first analyst sees task A, the second analyst sees task B, and so on. The next line up shows 2 managers; the first one supervises the first, second, third, seventh, and ninth analysts, and the second manager oversees the other ones. The top line depicts three CEOs. The first one oversees the first manager (A), as well as the first analyst (1A) and ask (0A). The second one sees the second manager, analyst and task. The third one oversees the third analyst and task. Finally, the first line indicates that this org has a President, who supervises the three CEOs.

Orgstat reads orgs from a file or stdin in this same format. It only reads orgs whose preceding line reads **Final Organizational structure is**. This way you could pipe output of orgsim to orgstat, and orgstat will ignore initial and intermediate orgs, using only final orgs, one for each simulation performed.

Output format for People (seen if -print_person is specified)

This format specifies the experience of every person in the org. If-print_person is specified, this data is printed for every person after each efficiency check. Here is what a single person's experience might look like:

Manager #1 has resources: A1 T2 Eff: 43.00% (Recent: 43%) from 400 tasks. For pattern: 1 1

```
42 = 41 1 0 | 31 0 0 8 0 0 10 0 0 = 49
13 = 12 1 0 | 12 1 0 1 0 0 6 0 0 = 20
3 = 3 0 0 | 3 0 0 1 0 0 0 0 0 = 4
```

For pattern: 1 2

From the top line, we see that the first manager oversees the first analyst and the second task. He has an overall efficiency of 43.00, and a 43% relative efficiency from the last efficiency check. And he's seen 400 tasks. Then we will see a listing of each pattern he may see; only his output for pattern (1 1) is shown above. The data is collected into 4 3x3 matrices, and they indicate his absolute, initial, relative, and old relative experience, from right to left. The rows indicate what the correct answer was (top=1, middle=2, bottom=3), and the columns indicate what he guessed (left=1, middle=2, right=3). So, in the full 400 tasks, where the pattern (1 1) emerged, the answer was 1 42 times, and 41 of those times he guessed 1. However, when he started off (initial experience) there were 31 1's and he guessed correctly every time. Since the last efficiency check, there were 8 1's, and he guessed them all, and in the previous efficiency check, there were 10 1's and he guessed them all correctly again. The numbers on the left and right sides are sums, the right ones are useful in judging how he will react the next time he sees (1 1) Since the answer was 1 42 times (from the left side), we figure he'd be best to guess 1. That's what he'll do, because the right number (49) isgreatest on the right side.

Output format for Tasks (seen if -print_task is specified)

This format specifies what happens for each task, what everyone decides, what the org decides, and what the correct answer was. If -print_task is specified, this is printed for each task. Here is what a single task might look like:

```
3
2 2 1
1 2 2 2 2 1 2 2
2 2 2 2 2 2 2 2 A: 3 D: 3
```

The bottom line shows that all the task bits were 2. The next line up indicates that the first (leftmost) and 6th analysts guesed 1; the others guessed 2. The next line shows that the first two managers guessed 2 while the third guessed 1. The top line shows that the CEO guessed 3. At the end of the bottom line, one can see that the answer was 3, and so was the decision.

Output format for Efficiency (seen if -print_efficiency is specified)

This format specifies what happens for each efficiency check, how everyone is doing, and how well the org is doing. If -print_efficiency is specified, this data is printed out during each efficiency check, before any orgal changes take place. A sample efficiency check might look like:

```
Organizational Efficiency: 53.00% Overall: 54.03%
54.00 54.00 37.00 54.00 54.00 54.00 54.00 45.00
54.00 45.00 54.00 50.00
37.00 53.00 48.00 45.00 47.00 51.00 56.00 47.00
```

The org's overall efficiency is 54.03%, while its relative efficiency (since the last efficiency check) is actually 53%. From the bottom line, we see the analysts all had efficiencies ranging from 37-56%. The managers, one line above, ranged from 45-54%, and the CEOs ranged from 37-54%.

Output Format for Orgstat

This section describes the output orgstat generates. A sample output might look like this:

Data Organizational structure is:

```
ab c - - - - - - -
abc def ghi - - - - - -
a b c d e f g h i
Connectivity = 0.5257 Hierarchy = 1.0000 ...
```

Data Organizational structure is:

AVG: 1.0000 SD: 0.0000 MIN: 1.0000 MAX: 1.0000 Connectivity
AVG: 1.0000 SD: 0.0000 MIN: 1.0000 MAX: 1.0000 Hierarchy

Central Graph Organizational structure is:

```
ab - - - - - - - -
abc def ghi - - - - - -
a b c d e f g h i
Connectivity = 0.1648 Hierarchy = 1.0000 ...
```

Hamming distribution (for nonparametric confidences):

```
1th: 1
2th: 1
...
10th: 7
Confidence at 90% = 4
Confidence at 95% = 7
Confidence at 98% = 7
```

First, orgstat prints out each org it just read in (after the org has been 'reduced' by orgstat's congruence algorithm.) After each org, it prints out some statistics about the directed-graph represented by the org's hierarchical structure. It prints out the means and standard deviations of the statistics. It then prints out the central graph of the 'data' orgs, along with statistics about the central graph. Then it optionally does the bootstrap analysis; in this case we used nonparametric random graphs. It creates a list of Hamming metrics, sorts the list, and prints it out. There were 10 samples used here, and the largest one was 7. Then it prints the 90% confidence metric, as well as the 95% and 98%.

Orgstat can also take as input a set of adjacency matrices, in which case the output will also be represented as adjacency matrices. There is also a -matrix switch to orgstat which forces it to output matrices even if orgs were read in.

OrgAhead Experience

NOTE : This function only available in the full version.

Experience; How each Member Learns

Each person has a set of resources, which may be tasks, or the decisions of his inferiors (or both). From these resources, he sees a 'pattern', a single vector of numbers ranging from 1-3, and he must guess if the true answer is 1, 2, or 3 based on this pattern. He does this by storing experience matrices for every possible pattern. So when he next sees that pattern, he knows what the answer has been recently, and therefore can make a good educated guess on what the answer will be this time.

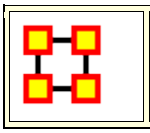
For each pattern, he stores 4 matrices. The first one, known as the initial matrix, records all of his experience while he is being trained. (He is in training as long as he has less than 500 tasks, this number is passed to the program under the paremeter Training_Period). When he is no longer in training this matrix ceases to be incremented.

He also stores relative experience and old relative experience. Assuming an efficiency check occurs every 100 tasks (the default), his relative experience will encompass all tasks he has seen since the last efficiency check (which will be less than 100 tasks). After the next efficiency check, his relative experience matrix gets copied to his old relative experience matrix, and then gets zeroed. So his old relative experience matrix records his guesses for the last 100 tasks before the last efficiency check.

The fourth matrix records his absolute experience, it gets updated for every task he views, but he does not use it in making decisions; it mainly exists to examine his efficiency.

Each matrix is a 3x3 matrix indicating how many times the member guessed 1,2, or 3 and how many times the answer was 1, 2, or 3. Whenever a person receives feedback, he increments a single index in his relative and absolute matrices, as well as his initial experience if he is still in training. As long as a person's resources don't change, his matrices give an accurate history of what tasks have transgressed.

When his resources change, then the numbers of his matrices will be altered to reflect the change. If he loses a resource, then the matrices that represent patterns only differing by that resource are summed together. When he adds a new resource, all his matrices are triplicated and divided by 3. Thus, adding and then deleting a resource should leave experiene matrices close to their initial values (there will be precision errors from discarded remainders when dividing numbers by 3).



OrgAhead Change

NOTE : This function only available in the full version.

Making a Change in the Org

Org change is handled very formally, and has different meanings in orgsim and orgahead. However, both treat change very similarly, so we will look at their similarities first, and then the difference in org change that distinguishes orgsim from orgahead.

Orgsim and orgahead conduct org change differently, but they may only change the org at specific points in the simulation. Periodically they stop simulation and attempt a change...if a change succeeds, the simulation continues with the changed org, otherwise, the original org continues until the next time for changing comes up.

There are five ways to change an org: hire someone new, fire someone, add a connection between two members, or a member and a task, change a connection, and delete a connection. Each of these may be done several times at once, but all the times must apply to the same level (or levels). For example the org can hire 3 new analysts, or change 2 connections between managers and tasks, but it may not hire an analyst and a manager at the same time.

Once a specific type of change is requested, orgsim and orgahead both proceed with the type of change in the same way. First they decide how many such changes can occur. This can be specified as either a constant (hire 2 people), or the program can be instructed to randomly decide how many changes to do based on a Poisson distribution.

Next, the programs pick a level of the org (for hiring and firing), or they pick a superior and inferior level (for add/change/delete connections).

Then they must decide which people on the levels picked are influenced. Usually there are parameters to decide this, and the options will be adjectives like **best**, **worst**, **busiest**, **laziest**, and **random**. Specifying **best** means use the person on that level with the highest relative efficiency, and **worst** means the person on that level with the lowest relative efficiency. Similarly **busiest** means the person on that level with the most tasks and **laziest** means the person with the least tasks. Finally, **random** means pick anyone on that level without regard to their efficiency or resources.

At this point the idiosyncracies of each change come into play. The behavior of each change is described below:

For hiring, the level chosen indicates at what level the new member will exist in the org. If that level is full of members (the number of members meets a limit variable set by the program), no one may be hired on that level. The new person can receive no resource, or a random task or inferior person to supervise. Or he can receive resources from a 'mentor', a colleague on that same level. Like all members chosen, you can elect to use the busiest, laziest, best, worst, or random person to be a mentor. The mentor gives half his tasks to the new person. You may elect to have the mentor continue to supervise the resources he gave away, or to drop them. Finally a superior on the next level is assigned to supervise the new person (unless the new person is a CEO).

The above scenario is typical for when a person is hired on a level that already has people on it (who could serve as mentors). When a person is hired on a level with no current people on it, the program behaves slightly differently, depending on the level. When a CEO is added to an org with no CEOs, he supervises all the managers, or all the analysts if there are no managers. When a manager is added to an org with no managers, he supervises all the analysts, and the CEOs that were (presumably) supervising the analysts drop them. Or the manager supervises all the tasks if there are no analysts. When an analyst is added to an org with no analysts, he gets all the tasks his supervisor is currently overseeing. One final note: instead of a person supervising all the resources on a level, the program can be directed to give him one resource at random on that level instead.

For firing, the level chosen indicates what level the 'victims' occupuy. A victim must be chosen from the level, and all his resources are given to one of his colleagues. It is possible to fire the last member on a level, but only if other members exist on other levels... you cannot fire the last person in an org. As with hiring, the programs behave slightly differently when the last person on a level gets fired. When the last CEO gets fired, his resources go to anyone that can supervise them (keeping mind that a supervisor must be on a higher level than a resource he must supervise). When the last manager gets fired, his task resources go to the analysts, and his analyst resources go to the CEOs if the CEOs were supervising the manger. When the last analyst gets fired, his tasks get distributed amongst his supervisors, or the existing managers, if no one is supervising the analyst.

When adding a connection, two levels must be chosen, the level of the superior and the level of the inferior, and someone on the superior level winds up supervising someone (or something) on the inferior level. The program first deciides if the inferior resource must be an 'orphan' resource, that is, the resource is currently not supervised by anyone on the superior level. Then it picks an appropriate inferior resource, and superior person, and directs the superior to supervise the resource. (It ensures that the superior is not already supervising the resource.)

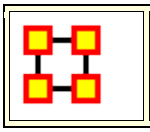
Changing connections also requires a superior and inferior level, and it is not possible to change a connection from level A to level B if there is no connection there in the first place. For example, you cannot change a manager-task connection if no managers are supervising tasks. First it picks a person on level A and resource on level B on which a connection exists. Then, it picks, either a second person on level A, or a second resource on level B, depending on whether it has been instructed to change the connection on the superior side or the inferior side, and makes the change.

Compared to the above, deleting connections is quite simple. A member on the superior level is found, who contains a resource on the inferior level chosen, and he loses that resource. Easy, isn't it?

Orgsim and orgahead differ in how they decide what kind of change to make Orgsim assigns for each change, a threshold. As long as the relative efficiency does not change by more than that change's threshold, the org will not undergo that change. Also, if a change is

successful, the org cannot be changed for a period of time depending on the type of change.

Orgahead ignores thresholds. It uses simulated annealing to determine what kind of change would be profitable...if a particular change improves the org, or at least, does not worsen the org significantly, that change is implemented, and the new org continues simulating, otherwise the old org continues until the next opportunity for change.



OrgAhead Murphies

NOTE : This function only available in the full version.

How To Handle Murphies

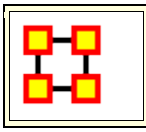
In organizational jargon, a 'murphy' is an event that embodies Murphy's Law; i.e. it is some catastrophe that afflicts orgs. A murphy can be represented as a person being lost, due to the person leaving the org, or disappearing. Or it can be represented as a line of communication that breaks, where one person cannot contact another, although both people are functioning perfectly fine in all other aspects.

Orgsim and the other programs provide flexible enough parameters to handle murphies, although they aren't implicitly aware of what a 'murphy' is. Here is how you would specify murphies to orgsim:

A murphy that destroys a person can be simulated in orgsim by firing a random number of people at a random level at a random time. Unlike normal firing, the org doesn't plan the action, so it does nothing (immediately) to reallocate resources. So the victim's resources are not immediately allocated to other colleagues. Of course, orgsim cannot destroy the last person in an org. Murphies should be used with hiring enabled, which simulates an org losing people at random intervals and having to patch itself up by hiring new people.

There is another type of murphy; it destroys a communication line between two people, leaving them otherwise intact. This is identical

to deleting a random connection between two random people at two levels. This can be done with adding and changing connections enabled, which simulates an org trying to compensate for losing communication lines at random intervals.



OrgAhead Task Problems

NOTE : This function only available in the full version.

Task Problem Specification

The task problem determines how to determine the actual solution from the task bits. Generally, you can use a decomposable problem (where each task bit has the same weight as any other), or a nondecomposable one. You can also determine that the task should be biased (lean heavily towards an answer of 3) or unbiased (equal probability on all answers). These can be specified by the nondecomposable and -biased switches.

First a total is determined from the task bits, and then it is compared against two cutoffs. If the total is less than the first cutoff, the answer is 1, if it is less than the second cutoff the answer is 2, otherwise the answer is 3. The -nondecomposable flag affects the cutoff points, and so does the -biased flag. Additionally, you can tweak the -cutoff_friendly and -cutoff_hostile flags to introduce whatever level of bias you please.

If a decomposable problem is used, the total is the product of the task bits. Otherwise, the following formula is used:

```
Total = 2*t1*t2*t3 + 2*t4*t5 + t6 + t7 + 2*t7*t8*t9
```

If the cutoffs are not specified, the following cutoff values will be used:

```
Friendly Biased Unbiasd Hostile Biased Unbiased
Decomposable 71 109 Dceomposable 287 432
Nondecomposable 28 34 Nondecomposable 42 49
```

Visualization

Measure Charts : When run this function will plot the three graphs, **Bar Chart, Scatter Plot, and Histogram** on the chosen Network.

View Measures Over Time : Requires multiple Networks. First plots points for measure selected on each of the Networks active with the option to see a direct line from the earliest to the latest point.

View Network Over Time : Requires multiple Networks. Displays nodes and links for each of the active Networks.

Network Drill-Down: Allows for quick, plotting of nodes connected to a chosen node.

Node Cloud : Create an image with higher used concepts showing up in larger font sizes.

Color Grid : Creates a colored grid representing the networks. White cells represent no connections.

Network Block :

GeoSpatial Networks : Analyze, forecast, and visualize a wide variety of spatial interactions and networks within a global-scale. **See *GeoSpatial/Loom* > *GeoSpatial* for more information**

View Trails : Works with nodes moving between places over time. Requires the use of a trailset.**See *Loom* for more information**

View Trails in GIS :

View Networks

3D Visualization : Visualizes the selected network in the 3D Visualizer



2D Visualization : Visualizes the selected network in the 2D Visualizer



Path Finder : is used to find, not only, the shortest path between two nodes but also paths to other nodes when particular situations occur.



Sphere of Influence : Each node within a network has a unique Sphere of Influence or Ego Network. Essentially it's a direct relationship with it's neighbors as a function of specified path length. The ORA Visualizer allows you to focus on this relationship by creating an Ego Map centered on any particular node you choose.



Key Set Selector : uses information input by the user to create a simplified visualization.



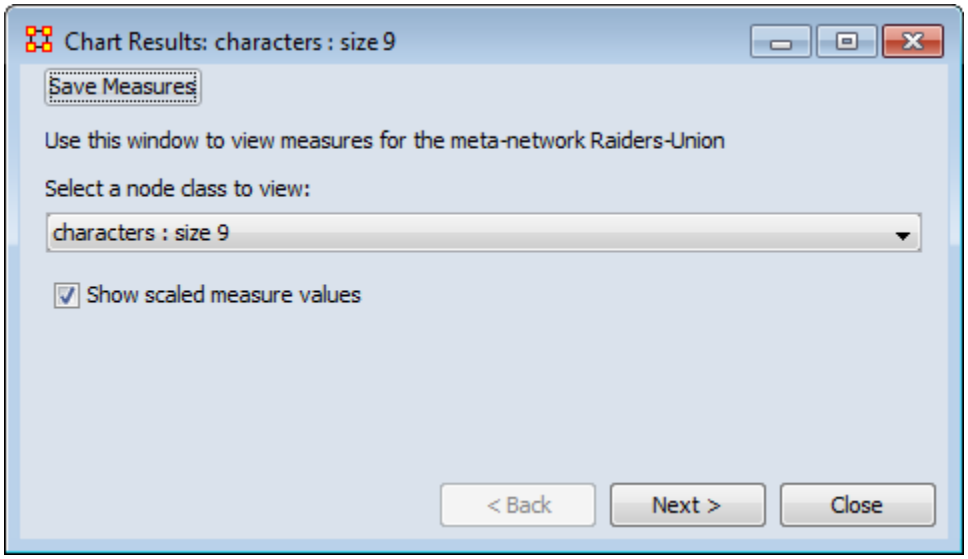
Blank Visualization : Opens the Visualizer with no active Meta-Network. Allows you to create Nodesets and Networks from scratch.

Measure Charts

Below are examples of each type of ORA charts: **Bar Chart, Scatter Plot, Histogram, and Regression.**

NOTE : The measures run can be changed by select from the main menu **Analysis > Measures Manager**.

Save Measures

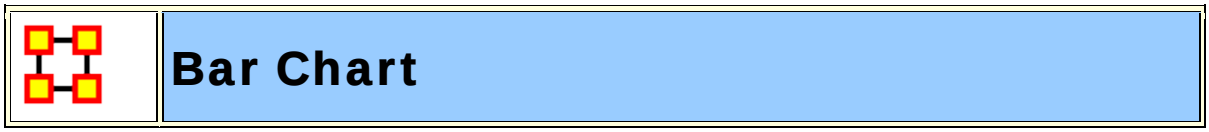


Use this button to save results measures to a text file. This file can be opened in either Excel or a text editor. ORA will not attach an extension to this file and it is suggested to give it either a **.txt or .csv** extension.

Opening the File

Opening this file in Excel, making sure to import it as a delimited file, will give you the measures it can use and the values associated with each node in the Nodeset chosen. You will notice that the names of the characters are **characters_1, characters_2, and so forth**. In this particular Nodeset the **Node ID** contained the text **Character_** plus a number and the **Node Title** contained the actual name of the character. This function used the Node ID when it exports this information.

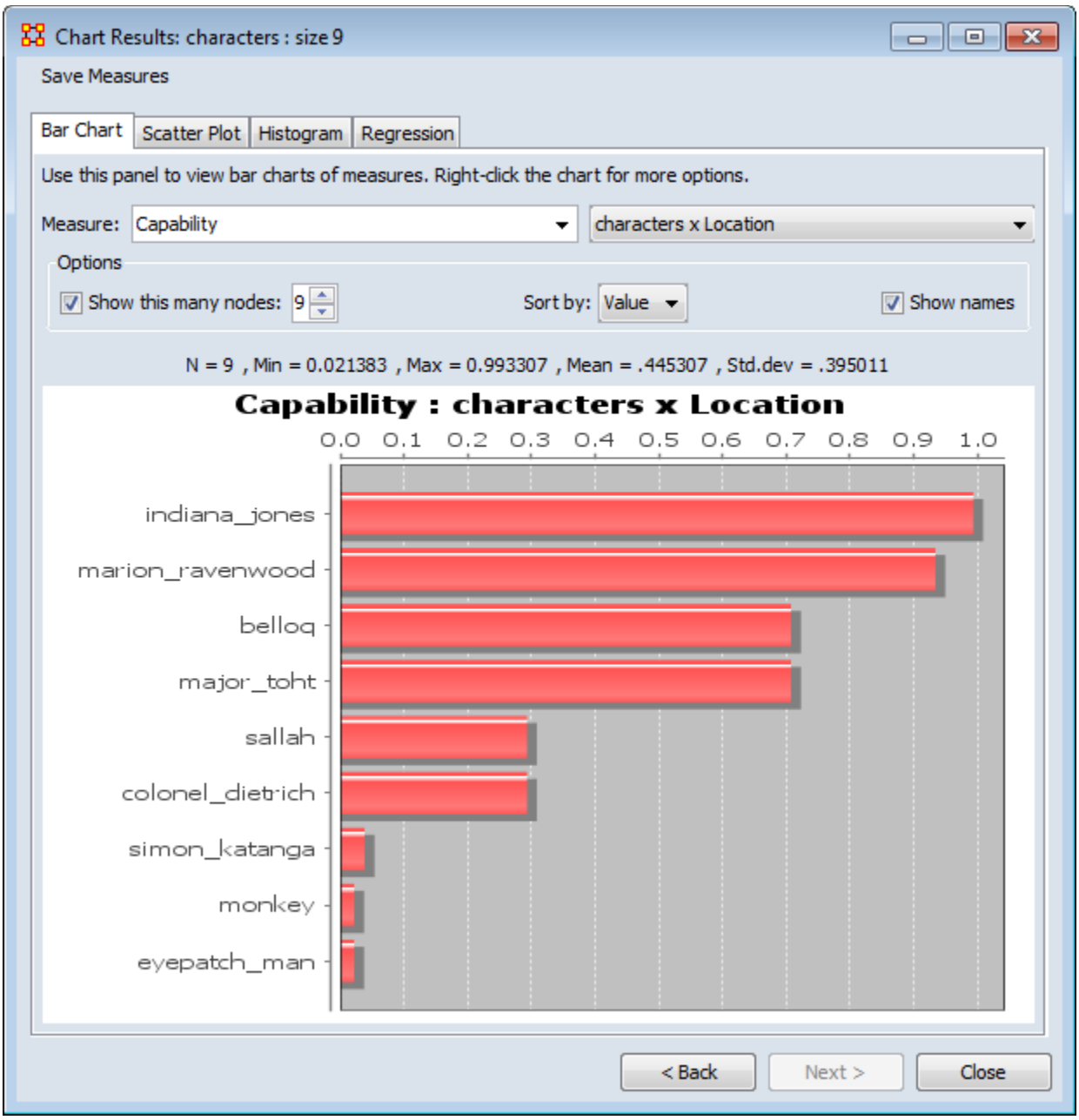
	A	B	C	D	E	F	G	H
1	Measure	Input networks	Input node classes	Input parameters	characters_1	characters_2	characters_3	characters_4
2	capability	characters x Location			0.9933072	0.9338295	0.2926904	0.0378589
3	cognitiveDistinctiveness	characters x Location			0.42	0.33	0.29	0.37
4	cognitiveExpertise	characters x Location			0.015625	0.1041667	0.2291667	0.3352273
5	cognitiveResemblance	characters x Location			0.58	0.67	0.71	0.63
6	cognitiveSimilarity	characters x Location			0.3860295	0.4101945	0.3309044	0.0890994



Bar Chart

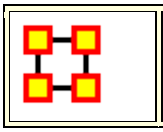
A bar chart contains horizontal bars representing the individual nodes in the set. These **rectangular bars** are usually proportional to the magnitudes or frequencies of what they represent.

Bar charts are used for **comparing two or more values**. The bars can be horizontally or vertically oriented. Sometimes a stretched graphic is used instead of a solid bar.



Use with Two-Mode data

When you have two-mode data you can get the Nodes of one Nodesets that are connected to the most nodes of the second Nodeset using measures charts. When using Measure Charts, first choose which Nodeset you want to get values for then choose the measure.



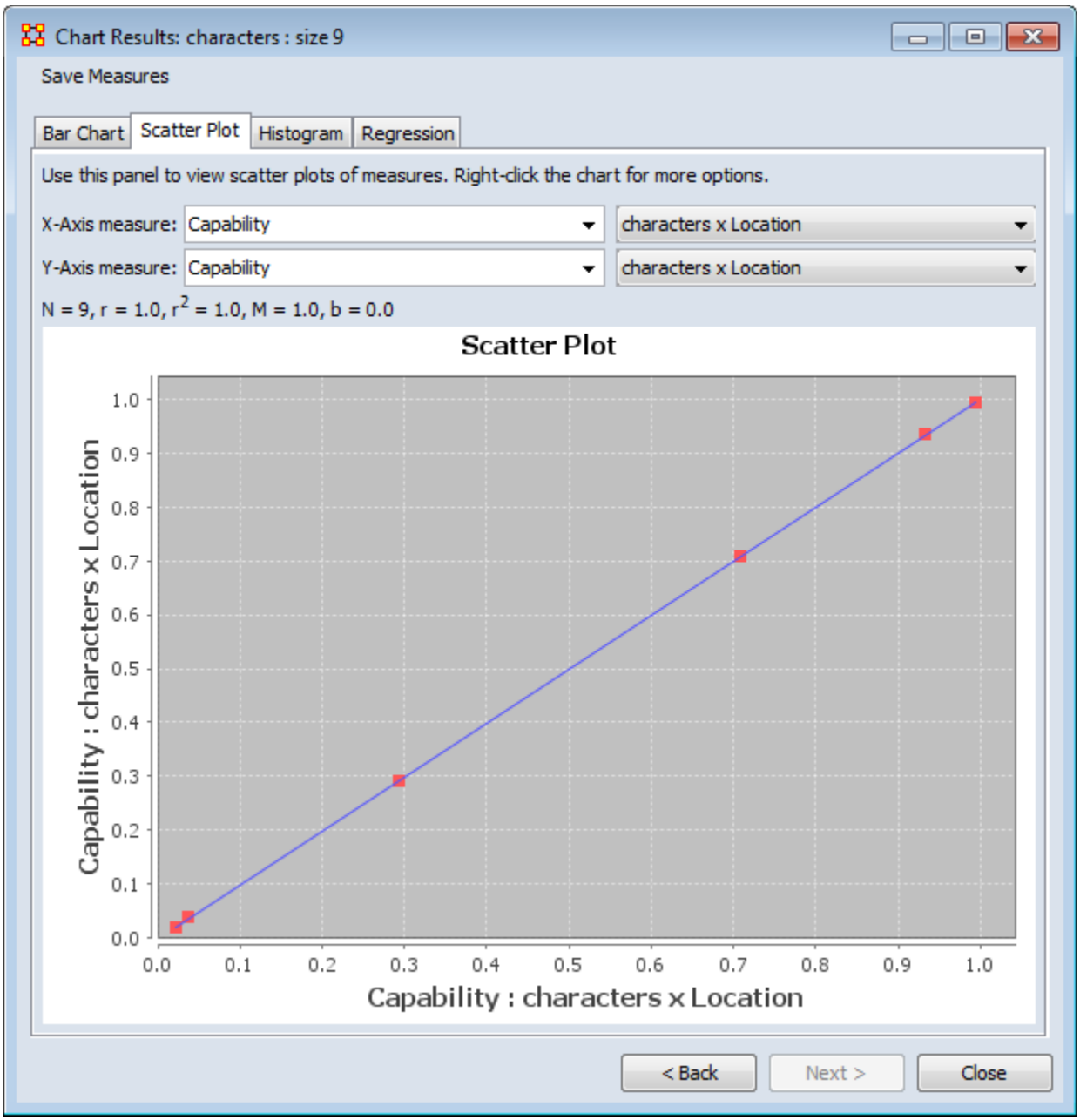
Scatter Chart

Scatter Plot

A scatterplot uses **Cartesian coordinates** to display values for two variables. The data is displayed as a **collection of points**, each having one coordinate on the horizontal axis and one on the vertical axis.

A scatterplot does not specify dependent or independent variables. Either type of variable can be plotted on either axis. **Scatterplots represent the association (not causation) between two variables**.

A scatterplot can show various kinds of relationships, including **positive (rising), negative (falling)**, and no relationship. If the pattern of dots slopes from lower left to upper right, it suggests a positive correlation between the variables being studied. If the pattern of dots slopes from upper left to lower right, it suggests a negative correlation. A line of best fit can be drawn in order to study the correlation between the variables. An equation for the line of best fit can be computed using the method of linear regression.



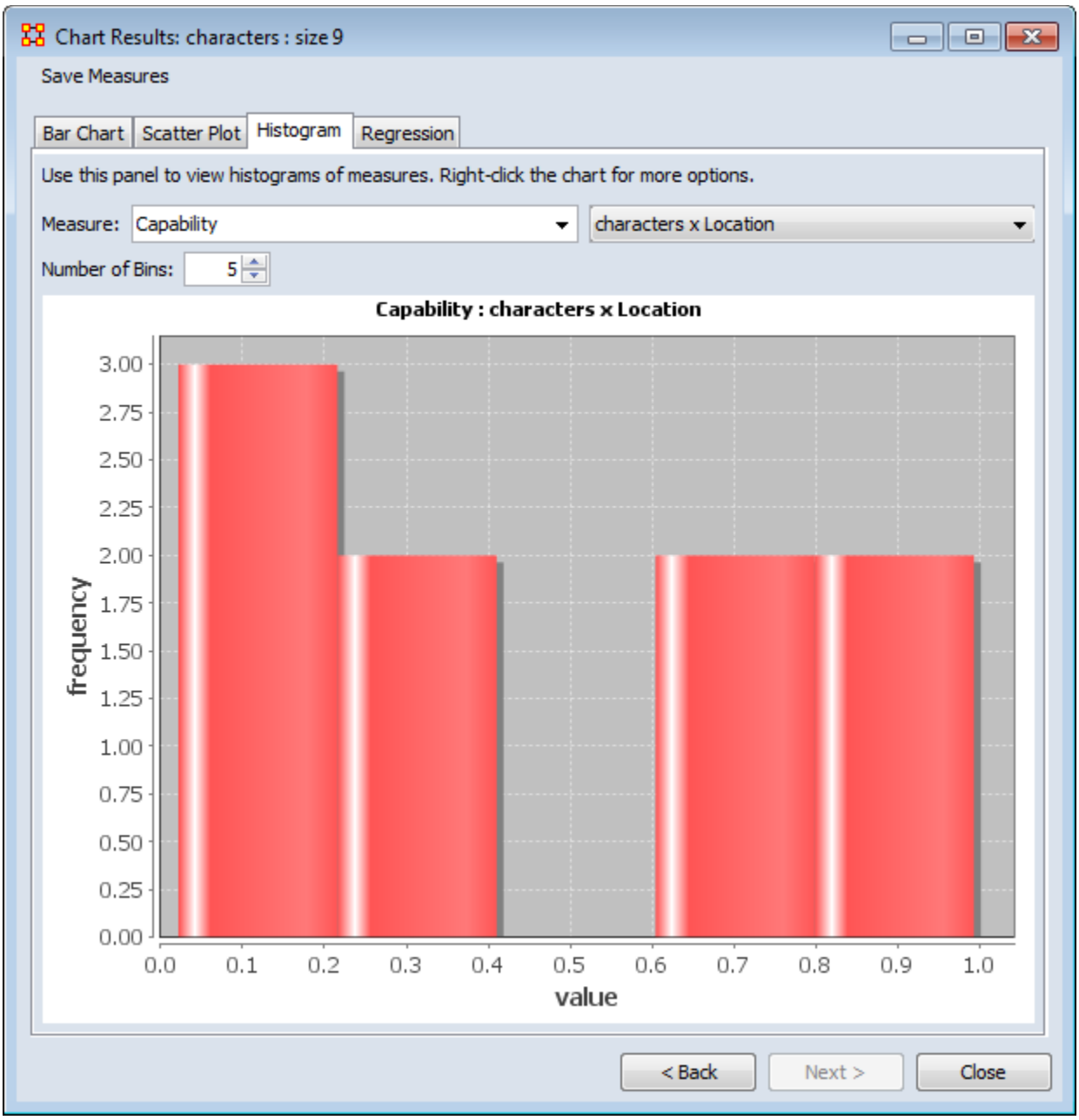
Histogram Chart

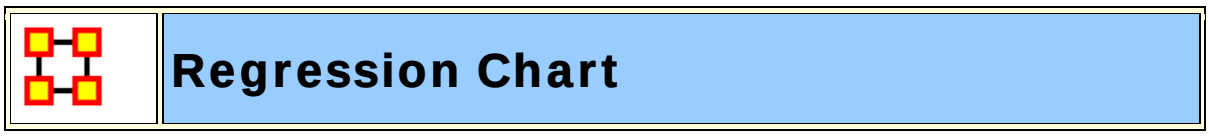
Histogram

In statistics, a **histogram** is a graphical display of tabulated frequencies. A histogram is the graphical version of a table which

shows what proportion of cases fall into each of several or many specified categories. The histogram differs from a bar chart in that it is the area of the bar that denotes the value, not the height, a crucial distinction when the categories are not of uniform width *(Lancaster, 1974)*. The categories are usually specified as non-overlapping intervals of some variable. The categories **(bars)** must be adjacent.

The word histogram is derived from histos and gramma in Greek, the first meaning web or mast and the second meaning drawing, record or writing. A histogram of something is thus, etymologically speaking, a drawing of the web of this something.





Regression

Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to

explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables.

The **dependent** and **independent** variables can be either a network measure or numerical attributes of nodes.

Calculating linear regression

The equation **$y = mx + b$** algebraically describes a straight line for a set of data with one independent variable where **x** is the independent variable, **y** is the dependent variable, **m** represents the slope of the line, and **b** represents the y-intercept. If a line represents a number of independent variables in a multiple regression analysis to an expected result, the equation of the regression line takes the form **$y = m_1x_1 + m_2x_2 + ... + m_nx_n + b$** in which **y** is the dependent variable, **x_1** through **x_n** are **n** independent variables, **m_1** through **m_n** are the coefficients of each independent variable, and **b** is a constant.

Calculating exponential regression

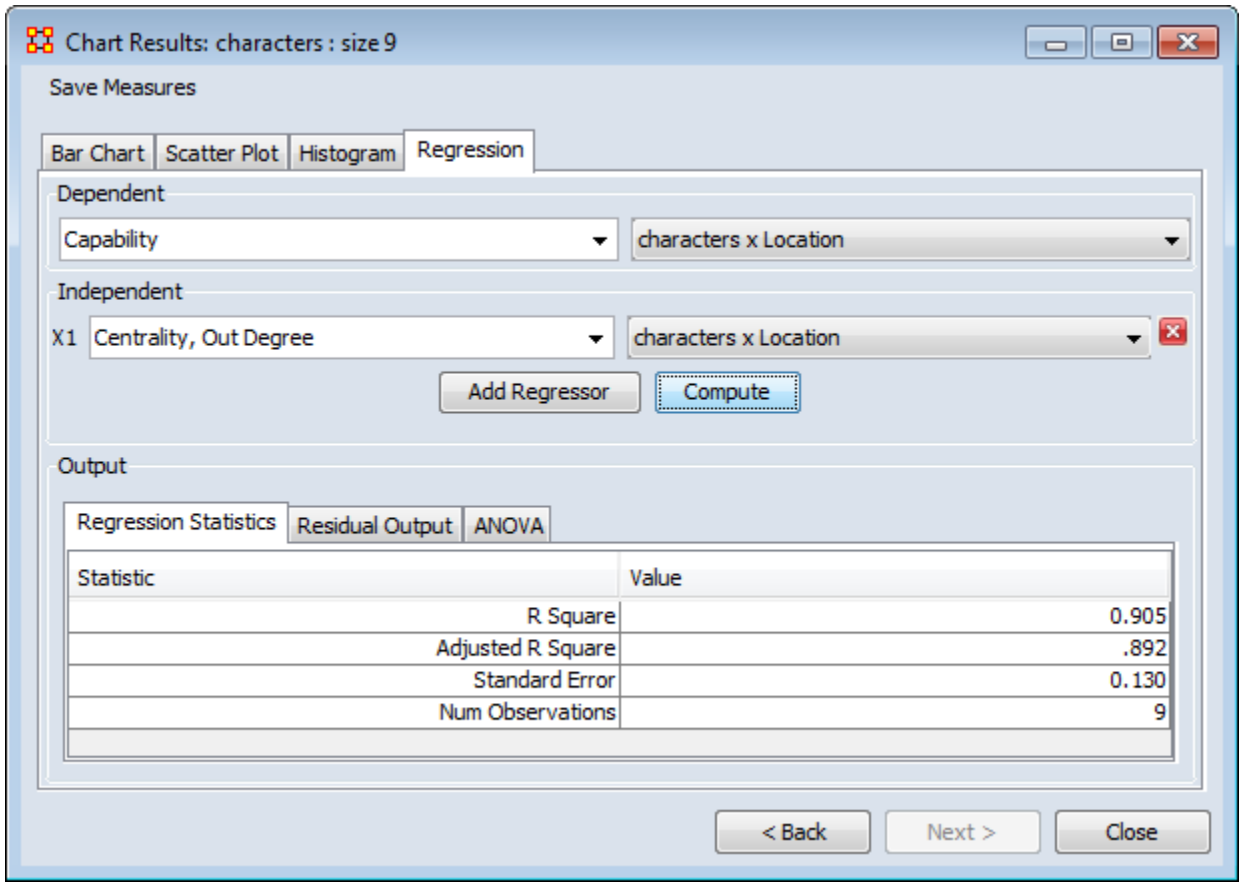
Unlike linear regression, which plots values along a straight line, exponential regression describes a curve by calculating the array of values needed to plot it. The equation that describes an exponential regression curve is

$$y = b * m_1^{x1} * m_2^{x2} * . * m_n^{xn}$$

If you have only one independent variable, the equation is

$$y = b * m^x$$

Output - Regression Statistics



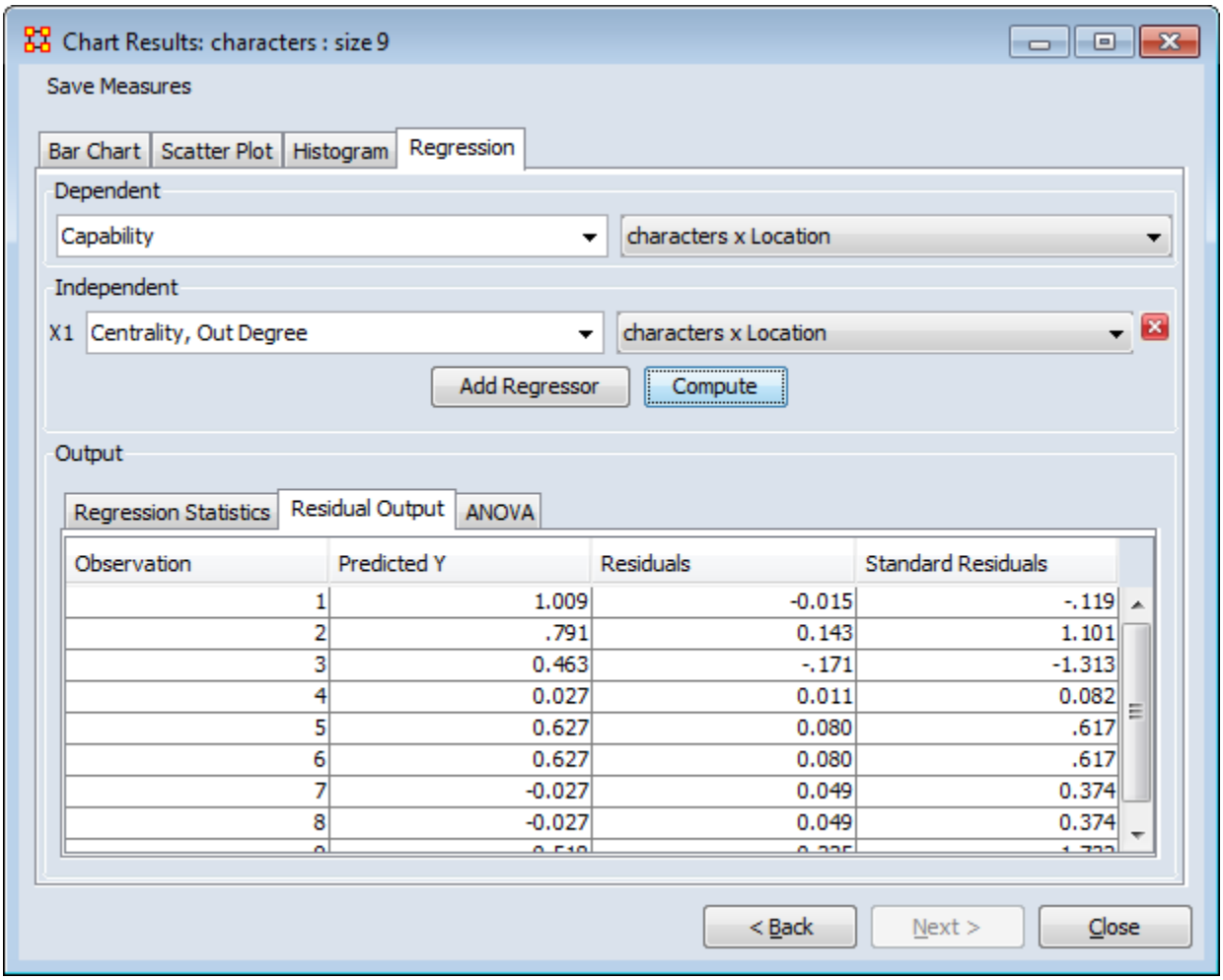
R-Squared : The coefficient of determination, R^2, is the proportion of variability in a data set that is accounted for by a statistical model. There is no consensus about the exact definition of R^2. Only in the case of linear regression are all definitions equivalent. In this case, R^2 is simply the square of a correlation coefficient.

Adjusted R-Squared : Unlike R^2, the adjusted R^2 increases only if the new term improves the model more than would be expected by chance. The adjusted R^2 can be negative, and will always be less than or equal to R^2.

Standard Error : The Standard Error is an estimate of the standard deviation of the coefficient, the amount it varies across cases. It can be a measure of the precision with which the regression coefficient is measured. If a coefficient is large compared to its standard error, then it is probably different from 0.

Num Observations : Number of nodes in the Nodeset.

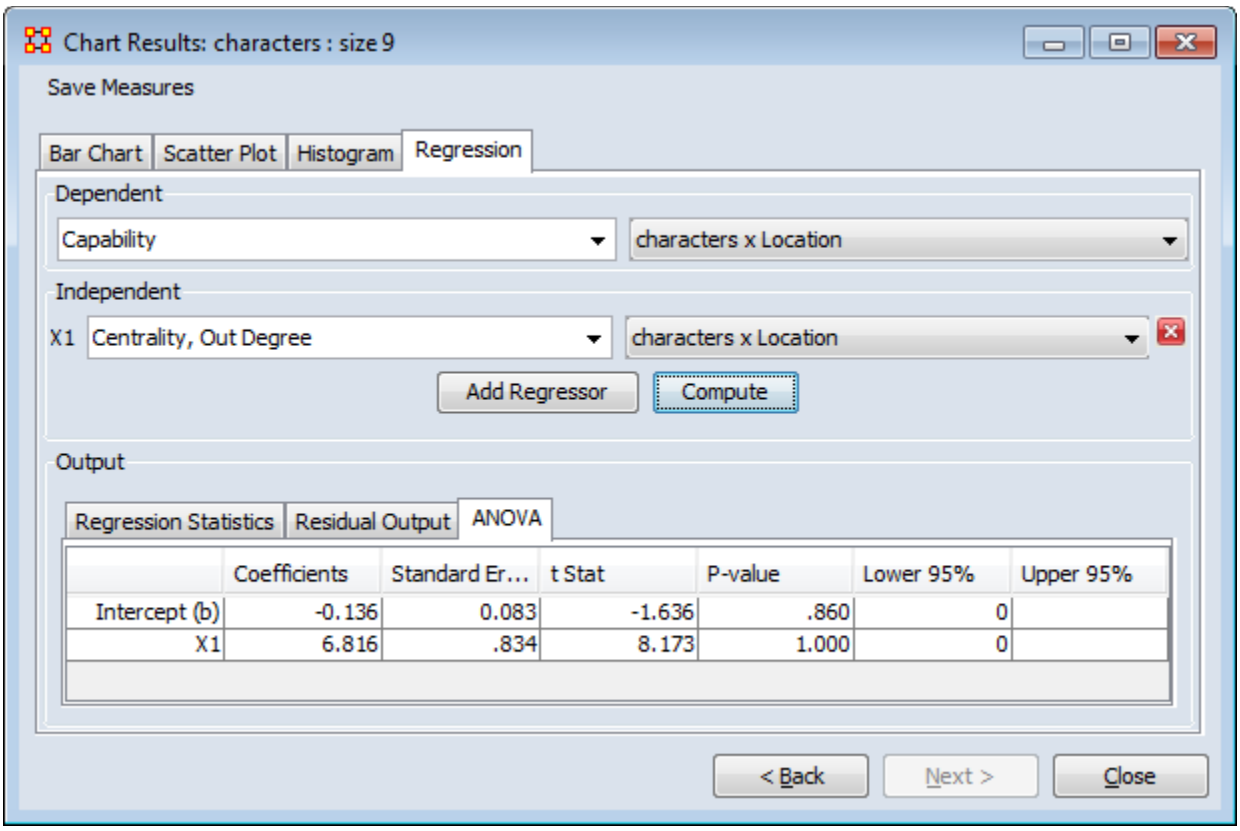
Output - Residual Output



Predicted Y Value : In the scatterplot, a point is plotted as (X , Y) The regression line will give the predicted Y value.

Residuals : The difference between the Predicted-Y value and the actual value.

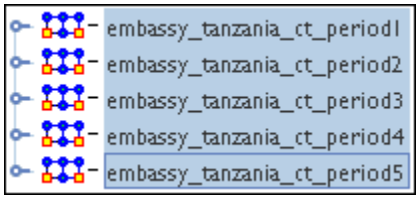
Output - ANOVA



ANOVA : Information about levels of variability within a regression model and form a basis for tests of significance.

View Measures Over Time

Using the **View Measures Over Time** on a Network allows an analyst to see how a network measures change over multiple time periods. If you use non-dated data, ORA will alert you if your Meta-Networks are not dated.

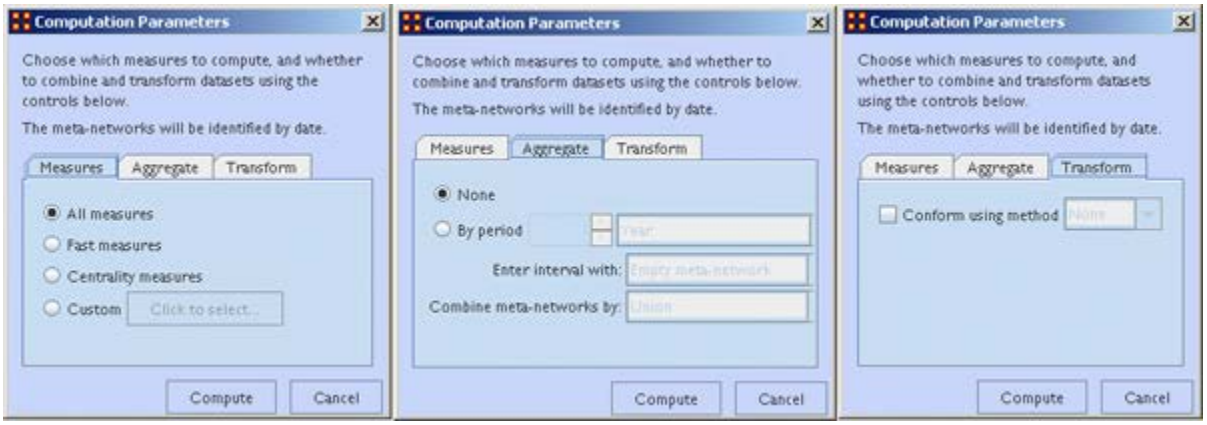


Highlight all the Meta-Networks and selectr from the main menu **Visualizations > View Measures Over Time...**

NOTE : Measures Over Time will only be run on the selected Metw-Networks.

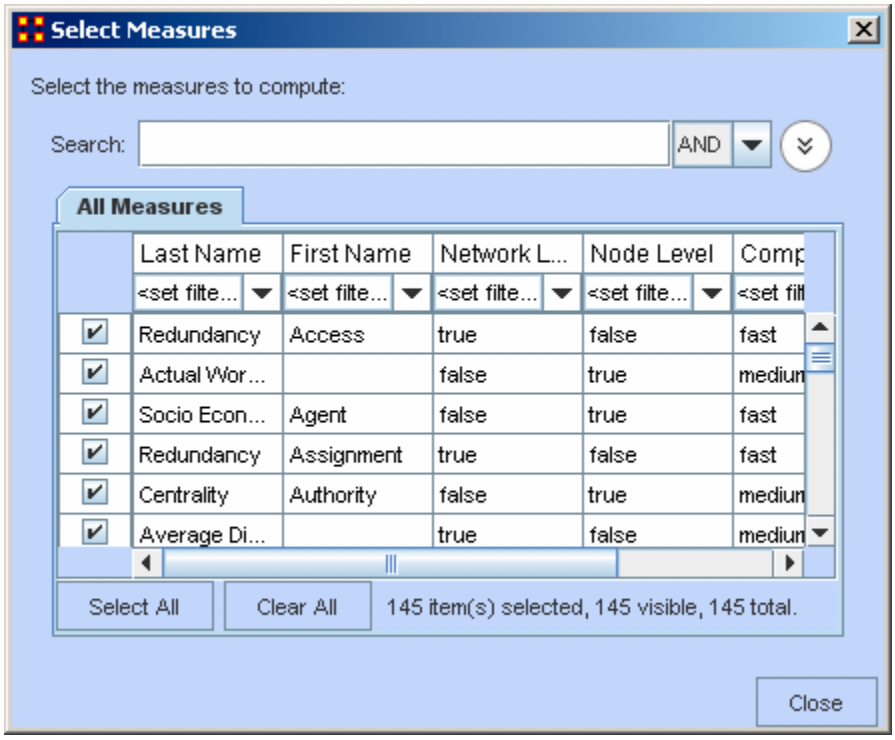
Computation Parameters

First, the Computation Parameters dialog window appears. Here you can select the measures to use and whether to combine or transform the datasets. When done, click the **[Compute]** button to continue to the analysis.



Measures tab : gives you control over the measures used in the computation. With the Custom option you can select as many or few measures to use.

- **All measures :**
- **Fast measures :**
- **Centrality measures :** Uses only the Network Centralization measures.
- **Custom :** Calls up a dialog box which allows you to selectively pick which measures to use. Place a check mark next to any measure you want to use. You can also use the [**Search**] textbox to find a measure(s).

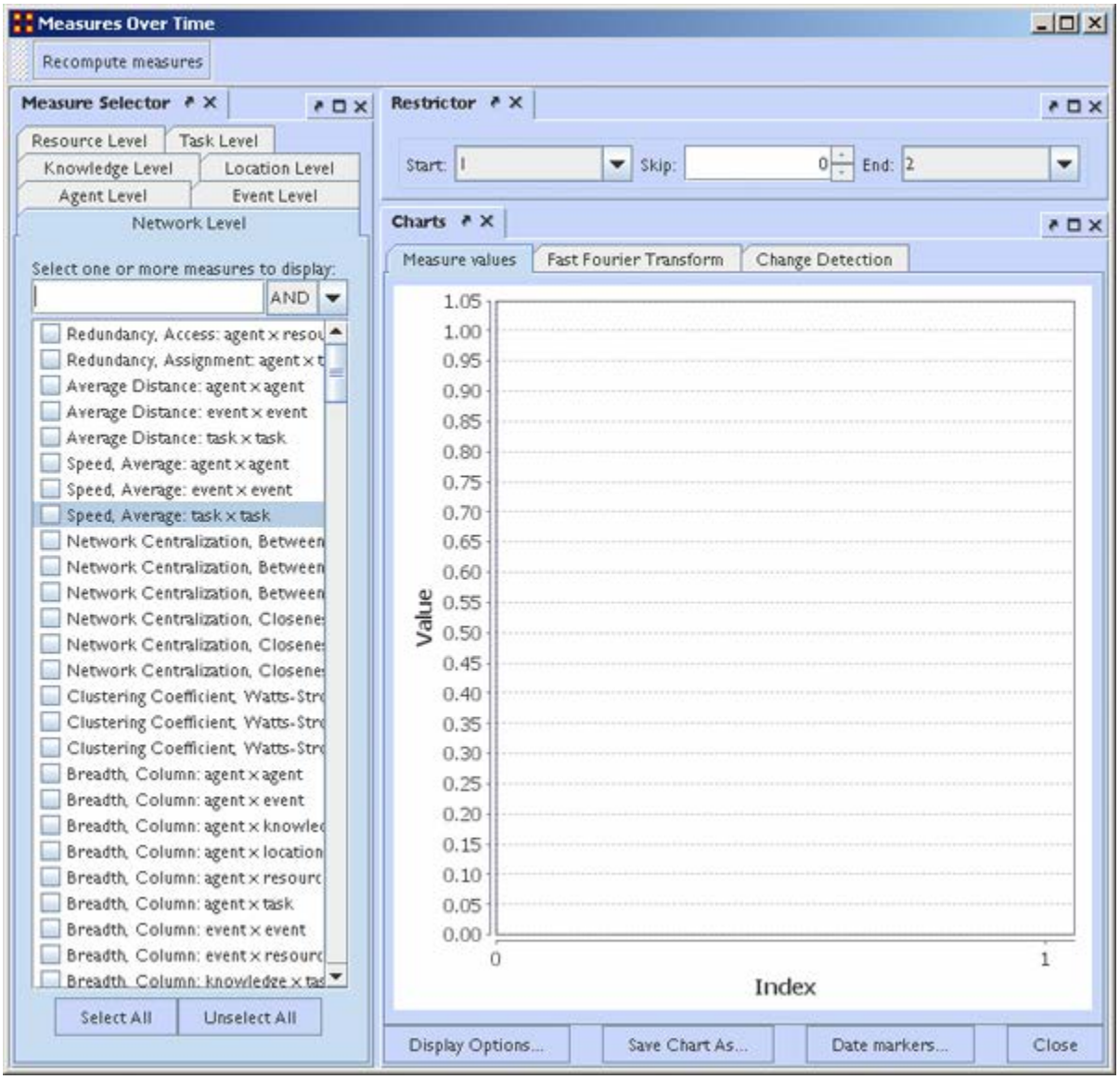


Aggregate tab : Combines multiple dates into one entry. If you have one meta-network for each day of the year, aggregating by month would reduce the 365 meta-networks into 12 meta-networks (the 12 would contain the 30 meta-networks for each day of the month unioned together).

Transform tab : The **Conform using method** makes the Node Classes indential across Meta-Networks. **Union** adds isolate nodes, and **Intersect** removes isolate nodes.

NOTE : Measure values computed on conformed Meta-Networks may differ from those computed on non-comformed data.

Measures Over Time window



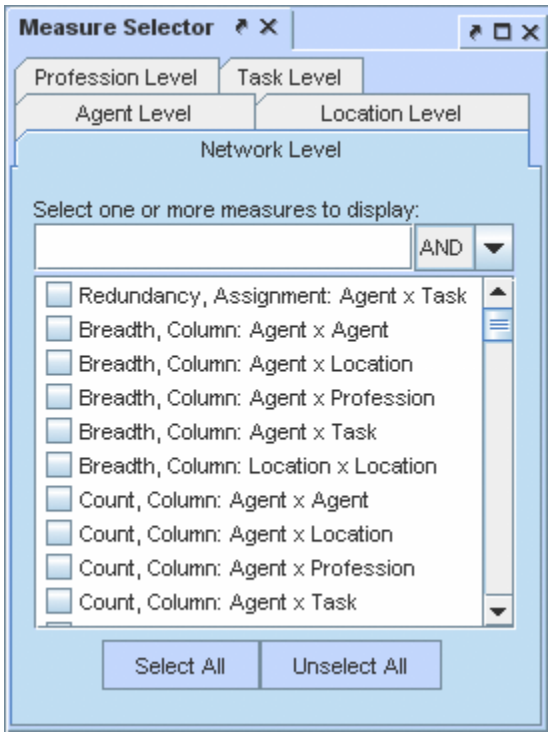
This window is divided into three panes.

The Measure Selector Pane contains tabs for all Node Classes in addition to a Network Level tab. If the **Network Level** tab is selected you can choose which measure(s) to apply to the entire Meta-Network. If a **Node Class** tab is chosen you can choose which Node(s) to view and in the **Select a measure:** text box select the measure to apply to them. All actions are instantly updated in the **Charts Pane**.

The Restrictor Pane allows you to set the beginning and ending time periods and additionally you can skip any number of intermediary steps.

The Charts Pane contains three tabs and a legend at the bottom showing the colors associated to which nodes. Each pane is further described on their own pages.

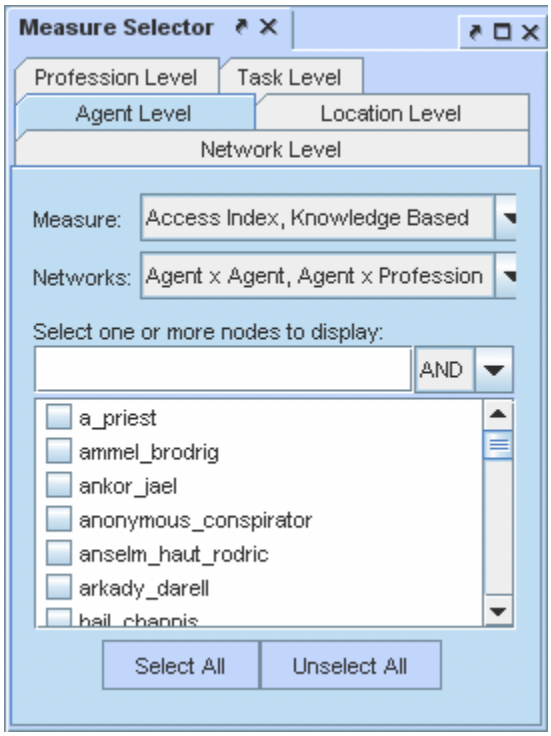
Measure Selector Pane



The Network Level tab is a list of all the measures used in the current operation. Place a check mark next to any measure you want to use.

The [**AND / OR**] drop down allows for boolen operations on the measures.

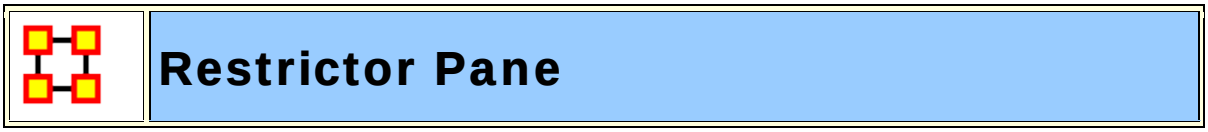
The [**Select All / Unselect All**] buttons can be used as a starting point to select mostmeasures or only a few measures.



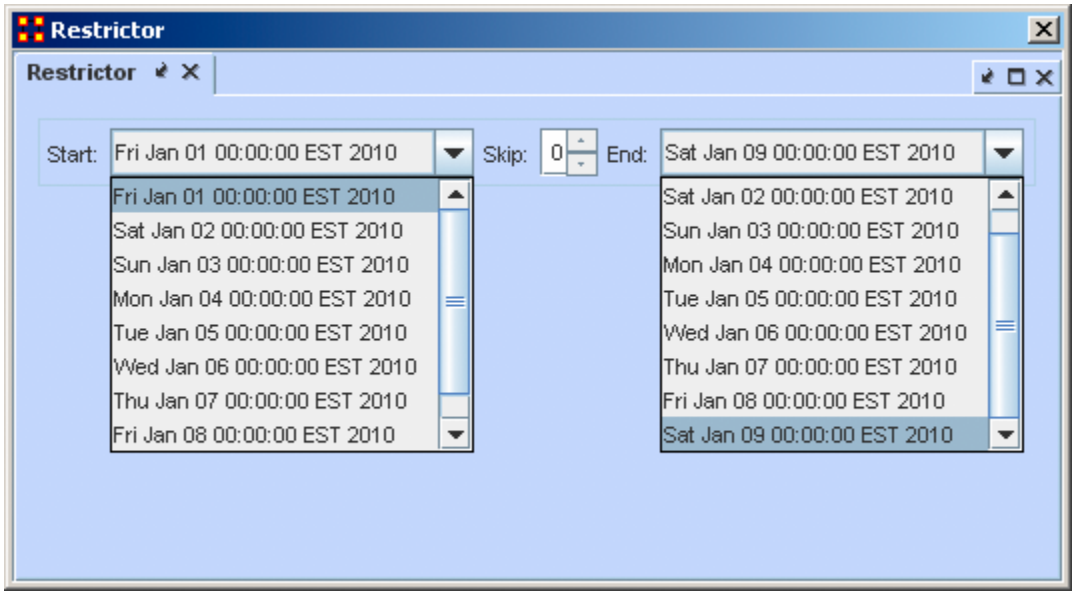
All the individual Node Class tabs work identically. Like the Network Level you place a check mark next to the nodes you want to use and it also contains the [**AND / OR**] drop down.

The **Measure:** and **Networks:** drop downs allow you to hone you selections.

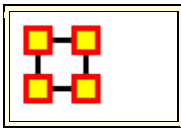
The [**Select All / Unselect All**] buttons can be used as a starting point to select mostmeasures or only a few measures.



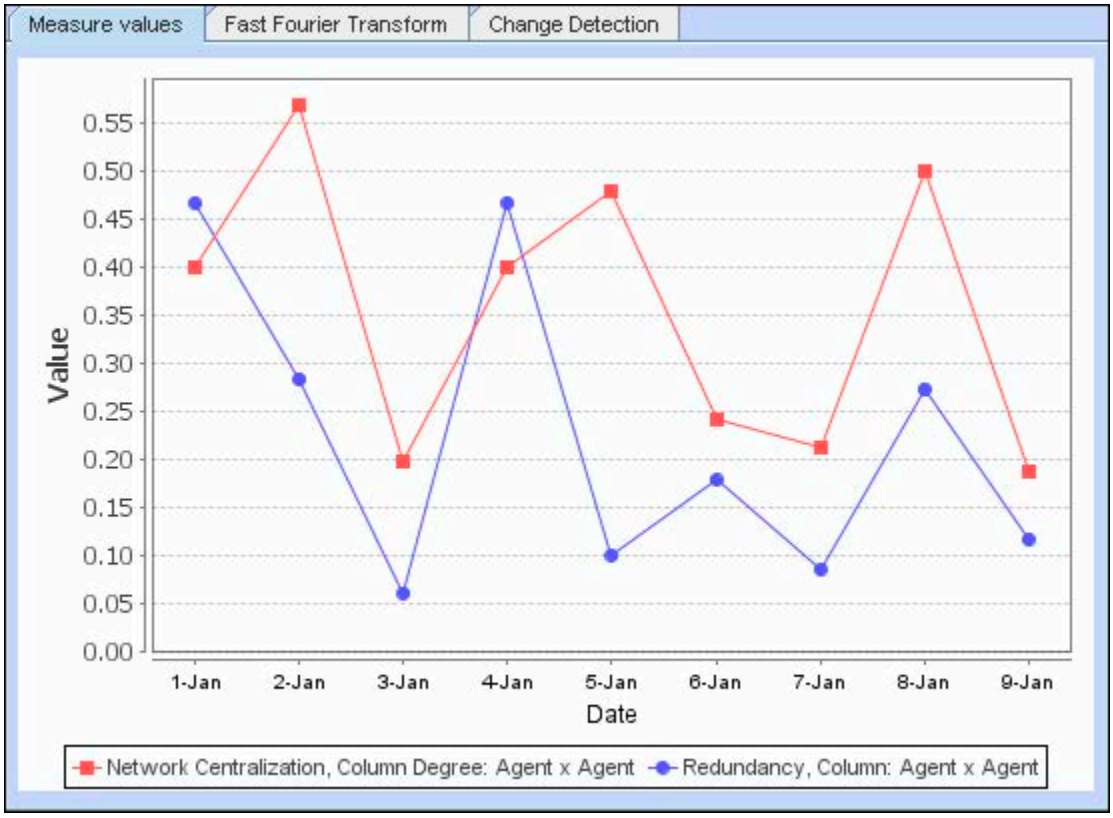
Restrictor Pane



The **Restrictor Pan** allows you to set the Starting and Ending Meta-Network to use and also to skip a number of Metaworks in the middle.

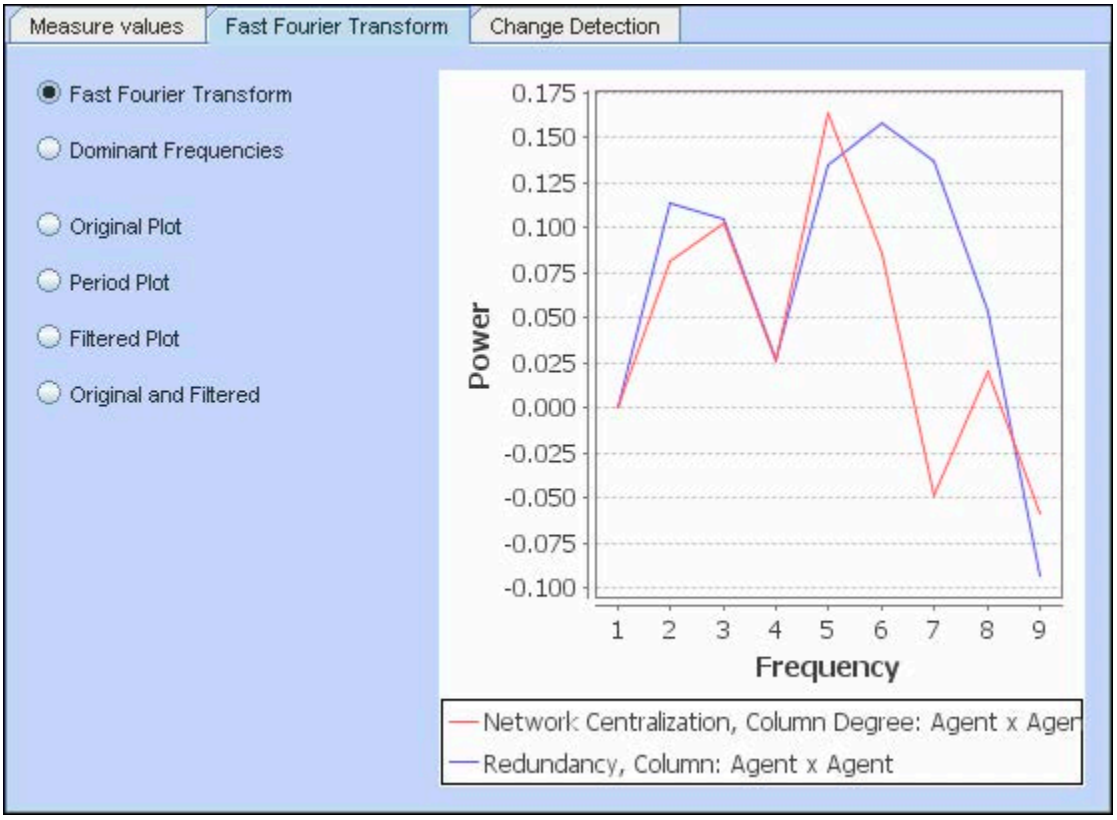


Over Time-Measures Tab



Displays the charting of plotted measures over time denoting each by an individual color.

Over Time-Fast Fourier Tab



Frequencies

Fast Fourier Transform : Transform measures values to identify cycles in a temporal situation. Doesn't plot measure values. It plots strength of cycles. (i.e. traffic patterns could have a heavy/light traffic pattern or a weekly pattern, heavy on weekdays and light on weekends). Defines cycles of different lengths.

Dominant Frequencies : Selecting Dominant Frequencies on the radio button to the lower right, displays only the statistically significant frequencies.

Plots

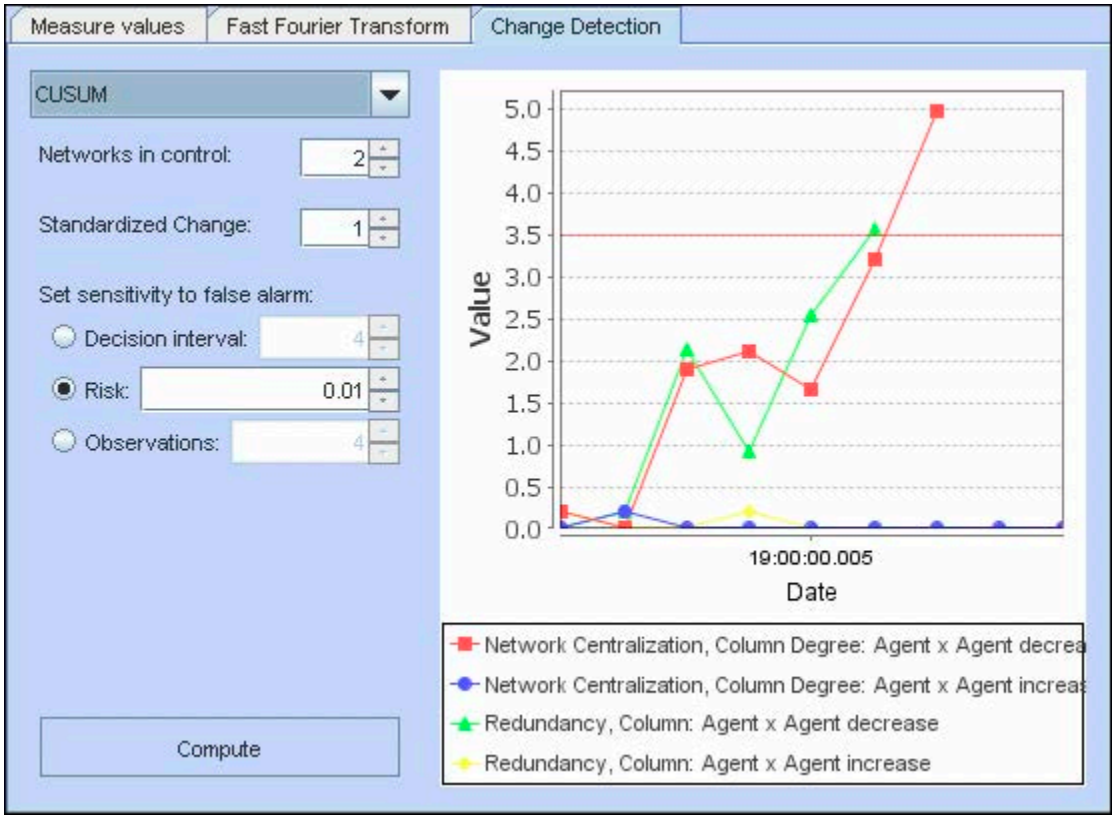
Original Plot :

Period Plot :

Filtered Plot :

Original and Filtered :

Over Time-Change Detection Tab



CUSUM

Keeps track of cumulative total of deviation across time. No matter how small the change.

Networks in Control : Number of Networks to use as a control group

NOTE : If your change time is in the "Networks in control" bunch then you'll never see the change.

Standardized Change :

Set sensitivity to false alarm

Decision interval :

Risk : Higher risk numbers will possibly give more false alarms.

Observations :

EWMA

Exponentially Weighted Moving Average. Check Wikipedia. Incorporates historical data but places more emphasis on recent data.

Networks in Control : Number of Networks to use as a control group

Risk : Higher risk numbers will possibly give more false alarms.

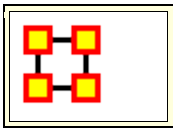
Weight : Shows the weight of the newer observations over the older observations. Start and Finish is for which network to use.

Shewhart X-Bar

Show how different the current observation is from the baseline. This only takes into account the current observation.

Networks in Control : Number of Networks to use as a control group

Risk : Higher risk numbers will possibly give more false alarms.



Networks Over Time

Networks are ways of connecting the who, what, where, why, how and when. Each type of who, what, where, why, how and when is called an entity class. The items within them are called nodes or entities. The set of networks for three or more of these entity classes is called the meta-network. The entire field of Dynamic Network Analysis is based on the concept of the MetaNetwork.

Terminology

Identity Crisis : Different entities with the same name could get confused. **Bob** #1 gets connected to **Alice**. **Bob** #2 gets connected to **Carol**. Alice and Carol get angry at their respective Bobs.

Meta-Network : A Meta-Network incorporates different Node Classes and allow you to perform an analysis on the model that way. Such a model is called a MetaNetwork.

A Meta-Network is network composed of multiple networks. A MetaNetwork is the sum of all networks we are considering. The Meta-Network is the foundation for Dynamic Network Analysis;

Network : A **Network** shows how the nodes connect to each other.

Node : A **Node** can literally be anything you can think of; on an abstract level, an Entity may be merely a dot in a visual network model. It is what we are networking and connecting our ties to and thus looking at in detail visually.

Node Class : A Node Class is a group of similar nodes [i.e. people, places, knowledge]

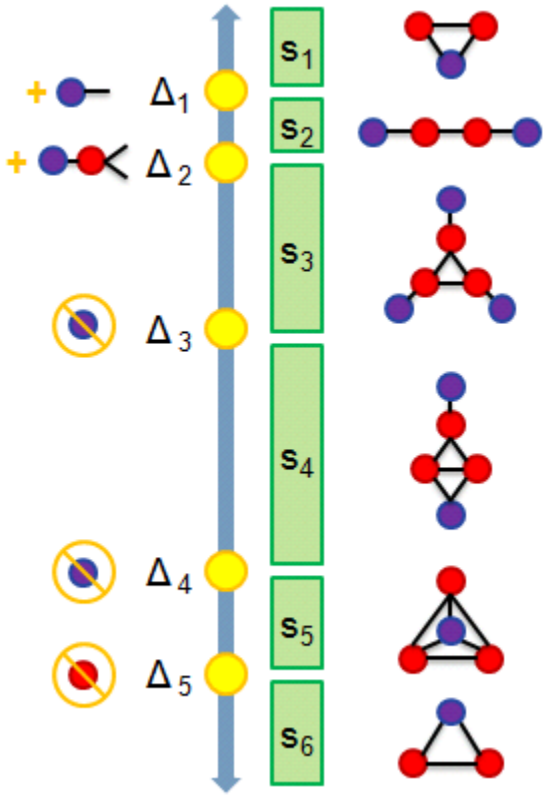
Node Occurrence Transparency : Easily see which nodes appear in the most timeslices.

Timeslice : A view of the data at a particular point in time. Often, one timeslice = one meta-network, but maybe a day/week/month-long snapshot.

Typos/Multiple IDs (think email addresses) : Bob is assigned task Driver. bob is given resource Truck. ORA can't find a way for that task to be completed.

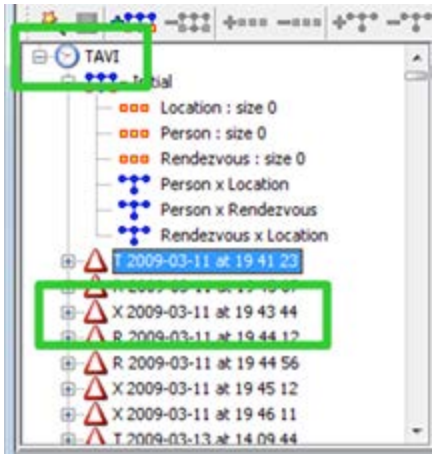
Vector Mapping : Views how measures and/or Attributes affect each other as the time moves on.

Dynamic Networks



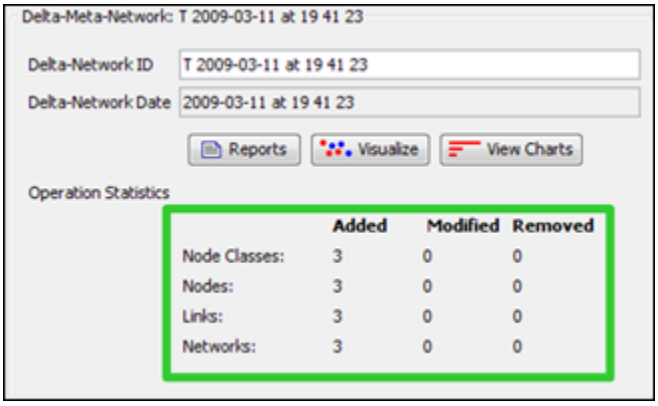
- **S1 :** 2 agents share 1 location
- **S2 :** They move apart to separate locations
- **S3 :** A 3rd connected agent is detected at its own location
- **S4 :** 2 of the agents meet
- **S5 :** The 3rd joins at same locale
- **S6 :** One agent disappears

Dynamic Meta-Network in ORA



The Clock icon indicates a Dynamic Network.

The Deltas contain changes to a Network at a point in time.



The Operational Statistics indicate the number of additions, modifications, and removals to the Network.

Manipulating Keyframes/Deltas

You can Convert Keyframes to Deltas, Deltas to Keyframes, or Aggregate by Day/Week/Month/Year.

Over-Time Visualizations

Visual Comparisons, Animating over time, and Plotting changing centrality.

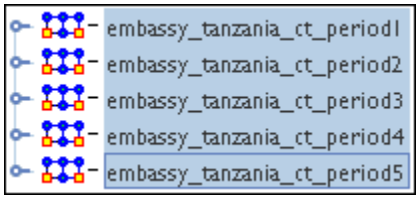
View Network Over Time

View Network Over Time : Uses all selected Meta-Networks for analysis in various time frames. Select all the Meta-Networks to use in the analysis.

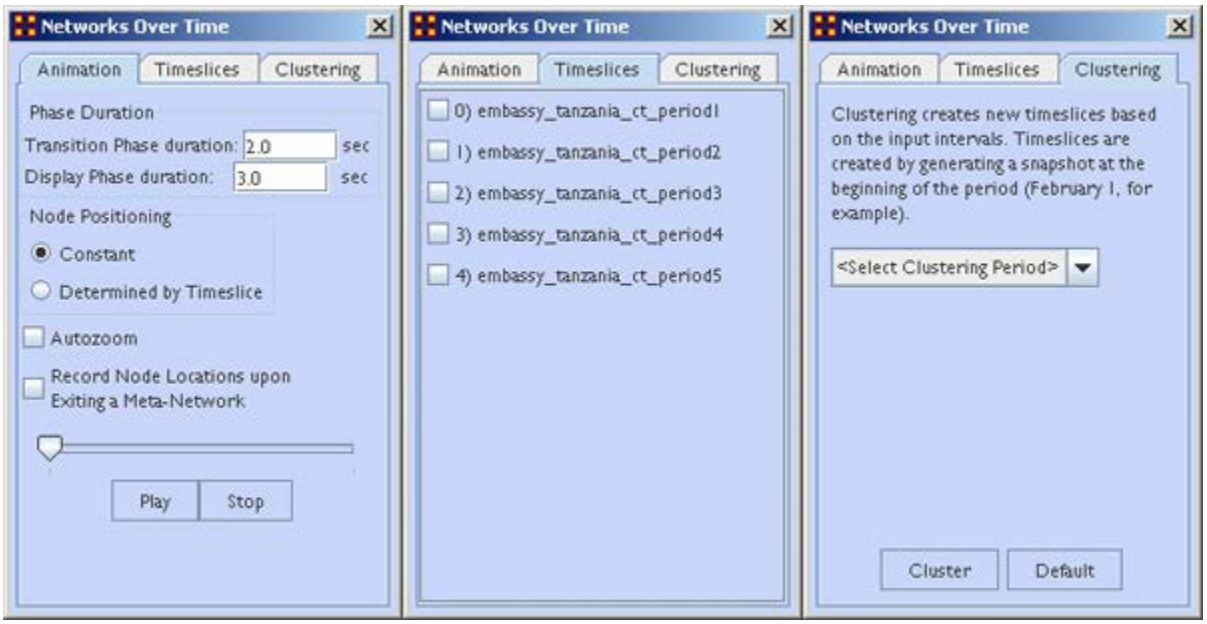
NOTE : It is of the utmost importance that the Networks in all Meta-Networks are named the same. If not, the Over Time function will not work correctly.

NOTE : Meta-Networks for use in the Over-Time tool are required to have date information. If they do not a warning box will appear telling you of the missing information.

NOTE : Menu options and right click context menus apply to what is currently selected. If an entire dynamic meta network is selected [**the parent item**] it applies to each snapshot/delta, otherwise it only applies to the currently selected snapshot/delta.



Now select from the menu **Visualizations > View Network Over Time** This will bring up the visualizer along with the **Networks Over Time** window.



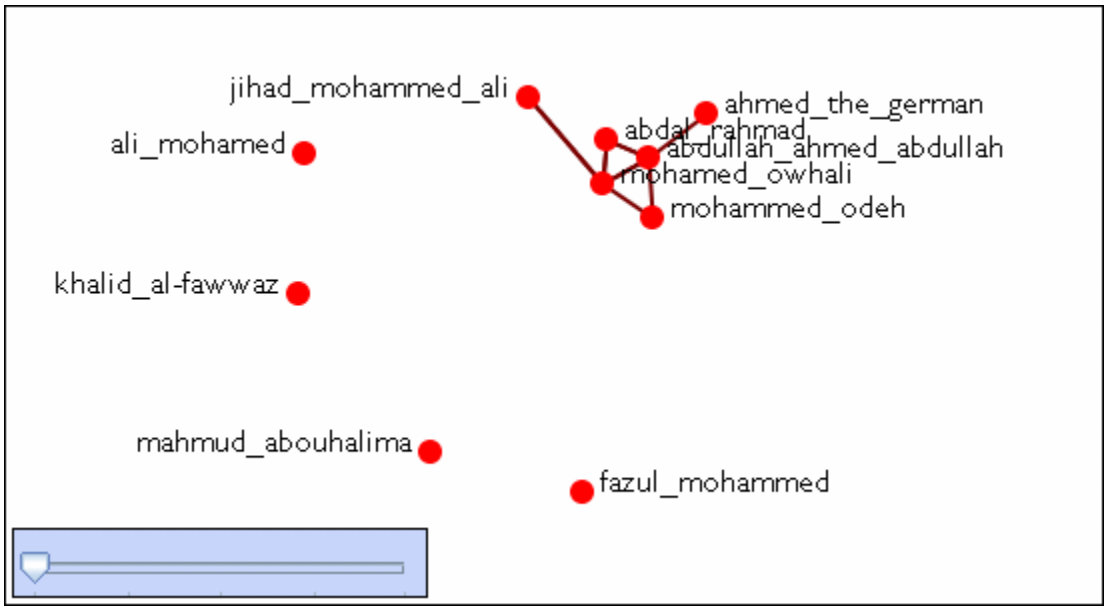
The Animation Tab controls the workings of the animation. It also contains the Play/Stop buttons.

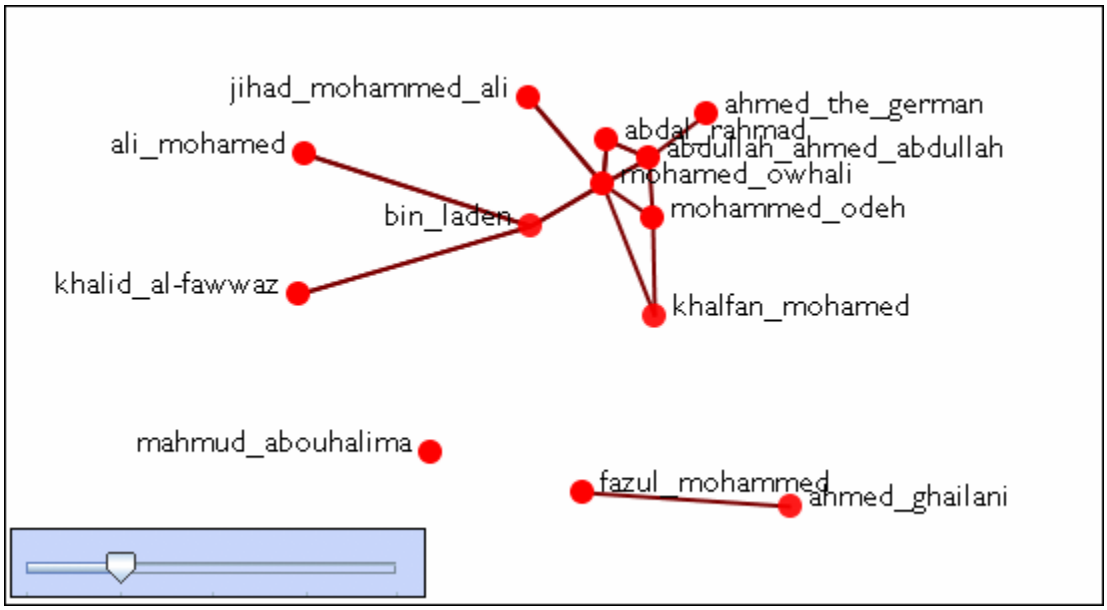
The Timeslices Tab contains check boxes for all active Meta-Networks. Placing a check mark in the boxes will use that particular Meta-Network.

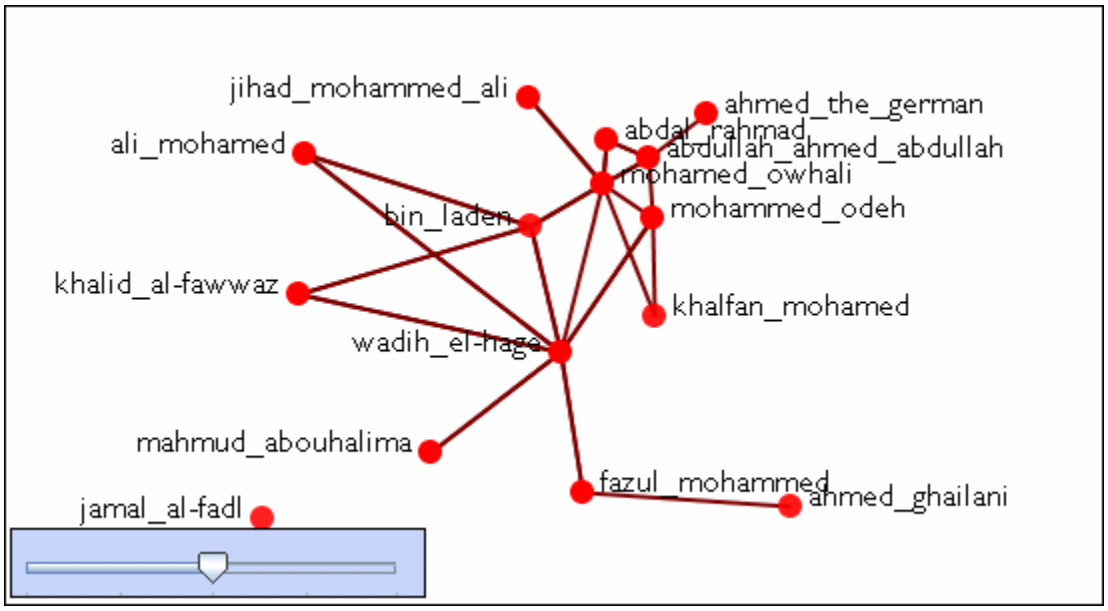
The Clustering Tab allows you to set the time frame for clustering by **day, week, month, or year**.

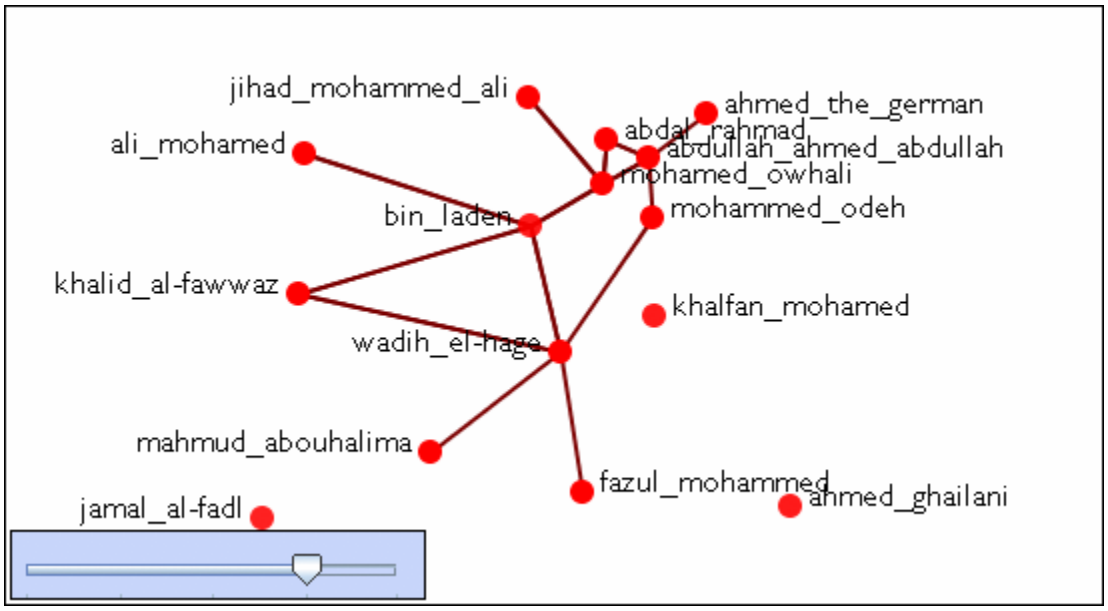
Animating the Display

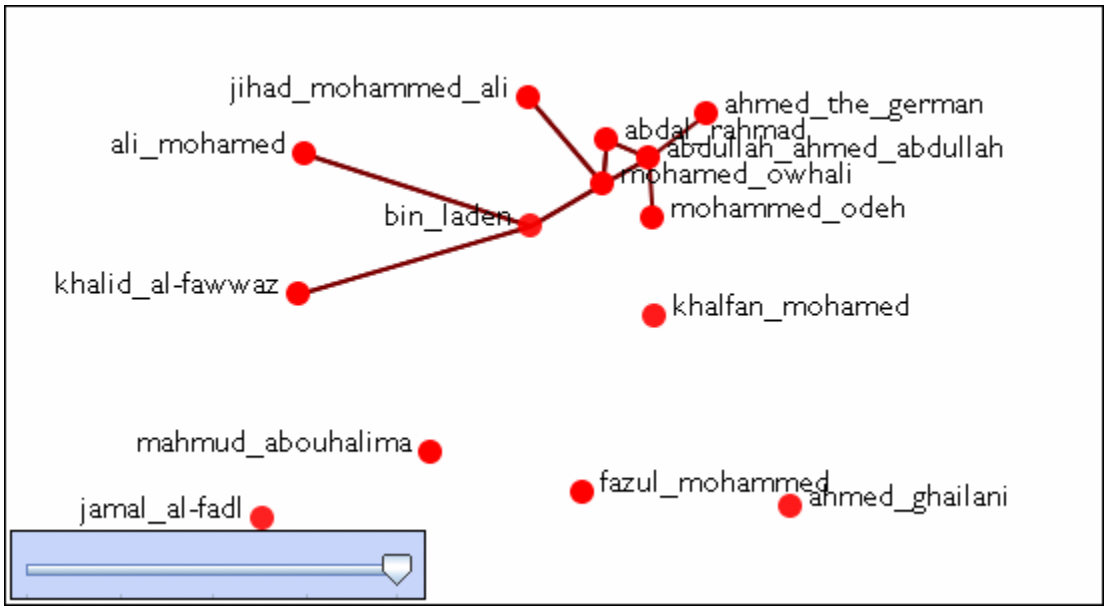
Pressing the **Play** button will start the animation. Below are the five **agent x agent** Networks. In different time slices new nodes appear and the connections between the agents changes.


jihad_mohammed_ali
ahmed_the_german
abdal_rahmad
ali_mohamed
abdullah_ahmed_abdullah
mohamed_owhali
mohammed_odeh
khalid_al-fawwaz
mahmud_abouhalima
fazul_mohammed


jihad_mohammed_ali
ahmed_the_german
abdal_rahmad
ali_mohamed
abdullah_ahmed_abdullah
mohamed_owhali
bin_laden
mohammed_odeh
khalid_al-fawwaz
khalfan_mohamed
mahmud_abouhalima
fazul_mohammed
ahmed_ghailani


jihad_mohammed_ali
ahmed_the_german
abdal_rahmad
ali_mohamed
abdullah_ahmed_abdullah
mohamed_owhali
bin_laden
mohammed_odeh
khalid_al-fawwaz
khalfan_mohamed
wadih_el-hage
mahmud_abouhalima
fazul_mohammed
ahmed_ghailani
jamal_al-fadl


jihad_mohammed_ali
ahmed_the_german
abdal_rahmad
ali_mohamed
abdullah_ahmed_abdullah
mohamed_owhali
bin_laden
mohammed_odeh
khalid_al-fawwaz
khalfan_mohamed
wadih_el-hage
mahmud_abouhalima
fazul_mohammed
ahmed_ghailani
jamal_al-fadl


jihad_mohammed_ali
ahmed_the_german
abdal_rahmad
ali_mohamed
abdullah_ahmed_abdullah
mohamed_owhali
bin_laden
mohammed_odeh
khalid_al-fawwaz
khalfan_mohamed
mahmud_abouhalima
fazul_mohammed
ahmed_ghailani
jamal_al-fadl

Change Detection (Over-Time Viewer)

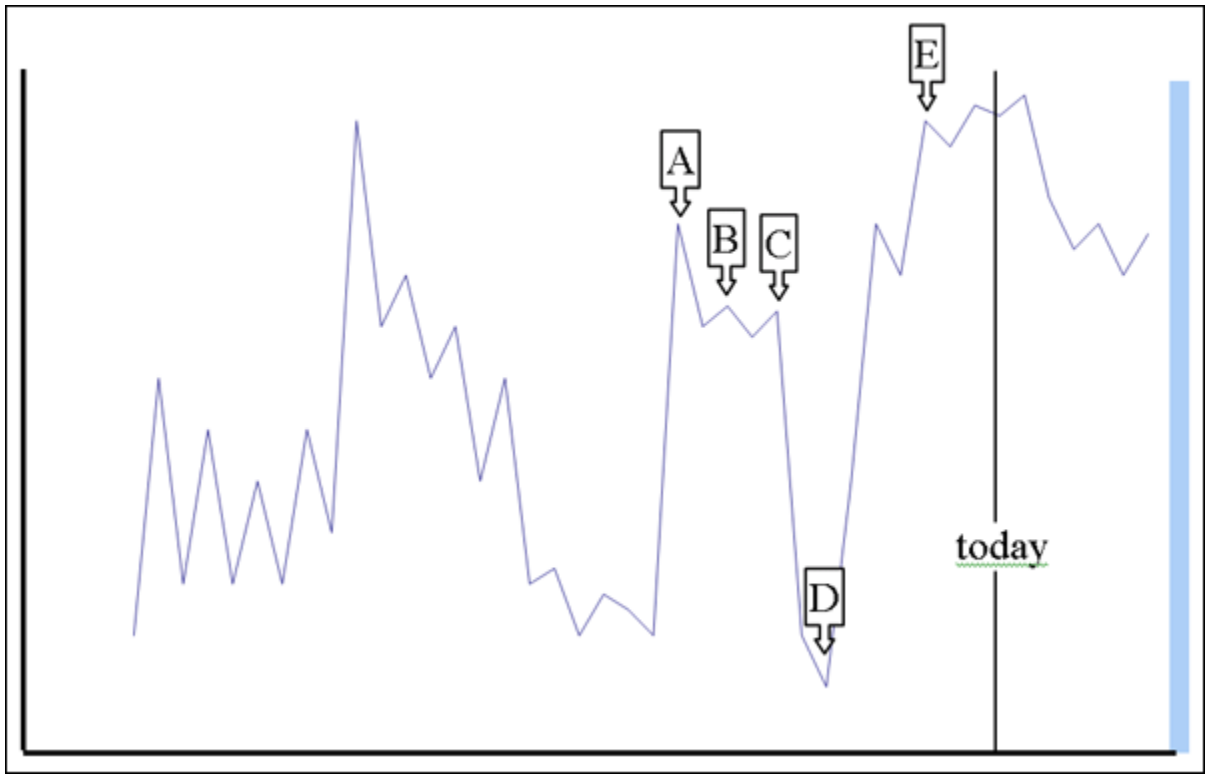
Description

The **View Measures Over-Time** is used to find out how quickly you can identify changes in a network to exploit subtle organization change, And also to facilitate improved command and control subject to a specifid risk of false alarm. Various measures of a network are taken at different points in time. You need to identify a) that a change **did** occur and b) **when** did that change occur.

NOTE : It is important to note that this is not predicting change. But rather it is detecting that a change has occurred quickly and be able to make some inference about the actual time of change.

Example of Change Detection

Change Detection may offer you a tool to operate inside the normal decision cycle. The following figure represents some measure of interest over time. It could be the revenue of a company, the combat power of an enemy, or a measure of interest from a social network. When do you conclude from this measure that a change may have occurred? Let's assume that by conventional methods you can detect a change in organizational behavior as of **today**, the vertical line. This time point might be too late to take preventative or mitigating action. In other words, this could be the point of inevitable bankruptcy for the company, or the successful culmination of a terrorist attack. Identifying that a change occurred by **time period E** might allow the analyst to respond to the change before it is too late; get inside the decision cycle.



Change detection is more challenging than it may seem at first. The **sudden change in the measure between time D and time E**, however, may look very similar to the **peak at time A**. Furthermore, if you assert that a change in fact occurs at time A, there may exist a large amount of time periods to investigate for the cause of any change. If you can identify more likely points in time where change may have occurred, you can reduce the costs in terms of time and resources to search for the potential causes of change. Identifying the likely time that a change may have occurred is called **Change Point Identification**.

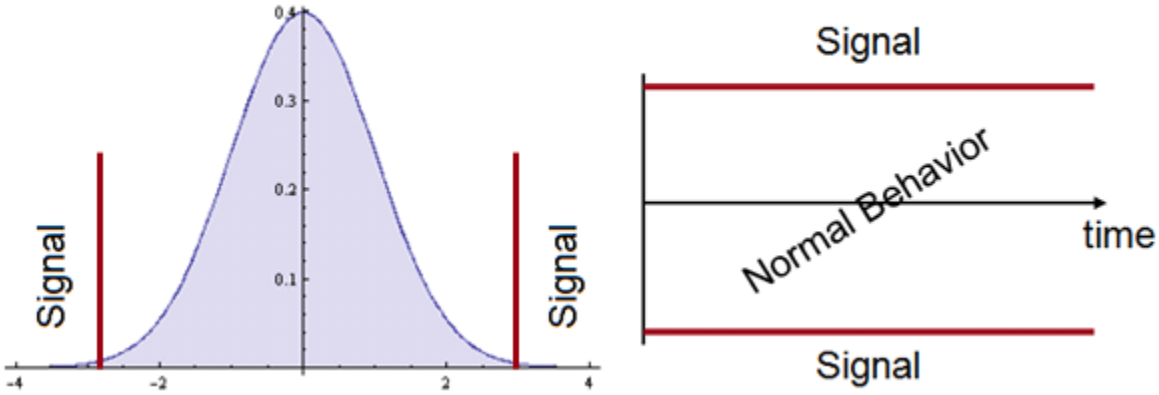
Another problem you face is detecting the change as quickly as possible after the change occurred. Can you improve the ability to get inside the decision cycle by detecting the change at time D, or even better at time B? **This is called Change Detection**.

NOTE : It is important that you use at least 10 time periods for an accurate simulation.

The Three Procedures

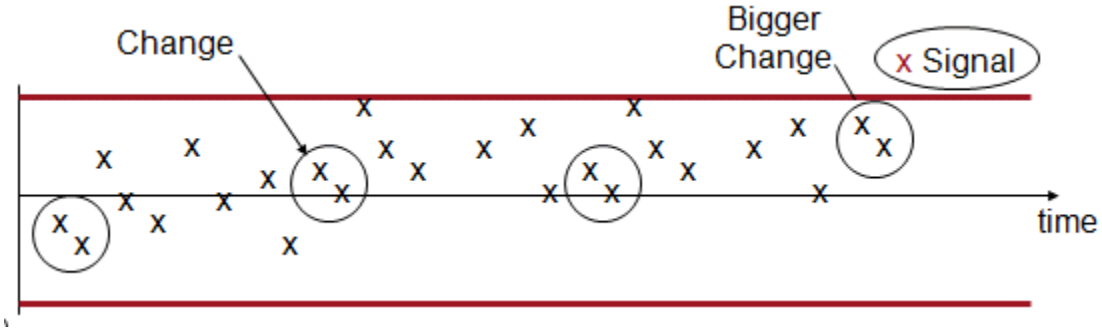
The Shewhart X-bar Control Chart

This is simple and easy to implement and provides a Proof of Concept. If calculates a samle average of observations and measures of a process. The decision interval indicates whether the observation is in the tail of the disbtribution.



Cumulative Sum (CUSUM)

Other statistical schemes increase power (faster detection, given the same probability for false alarm). The CUSUM considers previous values of the observed process. It can take a long time to detect small changes. Intuitively, we can see change earlier. How to detect it?



Cumulative Sum is good at detecting small changes in mean over time and has good buildt-in change point detection.

The **Load data and use CUSUM option**. CUSUM has an additional parameter. This is equivalent to ? in the equation presented earlier. It is an optimality parameter for the CUSUM approach that will make this approach

the uniformly most powerful for a change in the social network measure of ?. As a rule of thumb this is usually set to 1.

There are three ways to set the risk of a False Alarm.

1. The user can specify the decision interval.
2. The user can specify a probability as in the Shewhart approach.
3. The user can specify the average number of in-control networks expected before a false alarm.

This is due to the nested conditional probability inherent in the CUSUM.

The CUSUM signals a change, when the statistic exceeds the decision interval. The most likely point in time that the change actually occurred is interpreted as the point that the CUSUM was last equal to 0. In this case, the time period is 19, which is one time point before the actual change. This is where an analyst would begin to look for explanations of change in the group. There are two separate charts plotted. One is for increases (red) in the social network measure, and the other is for decreases (blue) in the measure.

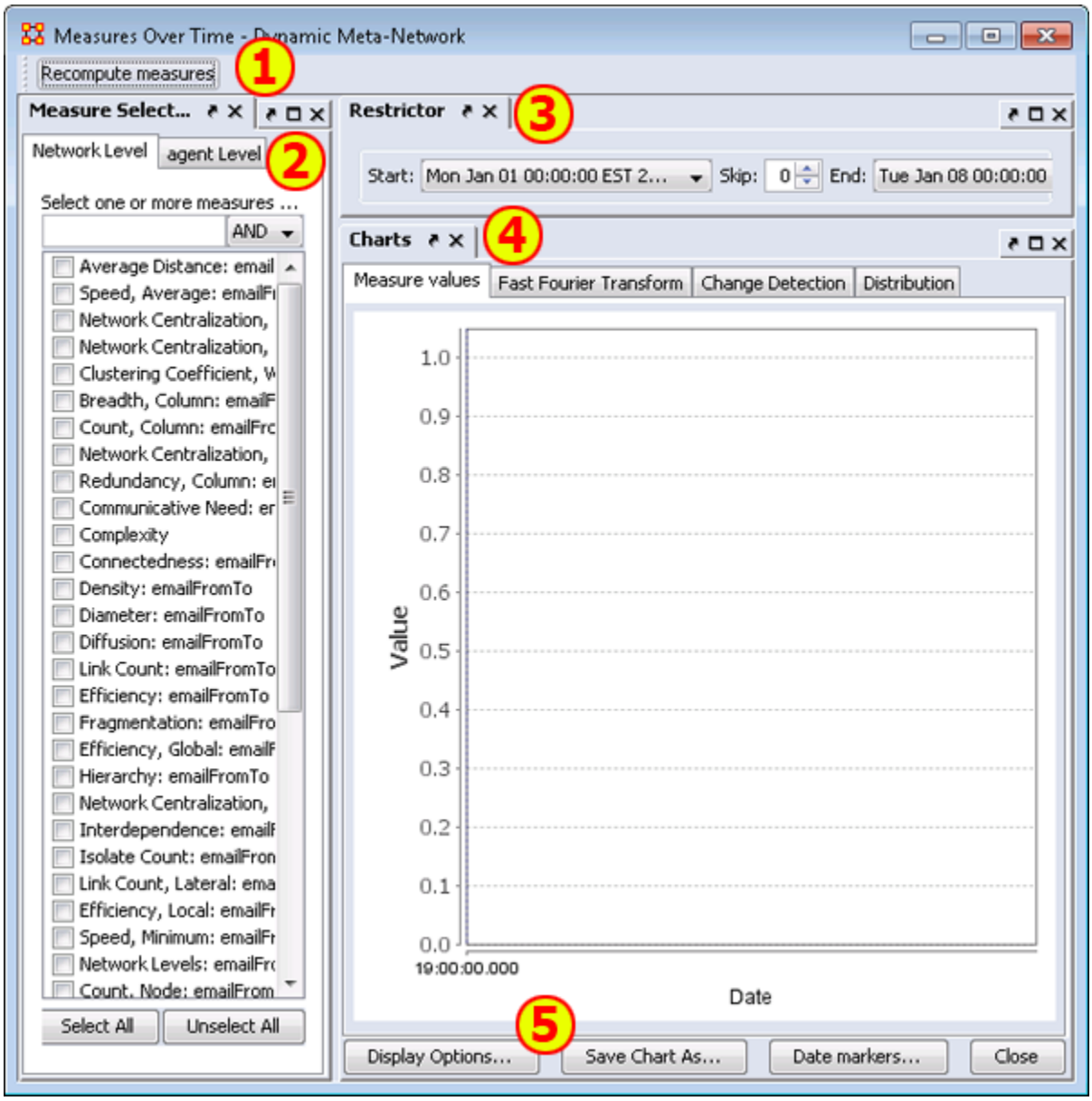
Exponetially Weighted Moving Average

This chart requires two items.

- A definition of what normal behavior is.
- What is the risk of false alarm. (This is a trade-off between speed and mistakes).

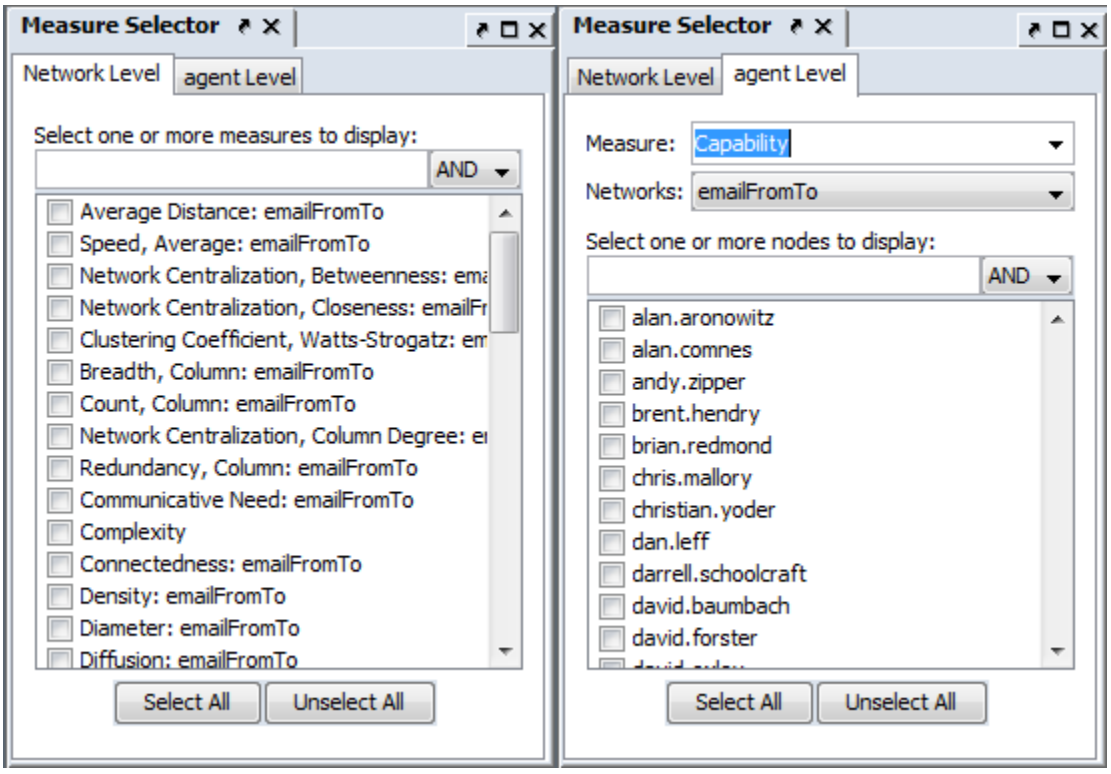


GUI



1) Recompute measures button : Runs the calculations. Allows you to change the measures used and obtain other results.

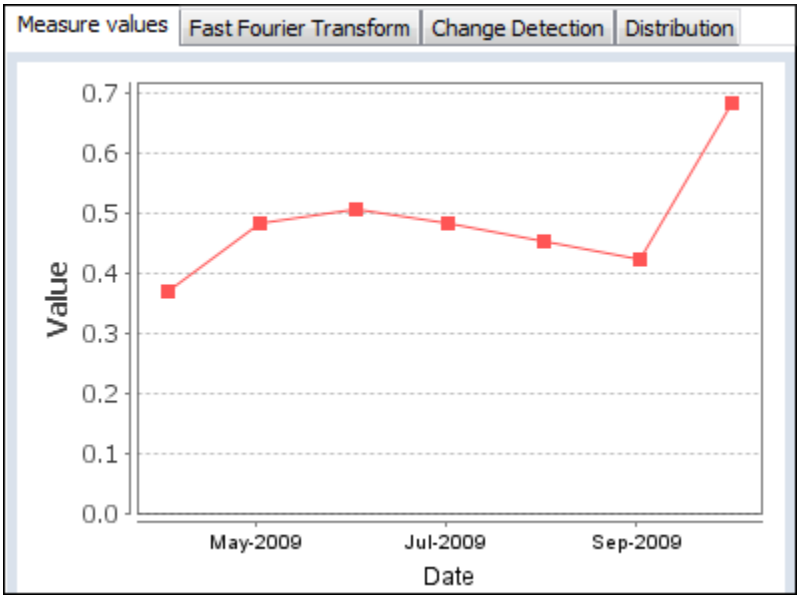
2) Measure Selector pane : In the left pane you can choose the particular measures that you want to analyze in either **Network or agent level**.



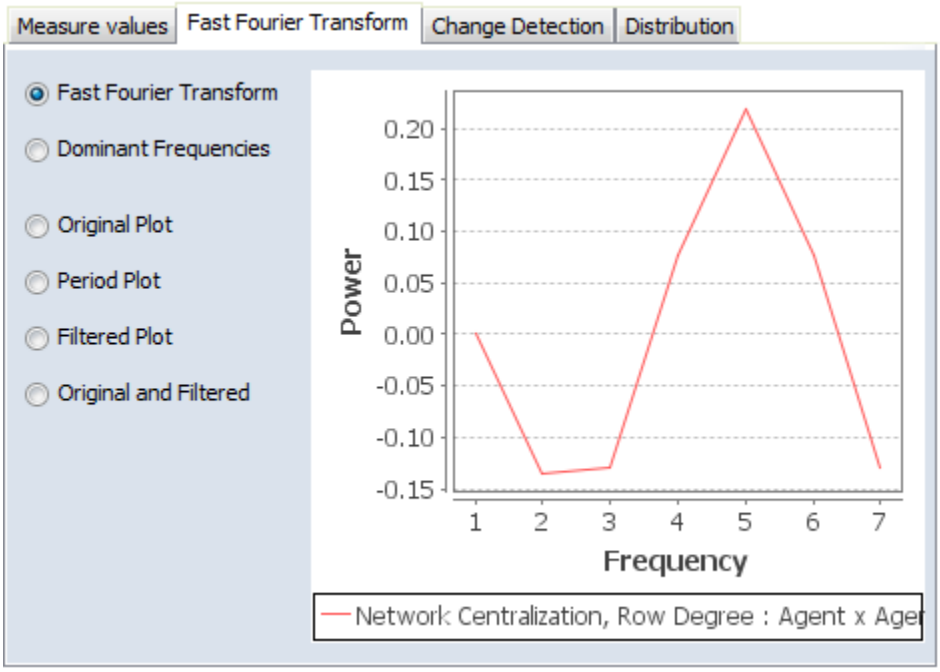
3) Restrictor pane : Allows you to set the dates which the Over-Time Viewer will work and also if you want to set a **skip** interval.

4) Chart pane : Area for displaying the final results. This area contains four tabs:

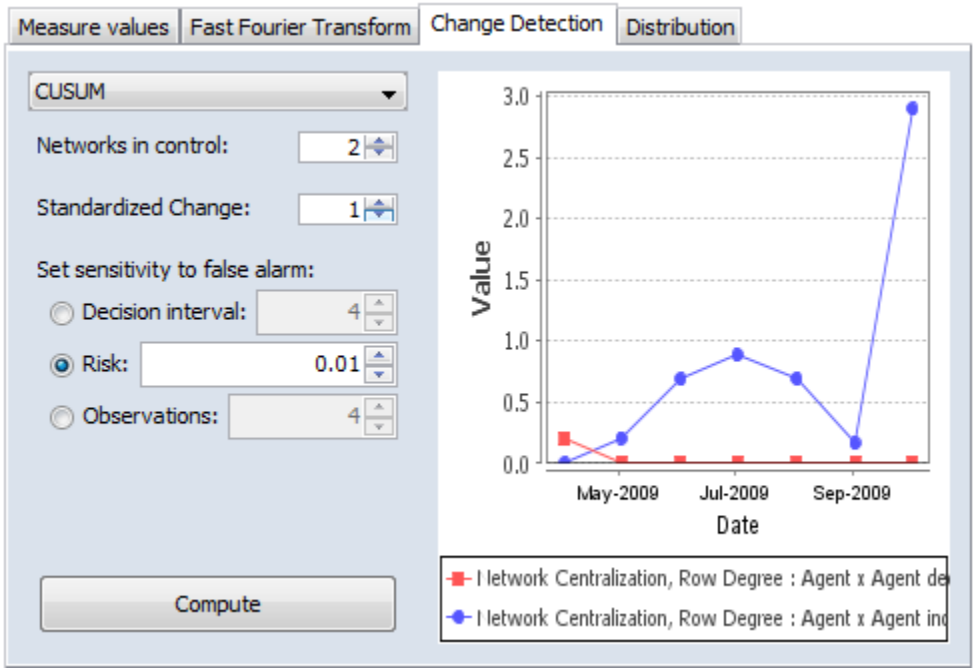
Measures Values :



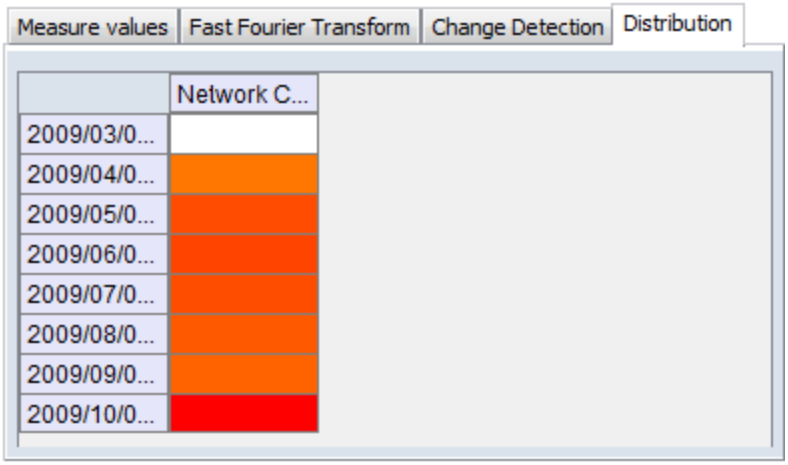
Fast Fourier : Charts the results of the selected measures after applying the Fast Fourier Transform [FFT].



Change Detection : Used to quickly determine **that** a changed has occurred. Find the **change point** to detemine the exact date.



Distribution : Display this information in a color grid. The darker boxes signal higher values.



5) Function Buttons :

- **Display Options :** Allows you to Rename the X-Axis, Y-Axis, or both, recolor the measures lines, change the width of the lines on the graph for better visibility.
- **Save Chart As... :** Navigate to a directory, give the chart a name and click [**Save**]
- **Date markers... :** A one or more dates to the graph which will place a vertical line on the chart.
- **Close :** Close the dialog box.



Over Time Dependence

One major obstacle to the study of network dynamics is **periodicity or over-time dependence** in longitudinal network data. For example, if we define a social network link as an agent sending an email to another, we have continuous time stamped data. Intuitively, we can imagine that individuals are more likely to email each other at certain times of the day, days of the week, etc. If the individuals in the network are students, then their email traffic might follow the school's academic calendar. Seasonal trends in data are common in a variety of other applications as well. When these periodic changes occur in the relationships that define social network links, social network change detection methods are more likely to signal a false positive.

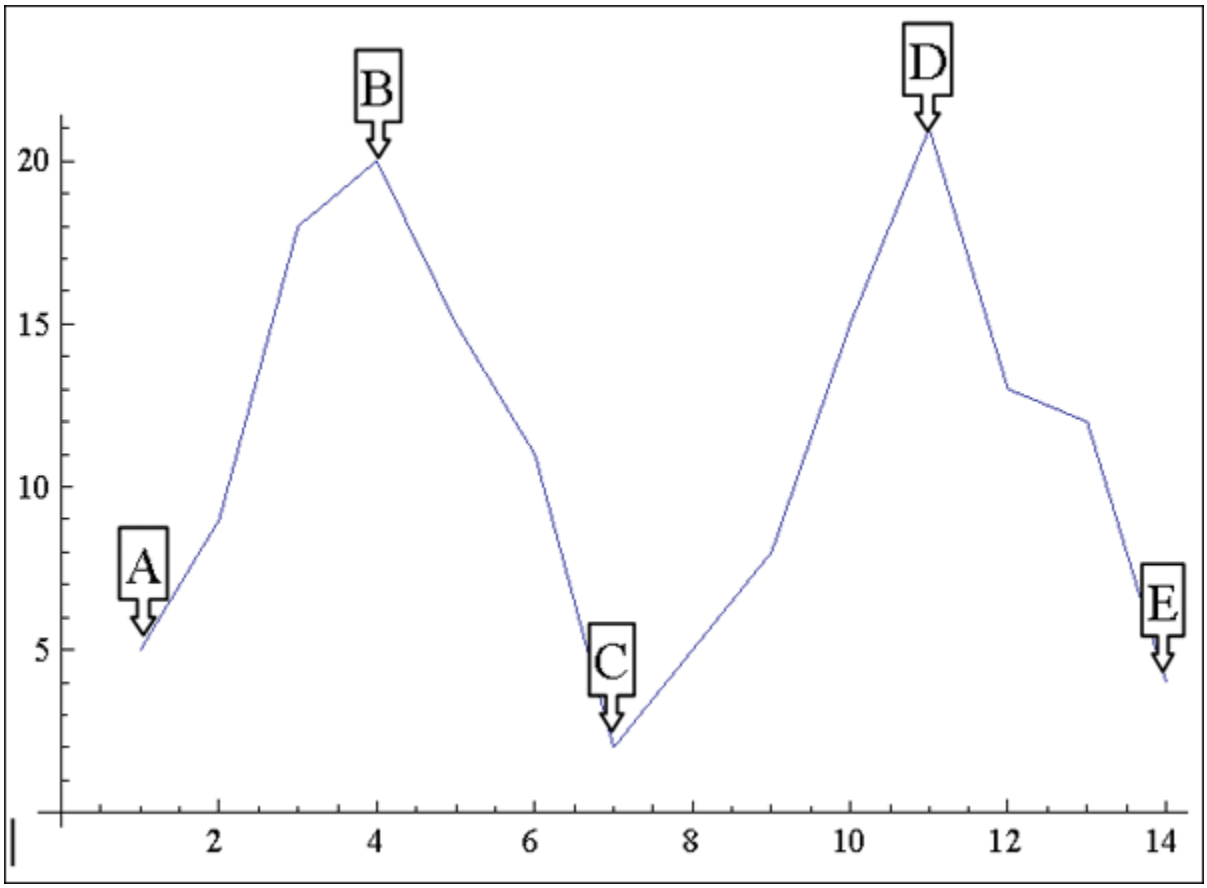
A False Positive : This occurs when the social network change detection method indicates that a change in the network may have occurred, when in fact there has been no change.

To illustrate, assume that you are monitoring the density of the network for change in hourly intervals. The density of the network measured for the interval between 3 A.M. and 4 A.M. might be significantly less than the network measured from 3 P.M. to 4 P.M. because most of the people in the network are asleep and not communicating between 3 A.M. and 4 A.M. This behavior is to be expected, however, and it is not desireable for the change detection algorithm to signal a potential change at this point. Rather, it would be ideal to control for this phenomenon by accounting for the time periodicity in the density measure. Only then can real change be identified quickly in a background of noise.

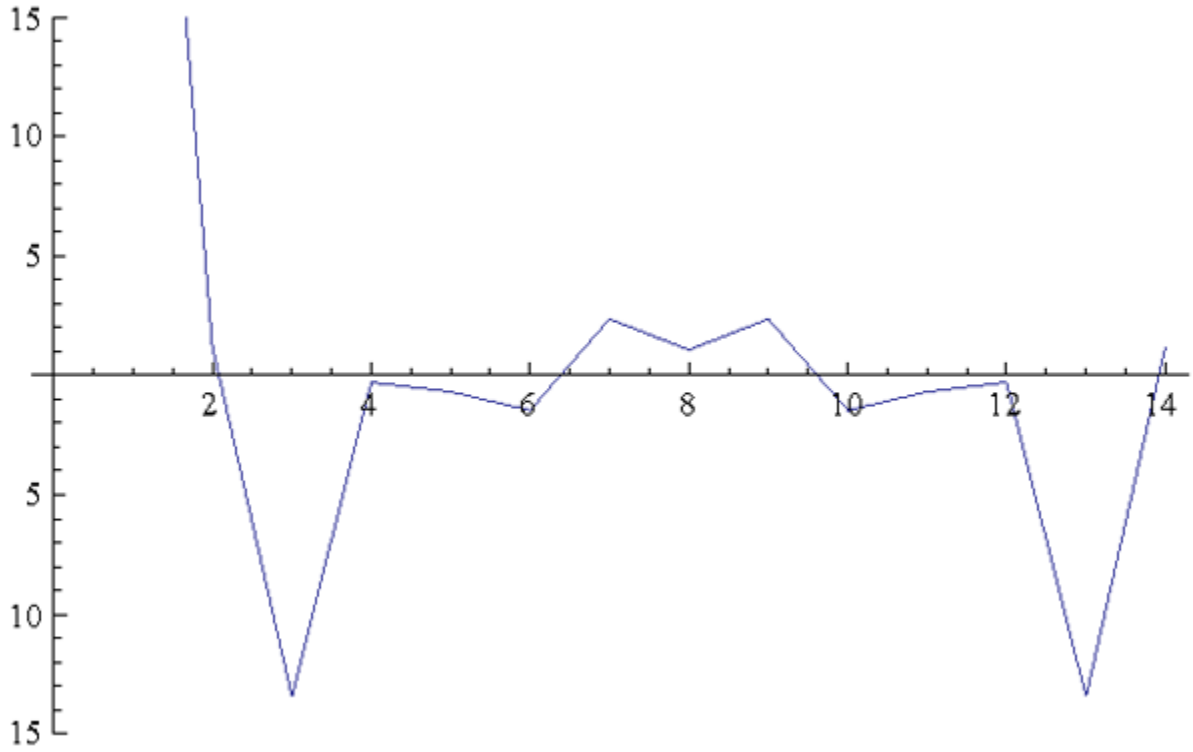
Periodicity can occur in many kinds of longitudinal data. Organizations may experience periodicity as a result of scheduled events, such as a weekly meeting or monthly social event. Social networks collected on college students are likely to have periodicity driven by both the semester schedule and academic year. Even the weather may introduce periodicity in social network data, as people are more or less likely to email, or interact face-to-face.

Spectral Analysis provides a framework to understand periodicity. Spectral analysis is mathematical tool used to analyze functions or signals in the frequency domain as opposed to the time domain. If we look at some measure of a social group over time, we are conducting analysis in the time domain. The frequency domain allows us to investigate how much of the given measure lies within each frequency band over a range of frequencies.

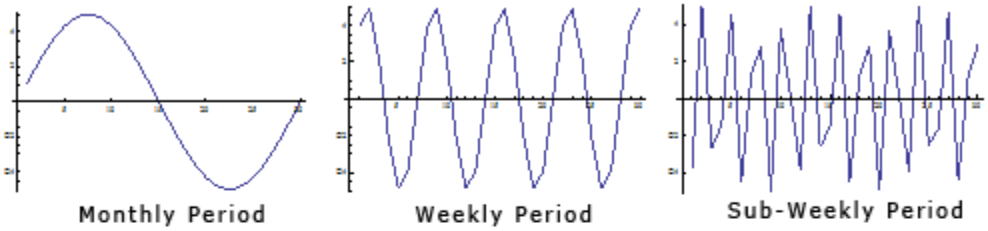
For example, the figure below shows a notional measure on some made-up group in the time domain. It can be seen that the measure is larger at points B and D corresponding to the middle of the week. The measure is smaller at points A, C, and E.

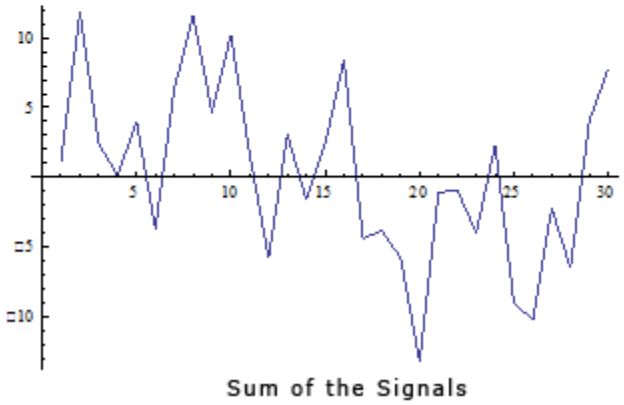


If that signal is converted to the frequency domain as shown in the figure bwlow, you can see how much of the measure lies within certain frequency bands. The negative spike corresponds to 7 days, which is the weekly periodicity in the notional signal. The actual frequency signal only runs to a value of 8 on the x-axis. The frequency domain signal after a value of 8 is a mirror image, or harmonic of the actual frequency signal.

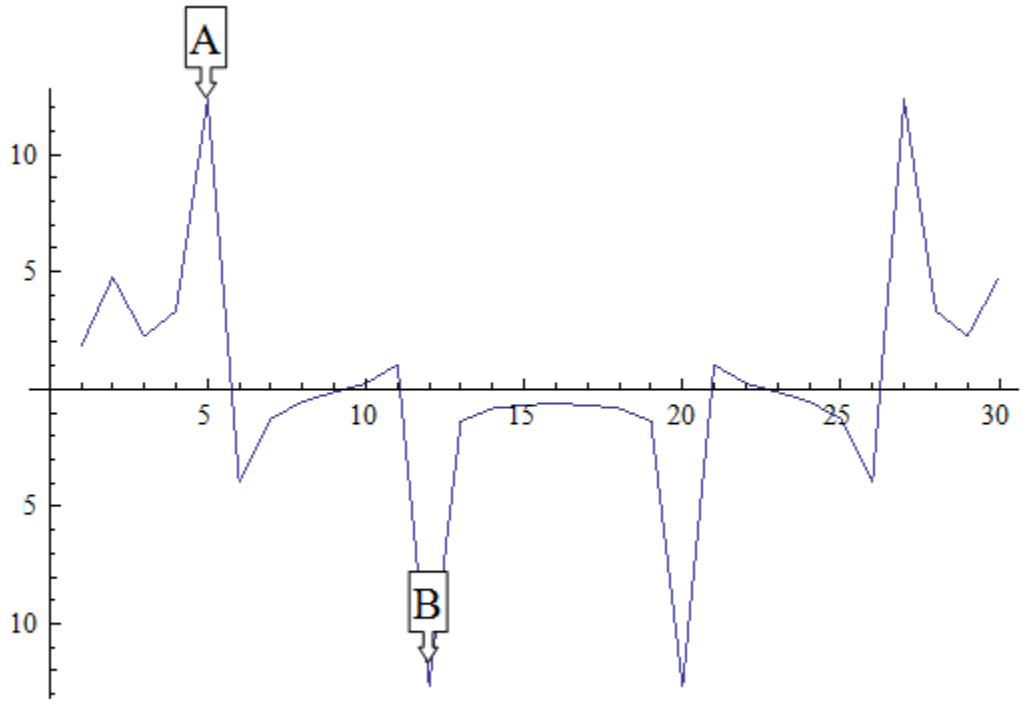


The frequency domain representation of a signal also includes the phase shift that must be applied to a summation of sine functions to reconstruct the original over-time signal. In other words, we can combine daily, weekly, monthly, semester, and annual periodicity to recover the expected signal over-time due to periodicity. For example, the next figures represent monthly, weekly, and sub-weekly periodicities. If these signals are added together, meaning that the observed social network exhibits all three of these periodic behaviors, the resulting signal is shown in **Sum of the Signals**.





If the periodicity in the signal is not accounted for, it appears that there may be a change in behavior around time period 20, where the signal is negatively spiked. In reality, this behavior is caused by periodicity. If you transform the signal to the frequency domain you can see the weekly periodicity at point B and the sub-weekly periodicity at point A.



Transformation to Frequency Domain

Spectral Analysis applied to social network measures over time will identify periodicity in the network. The next procedure will transform an over time network measure from the time domain to the frequency domain using a Fourier transform. Then the significant periodicity will be identified in the over-time network and present two methods for handling the periodicity.

The over time dependence analysis is accessed by selecting the **Fast Fourier Transform** tab in the Over Time Viewer. This displays the frequency plot of the data.

You can use the Over Time Viewer to help determine which frequencies are significant.

The [**Dominant Frequencies radio button**], displays only the statistically significant frequencies.

The [**Fourier Transform radio button**] uses the normal distribution in order to transform data from the time domain to the frequency domain. Therefore, the normal distribution is an appropriate distribution to fit to the frequencies plotted in the frequency plot. All frequencies that are within two standard deviations of the mean are then set equal to zero for the dominant frequency plot, revealing only the dominant frequencies.

NOTE : A dominant frequency is a potential source of periodicity, as opposed to random noise in the over time signal.

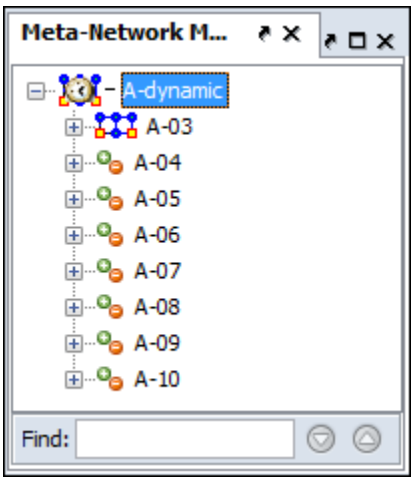
The analyst will often want to transform the statistically significant frequencies from the frequency domain back into the time domain so that he/she can make better sense of them. To do this, the analyst must select the radio button on the lower left called Period Plot.

The [**Period Plot radio button**] shows the analyst the expected periodicity in the over-time data. In the example, you can see weekly periodicity. The peaks and valleys in the period plot occur approximately every 7 days. At this point, the analyst may wish to merge the daily data into weekly networks. This would average out the effects of weekends and evenings that are likely to affect the properties of daily networks. Another approach is to simply look at the networks departure from what is expected.

The [**Filtered Plot radio button**] will create an over-time plot of how the measure deviates from what is expected, based on the periodicity of the measure. You can also plot the filtered measure with the original measure to see the difference as shown below.

Procedure

Your Dataset



Load your dataset which you need to run the Change Detection on into ORA. This should be a dataset with multiple time periods. Measures will be run on all the time periods and this will determine **IF** a change has happened.

Highlight the Meta-Network.

Start Measures Over Time Function

From the Editor's main menu select **Visualizations > View Measures Over Time...** to start the process. In the dialog box select **Centrality measures** radio button. The measures for Change Detection you are mostly concerned about are the Closeness and Betweenness measures. But this will not always be the case.

Finally click [**Compute**].

Set Parameters For Trigger

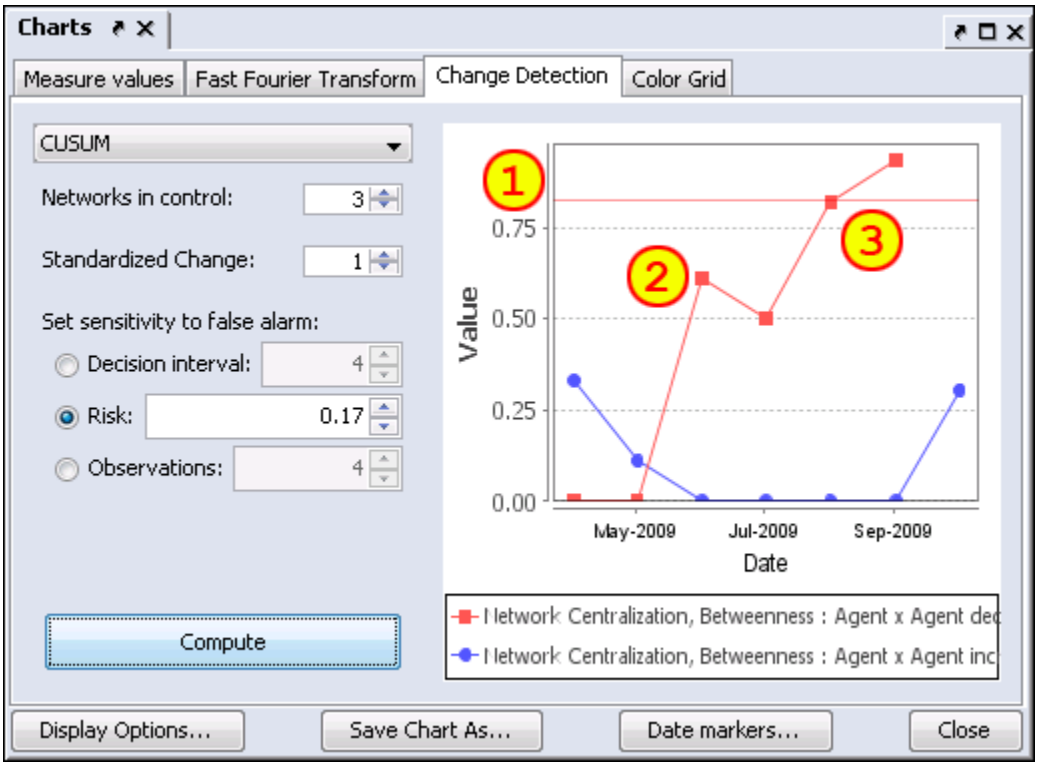
False Alarm vs. Fast Detection : You need to determine which type detection you are looking for. This will help you set the trigger point. Where you set the risk bar has an effect on triggering alarms. Set it too low and it will trigger an alarm quite frequently possibly giving too many false alarms. Set it too high and you might not see the trigger until it's too late.

Example

I select **Network Centralization, Row Betweenness : A-03**

Next I click the **Change Detection** tab abd select **CUSUM** from the drop down menu.

I then set the **Risk** to **0.17** and click [**Compute**].



Setting the Risk to 0.17 sets the trigger line in the chart **(1)**.

The datapoint at **(2)** is a major spike but has not set off the alarm yet.

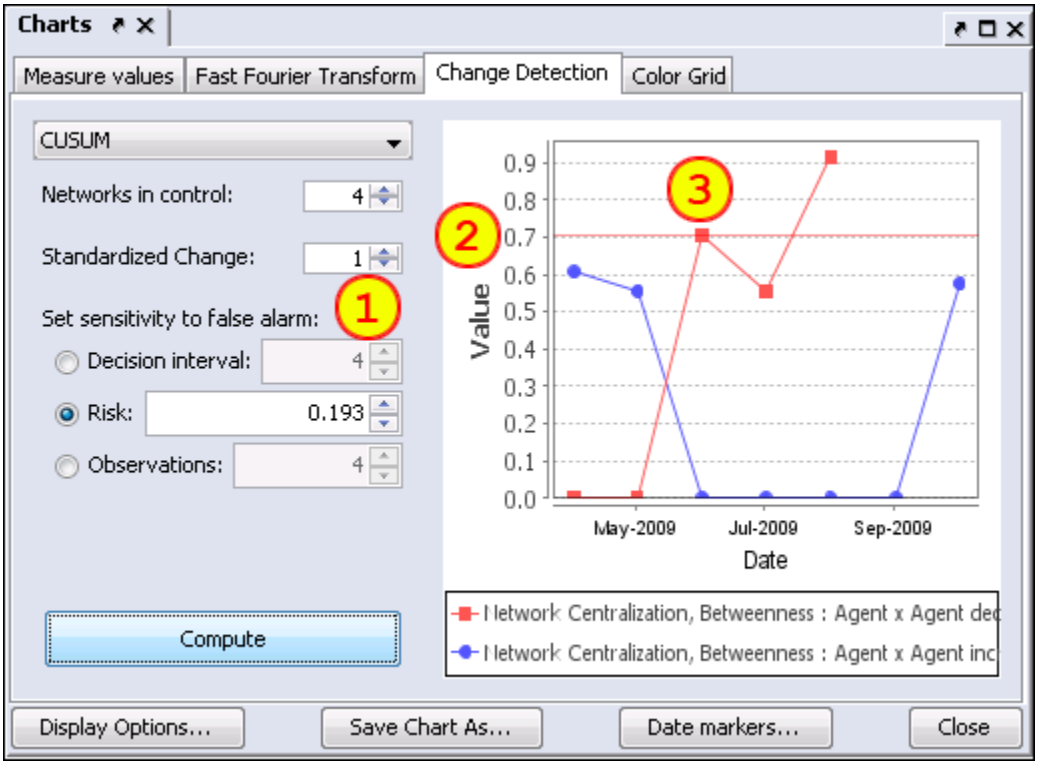
After a slight decrease the next jump at datapoint **(3)** is still under the trigger point but very close. and the following datapoint sets off the alarm **Sep-2009**. Tracing backwards the point of change is **Jul-2009** when the upward trend began.

NOTE : There are two separate charts plotted. One is for increases (red) in the social network measures, and the other is for decreases (blue) in the measure.

NOTE : When a change signals in both increasing and decreasing directions, it is likey a false alarm.

NOTE : Once a signal occurs the CUSUM is no longer plotted over time.

Early Detection / False Alarm



Setting parameters to different values can make changes in the alarm rate. Changes in the parameters **(1)** are **Networks in control** increase to 4 and **Risk** increases to 0.193. This lowers the alarm trigger point to 0.7 **(2)**.

(3) shows that the alarm is triggered in **Aug-2009**, a month earlier than the previous example although the upward trend is also **Jul-2009**.

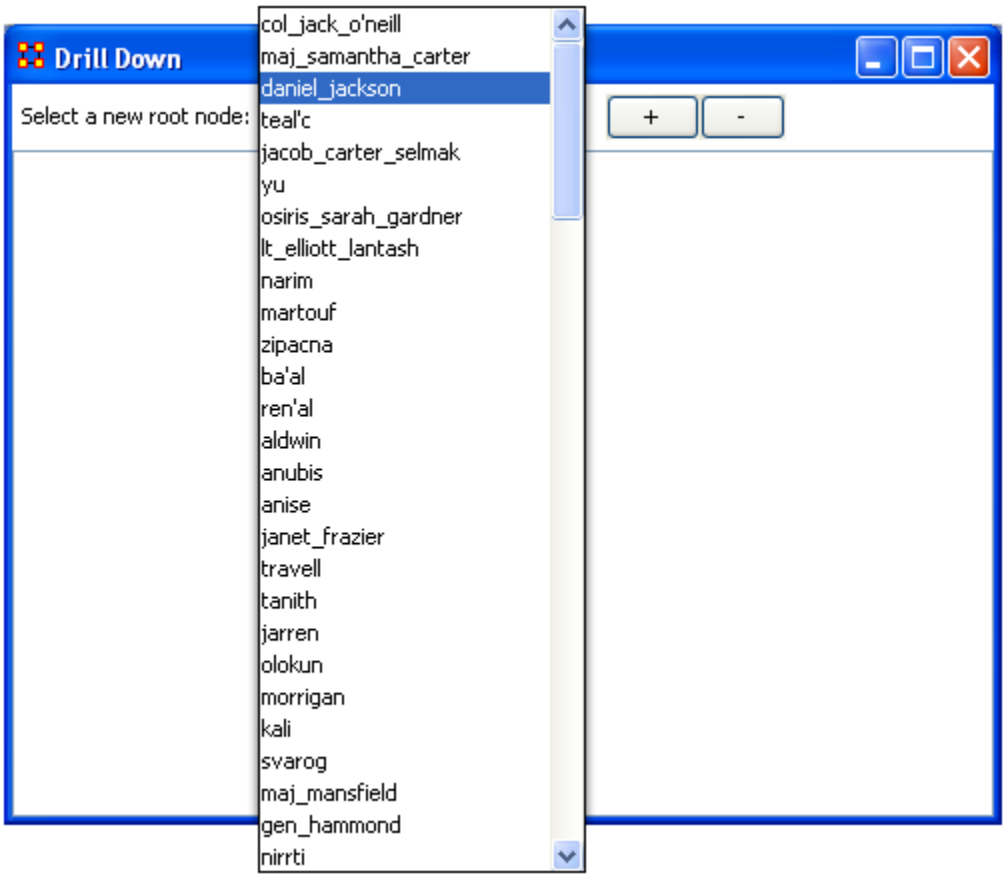
Had the Risk been risen any more the alarm would have been triggered in **Jun-2009** and the changed point would be taken as **May-2009**, a full two months earlier than the previous example.

The question would be is **May-2009** the true change point or is it merely a false alarm given the parameters set to detect it.

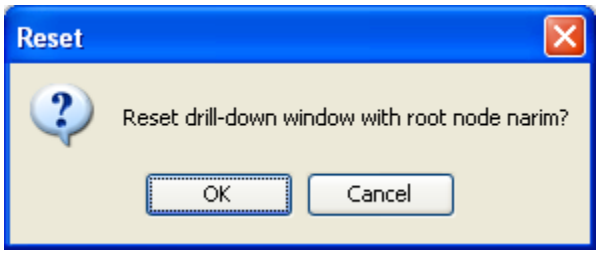
Drill Down

DrillDown allows for any path to be followed.

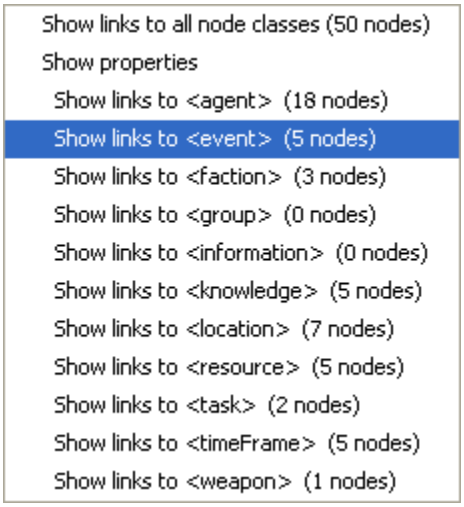
From the drop down textbox select the node you wish to start with. Here we'll begin with **daniel_jackson**.



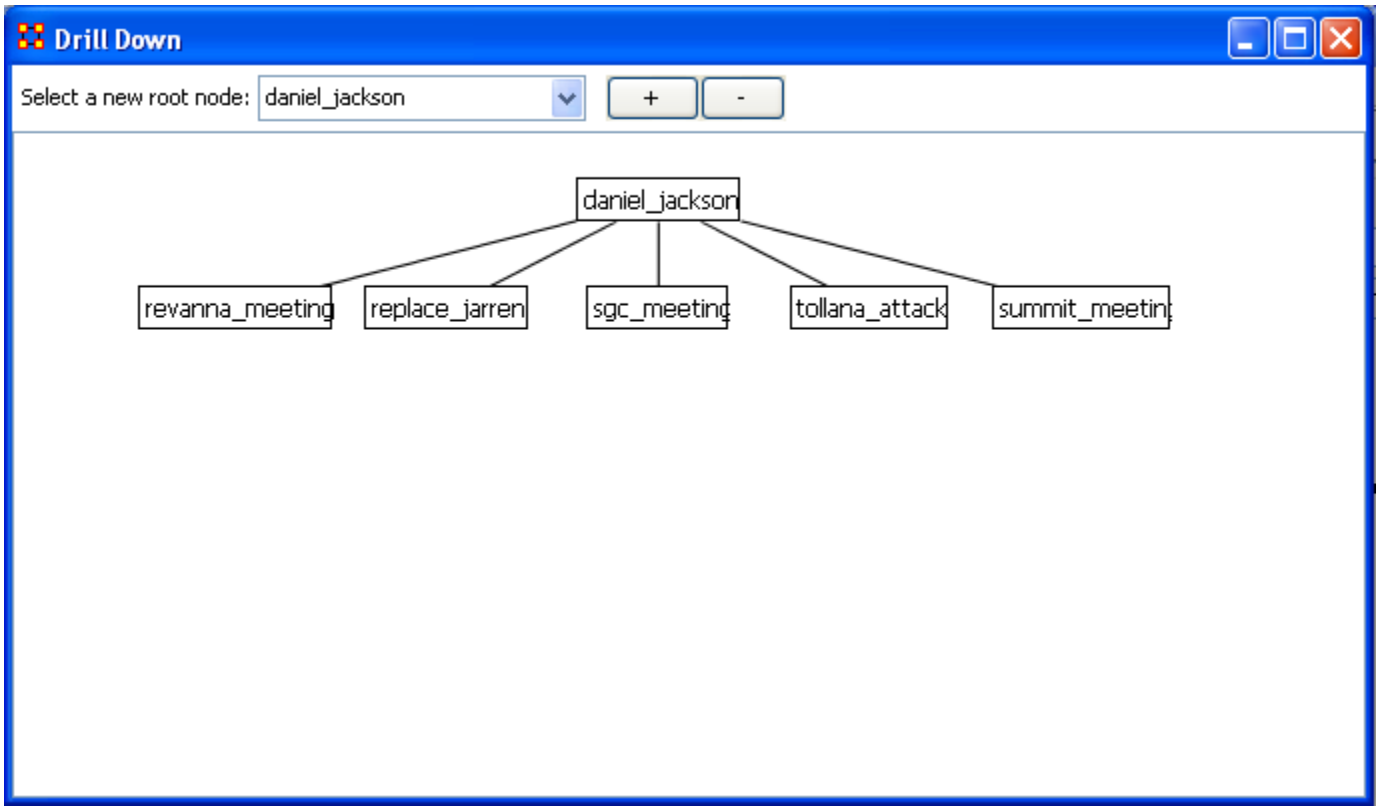
The dialog box below will appear confirming you want to discontinue your last drill-down session.



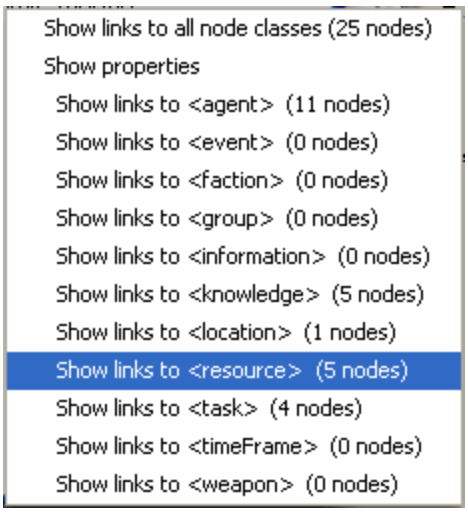
Click on the node and a contextual menu will appear with all the links it has to other nodes. I select **<event> (5 nodes)**.



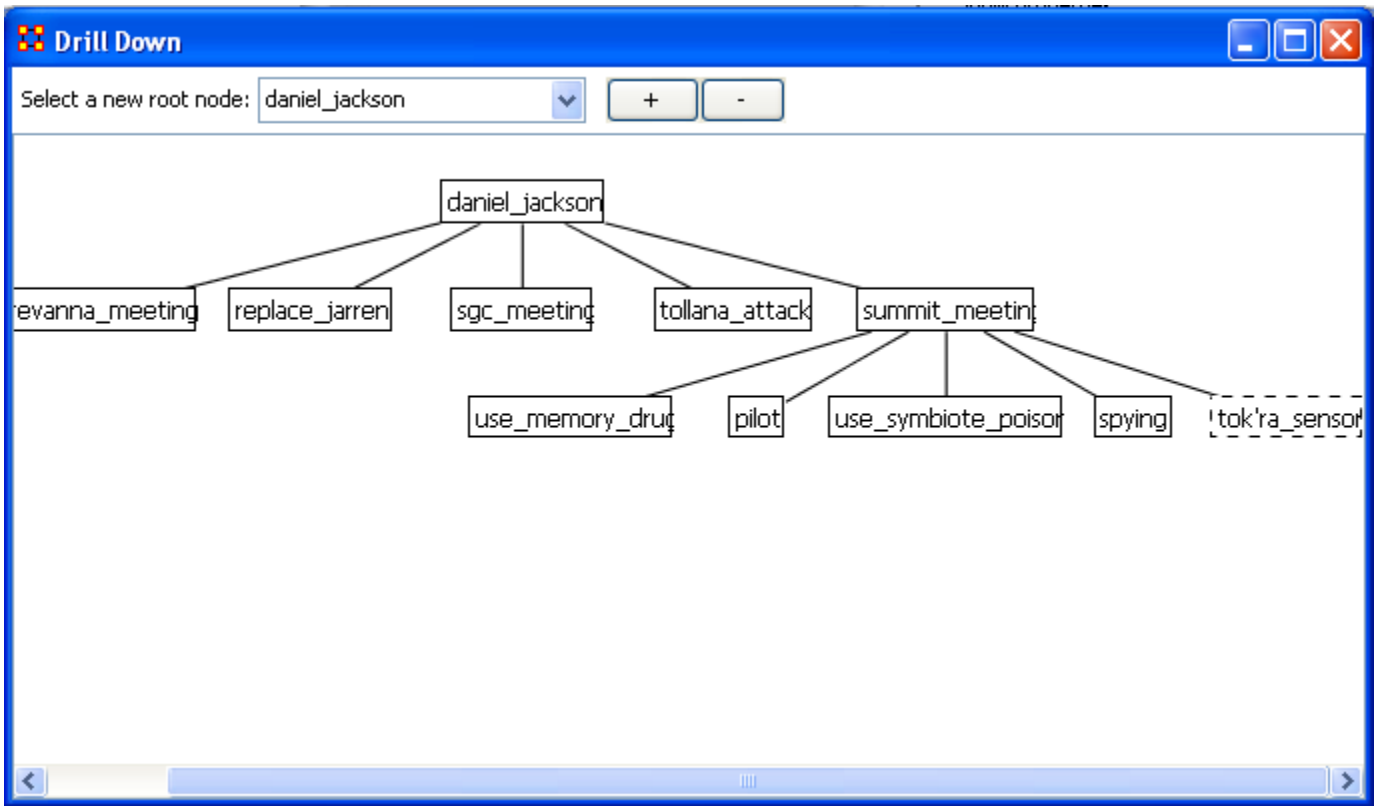
This shows the five events the daniel_jackson was at.



Next I select **summit_meeting** and from the contextual menu select **<resource> (4 nodes).**



It **drills down** showing the five links to resource nodes connected to the summit_meeting.

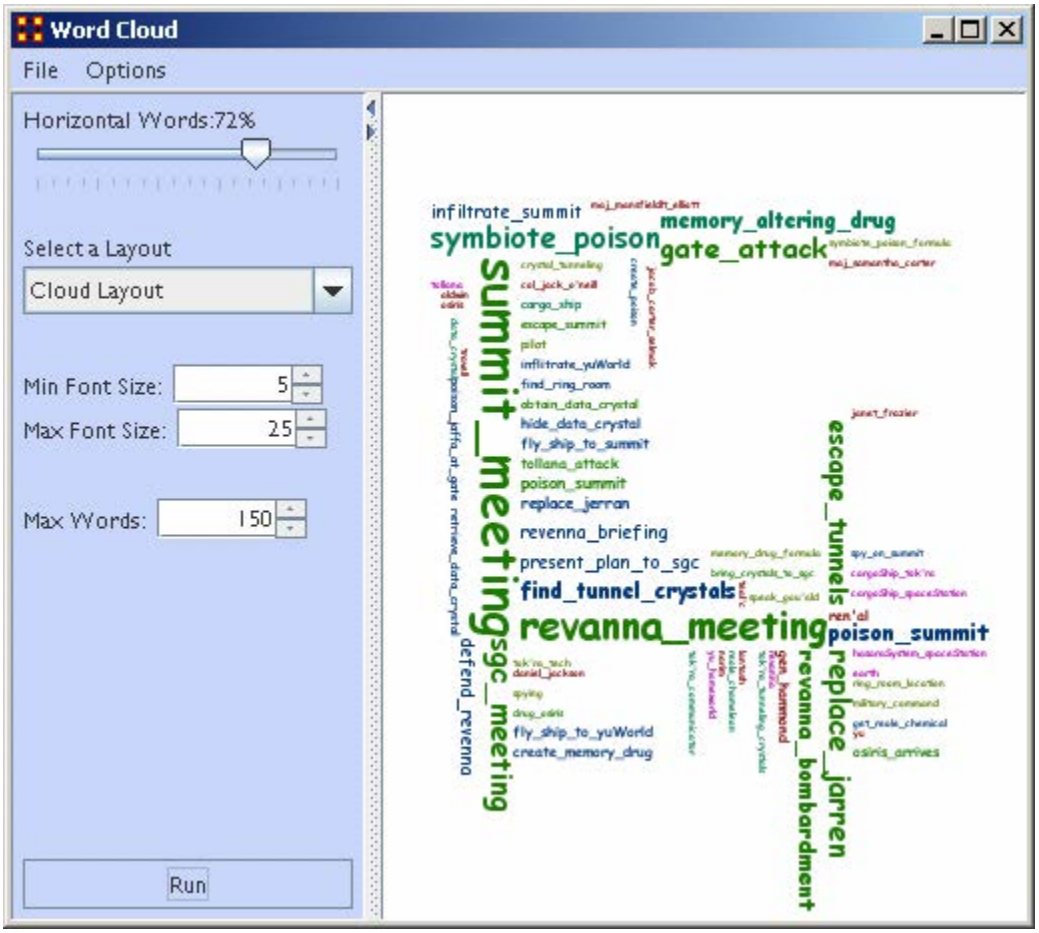


This can be continued for as long as you need.

The **[+]** and the **[-]** buttons increase and decrease the font size.

Node Cloud

In ORA you can opt to visualize your data as a word cloud. A word cloud can loosely be described as a visual representation of words that appear within your data by displaying words that appear with the most common frequency as the largest. Below is a screen image of the SG1 data set as visualzed in ORA's word cloud feature.



Word Cloud Tools and Settings

File : By accessing the File Menu you can open a previously saved Meta-Network, Save an Image to the clip board, and close your Meta-Network word cloud.

Options : In options, you can choose the measure you wish to apply to your word cloud visualization.

Horizontal Words : You can use this slider to set the ratio of the horizontal words visualized to the vertical word display (e.g, changing this setting to 100% would result in all horizontal word visualizations and no vertical words. Conversely, changing this setting to zero has the opposite effect.

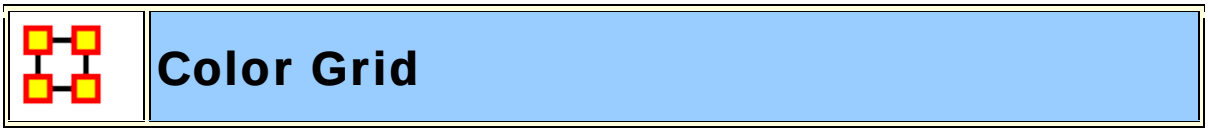
Select a layout : Choose either word cloud layout (default) or a square layout. The square layout will attempt to visual your word cloud in approximate equal ratio of width and height.

Min. Font Size : Sets the parameter for the smallest font size to display. Note: if you change this setting, click "run" to have the new setting applied.

Max. Font Size : Sets the parameters for the largest font size to display. Note: if you change this setting, click "run" to have the new setting applied.

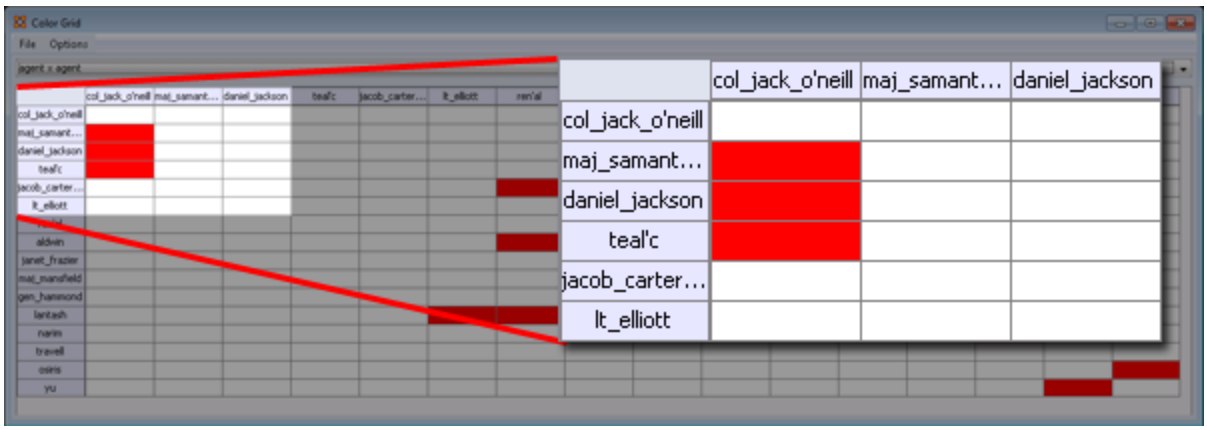
Max Words : Sets a limit on the maximum amount of words to visualize (e.g., if you set this at 10, the word cloud will only visualize the words that appear in the top ten in terms of frequency.

Run : Click **[Run]** to apply any changes to the settings.



The **Color Grid** is designed to allow you to quickly see what connections are in a network. Whereas the Editor either uses numbers in it's numeric view or check boxes in it's binary view the colored blocks used in the COlor Grid make it easier to discern who has a connection to whom.

The color ranges from **White :** no connection; **Yellow :** few connections; **Red :** the most connections.



Menus

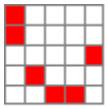
File > Save Image As... Creates a color image (**JPG or PNG**) of the currently display grid.

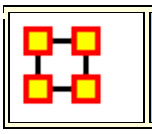
	mathemat...	attorney	judge	politician	spy
hari_seldon					
gaal_dorn...					
jerril					
lors_avakim					
linge_chen					

File > Save Image As... (Greyscale) Creates a greyscale image (**JPG or PNG**) of the currently display grid.

	mathemat...	attorney	judge	politician	spy
hari_seldon					
gaal_dorn...					
jerril					
lors_avakim					
linge_chen					

Options > Toggle Headers : Toggles on/off the display for the headers and reduces the size of the grid.





Region Viewer

NOTE : Before you start make sure you dataset contains both **Latitude and Longitude** data in order for information to be plotted and that it is in a **numeric** format.

From the main menu select **Visualizations > Region Viewer**. You will be presented with a dialog asking you to select a Shapefile. Click the [**Load**] button and navigate to the shape file to use. These files contain the extension **.shp** After selecting a file click the [**Run**] button.

File Type

NOTE : The Region Viewer only works with **WGS84-projected maps**

Region Viewer

The Region Viewer and Legend will appear on the screen. The Region Viewer with the ShapeFile you loaded and the Legend with the Node Class containing the Latitude and Longitude attributes. Currently there are no values. This needs to be assigned.

Shape Legend

Using the Shape Legend you can color individual shapes. Click on a color box and choose a color. After hitting [OK] the shape will take on that color.

The Menu

File

Save Screenshot : Options for saves a screenshot in either the .PNG of .JPG format.

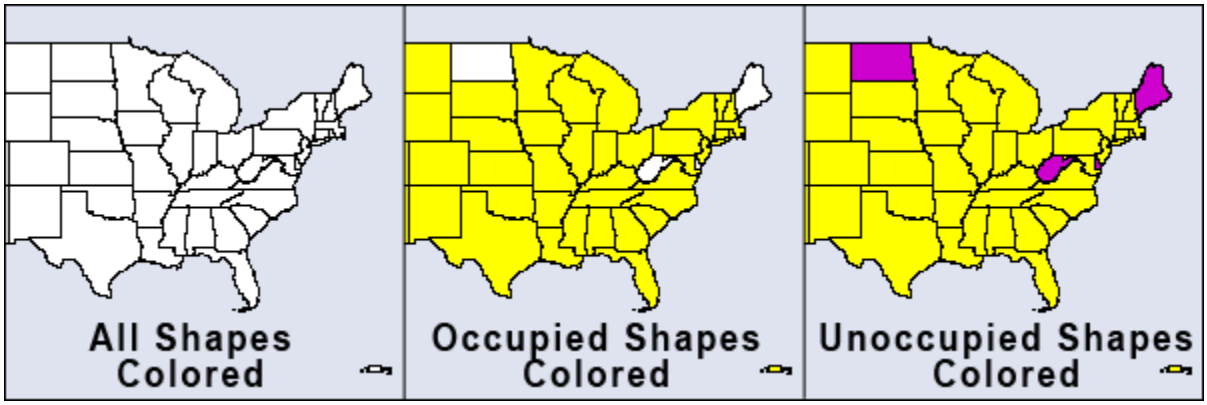
Close : Closes the Region Viewer

Action

Color All Shapes... : Brings up the **Select an Entity Color** dialog. All shapes will be colored.

Color All Occupied Shapes... : Will put selected color in shape which contains a node within the shape's boundaries.

Color All Unoccupied Shapes... : Will put selected color in shape which **does not** contain a node within the shape's boundaries.



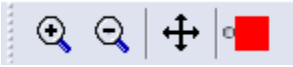
Color Shapes by Attribute... : Select an attribute from the drop down. All shapes will be colored based on the value of that attribute

NOTE : The attibute choosen needs to be a numeric value. Text values will not be shown in the drop down.

Color Shapes by Measures : Runs the selected measure on the Meta-Network and colors shapes from the **min and max** values.

Color Shapes Using Existing Value : With the Position tool deselected click on the color square and select a new color. Each shape clicked will be given this new color.

The Toolbar



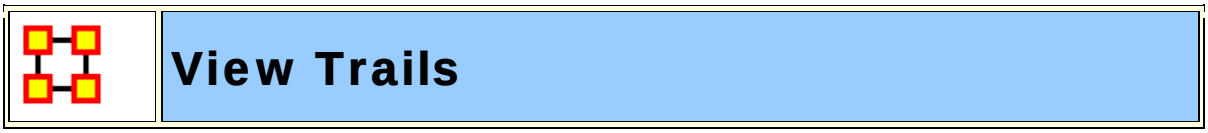
The first three tools are straight forward. The far-right tool needs a slighly longer explanation.

Zoom In : Clicking this button will zoom in the map based on the the center of the map

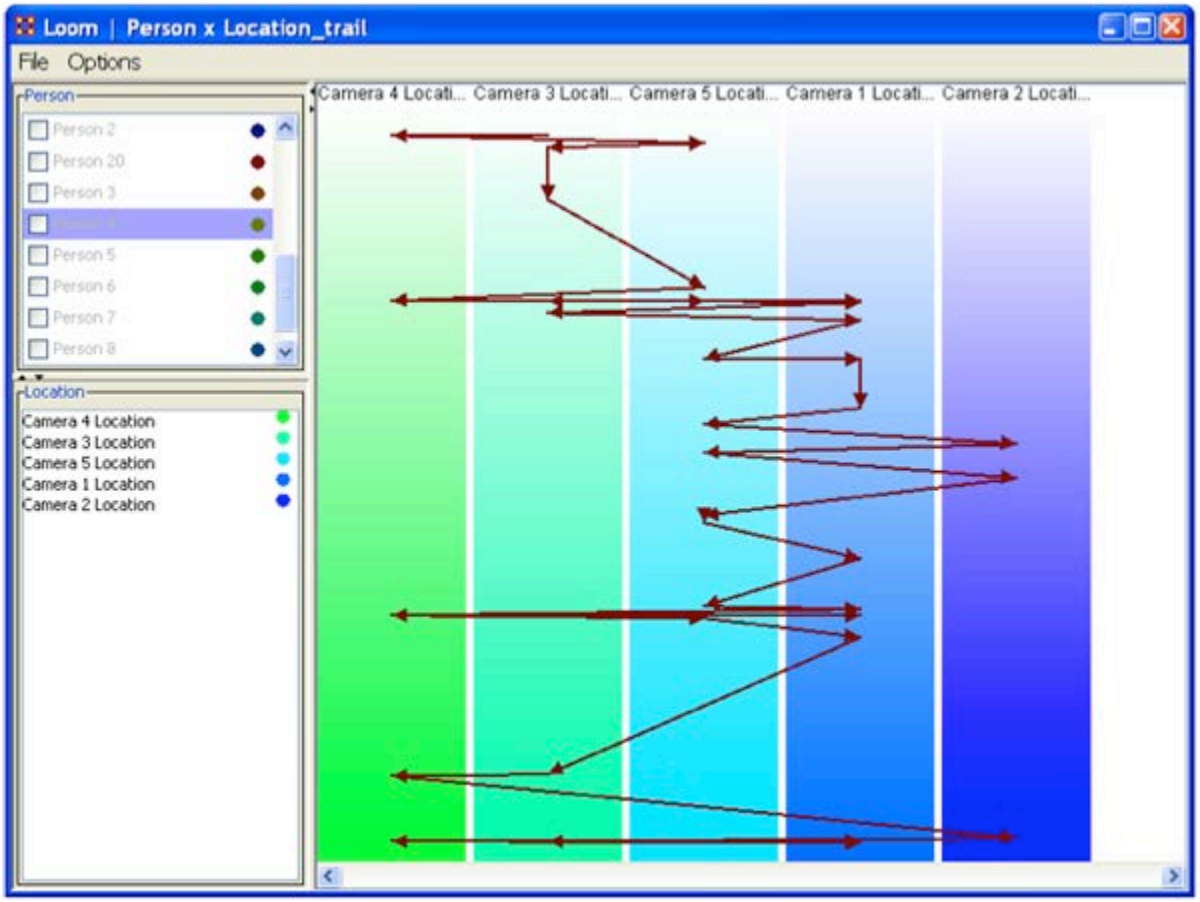
Zoom Out : Clicking on this button will Zoom Out based on the center of the map.

Position : Clicking this button will toggle the Center function and the Color function. When highlighted clikcing anywhere on the map will make that the current center. The map will redraw based on the new center. When unhighlighted the Colorize tool is activated.

Colorize : When the Position button is not selected this function is available by virtue of the small circle to the left of the color patch.



 Tracks agents as they travel from location to location finding when various agents were co-located in the same area.



The Person Pane allows you to choose which Trail(s) you want to visualize, as well as what color to use.

The Location Pane acts as more of a legend, showing you the currently active targets, while providing a way to change colors.

The Trail Pane is where the trails are actually visualized. The Y-Axis corresponds to time.

Trails Data

The data to be used is known as TAVI. It tracks persons as they move around, with their position decided by which camera locates that person for any given time. As such, at any given point in time, each person is only associated with one location TAVI makes use of a relatively new data format known as the Dynamic Meta Network. The Dynamic Meta Network allows for creation and usage of multiple time slices, while keeping file size complexity to a minimum. In TAVI's case, it works with around 2700 different time slices, tracking about 20 agents over the course of two years.

After a Trails dataset is loaded you can view the individual time slices in the Meta-Network pane. To view this is Loom select **Visualizations > View Trails**.

The **Focus of Activity** are figuring out where people tend to go and guessing what they do there?

It always involves both subjects and locations.

Unlike a network, subject may revisit location.

The time stream is an integral part of the data.

Subjects exist at one location at a time **(but longer relationships may be implicit in repeated visits)**.

Loom is primarily concerned with how specific entities move or evolve through other entities. In the most basic case, this involves Agents as they move through Locations, which is what we'll be looking at today. More abstract examples include Agents moving through Beliefs or Beliefs moving through Locations. When you first start Loom, you are prompted for a Network. The target nodes in the Network dictate what they're moving through. The source nodes are who/what is doing the moving. Once started, Loom goes through all time slices, and looks at the connections in that network only. It sets up a series of way points based on what connections are made at that time slice, upon which it constructs a trailset. Classically, we restrained Loom such that for any time slice, any source node could appear in at most one target, but now we allow for a source node to occupy multiple targets at a time (Agents having multiple beliefs, for example).

Notes on Trails : Everything is scaled according to time. This can lead to some interesting behavior. In this example, we see a horizontal line. This doesn't mean an entity occupied two targets at that time, but rather, is because of the scale. The change may have taken only minutes or hours when the entire thing looks at two years.

Procedure

The Trails Report : To access the **Trails Report** use the **Report Manager**. The trails report can be found either through the drop down menu or in the Geospatial category

Input : The report requires an input of at least two meta-networks with similar network structure (for the network we're interested in). Since TAVI is

dynamic, we can get all the meta-networks we need from it. However, 2700 meta-networks will take quite a bit of time to work on, so we can aggregate by month to reduce it to a much more manageable number.

Selecting a Trail(s) : The next window is perhaps the most important. While it doesn't ask for a specific Network, is does ask for nodes to track and a node class to track through.

In other words, we're selecting the Subjects (trails) up top, and the targets on the bottom. Since we've been looking at Person X Location, that is what has been selected.

Finish : Select the format for output, the directory in which to save it, and an optional extension.



Importing

You will need a Meta-Network with location data.

Benefits and Drawbacks

It's good to understand what different information visualizations of trail data give you. The **Over-Time Visualizer** displays data in individual time periods. The GIS visualizer displays all data simultaneously regardless of time. The **Loom** displays paths agents take to locations chronologically.

Cluster Similar Trails

Use Loom to cluster similar trails. It is a high level concept display for who was where when.

Procedure

Take your **Dynamic Meta-Network** and view them in Loom. From Loom menu select **File > Export to Ora NetScenes > Transition/Colocation/Visit Matrix...**. ORA takes the entire trailset and

outputs a single meta-network. It takes all the data from the multiple time periods and aggregates them into a single Meta-Network.

Colocation : An edge is created between nodes if they ever existed at the same place at the same time.

Visit Matrix : An edge is created between a location and node if the location was the site of an event.

Transition : An edge is created between locations if a agent traveled to that location.

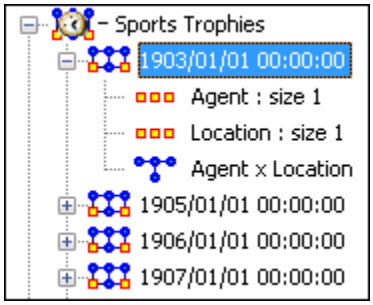
Visitation Frequency Matrix Location

The export operates from what is visible. It counts the total number of visits to all locations. The Matrix is similar to the Transition matrix.

Example

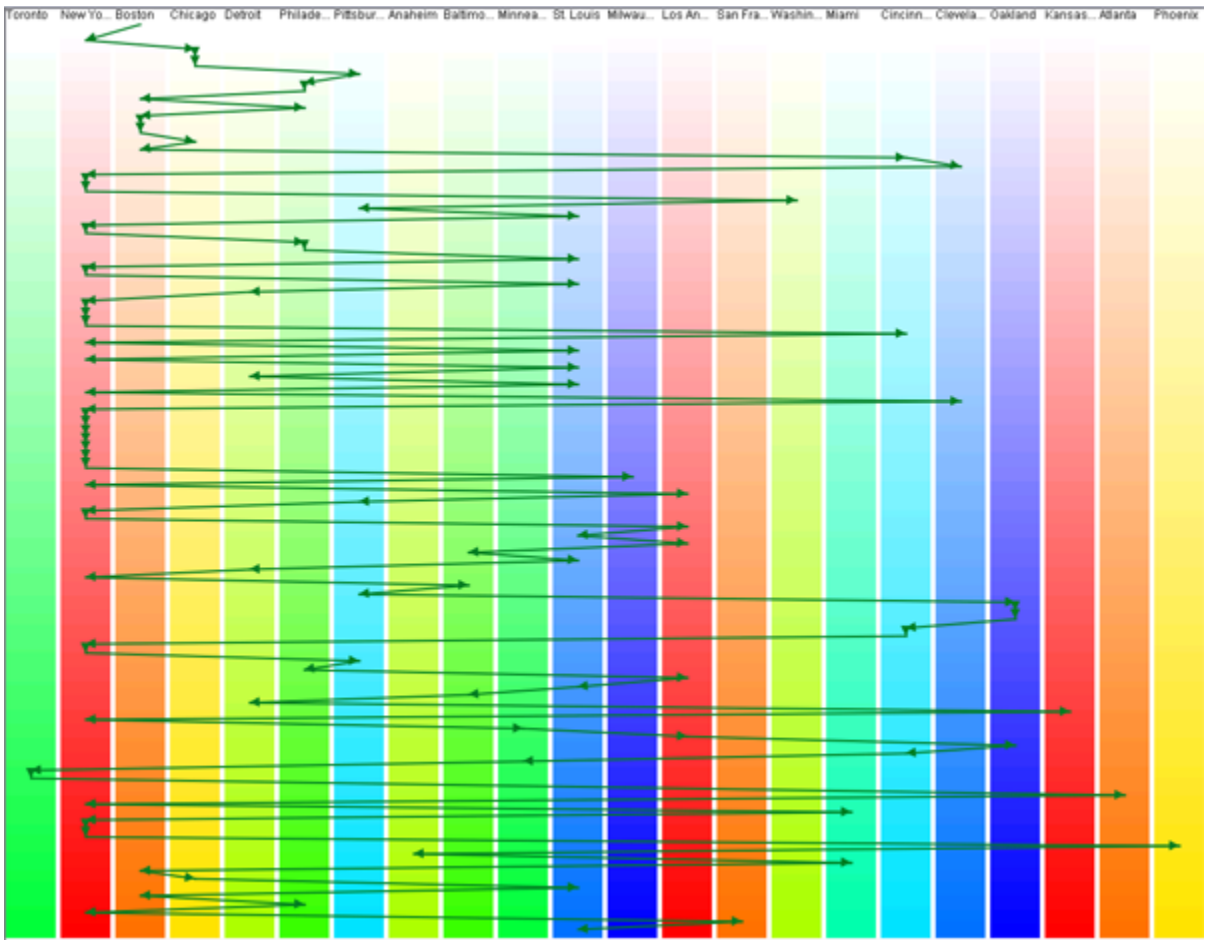
CLick the [**+**] to expand the Dynamic Meta-Network then click the [**+**] to expand the first time period. There are two nodesets, Agent [with one node] and Location [with one node], and an Agent x Location network. This represents the winner of the first World Series. As the time period progress, more trophies are added as various sports add trophies.

Load your Dynamic Meta-Network and make sure it is ighlighted. Either click the [**View Trails**] button or select from the menu **Visualizations > View Trails**.

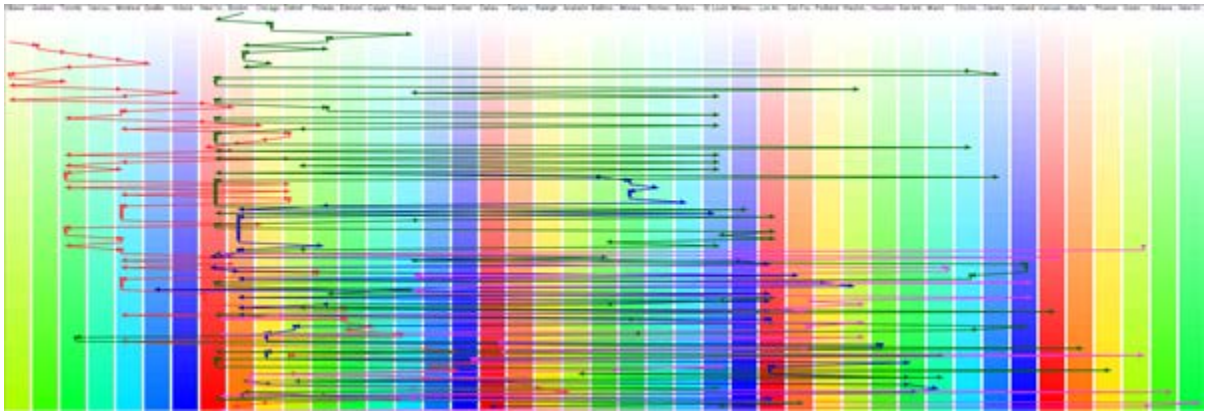


This Loom image displays all the winning cities of the World Series. Each stopping point represents one year. The other three looms are for Football, Hockey and Basketball. As each sports developed their own **final game**, an additional agent and location are added to the time period.

The display in Loom for the Baseball trophy is readable.

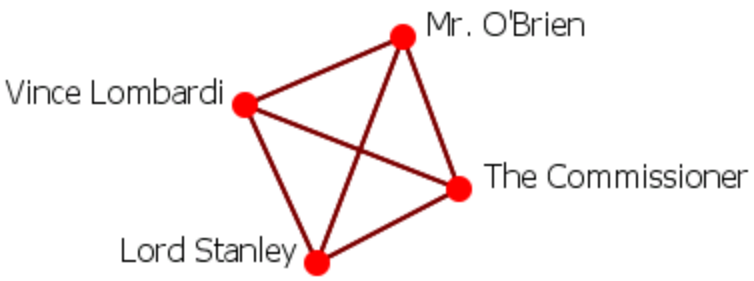


But adding in the other three creates a hard to decipher display.



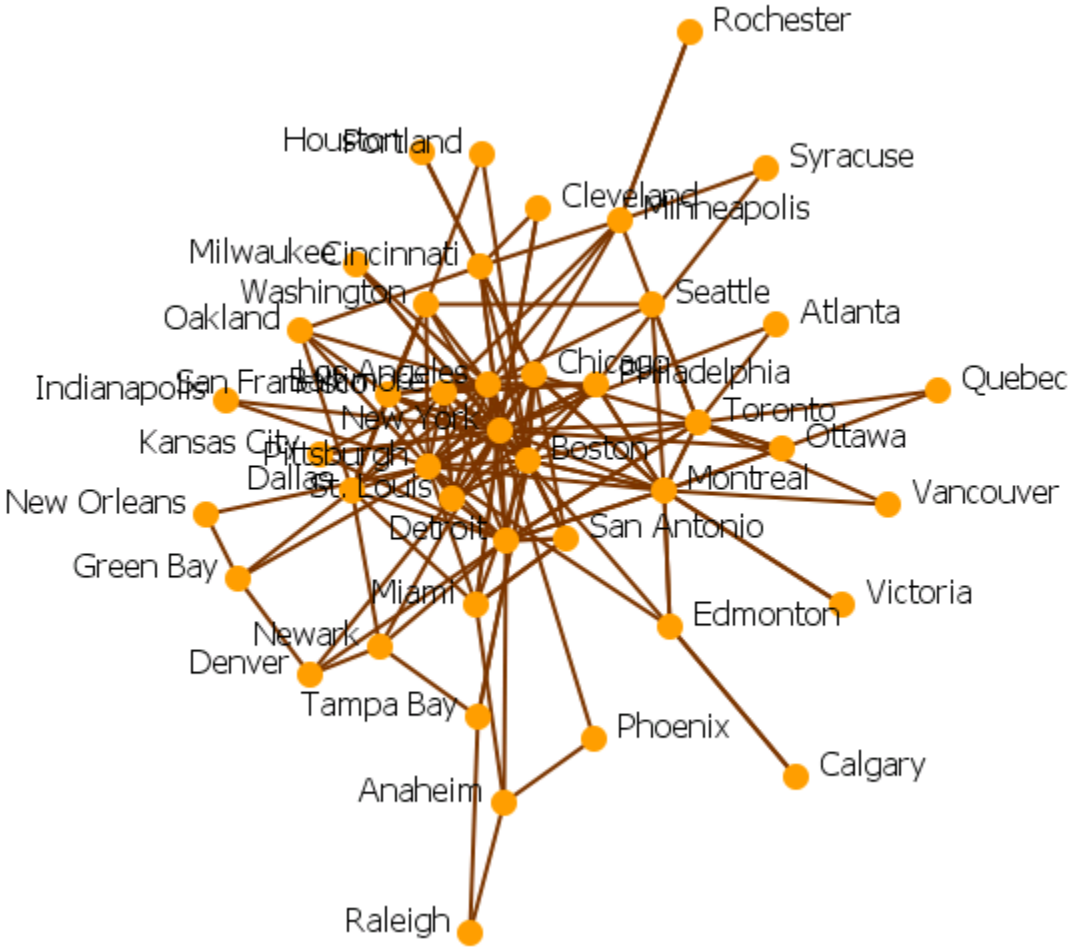
Colocation Network

An edge is created between nodes if they ever existed at the same place at the same time.



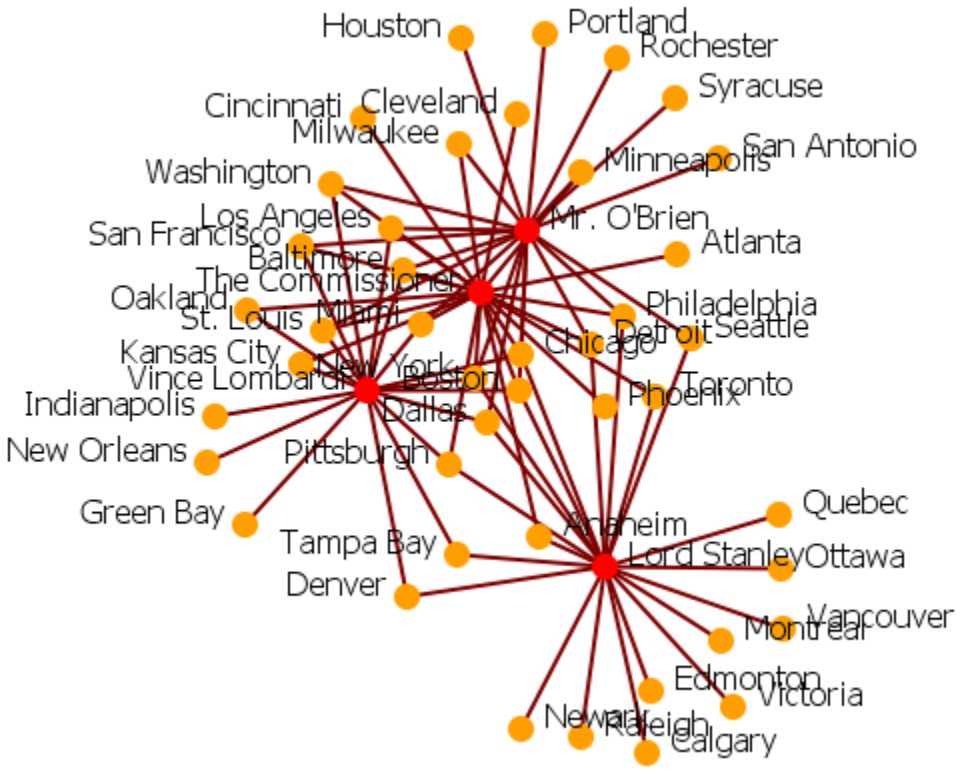
Transition Network

An edge is created between a location and node if the location was the site of an event.



Visit Network

An edge is created between locations if a agent traveled to that location.

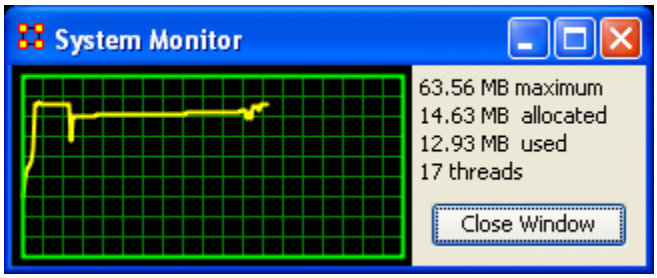


Help Menu

The Help Menu contains information which is beneficial in running ORA.

Help Contents : Calls up this Help File System

System Monitor :



About Ora : Contains information regarding this software, the institute of origin, permissions and warranties, version and build dates, and Java usage.

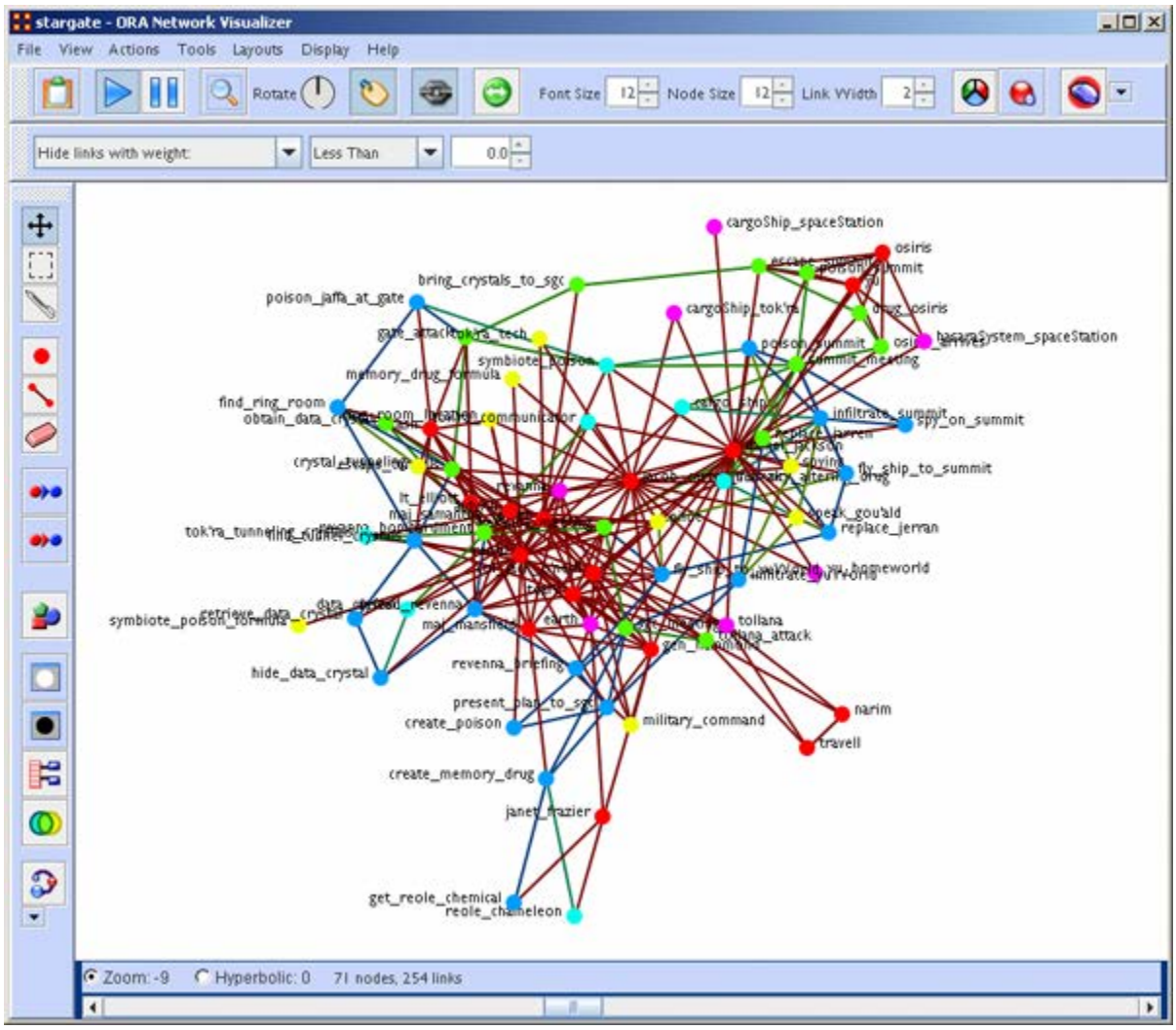
The ORA Visualizer

The **ORA Visualizer** produces a graphical model of a Meta-Network comprised of Links and Nodes. Moreover, you can interact with your Meta-Network model by **removing key actors, isolating certain links, focusing on any particular relationship between two nodes using tools such as the Path Finder.**

You can apply a host of grouping algorithms, look at node's Sphere of Influence, Locate Nodes, which may be hidden in complex clusters of nodes and links.

The Visualizer Interface

Below is a visualized Meta-Network displayed with the current tools available in the Visualizer. In this view all nodes and links are visualized. Note the different palette areas and options available from the Visualizer.



NOTE : If a Meta-Network contains more than 400 nodes then all node labels will be hidden. If a Meta-Network contains more than 1000 links then all links will be hidden also. The labels and links still exist and still factor into the layout, but just aren't drawn. The user still has the option to toggle them back on using the corresponding buttons on the Visualizer.

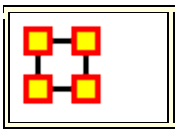
Closing the Visualizer

When you close the Visualizer you will be asked [**Save Visualizer options?**]. Selecting [**Yes**] will maintain the current state this Meta-Network is in. i.e. If you have hidden any nodes they will not appear the next time this Meta-Network is opened.

Synchronization

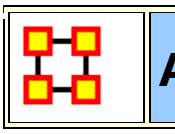
Synchronization allows you to work in the Editor and instantly see those effects in the Visualizer (or visa versa). Adding or removing a link in the Editor will place that link on the screen in the Visualizer.

The ORA Layout Algorithm uses a standard spring embedder algorithm. For large data sets, this has been enhanced using the Barnes-Hut Simulation for calculating the force of repulsion between any two nodes.
Reference : Nature 324, 446 - 449 (04 December 1986); doi:10.1038/324446a0, A hierarchical O(N log N) force-calculation algorithm, Josh Barnes & Piet Hut



Visualizer Basics

Contained in this section are some basics to the visualizer. Many are small, yet important aspects to the visualizer.



Add Deltas

Importing deltakey frame data

The easiest way to create a dynamic Meta-Network is to first create a number of regular Meta-Networks. Then select all the Meta-Networks you want to merge into a dynamic Meta-Network. Right-Click on one of the highlighted Meta-Networks in the editor tree. Select **Create a Dynamic Meta-Network** from the contextual menu.

This brings up a Dynamic Meta-Network importer dialog containing all Meta-Networks you had selected. Next you need to select which Meta-Networks you want to act as **keyframes**. This can be as little as just the first Meta-Network or as many as all the Meta-Networks. Click the [**Import**] button at the bottom of the screen. A Dynamic Meta-Network will be created.

Does data have to be in deltakeyframe to run Loom

No. It can be run with multiple Meta-Networks as long as the Node IDs in the locations Nodesets match in all Meta-Networks. In the zip file I sent for Star Wars, I included the regular meta-networks. Select all of 'em, and go the "visualizers -> view trails" route. It'll prompt for the network, and open up Loom.

Can you show only some time periods or some locations

In Loom, only the Locations that have entities currently moving through them gets shown. If an entity is currently moving through a location, that location cannot be hidden.

Similarly, there's no way to currently turn off a time period. The work-around would be to just not include that time-periods meta-network whenever you load up loom. I'm anticipating this being something I'm going to get to implement.

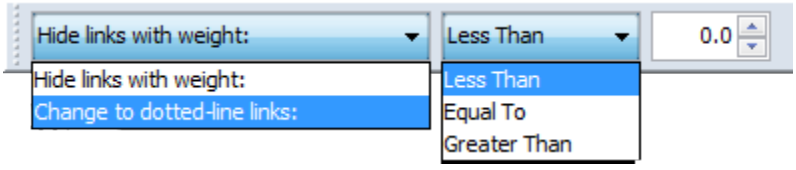
Danger of Creating Many Meta-Networks

In a Meta-Network that uses Deltas, each time period only contains the changes to be made (add, delete, move nodes and links). But if your Meta-Network is very large (i.e., the TAVI dataset has over 2,700 time period) exporting the imformation out would create over 2,700 separate Meta-Networks. This can overwhelm a computer system in very short order.



Dotted-Line Links

You can set this parameter to change certain links from solid lines to dotted lines by setting the parameter on the toolbar.



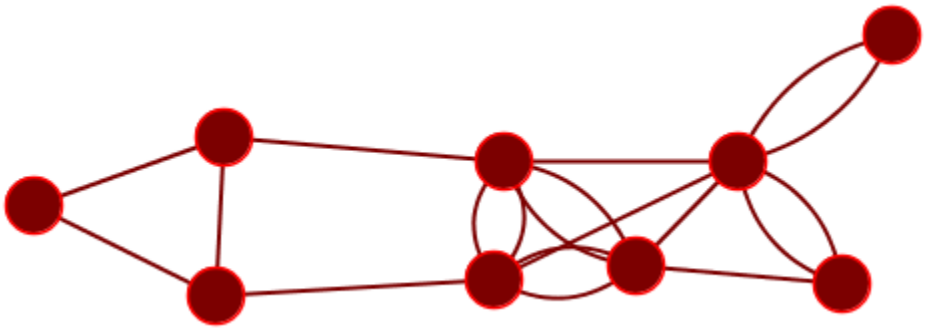
Change the dropdown menu from **Hide links with weight:** to **Change to dotted-lin links:**. Then set the trigger [Less Than, Equal To, Greater Than], and then set the value.

Any link which matches these parameters will be converted to a dotted line.

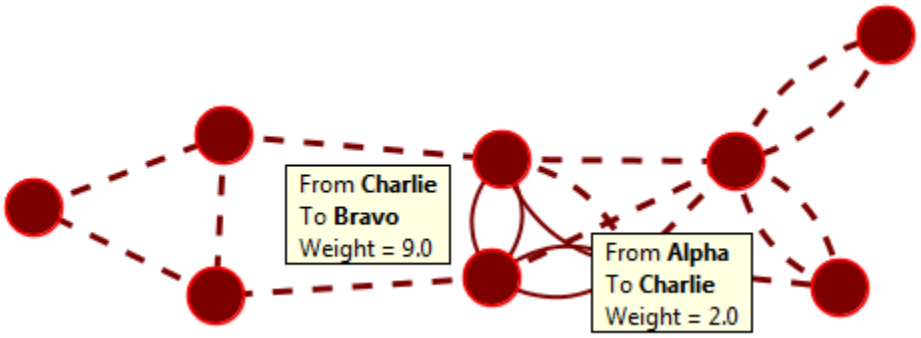
The Nodeset contains multiple links between agents most of which are a weight of 1. But five of the links are greater than 1. These links exist in the middle as we shall see.

	Alpha	Bravo	Charlie
Alpha	0.0	1.0	2.0
Bravo	2.0	0.0	4.0
Charlie	3.0	9.0	0.0

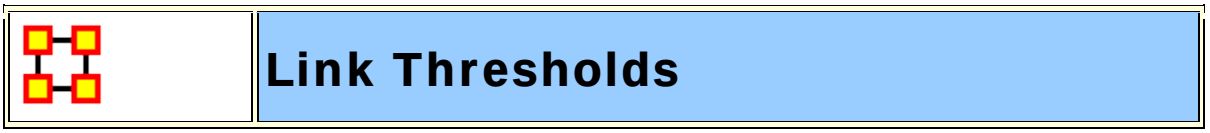
Here is the entire network. For ease of viewing I used **Display > Link Appearance > Show Multiple Links Between Nodes** to show the bidirectional links.



I change the option to **Change to dotted-link links:** and set the paramters to **Less than 1.1** and change the **And** to **Or**. All links with a weight less than 1.1 become dotted links.



The group of solid links in the middle are the links from matrix.



Link Thresholds

ORA attempts to find the link underneath the cursor. But as the number of links increases it becomes more difficult for to acquire the correct link.

A threshold limit of **5,000** has been set. ORA will not attempt to locate the link under the cursor when viewing a Meta-Network with more than this number.

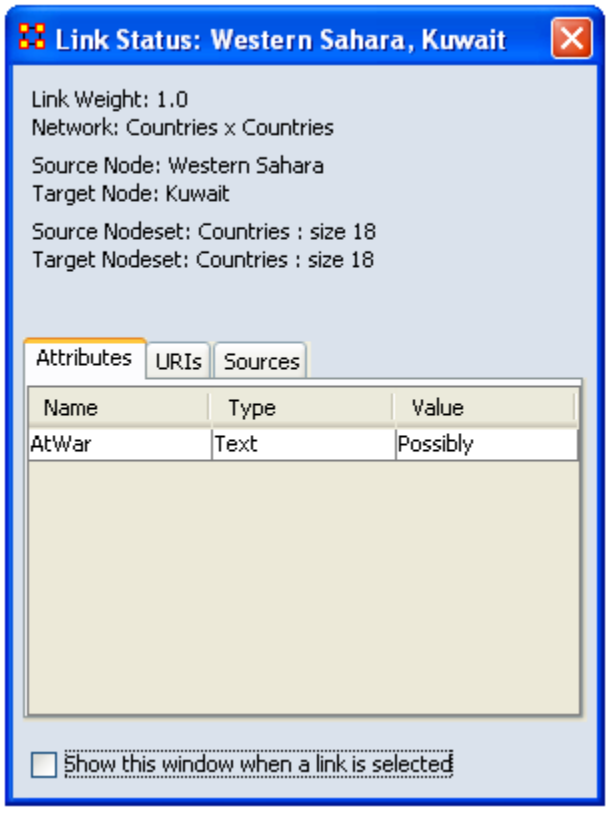
Link Status

Why Link Attributes Exist

Sometimes **Link Weight** isn't sufficient to hold all the necessary info about a link. You probably don't want to create 40 different Agent X Agent networks for each of the type of agent x agent links. But because you or your client made their data have link attributes you will have to support them

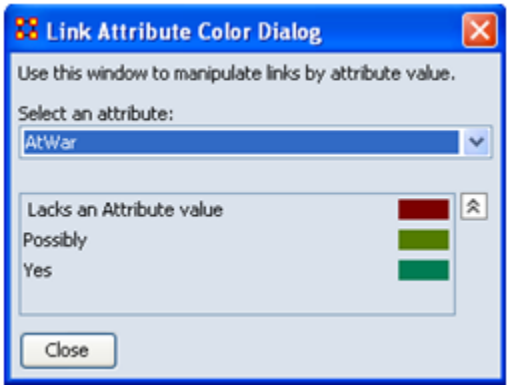
Link Status Dialog

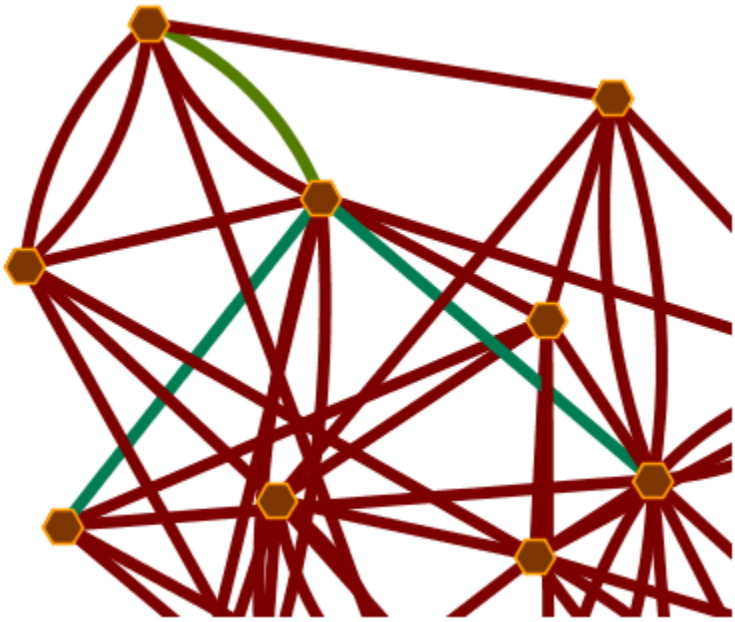
You can see link attributes easily enough though through the Visualizer's **Link Status Window**. This is done by **right-clicking or double-clicking a link.**



Coloring

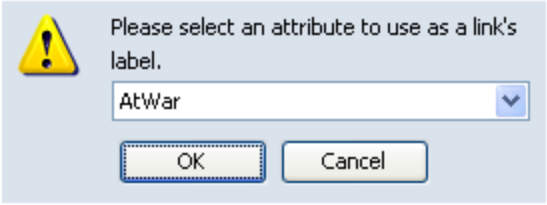
Links can also be given specific colors by selecting Display > Link Appearance > Link Color > Color Links by Attribute. Clicking on one of the color boxes will bring up the color picker. All links with this attribute will then be color the same.





Labels

You can select any attribute as your links labels by selecting Display > Link Appearance > Link Labels > Show Attribute...







There are times you need to have a set of nodes selected in order to work on them. Instead of clicking on each node individually you can use the **Marquee** tool.

Selecting a Set of Nodes

 With **The Marquee Tool** you can select a set of nodes to work with. To select your nodes, **Click and Hold** the mouse button, drag the pointer to select the nodes, and release the button.

The Visualizer Toolbar

This section explains the function of each of the toolbar's **default** buttons. The user can add or remove buttons from the toolbars. These are explained in other sections of this help.

When you first load a Meta-Network you will see the **pause button** depressed in the Visualizer tool bar. You can **layout** the Meta-Network by clicking the **play** button. The visualization will space apart across the screen. This is called **laying out** a Network. The Visualizer is separating nodes and links that, at first, appear on top of each other. You can **pause** this process again when you think the Meta-Network is satisfactorily spaced apart or you can let ORA lay out the entire Meta-Network. Your computer speed, as well as the complexity of Meta-Network, will determine how long this takes.



Copy / Paste : This feature allows you quickly capture a visualization and save it to be pasted into another document later.



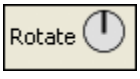
Play / Pause : The **Play Pause** function works very similar to the play pause feature on any device. The pause button **(two vertical bars)** is depressed, the Visualizer stops laying out a Meta-Network. When the play button is depressed **(right pointed triangle)** ORA Visualizer begins laying out the Meta-Network as described above. The red ellipse highlights on the tool bar where this feature is located and accessible.



Magnifying / Maximizing : The **Magnifying Glass** icon with the plus sign inside it, allows you to instantly fill the Visualizer window pane with the currently rendered Meta-Network. The red circle in the screen shot above highlights where to access this feature on the Visualizer tool bar.

If there are any nodes off screen, clicking the button once will bring all the nodes into view on the screen.

NOTE : This function works well when selecting a small part of your overall Meta-Network and magnifying it to fill the visualizer screen.



Rotating The Visualization : To **Rotate** your visualization look for the word next to the **Noon-pointing sundial** icon in

the tool bar. This feature is another way to manipulate your visualization to fill the entire visualizer window pane.

NOTE : Use this feature in conjunction with the magnifying glass function to work your visualization into largest size possible.



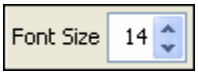
Show Labels : The **Show Labels** button allows you to toggle the labels on & off in the visualizer. Default is is **ON**.



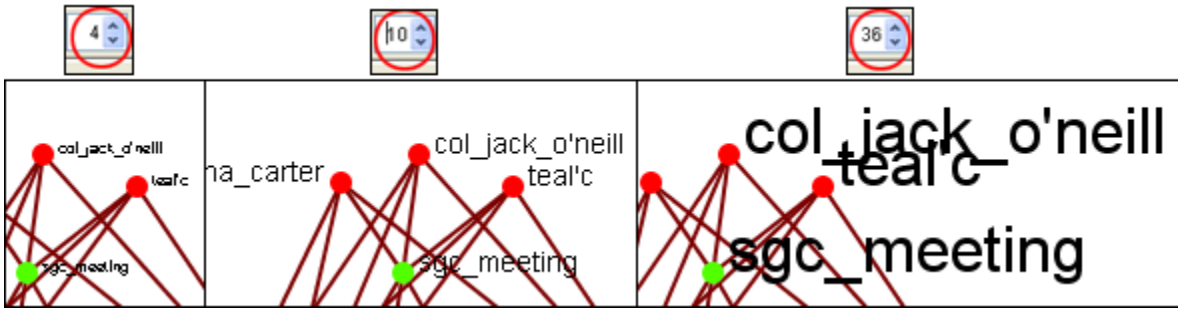
Show links : The **Show Links** button allows you to toggle the links on & off in the visualizer. Default is is **ON**.



Show Arrows : The **Show Arrows** button allows you to toggle the arrows on & off in the visualizer and show directional data. Default is is **OFF**.



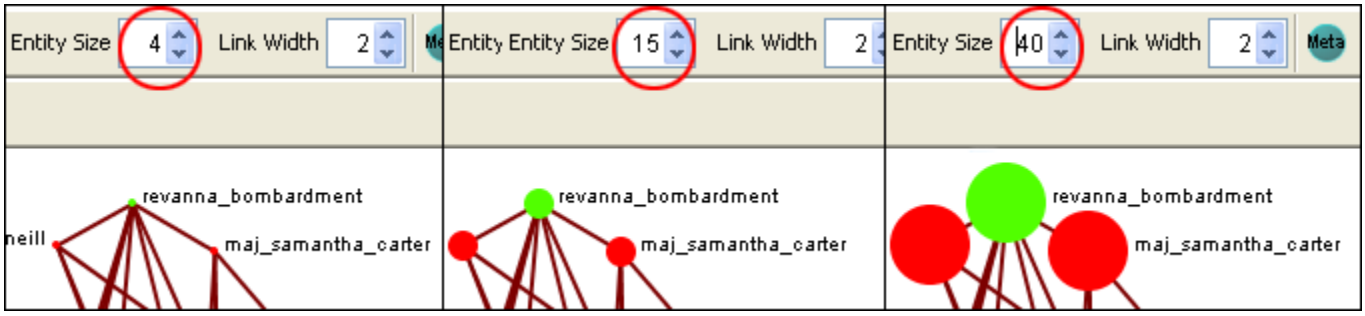
Font Size : The **Font Size** allows for setting the size of the font in the visualizer. This allows you to change the size of the font to suit you needs for each individual visualizer set. It ranges from **4**, which is almost unreadable, to extremely large numbers, which can also be unreadable by virtual of overcrowding. So pick the size of font that best suits your screen.





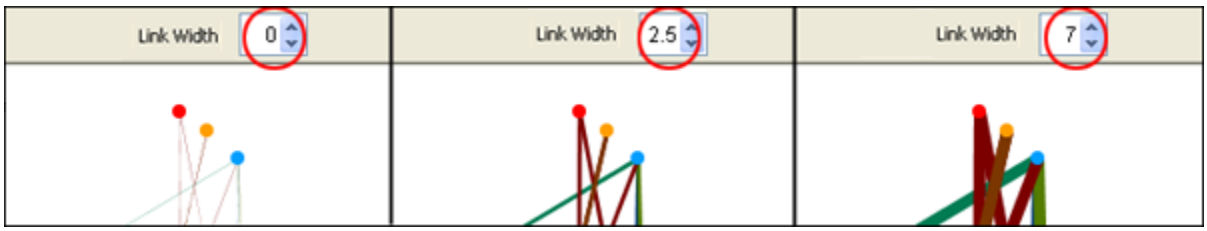
Node Size : The **Node Size** allows for changing the node size, larger or smaller by increments of one. Four is the smallest size possible and creates a very small, almost indistinguishable dot. As the number increases is becomes easier to see the individual nodes until the number gets to a point where is can simply overpower the screen. But this gives you the ability to customize the entity size to suit

your needs.



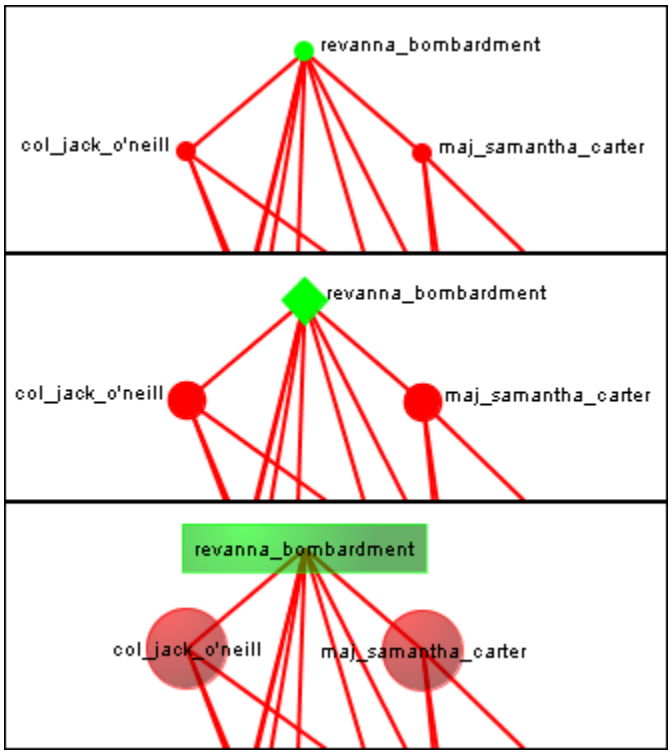
NOTE : This also affects the size of the nodes in the Legend.

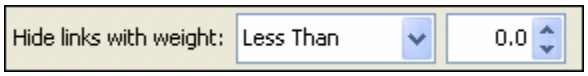
Link Width : Allows for changing the general width of the line, larger or smaller. And as the options before you can pick the exact size which best suits your needs for the display.



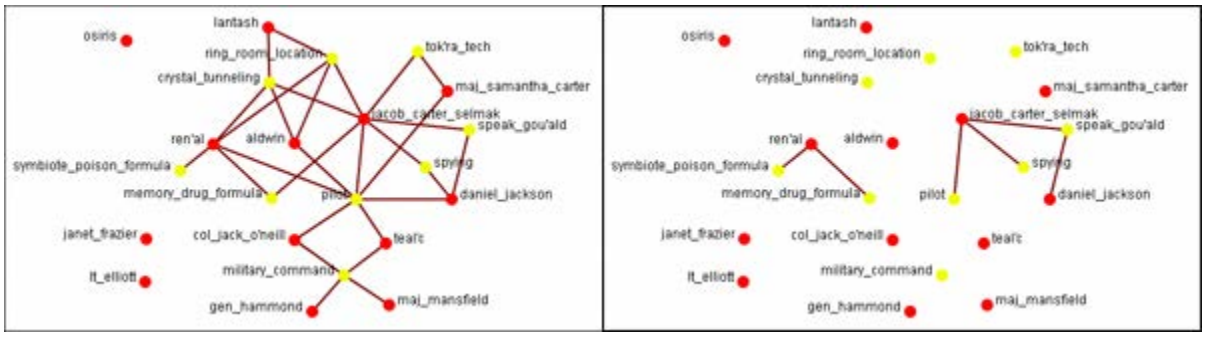
Meta- Size : Use the **Meta Node Manager** to handle creating and removing Meta-Nodes.

Node Sizes : The **Toggle Node Size** button rotates through three sizes for the nodes **(as seen below)**.





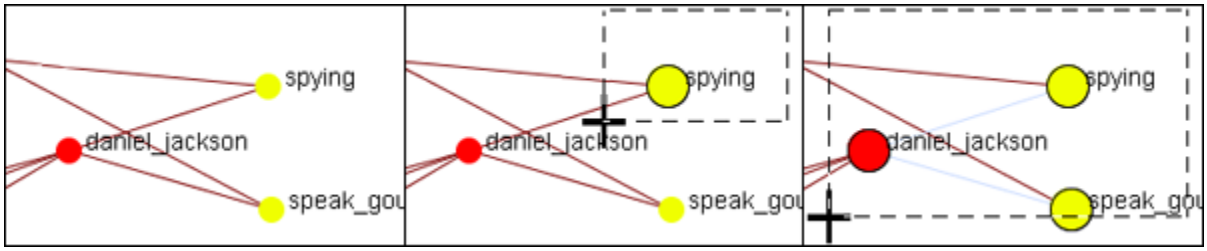
Hide Links by Weight : Use the **Hide Links with Weight** to select which links to display. As long as there are links with different values you can hide links of smaller values leaving only the more important links visible. This can assist in seeing links that might normally be too cluttered to view. Below left is a Meta-Network with all links in view. Below right is the same Meta-Network with links less than 2.0 hidden.



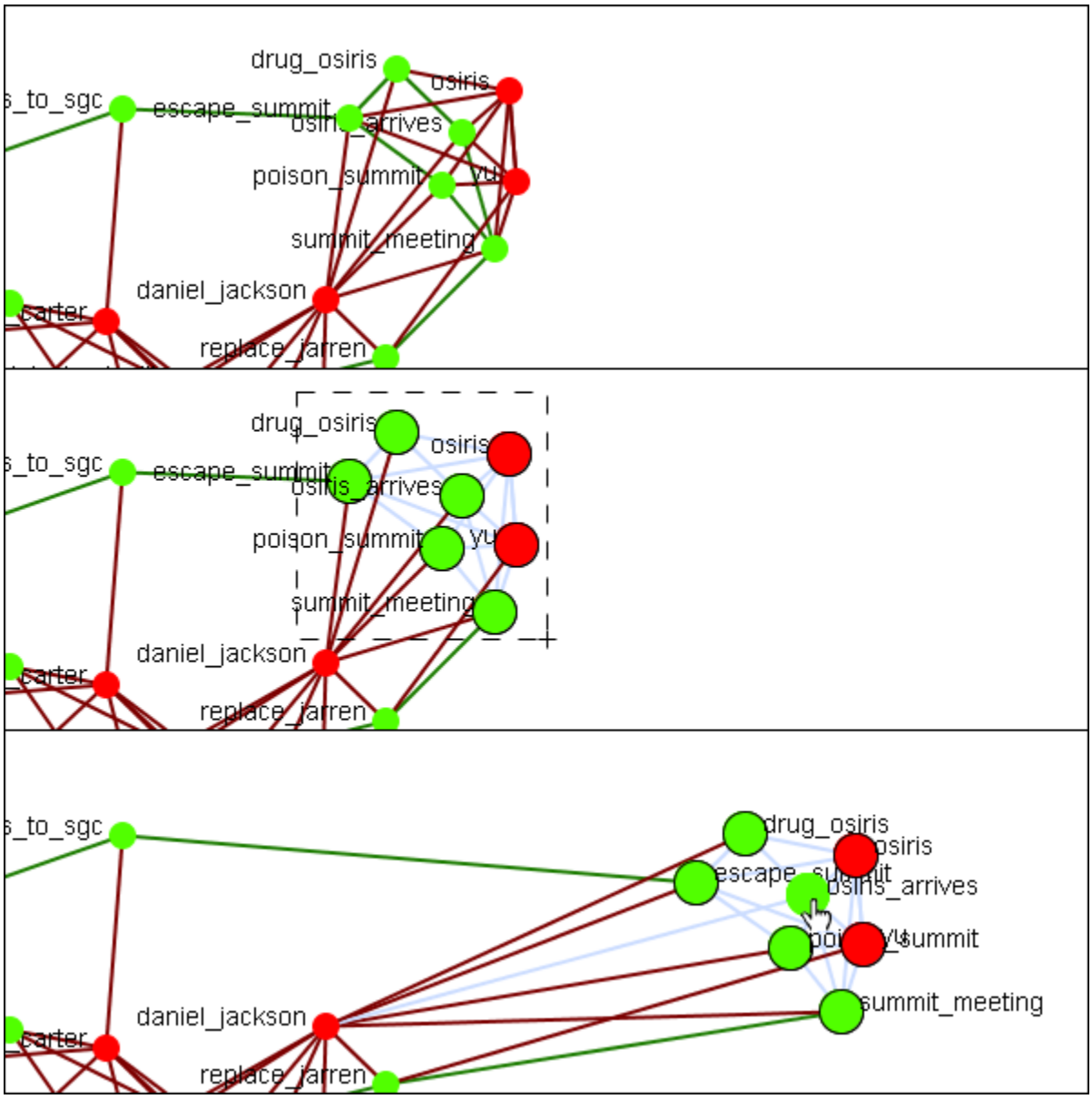
Drag : Used to move the view around the Meta-Network to see different parts. Press and hold the left mouse button and move the pointer around to view various parts of the Meta-Network.

Marquee : Click and drag the marquee over nodes to select them.

After releasing the mouse button the set of selected nodes will remain enlarged enclosed in a dashed line.



After selecting a group of nodes they can be moved all together. Press the **[Pause]** button on the toolbar, switch to the **[Move]** tool, then grab and move the group. This is useful in creating displays of small portions of the visualizer.



NOTE : Only one set of nodes can be selected at a time. Creating a second selection negates the first nodes selected.

The Paint Tool : The **Visualization Paint tool** allows you to draw on the visualization. You can select a brush size and a brush color via a small pop-up menu that appears whenever paint mode is selected. Nodes are also selected whenever you stop drawing, using the shape drawn (plus a line from the endpoints of the drawing) as a giant polygon, which selects nodes based on whether or not they're inside the polygon. There's also a "clear" button that removes all paint. "painting" works similar to using a marker on

your computer screen – no matter how much you zoom/pan/do whatever to the visualization, the marks will remain in the same place.

Node Creator : You can create new nodes within pre-existing Nodesets or create them in a new Nodeset.

Link Creator : Click on one node then drag the pointer to a second node. A link between the two will be created.

Node / Link Eraser : While the Eraser tool is active any node or link clicked will be removed from the Meta-Network,/tr>

Visualizer Toolbar

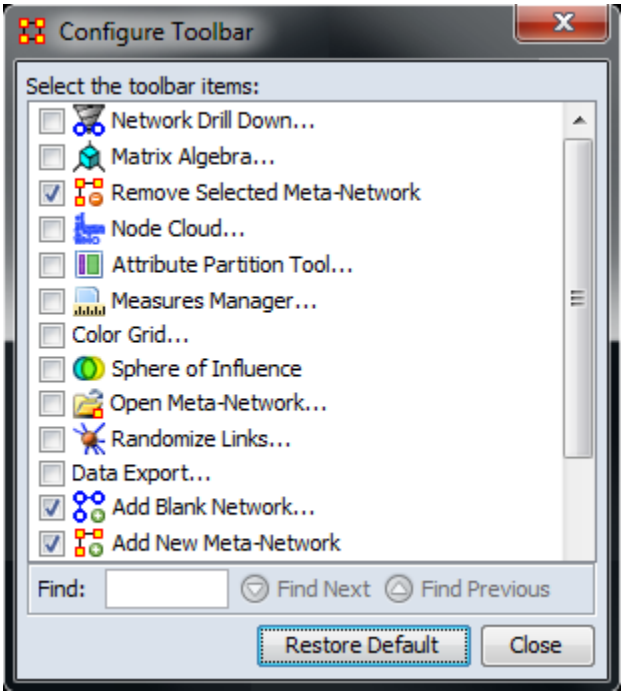




To help facilitate your workflow ORA allows you to mount/unmount tool buttons in the Visualizer's toolbar. The Visualizer contains two toolbars for this function. One on the top and another along the left side. Either of these toolbars can be placed in the horizontal or vertical position. Click the down-triangle to open the dialog box.

The grey-out buttons are the default set. The buttons at 100% are the ones I added to my GUI.

NOTE : Buttons without graphic images are placed on the toolbar using words. When placing a toolbar vertically it will expand to the width of the largest button.



The **Configure Toolbar** dialog box will appear. You will notice that some items are already checked. These correspond to the buttons already present. Placing a check mark next to any tool instantly mounts it on the toolbar. Removing the check mark from a button instantly removes the button from the toolbar.

When you are finished click [**Close**].

If at any point you can select the [**Restore Default**] button which will remove all the changes you made and restore the toolbar to the buttons found in the image at the top.

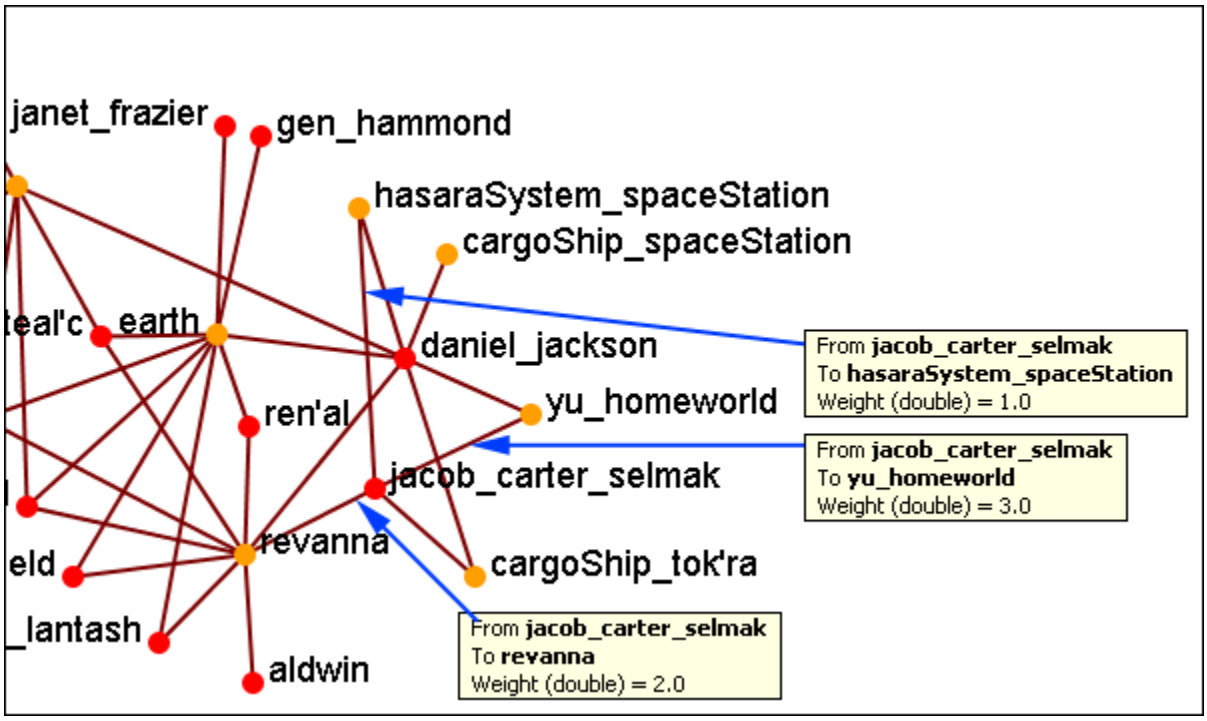
NOTE : The buttons appear in the order you select them. You can not re-arrange buttons once they are placed on the toolbar.



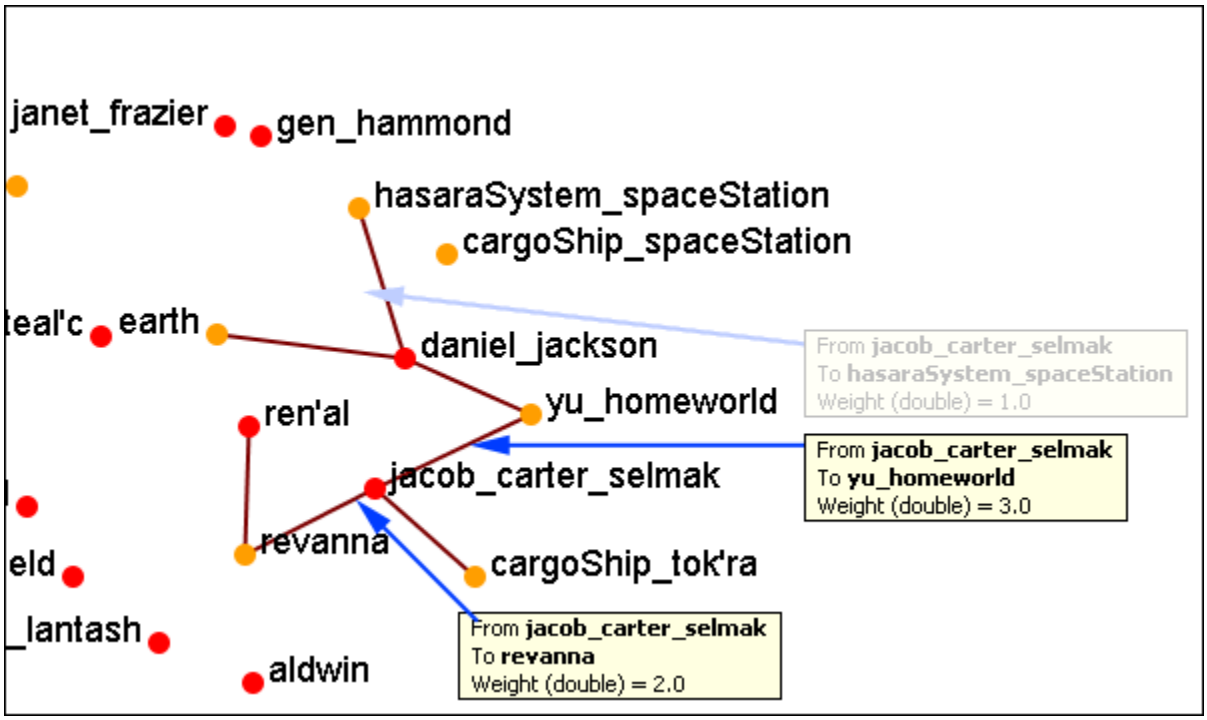
Hide Links By Weight

ORA can visualize your network with only the more **weighted** links displayed. Below are procedures to accomplish this task.

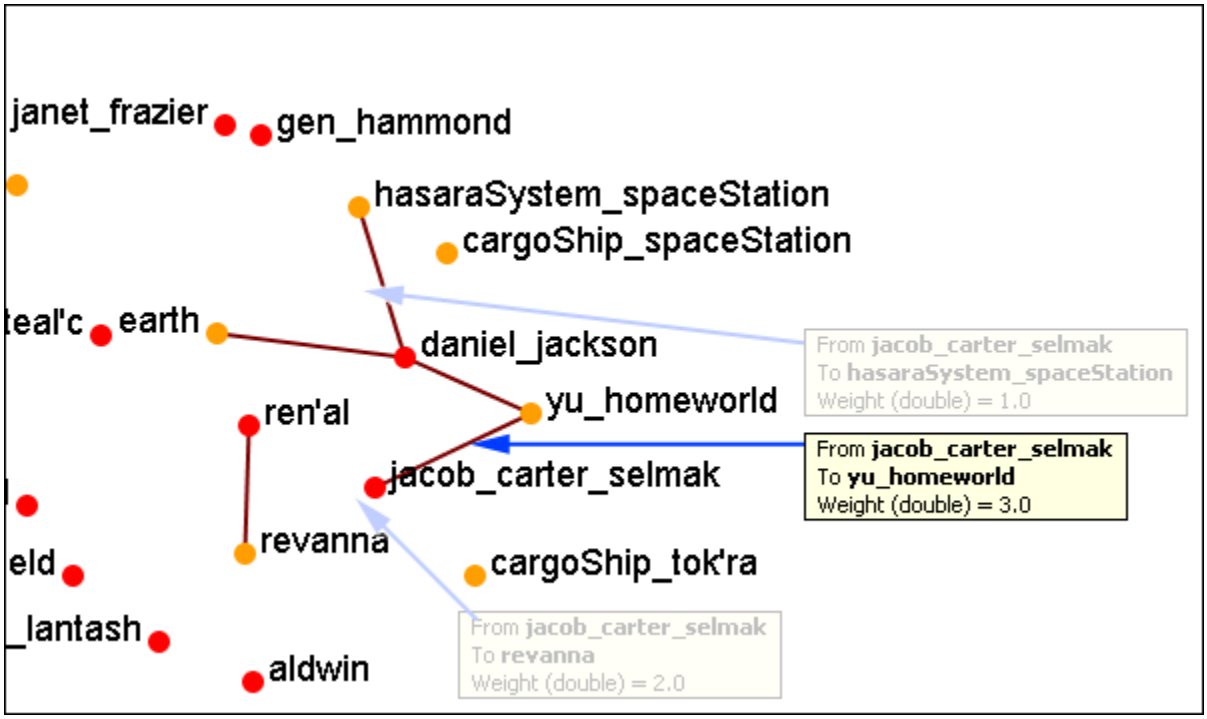
You can select to hide links either **Less Than or Greater Than** a certain value. Below is an agent x location network. And there are three tooltips displayed for jacob_carter for the values of 1.0, 2.0, and 3.0. We'll keep the hiding style as Less Than.



First we'll increase the value to 1.1 hiding all lower values. The link to the **hasaraSystem_spaceStation** is removed from view. The others, however are still on the screen.

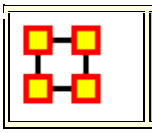


Now let's increase the value to 2.1. This removes the link from jacob_carter to revanna.



If we increases to value to 3.1 then all of the links would be removed.

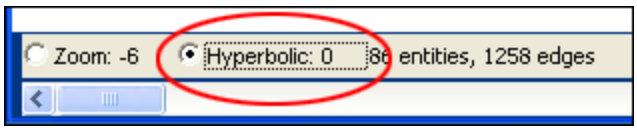
In this way you can remove links which are of lesser important to concentrate on a smaller set of data.



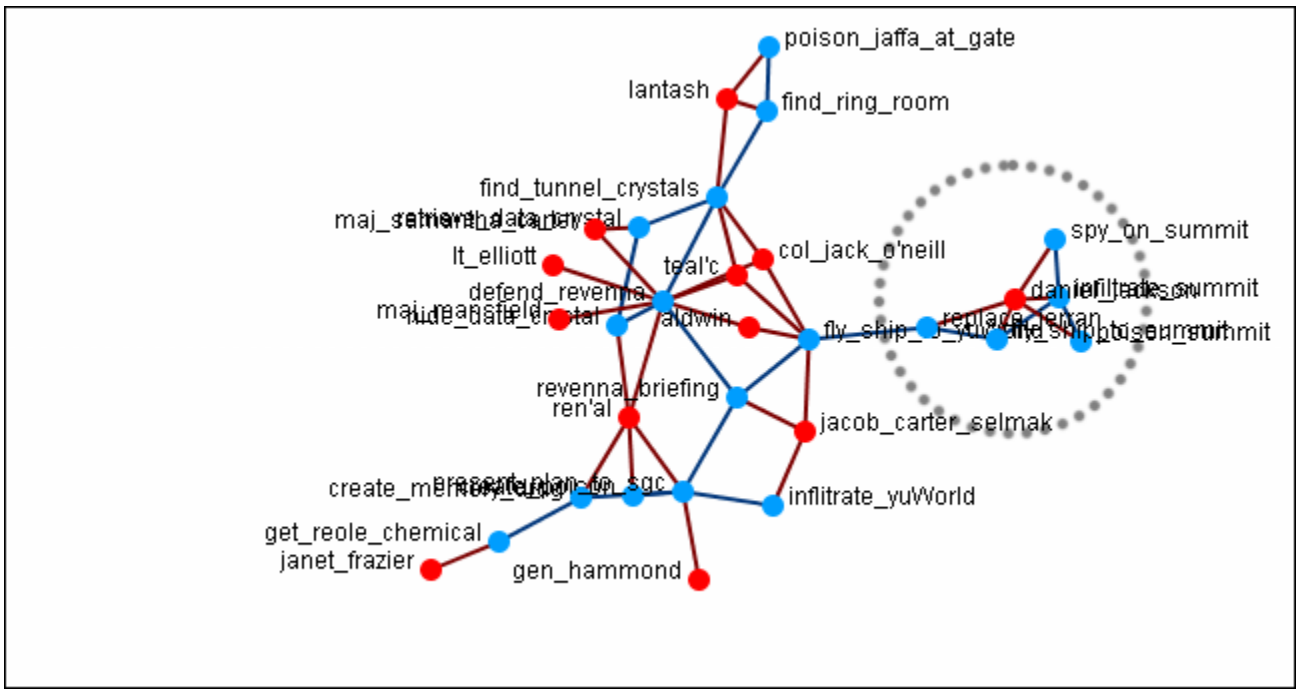
Hyperbolic View

The Hyperbolic function creates a **bulge** within your visualization adding a sense of depth. By moving the slider from right to left, you can increase or decrease this bulge effect and create different depth-added views. By moving the network around the window you can create the view you need. The **Hyperbolic radio button** and **slider** can be found at the bottom of the window.

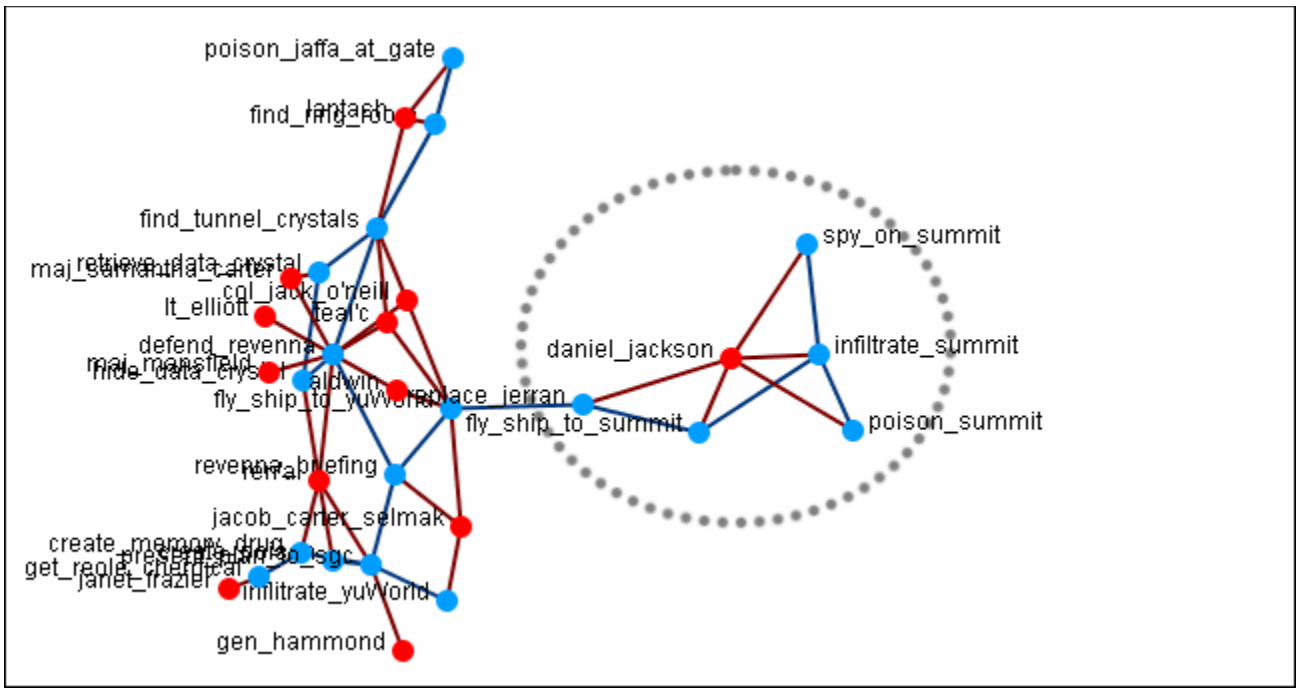
This tool is useful when nodes may be very tight on screen such as the ones in the following images. Using the Hyperbolic tool you can help space them out for easier viewing. Here is how to do so:



NOTE : The Hyperbolic function, when selected, converts the slider to this feature. This is also true of using the zoom and rotate functions. Use all three in conjunction to get your visualization just the way you want it. Scroll down below this screen shot for another when viewed with the Hyperbolic feature.



Select the Hyperbolic tool and move the slider to the right. Then click-and-hold on some part of the white background and move the entire network to the left. You will notice the space between the nodes begins to increase the closer them come to the center of the screen.



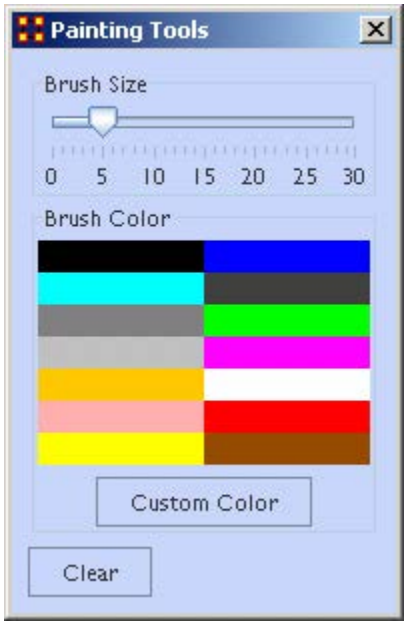
Now the nodes are able to be read much easier.

NOTE : It is useful to use this tool in conjunction with the **Rotate** and **Magnify** tools to obtain just the view you desire.

Visualizer Paint Tool



The **Visualization Paint tool** allows you to draw colored lines on a visualization. You can select a brush size and a brush color via a small pop-up menu that appears whenever paint mode is selected.



Nodes are also selected whenever you stop drawing, using the shape drawn (plus a line from the endpoints of the drawing) as a giant polygon, which selects nodes based on whether or not they're inside the polygon. There's also a **clear** button that removes all paint. Painting works similar to using a marker on your computer screen - no matter how much you zoom/pan/do whatever to the visualization, the marks will remain in the same place.

From the Paint Palette you can select a **brush size** by adjusting the slider. Then choose a color by clicking a pre-set colour or clicking the **[Custom Color]** button and select any color. Clicking the **[Clear]** button sets everything back to default. Once brush size and color are selected, you can draw on the Visualization.

To undo your drawing click the **[Clear]** button.

NOTE : If you pan the visualization, the paint drawing will remain stationery on the screen. It does not move with the visualization.

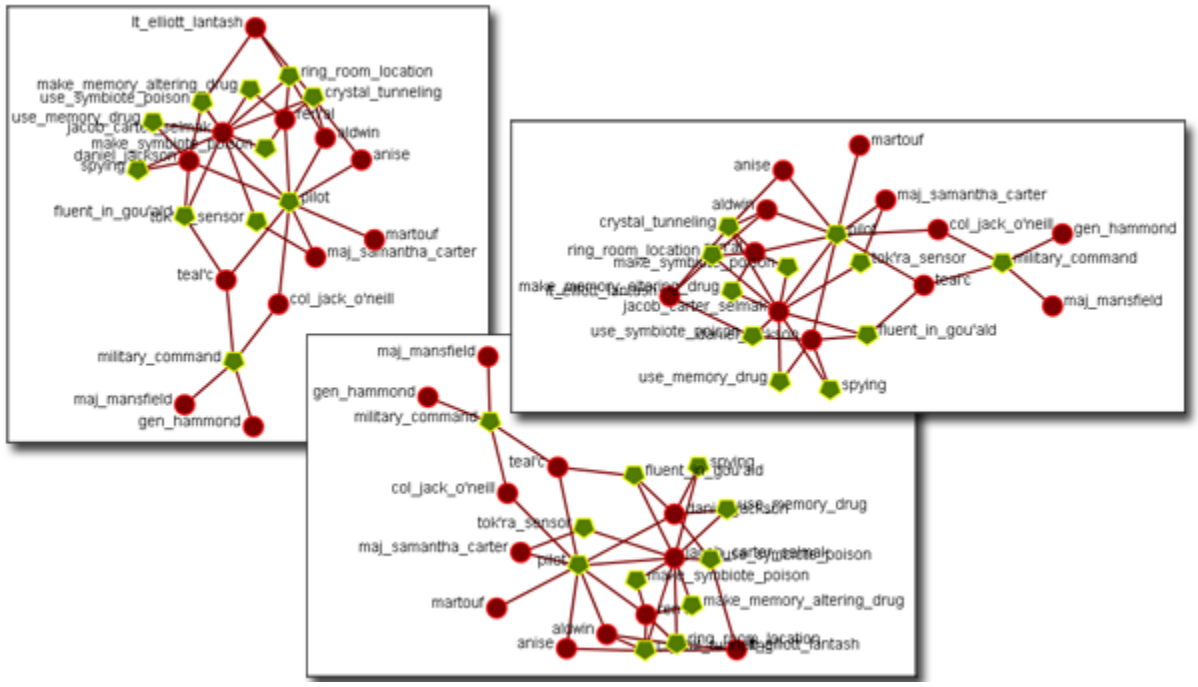
Rotating A Visualization

You can rotate a visualization with the slider bar at the bottom of the interface or from the tool bar at the top. To do this from the slide bar, click the rotate option toward the bottom of the interface. This activates the rotate feature.

As you move the slider from the left to right, your visualization will rotate correspondingly. From the tool bar, you can click inside the rotate icon, which will turn the visualization depending on exactly where you clicked.

In the screen shot below, the yellow ellipses highlight where to access ORA's rotate tool both at the bottom and top of the visualizer interface.

NOTE : Use the rotate feature in tandem with the magnifying glass to find a visualization's maximum screen size.

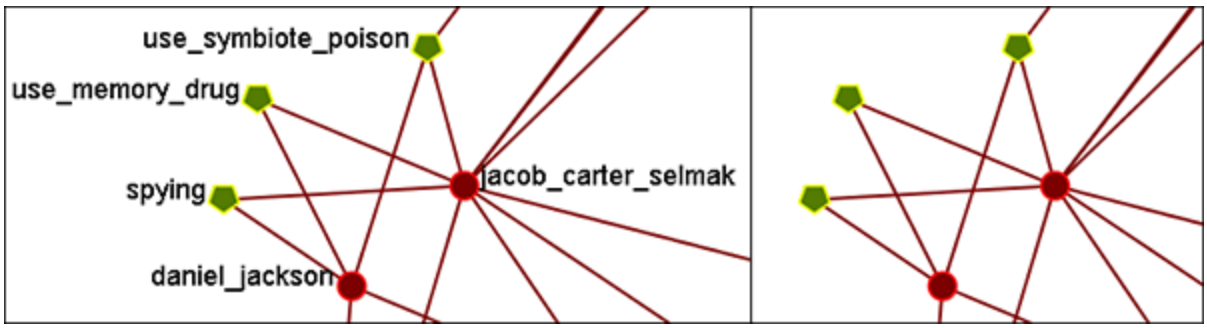




Show / Hide Labels

Node labels, which often prove helpful in describing Networks, can sometimes clutter a visualization. Thus, it may be necessary to eliminate labels from your visualization. To remove labels go to Visualizer tool bar and find the **Show Labels** button.

This initial screen shot shows the visualizer with all the labels.



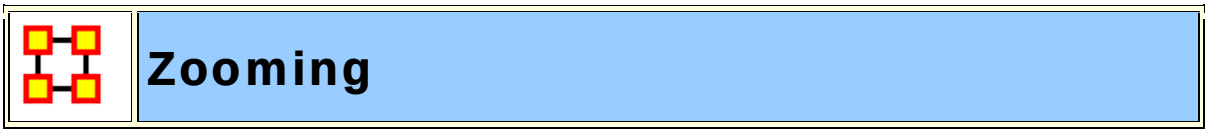
When you click the Label button on the Visualizer tool bar ORA toggles the labels on and off. Note that now a much more clearer conceptual picture of the network is produced. You can flip between the two views.

Hide Single Nodeset Label

In ORA you can hide the labels of one Nodeset but show the labels of another. You might want to do this, for example, if you want to show the names of organizations but not those of people (the agents). In order to do this you can do either of the following:

1) Turn on all labels. In the Legend, right click on the Nodeset whose labels you want to hide. The **Node Formatter** Dialog will appear. Under **Label** are options for **Hide Nodeset Name(s)** and **Show Nodeset Name(s)**.

2) Turn on all labels. Under **Tools** select **Node Selector**. In the top part, select the tab of the Nodeset whose labels you want to hide. Select the **Select Visible** option. This selects all nodes in that Nodeset (and only that Nodeset). Below that, Select the **Node Appearance** tab. Uncheck the **Show Label(s)** checkbox and click the **Set Labels** button to the right of it.



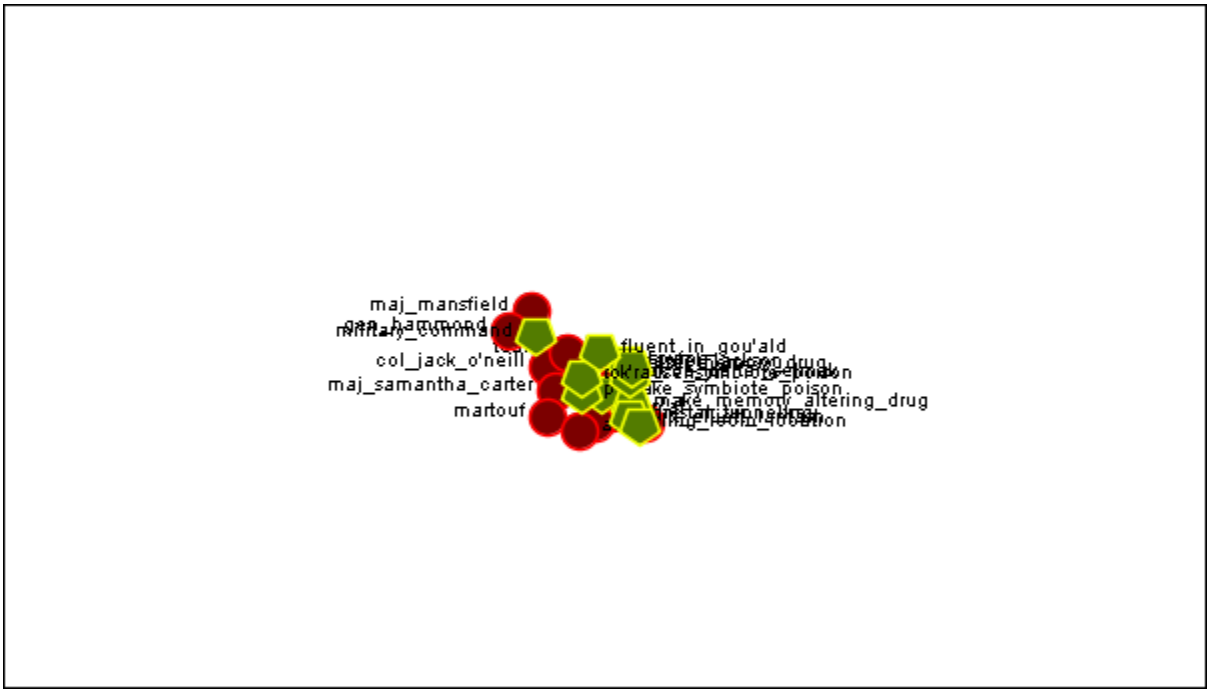
Zooming

At the bottom of the Visualizer interface is a sliding zoom bar (image below).

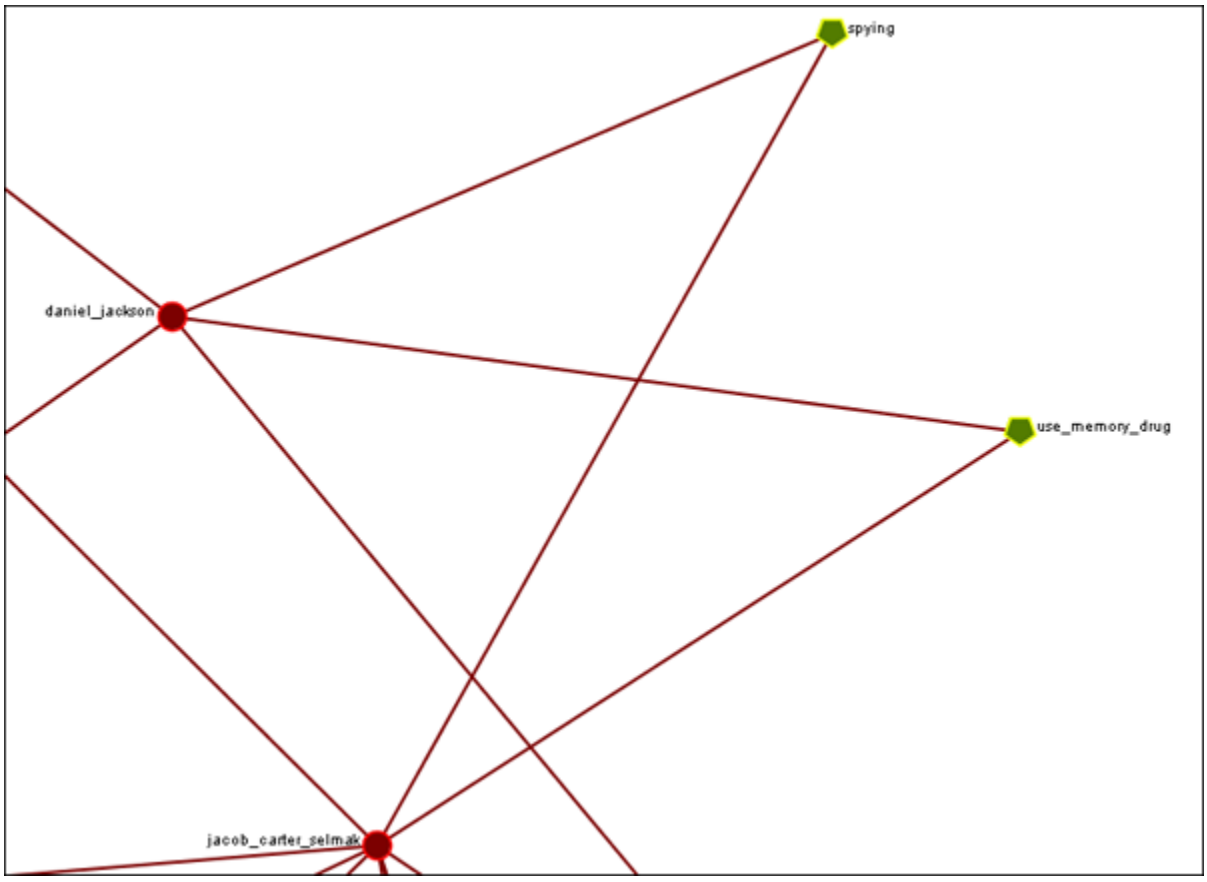
You can drag the scrollbar left **(to zoom out)** or right **(to zoom in).**



In the screen shot below the zoom bar has been set to the far left, the absolute zoom out possible. At this point very little is distinguishable.



In the next shot the zoom bar has been placed almost to the far right, absolute zoom in. It allows for extreme closeups of various parts of the Meta-Network.



NOTE : Clicking on the **Magnifying glass** in the Visualizer tool bar will set the view to include all visible nodes.

File Menu

Open Meta-Network : This opens an **Open File** dialog box so you can navigate to a directory and open a Meta-Network into the Visualizer.

Open Ora-Image :

Save Image to File : This opens a **Save As...** dialog box and allows you to save an image of the current Visualizer in one of the following formats: **PNG, JPEG, SVG (scalable vector), or PDF**.

Save Meta-Network to File : After you've made changes to the information you can save the current status of the Meta-Network into a new file in a **DyNetML*** format.

Save Special :

Save Meta-Network (Only Selected Nodes) : Saves a new Meta-Network file which will contain only nodes currently selected, i.e. a subset of the currently loaded Meta-Network.

Save Grouping to New Meta-Network :

Save Meta-Network (No Dotted Links) :

Save Meta-Network (Only Dotted Links) :

Copy Image to Clipboard : Similar to the **Save Image to File...** only saves it to the clipboard where you can paste it into an image-editing program.

Record Movie :

Add Meta-Network to ORA : Save the currently **visible** network into a new Meta-Network titled, **New Meta-Network**. This new Meta-Network can be renamed accordingly.

 **Add Grouping to Current Meta-Network :**

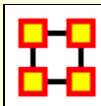
 **Add Meta-Nodes to Current Meta-Network :**

 **Visualize in 3-D :**

 **GeoSpatial Networks :**

 **Node Cloud :**

Close : Close the Visualizer and returns to the Main Interface.



Save Image to File

An image can be captured from the Visualizer and saved in one of four formats:

- **PDF :** This format us usable with Adobe's Acrobat and Reader programs.
- **JPEG :** A standard compressed format for image editing.
- **PNG (**Portable Network Graphics). PNG is a bitmapped image format that employs lossless data compression. PNG was created to improve upon and replace the GIF format.

ORA Images are functional in regards to PNGs. Whenever you save a PNG, relevant information about the visualization gets stored inside the image. This makes saving a little longer, but not so long that you'd notice if you were not looking for it. These images **Node Colors**, **Node Location**, **Screen Center**, and **Zoom Value**.

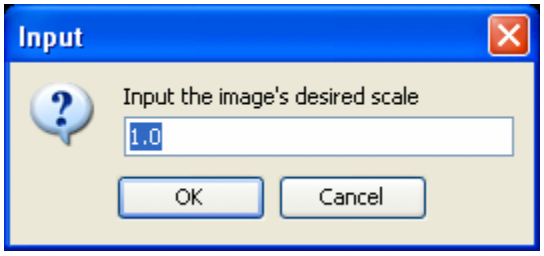
Loading images into a visualizer will re-create the image inside the visualizer. Loading an image is as simple as **dragging-dropping** it onto the visualizer.

SVG : Stands for Scalable Vector Graphics. SVG is an XML specification and file format for describing two-dimensional vector graphics, both static

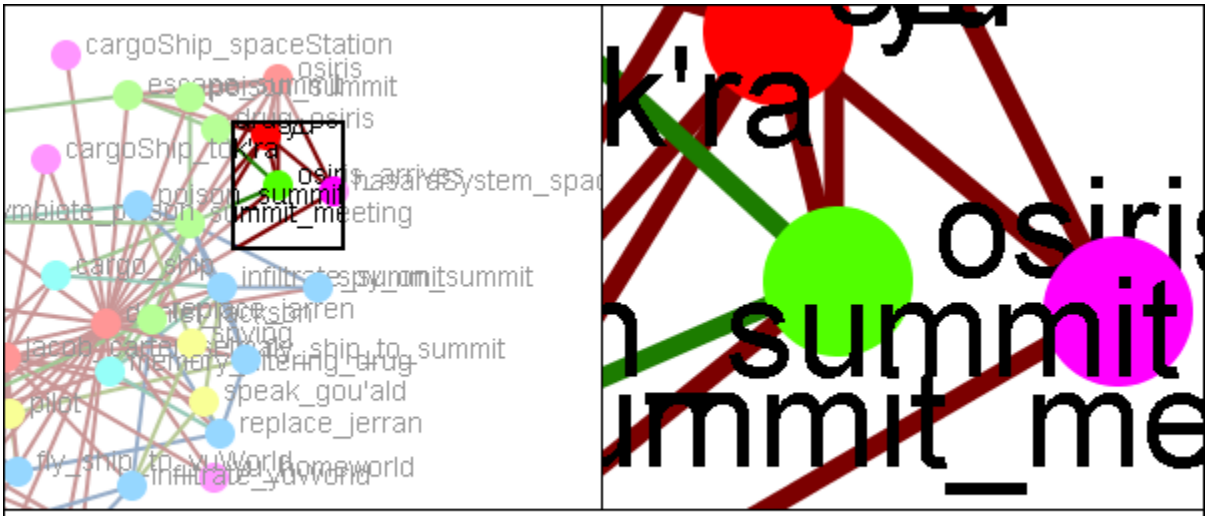
and animated. SVG can be purely declarative or may include scripting. Images can contain.

Selecting Image Resolution on Save

After choosing a format form the drop-down menu and specifying a filename press **[Save]**. A dialog box will appear asking for the quality of the image. The **1.0** saves the image in the same resolution. A higher number will result in a higher resolution image.



Below are examples of an image saved with a scale of **1.0** (on the left) and then saved with a scale of **5.0** (on the right). Use a number higher than 1.0 if there is a need for a higher resolution image.



NOTE : Values less than 1.0 are ignored when scaling images.

Saving New Meta-Networks

Occasionally you need to select only a portion of the visible Meta-Network and save them to a new Meta-Network. Using the Marquee tool and **Control-Clicking** individual nodes you can select exactly which nodes you need to create a new Meta-Network.

From the main menu select **File > Save Special > Save Meta-Network (only Selected Nodes)**. Navigate to the directory to save the new Meta-Network and click [**Save**]

This new Meta-Network can be loaded into ORA and viewed independent of the original Meta-Network.

Save Selected Sub-Network

Ability to save selected sub-Meta Network/Network comprised of dotted-links/network comprised of non-dotted links, ability to launch into GIS (if network has locations with appropriate data)

Views

This section of the help contains a description of the functions of the **View Menu**:



Change Font : Allows you to change the GUI font to any font on your system. Be careful with the font chosen as some fonts are built more for custom design rather than readability.



Log Hidden Nodes to Event Log :



Log Hidden Nodes to File :

Actions

This section of the help contains a description of the functions of the **Action Menu**:



Undo : Undoes a variety of actions performed in the Visualizer.



Add Node(s) : Function for adding Nodes directly into the Visualizer. These can be added to existing Nodesets or within newly created Nodesets. You also have the option of the number of nodes to create.

Add Node (with links or attributes) : Allows you to add a Node directly into the Visualizer. In addition you can create links and assign weights to these new links. You can also select attributes and assign values to these attributes.



Add Link : Allows you to create new links in a Meta-Network in the Visualizer. Then select the source and target nodes and then select the network. You have the option of creating a new network for this link. Lastly you can select the weight of the new link.

Notes on Display of Multiple Edges : If your Meta-Network contains graphs with **multiple edges between two nodes ORA will display the edges as curved lines so as to allow visualization of overlapping Edges. This is to say that if there is represented two nodes with four edges coming from four different graphs.**

Please note that **Tool tips are currently handled by math looking at the edge as if it were a straight line**. Since our line is not straight anymore, it will only be highlighted if the cursor's in the middle - nowhere near the edge. But otherwise, you should still see tool tips.

Delete Isolates... : Allows you to remove Isolate nodes in two ways.

Delete Pendants : Allows you to remove Pendant nodes in two ways.

Delete Currently Visible Isolates/Pendants : Currently Visible is exactly as it sounds. If it has no visible link on the screen, it's an isolate. It does not matter if there's a link that is hidden, it's an isolate/pendant.

Delete Underlying Isolates/Pendants : Underlying ignores was is currently set to visible and hidden. It looks at the data itself. If the Data says it's an isolate/pendant, then it's an isolate/pendant and is removed.

WARNING : These actions DELETE the nodes from the Meta-Network. Saving the Meta-Network will permanently remove the nodes.



Pin All Nodes : Set all nodes as unmovable



Unpin All Nodes : Release all nodes and allow them to be moved independently.

Show Motifs



Show Isolates : Nodes which have no connection to any other node.



Show Dyads: Nodes which have a connetion to only one other node



Show Triads : Nodes which have a connection to two other nodes



Show All-In-All Cliques : A group in which every node is connected to every other node in the group



Show Stars : A central node with connections to all other nodes in the group. The pendant nodes are not connected to each other.

Show Long Chains : Seeks out links which are nodes with only two neighbors.



Show Cycles : A cycle exists if for any node in the group, there is a path back to that same node.

NOTE : Cycles is the only motif that really looks at link direction.

Isolates



Hide Isolated Nodes : Remove any node which has **zero** links connecting it to other nodes.

Periphery : Moves Isolates back to their original position.



Combine into MetaNode : Collects all the Isolate nodes into a Meta-Node.



Move into Column : Moves all isolates to the right side of the screen in a column. The isolated nodes can be moved back using the Periphery option.



Hide Pendant Nodes : Remove any node which has **only one edge** connecting it to another node.



Recursively Hide Pendants : This function will run the both the **Hide Pendant** routine until there are no more Pendants.



Recursively Hide Pendants and Isolates : This function will run both the **Hide Pendant and Hide Isolate** routines until there are no more Pendants or Isolates.

Hide Nodes by Degree: You are asked for a **degree** (visible neighbors) a node has and will hide all of these.

Recursively Hide Nodes by Degree: Works similar to **Hide Nodes by Degree** but continues processing until no mode nodes can be hidden.



Show All Nodes: Any nodes that were previously hidden will be revealed.

Show All Nodes Except Isolates : Reveal any nodes that were previously hidden with the exception of nodes that have no links connecting them to another node.



Compute Standard Measures for Visible Network : Compute Standard measures computes the following collection of measures on the visible network: Total Degree Centrality, Betweenness Centrality, Eigenvector Centrality, Cognitive Demand, Resource Exclusivity, Task Exclusivity, Knowledge Exclusivity. The measure values can then be viewed within the Entity Status Window.

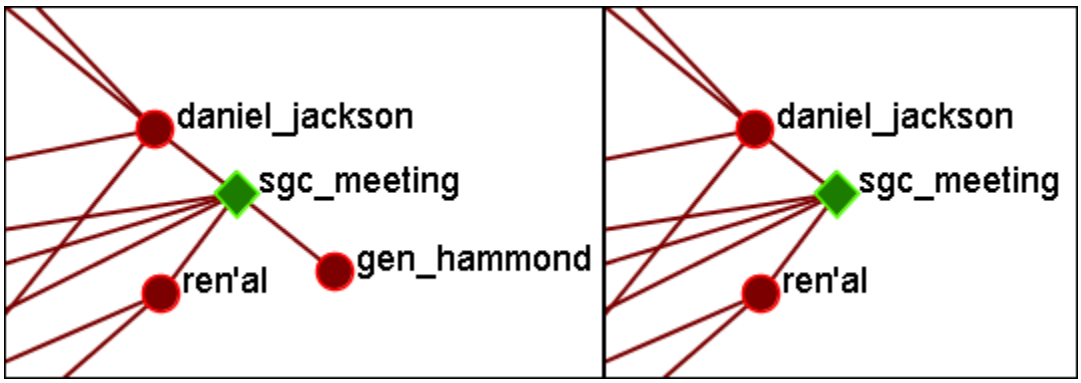


Hide Pendants

Pendants share links with only **one** other node. Their linkage is tangential and therefore isolated from the core linkages you may be interested in examining. **Pendant Nodes**, like **Isolated Nodes**, can be hidden.

From the drop down menu in the Visualizer select **Tools > Hide Pendant Nodes**.

Below is a **Before / After** screen shot of the visualization before showing the removal of the pendant nodes.



Add Node

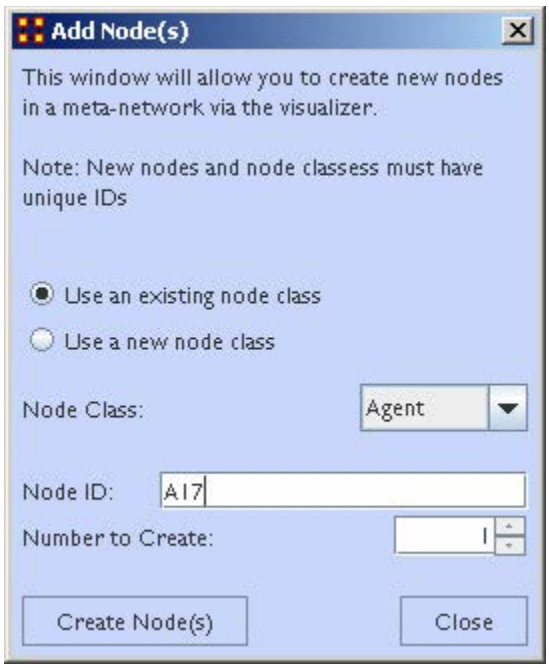
IMPORTANT NOTE : Changes done using Add Node(s) and Add Link(s) are transient. Be sure to use either the **File > Save Meta-Network As...** (to save the entire Meta-Network with additions) or **File > Add Meta-Network to Ora** (to create a new Meta-Network using only the currently visible nodes). Changes can not be saved back to the currently open Meta-Network.

The **Add Node(s)** function allows addition of nodes to the current Visualizer. These **added Nodes** are not added to the currently open Meta-Network. If there is a need to save the Meta-Network with the added nodes then use the menu item **File > Save Meta-Network to File...** and create a new Meta-Network.

Below is the NodeSet for **Stargate** with the original 16 node NodeSet.

	Node ID	Node Title
	<set filt...	<set filt...
☐	A01	col_jack_...
☐	A02	maj_sam...
☐	A03	daniel_jac...
☐	A04	teal'c
☐	A05	jacob_cart...
☐	A06	lt_elliott
☐	A07	ren'al
☐	A08	aldwin
☐	A09	janet_frazier
☐	A10	maj_man...
☐	A11	gen_ham...
☐	A12	lantash
☐	A13	narim
☐	A14	travell
☐	A15	osiris
☐	A16	yu

From the main menu select, **Actions > Add Node(s)** which brings up the Add Node(s) dialog box.



1. Use an Existing Nodeset :

   allows for for a NodeSet selectable in option 2 or **Use a new nodeset** creates a new empty NodeSet.

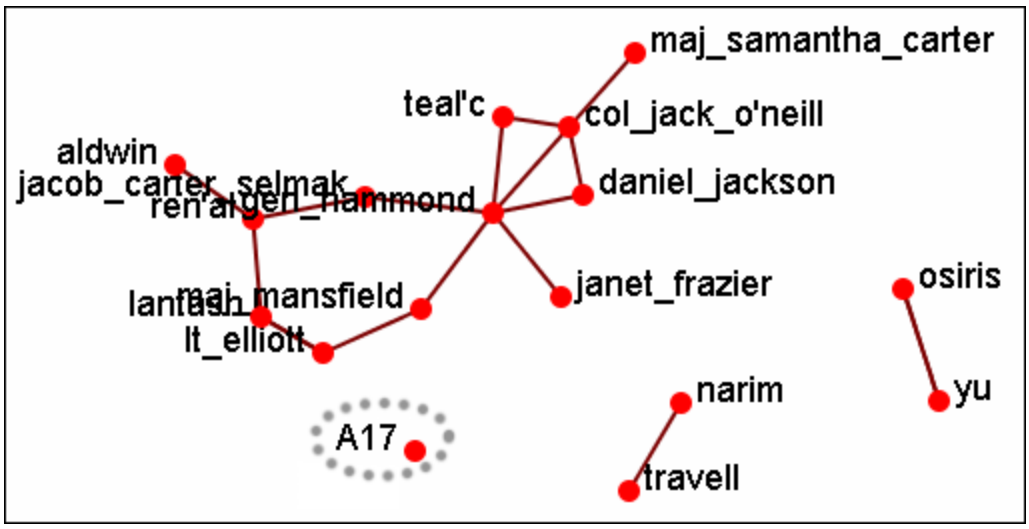
2. This dropdown gives the option for selecting a pre-existing NodeSet to place the new node.

3. The **Node ID:** textbox is used for giving the new node an ID.

4. The **Number to Create:** specifies the number of new nodes.

NOTE : If the **Number to Create** is larger than 1 then the text placed in section 3 for Node ID will be used as a prefix for all new nodes crated.

After inputting the information to add node A17, the Visualizer will now display the new node as **A17** with no connections. In order to display this node with a **title** will require saving the Meta-Network and changing the information within the ORA Editor.

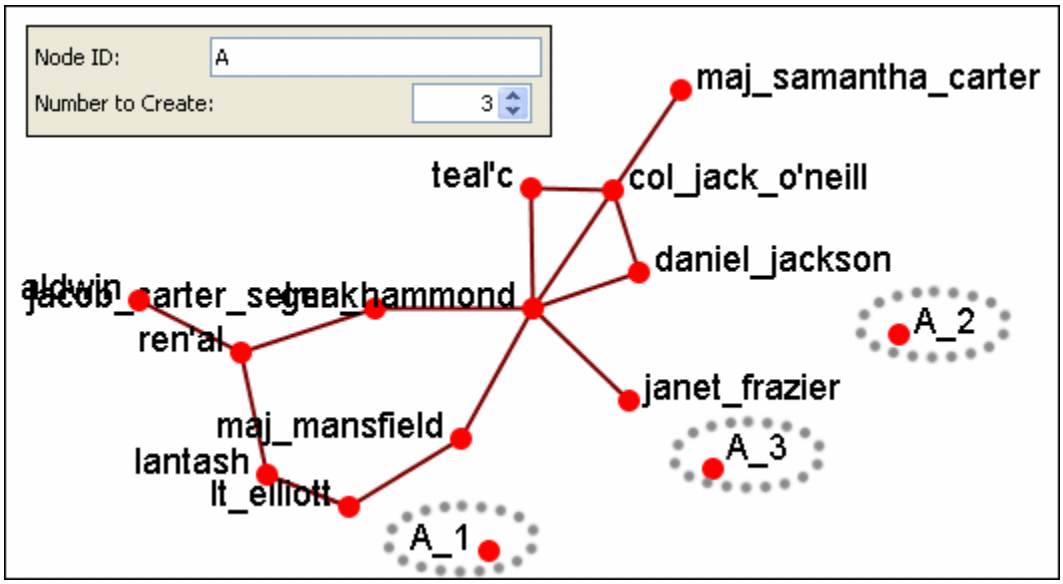


Adding Multiple Nodes

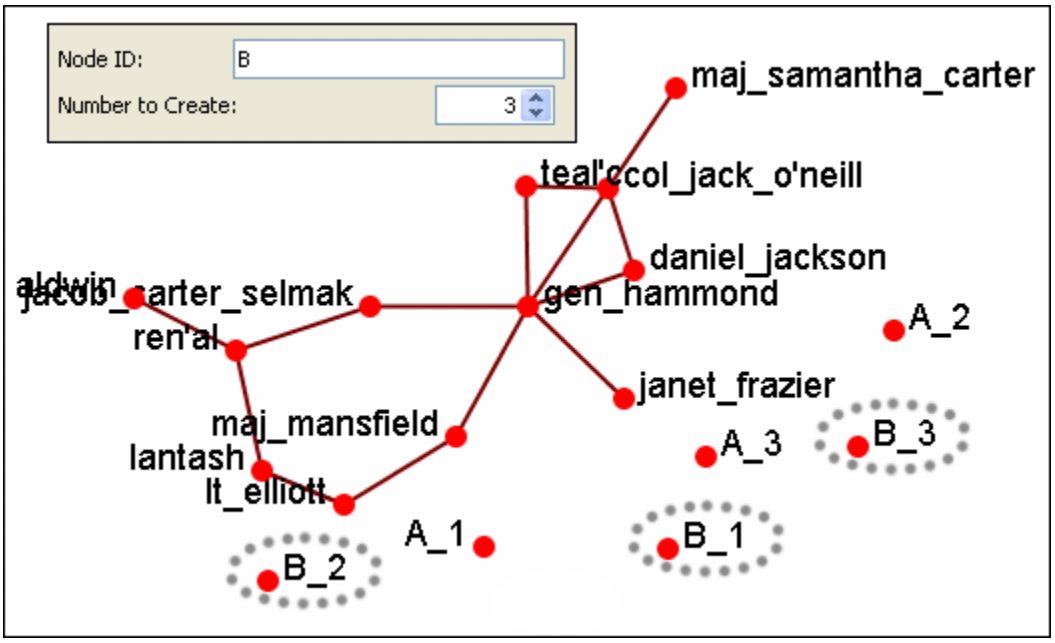
The procedure for adding multiple nodes is similar to adding a single node. The exception is the text in the **Node ID:** textbox. When adding multiple nodes only use a prefix. ORA will attach numbers, starting at 1, for each node.

Here's the addition of three new nodes and the prefix **A** will be used. Three nodes, **A_1, A_2, and A_3** are created on screen.

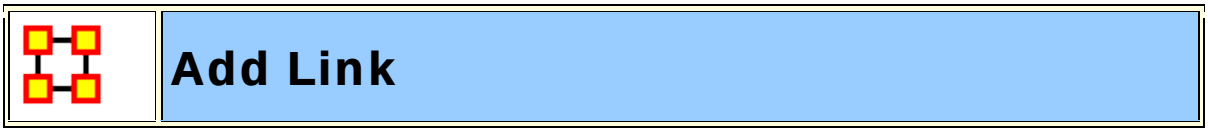
NOTE : You can only use a prefix **ONCE**. ORA will not accept any previously used prefixes a second time.



To add additional nodes use a **different** prefix.

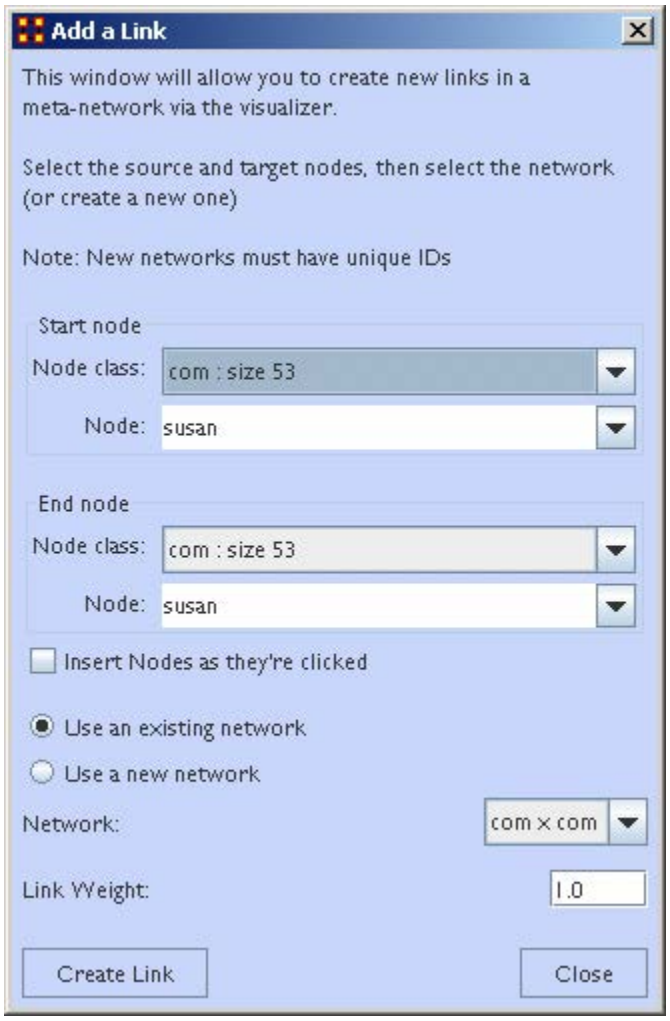


NOTE : Now either save the altered Meta-Network using the **File > Save Meta-Network As...** to a new filename or continue with **Add Link(s)**.



Add Link

Allows you to create links between nodes in the Visualizer and place them in an existing Nodeset or create a new Nodeset. You can also set the weight for the new link.



NOTE : Changes done using Add Node(s) and Add Link(s) are transient. Be sure to use either the **File > Save Meta-Network As...** (to save the entire Meta-Network with additions) or **File > Add Meta-Network to Ora** (to create a new Meta-Network using only the currently visible nodes). Changes can not be saved back to the currently open Meta-Network.

1. **Start node :** The start of a directed link.
2. **End node :** The end of a directed link.
3. **Insert Nodes as they're clicked :** Fills in the text boxes for **Node**. The first click adds the node in the **Start node** section. The second click adds the node to the **End node** section. Any further clicks will make the previous End node the start node and the newly clicked node becomes the new End node.

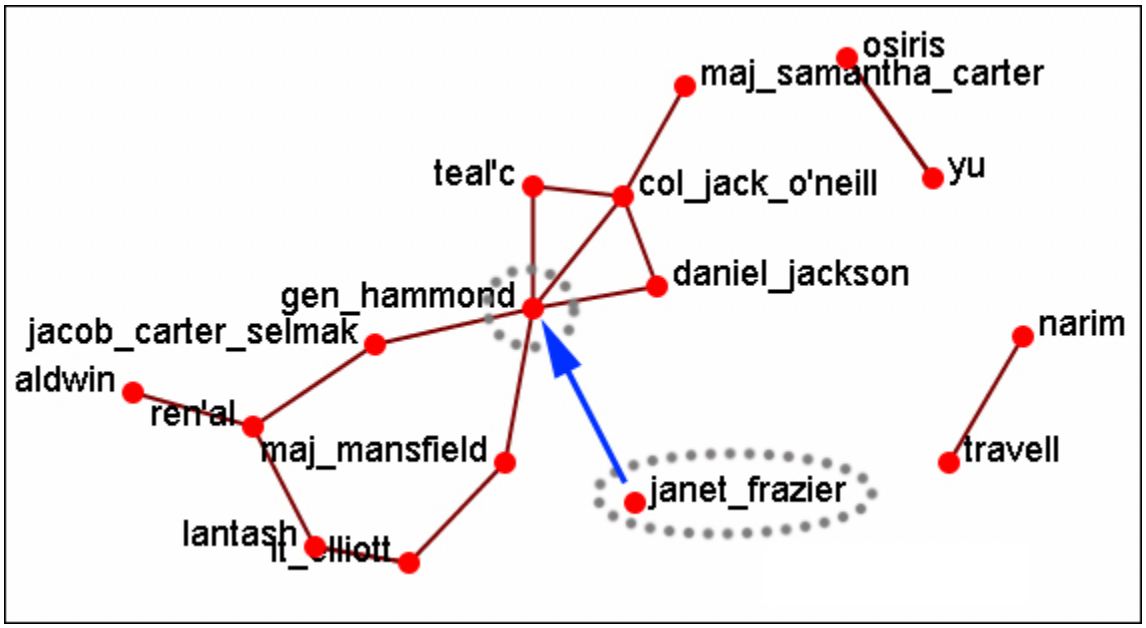
4. **Use an Existing network :** will place the links within the chosen network form the dropdown menu and **Use a new network** creates a new network from the name in option **5**.
5. **New Network ID :** is the name for the new network from option **4**.
6. **Network :** allows you to choice the Network to create the link in.
7. **Link Weight :** The weight to assign the link between the nodes.

NOTE : Since this function creates **directed links** a second link would need created for reciprocal action.

Example : If a connexion was made starting with A to B, a second connexion would need to be made starting with B to A.

Adding a Missed Link

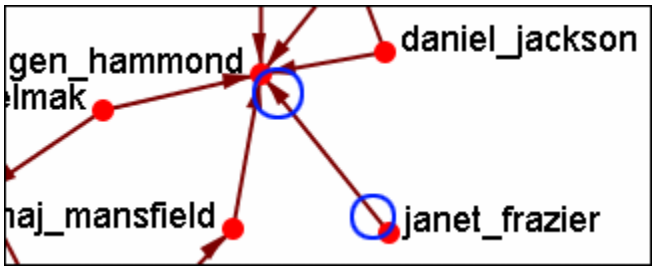
If after the Meta-Network was constructed and it's noticed an link is missing (e.g. janet_frazier should have been connected to gen_hammond), the missing link can be added immediately without returning to the editor.



From the Visualizer menu select **Actions > Add Link(s)**.



Be sure that the **Insert Nodes as they're clicked** has been check marked and that **Use an existing network** is selected with the correct network is visible in the dropdown. Then select the **[Create Link]** button.

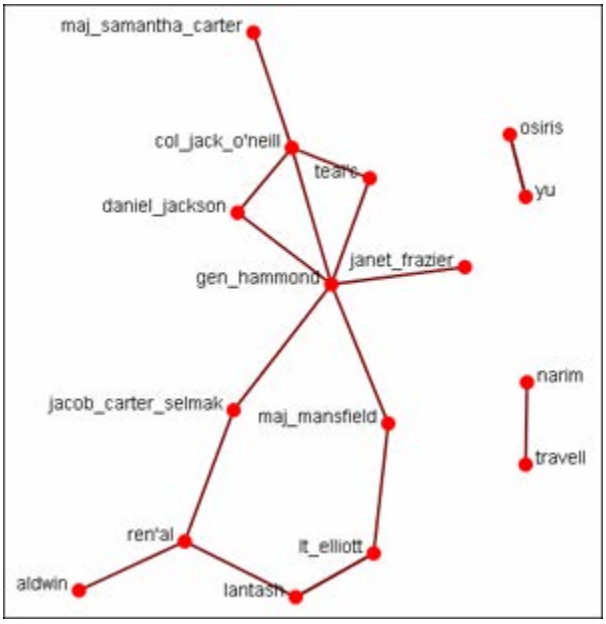


The two nodes are now connected with a **directed link**.

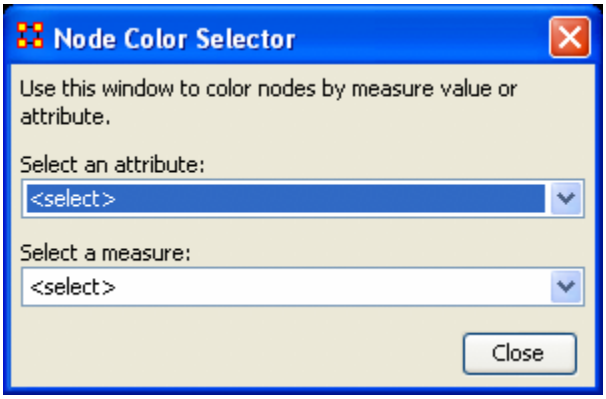
NOTE : this created a directional link from **janet_frazier** to **gen_hammond** but not the other way. To make it go both ways, a second link from **gen_hammond** to **janet_frazier** would need to be created.

Color Nodes By Attribute

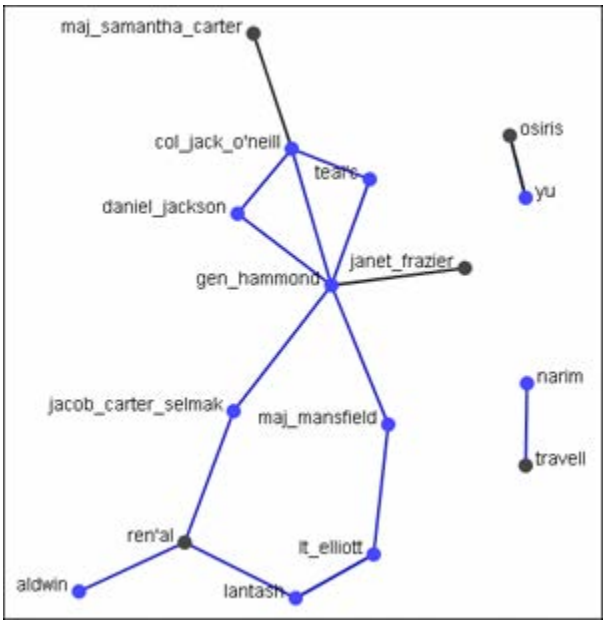
When the **agent-by-agent** network is opened all the nodes default to the color **red**. ORA has default colors for all the various Node Classes. But ORA can also color the nodes based on their individual attributes. Here's the default **agent-by-agent** Node Class in red.



From the Visualizer main menu select **Actions > Color Nodes by Attribute or Measure**. This brings up the **Node Color Selector** dialog box.

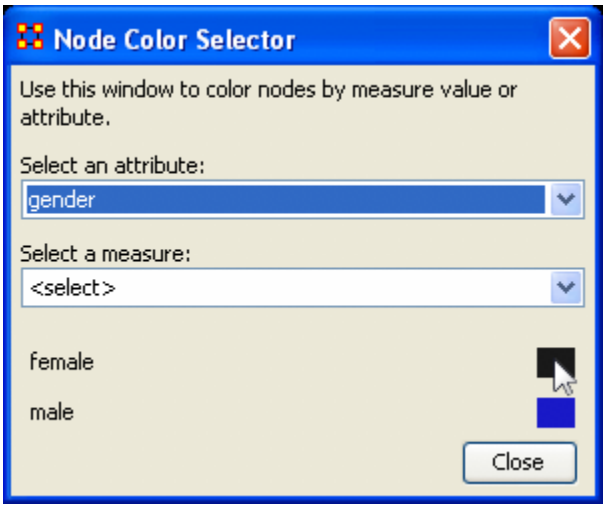


Selecting the **down arrow** for **Select an Attribute:**. Highlight an attribute from the list. ORA gives **default colors** to the nodes.



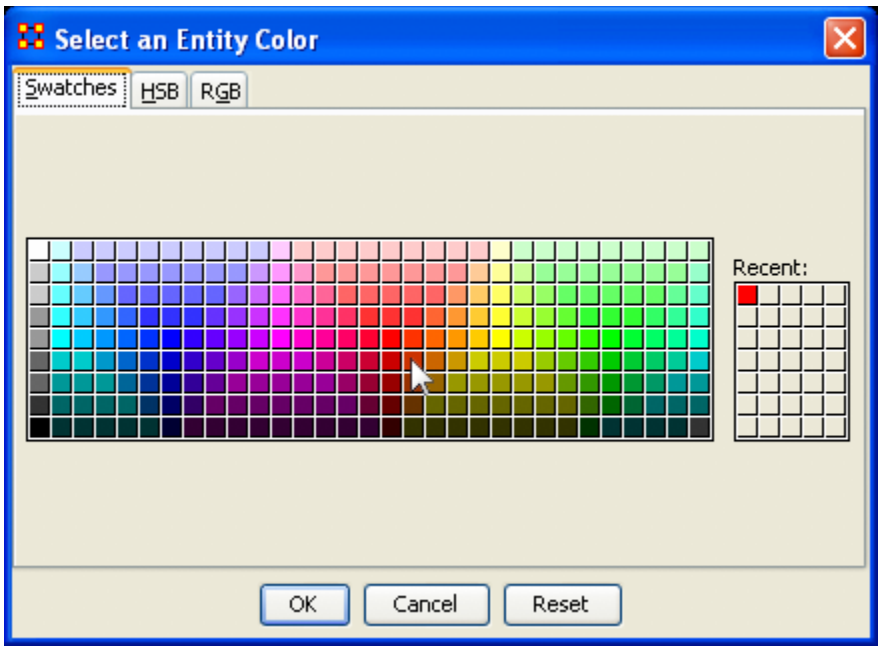
In some instances the color distinction isn't highly visible. And for presentation purposes a good contrast is necessary.

To bring up the **Color Selector** click on the color you want to change.



Note: *By* ***hovering*** *over the measure or attribute, you can bring up detailed tool tips.*

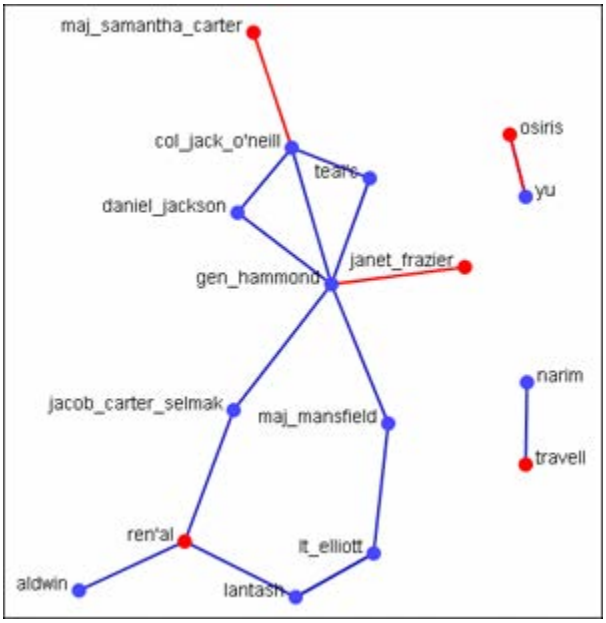
Select a new color from the swatches. Then select **[OK]**

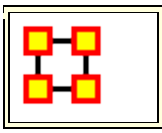


Your new color choice is now reflected in the dialog box.



And the nodes with the attribute you selected are now a new, and brighter, color.





Compute Standard Measures

This functions runs four standard measures:

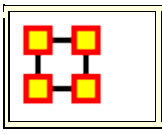
Cognitive Demand: Cognitive Demand measures the total amount of effort expended by each agent to do its tasks. Individuals who are high in cognitive demand value are emergent leaders. Removal of these individuals tends to be quite disruptive to networks.

Centrality, Betweenness: Betweenness tells us which node is the most connected to other parts of a network. For example, Betweenness can tell us which person in a network is the most central to the network as a whole. Betweenness measures the number of times that connections must pass through a single individual to be connected.

Centrality, Eigenvector : Eigenvector Centrality reflects one's connections to other well-connected people. A person connected to many isolated people in an organization will have a much lower score in this measure then those that are connected to people that have many connections themselves. This would be true even if such a WHO might have a high amount of actual connections (i.e. high degree centrality).

Centrality, Total Degree: Degree Centrality tells us the relative number of direct connections a WHO might have in a network; the higher the score the more likely a WHO might be likely to receive and potentially pass on critical information that flows through the organization.

These values can be viewed either by hovering over a node and revealing the tooltip or double clicking a node and bringing up the Node status dialog and selecting the Measures tab.



Isolates

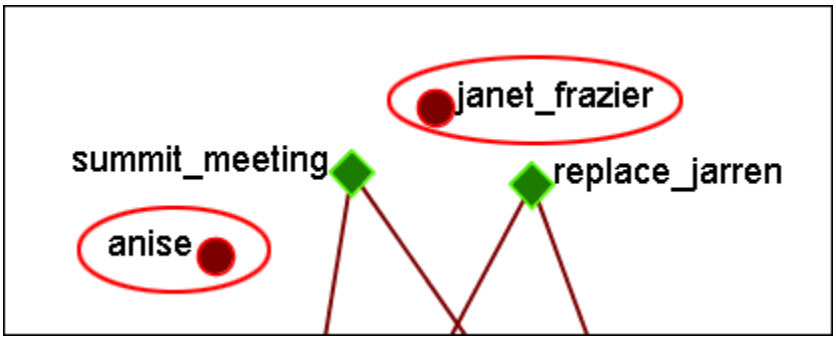
Periphery

Places isolates that were moved into column back to their original positions.

Hide Isolate Nodes

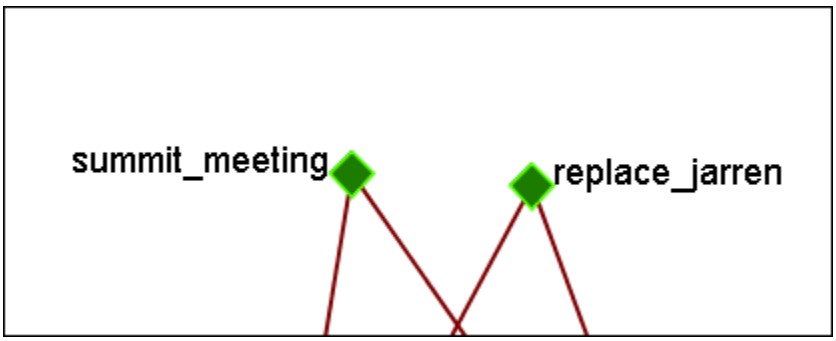
To further simply a visualization, it may prove useful to remove isolated nodes from the visualization.

Isolated nodes are not directly linked or connected to other nodes, which share direct links with each other. In the screen shot below, the red ellipses highlights an isolated nodes which need removed.



Select from the Main Menu: **Actions > Hide Isolated Nodes**.

In the screen shot below, after removing isolated nodes, the visualization is further simplified.



Combine into Meta-Node

This option will combine all the Isolates into one Meta-Node. This can be expanded right-clicking to bring up the contextual menu.

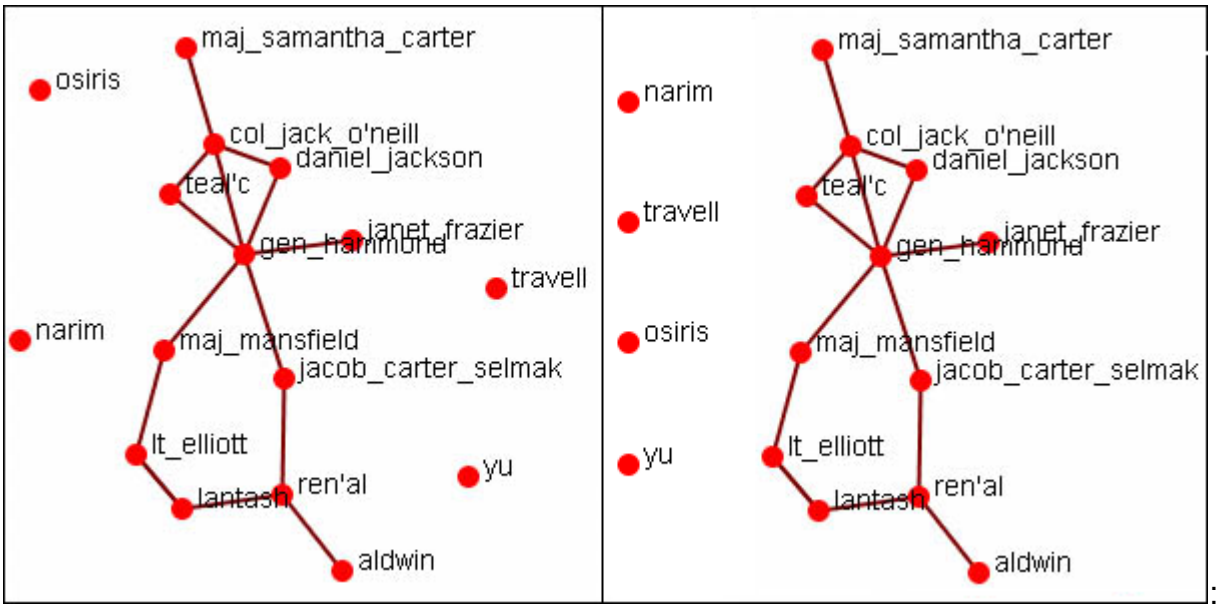
Move into Column

This function is used to move isolate nodes from the main viewing area to move easily view the connected nodes. These will be lined up on the left side of the screen.

NOTE : The original dataset was changed in order to create the isolates.

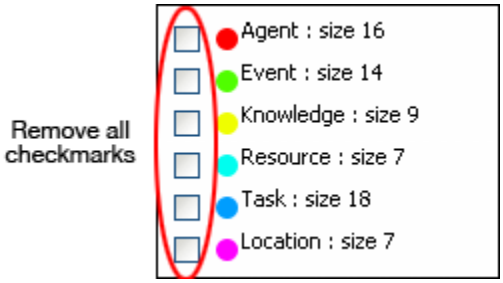
NOTE : If the names are not viewable and off the screen, change the position of the labels

The isolates can be returned to the original position using the Periphery options.



Add Network From Scratch

This function also allows the *creation of Networks from Scratch*. First, remove the check marks from all the Nodesets in the Legend to remove them from the screen.



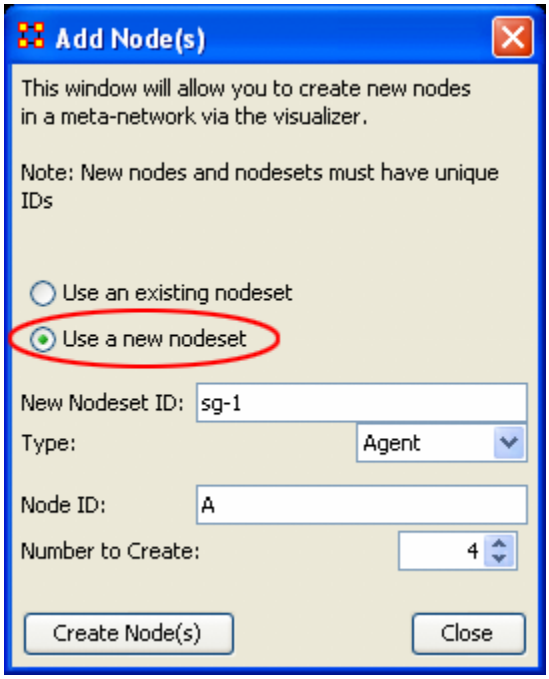
The DataSet

Next prepare your data for inclusion. Here is a small, five , Nodeset.

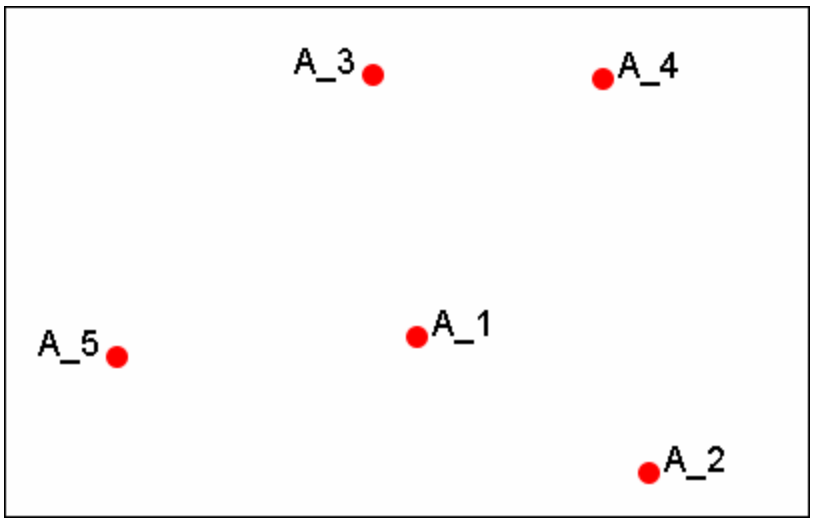
A01	col_jack_o'neill
A02	maj-samantha_carter
A03	daniel_jackson
A04	teal'c
A05	gen_hammond

From the main menu select **Actions > Add Node(s)**.

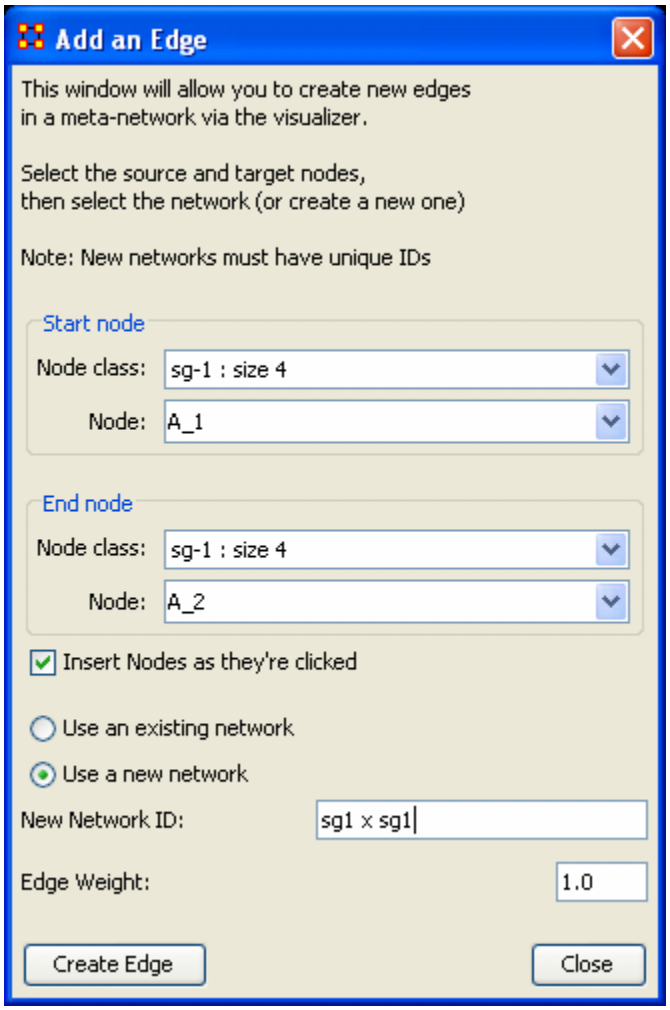
In the dialog box activate the **Use a new Nodeset** radio button. Underneath, in the **Type:** dropdown menu, select the type of Nodeset. Then in the **New Nodeset ID:** textbox give it a name. Then select the **[Create Node(s)]** button.



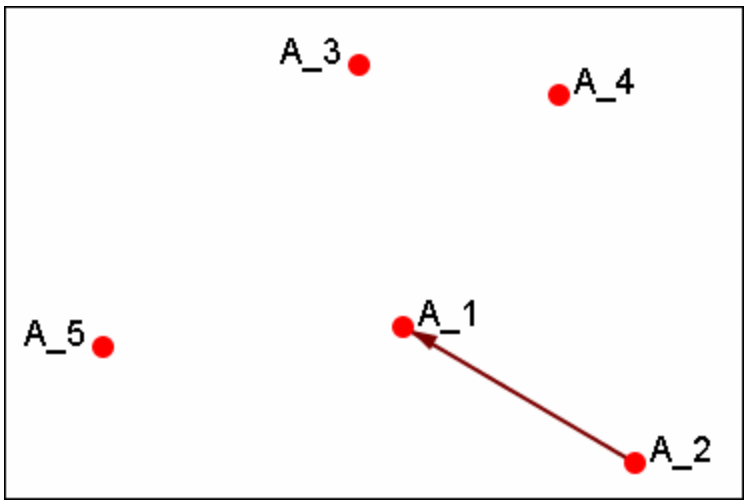
The five nodes will appear in the Visualizer with the prefix and attached numbers. Now it's time to connect the nodes.



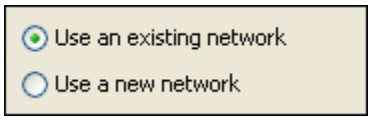
From the Visualizer menu select **Actions > Add Link(s)**.



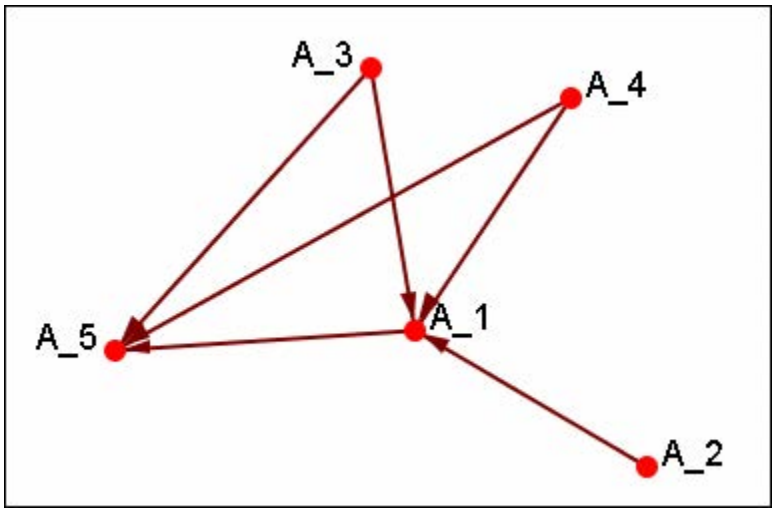
After selecting **[Create Link]** a new link will be drawn in the Visualizer.



Now switch the Nodeset to use to **Use an existing network**, select the newly created Nodeset in the dropdown, and create the rest of the links.



All of the links are now complete.



Save the Meta-Network with either **Save Meta-Network As...** or **Add Meta-Network to Ora** and use the ORA editor to add in titles and attributes.

Resize Nodes By Attribute

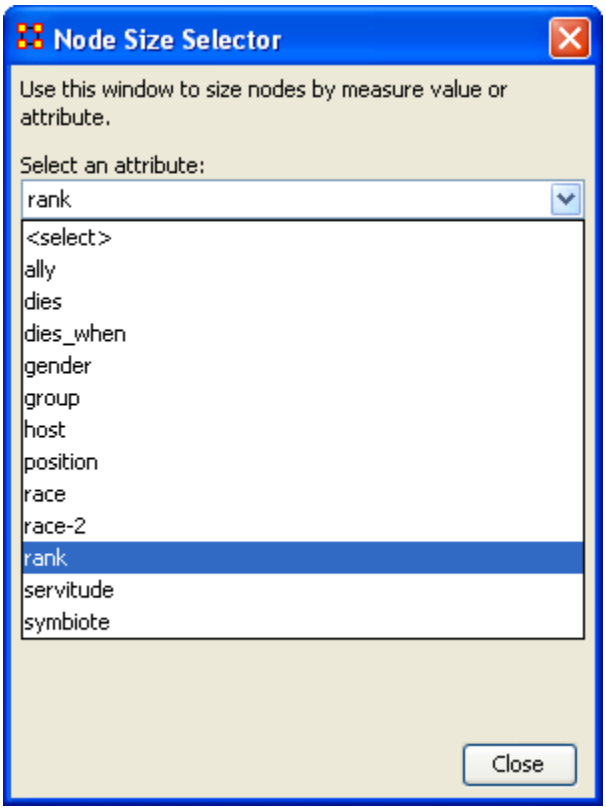
Resize by Attribute uses the numerical value of an attribute to size the nodes. Sizes will be scaled accordingly. Below is an attribute created for this example.

The numbers range from 0 to 10 and denote approximate rank. **10** denoting general/leader down through the ranks to **5** for civilians and finally **0** for persons not involved.

	Node ID	Node Title	rank
	<set filt...	<set filt...	<set filt...
☐	A01	col_jack_...	9
☐	A02	maj_sam...	7
☐	A03	daniel_jac...	5
☐	A04	teal'c	5
☐	A05	jacob_cart...	5
☐	A06	lt_elliott	6
☐	A07	ren'al	10
☐	A08	aldwin	5
☐	A09	janet_frazier	5
☐	A10	maj_man...	8
☐	A11	gen_ham...	10
☐	A12	lantash	7
☐	A13	narim	2
☐	A14	travell	10
☐	A15	osiris	0
☐	A16	yu	0

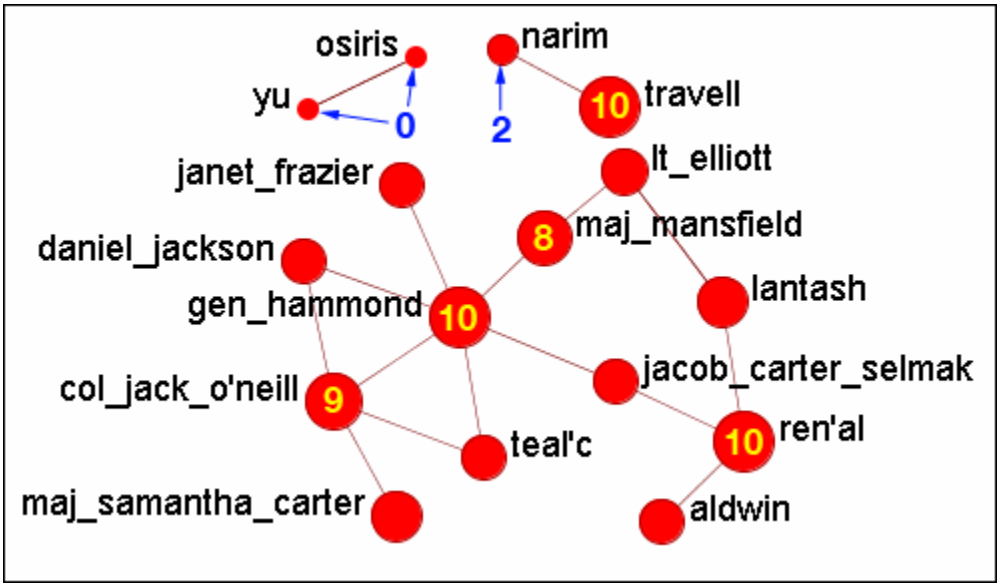
From the main menu select **Actions > Size Nodes by Attribute or Measure**. Then select the attribute to use for the sizing. When finished, select **[Close]**.

NOTE : Sizing nodes by attributes only works with attributes of numerical content. Alpha content will have no affect on the size of the nodes.



Each node will now be displayed according to the value in the chosen attribute.

NOTE : The numerals are not displayed in ORA and are shown only for display purposes.

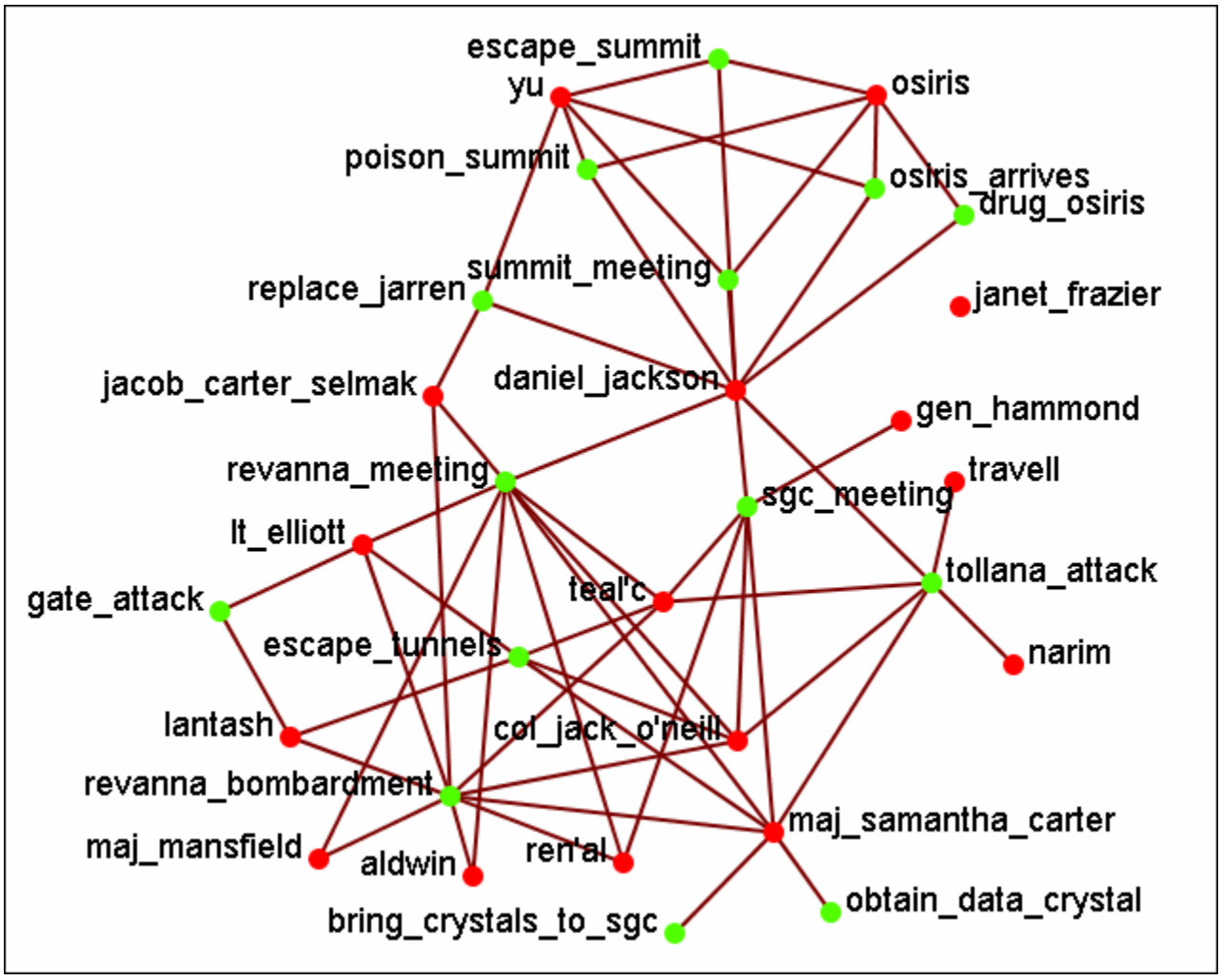


Resize Nodes By Measure

ORA has the capability to visualize nodes by scaling them relative to each other in relation to common SNA Measures or Attributes as selected within the ORA Visualizer.

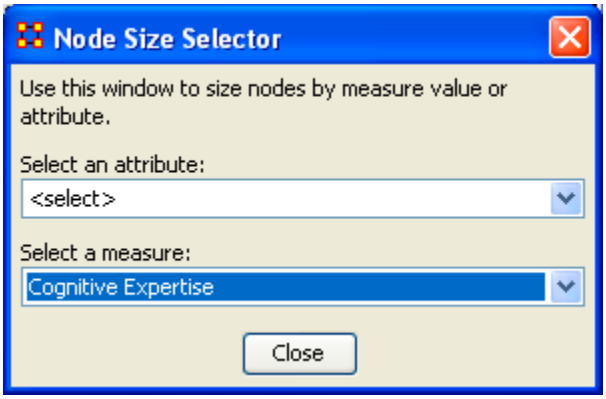
The key benefit to sizing nodes by Measure or Attribute is the ability to conceptually capture which nodes in your network figure more prominently in terms of measures by simply gauging their size visually and intuitively.

First, visualize one of your networks. Below is the Stargate **agent x event network** to find the agent with expertise regarding events in the scenario.

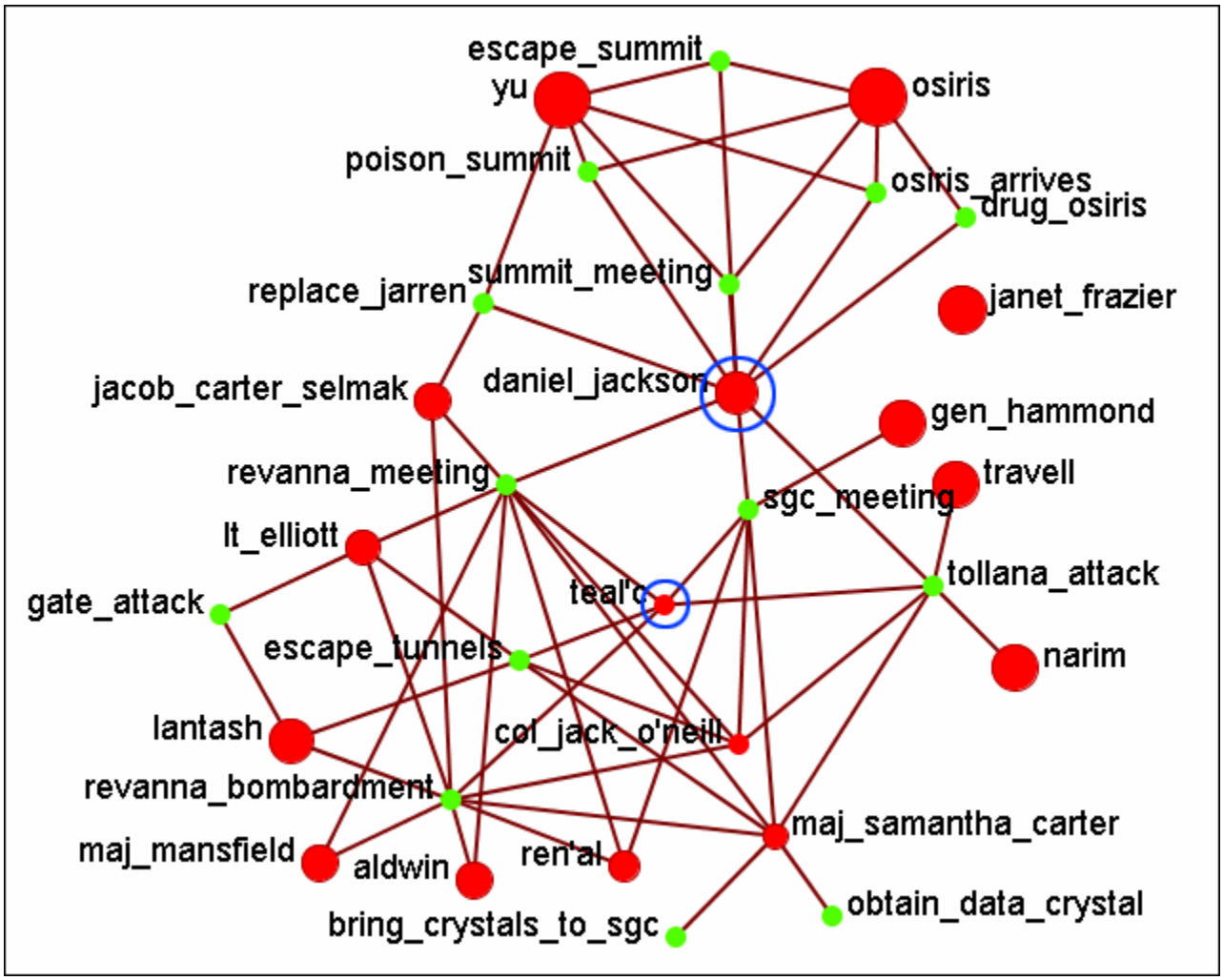


From the main menu select **Actions > Size Nodes by Attribute or Measure**.

From the bottom textbox I selected **Cognitive Expertise**. Each of the nodes in turn grows to reflect it's value from that measure.



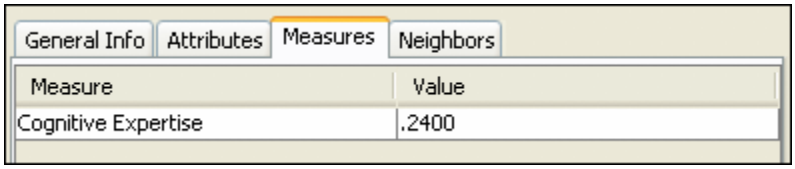
The display now changes to reflect each node's value by size.



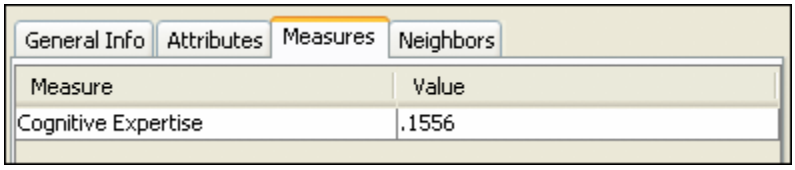
We'll compare two nodes: **daniel_jackson and teal'c**.

daniel_jackson's cognitive expertise value is 0.2400 and is displayed with a large red circle while teal'c's value is 0.1556 is displayed by a much smaller red circle. The values can be read in the **Node Status** dialog box.

Cognitive Measure for daniel_jackson



Cognitive Measure for teal'c



Visualizer Tools

The **ORA Visualizer** provides a suite of tools to visually analyze your Meta-Network. The Visualizer Tools can be located accessed from within Visualization mode on the main menu bar (image below):



Legend : Allows for toggling visibility of nodes and links on the fly.



Drill Down : With the ORA Drill-Down Wizard you can quickly visualize ego networks by overall Node Class **knowledge, tasks, resources, agents)** or by choosing individual nodes from a checklist. The ORA Drill-Down Wizard is only accessible through the Visualizer:



Node Status : The Node Status Window is selected by default. It first pops-up when you select any node in the Visualizer. This window provides you with a snapshot of the currently selected node by displaying that nodes unique Attributes, Measures, and Neighbors.

Attribute/Measure Viewer : Selecting an **Attribute** will group nodes by the selected Attribute. Selecting a **Measure** groups nodes by the selected Measure value.



Node Selector : You can use the Node Selector to simply complex visualizations.

Link Selector : In a complex network it may be difficult to locate one particular link. The Link Selector allows you can chose to work with One Node or Two Nodes, pick which is the Source/Target node, and the appearance of the link in the Visualizer.



Path Finder : The Path Finder allows you to focus or **drill down** on a particular node, or multiple nodes, that you may be interested in analyzing in greater detail.



Sphere of Influence : Each node within a network has a unique **Sphere of Influence** or **Ego Network**, essentially it's direct relationship with it's neighbors as a function of specified path length.

Backward Influence : Used to view how a node influences other nodes.



Block Maps : Block Maps display varying intensities of data by displaying "blocks" correlating to the value of data. For instance, a block map displaying node centrality values would reserve the largest block for the node highest in that value. Color is used to as well to visualize different values with the the darkest color reserved for the highest value. Block Maps can also be referred to as heat maps.



Node Locator : Brings up a window with the Meta-Network in a collapsible tree structure. Selecting any node within this tree will highlight the node, enlarge it, and bring it to the center of the display.

Micro Simulation : Micro Simulation allows you to run some basic simulations on the curretly loaded visualization. LInk weights are important as once they are normalized, they correspond to the probablity of a transmission.

Pie Nodes : Use multiple colors for nodes taken from attributes or measures.

Meta-Network Designer : Allows you to create, or add icon nodes, to a Meta-Network display. Select a Nodeset then Drag and drop icons onto the display.



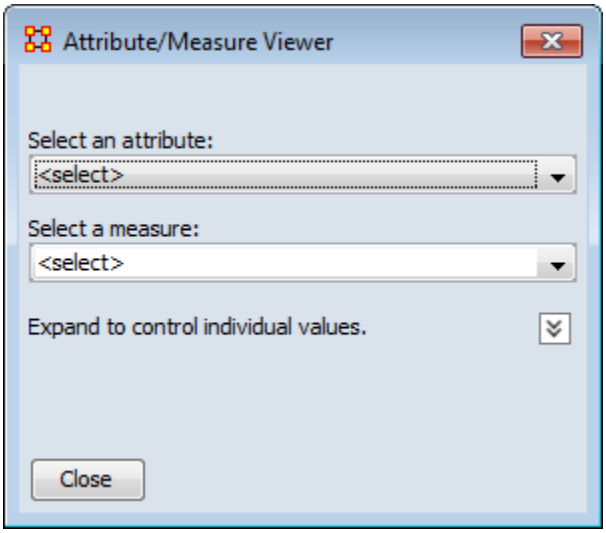
Networks Over Time : Allows you to view a version of your network across multiple time periods.



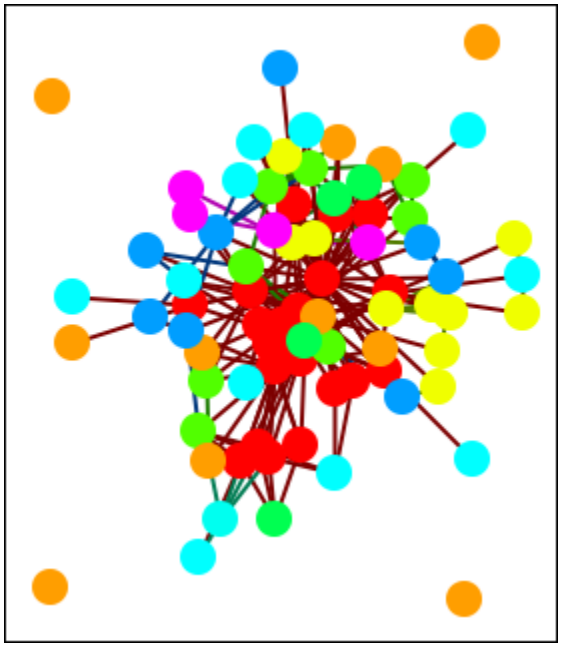
Vector Maps :

Attribute Measure Viewer

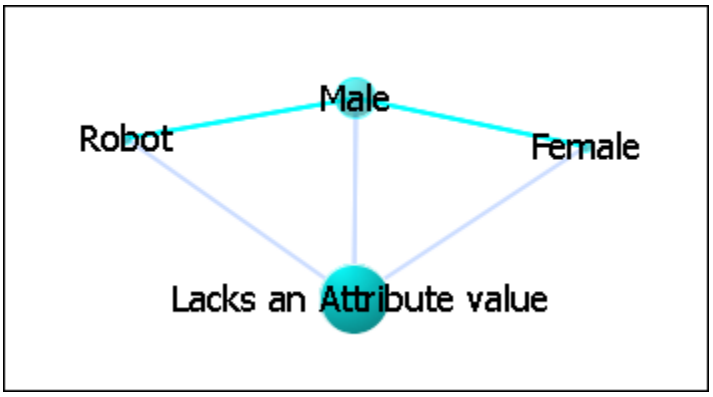
The **Attribute/Measure Viewer** allows you to view multiple variations instantly of grouping nodes by attribute or running various measures on nodes to create Meta-Nodes.



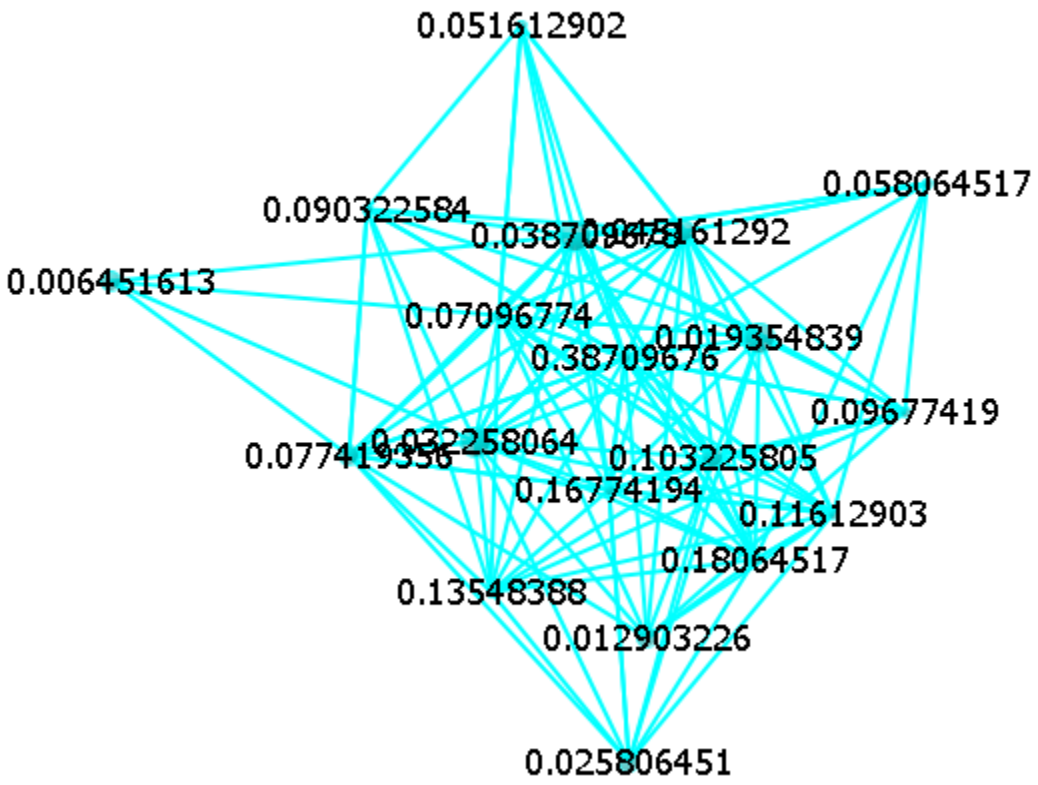
We start with a Meta-Network containing agents, knowledge, or whatever yours contains.



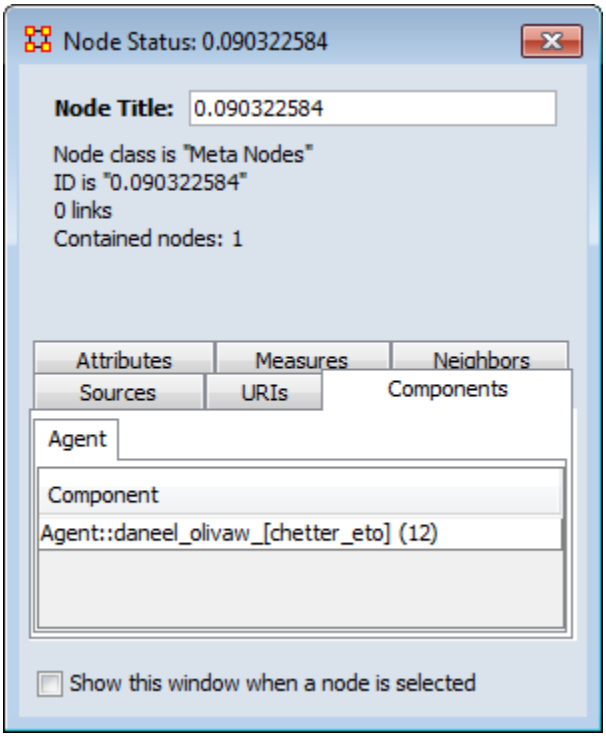
Under **Select an attribute:** I chose **gender** which is one of the agent attributes. This created four Meta-Nodes for **male, female, robot, and lacks an Attribute value**. Yes, this is a science fiction dataset.



Next under **Select a measures:** I chose **Total-degree centrality**. This gave each node it's centrality value in the display regardless of Nodeset. At thie point we're unable to distinguish which node is which. For this information double-click on a node to bring up the **Node status** dialog box.



This will display the information about the selected node. Under components it will display the Nodeset and the name of the node.



Backward Influence

Interface

Select a number of Levels:

Allow Self Links: Shows any link links from a node back to iteself.

Allow Cycles: Shows cycles that appear in the influence flow

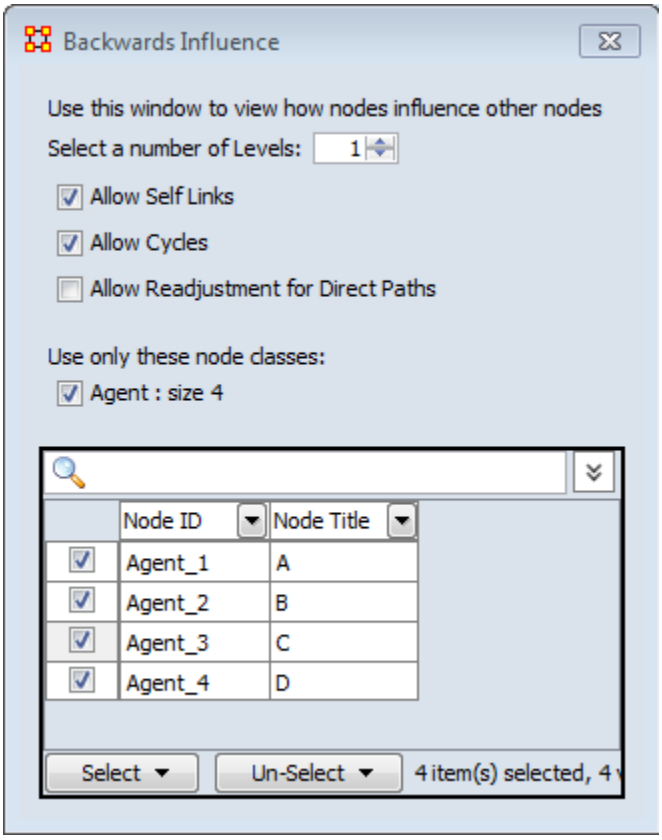
Allow Readjustments for Direct Paths: Options that appear in consecutive levels will be streamlined by placing nodes that occur on two consecutive levels on the further back one and sliding nodes around based on that.

Example

The network we use is a simple four-node network with limited links. Note that node C has no out links though others nodes have links TO that node.

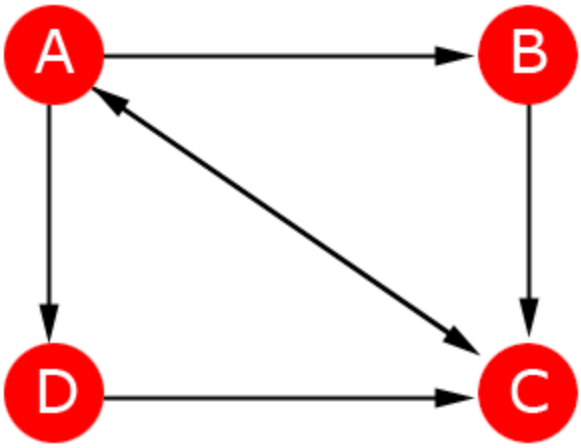
	A	B	C	D
A	1.0	1.0	1.0	1.0
B	0.0	0.0	1.0	0.0
C	1.0	0.0	0.0	0.0
D	0.0	0.0	1.0	0.0

For this example we select all four nodes as well as the **Allow Self Links** and **Allow Cycles**. If you have multiple Nodesets in your Meta-Network you can choose nodes from all of them.

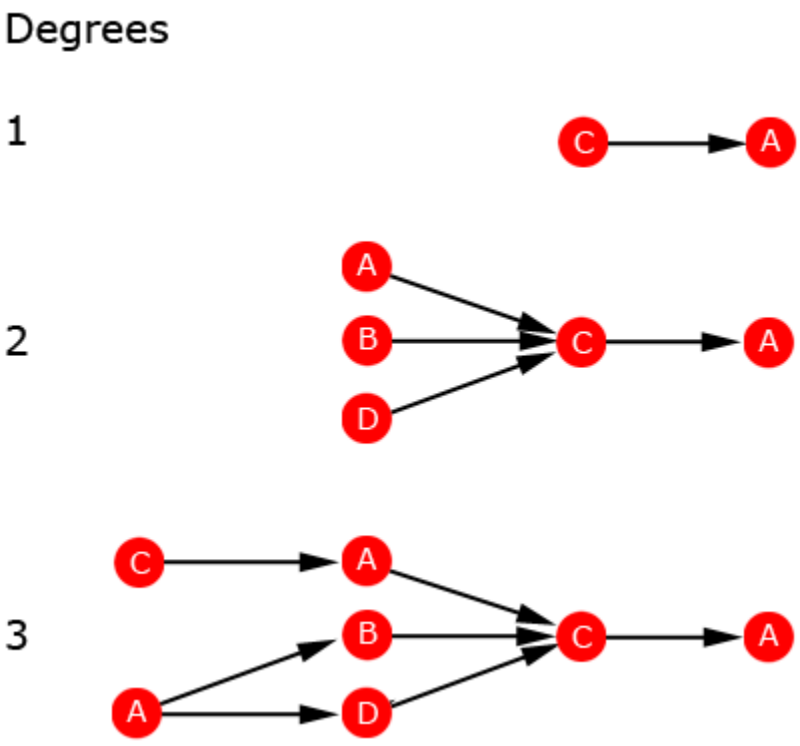


Visualization Example of a Network.

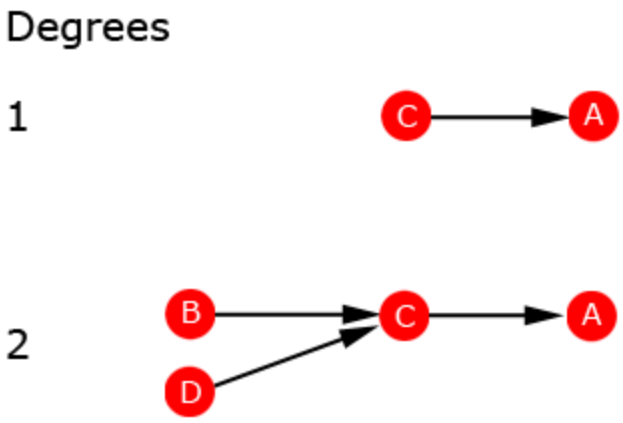
Here is the example network visualized.



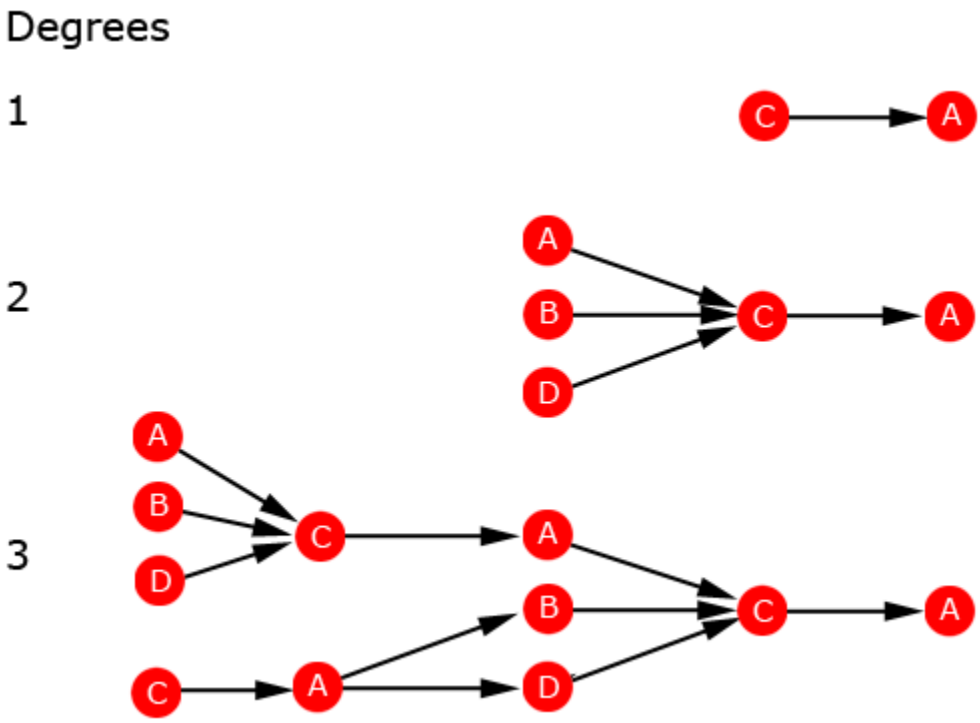
Select (a), Cycles, No Direct Path Adjustment (NDPA)



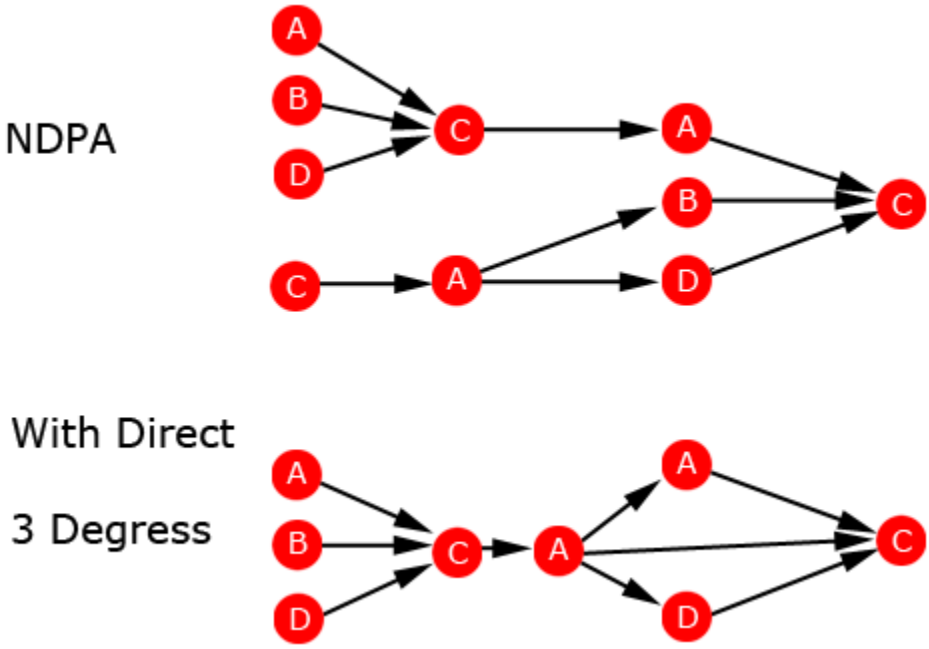
Select (a), No Cycles, No Direct Path Adjustment (NDPA)



Select (c), Cycles, No Direct Path Adjustment (NDPA)



Select (c), Cycles, 3 Degrees



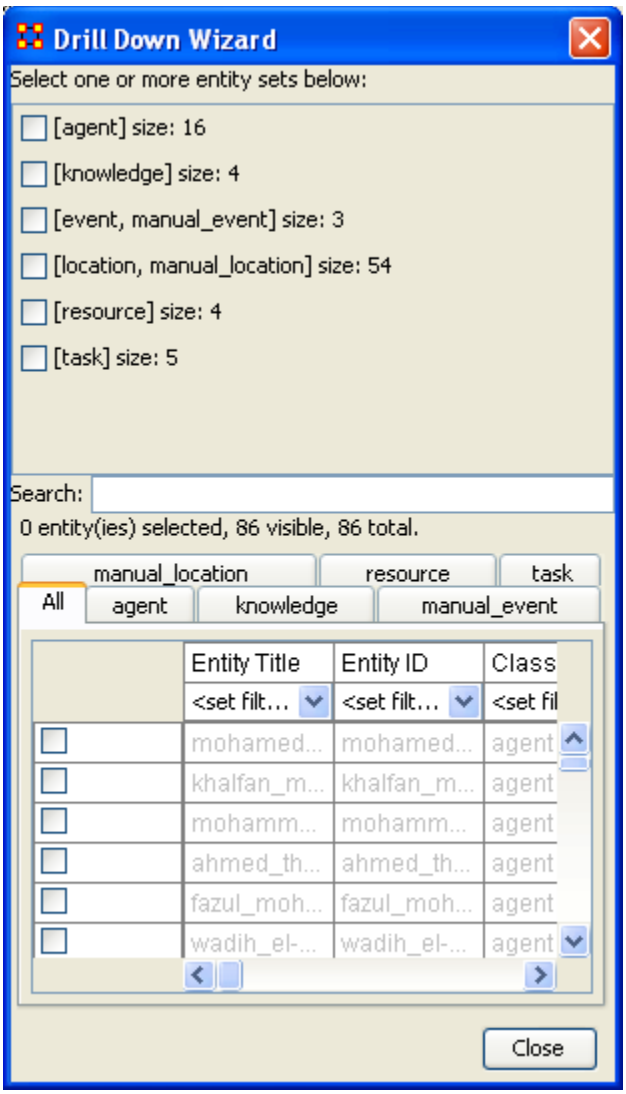
With Direct Path Adjustment, (a) on Degree 1 and (a) on Degree 2 merge(c) On Degree 2 and (c) on Degree 3 merge

Drill Down Wizard

With the ORA Drill-Down Wizard you can quickly visualize **ego networks** by overall Nodeset **(knowledge, tasks, resources, agents)** or by choosing individual nodes from a checklist. The ORA Drill-Down Wizard is only accessible through the Visualizer:

From the ORA Visualizer Main Menu select **Tools > Drill Down**.

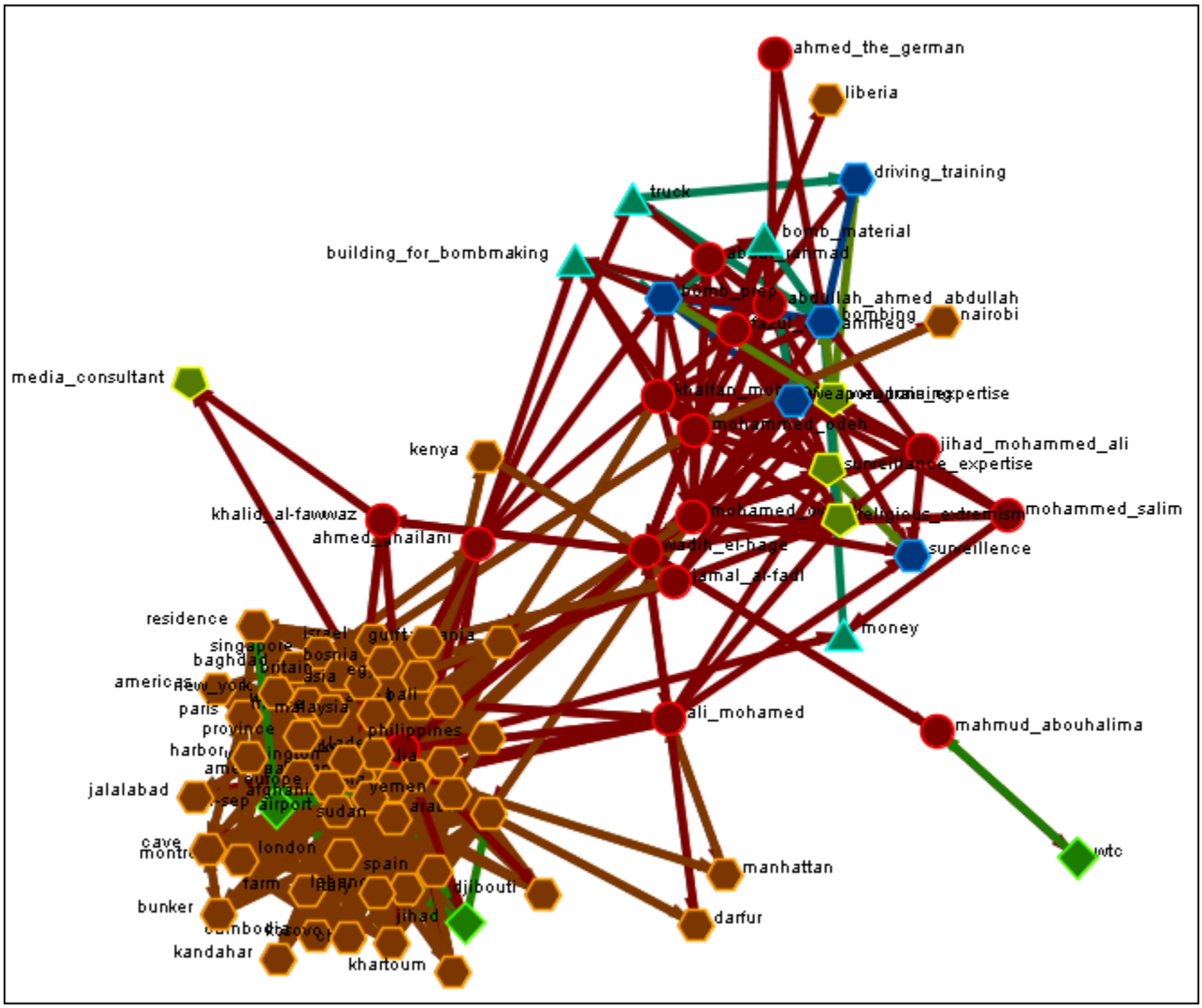
The following window box will appear.



The top sections allows you to chose the nodes for use. The bottom tabs allow for choosing specific nodes within a set.

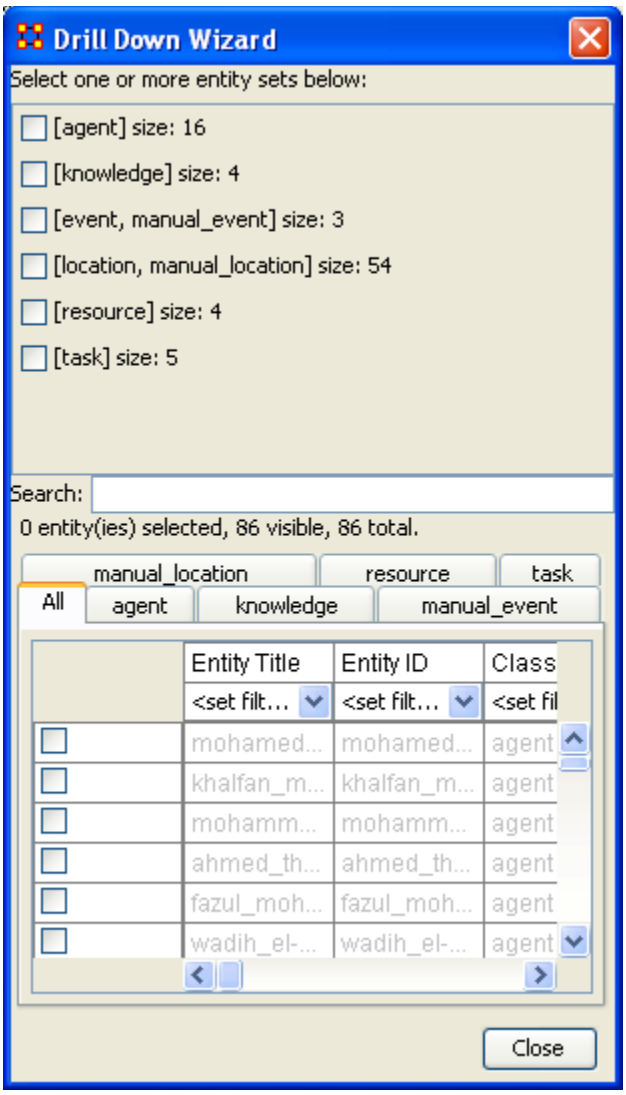
Drill Down Wizard Example

Using the Embassy Meta-Network, we will render the various Nodesets using the Drill-Down Wizard Tool. The screen shot below displays the Embassy Meta-Network as it should first appear in the Visualizer.

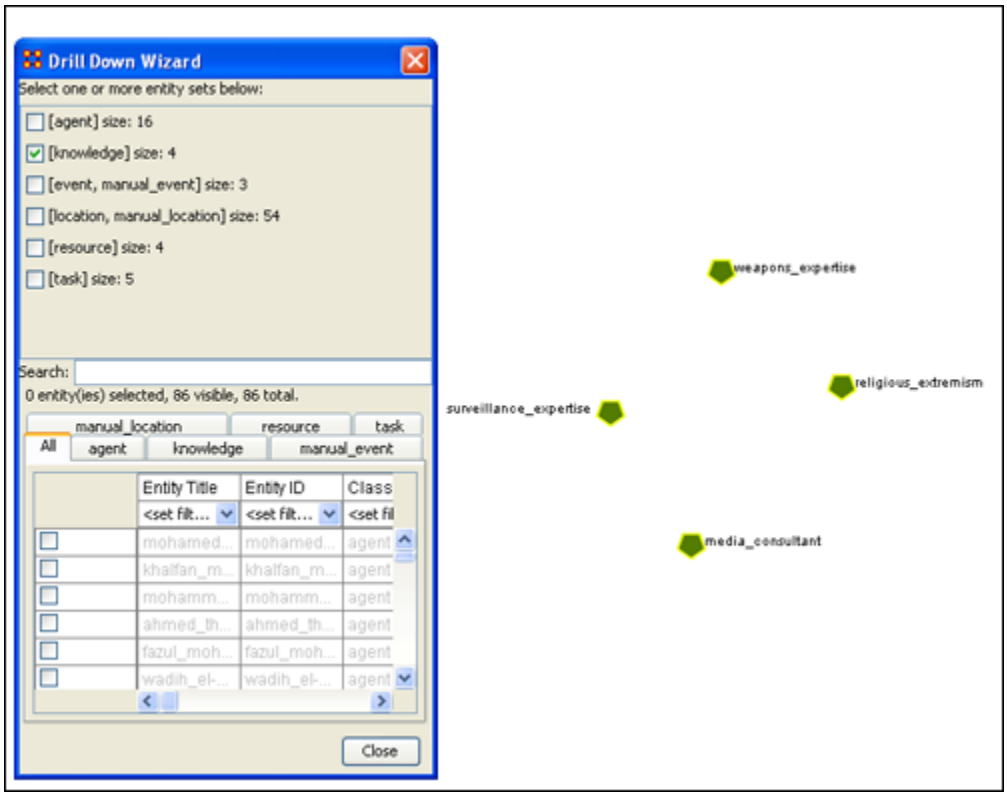


From the Main Menu select **Tools > Drill Down**.

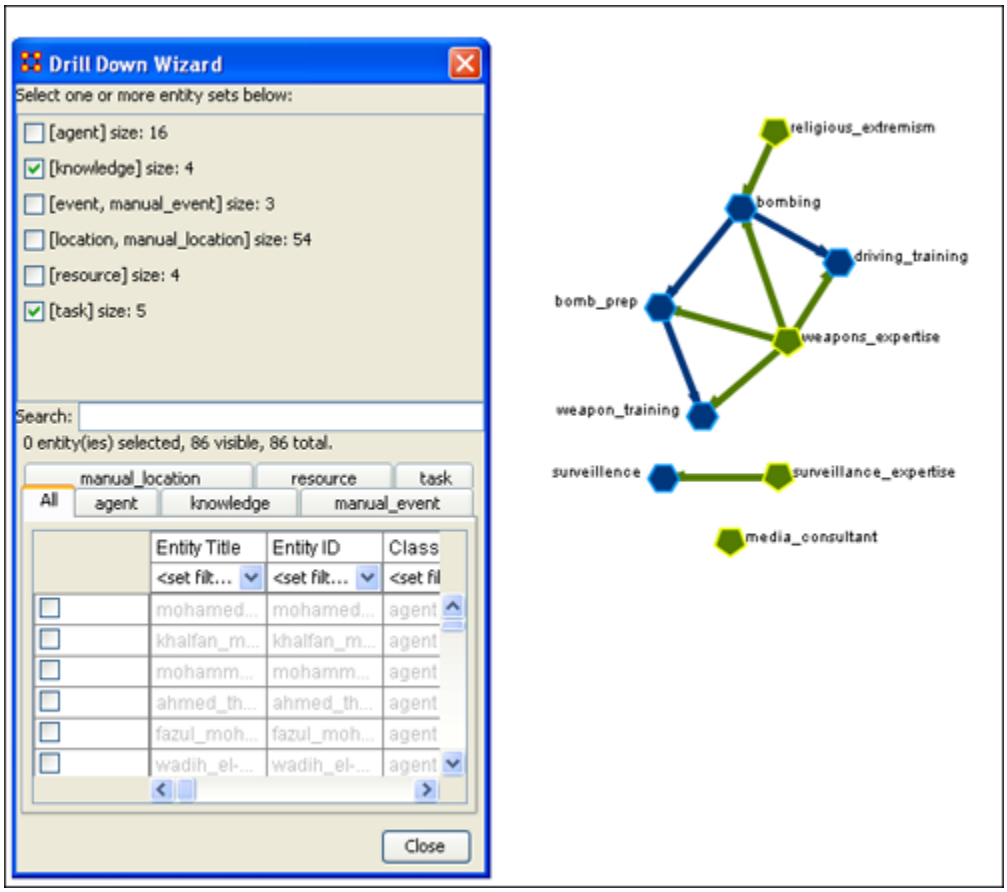
This will bring up the **Drill Down** dialog box as shown below).



Here, select the Nodeset **Knowledge** by selecting the Knowledge check mark box. The screen shot below, displays the end result that you should now see in the Visualizer.

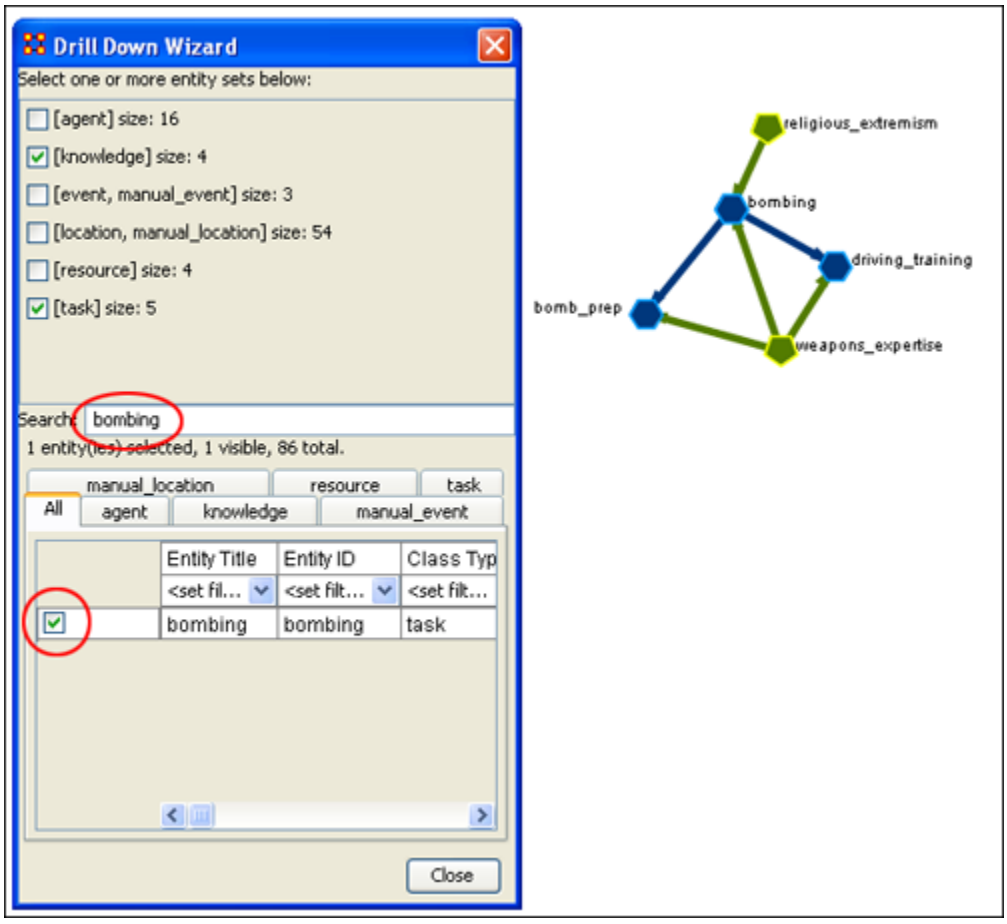


Next, with the Knowledge box checked, add the Nodeset **Task**. The screen shot below displays the end result.



Next use the search bar feature of the Drill-Down Wizard to narrow the search.

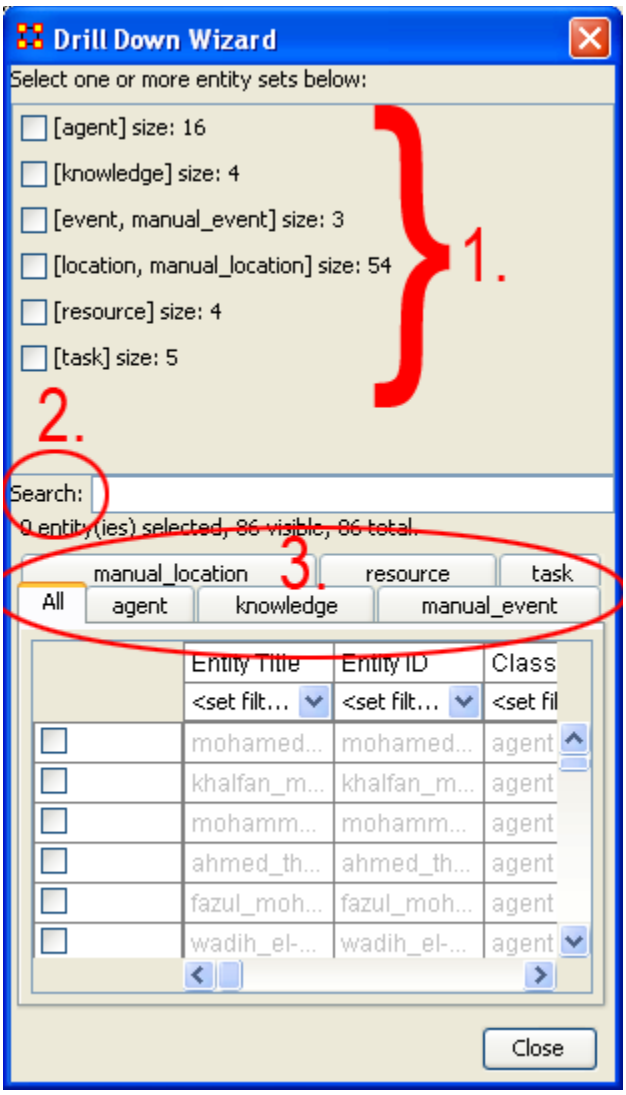
Enter the word **Bombing** in the Visualizer search field below. Then select the check box on the bombing row. The screen should now reflect your new search parameters. Everything not associated with **bombing** has been turned off.



Drill Down Wizard Explained

The ORA Drill Down Wizard can be broken down into three primary sections of input:

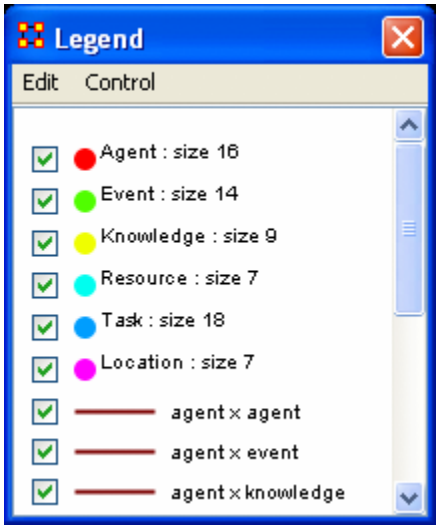
1. **Section 1:** enables you choose individual Nodesets or combination of Nodesets to display in the Visualizer.
2. **Section 2:** of the Drill Down Wizard enables you to search for a particular node within your Meta-Network. This can be handy when you dealing with large Nodesets and the one you are interested in finding is not easily located.
3. **Section 3:** enables you **check mark** an individual node within your Meta-Network by Nodeset if so desired.


Drill Down Wizard
Select one or more entity sets below:
[agent] size: 16
[knowledge] size: 4
[event, manual_event] size: 3
[location, manual_location] size: 54
[resource] size: 4
[task] size: 5
1.
2.
Search:
0 entity(ies) selected, 86 visible, 86 total.
3.
manual_location
resource
task
All
agent
knowledge
manual_event
Entity Title
Entity ID
Class
<set filt...
<set filt...
<set fil
mohamed...
mohamed...
agent
khalfan_m...
khalfan_m...
agent
mohamm...
mohamm...
agent
ahmed_th...
ahmed_th...
agent
fazul_moh...
fazul_moh...
agent
wadih_el-...
wadih_el-...
agent
Close

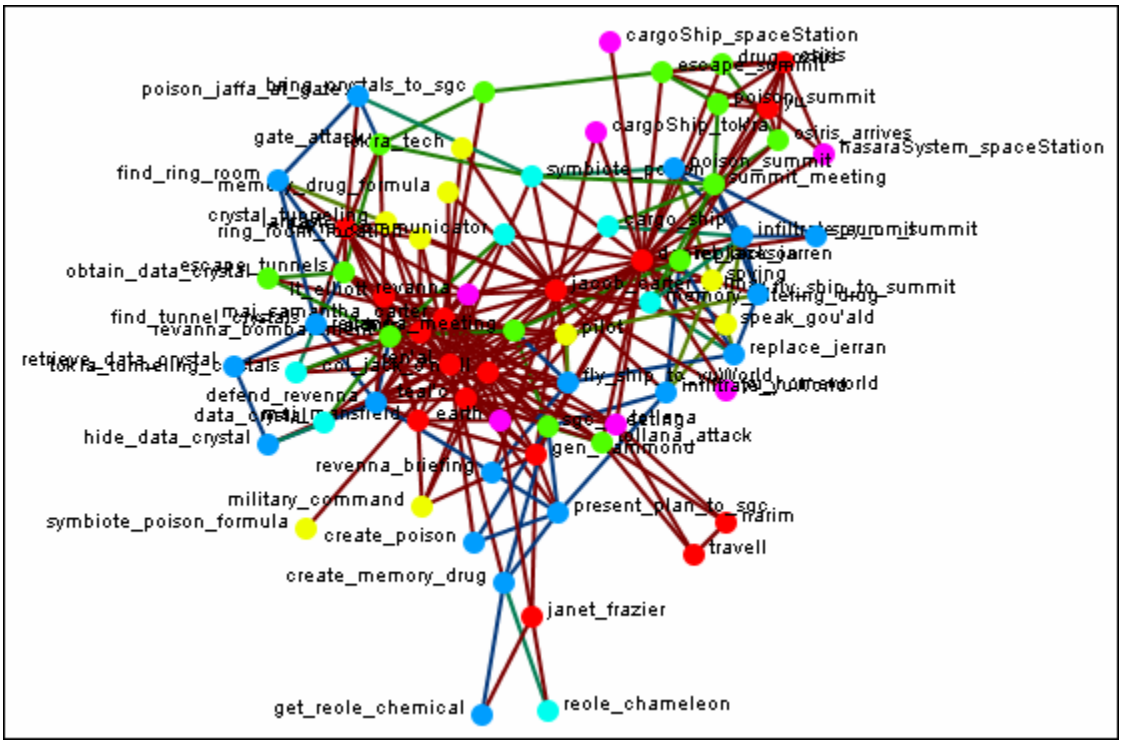
Legend

The **Legend** dialog box allows you to quickly hide and reveal nodes and links in the visualizer.

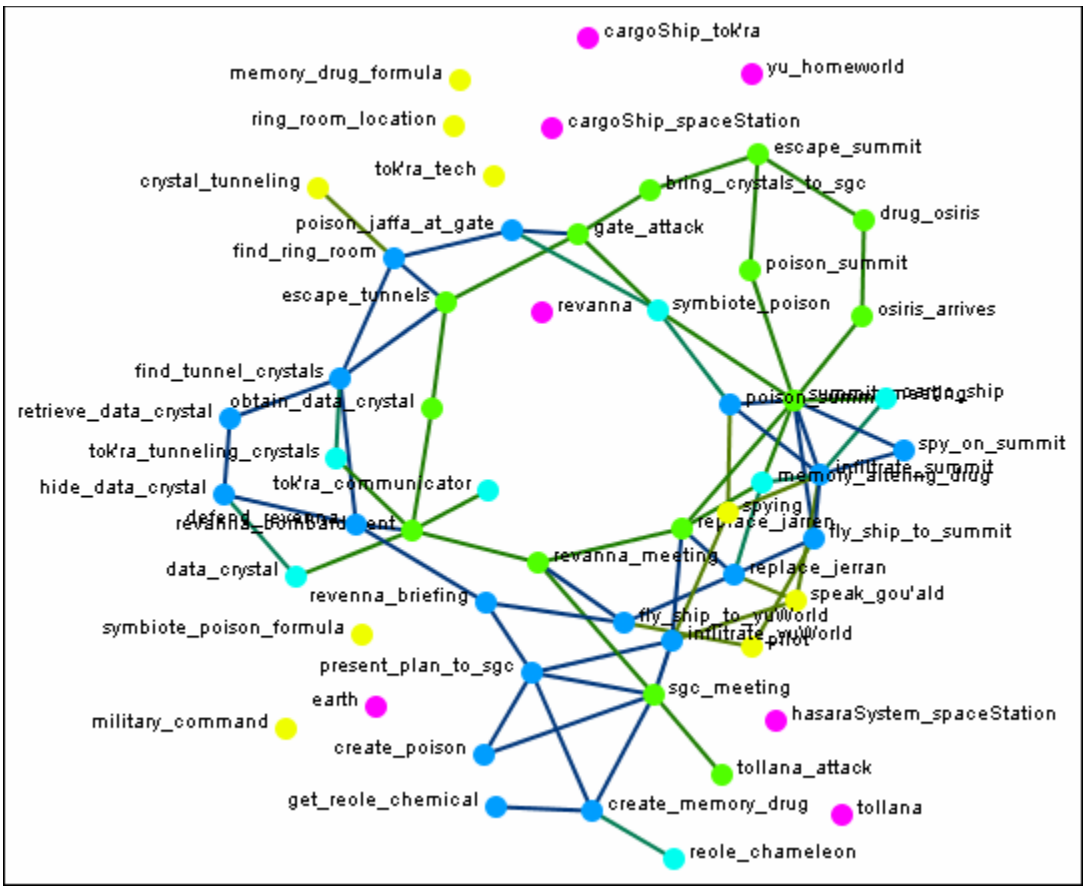
Use the check boxes to change a Nodesets visibility. When you first call up the Visualizer all the boxes will contain checkboxes...



...and in the Visualizer all nodes and links are revealed. A little hard to make heads or tails of something like that.



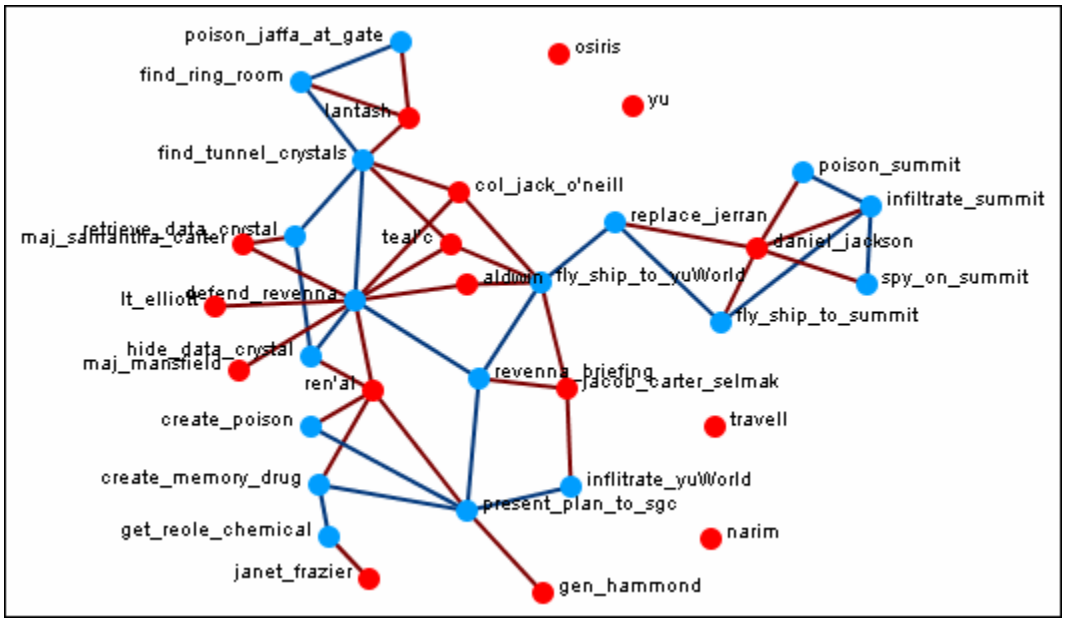
By using the Legend check boxes you can selectively **show / hide nodes and links**. Deselect the checkbox to the left of **Agent**. Instantly all of the Agent nodes are hidden along with any connections they had with the rest of the nodes. The node structure is a little easier to see now.



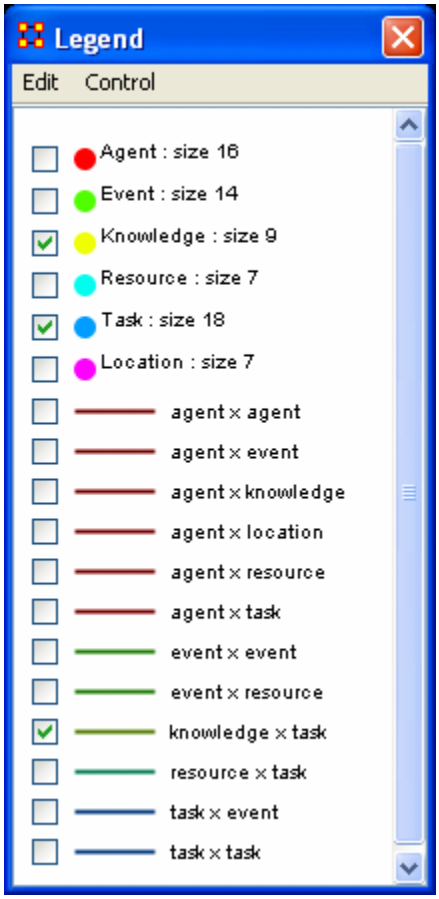
Next think about a particular set of connexions you'd like to see, say a **task x task network and how the agents relate to the tasks**.



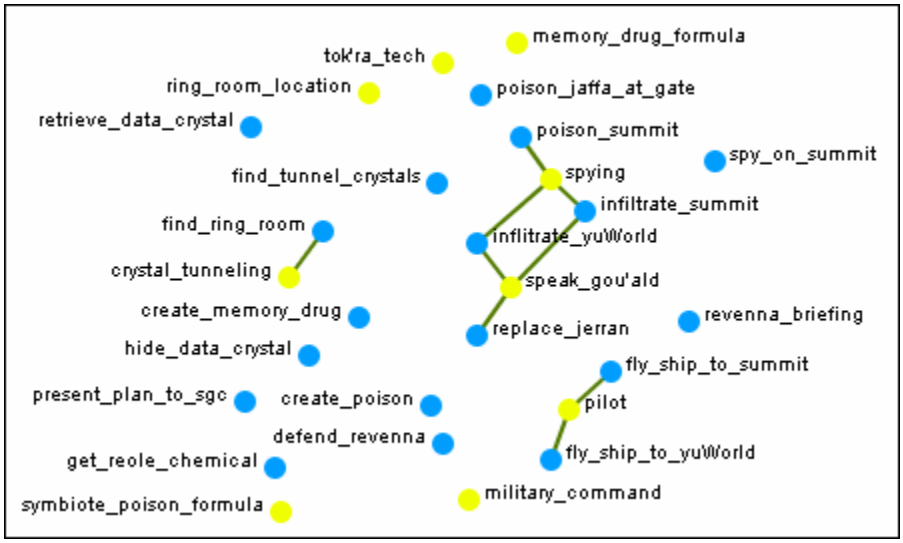
From the Legend box menu select **Control > Hide All nodes** Then again from the menu **Control > Refresh Legend**. Now place check marks in the check boxes for **agent, task, and task x task**. All the tasks will be linked together as per your network and all the agents will have connexions to the tasks they are associated with.



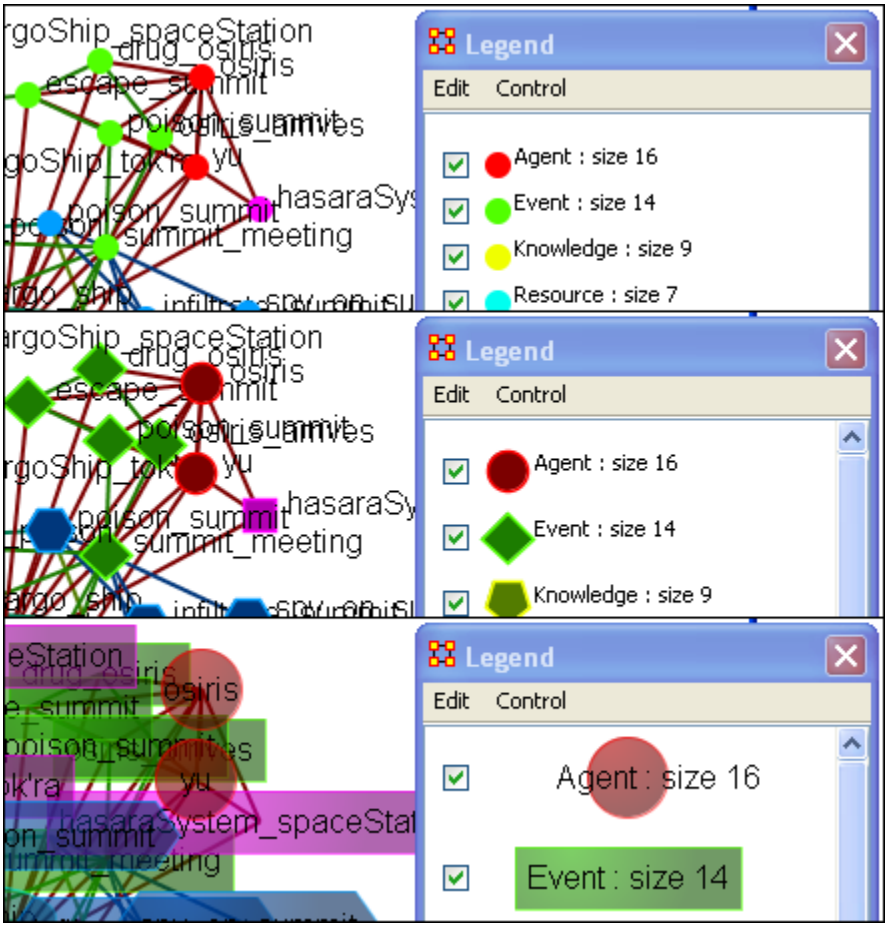
Another example is how **knowledge relates to specific tasks**. From the Legend menu select **Control > Hide All Nodes**. Now place check marks next to **knowledge, task, and the Knowledge x task network**.



Now the Visualizer reveals which knowledge is required for which specific tasks.

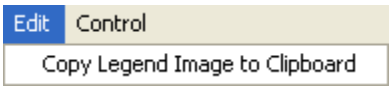


The legend also reflects the size, shape, and color of the nodes in the Visualizer.



Legend Edit Menu

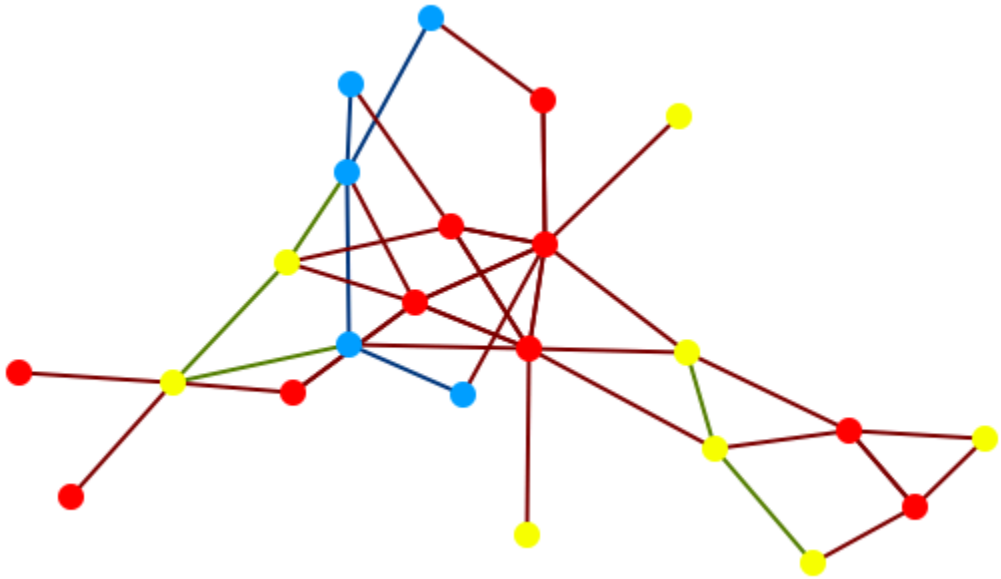
Below is an image of the Legend Edit Menu and a description of this tool:



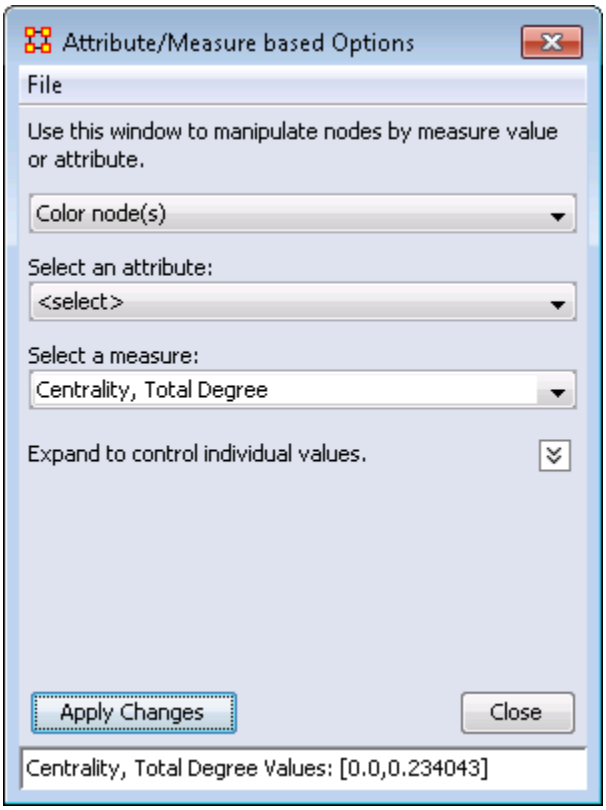
Copy Legend Image to Clipboard : Copies an image of the **entire** legend that can be pasted into an image-editing program.

Save Color Scheme

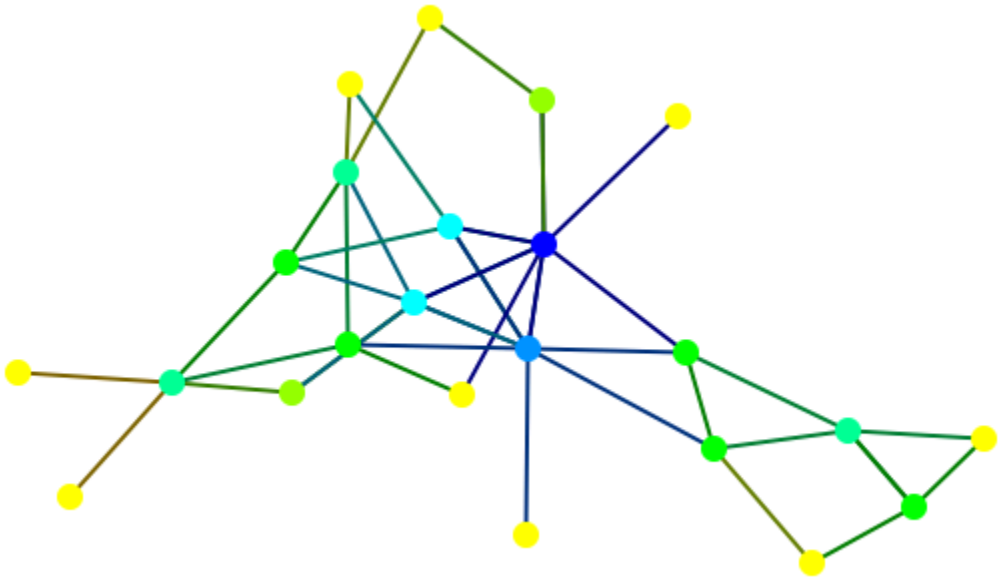
Here is a network of agents, knowledge, and tasks.



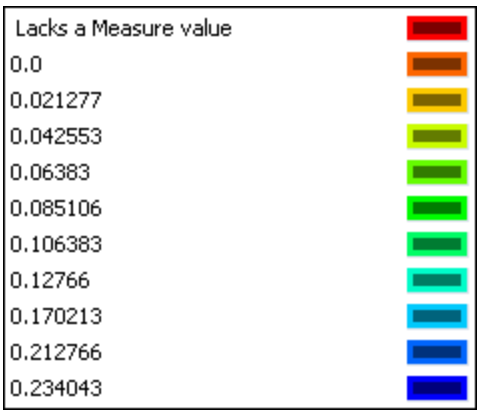
Open a visualization. Select **Node Appearance > Attribute/Measure based Options**. In this example I set it to **Color node(s)** and color those nodes using the **Centrality, Total Degee**. You'll notice at the bottom of the dialog box there is a panel with the range for the measure. This can be copied and pasted into a document you're working on.



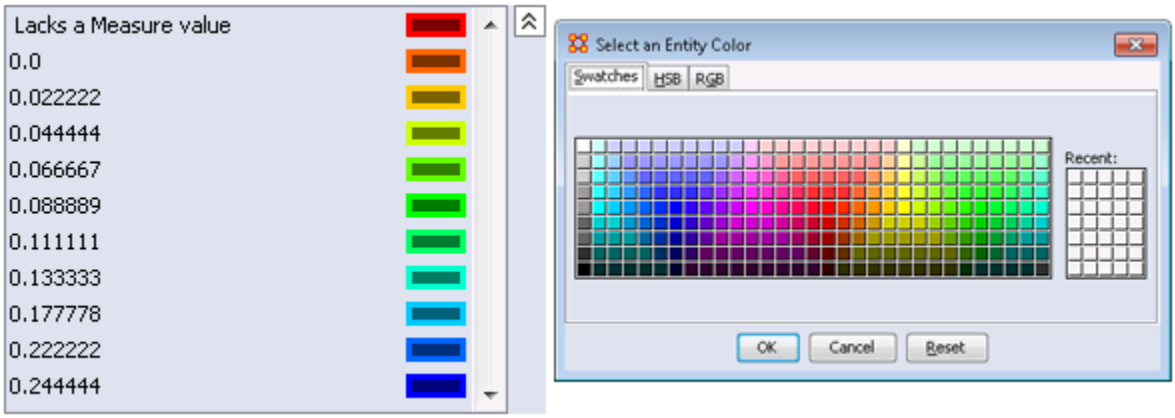
The nodes have now been colored according to the measure.



From the dialog Box menu, select **File > Copy Legend to Clipboard**. This places a copy of the legend onto the clipboard which you can paste into your paint program of choice.



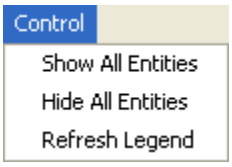
Furthermore, you can adjust any of the colors by clicking on the color well. This brings up the color picker where you can change the color of the range.





Legend Control Menu

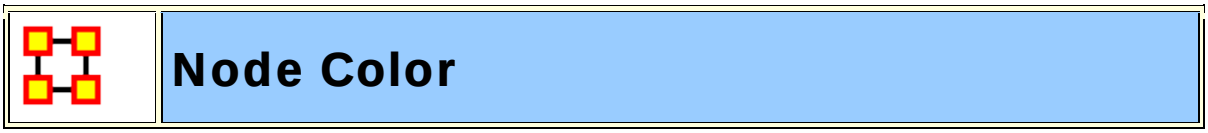
Below is an image of the Legend Control window:



Show All Nodes : Will bring into view all entities in the Meta-Network. Good to use if you need to make a fresh start.

Hide All Nodes: Hides every node. Good starting point when you only wish to display a small subset of nodes.

Refresh Legend : After using the menu items above and/or using the check boxes this item will bring the visualizer up to date.

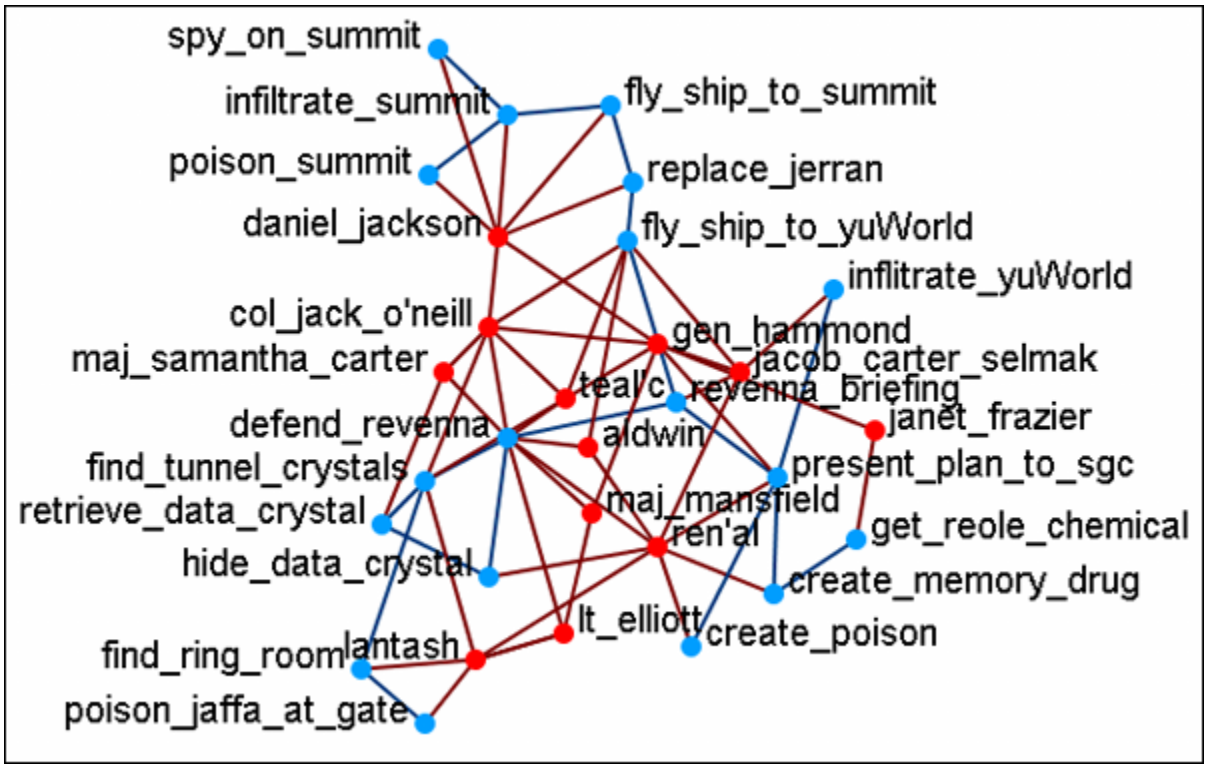


Node Color

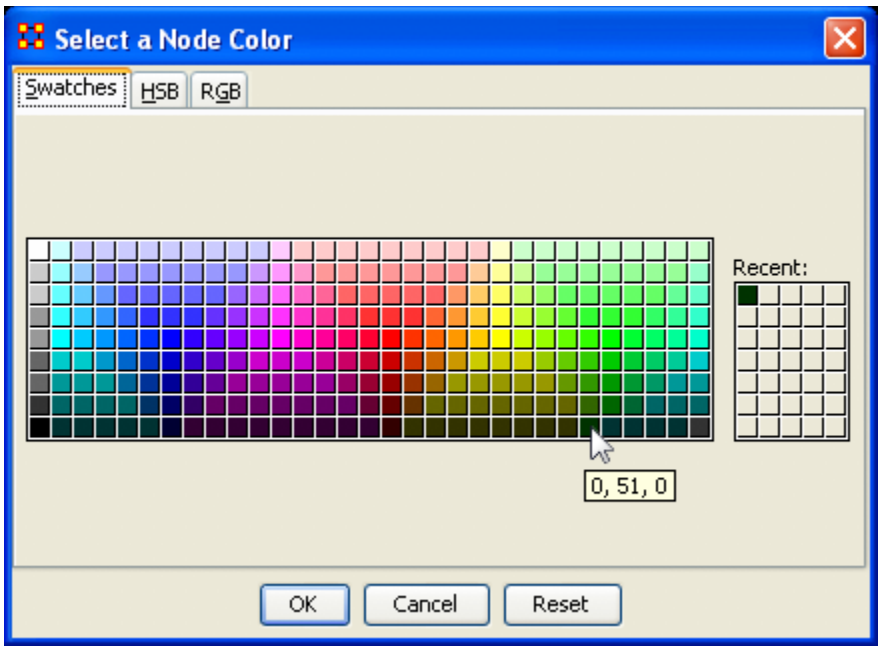
The color of a Nodeset can be changed in the Visualizer. In the Legend window click on the colored node of a Nodeset. This will bring up a color selector box. Select a new color and click **[OK]**. All the nodes of that Nodeset will change colors.

NOTE : This color change is in effect for as long as the Visualizer is open. If you close and re-open the Visualizer the colors will revert to their default colors.

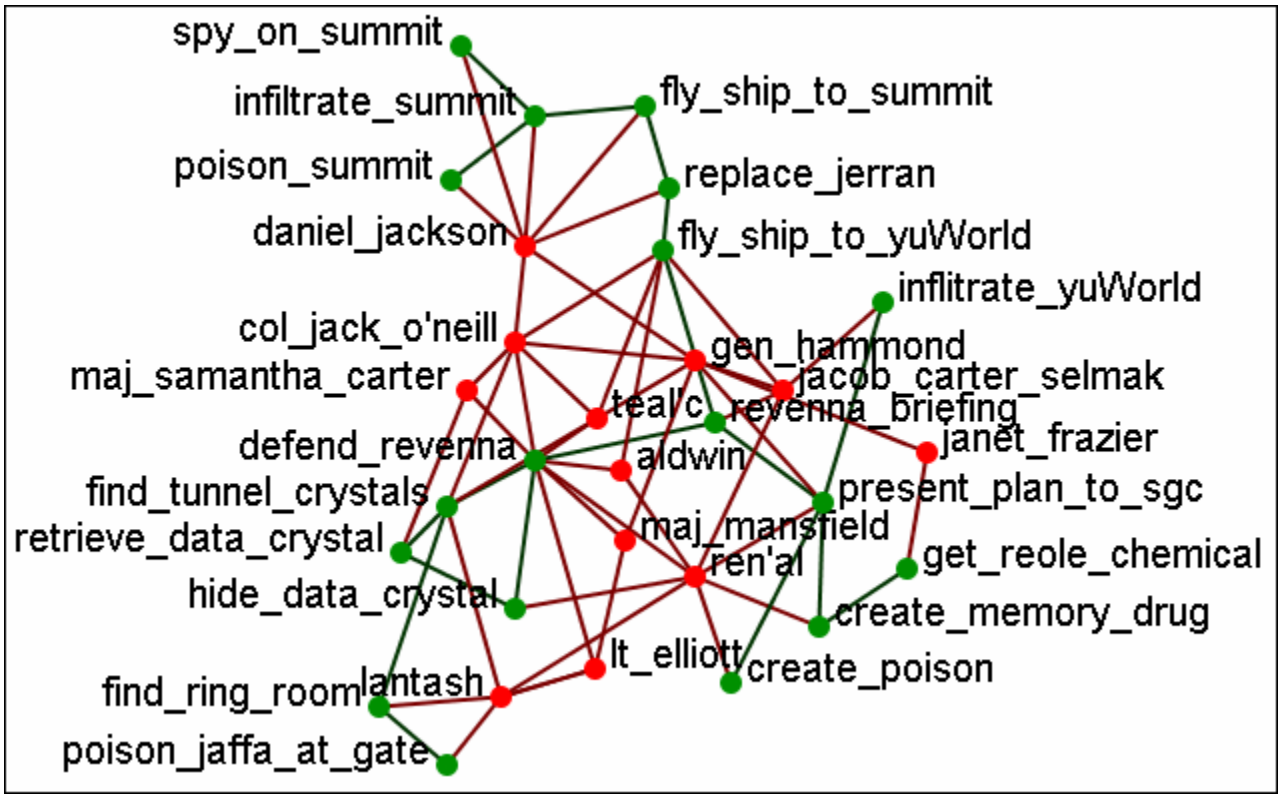
Here is a section with the default colors of **red** for agents and **cyan** for tasks.



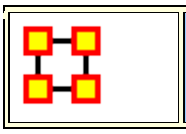
Open the Legend window (if it's not open already) and click once on the Nodeset you want to change. This will bring up the **Color Change** dialog window.



Select **[OK]** and the new color will be displayed for the chosen Nodeset.



The newly selected color appears in both the Visualizer and Legend windows.



Legend Contextual Menu

With the Legend displayed clicking on either a Nodeset or a network will bring up the color picker which allows you to change the color of the node or link. But right-clicking on either of these will bring up other options.

Node Formatter

There are two ways to select nodes. **1]** You can Control-Click on each node separately in the Visualizer. **2]** You can use the **Selector** tool and lasso a group of nodes. When you have the nodes selected righ-click to bring up the **Node Formatter** dialog box.

Appearance Tab : Controls the color, transparency, and labels of the Node(s) selected.

Node Color : Control the color of individual nodes.

Match Nodeset Color : Resets the color of the node(s) back to the default color of the Nodeset.

Choose a Custom Color : Click the color box. From the color the selector palette select a new color and click [**OK**]. In the Node Formatter box click [**Apply**].

Node Transparency : Set the Node Transparency from 0 [transparent] to 1 [visible].

Node Size : Set the Node Size from 4 [small] to 25 [large]

Visibility Tab : Controls visibility of nodes.

Hide Node(s) button Removes nodes from the display.

Show Node(s) button puts the nodes back into the display. To bring back Nodes of a Nodeset which have been hidden you can toggle the check box in the Legend off and on and all nodes of a Nodeset will reappear.

Label Tab : Set the label size from 1 [small] to 25 [large]. You can also show or hide the labels of the selected Nodeset.

Label Size : Change the size of the label from 1 [small] to 25 [large].

Hide Node Label(s) button Removes label from the display.

Show Node Label(s) button Puts the label back into the display.

NOTE : The Node Formatter works only with the node(s) originally selected. To change the parameters for another node(s) you must close the Node Formatter dialog box, select another node(s), then perform your changes.

Link Formatter

Right-Clicking on a Link in the Visualizer brings up the **Link Formatter**.

Appearance Tab : You can color the selected links by Source node, Target node, or pick a custom color. You also have the option of using **solid or dashed lines**.

Node Color : Control the color of individual nodes.

Color by Source Node : Sets the color of the link(s) to the color of the **Source Node**.

Color by Target Node : Sets the color of the link(s) to the color of the **Target Node**.

Choose a Custom Color : Click the color box. From the color the selector palette select a new color and click [**OK**]. In the Link Formatter box click [**Apply**].

Visibility Tab :

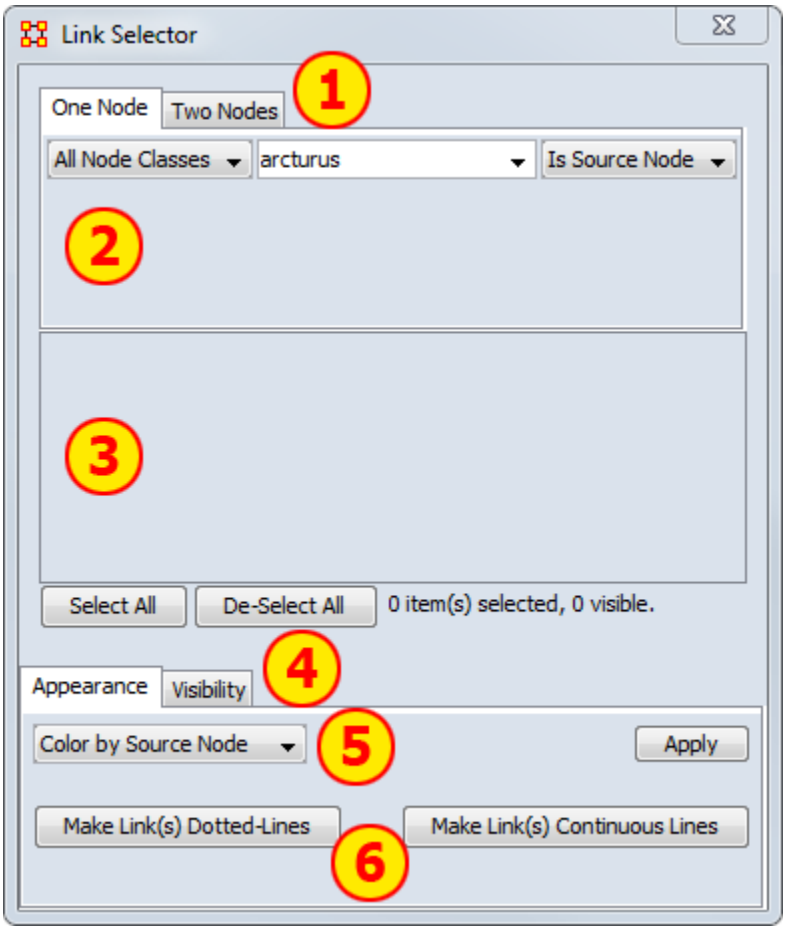
Hide Link(s) button Removes link from the display.

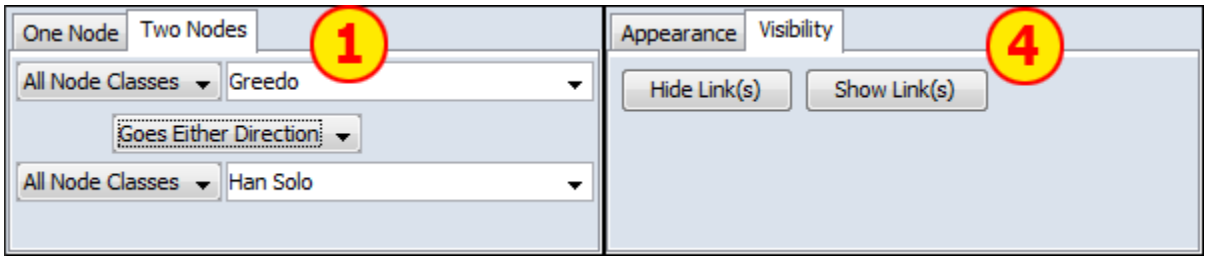
Show Link(s) button Puts the Link back into the display.

NOTE : If after you hide a link and close the Link Formatter dialog box the only way to bring that link back a link you have hidden is to use the menu item **Actions > Show All Nodes**. But remember, this will also undo any other hidden nodes and links you have.

Link Selector

In a complex network you may find it difficult to locate one particular link. This is where the **Link Selector** will help.You can chose to work with **One Node** or **Two Nodes**, picking which is the **Source/Target** node, and the appearance of the link in the Visualizer.

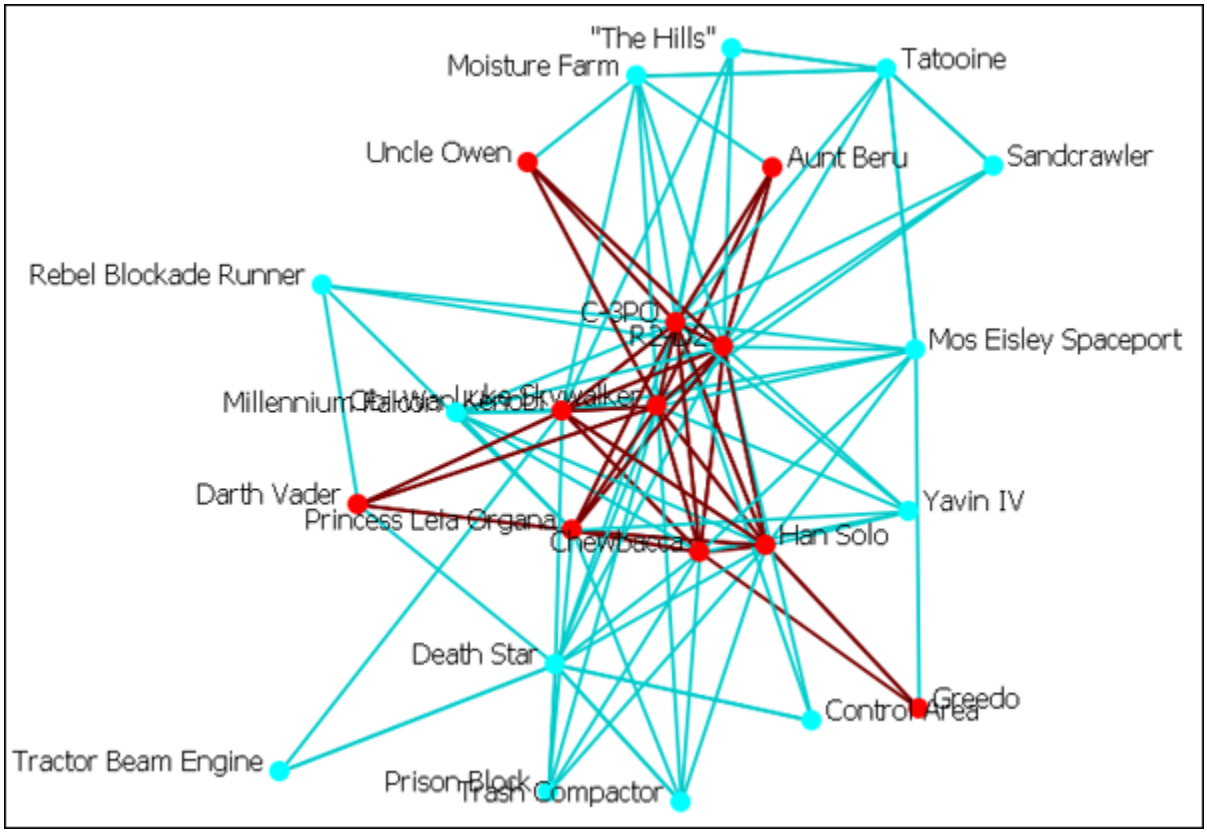




1. **One or Two Nodes :** Chose to specify links using methods for One Node (shows all nodes linked to node picked) or Two Nodes (where you specify the exact two links to use) or

2. **Node Area :** In **One Node** you pick the node and ORA shows you all the links. In **Two Nodes** you pick two nodes the chose one of three **direction options :** From First to Second, From Second to First, Goes Either Direction. This last one is handy in order to change the apprearance of bi-directional links.
3. **Link Area :** Displays all links that meet the parameters in the Node Area. Beneath this are the [**Select All**] and [**De-Select All**] buttons.
4. **Appearance / Visibility :** This allows you to control the look of the links. **Appearance** allows you to change link color and make then dotted or continuous lines. **Visibility** allows you to **Hide or Show** links.
5. **Link Color :** The drop down menu has three options : Color by Source node, Color by Target Node, or Choose a Custom Color.
6. **Dotted / Continuous Lines :** Allows you to choose the style of line.

The Original Network

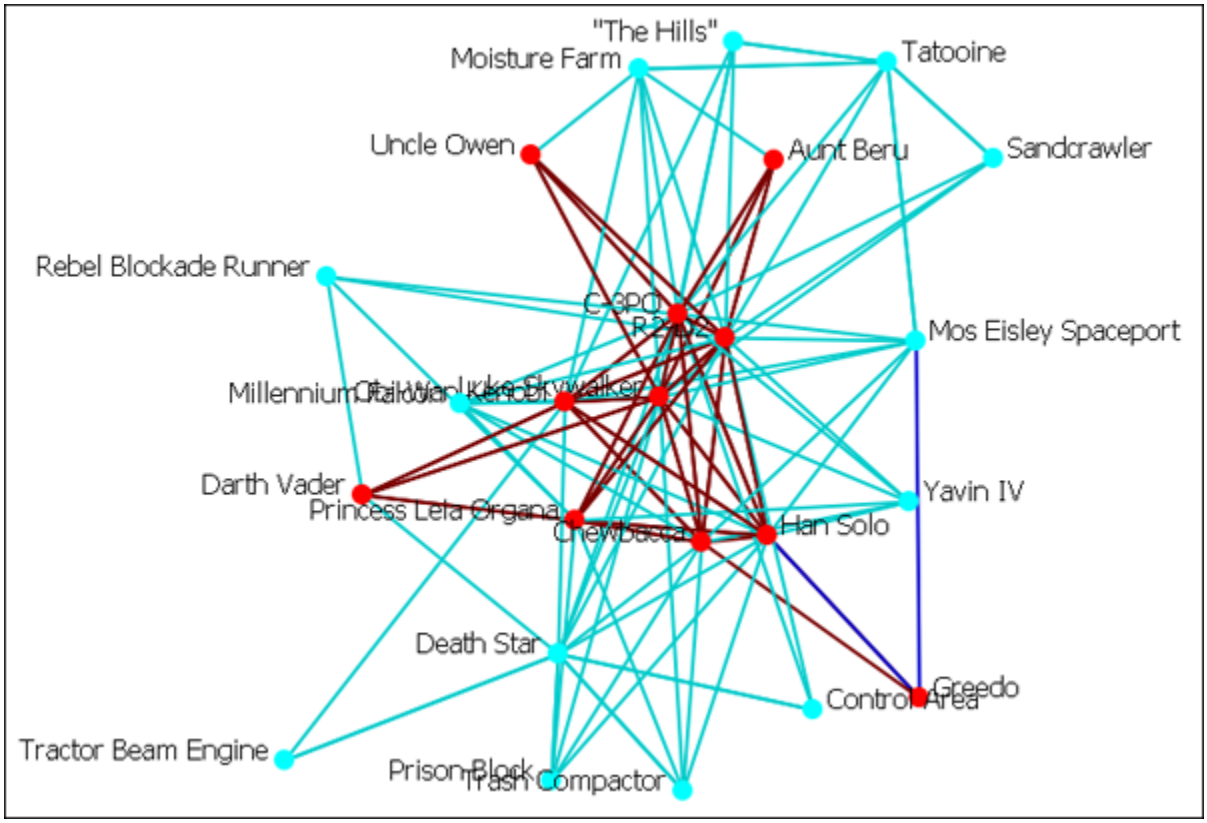


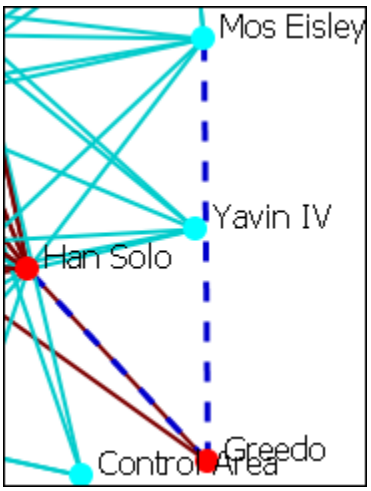
NOTE : For these examples I changed the color of the location nodes to light blue for better visibility during changes. See **Node Color for procedure**

Link Selector-One Node

In [Area 1] Select the [**One Node**] tab. In [Area 2] select a node from the drop down menu. To the right select from the other drop down menu whether you want this to be a **source** or a **target** node. All links associated with this node will be displayed in [Area 3]. Click on links you want highlighted. Click the [**Appearance**] tab in [Area 4]. Select [**Choose a Custon Color**] from the drop down menu in [Area 5]. In the Color Select dialog box select a complementary color and click [**OK**] then click [**Apply**].

Example : I select the node **Greedo** and place checkmark in both boxes. Under the tab **Appearance** I select [**Choose a Custom Color**] from the drop down menu. A distinctive dark blue color is selected then I click [**Apply**].





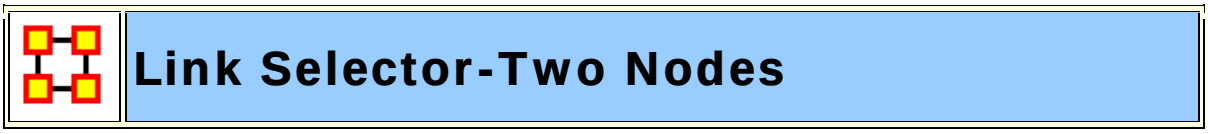
You can further enhance this information by use of the [**Make Link(s) Dotted-Lines**] button.

Notice that in this example the link **Greebo to Mos Eisley** is a clearly defined dotted-line. The link **Greebo to Han Solo** is a blue dotted line but the link **Han Solo to Greebo** is still the default red and could obscure it in a more densely packed network.

Caution should be observed when working with a large network.

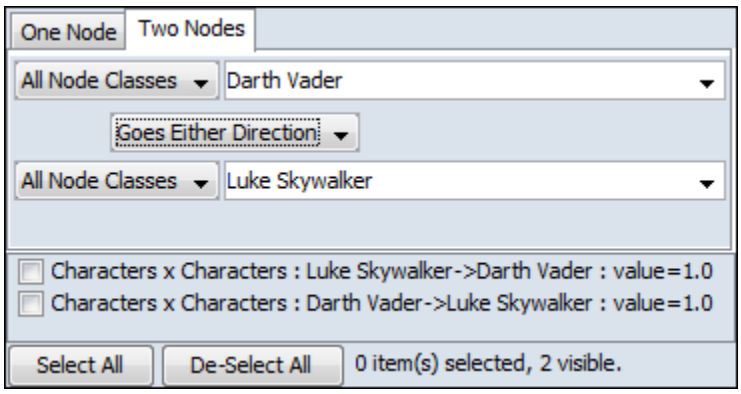
When finished you can, from the main menu, select **Display > Link Appearance > Link Color** and chose either **Match Source Node** or **Match Target Node** to reset your colors. Another choice is to select the particular links and change the colors via the method described above. You can also change any dotted-lines back using the [**Make Link(s) Continuous LIne**s] button.

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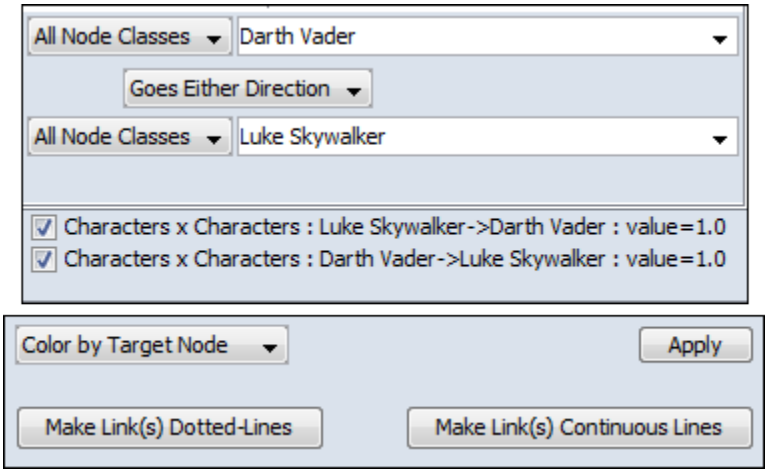
Link Selector-Two Nodes

Two Nodes

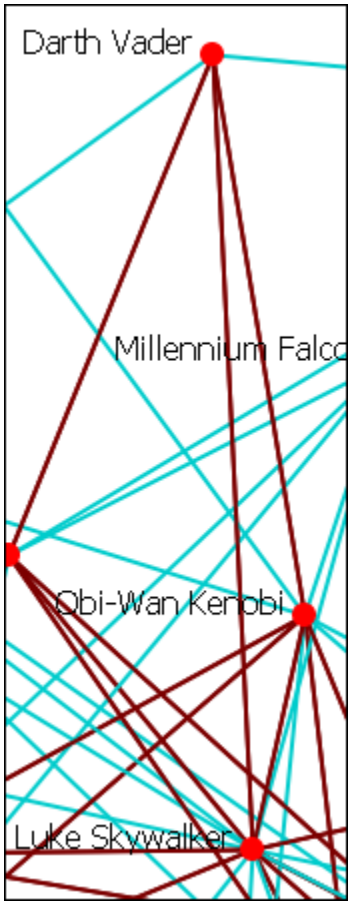


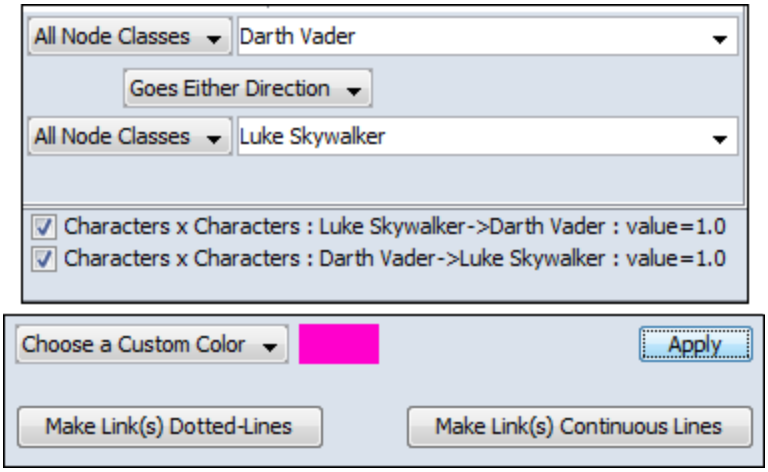
In [Area 1] Select the [**Two Nodes**] tab. In [Area 2] select a node from both of the drop down menus. Between these menus is another drop down

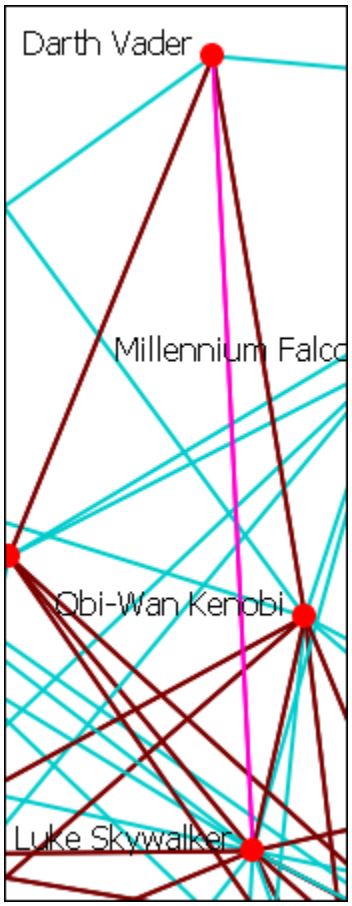
menu about whether you want this to be a **From First to Second**, **From Second to First**, or a **Goes Either Direction**. Choosing either of the first two will result in a single link. Choosing **Goes Either Direction** will give you one link (if the link is bi-directional) or two links (if the link is bi-directional). The links will be displayed in [Area 3]. Click on links you want highlighted. Click the [**Appearance**] tab in [Area 4]. Select [**Choose a Custon Color**] from the drop down menu in [Area 5]. In the Color Select dialog box select a complementary color and click [**OK**] then click [**Apply**].



Two nodes have been selected, **Darth Vader** and **Luke Skywalker**, with the option [**Goes Either Direction**. A check mark is placed next to both links. At present both links are their default color, red.

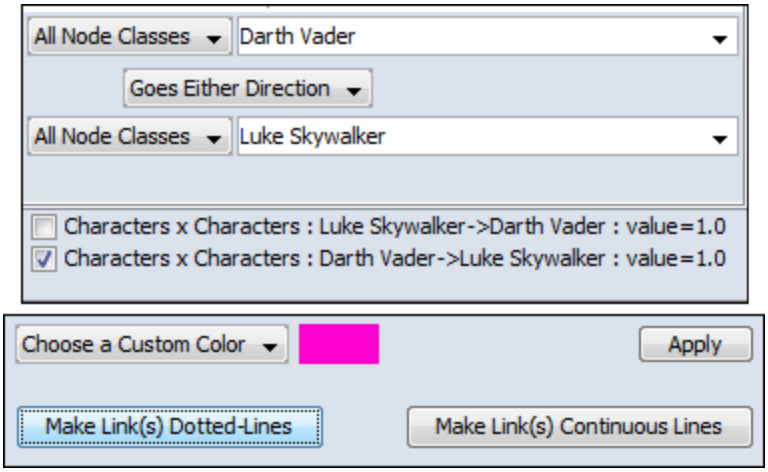


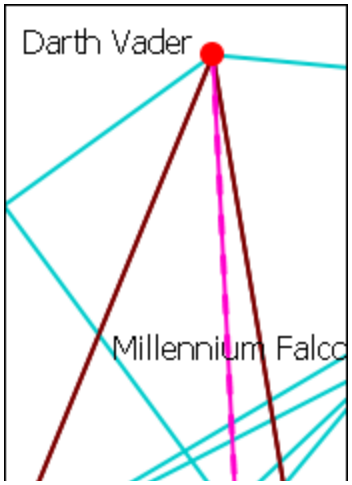




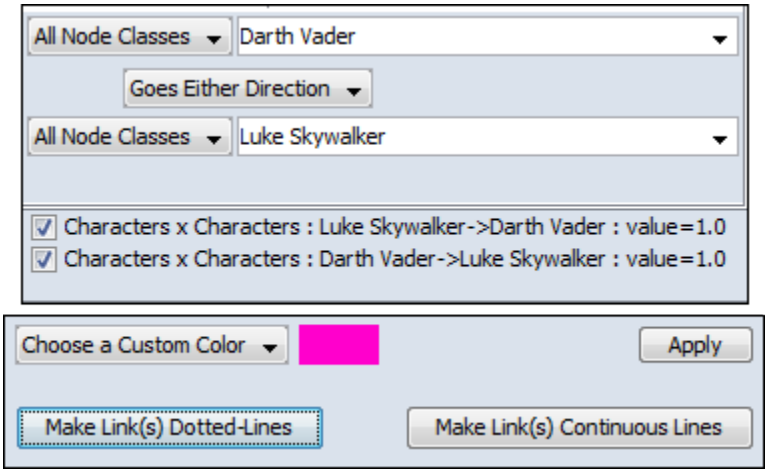
Under the appearance tab select from the drop doen menu [**Choose a Custom Color**]. Click the color block to the right and select a complementary color. For example, **Fuchsia**. CLick the [**Apply**] button and the links then take on that color.

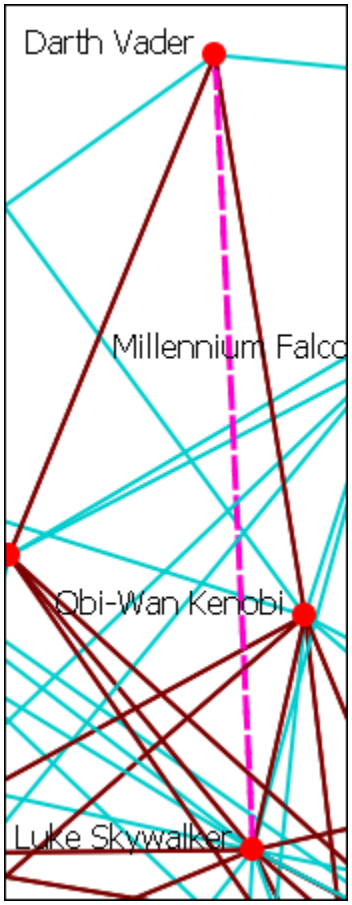
You can see how well they stand out now.





Notice here that a check mark is placed only next to **Luke Skywalker**. When the [**Make Link(s) Dotted Lines**] is clicked the dotted line is obscured by the continuous line from **Darth Vader** to **Luke Skywalker**.

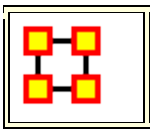




Making them both Dotted Lines helps clarify the connection.

NOTE : You can also revert these changes by using the drop down menu to select **Color by Source Node** or **Color by Target Node** which will remove any custom color. Clicking [**Make Link(s) Continuous Lines**] will revert any selected links back to one solid link.

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Micro Simulation

Micro Simulation allows you to run some basic simulations on the curretly loaded visualization. LInk weights are important as once they are normalized, they correspond to the probablity of a transmission.

ORA Micro-Simultation Overview

	I can give it to others	I keep it after sharing	I lose it after some time	I can get it back
Ideas	**Yes**	**Yes**	No	N/A
Disease	**Yes**	**Yes**	**Yes**	No
Money	**Yes**	No	No	**Yes**
Technology	**Yes**	**Yes**	Sometimes	**Yes**

General Thoughts on MicroSims

The simulations themselves are not that complex. Typically Disease, Money, and Information can be described as **types of flows**. At any given timepoint, any entity that has one of those things are going to try to give it to another node, with each flow having their own rules.

Ideas : Once an entity gets information, they cannot lose it. They also never stop giving out the information.

Disease : An entity can not re-get the disease, and an entity can only give out the disease while it has the disease. The entity can also give out a disease to multiple other entities. After a user-specified number of time periods, the entity loses the disease.

Money : Once an entity gives away the money, he cannot give the money to anyone else. There is no limit on re-getting the money.

Technology Adoption : How quickly a new technology might spread through a network.

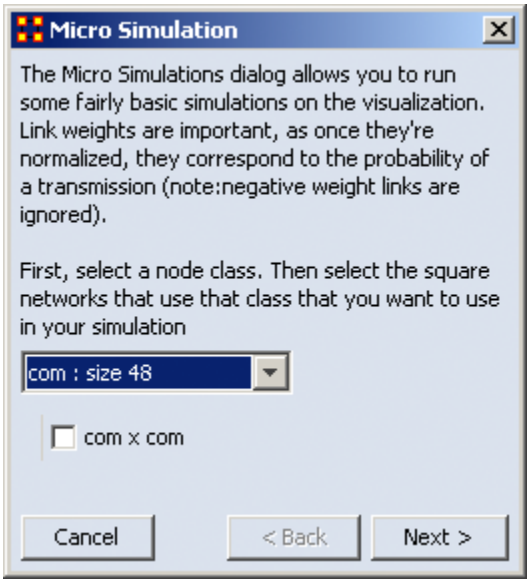
It's important to understand how these transmissions occur. During the **transmission** phase, it looks at every node that has a resource. Then it iterates through all outgoing links trying to give that resource through that

link (in the case of money, since it can only go through one link, we randomize the order links are tested). When looking at a link, it first does a check to see if the transmission can occur based on the link weight. Then it does another CHECK to see if the transmission can beat the transmission resistance.

These transmissions continue based on the rules outlined above for the user specified number of time periods. Then it generate a dynamic meta-network that shows for any given time period what entity was associated with a resource.

Diffusion of Ideas

NOTE : Negative weight links are ignored.

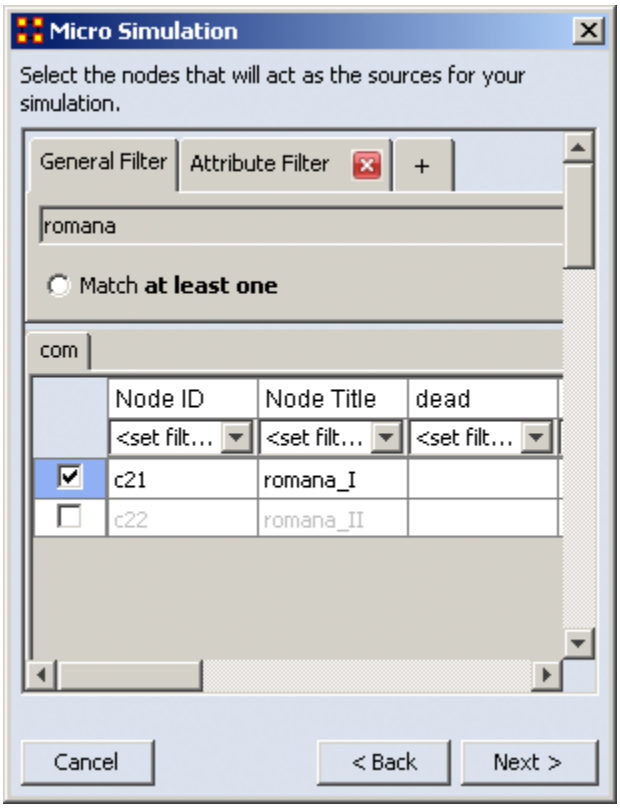


In the drop down box you are prompted to selected a **Square Network** for the simulation. If the Nodeset you select is in multiple square networks, then all will be displayed below. Place a check mark next to the network to use.

This will create a new meta-network consisting of a single Nodeset with the same nodes as the input Nodeset, and a single network with the same links present in the selected networks. In the event multiple networks are selected and multiple links from node A -> node B are present, the resulting link from A -> B has a weight equal to the sum of all A -> B links.

Click [**Next**]

NOTE : Once a new meta network is created, it takes all the links and normalizes them between zero and one. The link weight then corresponds to the probability that a transmission will occur down that link. This obviously means that both Link Direction and Link Weight play a pretty important role here.

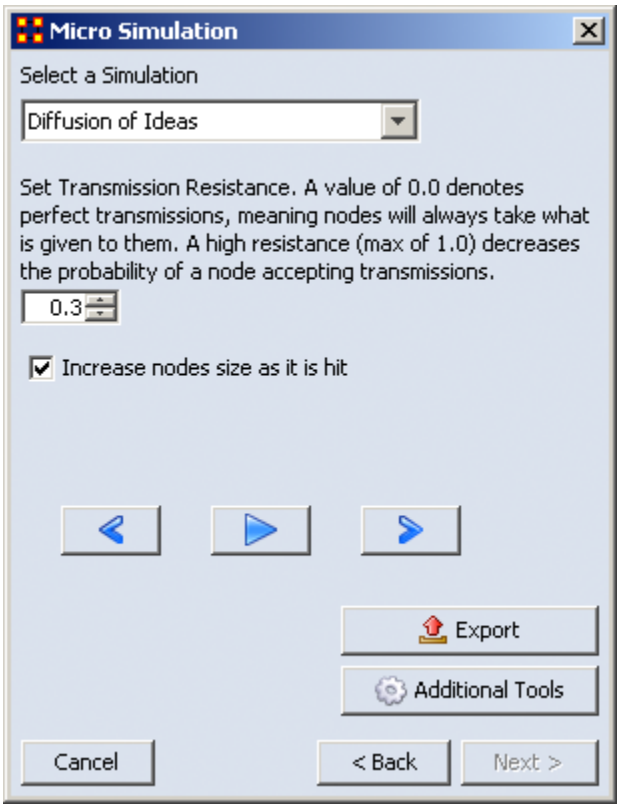


In the Node Selector box you chose a node(s) where an idea begins. I typed **romana** into the search box which displayed two choices. I placed a check mark to chose the **romana_I** node. When you've made your select, click [**Next**]

Two main controls

Transmission Resistance : ranges from 0.0 to 1.0. The higher the resisitance the less likely a node will accept what is offered. Setting this to [**0**] allows for perfect transmission and the target node will accept whatever is offered.

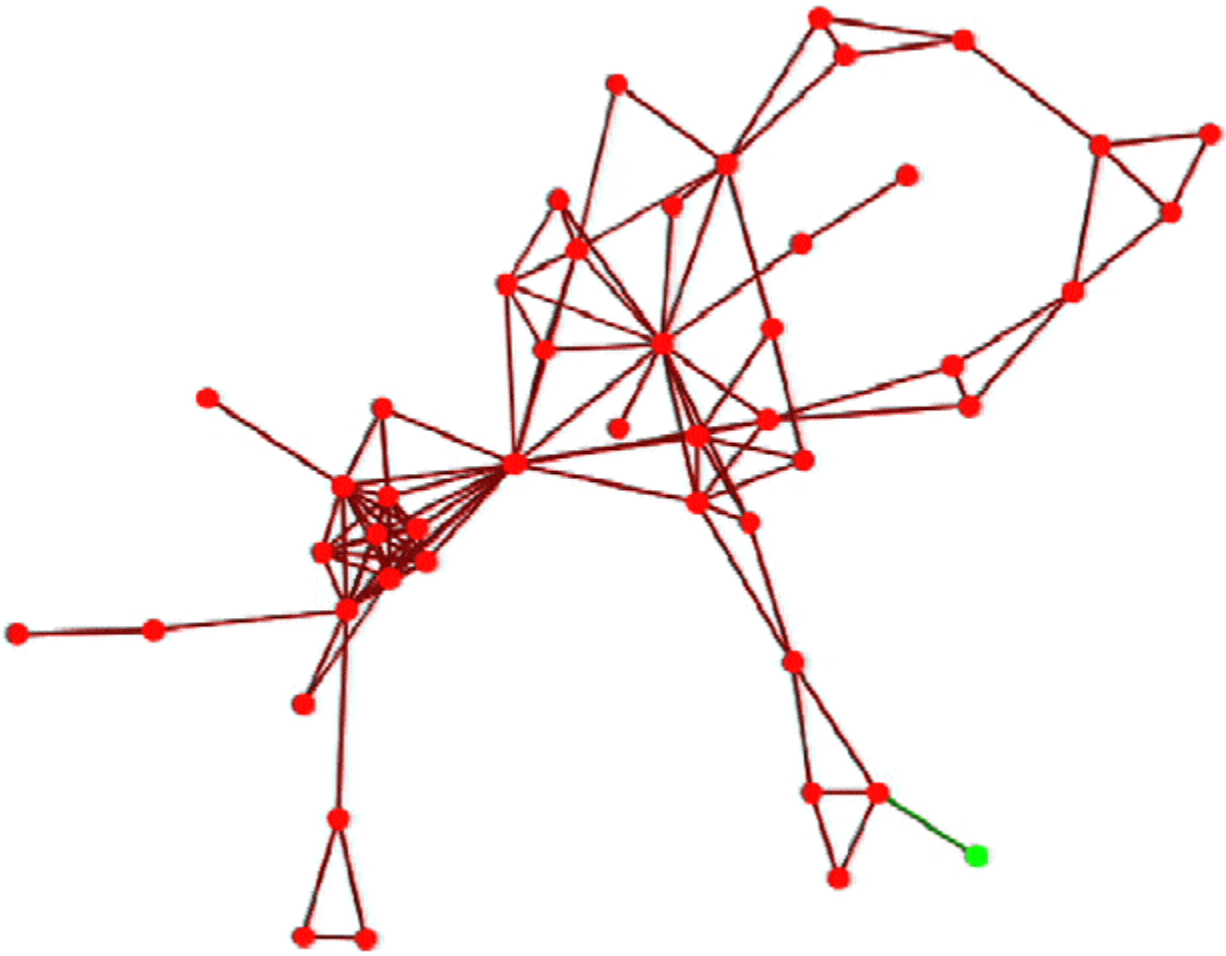
Increase nodes size as it is hit : helps in seeing which nodes have been activated. Nodes get progressively bigger with each hit.



We'll leave the Simulation to **Diffusion of Ideas**. Say we don't want ideas to spread automatically but want the nodes to have a little resistance. So the Transmission Resistance it increased to 0.3. I also placed a check mark in the **Increase node size as it is hit** box so it will show the amount of hits a node gets.

When you are finished, click [**Next**].

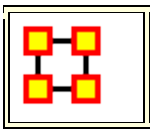
Below is an animated example



Micro Simulation-Ideas

Ideas

- An agent can give away information it has access to.
- An agent retains information even after giving it away.
- An agent never looses information it gains.
- An agent never stops giving away information.



Micro Simulation-Disease

Diffusion of Disease

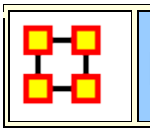
This function has two additional parameters:

Number of periods nodes remain contagious : After a node gets infected it will stay infected for a set number of periods before it then becomes immune. After that it can no longer spread the disease.

Percent nodes immune at start : You can set a percentage of nodes to be immune from the start. These nodes will be colored yellow.

Information for disease simulation.

- An agent can not **re-get** the disease.
- An agent can only give the disease while it is infectious.
- An agent can give the disease to multiple other entities
- An agent loses the disease after a user-specified number of time periods.

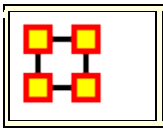


Micro Simulation-Money

Dispersion of Money

This mode asks for the amount of **money units** to start with then makes them travel around the network. The amount of money stays constant.

- An agent can give away money it posses (all or nothing).
- Once given, an agent cannot give away the same money.
- An agent can re-acquire money previously given away.
- There is no limit to the amount of money an agent can receive/hold.
- Agents pick randomly the order of neighbor(s) to give away money to in effort to reduce endless loops.



Micro Simulation-Technology

Adoption of Technology

The Transmission Resistance determines how easily technology is adopted by the network. This is a unique simulation. A node is more likely to adopt a piece of tech if it has many neighbors trying to convince it to adopt the tech. A node is more likely to un-adopt a piece of tech if the user has fewer neighbors also using the tech.

- An agent may adopt technology if enough of its neighbors use the technology.
- An isolated agent will flip a coin to adopt a technology.
- An agent can stop using a technology, especially if its neighbors are not using the technology.
- An agent can re-start using a technology.
- An agent has a user-adjustable level of resistance to using **new** technology.

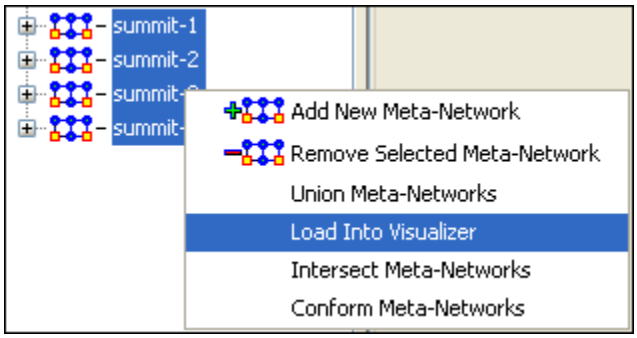
View Networks Over Time

The **Networks Over Time** loads multiple Meta-Networks into the Visualizer and displays them as **Time Slices**.

NOTE : Data that is not dated will be loaded in the order it was selected, not the order it is in the tree and not the order it was loaded in. This only happens when the data has no dates associated with it.

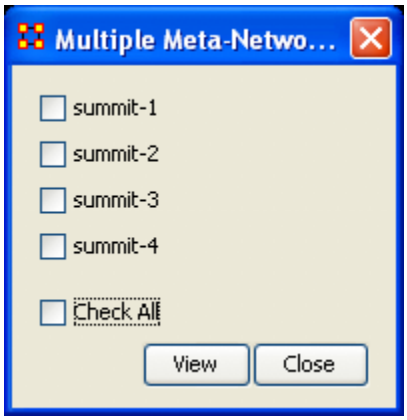
Procedure

Highlight the Meta-Networks to load into the Visualizer. For this example I divided the whole Stargate Summit network into four distinct phases. 1) The meetings; 2) What was supposed to happen; 3) What did happen; 4) The attack on the Tok'ra homeworld. These are Summit 1-4.

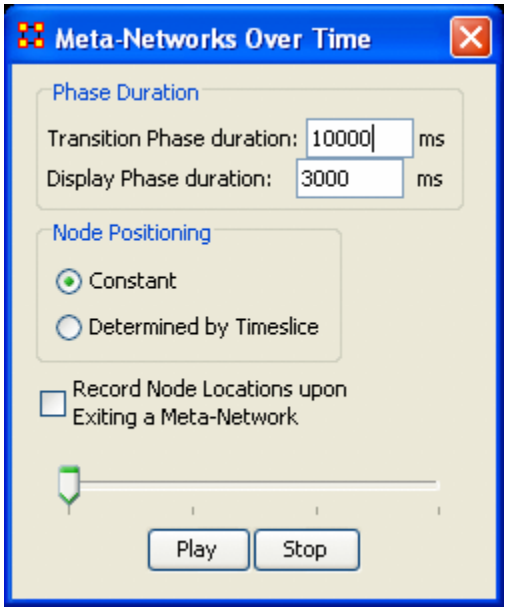


Start the Visualizer. Then select **Tools > Networks Over Time**

The dialog box appears to verify you've chosen the correct Meta-Networks. Place a checkbox in the ones you want or **Check All**. Then select **[View]**.



To control the Over Time function from the main menu, select **Tools > Networks Over Time**.



The **Phase Duration** has two controls. **Transition Phase duration** sets the amount of time in milliseconds for the fading out of the previous set and the fading in of the new set. The **Display Phase duration** sets the amount of time in milliseconds that a set will be displayed before moving to the next set.

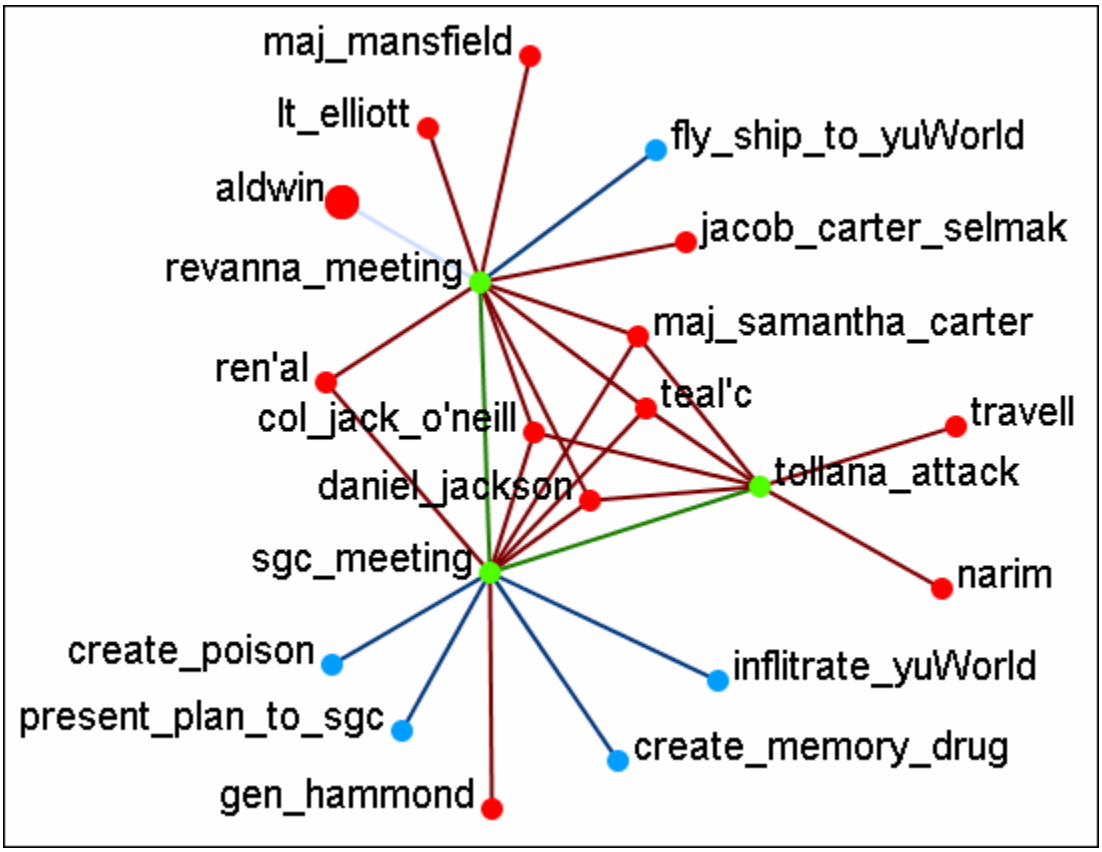
Constant maintains a node's position throughout all Timeslices. **Determined by Timeslice** allows you to move a node independently in each Timeslice.

Record Node Locations upon Exiting a Meta-Network maintains a node's position when changing Timeslices. **NOTE:** It does not maintain the node's positions after you exit the Visualizer. Upon returning to the Visualizer all nodes will be in default positions.

The **Slider bar** controls which Timeslice is displayed. The buttons at the bottom, **[Play] and [Stop]** control the motion display.

Summit-1

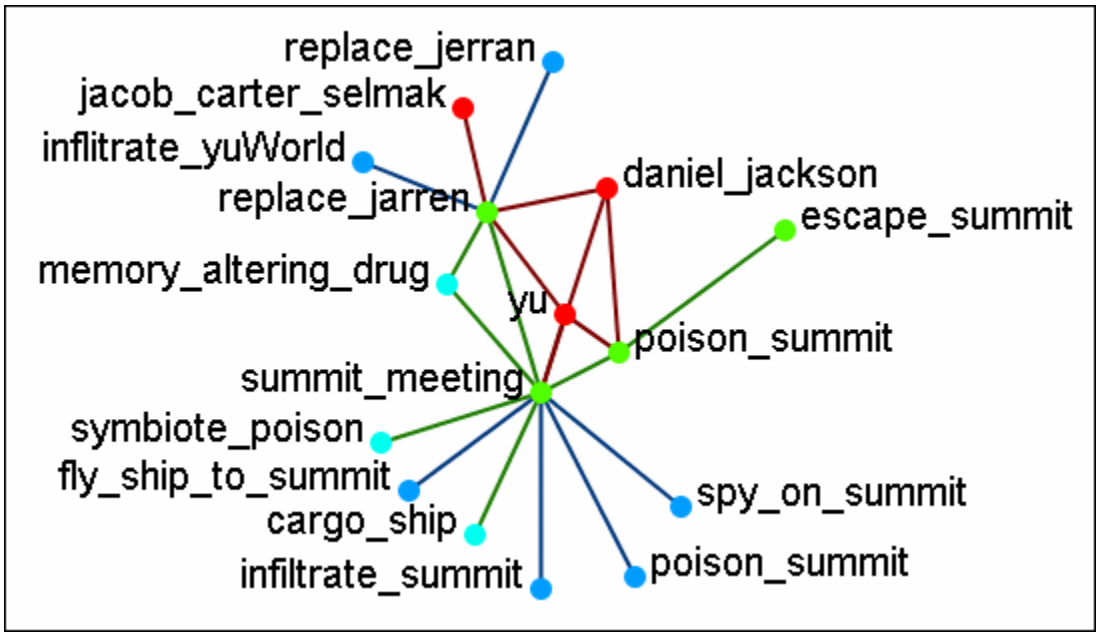
The initial meetings between the SGC and the Tok'ra



Note: You can select multiple nodes by simply clicking on them. You do not need to depress any other keys (i.e., ctrl+shift, etc.).

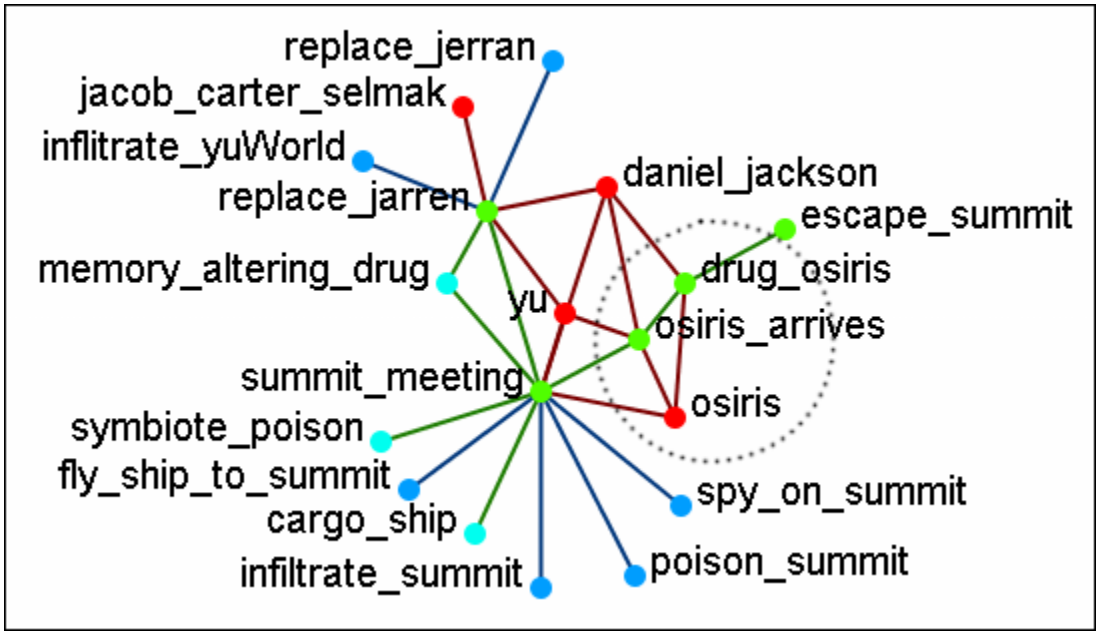
Summit-2

The plan as it was **supposed** to go



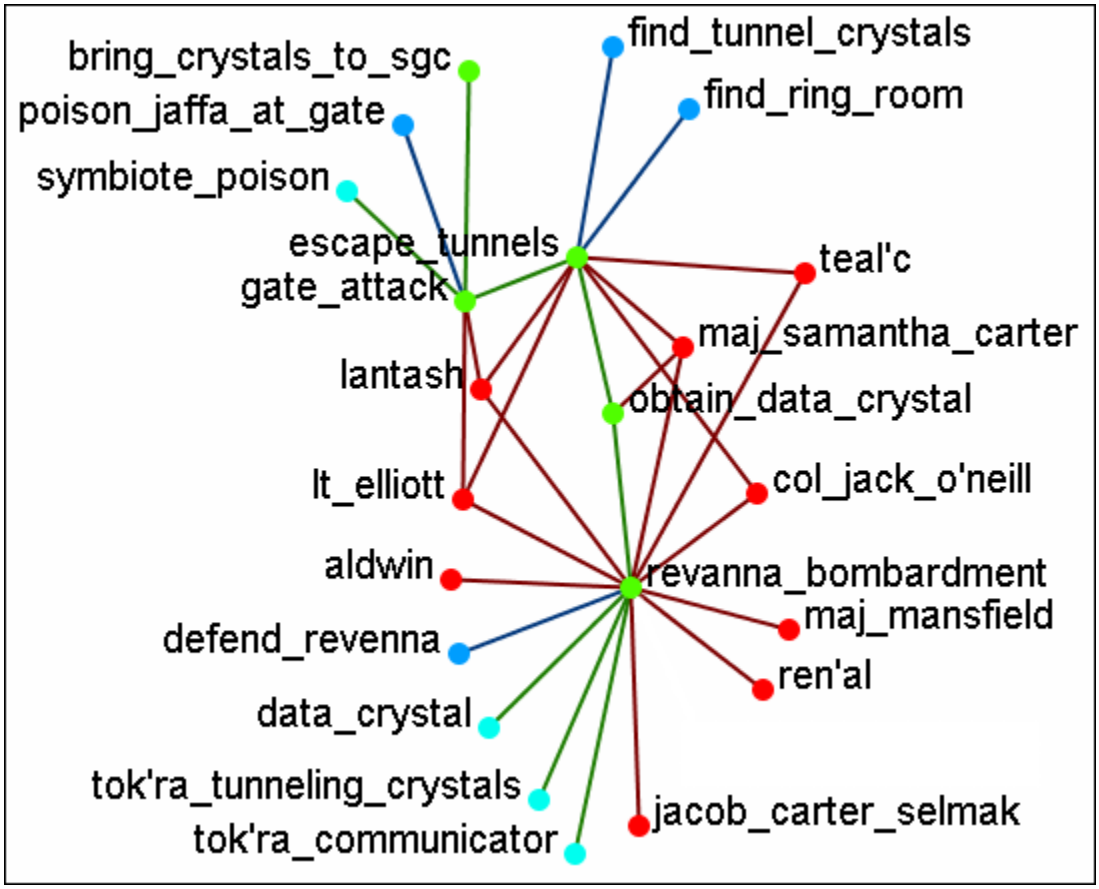
Summit-3

What really happened when Osiris showed up unexpectedly. Instead of poisoning the Summit daniel_jackson decides to forgo that action after hearing the information from Osiris. He's almost found out but still escapes.



Summit-3

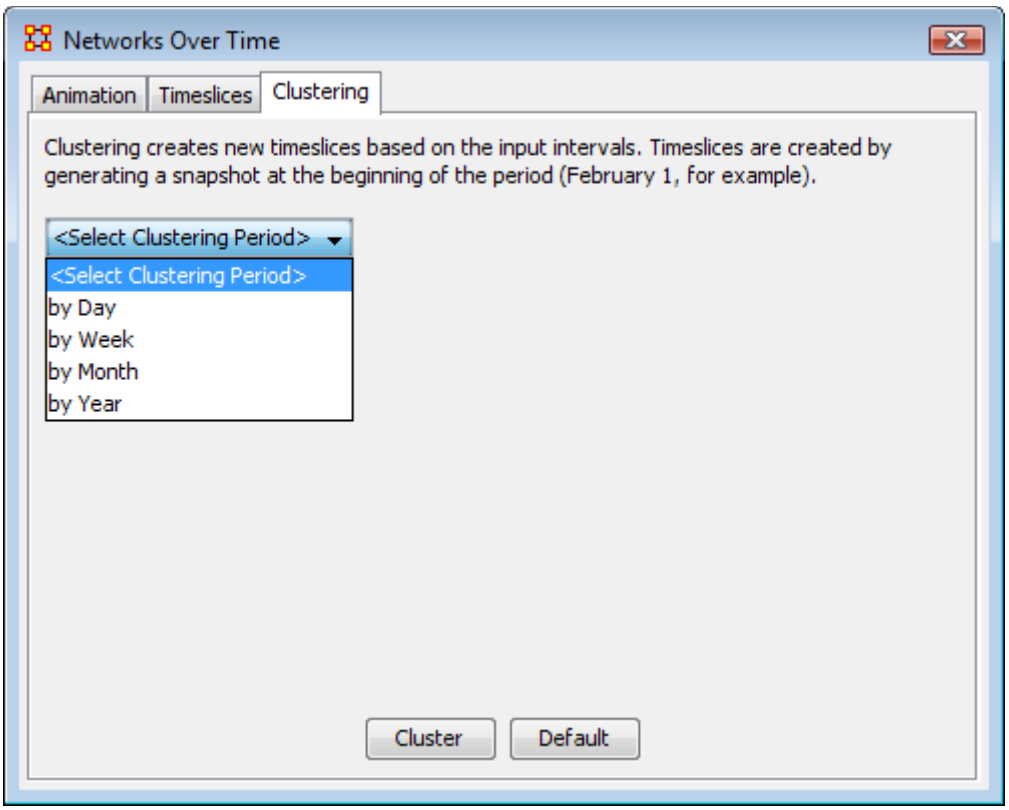
What was happening back on Revanna while daniel_jackson was at the Summit.



NOTE : Measures and reports run on these multi-Meta-Neworks are for all connexions, not the individual Meta-Networks.

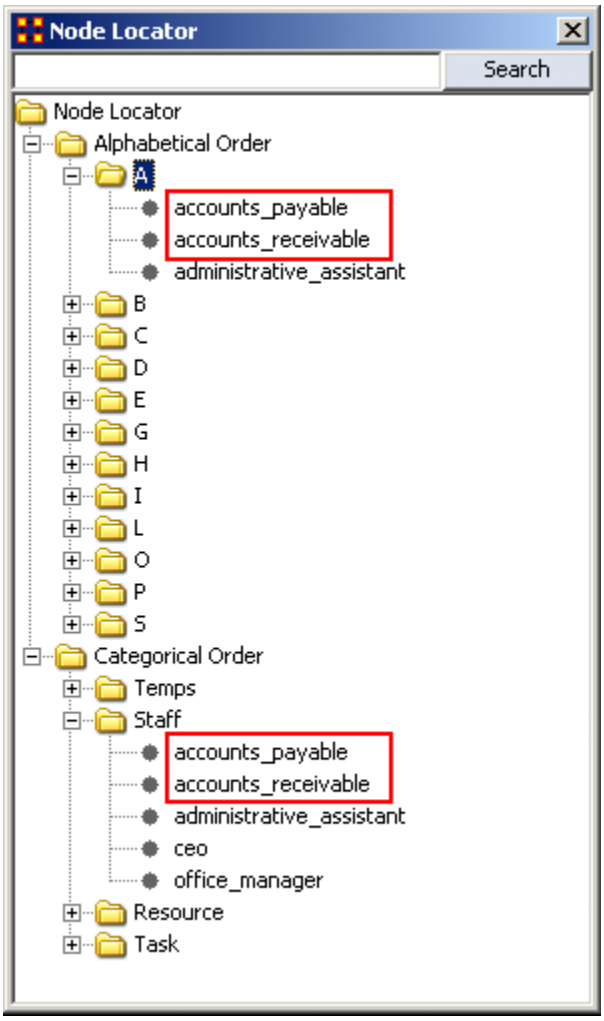
Time Clustering

Time clustering is available via the Over Time dialog in the visualizer. It's a fairly simple panel - there's a ComboBox to select which period you want to cluster by (by Day, by Week, by Month, by Year), and two radio buttons to select what a week begins with (only used when clustering by week). Finally, there's a simple button to cluster.



Clusters are fairly straightforward. It looks at the start date (earliest date available in a set of timeslices) and the end, and grabs snapshots at the given interval, looking at the beginning of that interval. So, if you cluster by month, it'll move through each month, grabbing a snapshot of the 1st day. If no Timeslices exist for that day, it just uses the Timeslice with a date closest to that day without going over.

Node Locator



The **Node Locator** is a tool palette that allows you quickly zero in and find a node that may be obscured in a complex visualization. Essentially, when you click on a node in the Node Locator tool, the Visualizer will then pan over to the node centering on it. Below are procedures for using the node locater.

From the ORA Visualizer: **Tools > Node Locator**. This brings up the Node Locator dialog box. It contains to folders in it's root, **Alphabetical Order** and **Categorical Order**.</td

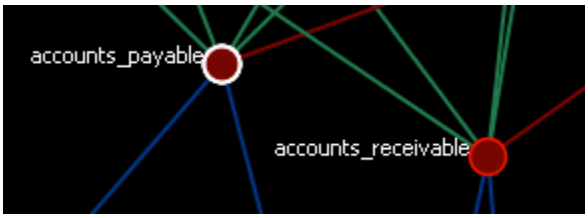
Alphabetical Order : Contains one folder for each set of nodes divided into letter groups. All nodes beginning with the same letter will contained in one folder.

Categorical Order : Divides the nodes into Node Categories. There were four Nodesets in this example and it created four folders under Categorical Order.

Notice how the nodes for Accounts_Payable and also for Accounts_Receivable appear in both areas.

Selecting a Node

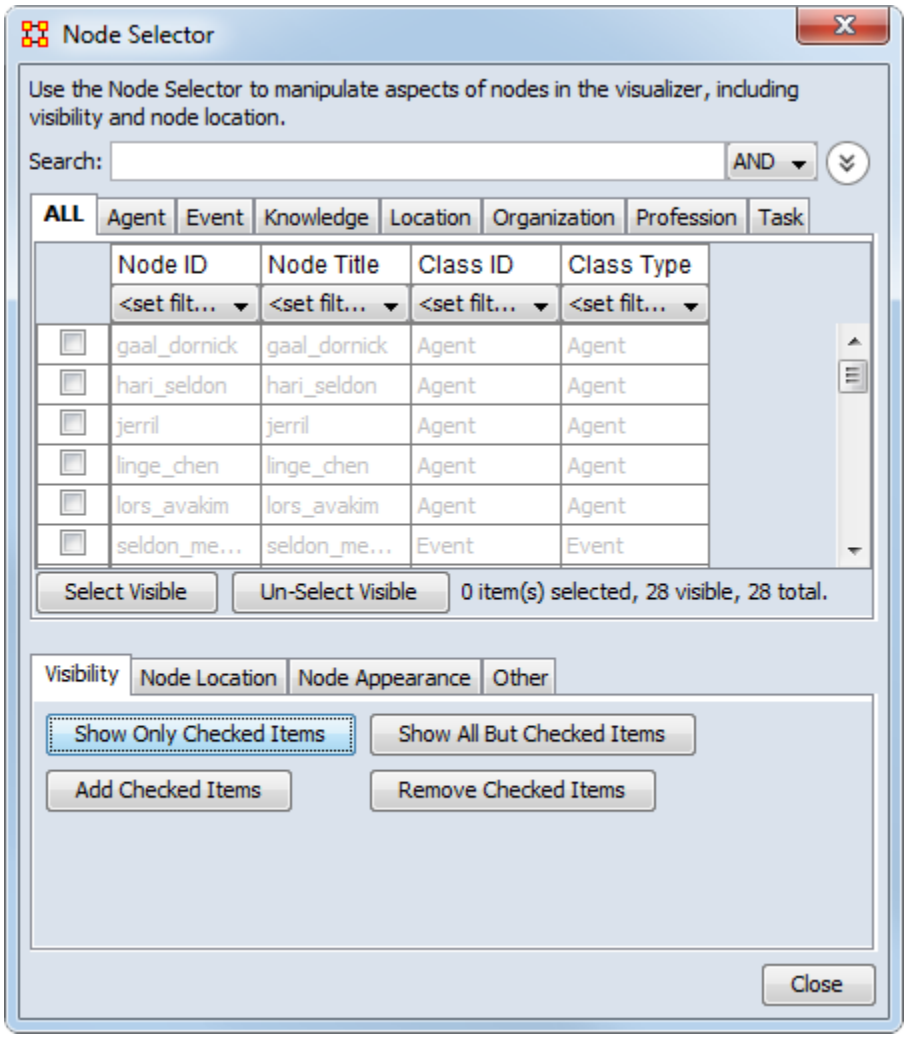
Whenever you select a node in the Node Locator dialog box that node will be highlighted. Since it's hard to see with a white background this example uses the black background. Notice the white circle around the accounts_payable node denoting it has been selected. If you select a new node the previously selected node will return to normal and the new node will be highlighted.



Node Selector in Visualizer Tool

Note : A slightly different version of this tool is available in the ORA Main Menu interface (i.e., non-Visualizer tool).

You can use the Node Selector to simply complex visualizations. The Node Selector tool is accessible from the Visualizer menu: **Tools > Node Selecter**.



Node Selector

Search : Displays only nodes which have matching content. To the right is the **AND / OR** dropdown box where you can select whether to make ORA search for entries with all terms in the box or terms in the box.

Node Class tabs : Contains a tab for each Node Class in a Meta-Network.

Node Display Area Displays all the nodes for the currently active tab. The checkbox to the left allows you to select/deselect nodes to work with.

Select Visible / Un-Select Visible buttons : This works on all nodes currently displayed in the Node Display area. If places a checkmark [selects] or removes a checkmark [deselects] on al items visible.

Visibility

Show Only Checked Items : Shows only nodes **which have** a checkmark next to their names.

Show All But Checked Items : Shows only nodes **without** a checkmark next to their names.

Add Checked Items : Adds to the visualizer display (if they are not already visible) any nodes which have a checkmark to the left of their names.

Remove Checked Items : Hides in the visualizer display (if they are not already hiddne) any nodes which have a checkmark next to their names.

Node Location

Move to the Left : All selected nodes will be moved to a column to the left side of the screen.

Move to the Right : All selected nodes will be moved to a column to the right side of the screen.

Node Appearance

Show Label(s) : Works in co-ordination with the [**Set Labels**] button and all selected nodes. Will make the lables visible [checkmarked] or hidden [no checkmark].

Set Labels button : Clicking this button activates your choices with the **Show Label(s)** option.

Node Color : Brings up a color palette to chose a color.

Change Color button : The color of any node(s) selected will be changed to the new **Node Color**.

Other

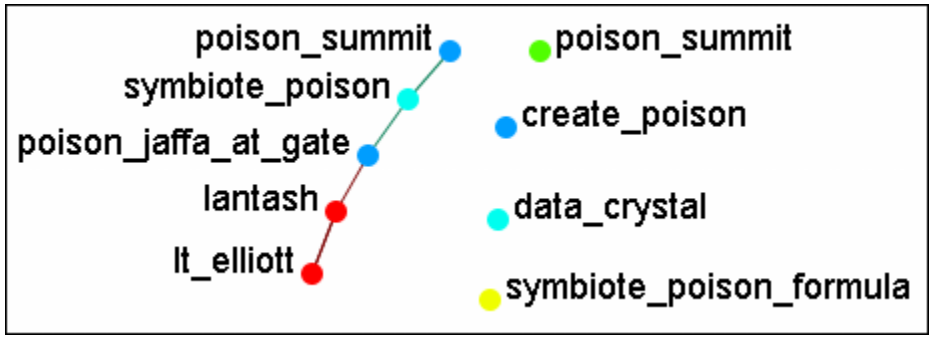
Create Meta-Node : Creates a Meta-Node from all selected nodes.

Highlight Checked Items : Draws an outline around all nodes selected. This functions with nodes of all sizes.

Node Selector Examples

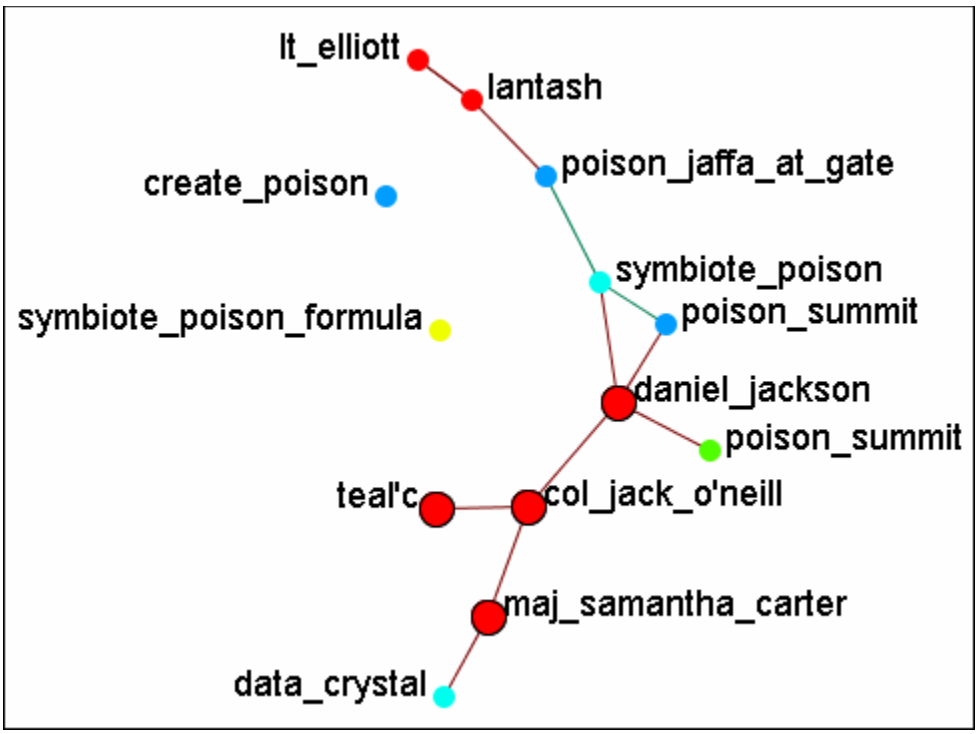
Following is a short example of the KeySet Selector. It covers the main aspects of the tool only.

In the **Filter Commands** textbox the word **poison** is typed which causes all nodes with **poison** in any attribute to be revealed. Pressing the **[Select All]** button places a check mark in all the nodes. Lastly in the **Visualizer Commands** pressing the **[Show Only Checked Items]** button hides all but the checked items.

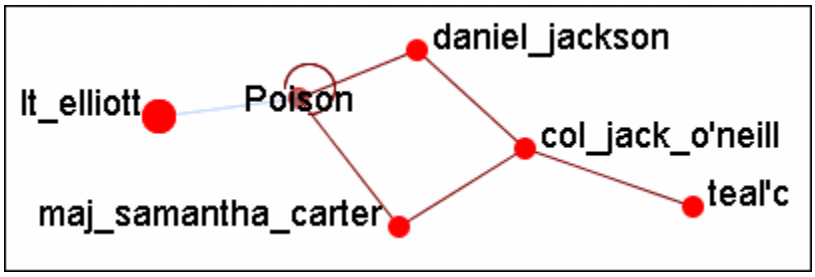


The **[Clear All]** button is pressed to clear all the check marks. **poison** is replaced in the **Filter Commands** with the word **sg-1**. Be aware that even though only nodes with **sg-1** are to be added the two nodes with **sg-17** also appear as sg-1 is a sub-string of sg-17. SO instead of using the **[Select All]** button check marks are manually placed in the check boxes desired.

The **[Add Checked Items]** button is pressed and the four new nodes are added to the visualizer.



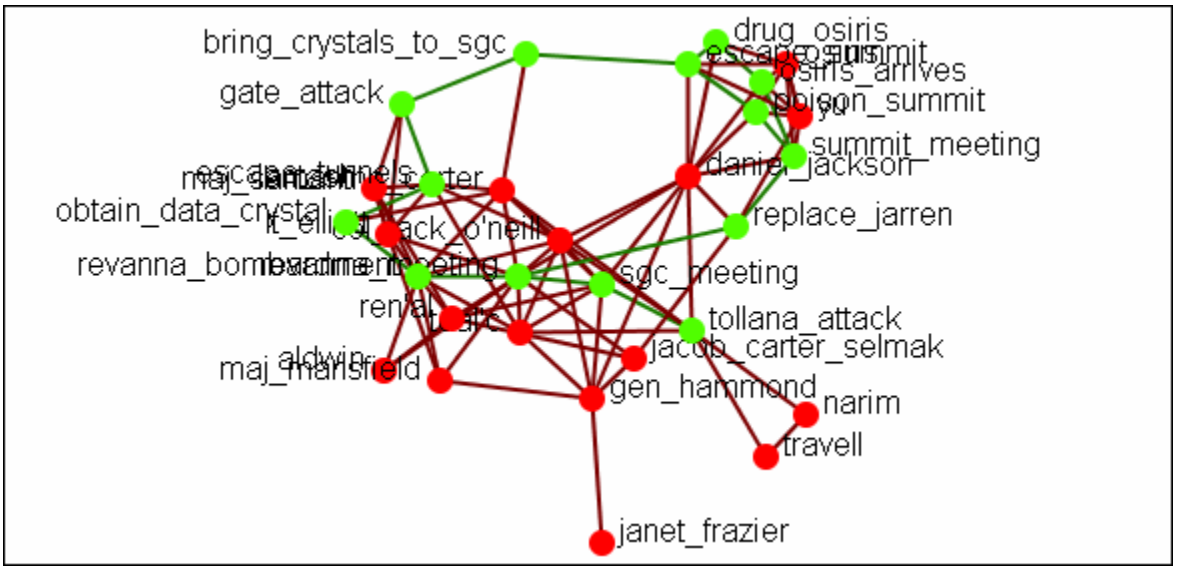
With the four nodes of sg-1 still check marked press the **[Highlight Checked Items]**. The four nodes are now displayed in a larger format.



The last button, **[Create Meta-Node]** will cull nodes into a Meta-Node.

Move Left / Right

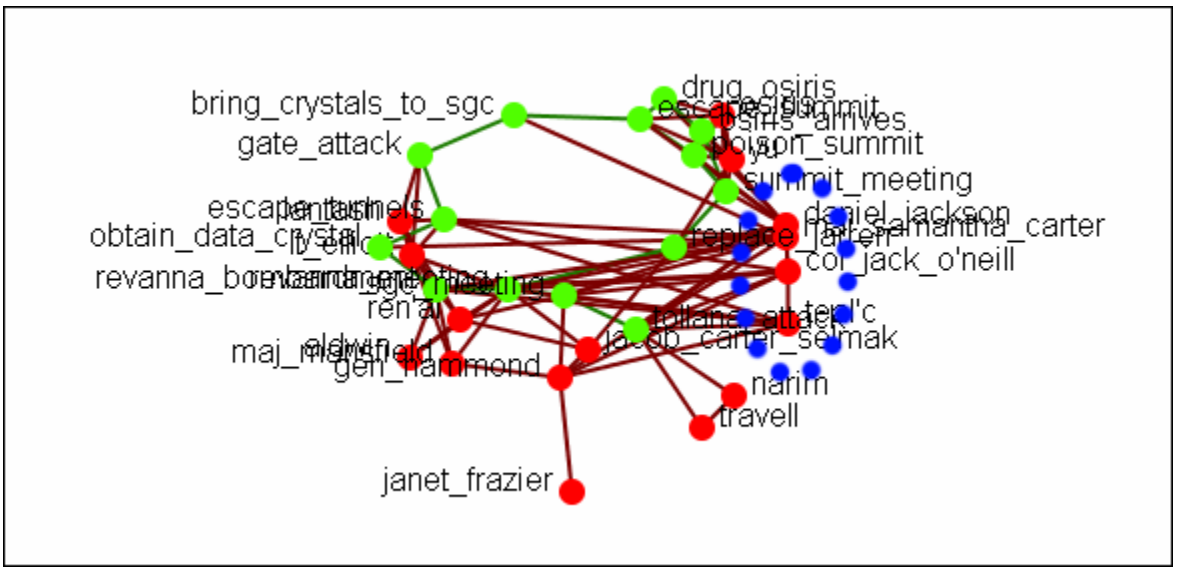
If a set of nodes needs "pulled out" of the display the **Move Left / Move Right** buttons can help. Below is a normal display. The nodes for SG-1 are quite difficult to see.



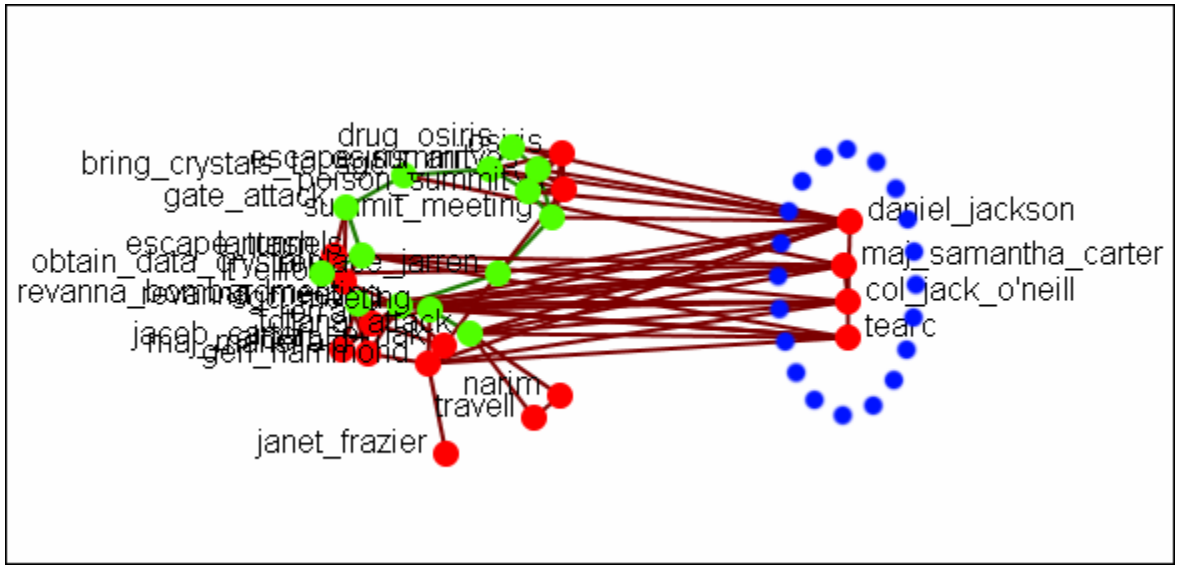
From the Node Selector dialog select the nodes to be highlighted and place a check mark in the box.

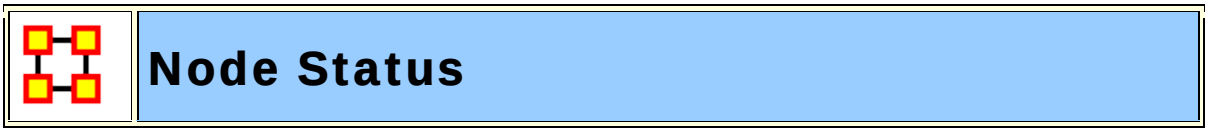
	Node ID	Node Title	Class ID	Class Type	pos
	<set filt…	<set filt…	<set filt…	<set filt…	<se
☑	A01	col_jack_...	Agent	Agent	sg-
☑	A02	maj_sam...	Agent	Agent	
☑	A03	daniel_jac...	Agent	Agent	
☑	A04	teal'c	Agent	Agent	

Press the **[Move to the Right]** button. This brings the selected items toward that side of the display.



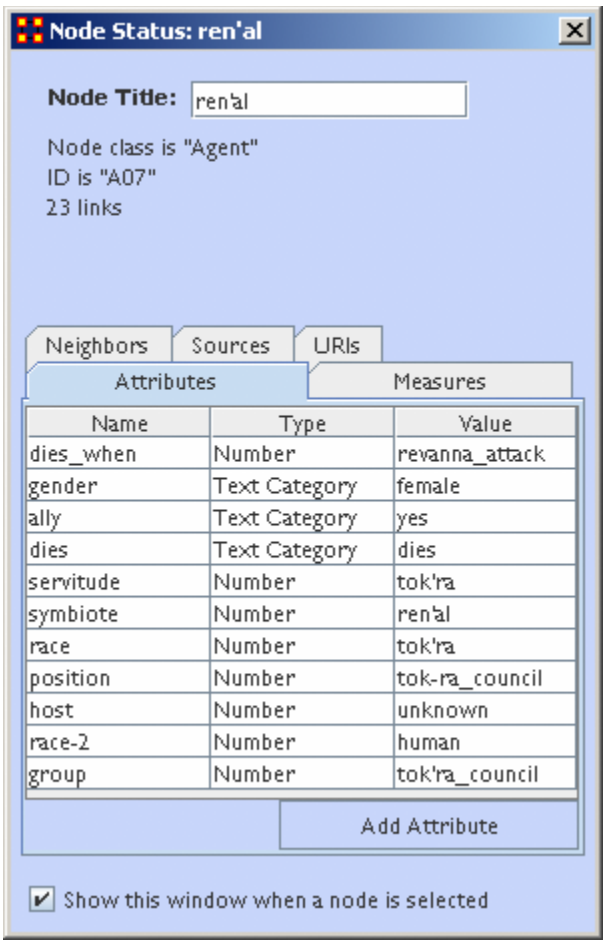
Pressing the button again will move the selected nodes farther in that direction.





Node Status

The **Node Status Window** is used to reveal pertinent information about one selected node. The window can be brought up by either selecting it from the main menu, **Tools > Node status** or by double-clicking the node in the visualizer. The dialog box below will appear.



The top of the box will contain general information about the selected node. Underneath there are five tabs available which will display the node's information. You can switch nodes by selecting any other node in the visualizer. ORA will automatically change the display.

The **Node Title:** box allows you to change the title of the selected node.

Tabs

Neighbors : displays the nodes which are linked to the selected node. It also displays the weight of each link.

Sources :

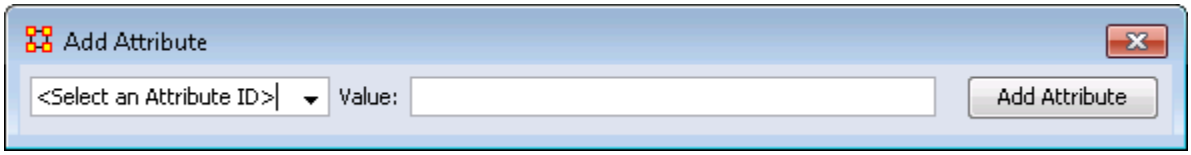
URIs : If there are any URIs attached to the node they are display under this tab.

Attributes : Types and Values of all attributes are displayed under this tab.

Measures : If Measures were run on the Meta-Network their values are displayed under this tab.

Attribute Button

This dialog box allows you to add attributes to a node. Click the **Add Attribute** button.

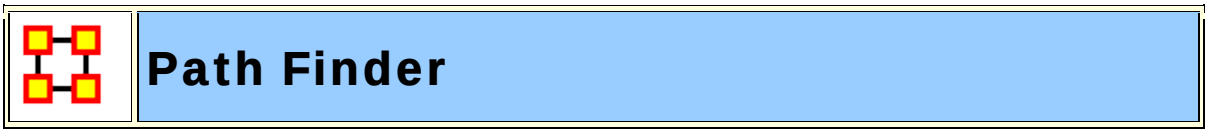


The drop down menu on the left contains all the current attributes for the node. You can select a pre-exising attribute, enter a value, the click the **Add Attribute** button.

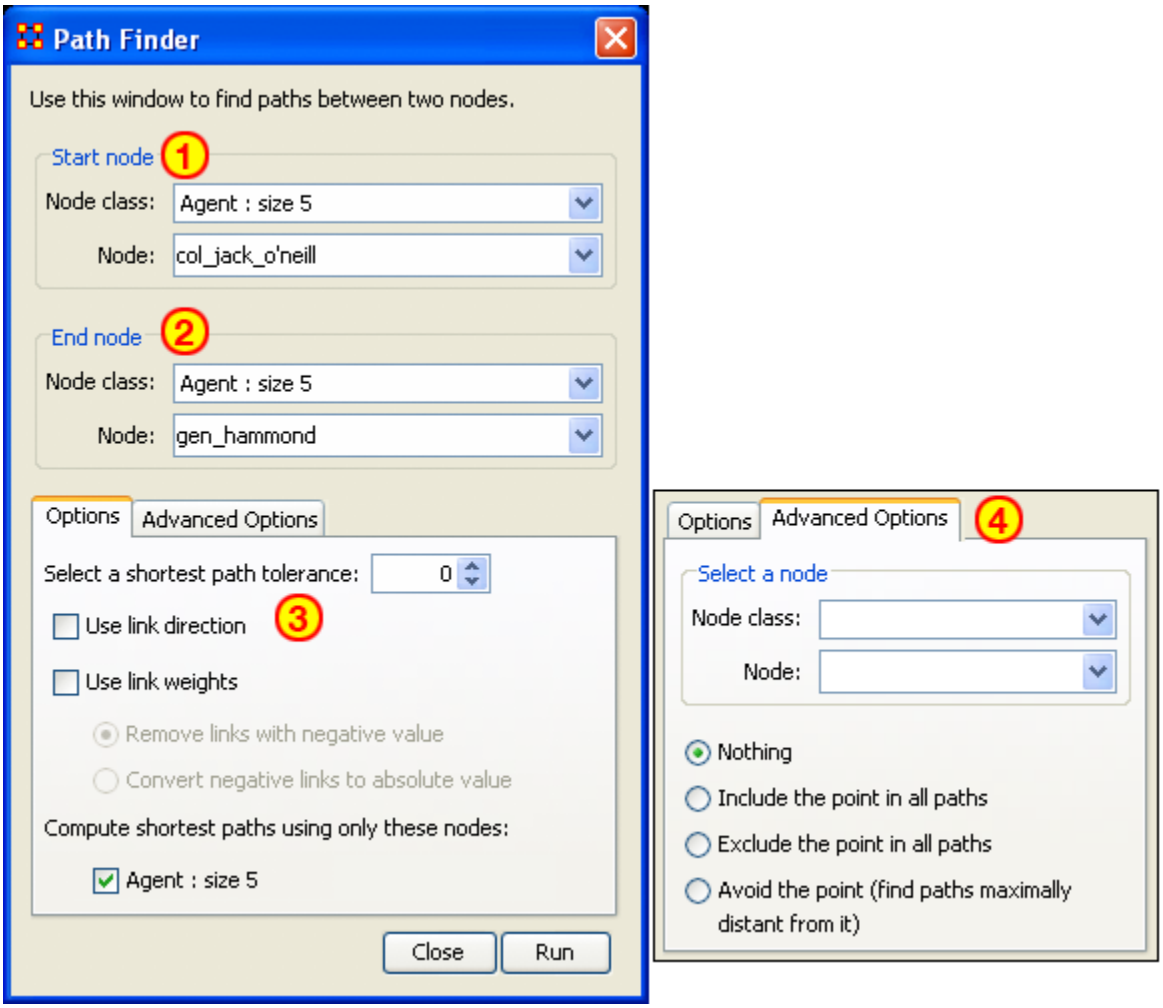
This also allows you to create **New Attributes**. Scroll down to the bottom of the drop down menu and select **<Enter New Attribute ID:>**, enter a Value, and click the **Add Attribute** button. Your new attribute will appear in the Meta-Network.

Show This Window check box

When a check mark is placed in this box it causes this dialog box to appear whenever you click a node in the Visualizer.



The Path Finder is used to find, not only, the shortest path between two nodes but also paths to other nodes when particular situations occur. Below is an image of the The Path Finder tool and a description of its various elements.



The interface contains four sections:

Start node : Select the Nodeset/Node to begin the path.

End node : Select the Nodeset/Node to end the path.

Options : Options regarding link parameters and which Nodesets to use.

Advanced Options : Options regarding whether, and how, to use one particular node within the Nodeset.

Using only Agent nodes (tolerance = 0)

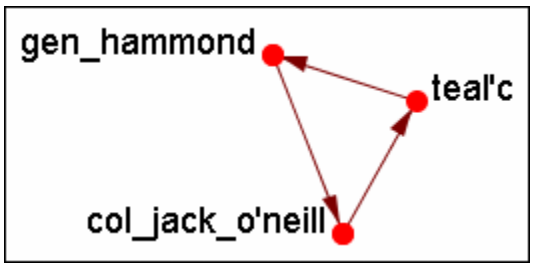
Using only the Agent Nodeset the pathway requires three intervening nodes.

	col_jack_o'neill	maj_samant...	daniel_jackson	teal'c	gen_hammond
col_jack_o'neill	0.0	0.0	1.0	5.0	0.0
maj_samant...	1.0	0.0	1.0	0.0	0.0
daniel_jackson	-1.0	0.0	0.0	-1.0	0.0
teal'c	0.0	0.0	0.0	0.0	1.0
gen_hammond	-5.0	0.0	0.0	0.0	0.0

NOTE : For this example the values in the Network have been altered from the regular values.

Tolerance of "1", nothing else checked.

Shortest path: 1

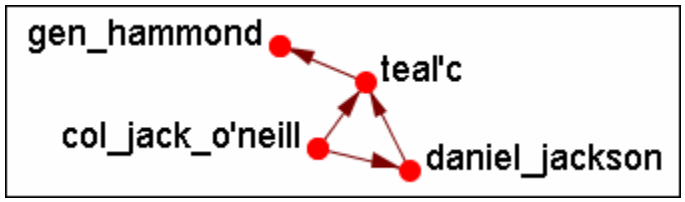


There is the direct link from gen_hammond to col_jack_o'neill and the secondary pathway with teal'c in the middle.

Use link direction

Shortest path: 2

The path direction **must** lead **from** the source **to** the target.

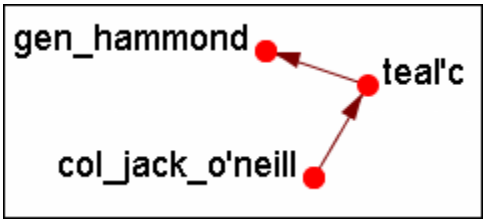


The link from gen_hammond to col-jack-o'neill is removed as it's a directional link in the wrong direction. The shortest link is "2".

Use link weight (Remove links with negative values)

Shortest path: 6

Use link weights finds the shortest path from A to B using minimal weights as opposed to minimal number of links. Also the shortest path is the total of the link weights — not the number of links total.

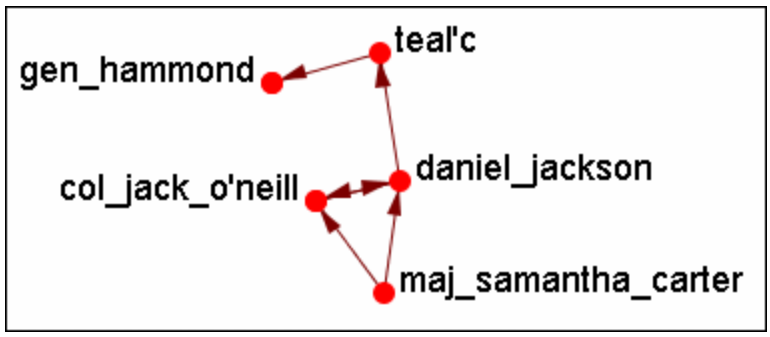


The shortest path is from col_jack_o'neill to teal'c (5) then from teal'c to gen_hammond (1) for a total of "6".

Use link weight (Convert negative links to positive values)

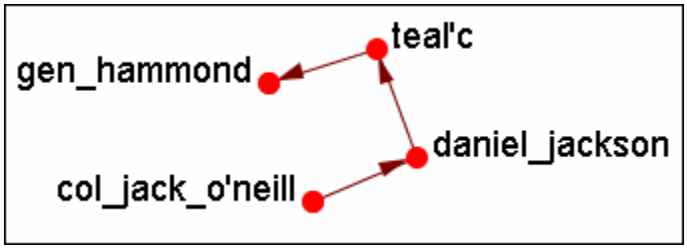
Shortest path: 3

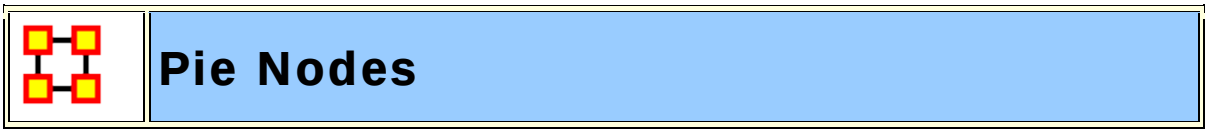
Uses the **absolute** values of numbers. A **negative number** becomes a **positive number**.



Use link direction and link weight with absolute values

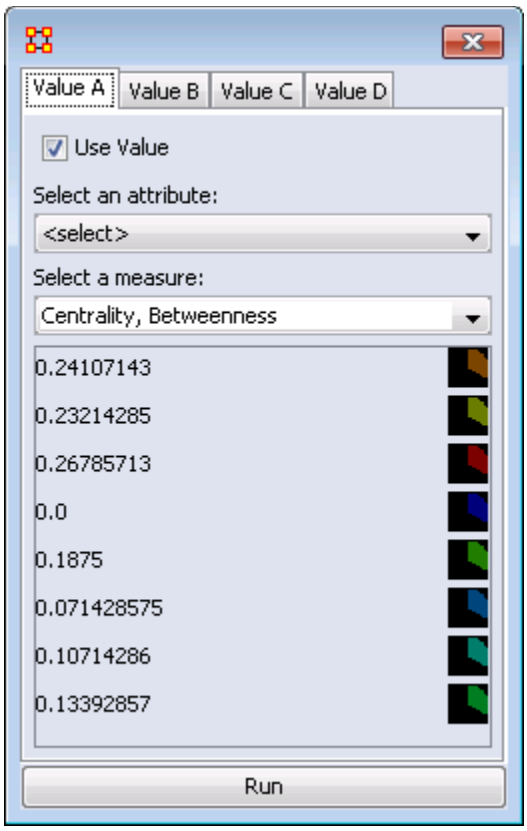
Shortest path: 3





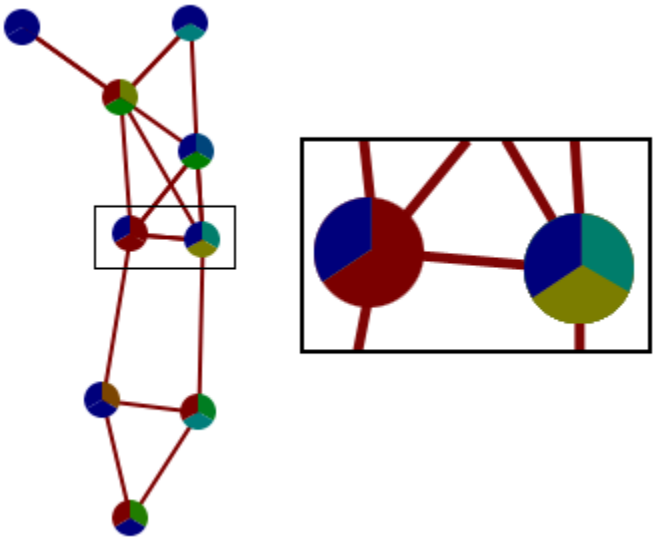
Pie Nodes

You can color nodes with individual colors based on Measures or Attributes. From the Visualizaer Main Menu select **Tools > Pie Nodes**. This brings up the Pie Nodes dialog. You can select up to four values to color your nodes each using either a measure or an attribute. The bottom section shows the values which correspond to the colors.

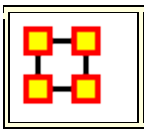


When you have your values selected and whether they will be attributes of measures, click the [**Run**] button.

The nodes will change colors depicting the amount of values you chose. Notice that **Value A** is represented in the top right and continue in a clockwise direction.



These values can be altered and redrawn by clicking the [**Run**] button.

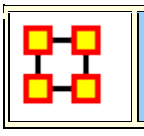


Sphere of Influence/Ego Network

The **Sphere of Influence** tools helps show how nodes are interconnected by displaying links to other nodes. You can also control the size of the Sphere of Influence.

It is important to understand that **Sphere of Influence** is similar to **Reverse Influence** but not identical. Sphere of Influence ignores directionality and looks at both in and out degress for each node. Sphere of Influence answers the question **What other nodes are connected to the ego network**. By using both in and out degrees it finds the sphere surrounding a node. Cycles are an endemic part of a Sphere of Influence and are not highlighted.

Reverse Influence only looks at the in-degree and answers the question what nodes influence the ego node. As such, cycles can be critical, leading to never ending chains, as when A influence B, B influences C and C influences A. The Cycle and self-loop options enable the user to stop backward chaining when a loop or cycle is encountered.

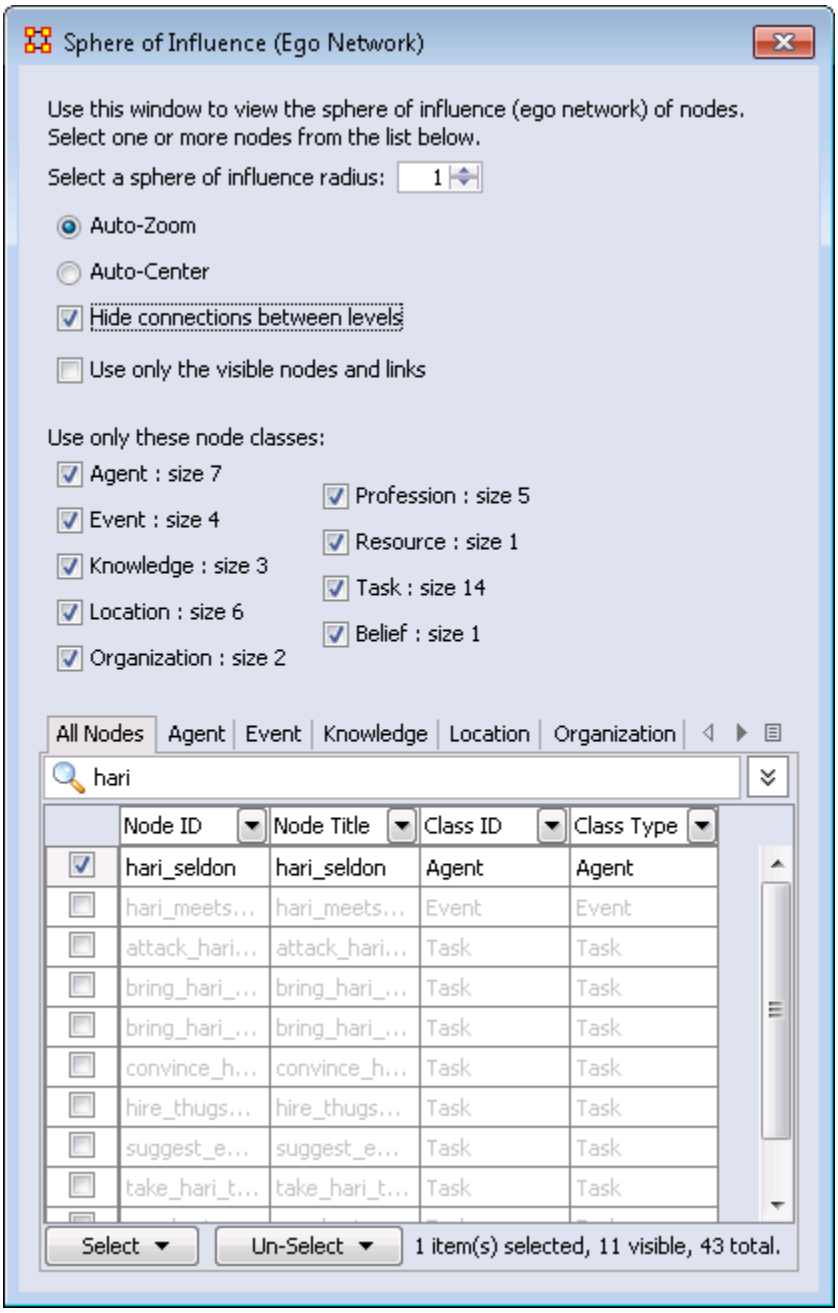


Sphere of Influence

Each node within a network has a unique **Sphere of Influence** or **Ego Network**. Essentially it's a direct relationship with it's neighbors as a function of specified path length. The ORA Visualizer allows you to focus on this relationship by creating an **Ego Map** centered on any particular node you choose. This mapping ignores directionalty and counts equally both in and out degrees it finds to the sphere surrounding the node. Cycles afre an andemic part of a Sphere of Influence and are not highlighted.

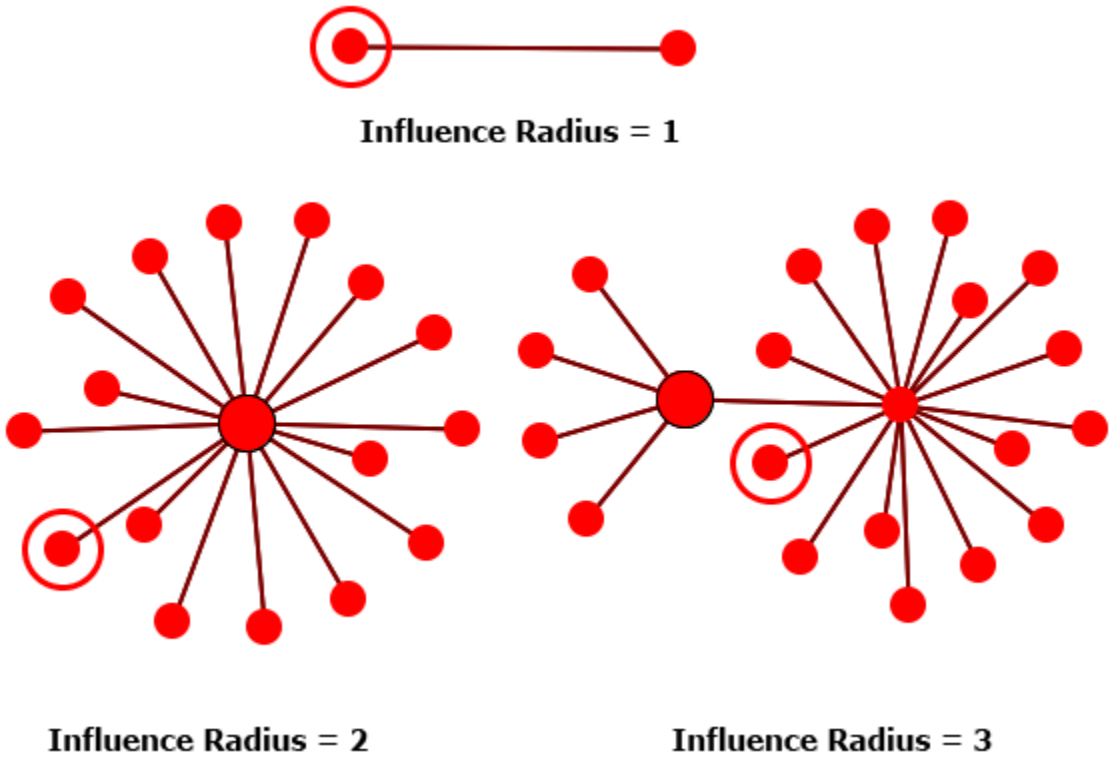
From the Visualizer's Main Menu select **Tools > Sphere of Influence**.

The following dialog box will then appear. From here you can select the **Size of your sphere's influence, the Nodesets, and Key Sets to use**.



Select a sphere of influence radius

The drop down box allows you to choose the **path length** for a particular node(s). The value starts out at 0. Below is an example of a radius of 0, 1, 2, and 3. In many other cases the links will branch out as you increase the radius.



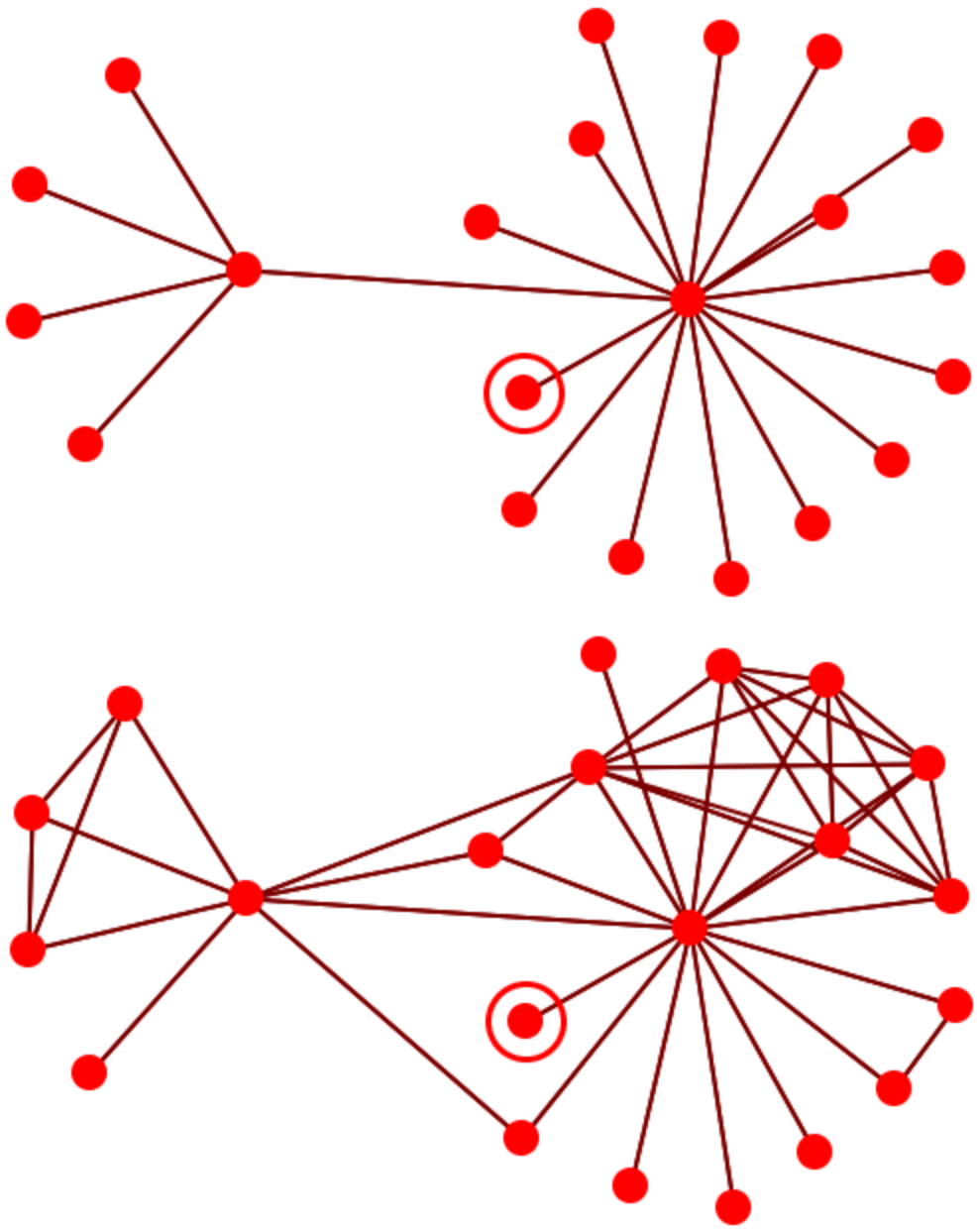
Auto-Zoom : Maximizes your ego network within the Visualizer.

Auto-Center : Keeps the visualized Ego Network centered within the visualizer display.

Hide connections between levels : Removes any connections between nodes that do not have a connection to any node in the filter.

There is a simple step that often gets forgotten when using ORA's sphere of influence feature. When you are about to click **run** make sure you have checked the box which reads **hide connections between levels.** Failing to click this, ORA will give you all connections between all nodes in the network. For instance, if you want to look primarily at a single node, but you fail to click this box, ORA will show how all nodes are connected to all other nodes. In summary, just make sure that the **hide connections between levels** box IS checked unless you have a need for viewing those other connections.

The top image has connections hidden. The bottom image has connections visible.

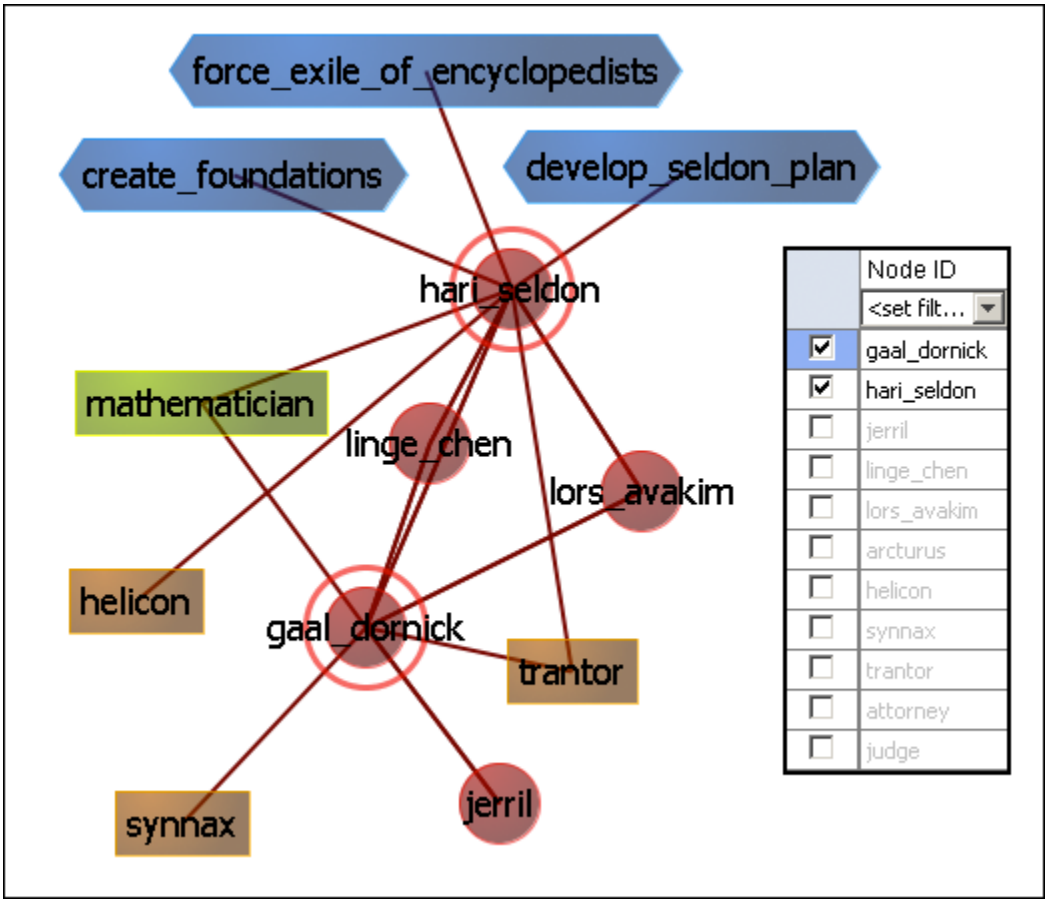


Node selection table : Allows the selection of individual nodes for visualization. Place a check mark next to the node(s) you want in the Visualizer.

Rings

What are node rings in the visualizer?

Rings help you keep track of which nodes have been selected in a Sphere of Influence. Right-Clicking on a node allows you to toggle the ring on and off.



They're not much more than rings around a node but rather they are used to help accentuate node(s) amongst other nodes. Currently, the only use they have is for Sphere of Influence, where the node(s) whose Sphere of Influence we're looking at get a ring around them.

Visualizer Layout Menu



Run Active Layout : Turns on the motion and allows ORA to attempt to sort out the positioning of the nodes.



Stop Active Layout : Turns off the motion and stops all nodes from moving. This allows you to move individual nodes around without disturbing the rest of the Meta-Network.

Spring Embedded Layout : This layout operates fine in datasets of approximately under 500 nodes. Much higher than that and the layout gets sluggish. A single layout iteration could take two minutes or longer. Not really practical.

Spring Embedded (with enhancements for large data) : The enhanced layout with large datasets. It uses the same basic algorithm but has some optimizations built in. With 10k nodes or so, a single layout iteration takes 10 seconds or so.

It treats large clusters of nodes as blocks to help in reducing computations. In decreases the time for the final computations but the display loses flexibility in the process.

NOTE : Now you're probably asking **"if this new algorithm is so good, why not keep it on all the time?"** Reason: If you pick up and drag a node, and as such drag an entire meta-network, the display will look jittery and confusing. So, whenever you load in under 500-nodes, the normal version is enabled. More than that, it uses the enhanced version.

Run MDS Layout : The purpose of Multidimensional Scaling [**MDS**] is to provide a visual representation of the pattern of proximities (i.e., similarities or distances) among a set of objects. Given a matrix of perceived similarities between objects, MDS plots these on a map such that those nodes that are perceived to be very similar to each other are placed near each other on the map, and those nodes that are perceived to be very different from each other are placed far away from each other on the map.



Run Tree Layout : This is a hierarchical stylewhich attempts to find

the root node (a node with an in-degree of 0). It then builds the network down from there.



Run Circle Layout (Pendants to Outside): Takes all pendants and puts them in a circle. All Nodes connected to a pendant are on a circle inside the pendant circle. Repeat until all nodes are in some circle, with the inner most nodes being the farthest from any pendant.



Run Circle Layout (Center is High Betweenness) : Calculate the Centrality-Betweenness for the graph. Take the node(s) with the highest value. Place them in the center. All nodes connected to those nodes get put on a circle surrounding the center. Repeat as necessary.

Run Circular Layout for Groups : NOTE : You must set **Meta-Nodes > Meta-Node Appearance > Show Component Node Membership** for this to display properly.



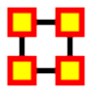
Run Hierarchical Layout : Tries to layout the network in a pyramid formation so that all arrows either point up or point down.



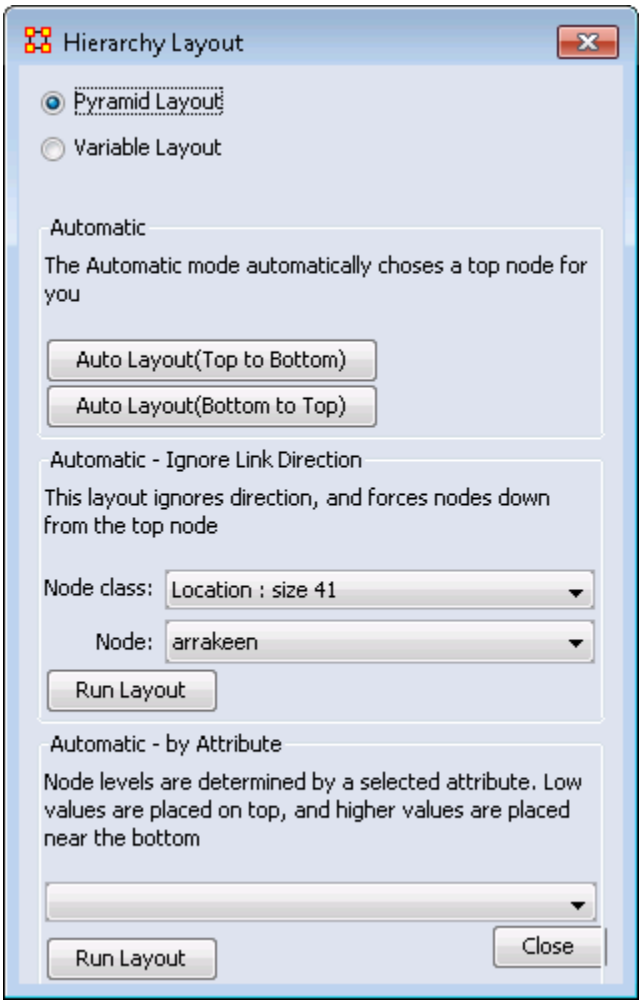
Run Box Layout : More of a Polygon Layout, really. You select 1-4 groups of nodes (either by Nodeset or by Node Class). Each group is then laid out as one edge of a polygon. 1 Group = circle, 2 Groups = 2 parallel lines. 3 Groups = Triangle, 4 Groups = square



Attribute / Measure Layout : Uses the input attribute and/or measure as the x,y coordinates of the nodes.



Hierarchical Layout



Run Hierarchical Layout : The Hierarchical layout option allows for two different layout styles.

The **Pyramid style** looks at level 0 as being the peak of the pyramid. Level 1 being the one beneath that, and so on. A level's width is equal to the level number (with the distance between levels being a constant). This gives it the appearance of a pyramid. This is the one that's been implemented for ages now.

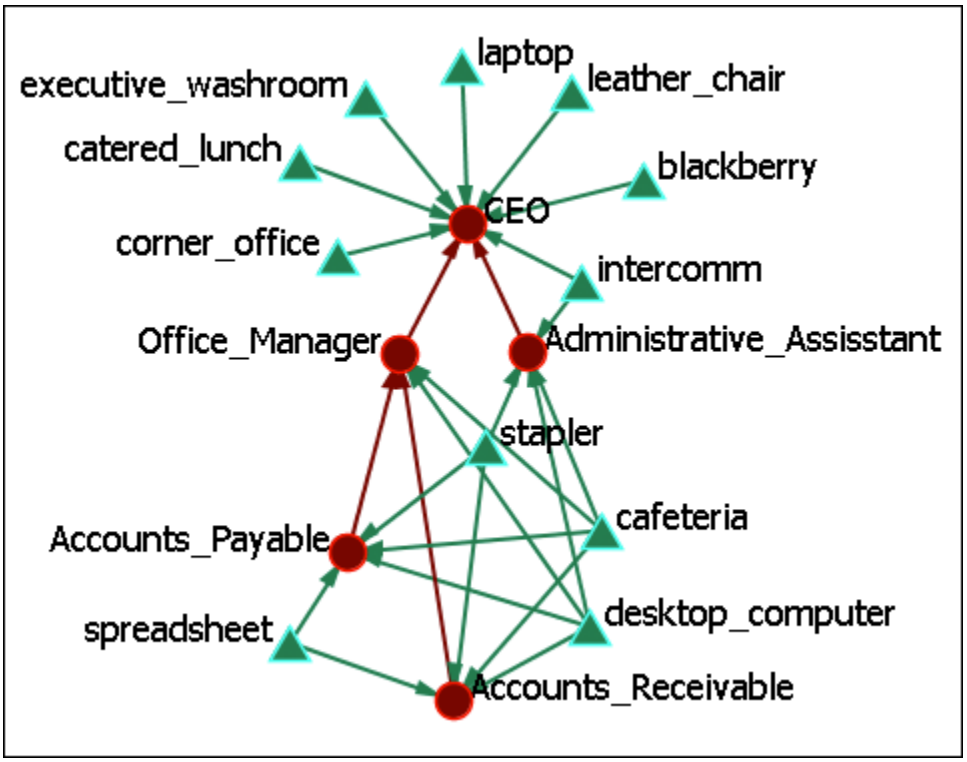
Variable style Variable Style is similar in that the distance between levels is still constant, but the width of a level is now variable. Instead of being based on the level number its based on the number of nodes in that level. If you look at top-heavy networks, you'll learn the appeal of this layout.

You will be prompted for a square network (including the Visible meta-network, since technically it's square), and then for a node to use as the **peak** node.

Finally, you must choose the desired build direction. This refers to Link direction, since a link could mean **reports to** just as easily as it could mean **commands**.

NOTE : This layout typically works well with **non-circular** networks. i.e. networks were links have links going only one direction. Using circular layouts can create problematic displays.

Regular Layout : showing links between resources and the office staff.

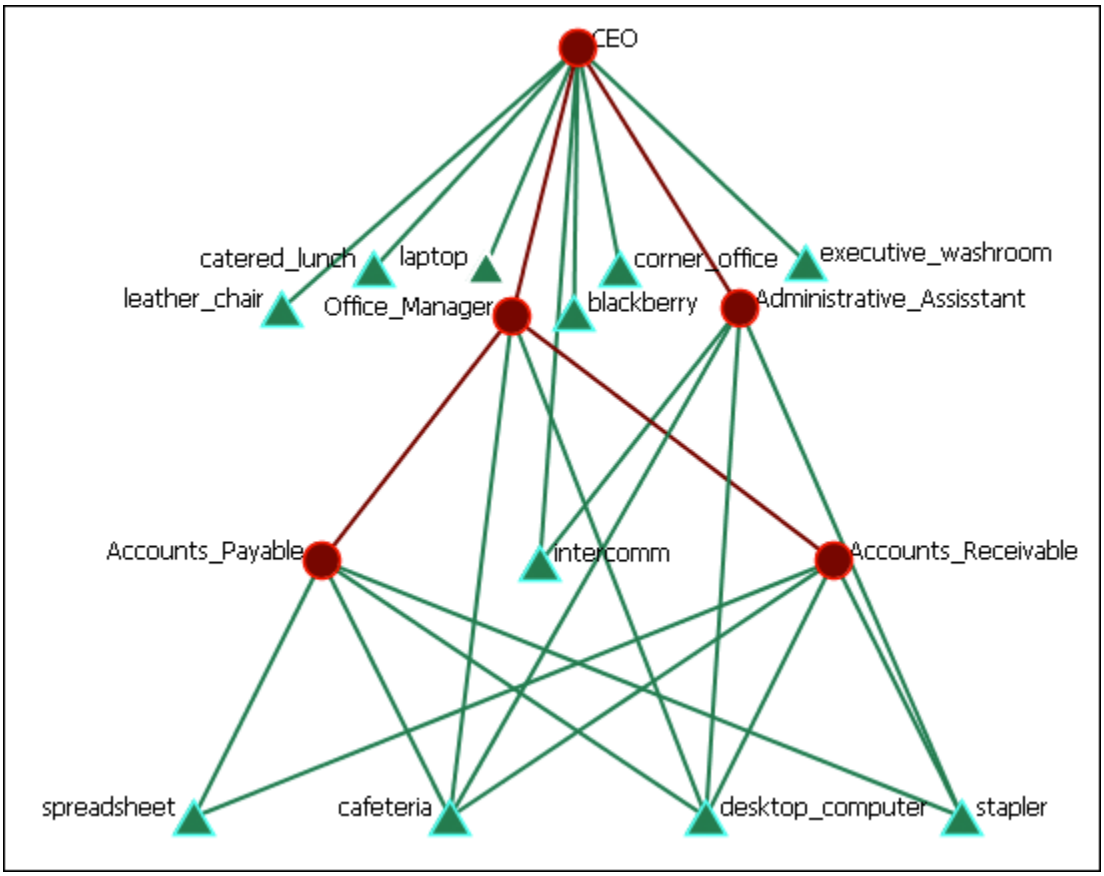


Automatic

The **Automatic** buttons will take the most direct path in creating a hierarchy. Whichever node has no links out will most likely become the top node. You can chose [**Auto Layout (Top to Bottom)**] or [**Auto Layout (Bottom to Top)**].

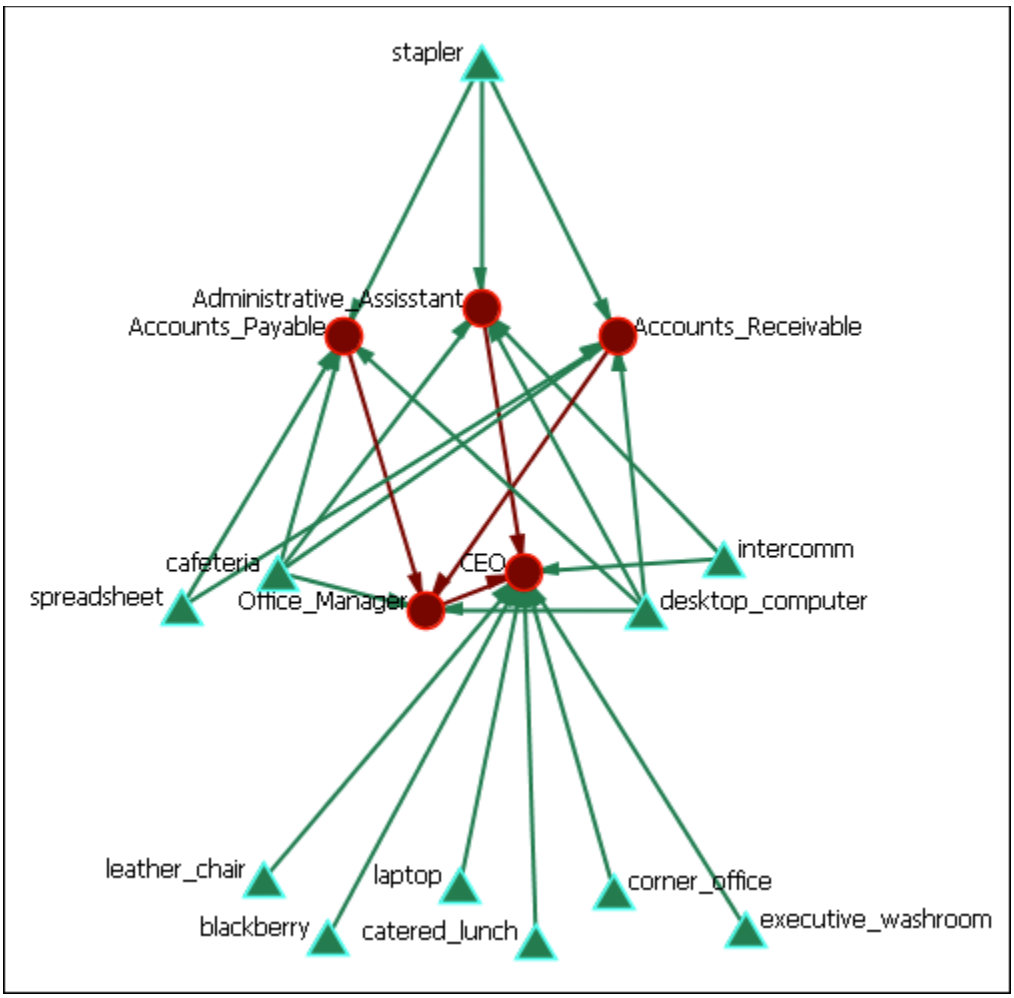
Arrows always try to maintain their direction meaning, in the event of cycles, for example, we try to minimize the number of arrows that go "against the current", so to speak. It will also warn you should you try to input a symmetrical network, as those don't really have **bosses** or **subordinates**.

Hierarchical Layout (Top to Bottom) : which places both staff and resources in a top to bottom pyramid. This view makes it much easier to detect which resources are used by which staff member.



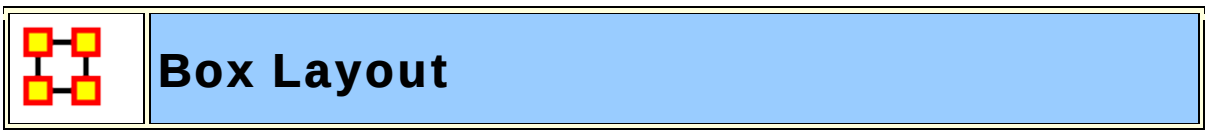
Automatic - Ignore Link Direction

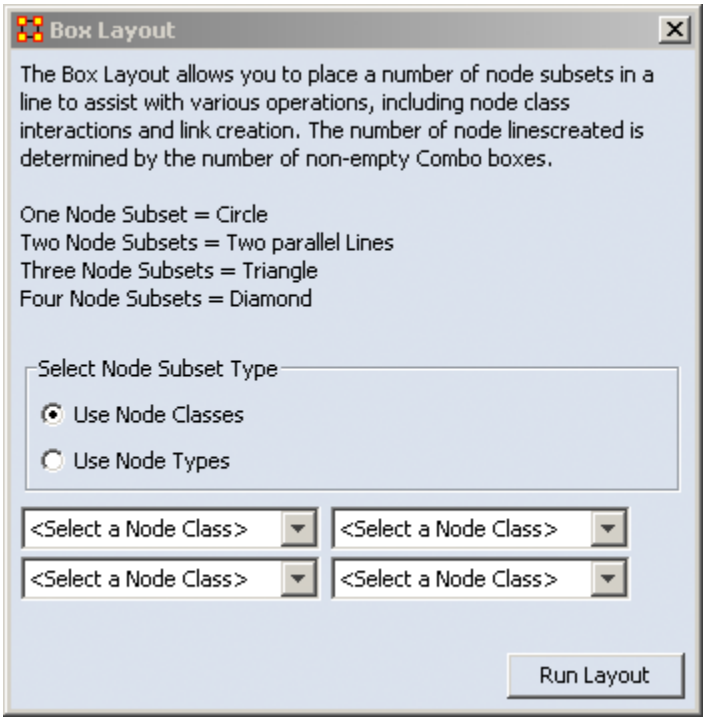
Automatic - Ignore Link Direction Layout : Allows you to chose the node you want at the top. Notice in the image the direction of the arrows are not in the same direction.



Automatic - by Attribute

This layout is based on the attributes of the ndoes. It requires all relevant nodes to have **some number-based attribute**. The lower the value of the attribute, the higher in the hierarchy it will be. Think of 0 as being the top...level 1 is one below, and so on.





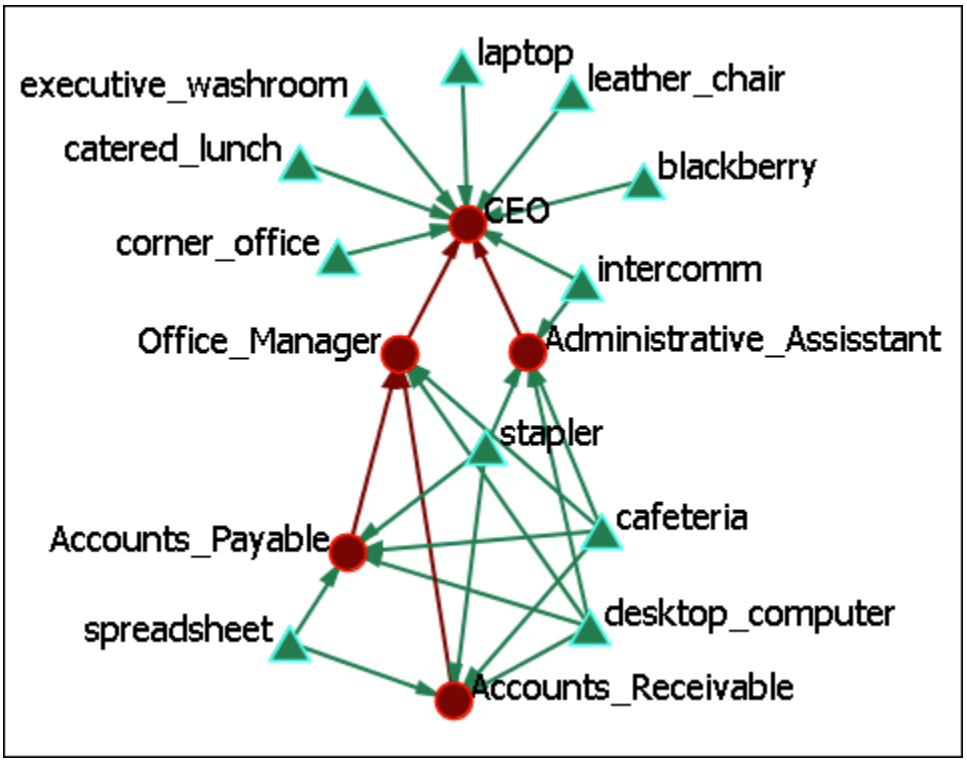
Run Box Layout : This layout allows you to chose from one to four Node SubSets and will arrange they depending on how many are choosen. The default is to use individual Nodesets. i.e. This would allow you to choose different agent Nodesets for different sides of the shape.

Use Node Types

Using this option allows you to choose all Node Sets which are the same Node Class, e.g., all Nodesets of the Node Class agent, at the same time. It selects all of them for a single side of the shape.

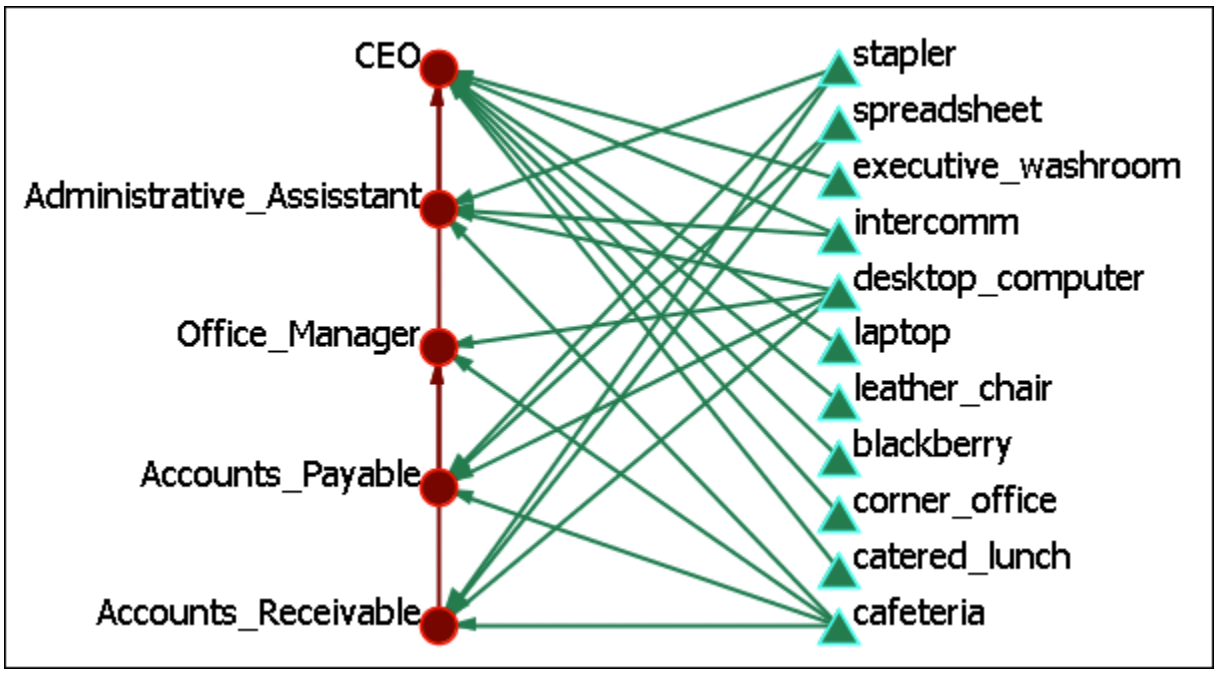
Regular Layout

Here's a Meta-Network as originally display in ORA.



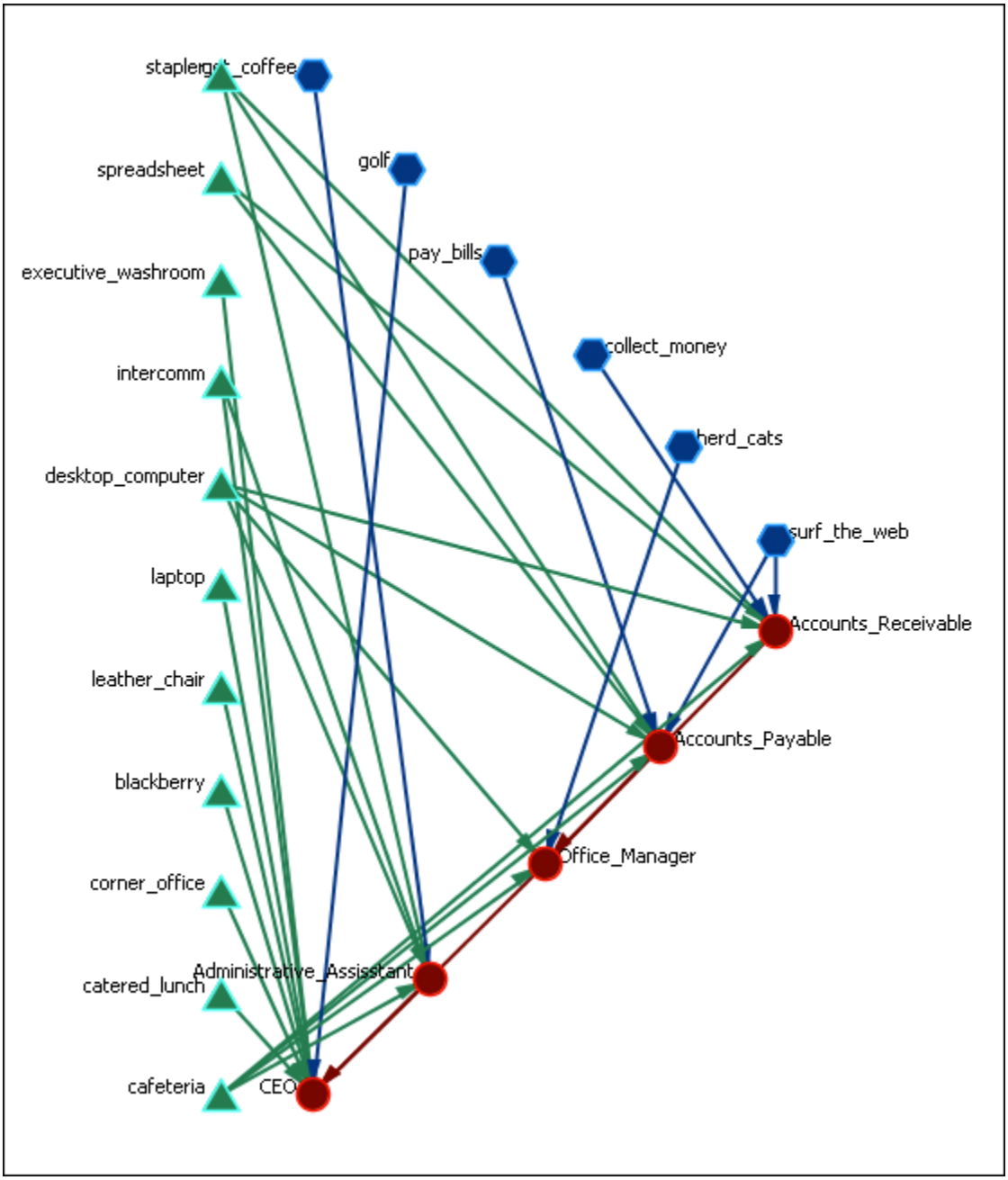
Box Layout (Two Nodesets)

Running the Box Layout lines up the Node Classes opposite each other with their links displayed between them.



Box Layout (Three Nodesets)

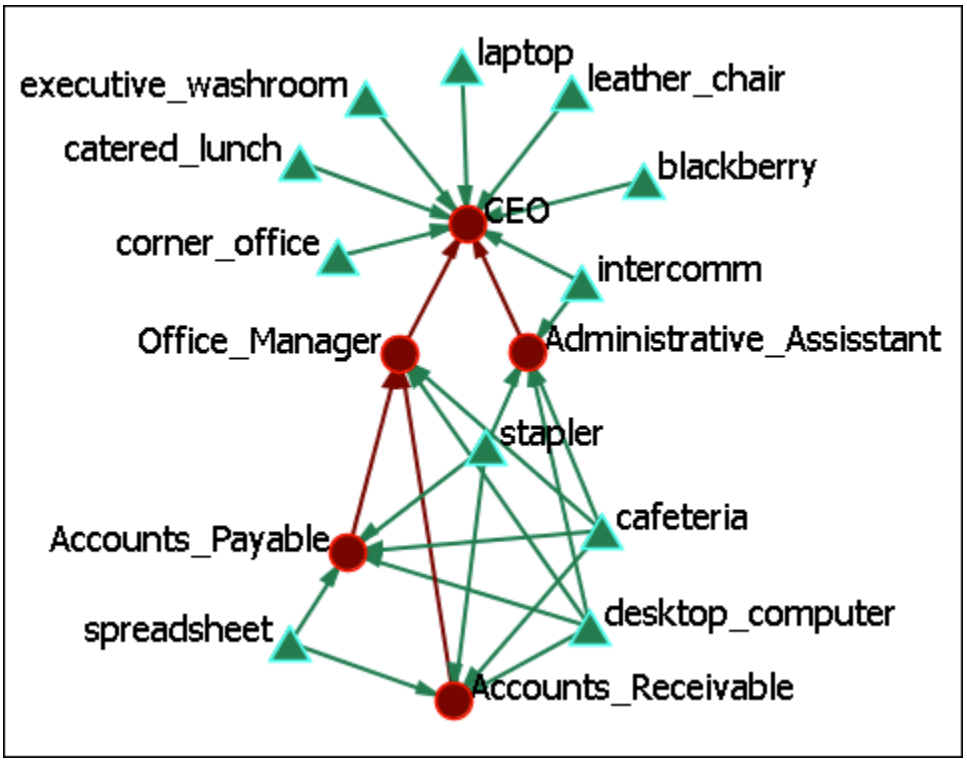
Adding a third Node Class would form a triangle with each Node Class on one of the three sides.



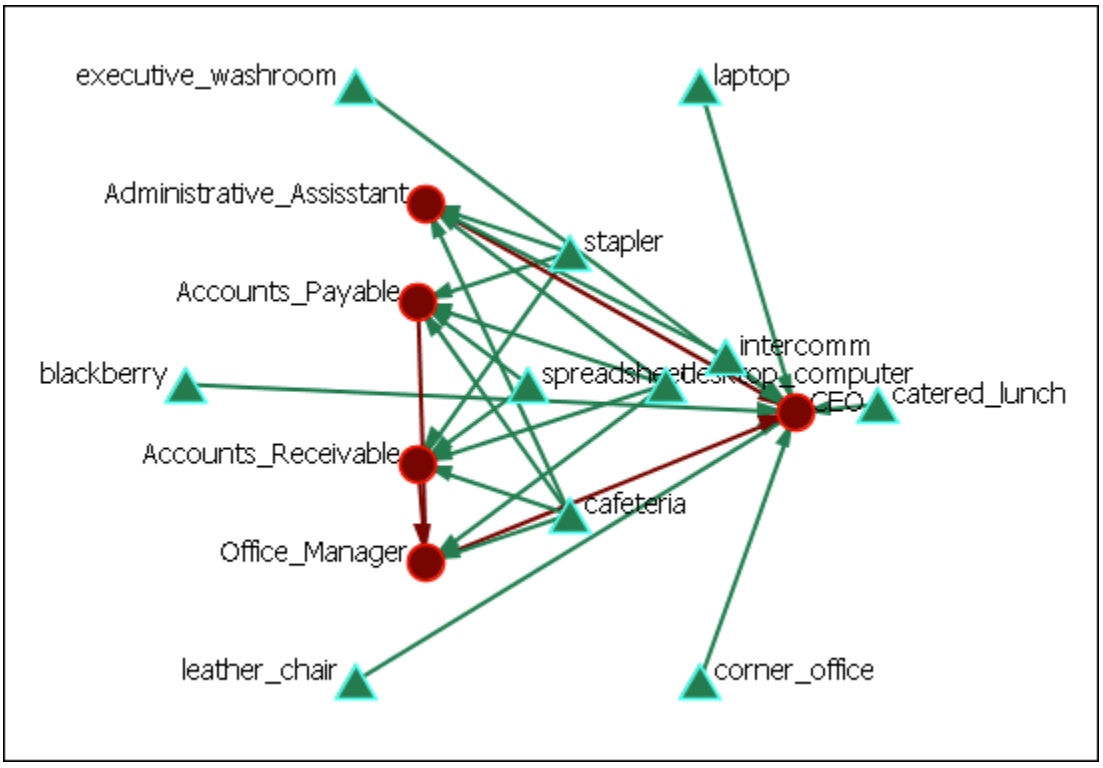
Circle Layout (Pendant to Outside)

Run Circle Layout (Pendants to Outside) :

Regular Layout



Circle Layout (Pendants to the Outside)

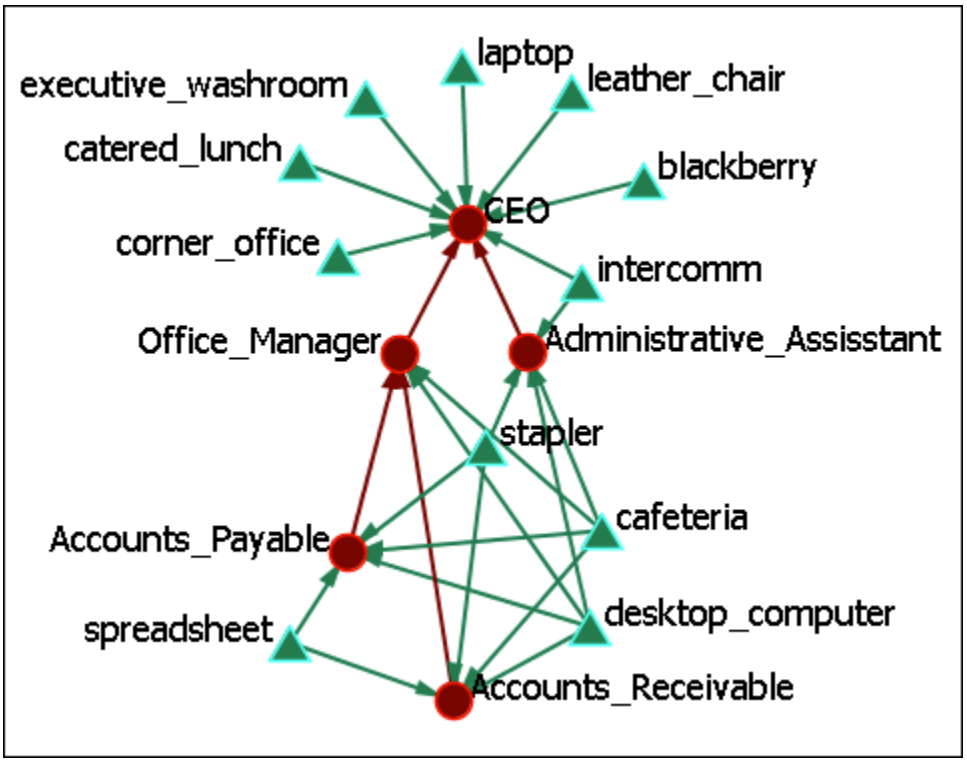


Here we see the spreadsheet and the desktop computer are at the center of the circle as they have multiple connections. You can also see the pendants (executive washroom, laptop, catered lunch, corner office, leather chair, and blackberry comprise the outer circle. Lesser connected nodes drift to the outer circle.

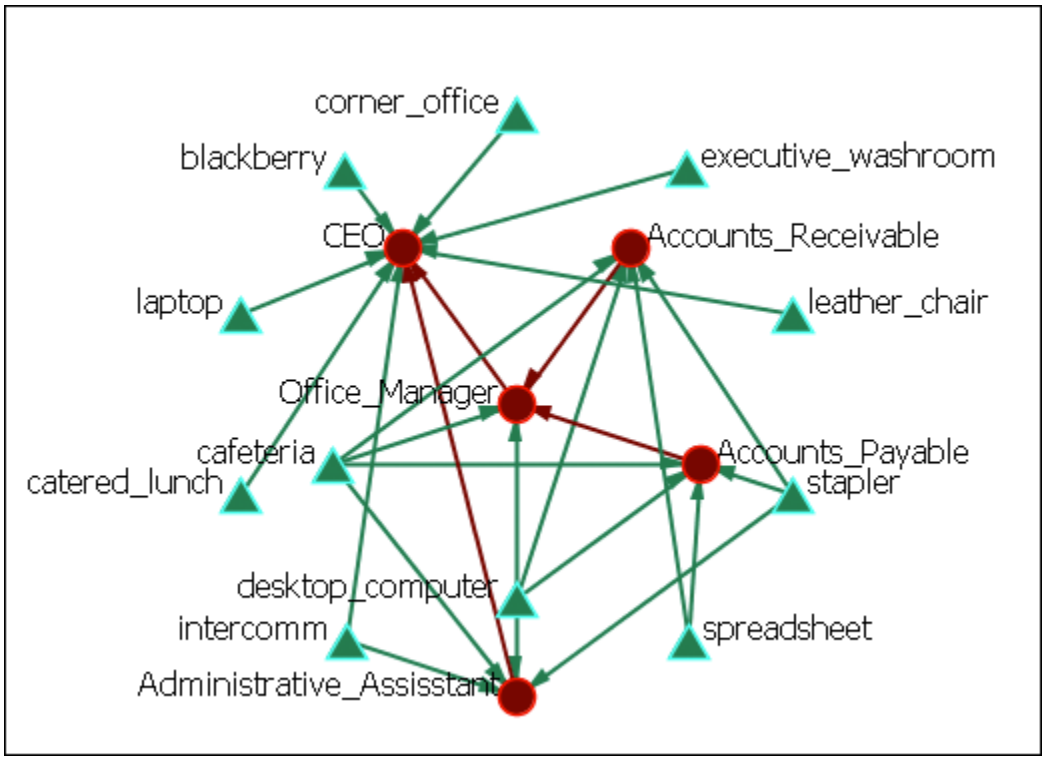
Circle Layout (Center is High Betweenness)

Run Circle Layout (Center is High Betweenness) :

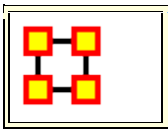
Regular Layout



Circle Layout (Center is High Betweenness)



This example shows how the Office Manager is the most connected node being responsible for two nodes under him and reporting to the CEO.



Circular Layouts For Groups

Used to display Meta-Network done in various Grouping styles.

NOTE : You must have **Meta-Nodes > Meta-Nodes Appearance > Show Component Nodes by Membership** for this to display correctly.

Newman : Used to find clusters in a network.

Girvan-Newman : This is a hierarchical clustering method where all nodes start off in the same group and are split off into new groups based on maximum betweenness scores.

MST :

Cliques : The number of distinct cliques to which each node belongs. Individuals or organizations who are high in number of cliques are those that belong to a large number of distinct cliques. A clique is defined as a group of three or more actors that have many connections to each other and relatively fewer connections to those in other groups. The scientific name of this measure is clique count and it is calculated on the agent by agent matrices.

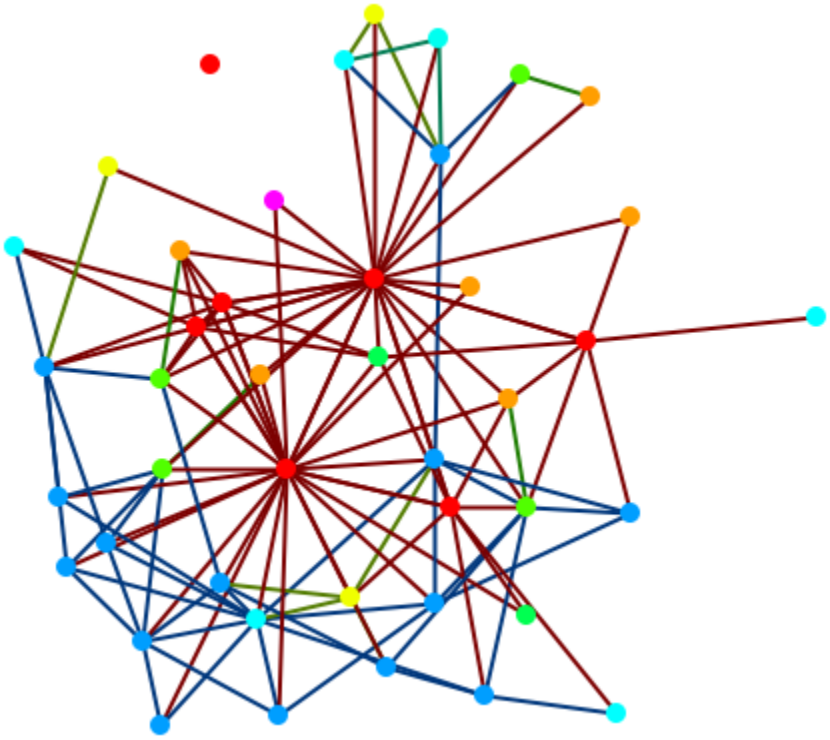
CONCOR : oncor recursively splits partitions and the user selects n splits. (n splits -> 2n groups). At each split it divides the nodes based on maximum correlation in outgoing connections. Helps find groups with similar roles in networks, even if dispersed.

Johnson : This is a Hierachical Clustering based on Similarity Standard hierarchical approach that builds groups based on similarity scores.

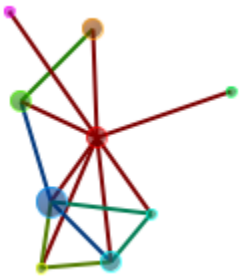
K-Means : This clustering aims to partition n observations into k sets (k ? n) S = {S1, S2, ., Sk} so as to minimize the within-cluster sum of squares.

K-Fog : Works with either one-mode or two-mode networks to form nodes into groups (clusters or communities) and show which nodes share the secondary functions.

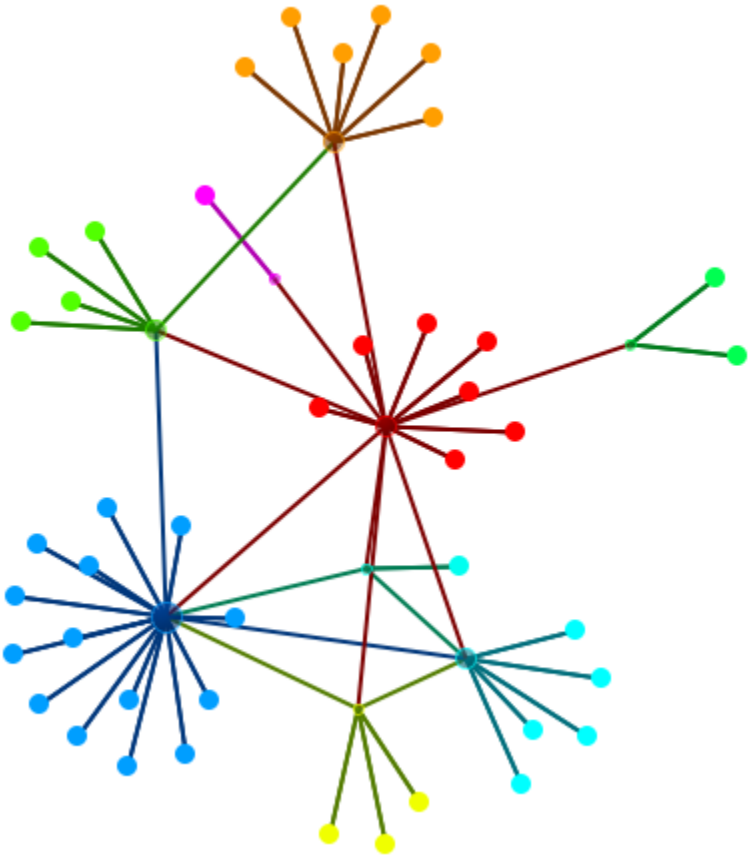
Procedure



From the main menu select **Meta-Nodes > Create Meta-Nodes by Node Class**. All nodes of one Node Class are now represented by one Meta-Node. But you have no information about the individual nodes within each Meta-Node.

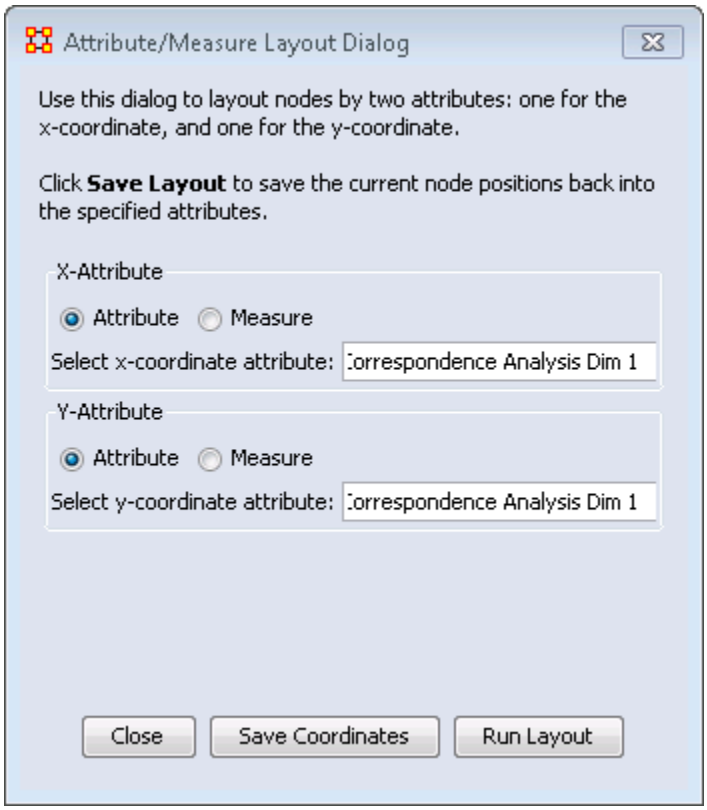


From the main menu select **Meta-Nodes > Meta-Node Appearance > Show Component Node Membership**. This will display the individual nodes for each Meta-Node.



Attribute Layout Measure

Once you create a specific visualization there are ways to save the information so that you can use it in the future. From the Visualizer menu select **Layouts > Attribute / Measure Layout**.



Placement of Nodes

When you have the nodes of your Network you can save your coordinates for a future session. The layout will mirror the positions you were using at the time of the saving.

Set the X-Attribute to **X-Axis** and the Y-Attribute to **Y-Axis** and click [**Save Coordinates**]. The next time you need to work with this layout set the X and Y Attributes back to the Axis attributes and click the [**Run Layout**] button.

Node Color

After coloring NodeClasses, and even individual nodes, you can save these colors as an attribute. From the Visualizer menu select **Node Appearance > Node Color > Save/Load Node Color to/from Attributes**, which allows for saving and loading node colors.

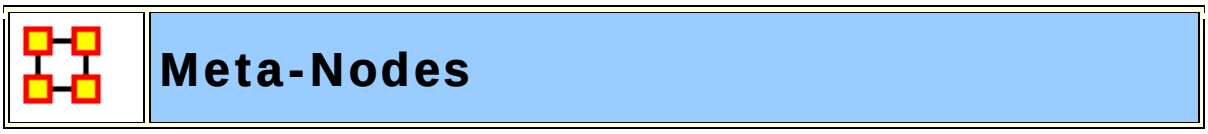
NOTE : In less new versions, the same functions are stored under **Node Appearance > Node Color > Save Node Color to Attributes** and **Node Appearance > Node Color > Load Node Color from Attributes**.

Full Image

NOTE : Early Prototype Version

There is an early prototype for visualization saving called the **ORA - PNG**. This encodes node visibility/color/layout inside the image that gets saved.

Save a visualization using **File > Save Image to File...** and select the **ORA-NetScenes-PNG format** format. Close your visualization and Meta-Network. Reopen your Meta-Network then visualize it as normal. **Drag/Drop** the ora-png into the visualizer, and it should load in.



Meta-Nodes

A **Meta-Node** contains multiple nodes collapsed into one. You can create Meta-Nodes based on the Nodesets in your organization, or you can create Meta-Nodes based on the attributes of the nodes. From the main menu select **Meta-Nodes**. This brings up the Meta-Node dialog box.

Menu

Meta-Node Appearance

NOTE : To view these options you must create Meta-Nodes first.

Hide Component Nodes : Resets these to their defaults

Show Component Node Membership :

Show Component Node with Bounding Box :

Show Component Node with Bounding Polygon :

Compute Meta-Link Weight By..... :

Proportion of the maxmum possible links : Takes the total number of links in the Meta-Nodes and divides this by the totasl possible number of links.

Absolute count of links : Counts any link from any node in the Meta-Nodes to any other node as 1.0. Uses this as the total

Block model links and weights : Uses two terms. A) The Proportion of the maximum possible links (as calculated above); and B) The total number of links in a Meta-Network divided by the total number of possible links in a Meta-Network. If (A) is higher than (B) then the value used equals (A). If (A) is lower then the value is 0.

Pin All Meta-Nodes : Immobilizes all nodes in place.

Expand All Meta-Nodes : Restores all nodes to individual display.

Color Nodes by Meta-Node Membership : Colors the Meta-Nodes to the Nodeset color set by the Meta-Network.

Increase Link Rigidity Between a Meta-Node's Component Nodes : In a Meta-Node, there are nodes. If a link exists between a pair of nodes in the same meta-node, that link has its rigidity increased so that when meta-nodes are expanded/destroyed, the nodes in the same meta-node will band together via the layout.

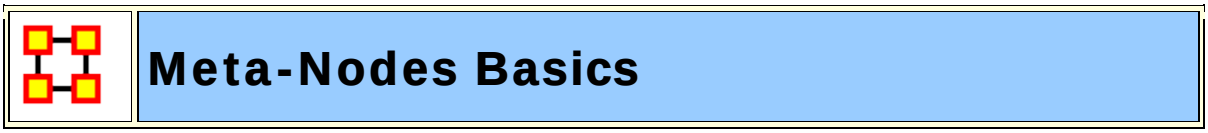
Create Meta-Nodes by NodeClass : Creates one Meta-Node per NodeClass.

Create Meta-Nodes by Node Association : After selecting a Nodeset will create Meta-Nodes and their connections.

Create Meta-Node by Grouping... : Allows you to choose from any of the installed grouping schemes.

Create Meta-Node by Attribute / Measures : You can create Meta-Nodes using either any Attribute or collected by measure value.

Meta-Nodes... : Calls up the Meta-Node dialog box.



Meta-Nodes Basics

Display Meta-Node in Own Window

Right-Click on a Meta-Node in the Visualizer and select **Open Meta-Node Components in New Visualizer**. This allows you to view the contents and connections of a Meta-Node on its own.

View Meta-Node Information

This item displays in a box all the information for the selected Meta-Node including:

Meta-Node Details : The Id, Label and Type

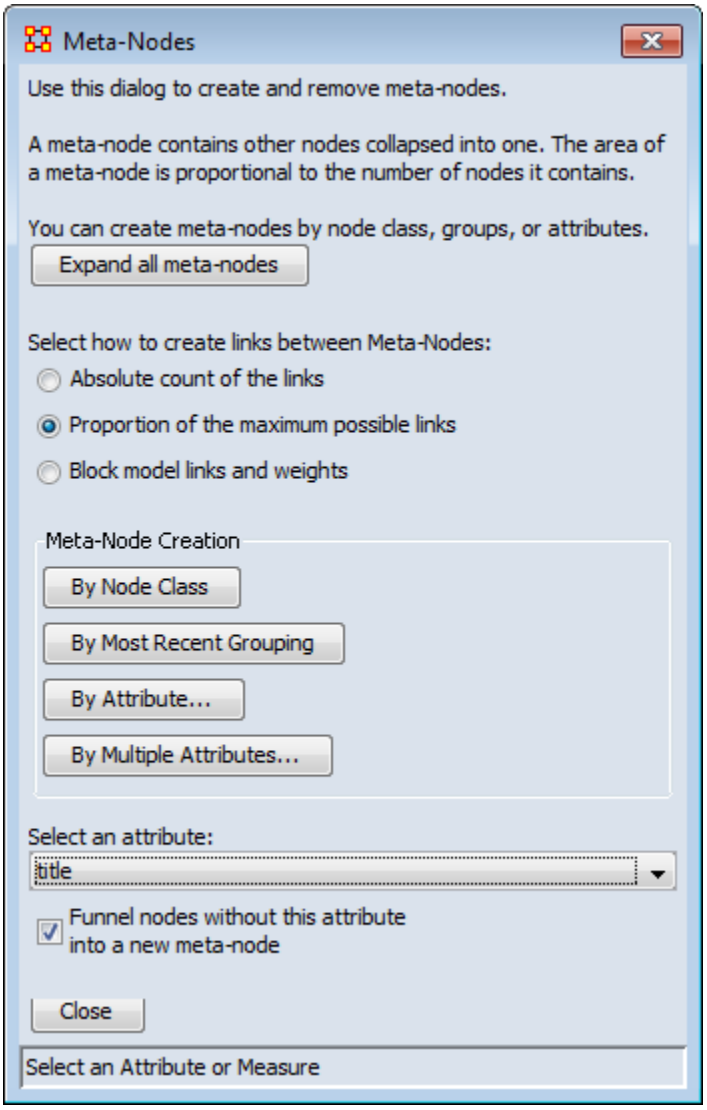
Meta-Node Density :

Component Nodes : The Ids, and Titles of all contained nodes

Component Edges : The Source and Target of every Link.

Meta-Nodes Dialog

Meta-Nodes Dialog



The dialog box consists of four sections :

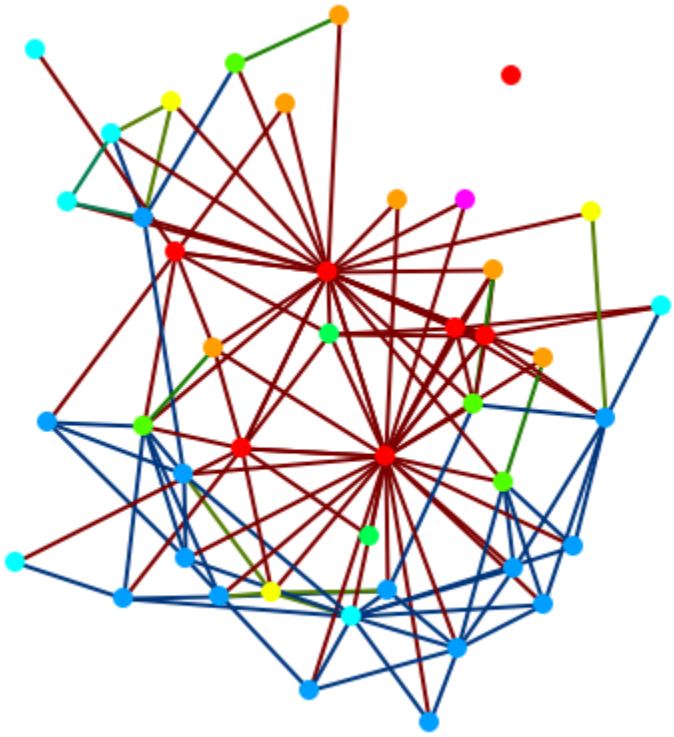
Expand all meta-nodes : Returns to the default display

Select how to create links : see main page above for more details.

Meta-Node Creation : Choose from creating by Node Class, Most Recent Grouping, Attribute, or Multiple Attributes.

Select an attribute : Choose an attribute from any Node Class. Only those nodes connected to those attributes will be displayed.

Base Meta-Network Display



First call up the Meta-Node dialog box from the main menu **Meta-Nodes > Meta-Nodes** which will display the dialog box shown above.

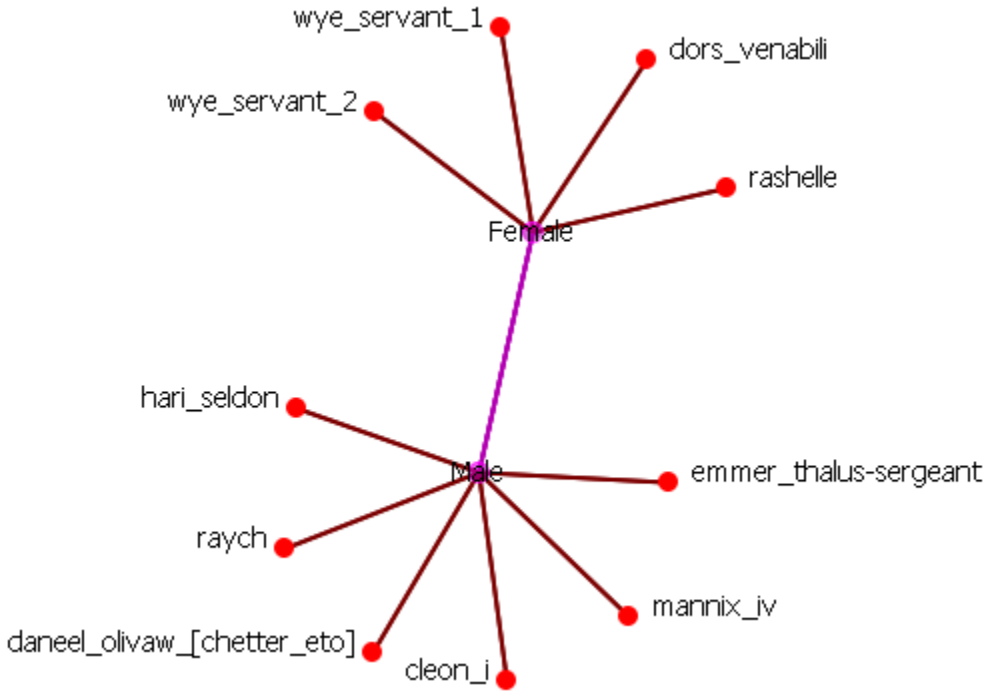
Create By Attribute

Make sure the section, **Select an attribute:** is visible. If not then click the [**By Attribute**] button. In the drop down select an attribute. The display will create Meta-Nodes corresponding to your choice. Below I chose my attribute **gender**.



Show Nodes By Meta-Nodes

By itself this is of little use. To reveal the nodes which are contained in these Meta-Nodes use the function **Meta-Nodes > Mets-Node Appearance > Show Component Node Membership**. Now there are two Meta-Nodes with the pendants being the nodes associated via that attriutes.



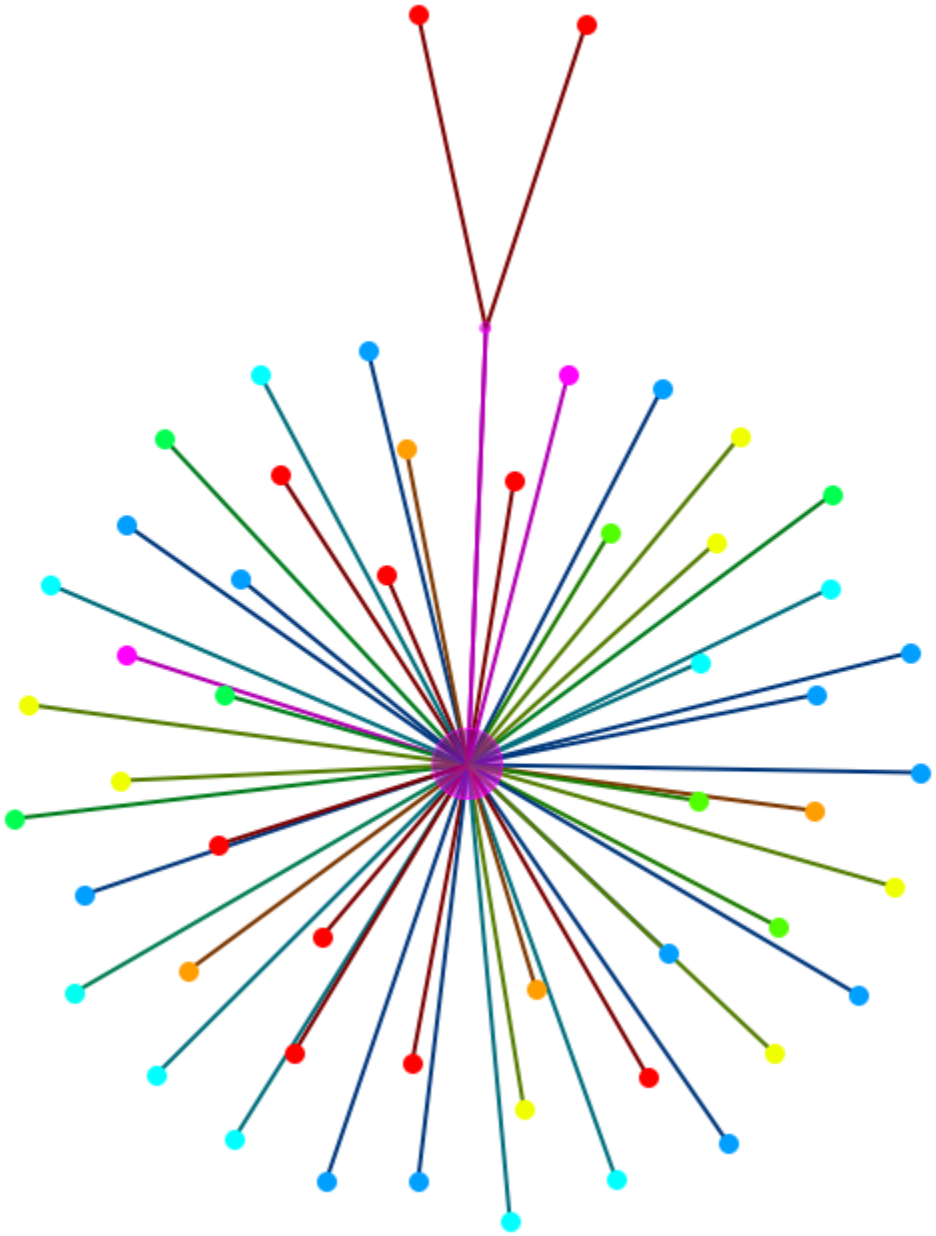
Reset

I reset the display with **Actions > Show All Nodes** to display all nodes.

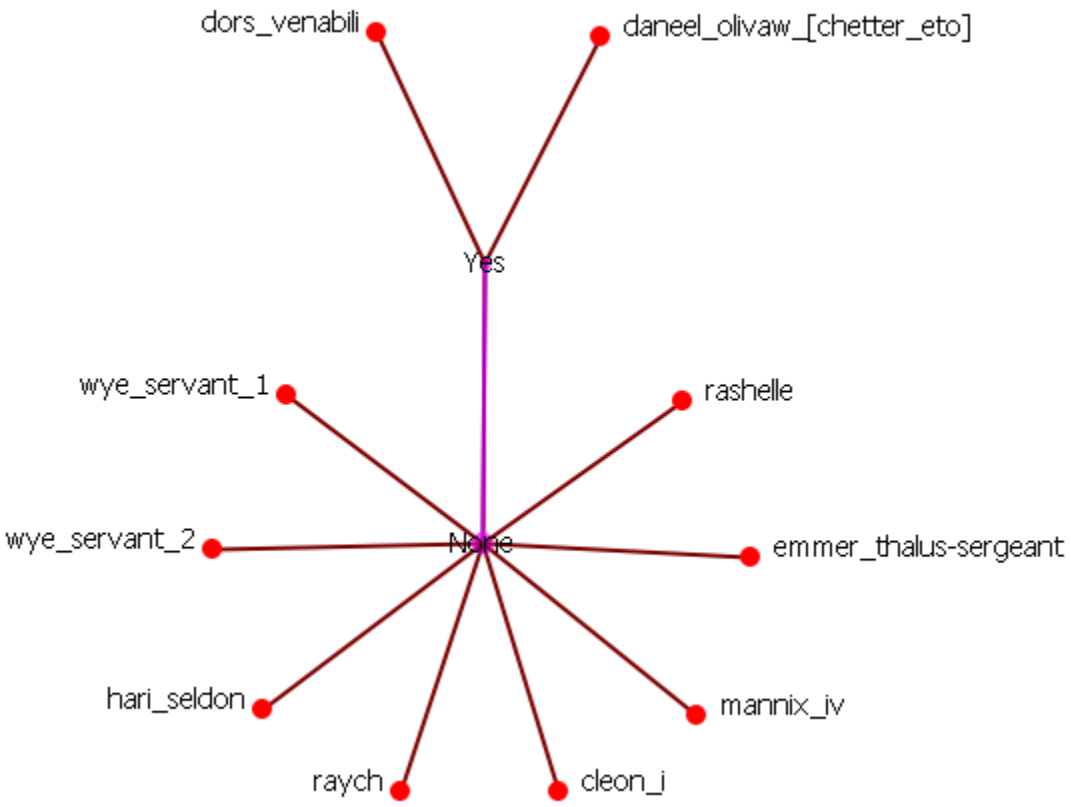
Funnel Nodes Without Attribute

Another important function on the Meta-Node Dialog is the check box, **Funnel nodes without this attribute into a new Meta-Node**. Instead of just hiding any node without information in the specified attribute these nodes will become part of Meta-Node labeled **None**. To funnel these nodes place a check mark in the box near the bottom of the dialog box.

Here I change the attribute to **robot** and any node with **Yes** in that attribute belongs to the **Yes Meta-Node**. All others without a value in that attribute are grouped within the **None Meta-Node**.

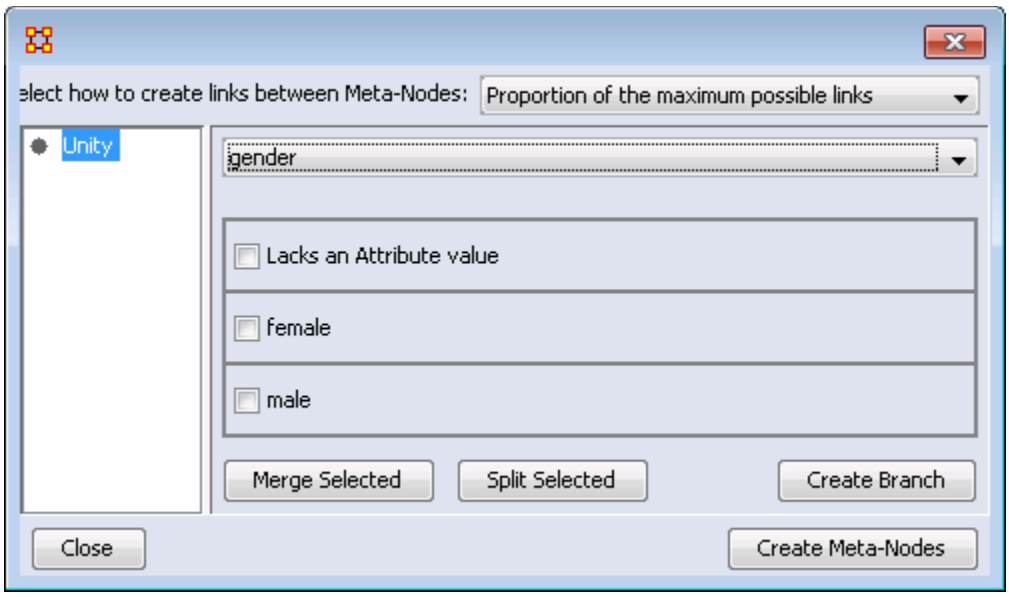


But in this instance it's rather unweildly, and unnecessary, to show all the nodes as the only Node Class with this attribute is the Agent Node Class. Using the Legend you could **deselect** any Node Class. Here I deselect all except the Agent Node Class.

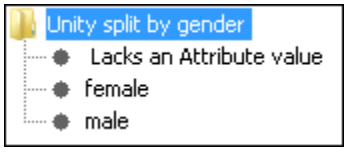


Multiple Attributes

Click the [**By Multiple Attributes...**] button to call up the dialog box. From the drop down menu shoose an attribute i.e. gender. This gives the two regular attribute choices, male or female, and a third choice - **Lacks an Attribute Value**. This will collect any node which does not contain a value for that attribute.

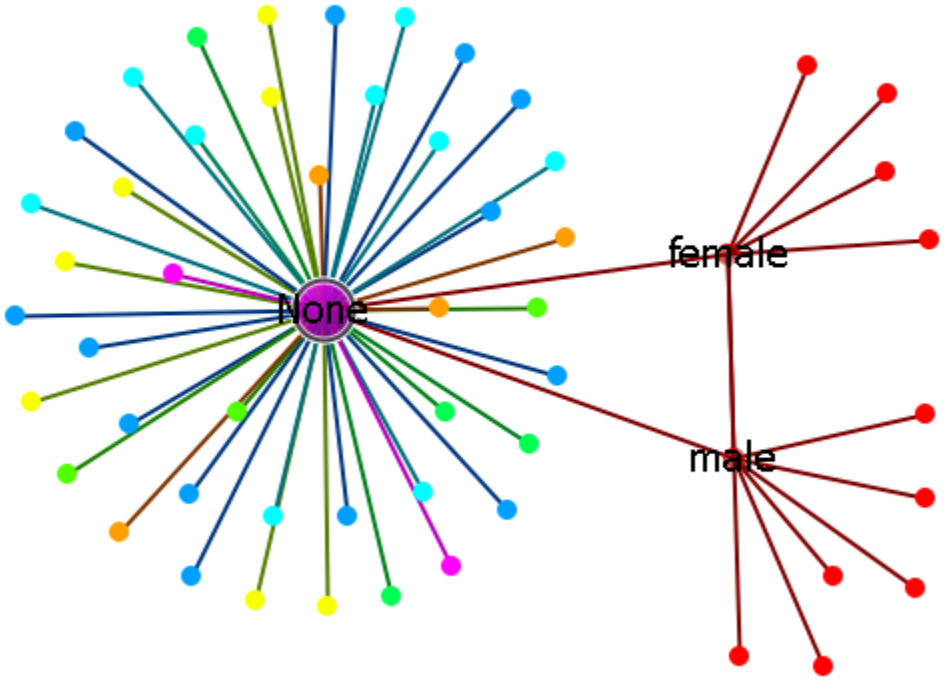


Place a check mark in all the boxes you want to use. For this I marked all three. Then click the [**Create Branch**] button.



The left hand box now display how the Meta-Nodes will be created. Click the [**Create Meta-Nodes**] button.

NOTE : For easier viewing I made only the three Meta-Node names visible. Then I double-clicked on them and used the Node Status box to rename them.



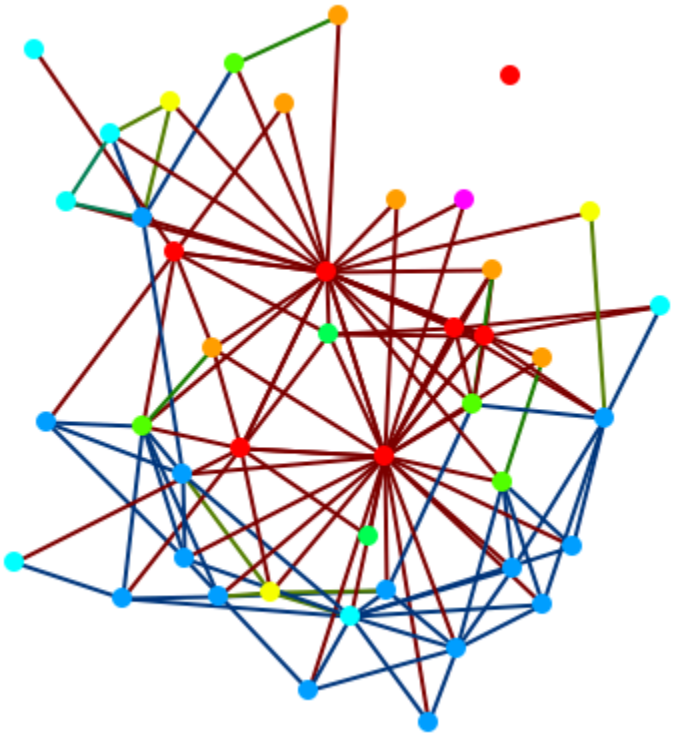
This collects all nodes, no matter what their NodeClass, into the None Meta-Node

If you give each node one or more attributes then you can change the appearance of nodes based on the attributes. Illustative attributes are gender (female,male) or the type of organization (hierarchy, matrix, team ...).

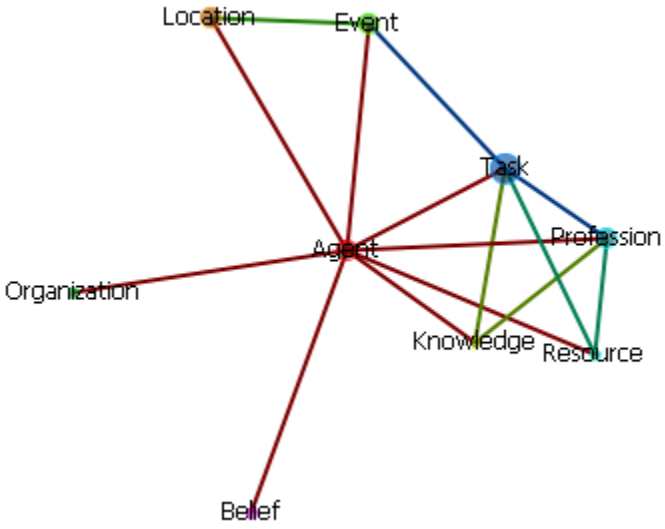
Meta-Node - Create By

Using the **By Node Class** button separate all nodes into Meta-Nodes based on their Node Class.

Start by visualizing a Meta-Network.

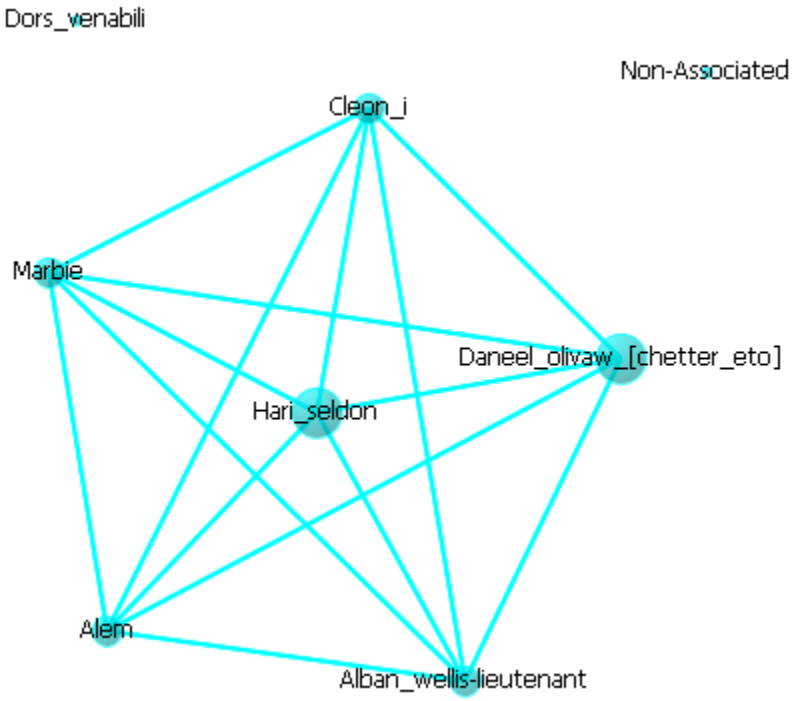


Create Meta-Nodes by Node Class



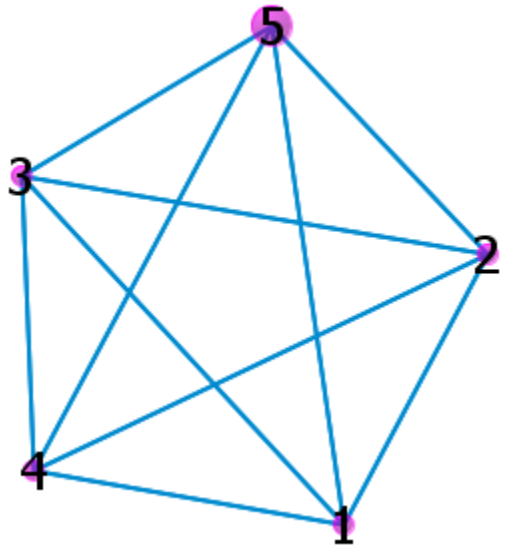
This creates one Meta-Node per Node Class in your Meta-Network.

Create Meta-Nodes by Node Association



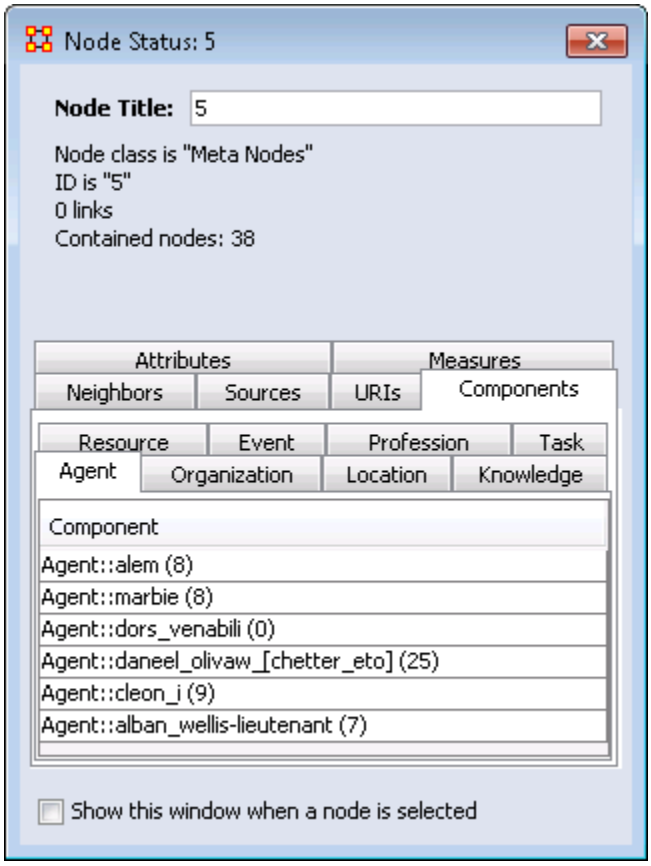
Choose a Nodeset for display. The Meta-Nodes consist of all nodes with a connection to any of the nodes in that Nodeset. These components can be found by double-clicking any Meta-Node to bring up the **Node Status dialog**. Click on the **Component** tab and the sub tabs will display which Node Classes contain any nodes within.

Create Meta-Nodes by Grouping



Creates Meta-Nodes based on the grouping style choosen. The Meta-Nodes consist of all nodes with a connection to any of the nodes in that Nodeset. These components can be found by double-clicking any Meta-Node to bring up the **Node Status dialog**. Click on the **Component** tab and the sub tabs will display which Nodeset contain any nodes within.

Node Status Example

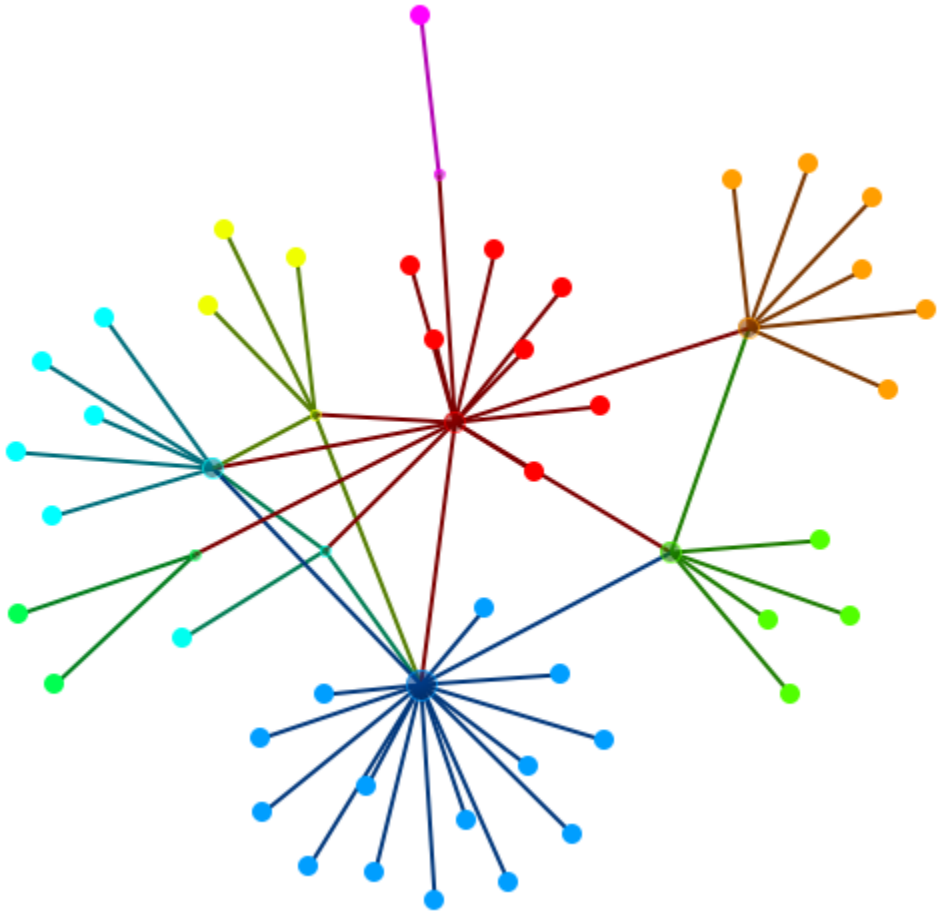


The Node Title will reflect the Meta-Node choosen with the information below it containing other relevant information. The tabs contain the rest of the information for the Meta-Node.

Meta-Node Appearance

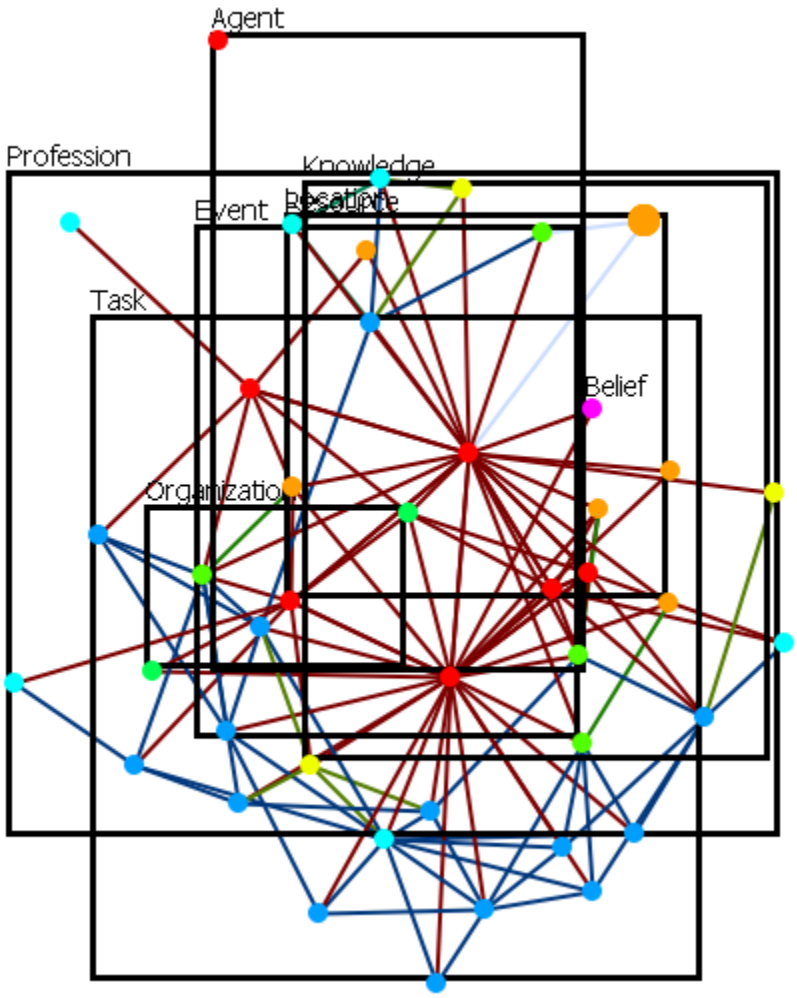
Meta-Nodes by Component Nodes

This is similar to the **Create Meta-Nodes by NodeClass**. The center of the cluster is the Meta-Node and the pendants are the individual nodes



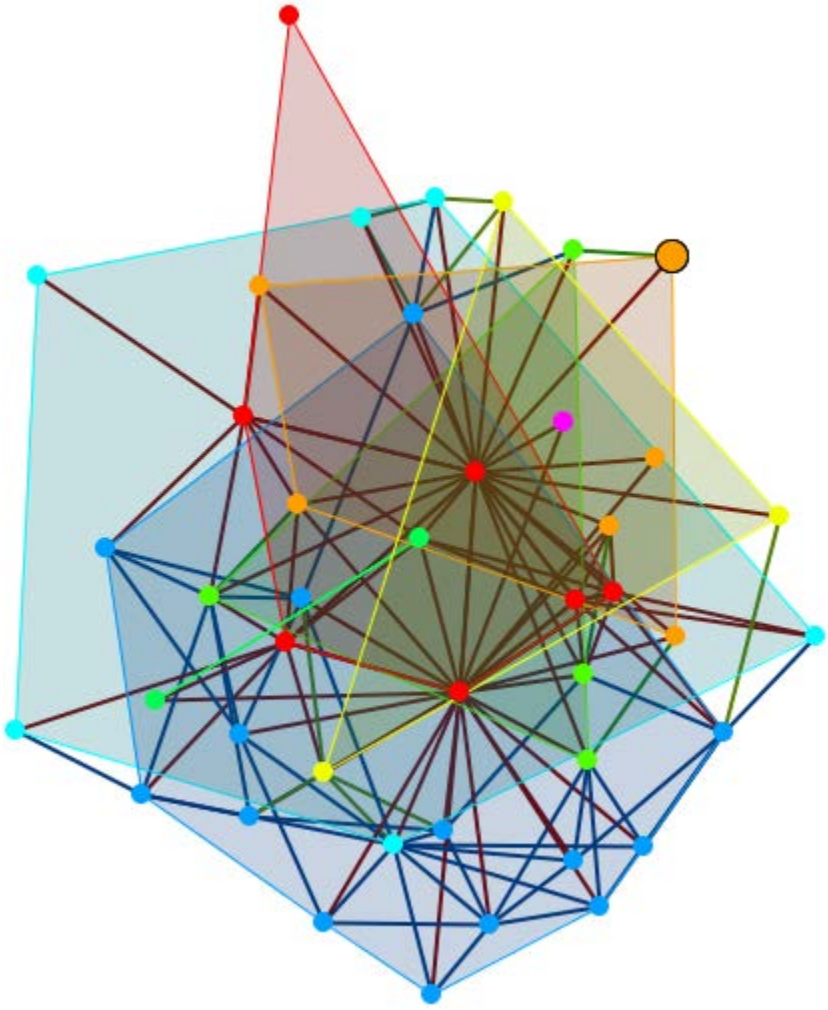
Meta-Nodes by Bounding Box

This shows all nodes in a Meta-Network with the Meta-Node names displayed near the Meta-Node. All nodes in that Meta-Node are contained within their box.



Meta-Nodes by Bounding Polygon

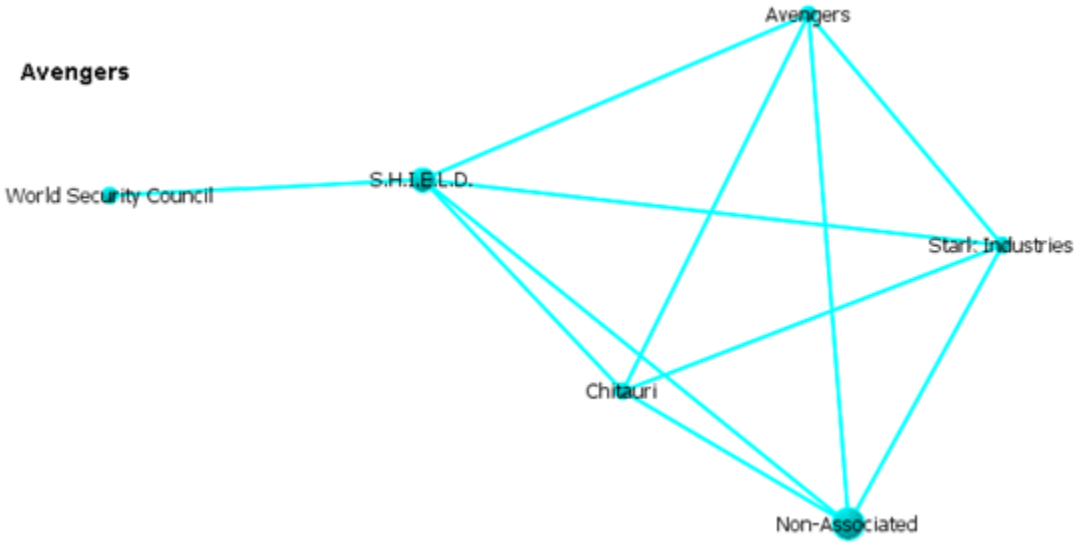
Each Meta-Node is contained within their individual colored polygons.



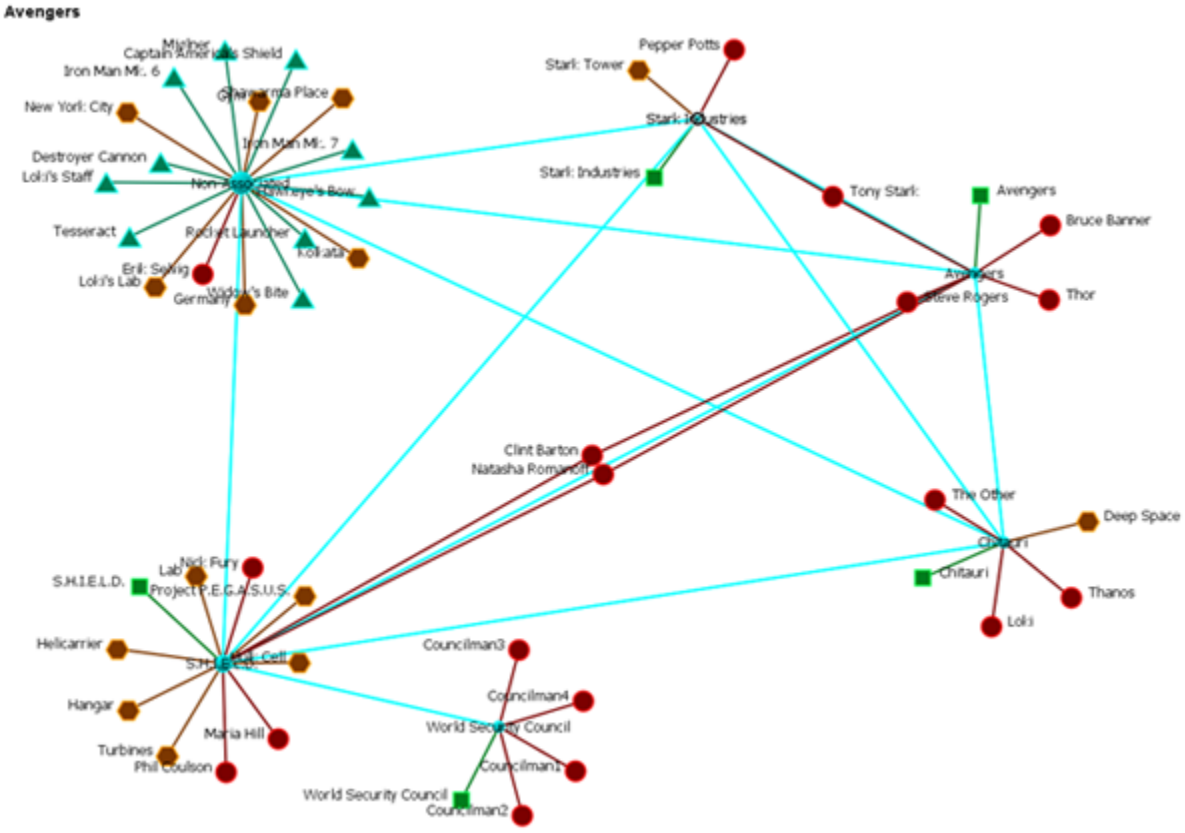
Other View Srtles

There are many ways to display your network in ORA. Below are a few examples showing the diverse styles available

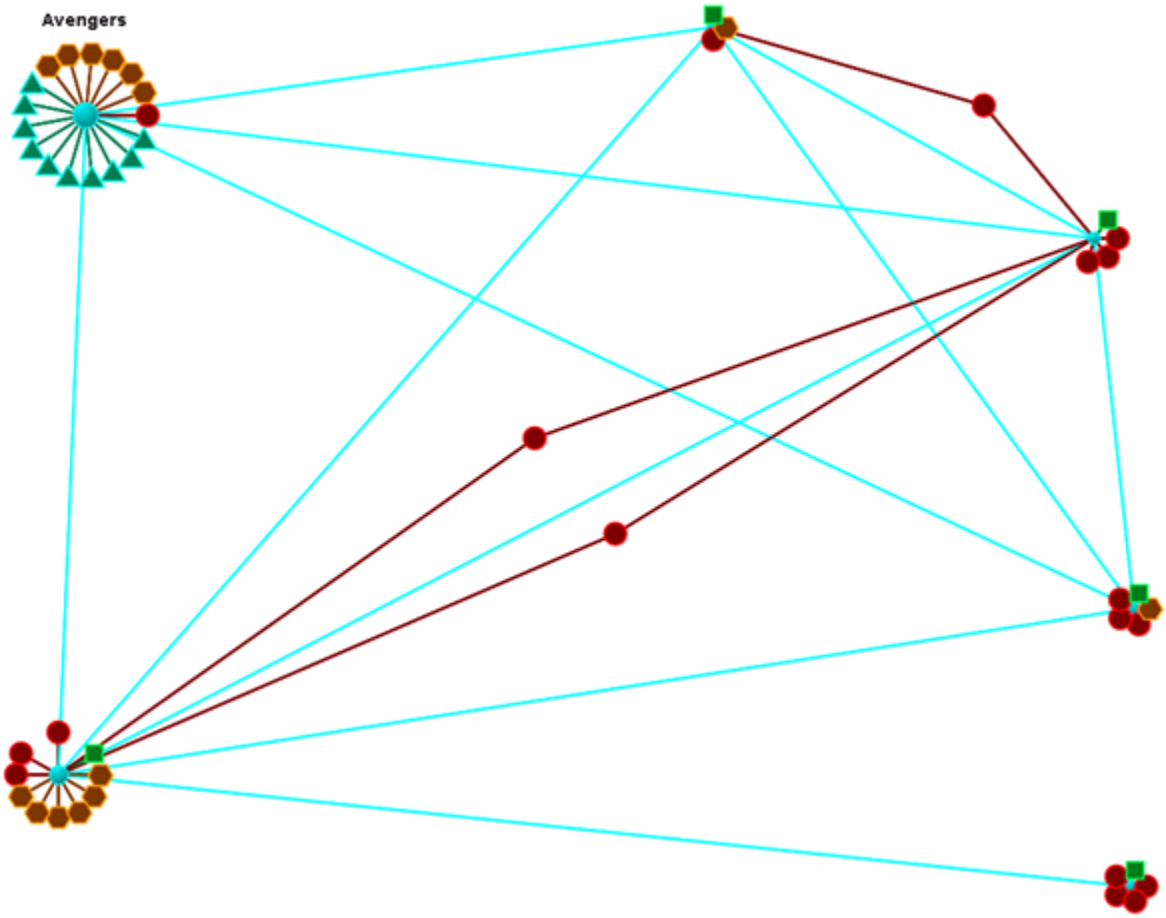
By Organization



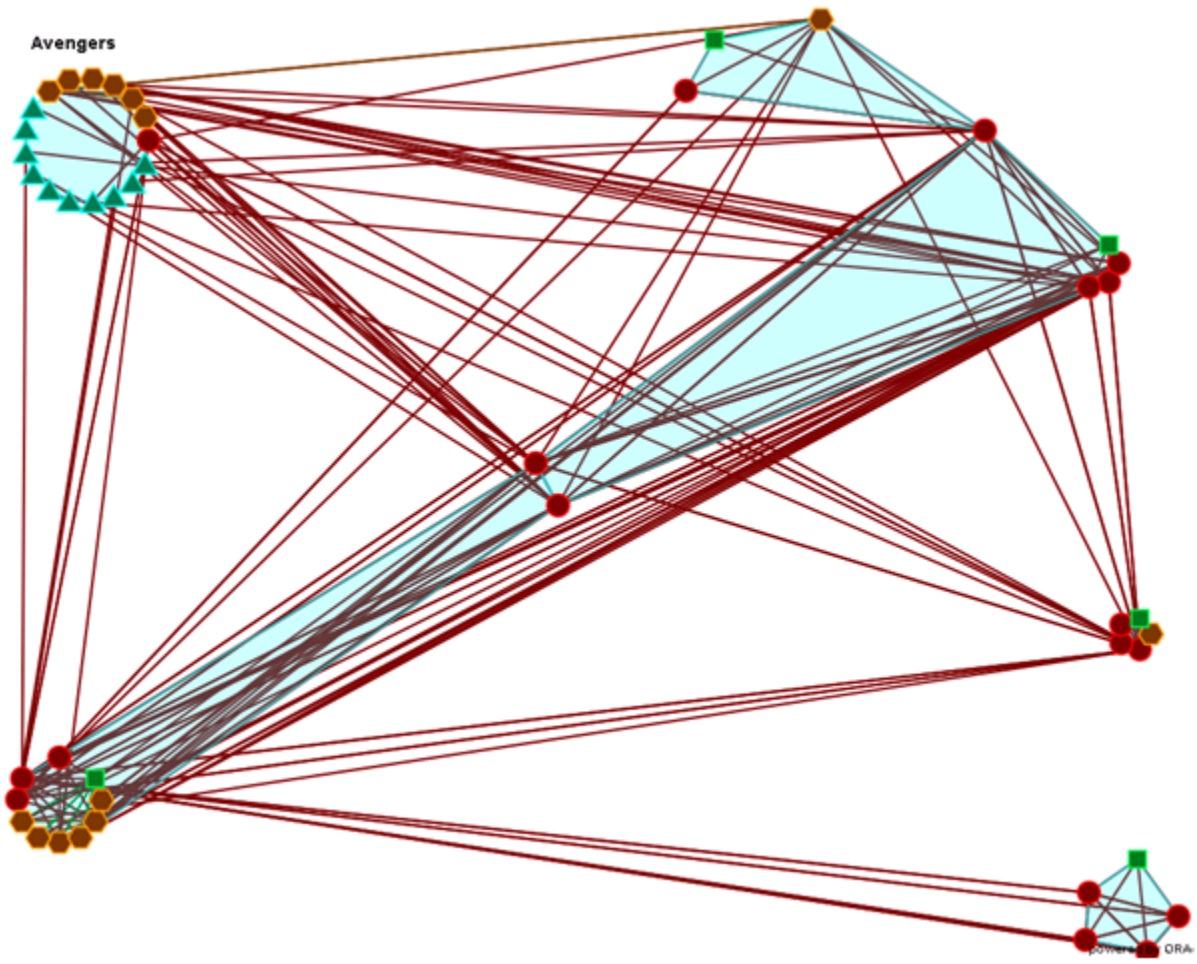
Organization with Components

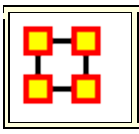


Links To A Meta-Node



Links To Other Meta-Nodes


Avengers



Group Viewer

The Group Viewer helps separate nodes into distinct groups.

We'll use one of the networks for each of the groups to further examine the breakdown.

There are six groupings which can be called up:

Clique :

CONCOR :

Johnson :

Newman : Used to find clusters in a network.

FOG :

Alpha-FOG :

ORA implements the newman algorithm presented in the following paper:

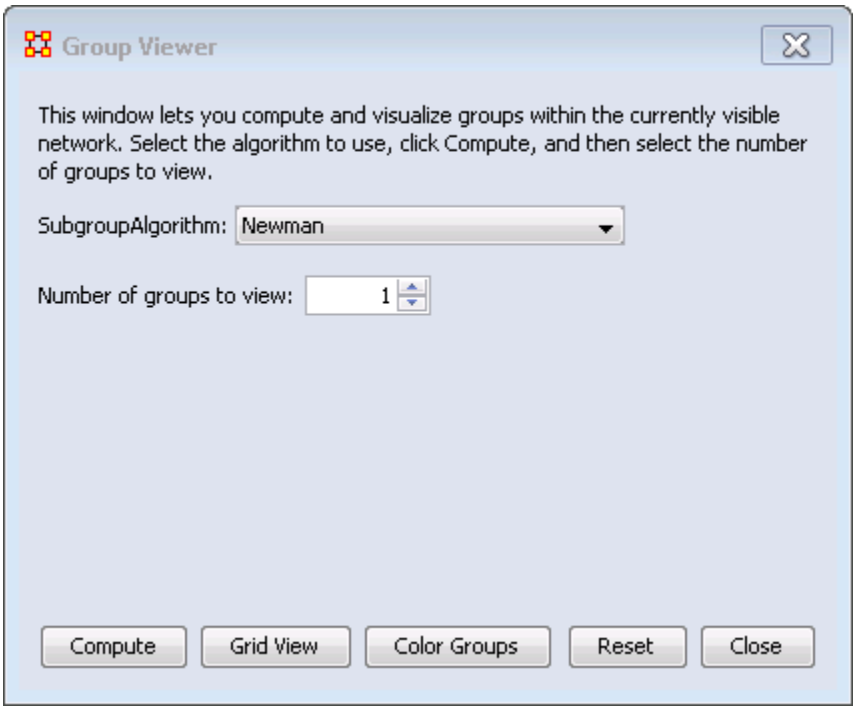
Finding community structure in very large networks, Aaron Clauset, M. E. J.

Newman, and Cristopher Moore, Phys. Rev. E 70, 066111 (2004). The algorithm uses link weights. It is not the Newman-Girvan algorithm based on betweenness centrality.

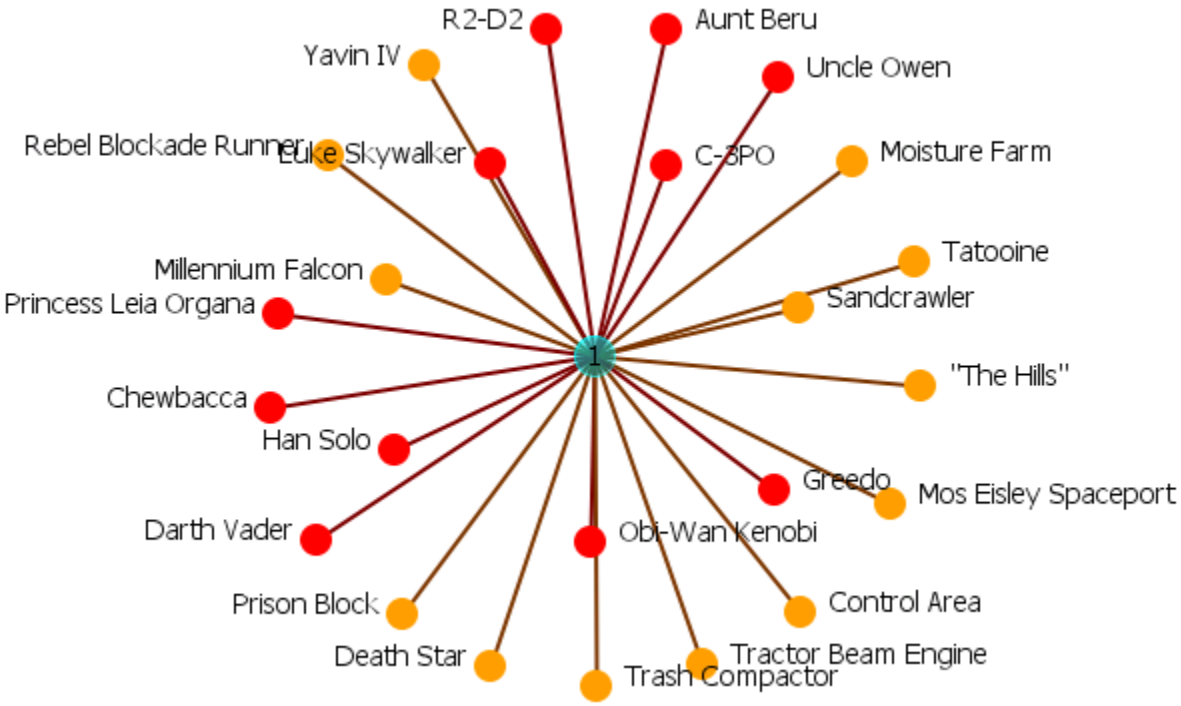
Please note, Newman developed this algorithm as it scales better than the Newman-Girvan for large networks.

Group Viewer-Newman

Description

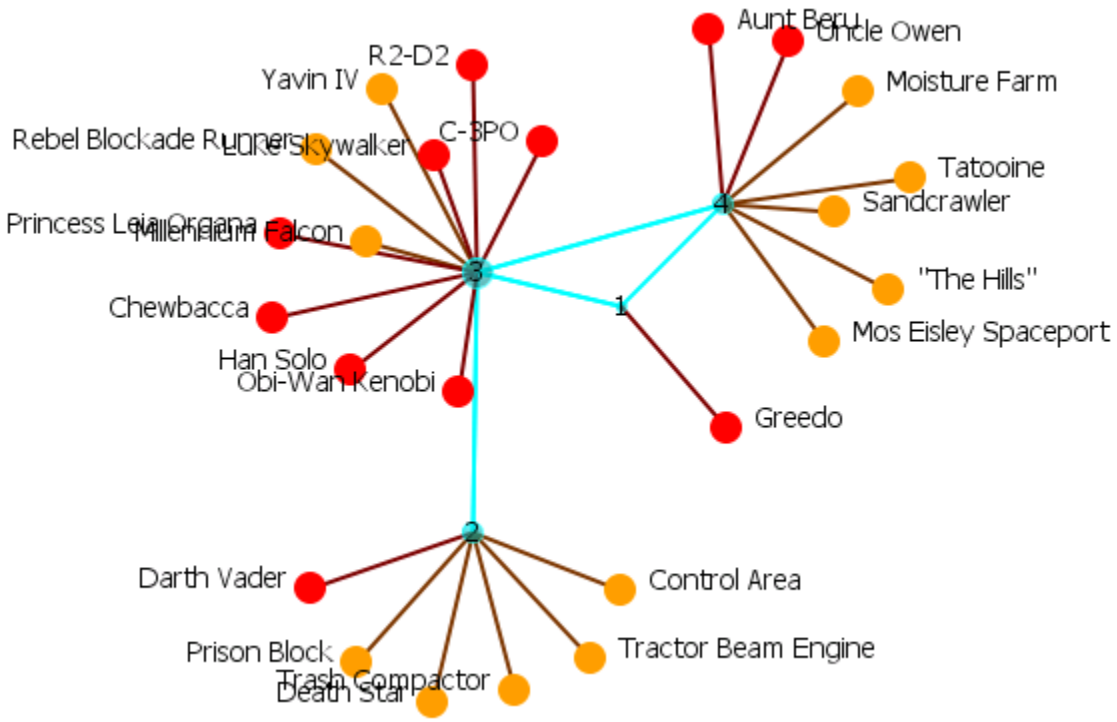


The Newman grouping is used to find clusters in a network. I began increasing the number of groups to view until the larger cluster began to break up. Newman's Algorithm starts with each node as its own group, and then combines groups in a hierarchical manner until only one group remains (e.g. it is agglomerative hierarchical clustering). At each step, which two groups to merge is based on what will maximize the **modularity** value - or group community structure value.



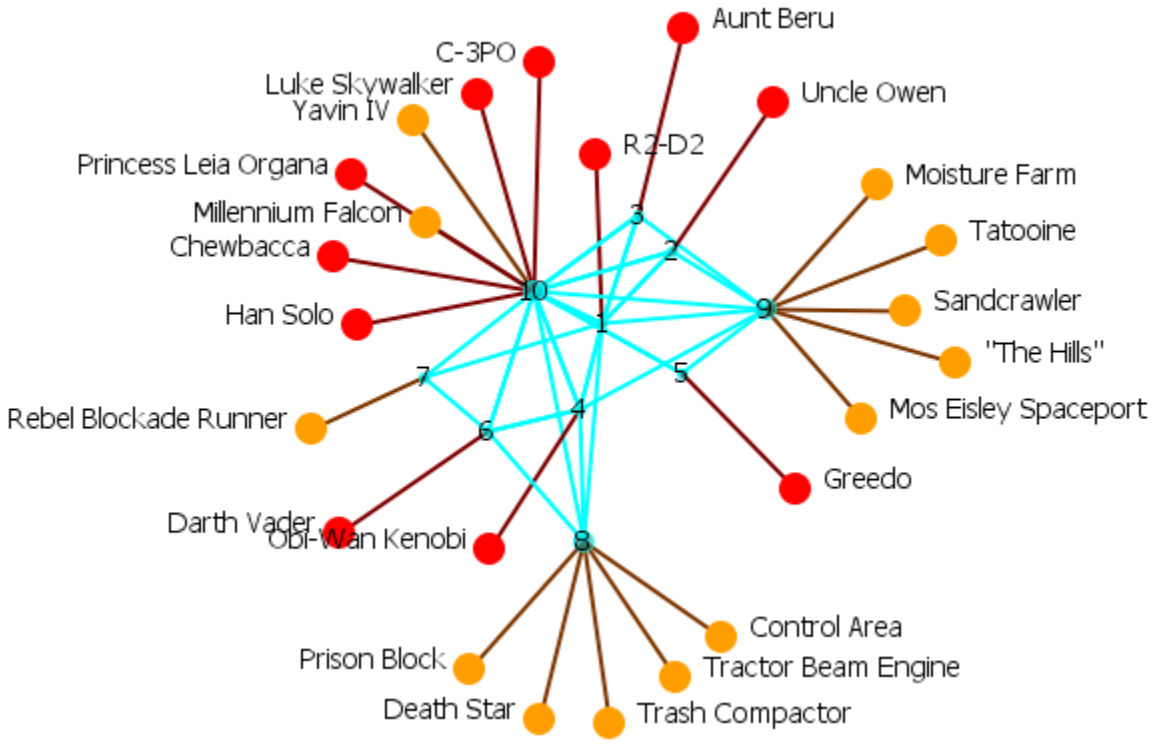
Newman with 4 groups

In the Group Viewer window set the **Number of froups to view:** to 4.



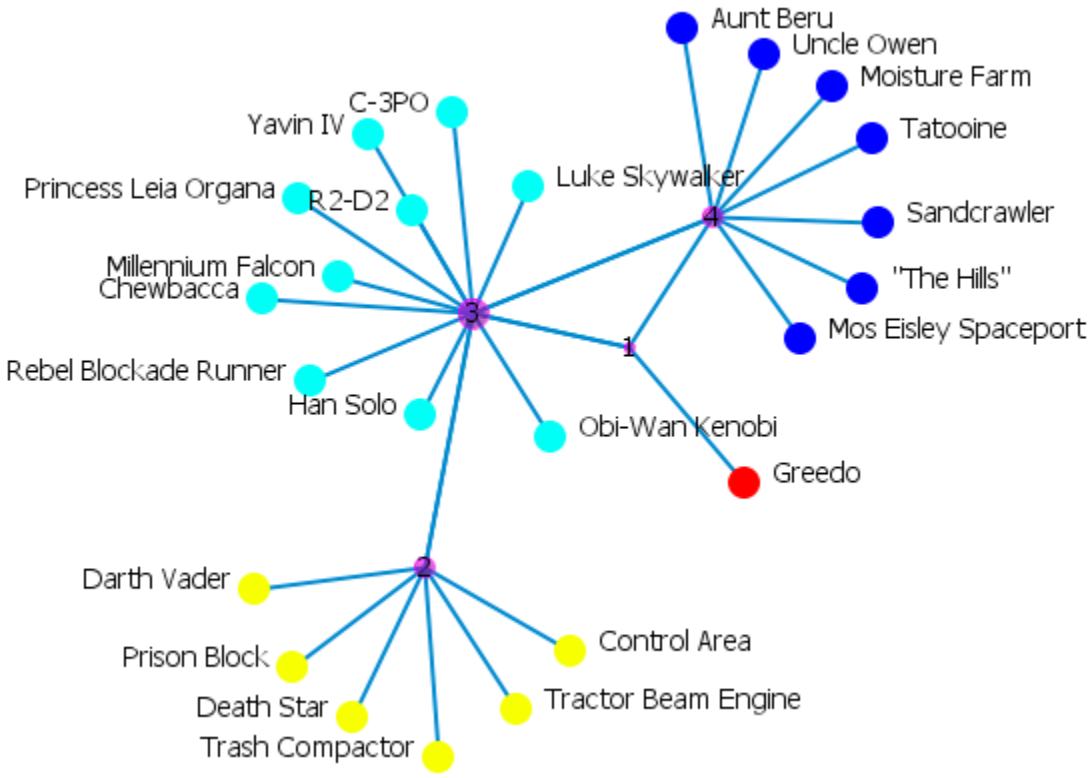
The Newman grouping is used to find clusters in a network. I began increasing the number of groups to view until the larger cluster began to break up.

Newman with 10 groups



Newman with 4 groups - Colored

Ora can also color-code each group for easier viewing.



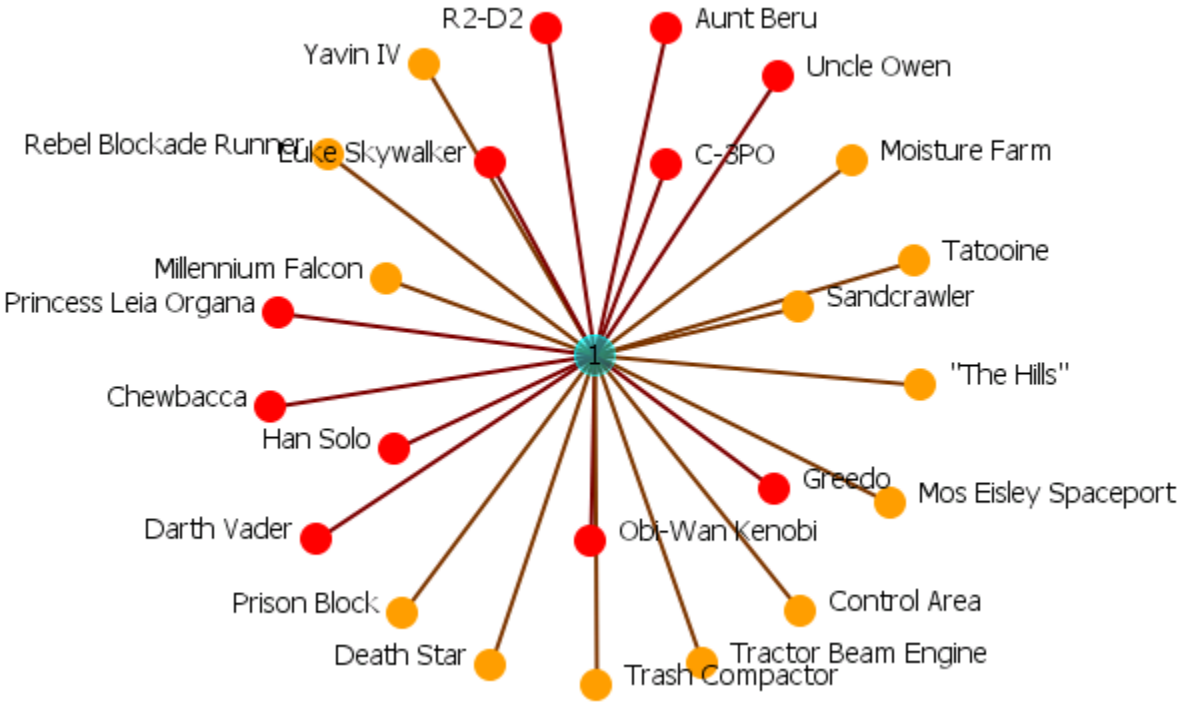
Clauset, A., M.E. Newman, et al. (2004). *Finding community structure in very large networks.* Physical Review 70 SP - EP

Group Viewer-Girvan Newman

Description

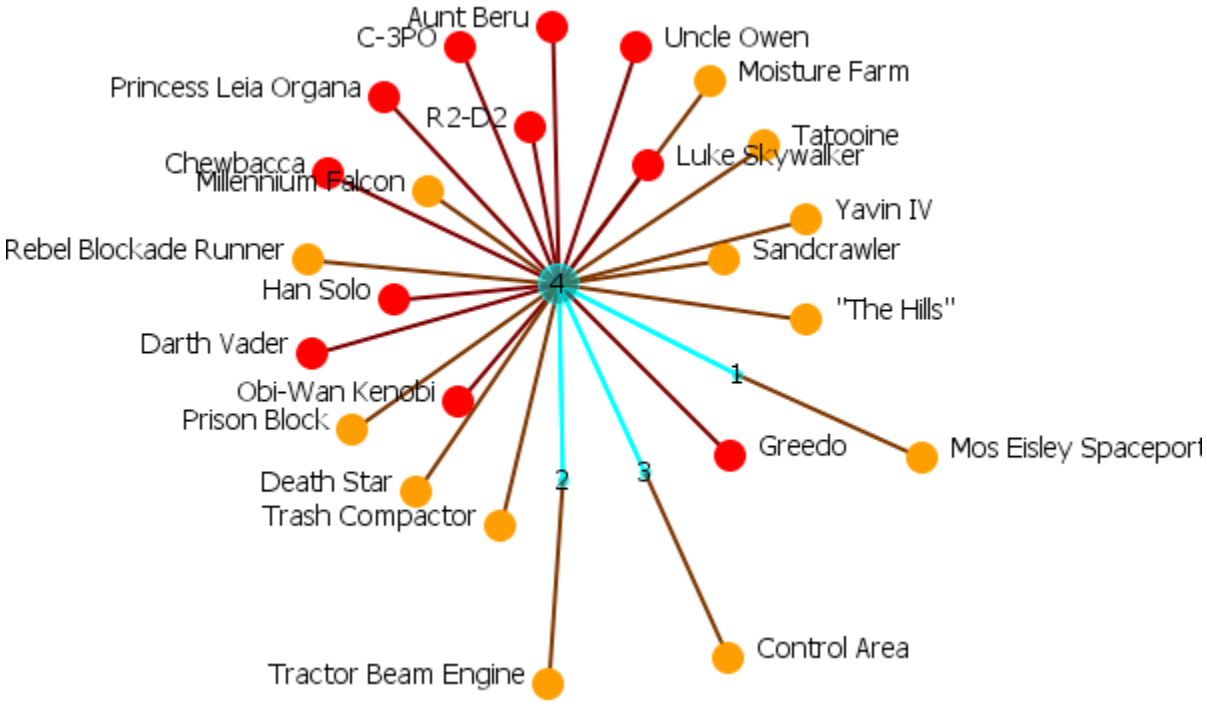
Girvan-Newman is divisive hierarchical clustering (all nodes start off in the same group and groups are split until each node is its own group). Groups are split by choosing from the edges that remain the one with the maximum edge betweenness score.

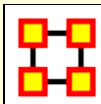




Girvan Newman with 4 groups

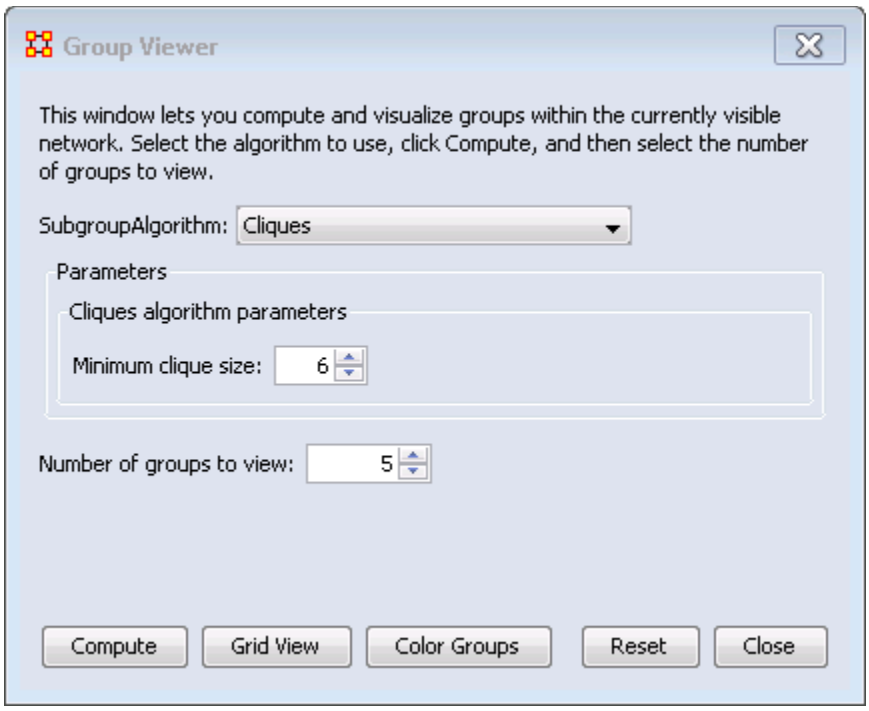
In the Group Viewer window set the **Number of groups to view:** to 4.

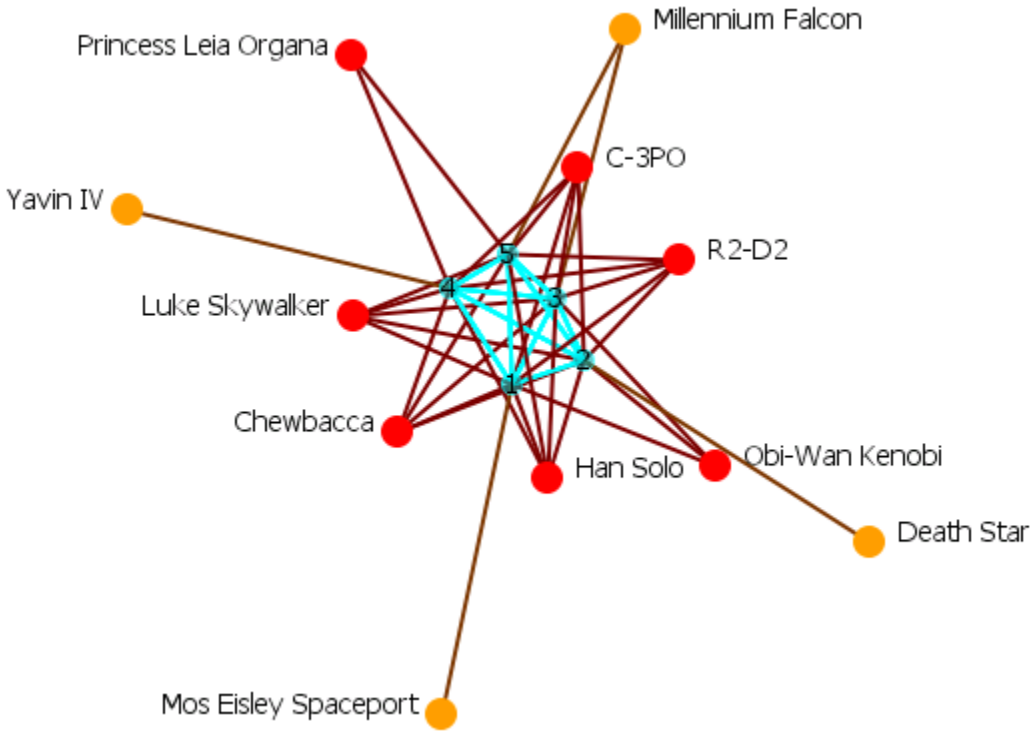




Group Viewer-Cliques

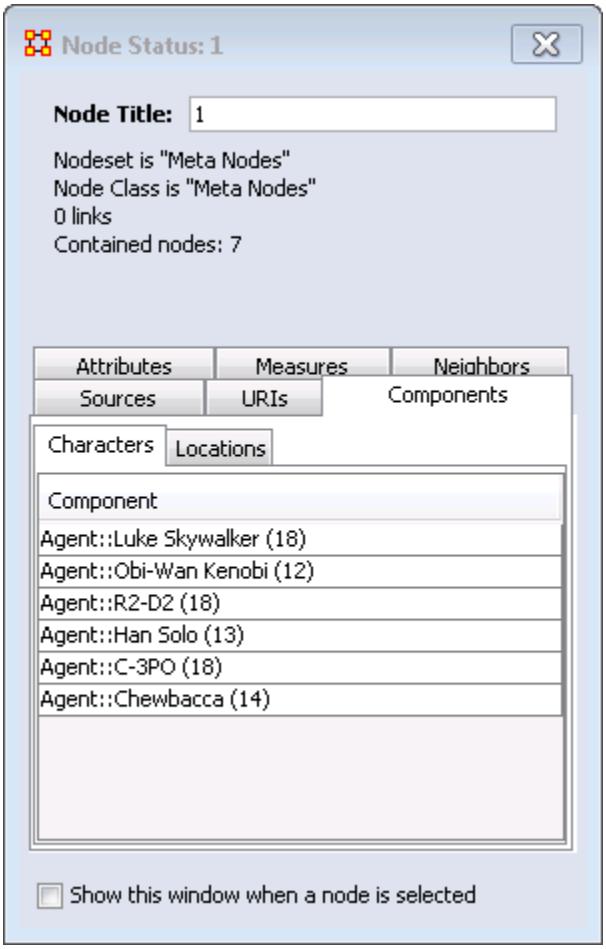
The defaults for **Cliques** for this network are set to **Minimum clique size: 3** and **Number of groups to view: 25**. This produces an unreadable display. Increase the number of groups until the number of groups becomes viewable. In this case **Minimum clique size: 6** and **Number of groups to view: 5**.


Group Viewer
This window lets you compute and visualize groups within the currently visible network. Select the algorithm to use, click Compute, and then select the number of groups to view.
SubgroupAlgorithm:
Cliques
Parameters
Cliques algorithm parameters
Minimum clique size:
6
Number of groups to view:
5
Compute
Grid View
Color Groups
Reset
Close


Millennium Falcon
Princess Leia Organa
C-3PO
Yavin IV
R2-D2
5
4
3
Luke Skywalker
2
1
Chewbacca
Obi-Wan Kenobi
Han Solo
Death Star
Mos Eisley Spaceport

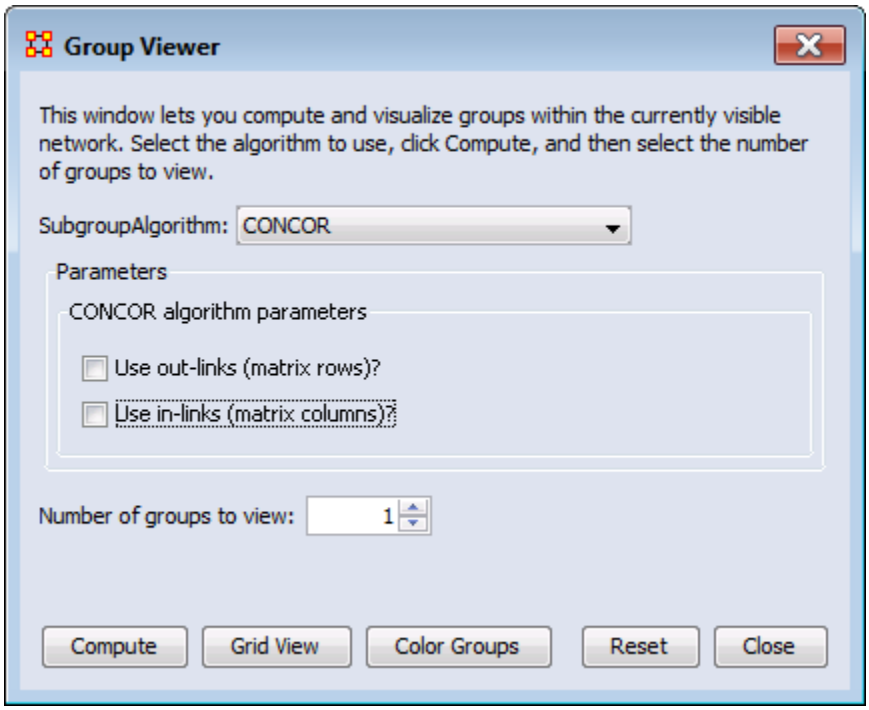
Examining a Meta-Node

To view a list of the components of a Meta-Node, double click the node. Select the **Components tab** for a list of the nodes.



Group Viewer-CONCOR

Below is an image of the Group Viewer window and procedures for using this tool. This is a Structural Equivalence/Clique which can be used on one or two mode data, and one or a set of networks at once.



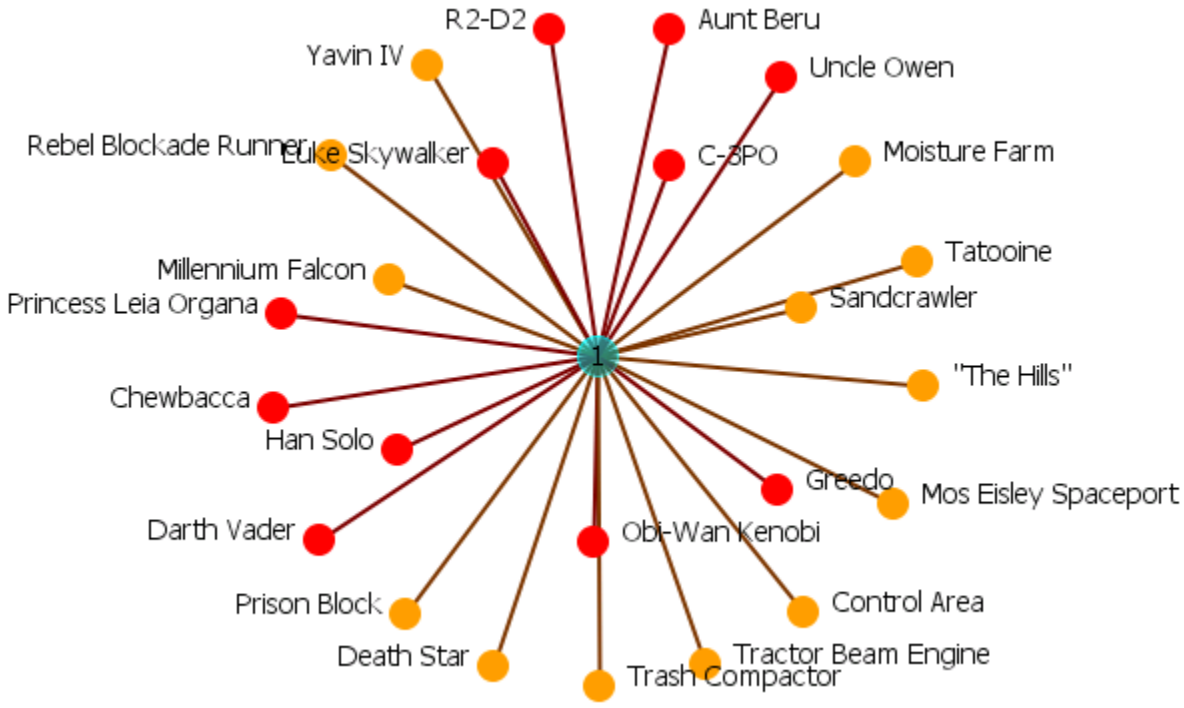
Parameters

Use out-links (matrix rows)? The links leading **out of** the chosen node into another node.

Use in-links (matrix columns)? The links leading **into** the chosen node from another node.

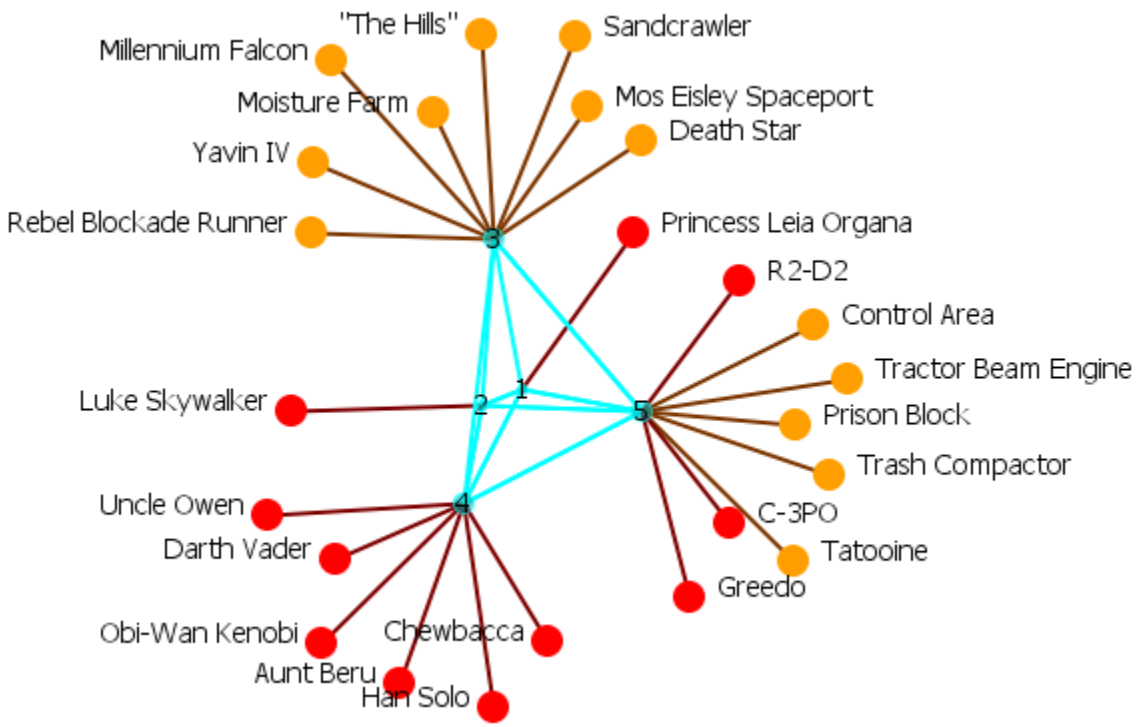
Number of groups to view:

Example

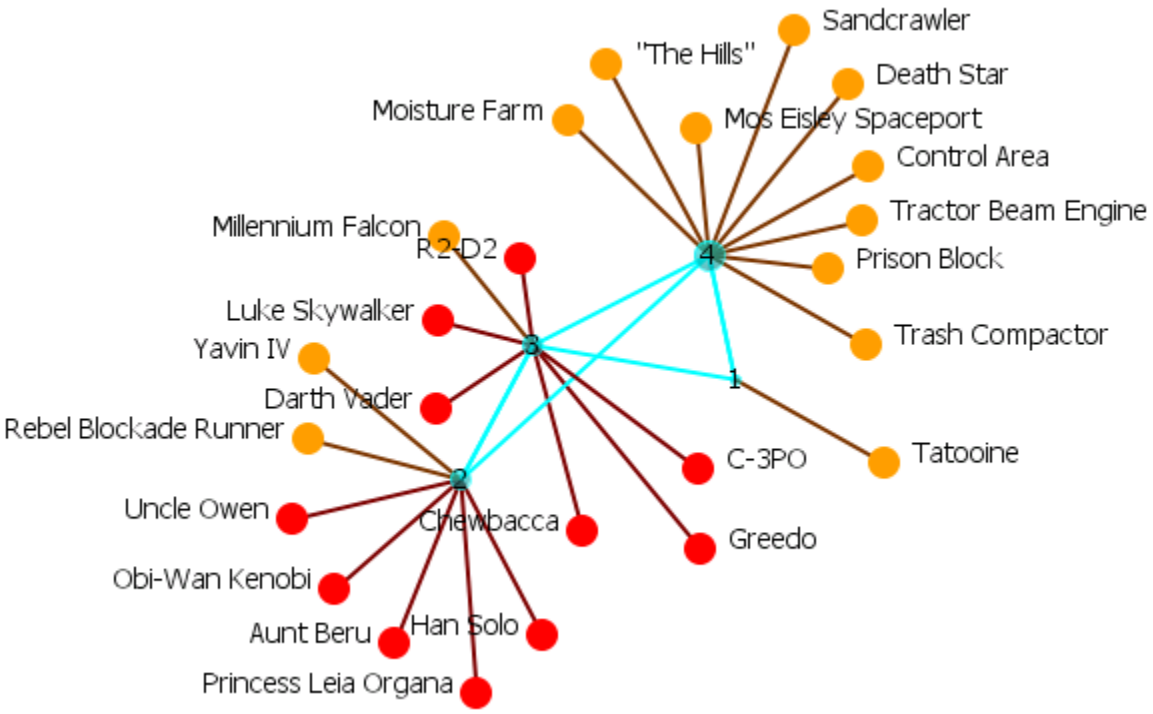


The example uses the network **Star Wars** dataset. For each of the three possibilities ***in, out, both*** the display is shown with the number of groups set to **4**. The resulting displays show how the in and out links affect the groupings.

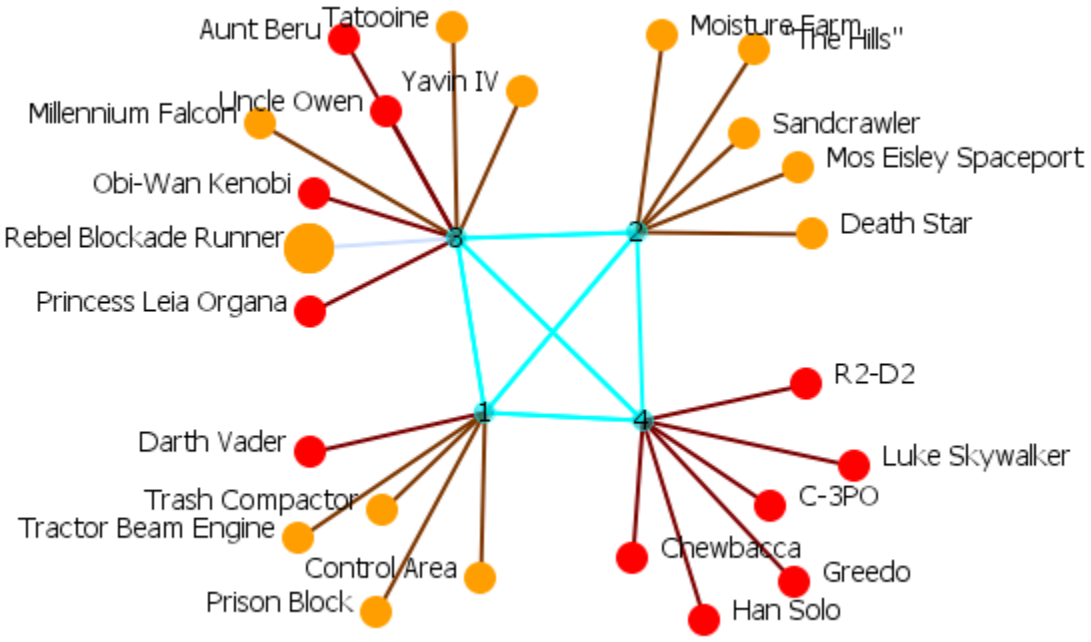
Use out-links

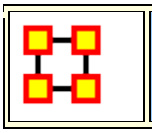


Use in-links



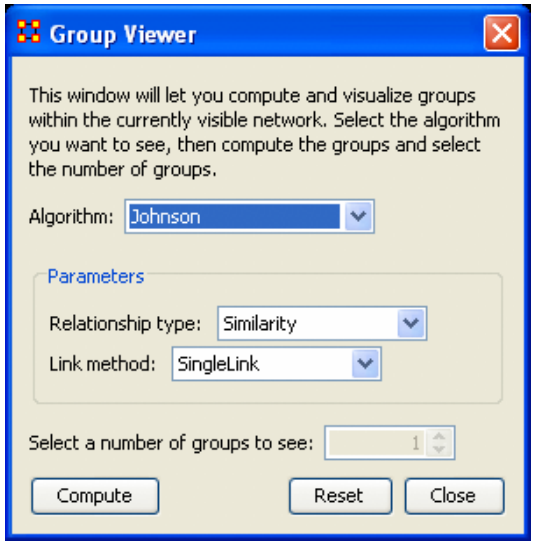
Use both in-links and out-links



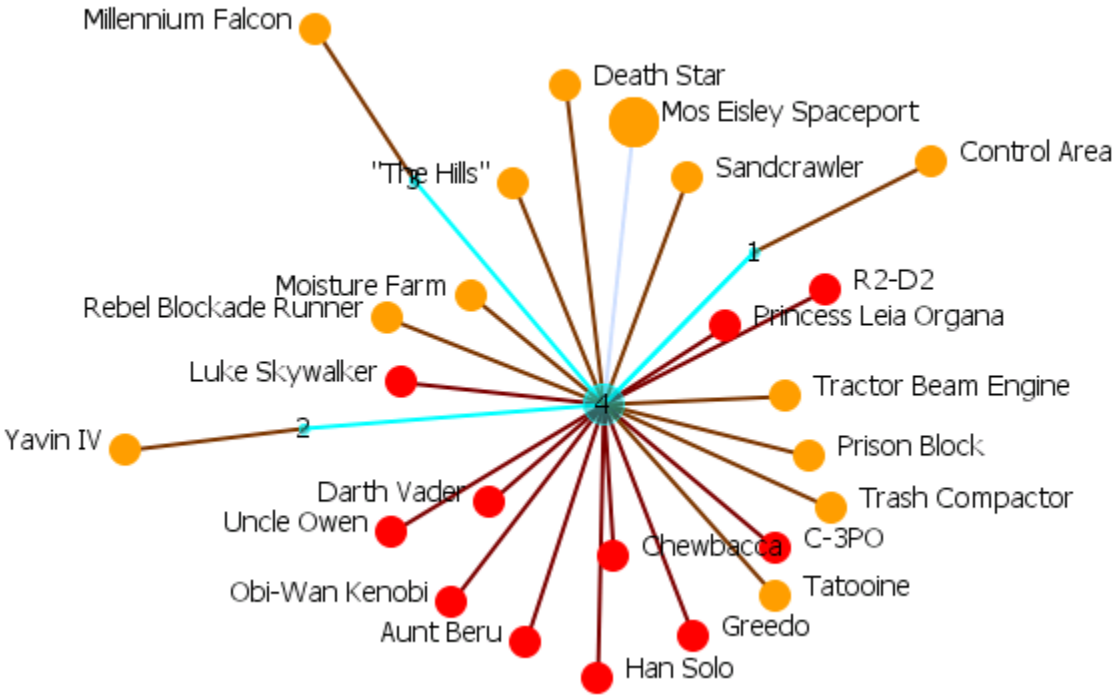


Group Viewer-Johnson

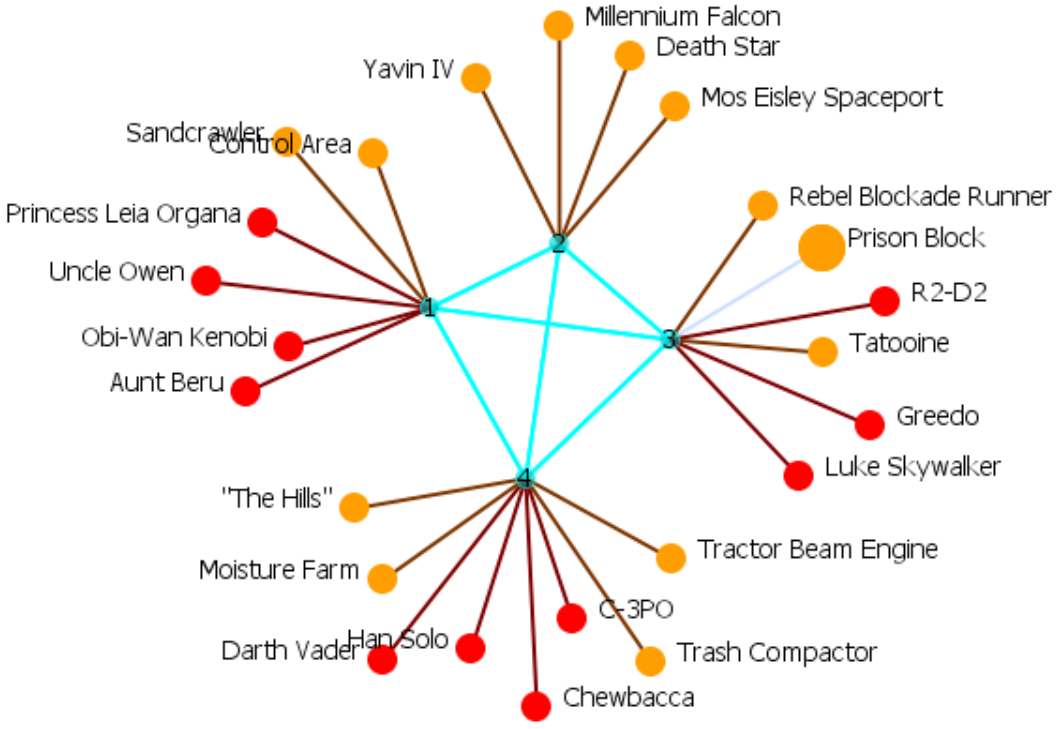
Below is an image of the Group Viewer Johnson window and procedures for applying the Johnson algorithm. This is a Hierachical Clustering based on Similarity Standard hierarchical approach that builds groups based on similarity scores.



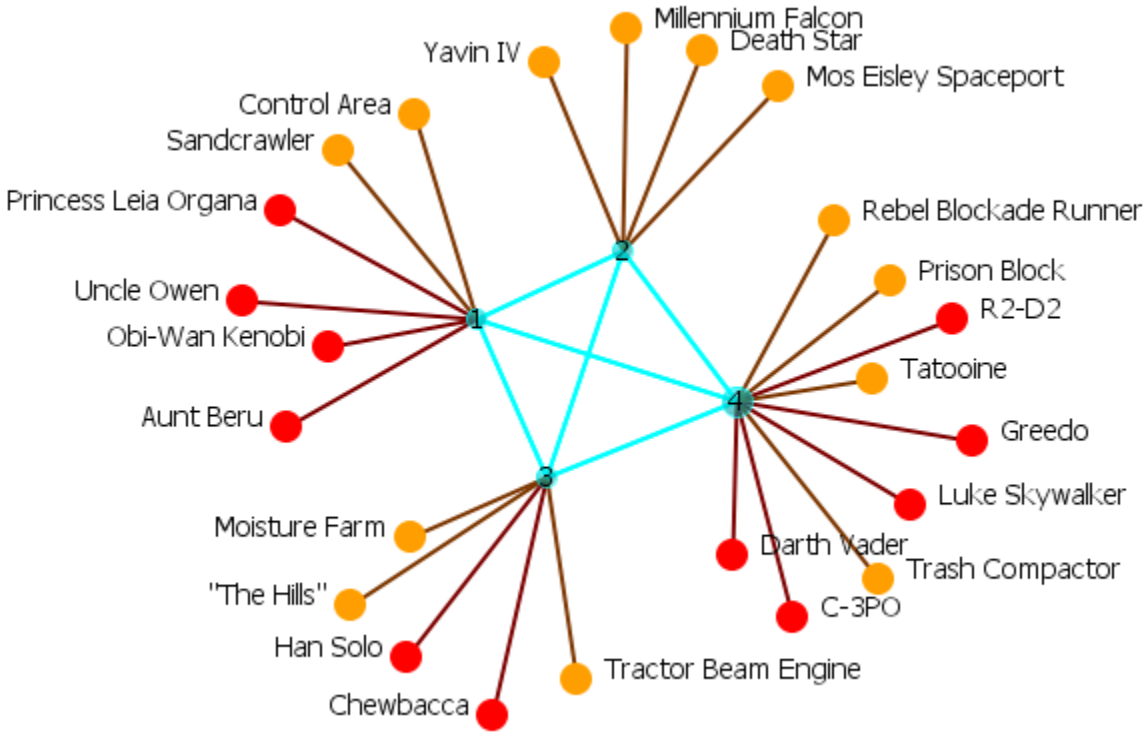
Johnson - Similarity, Single Links

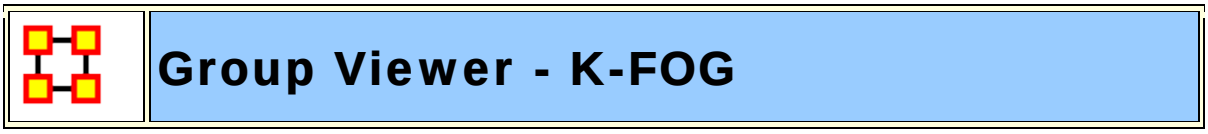


Johnson - Similarity, Complete Links



Johnson - Similarity, Average Links





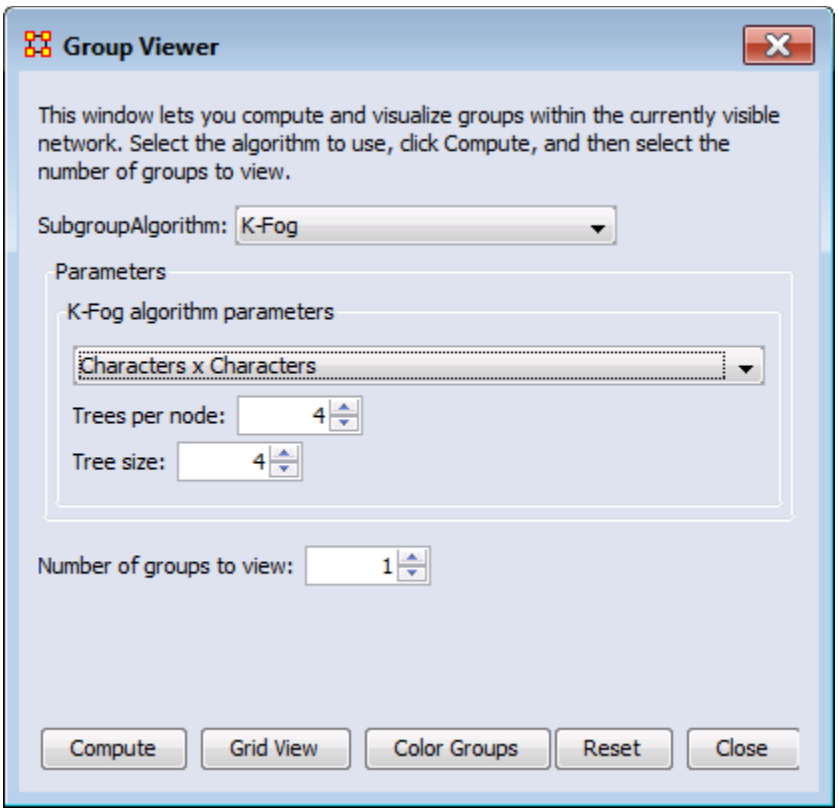
FOG (or Fuzzy Overlapping Groups) works in either one-mode (NodeSet-1 x NodeSet-1) or multi-mode (NodeSet-1 x NodeSet-2). The multi-mode is the more natural procedure. It's prime function is to form nodes into groups (clusters or communities) and show which nodes share the secondary functions.

REMEMBER : Groups produce tasks - people participate in tasks.

Select a Network: The same in both. The dropdown menu lists all the available networks in the selected Meta-Network. Which network you choose will determine the dialog that is present.

One-Mode

These are **square** networks [i.e., characters x characters]



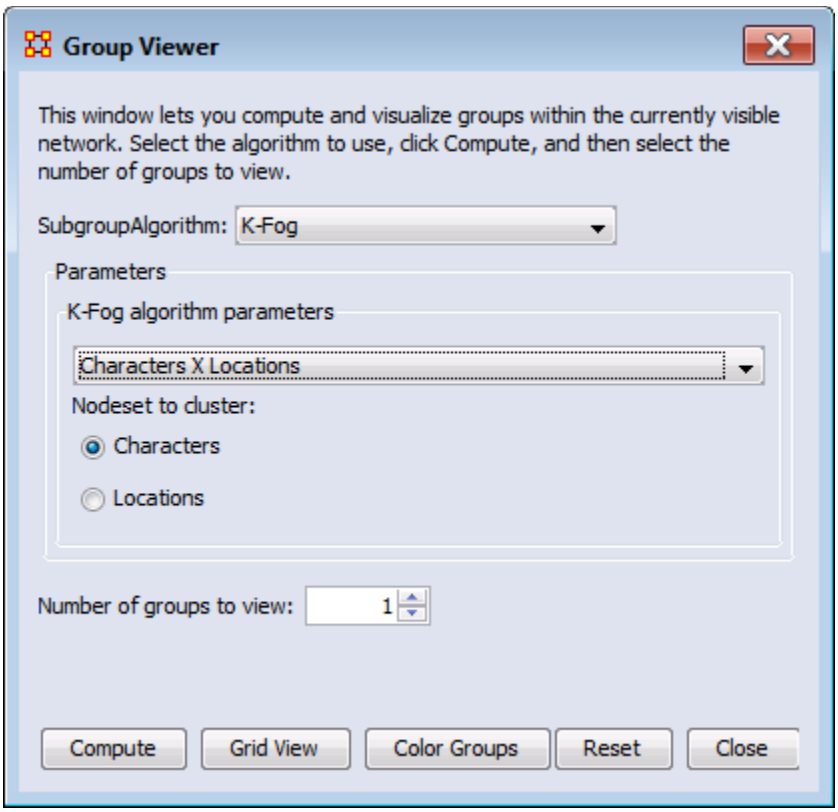
Select the number of trees per node : The number of sample events to generate.

Select the tree size : The number of people involved in each group

Number of groups to view :

Multi-Mode

These use two different networks [i.e., characters x locations].



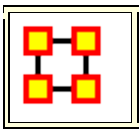
Select Nodeset to Cluster : Select which network in this multi-mode network to form clusters.

Links

The thickest link is usually the leader of the group. The question to ask is **WHY** is that particular person the strongest link. It is important to look at the composition of the group(s) involved.

If the weights are Lopsided (many strong and/or weak links) the analyst needs to look at the association of the **interstitial*** actors whose information will assist in analyzing the groups.

If a node is connected to only one group and that group has few actors then it is considered somewhat **insular**.



Node Appearance

Node Appearance

Label Style > Default : Sets the label to appear to the right of the node. This is the default position for labels.

Label Style > On Right of Node : Sets the label to appear to the right of the node.

Label Style > On Left of Node : Sets the label to appear to the left of the node.

Label Style > On Top of Node : Sets the label to appear on top of the node.

Label Style > On Bottom of Node : Sets the label to appear beneath the node.

Label Style > Centered on Node : Sets the label to appear directly centered on the node.



Node Style > Toggle Node Size : Rotates between the three sizes and styles for the display of the nodes.

Node Style > Spot : Sets the size of all nodes to a small colored circle.

Node Style > Small Shapes : Sets all nodes to a colored shape (circle, square, triangle, pentagon, diamond, hexagon).

Node Style > Large Shapes : Sets shape of nodes to a colored shape only large enough to contain the label.

NOTE : Meta-Network must be saved in the Editor in order for colors to be reloaded the next time the Meta-Network is loaded.

The Nodesets retain their default color in the Legend dialog. i.e. all agent NodeClasses will default to red.

Node Color > Show Node Occurrance Transparencies :

Node Color > Color Nodes by Attribute or Measures : ALlows you to chose an attribute or measure to run on a Meta-Network and will color the nodes in specific groups.

Node Color > Color Nodes by Componant :



Node Color > Color Nodes by Concor Grouping : Divides and colors nodes according to the Concur Grouping

Node Color > Color Nodes by Newman Grouping : Divides and colors nodes according to the Newman Grouping

---



Reset Node Color and Size : Sets the color and size of all node to the default values.

NOTE : Primarily used to resetting size after using **Size Nodes by Attribute or Measure**. The size set on the toolbar is the default size.

Size Nodes by Attribute or Measure : Allows you to chose an attribute or measure to run on a Meta-Network and will size all nodes accordingly.

Performing measure-based operations is not dependent on having previously run a report.

A Meta-Network asks if a measure can be run. If so, it is added to the list. That is why you may not see all measures appear in the dropdown menu.

Apply Log Scale to Current Sizing :



Show Labels : Toggles the names of the nodes on and off.



Load Node Images : If nodes have image files attached to an attribute this will display the picture instead of the node icon.



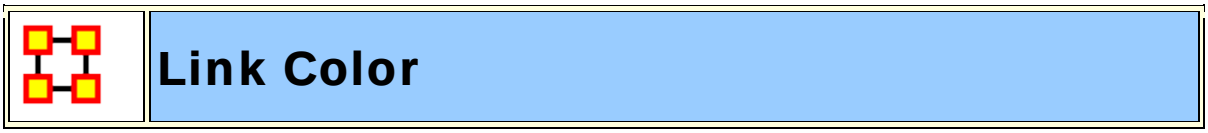
Remove Node Images : Removes all images from the visualizer and returns all nodes to their icon status.



Node Shaper : Allows you to chose the size and/or shape of any set of nodes. The set is not just one particualr Nodeset but can be created from individually choosen nodes from any Nodeset.



Attribute Measure related Options :



In ORA you can color links according to several preferences. Below are the procedures for doing so.

	Alpha	Bravo	Charlie
Alpha	0.0	1.0	2.0
Bravo	2.0	0.0	4.0
Charlie	3.0	9.0	0.0

NOTE : For this example all the nodes are colored black so as to decrease the color confusion.

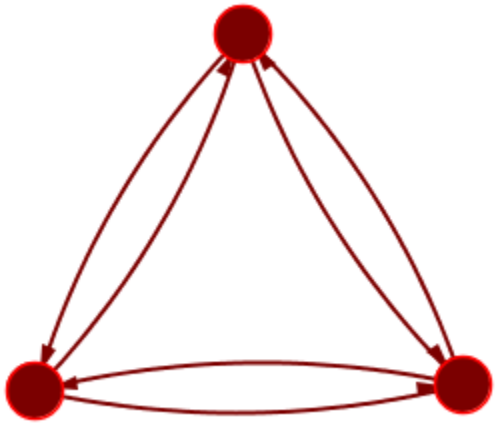
NOTE : For this example the link weights have been drastically altered from the original values to assist in display purposes.

NOTE : Below is a warning for the placement of the **Min** and **Max** sliders. When the sliders are set to the absolute left and right positions this causes all the colors to be set to red. Move the sliders in to prevent this.

Default Colors

When ORA starts out all agent nodes are red with red links. There is nothing to distinguish the weights of the links.

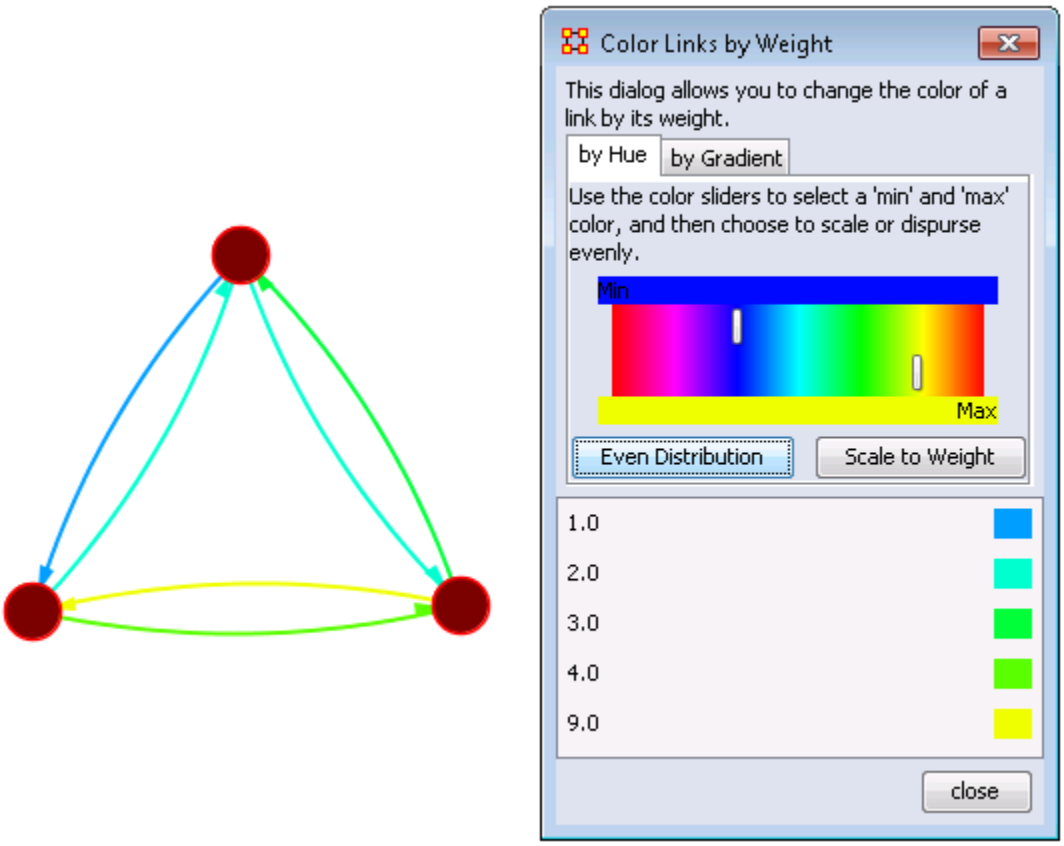
For clarity I will split the links using **Display > Link Appearance > Show Multiple Links Between Nodes > Split Bidirectional Links** so we can see the change in colors of the birectional links.



Now to distinguish the links by their weights select **Display > Link Appearance > Link Color > By Link Weight**. There are two options for coloring link weights.

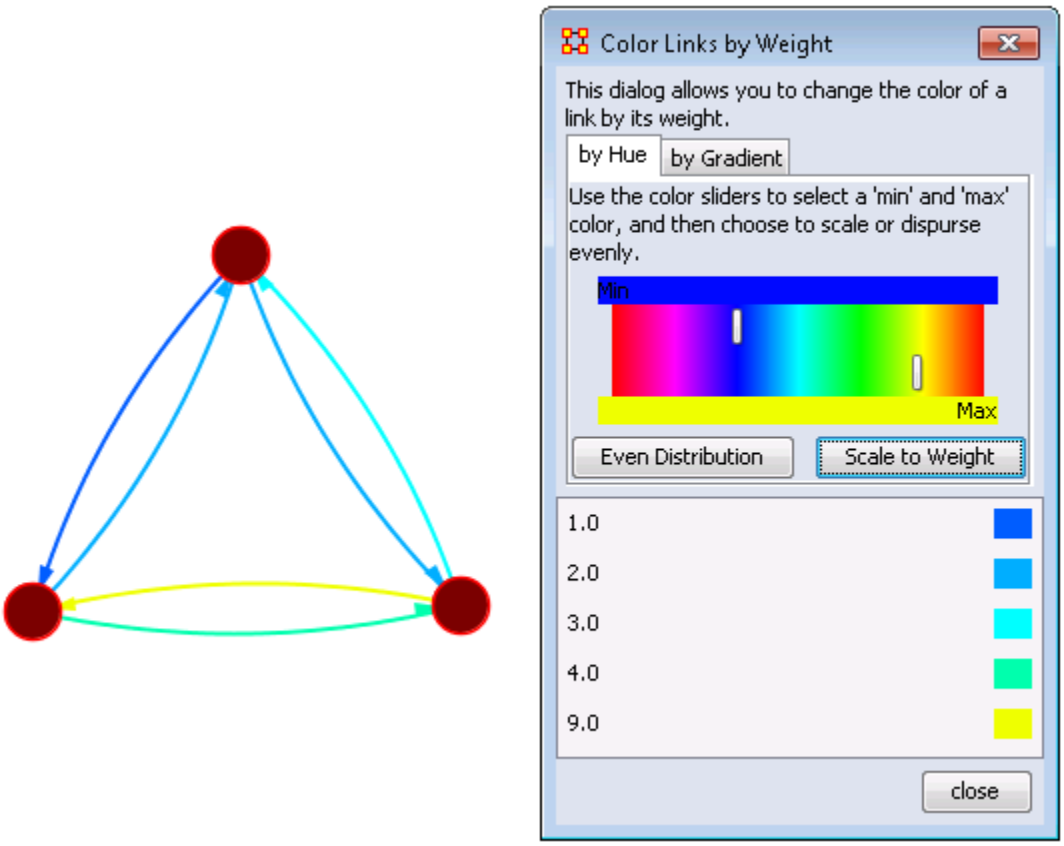
Even Distribution

The colors used are evenly distributed across the chosen spectrum. Using a Nodeset with weights of 1, 2, 3, 4, & 9 would have five colors chosen at evenly spaced intervals across the spectrum.



Limiting the spectrum too small might cause some of the numbers to contain very similar colors. This might make it difficult to tell the various shades of blue apart. Use this only when there are a very limited number of values.

Scale to Weight



Notice that values for 1.0 and 9.0 remain the same as the outer limits but the distribution for 2.0, 3.0, and 4.0 vary slightly.

Link Values

Notice that most of the colors are now in the blue to blue-green range and then a large gap over to yellow for the link weight of 9. These are scaled by the weight.

NOTE : When a link is bi-directional and the weights of the links are not the same the Visualizer will color the link that was drawn last. Sometimes it makes it difficult to tell the actual link color.

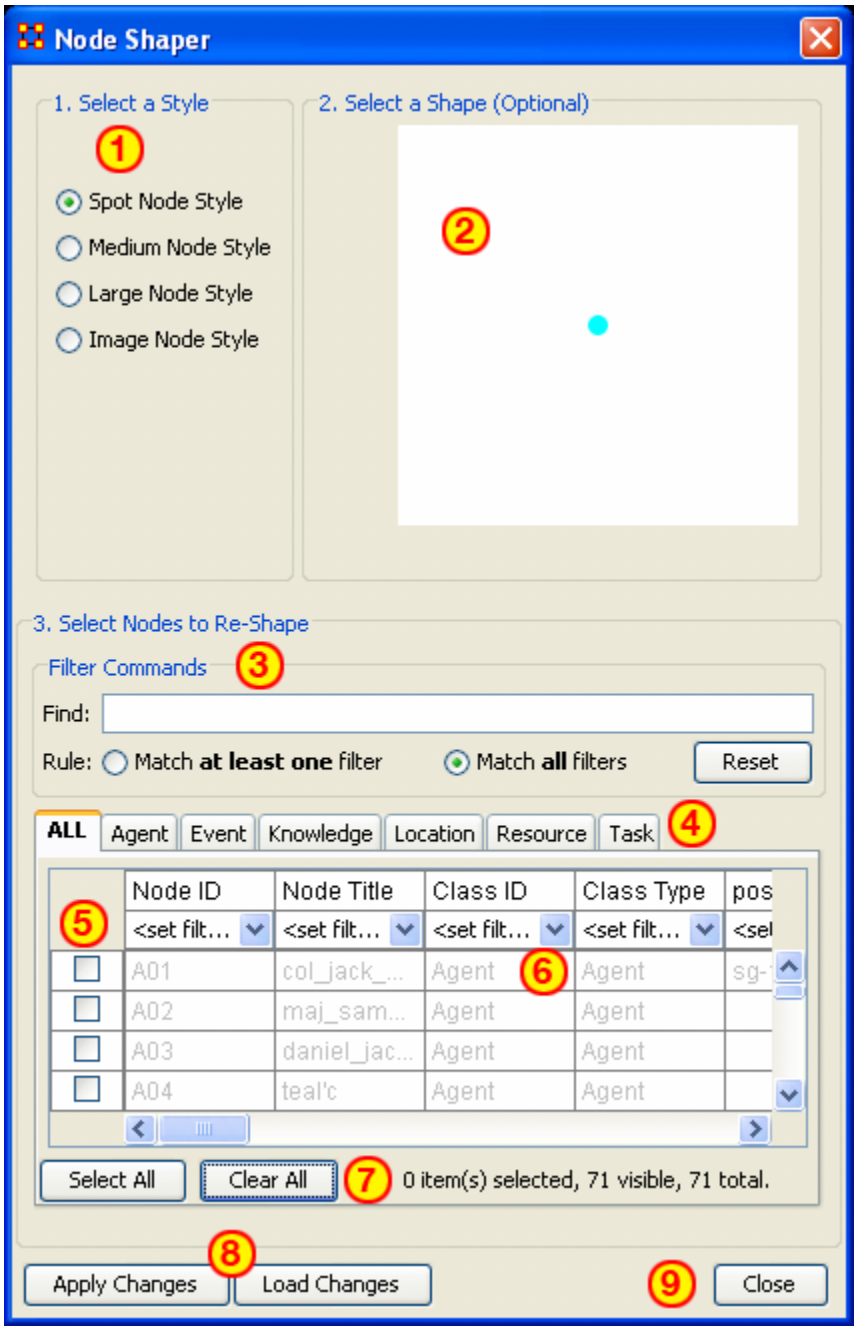
Change link Color

After setting the type **Even Distribution / Scale by Weight** the color of the links can be set manually through the color

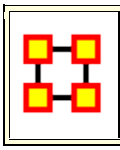
changer. Click on the color box of any of the links to bring up the color change dialog box. Select a new color and select **[OK]**.

Node Shaper

The **Node Shaper** allows you to change the size of individual node(s) or assigning pictures. Below is an image of the Node Shaper widow and a description of how to change the shape of the nodes in your model.



1. **Select a Style :** Select from three Node Style Sizes or use an image in it place of the node.
2. **Select a Shape :** An optional shape can be used instead of the Nodeset's default shape. The node will retain it's default Nodeset color.
3. **Select Node to Re-Shape :** The bottom section contains the controls for selecting which nodes to work with. Typing anything in the **Find** textbox will automatically filter out non-matching nodes.
4. **Nodeset tabs :** Select which Nodesets to view. **ALL** shows every node or the tabs will show only their individual Nodesets.
5. **Check boxes :** Place a checkmark in the box next to the nodes you want to change.
6. **Filters :** Use for filtering based on individual attributes. You can filter on more than one attribute at at time. An example can be found in **Create a new Meta-Network**
7. **Select/Clear All buttons : Will either Select or Clear all VISIBLE nodes.** If a check marked node has been filtered out and is currently **NOT** visible when the **Clear All** button is pressed, then that node will retain it's checkmark and be affected by future changes.
8. **Apply/Load Changes :** After any changes have been made to the top portions selecting the **[Apply Changes]** buttons will cause them to be displayed int he Visualizer.
9. **Close :**



How The Node Shaper Changes The Nodeset

What follows are examples of how the **Shaper** changes the **Nodeset**.

Whenever the **Node Shaper** is called and a node is assigned something other than it's default shape new attributes will be added to **Every** Nodeset, not just the Nodeset you're working with.

- **Drawing Type :** This will define what type of node is to be drawn, shape of image. There are three options for size (small, medium, and large) and one option for image.
- **Nodes Shape :** There are four large shapes (circle, rectangle, ellipse, and hexagon), eight medium shapes (circle, hexagon, down triangle, pentagon, diamond, square, up triangle, and octagon), and one small shape.
- **Image :** Contains the name of the file associated with that node.

Changing one node will **create these three attributes** and place the default value in every node in every Nodeset. Any of these attributes can be manually changed from within the Main Interface Editor.

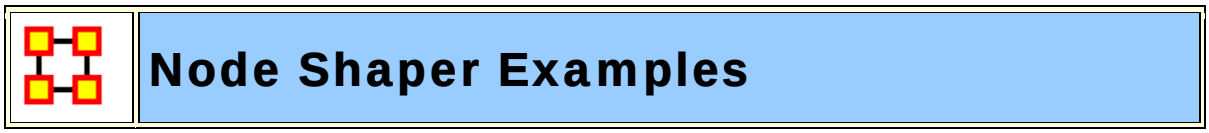
This is useful if you have changed many nodes and want to restore them all to their defaults quickly and easily. The quickest way is using the **Copy and Paste** method.

①	②	③	④
Drawing T...	Drawing T...	Drawing T...	Drawing T...
<set filt...	<set filt...	<set filt...	<set filt...
image	image	medium	medium
image	image	medium	medium
image	image	medium	medium
image	image	image	medium
small	small	small	medium
small	small	small	medium
medium	medium	medium	medium
medium	medium	medium	medium
large	large	large	medium
medium	medium	medium	medium
small	small	small	medium
medium	medium	medium	medium
large	large	large	medium
medium	medium	medium	medium
medium	medium	medium	medium
medium	medium	medium	medium

Column "1" contains the modified values. In column "2" three values of medium are highlighted and copied using **Ctrl-C**. In column "3" the cursor is moved to the top cell and **Ctrl-V** is used to paste those

three values in. In column "4" this is repeated until all values are back to their defaults.

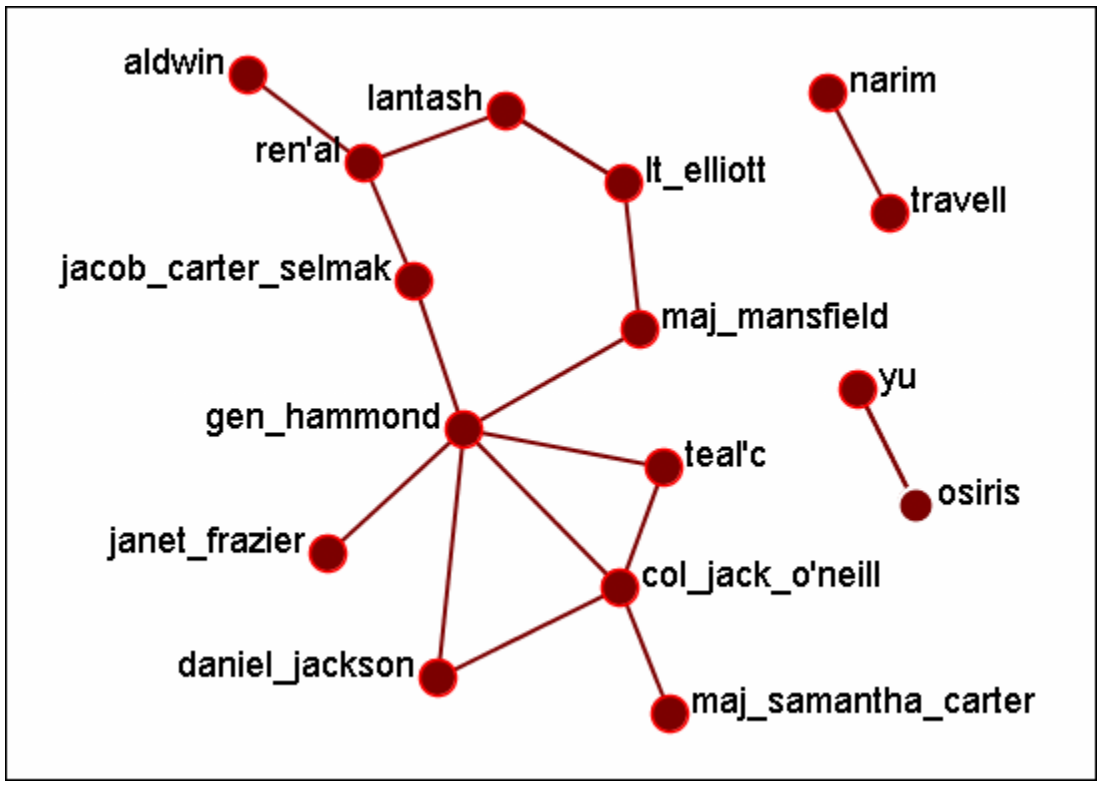
If the **Image** attribute contained a filename then changing **Drawing Type** to image will relink that file to the picture. Any of the four **Drawing Type** values can be placed in this column.



Original agent x agent Network

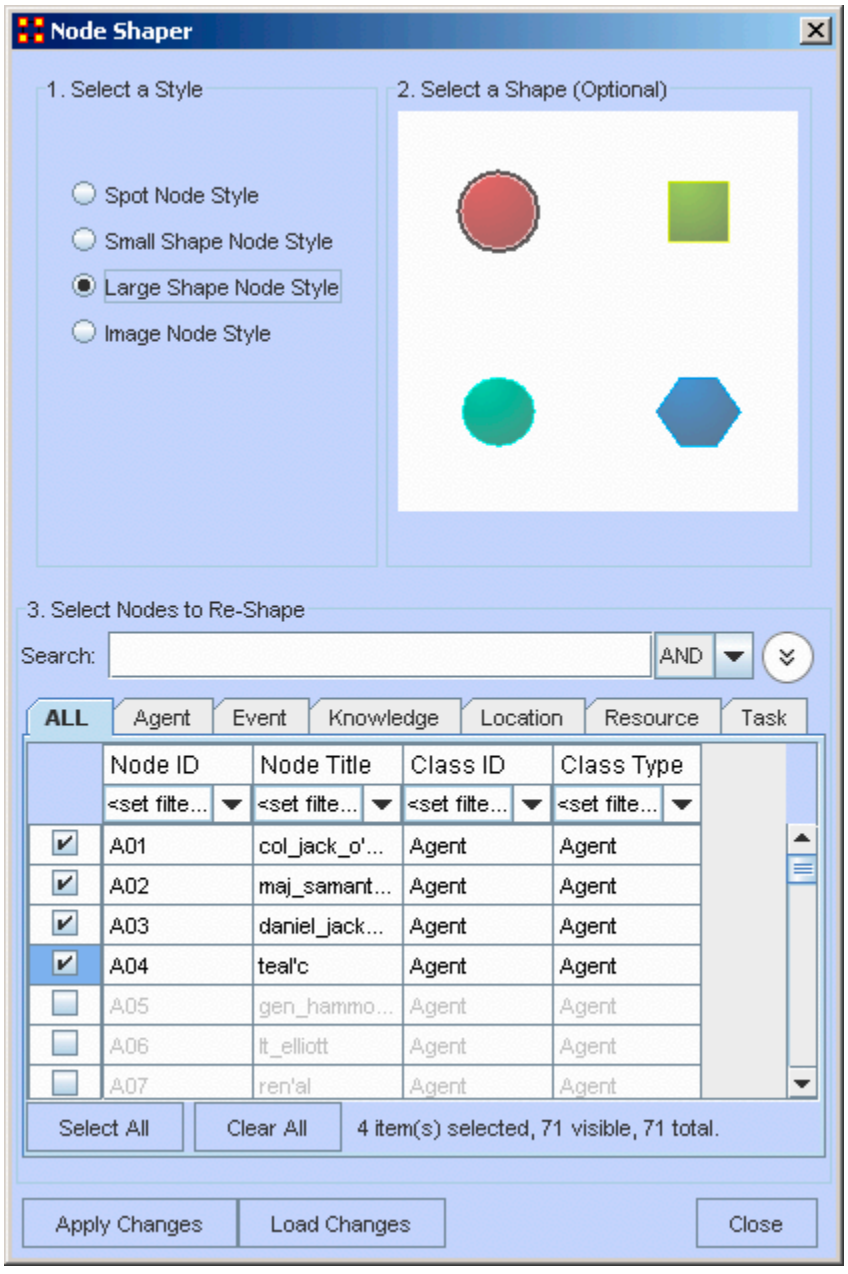
Below is the **agent x agent** network in the normal **medium sized nodes**.

We start out with the stargate agent x agent Node Class set to medium size nodes.

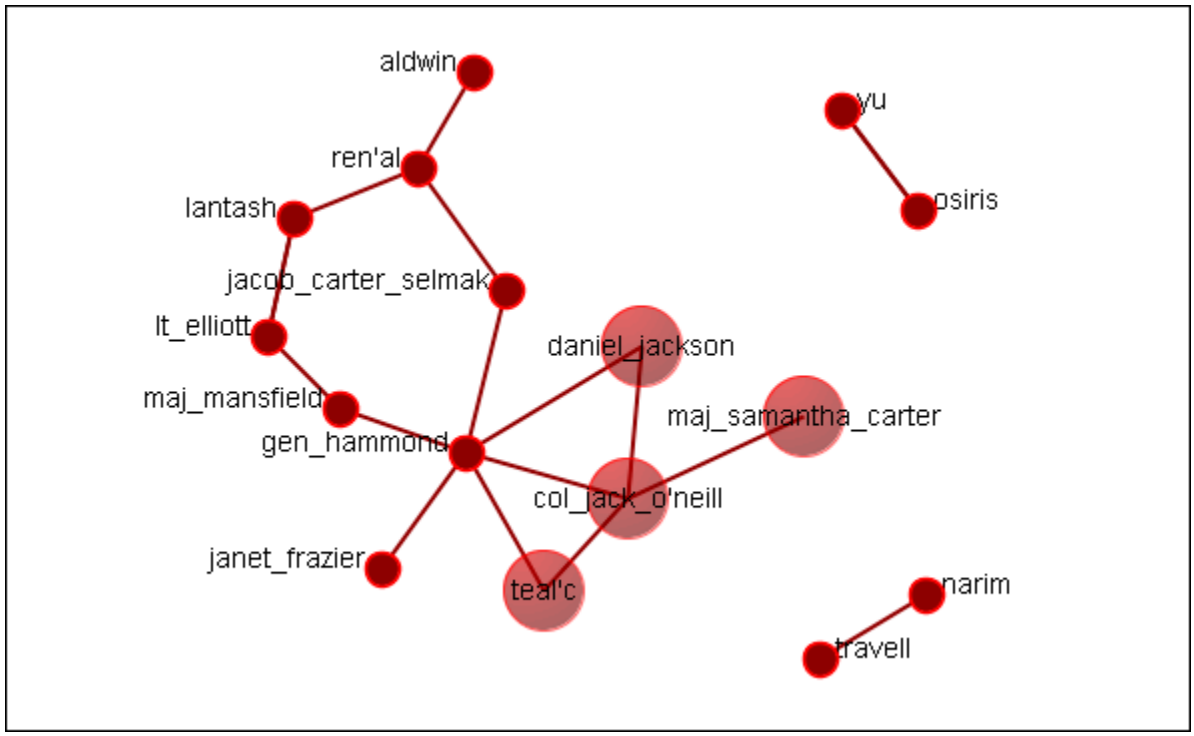


Changing a few nodes

From the Visualizer menu select **Display > Node Appearance > Node Shaper**. Click the tab marked [**agents**]. Place a check mark next to **col_jack_o_neill, maj_samanatha_carter, daniel_jackson, and teal_c**. Select the **Large Node Style**.



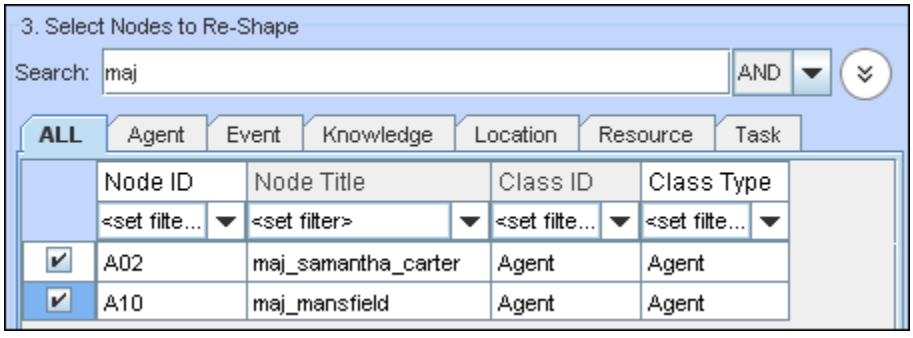
When you are finished click the [**Apply Changes**] button.



Now the four members of SG-1 stand out represented by larger nodes.

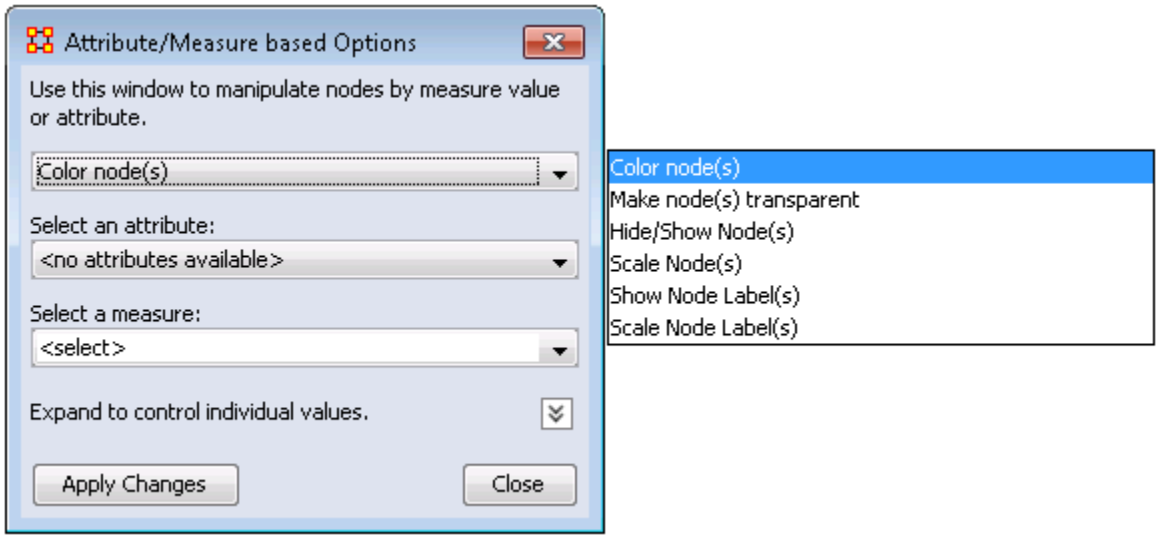
Select Nodes to Re-Shape

You can also use the Search box, in conjunction with the tabs, to bring up specific nodes in the grid. It's predictive so as you begin typing the grid will change. Continue typing until you see the node(s) you need. I wanted the two characters with the rank of major and knew their rank was a prefix. I typed **maj** into the search box and the two nodes were singled out.



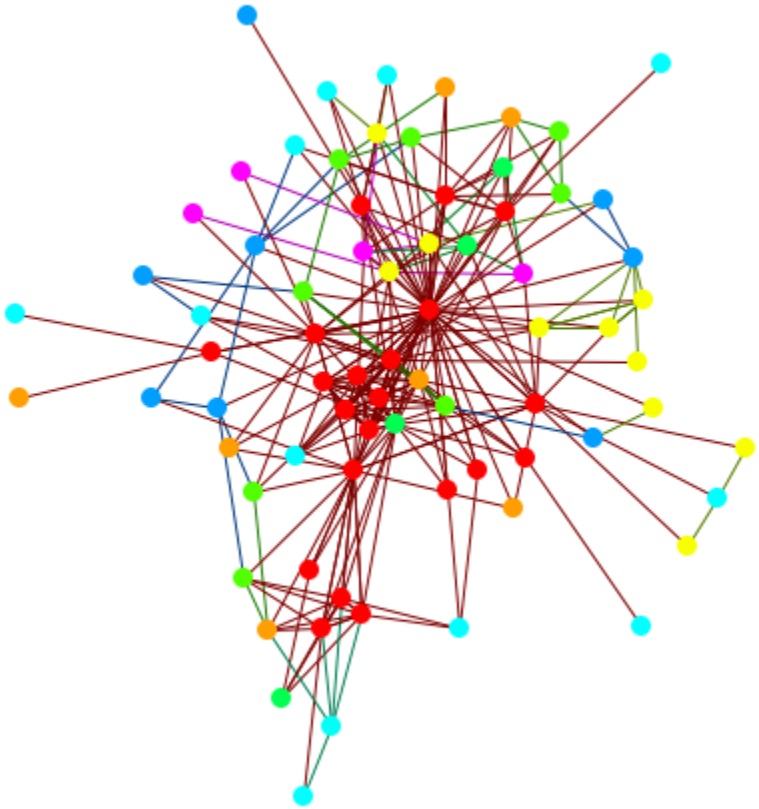
Attribute / Measure Based Options

ORA allows you to alter the appearance of the nodes in a multitude of ways as seen from the drop down menu below. We'll take a look at two of these items which will give you an understanding of how they work.



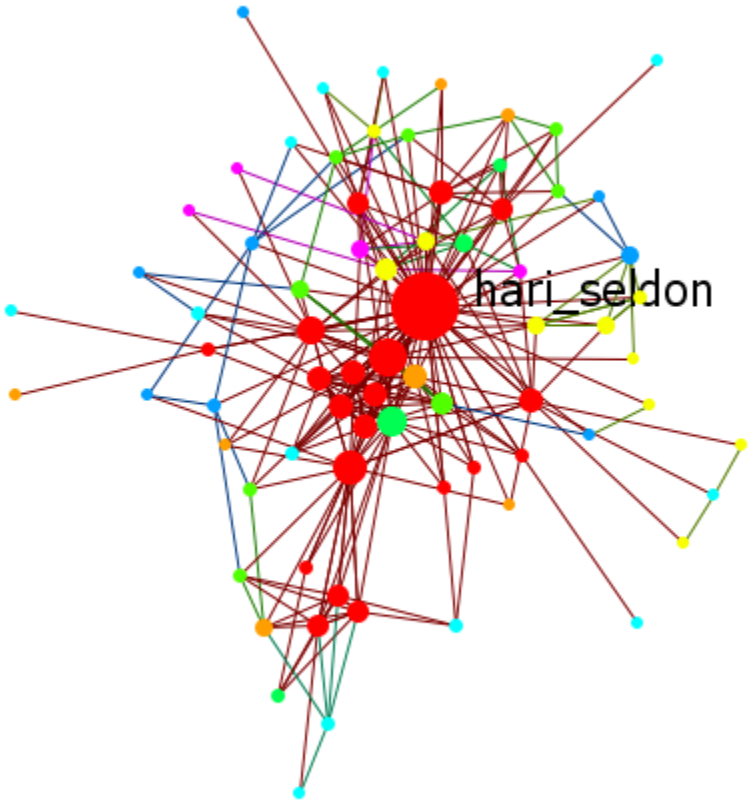
Let's take a look at a few of these.

Here is a Network with all nodes set to the spot style and are all the same size to begin with. It contains agent, knowledge, resource, location, event, and task Node Classes.



Scaling Nodes

Setting the controls to **Scale Nodes** and selecting **Centrality, Total Degree** it now scales the nodes to reflect the number of in and out links each node has. The bigger the node, the more links it has.

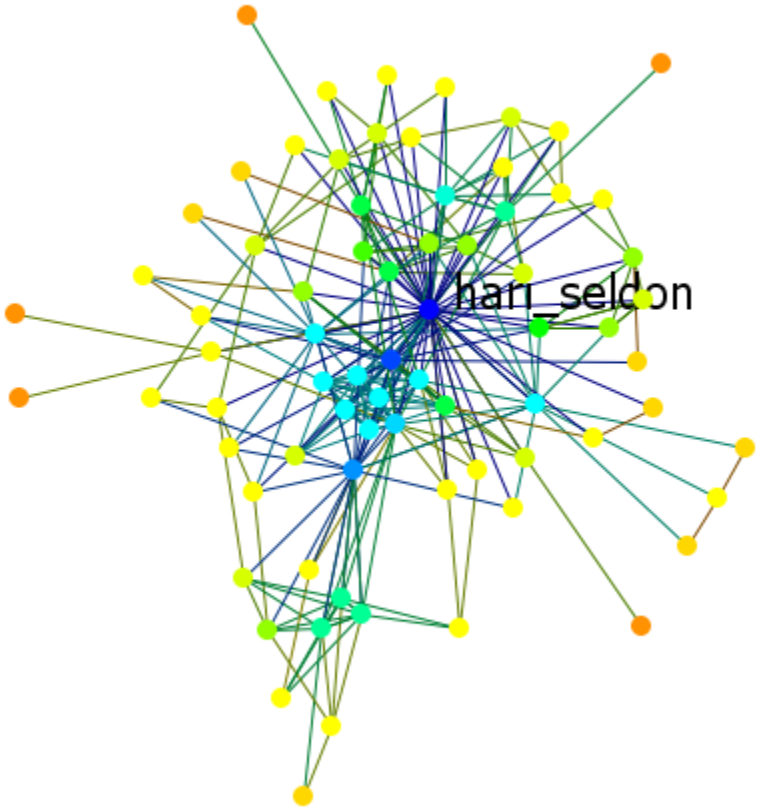


I reset the nodes to their default settings with **Display > Node Appearance > Reset Node Color and Size**. Changing the top drop down to **Color node(s)** colors the nodes in a sliding color scale.

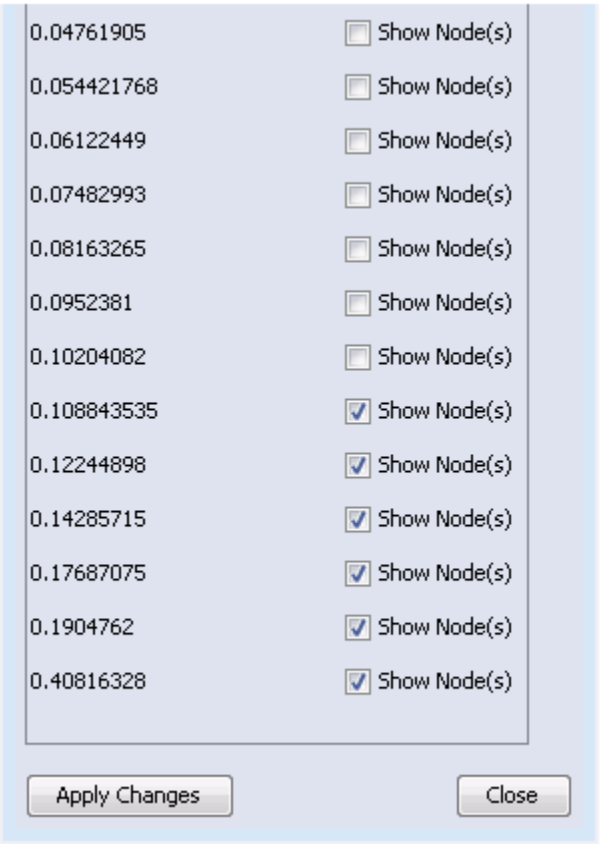
NOTE : If you do not reset the node color and size they will remain the same size as before but only change their color.

Coloring Nodes

You can click the double downward facing angles to reveal further options. For coloring nodes click any color box which brings up the color picker. This allows you to pick your exact colors for each level.

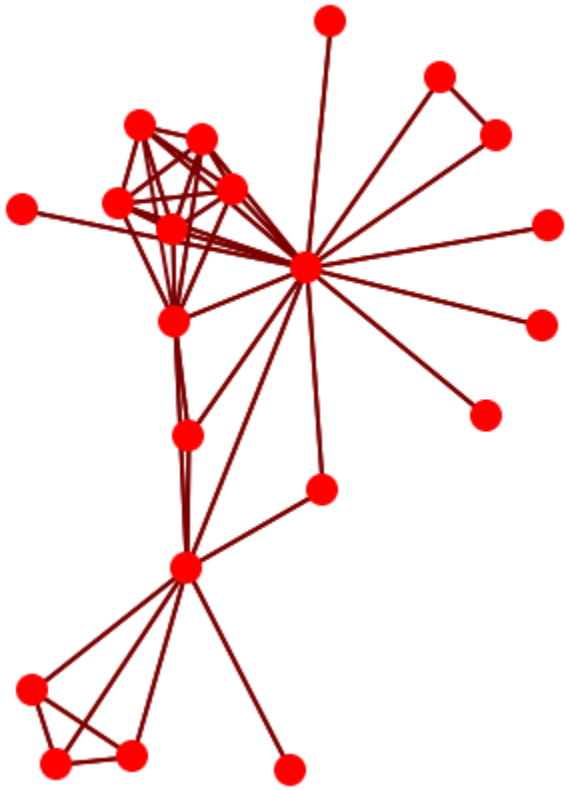


Next you can select only particular values to be display. Here I selected to show only the top six values for the measure. The display is to the right.

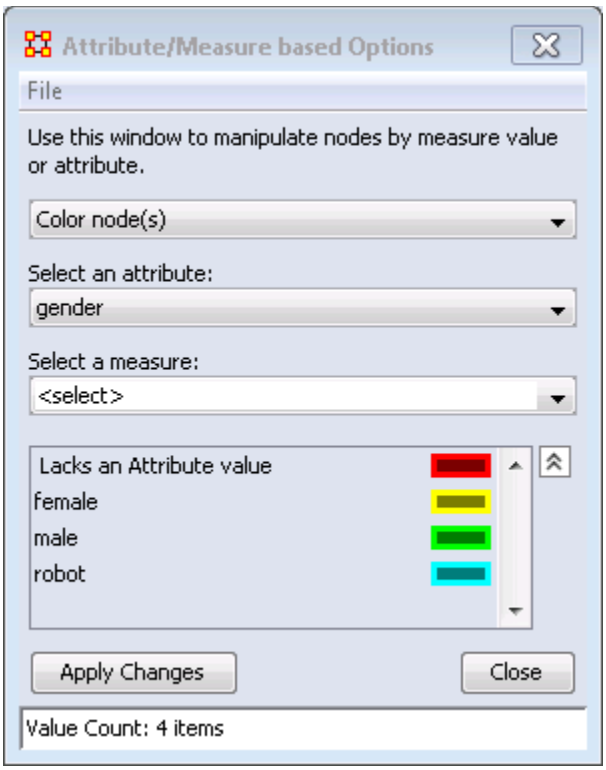


Color By Attribute

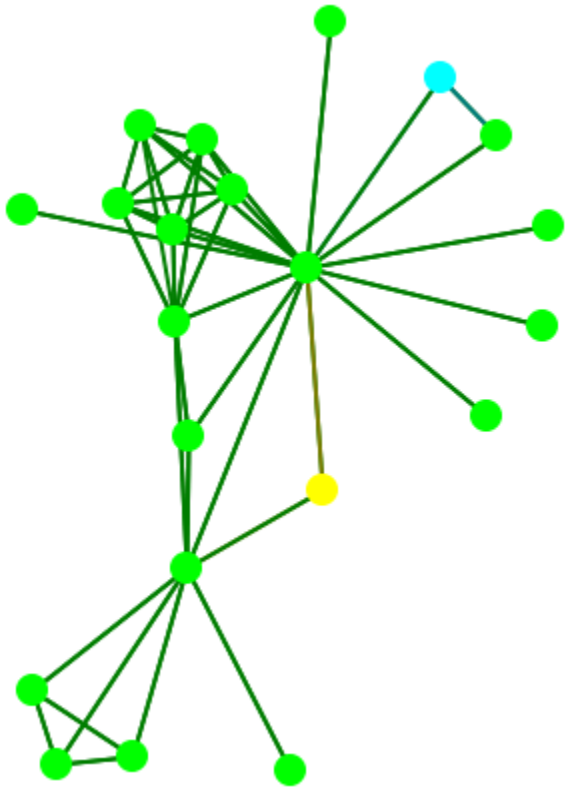
The Agent x Agent network defaults to all agents being red.

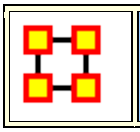


The display can reflect agents by individual attributes. First select **Color Nodes** then select an attribute [i.e., gender]. Click [**Apply Changes**].



The display now shows all Males as green, one Female as yellow, and the Robot of the story as blue.





Link Appearance

Link Appearance

Reduce Visualization Complexity : Turns off links and labels, resets nodes to spot style, and hides nodes with less than two neighbors.



Link Labels > Show Link Labels : Toggles on/off the display of the labels of the links.



Link Labels > Show Weight Value Labels : Toggles on/off the display of the weight of the links

Link Labels > Show Weight Sign Labels : Sets the label and shows whether their weight is positive or negative.



Link Color > Default : Removes all custom link coloring and resets all links to default.



Link Color > By Link Weight : You can set a range of colors to represent the weight of links. A dialog box allows you to chose the colors for the minimum and maximum weights.



Link Color > Match Source Node : Colors the link the same as the source.



Link Color > Match Target Node : Colors the link to match the target.



Retain Bidirectional Links : When two nodes have links to each other only one link will be displayed.



Split Bidirectional Links : When two nodes have links to each other only both links will be displayed. These links will be rendered

as curved links between the nodes.



Show Links : Toggles on/off the display of links between nodes.



Scale Link Width to Weight : Toggles on/off the display of links between nodes.

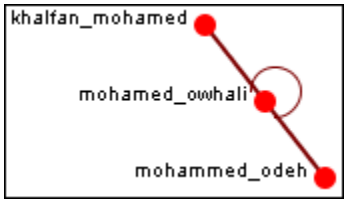
Scale Link Width to Number of Links Between Nodes : Adjusts the width of the link to represent the weight of the link.

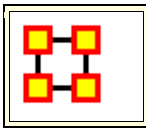


Show Arrows : Toggles on/off the display of the arrows of the links.



Show Self Links (Loops) : Shows whether there is a connection between a node and itself. It is designated with a circle pointing back to itself.





Display

Reduce Visual Complexity : Hides links, hides isolate, and sets node shape to small circle.

Comments



Set Comments Font : Sets the font used in Visualizer comments.



Set Comments Color : Sets the color used in Visualizer comments.

Title

Title Location > Top : Sets the Title to the top of the Visualizer window.

Title Location > Bottom : Sets the Title to the Bottom of the Visualizer window.

Title Location > Left : Sets the Title to the left of the Visualizer window.

Title Location > Right : Sets the Title to the right of the Visualizer window.

Title Location > Center : Sets the Title to the center of the Visualizer window.

Set Title : Create a title for a screen shot. The title will remain a static size and retain its position regardless of the zoom of movement of the display.

Set Title Font : Set the font used in the title of the screen shot

Show Title : Toggle visibility of the title.

Allow Click to Edit Node Title :



Show Mouse Overs : Toggles the information boxes on and off whenever you hover the mouse over a node or link in the visualizer.



Autozoom : Zooms the display either In or Out to bring all nodes into view.

Background Color



Background Color > Black : Sets the Visualizer background to black.



Background Color > White : Sets the Visualizer background to white.



Background Color > Custom : Brings up the color picker which allows you to chose any color for the background.

NOTE : Some of the possible background colors can make it difficult to view the visualizer. Your best choice is black (although white is used in the examples for easier printing).

Background Image

Background Image > Load : Allows you to chose a **.jpg, .gif, or .png** to use as a background.



Background Image > Clear Image : Removes the image and returns the background to the last background color used.

NOTE : Some pictures may make viewing the network somewhat difficult.



Black and White Only : Removes all colors form the visualizer.



Grayscale : Removes the hue from all nodes and links displaying them as shades of gray. If any of the nodes are difficult to read try

changing the background color to a darker or lighter color. A black background works very well for grayscale images.

Reset Node/Link Options : Resets all node and link colors back to default.

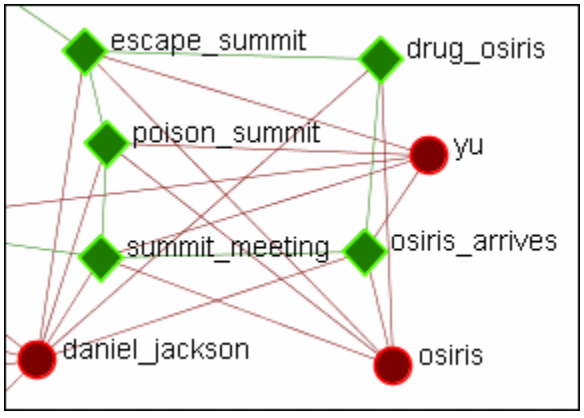
Comments

While in the Visualizer **Comments** can be added to the display. Right-click a node and from the contextual menu select **Add Comment**. The comment is placed in a colored box with a dashed arrow connecting them to the original node.

NOTE : These comments are not saved when exiting the Visualizer.

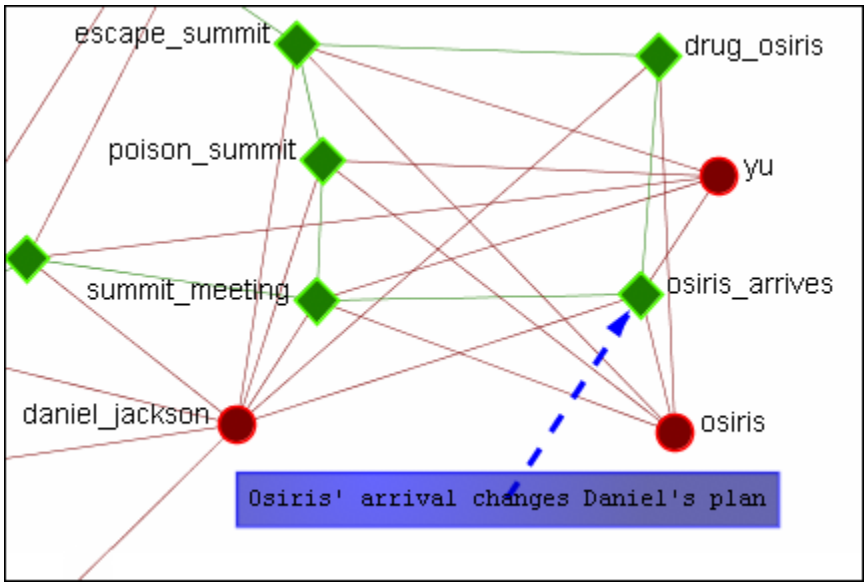
NOTE : The main use of these comments would be in creating screen shots for display in order to add commentary for a report.

Below is a section of the Stargate scenario with the unexpected appearance of Osiris.

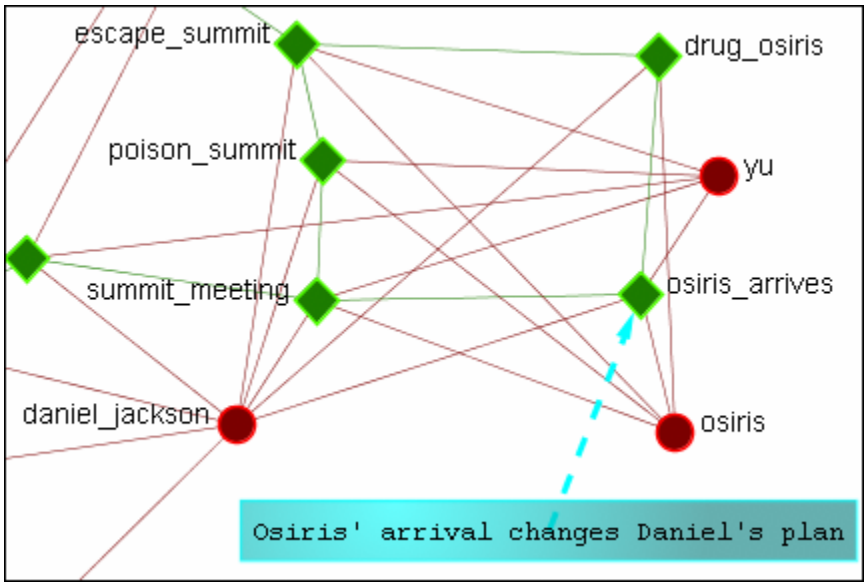


Adding a Comment

A comment is added stating Osiris's arrival changes the plan.

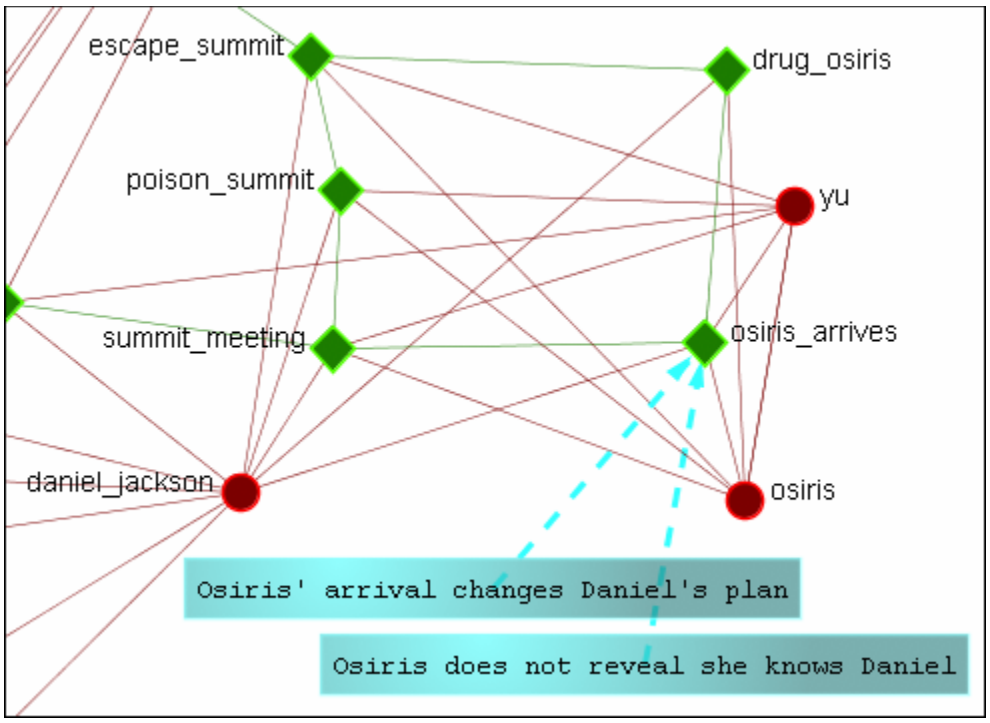


From the main menu, under the Tools item, the font size and color, as well as the color of the box, can be changed.



Adding Multiple Comments

It is also possible to add multiple comments to the same node.



NOTE: These comments are not saved when exiting the Visualizer.

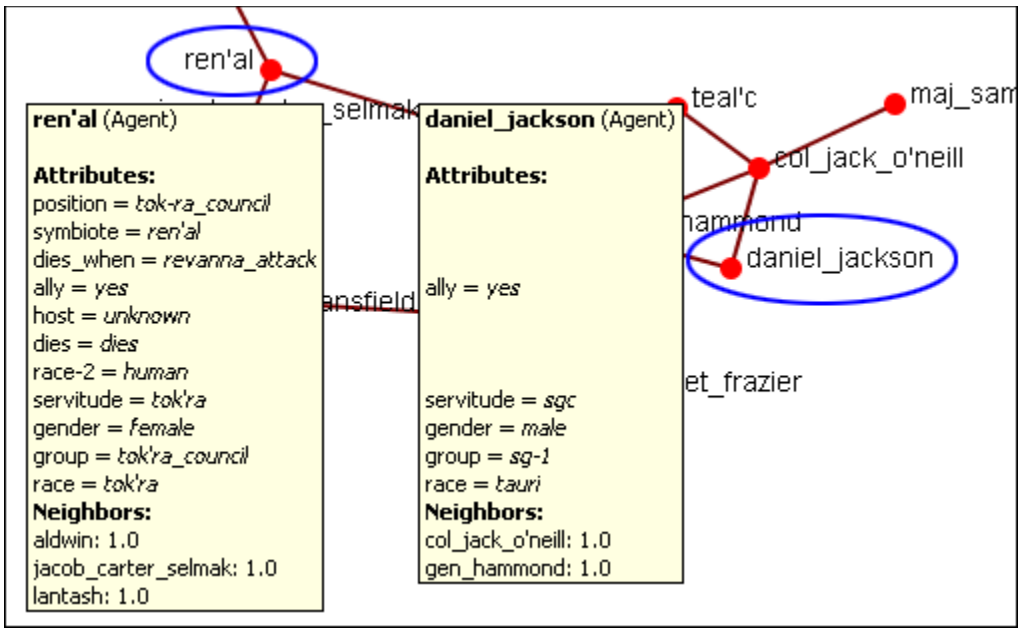
Deleting a Comment

A comment can be deleted by first selecting that comment. A right-click brings up the contextual menu. From this menu select **Delete Selected Node(s)**.

Mouseovers

NOTE : To access the contextual menu the option must be checked. Go to **Display >** **Show Mouse Overs** and make sure the option is check marked.

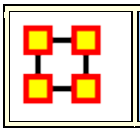
When the pointer is passed over any Node in the visualizer a **yellow tooltip box** will appear showing information on links to other nodes as well as values for measures than have been run. Below is a screen shot comparing two mouseovers.



If an **Attribute** is eompty ORA will leave a blank line for that attribute. Only if the attribute has a value will it be displayed. **Neighbors** are all the links to other nodes.

Mouseover Display Limit

With the mouseover display active ORA will attempt to display which node or link you have the pointer hovering over. But there is a limit of **5,000** links when ORA no longer attempts to dusplay the link. It will, however, still attempt to dusplay which node the pointer is hovering over.



Multi Color Links

There may be an instance when you would want to differentiate links between the same nodes. This is done by creating separate Networks for each instances. In the following example there are two Nodesets with three nodes each. We want to show different relationships between these two Nodesets.

	Node ID	Node Title
☐	Alpha	Alpha
☐	Bravo	Bravo
☐	Charlie	Charlie

	Node ID	Node Title
☐	Echo	Echo
☐	Delta	Delta
☐	Foxtrat	Foxtrat

We do this by creating individual Networks for each separate instance. Two for **abc x def** and two for **def x abc**.

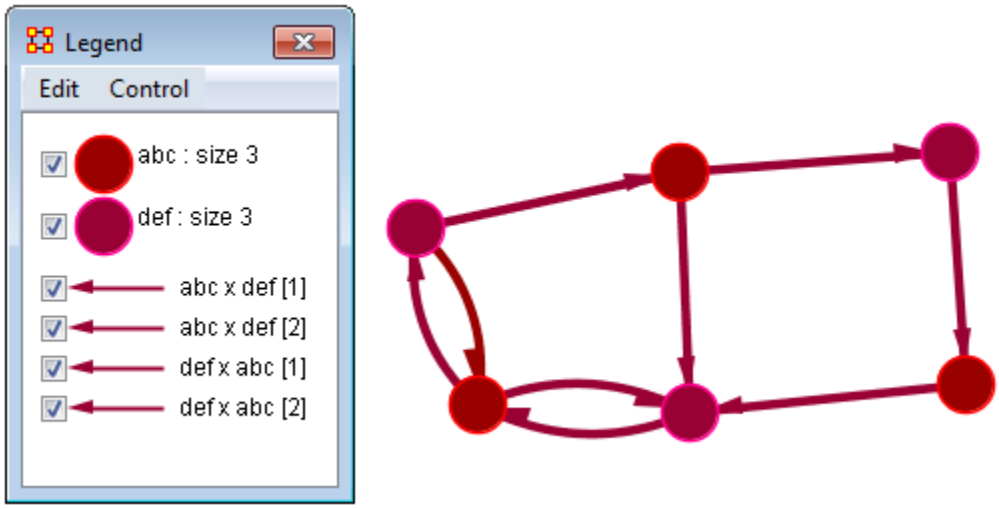
	Echo	Delta	Foxtrat
Alpha	1.0	0.0	0.0
Bravo	0.0	1.0	0.0
Charlie	0.0	0.0	0.0

	Alpha	Bravo	Charlie
Echo	0.0	0.0	0.0
Delta	0.0	1.0	0.0
Foxtrat	0.0	0.0	0.0

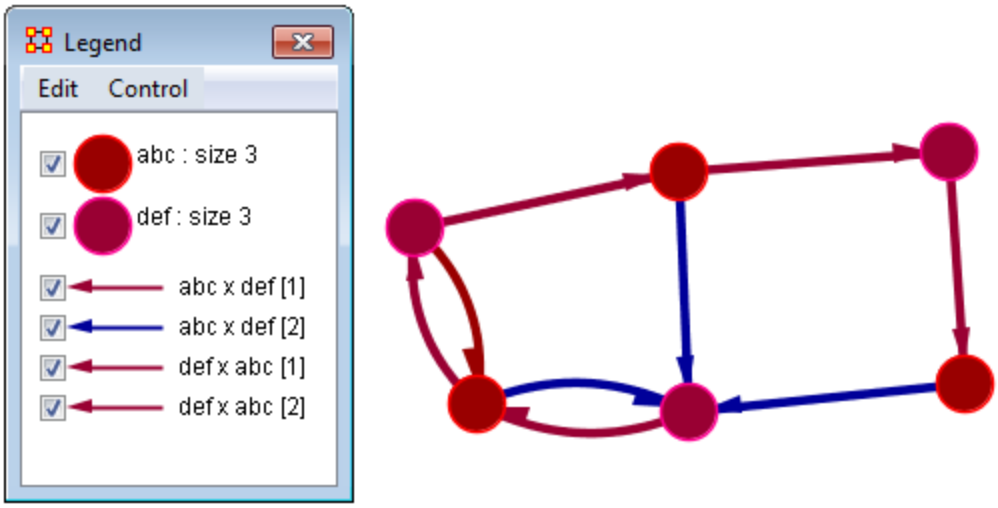
	Echo	Delta	Foxtrat
Alpha	0.0	0.0	1.0
Bravo	0.0	0.0	1.0
Charlie	0.0	0.0	1.0

	Alpha	Bravo	Charlie
Echo	0.0	0.0	1.0
Delta	1.0	0.0	0.0
Foxtrat	0.0	1.0	0.0

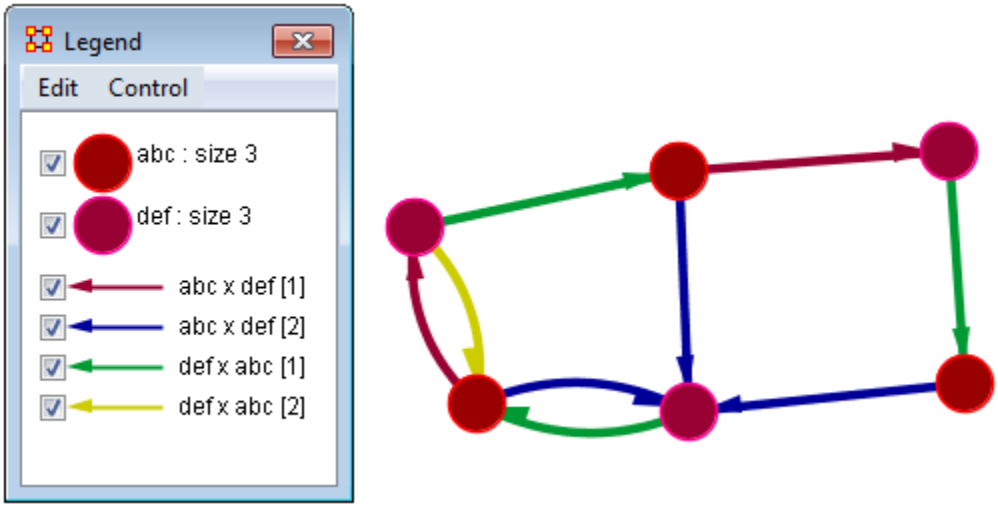
When first visualized all nodes are red as are their links.

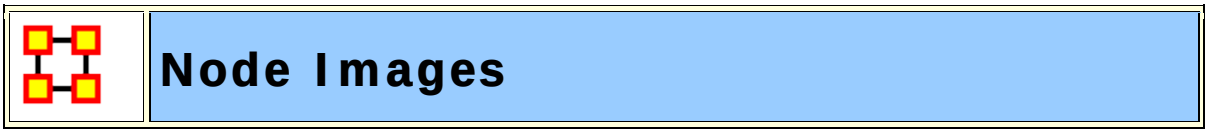


To show one set of links differently click on the arrow next to one of the Networks and the color picker will appear. Pick a new color and click [**OK**]. Notice how only the links in that Network turned blue in the Visualizer. You can then continue this for all Networks you want to reveal.



The third Network was turned green and the fourth Network was tuend orche. It is now easy to find which links belong to which Network in the Visualizer.





Node Images

Nodes can be replaced with various symbols or pictures to make it easy to identify individual nodes. There are a few items to note.

All images should be reduced to approximately **50 x 50 pixels** before using in ORA. Bigger images will be reduced in size on the display and the image quality may possibly be degraded.

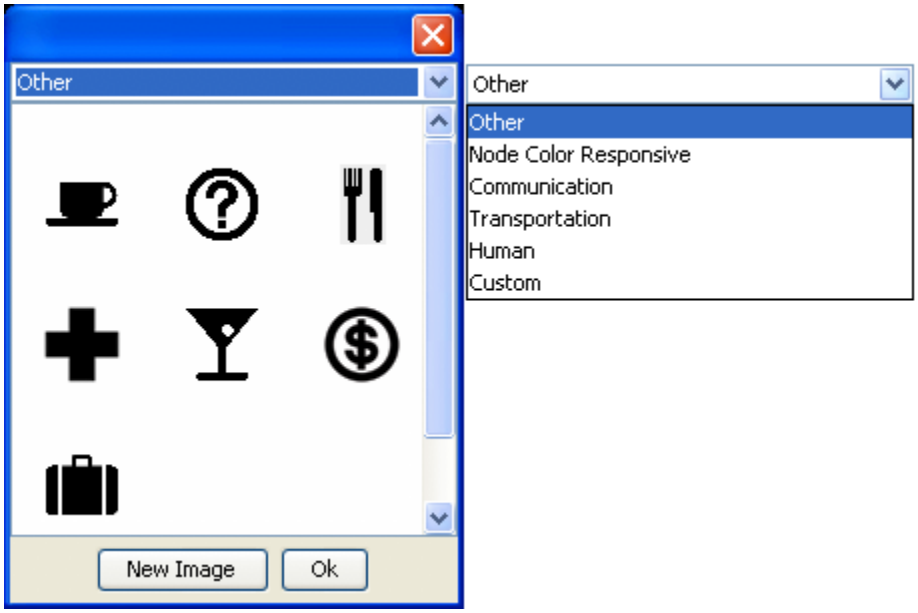
If a picture is placed on a background with the color **R=255, B=0, G-192** the background will be changed to the color of the node.

Setting a Image Folder

The Set Picture option is designed with modularity in mind, with adding new images as easy as putting a folder with images in the **include\OraFiles\images\visualizer\node** folder. The dialog will automatically read that folder for subfolders, use the subfolder names as categories, and the images inside the subfolders as the images for each category.

Set Picture

Right-click any node and select from the contextual menu **Appearance Submenu > Set Picture**. The Node Selector dialog box will appear. The drop down menu contains various types of node images. With a node selected a custom image can be applied. Nodes with Images will scale.



Custom

The **Custom** option allows for the inclusion of a user's own icons.

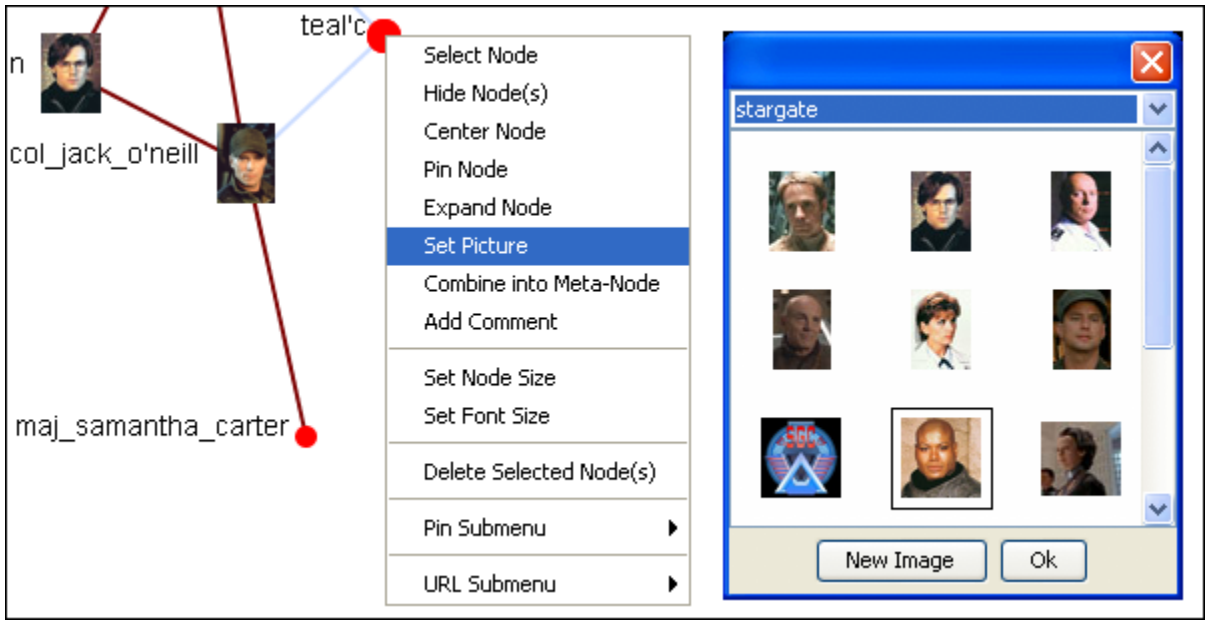
The custom category is used for images that have been previously loaded in the current meta-network. Clicking OK applies the currently selected node's image to all nodes selected in the visualizer.

Additional information can be found in the **Node Shaper** section.

The **[New Image]** button brings up a navigation box from which to navigate any directory and select an image file. The picture types can be **jpg/jpeg, gif, or png**. These will all be collected into the **Custom** section.

NOTE : Remember to reduce the picture size BEFORE importing it into ORA.

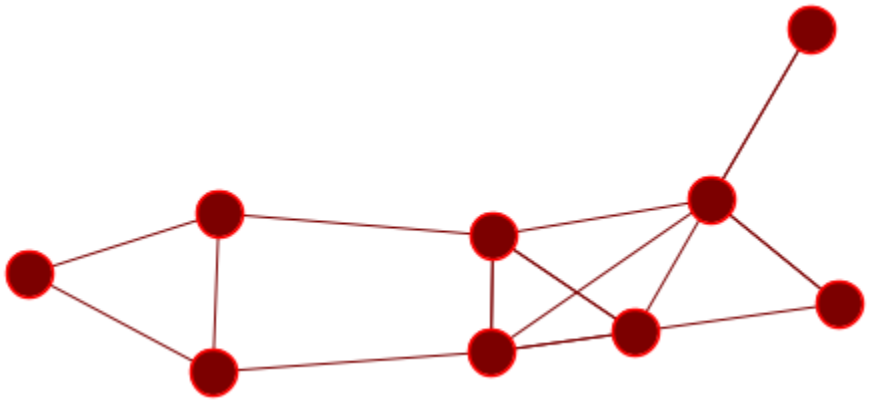
To set a new image right-click the node and select **Set Picture**. This brings up the picture dialog box. Locate the appropriate picture and select it. A black border will appear around the image. Select **[OK]** will set the picture to the node.



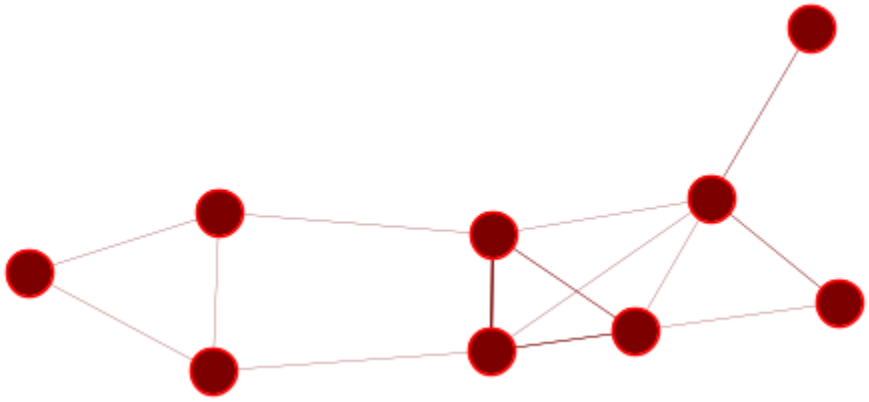
Links By Weight

There will betimes when you need to see the differences in link weights in the Visualizer. This is accomplished using **Display > Link Appearance > Scale Link Width to Weight**.

This network contains links of varying weights but at a link weight set to **1** that is not visible on the screen.

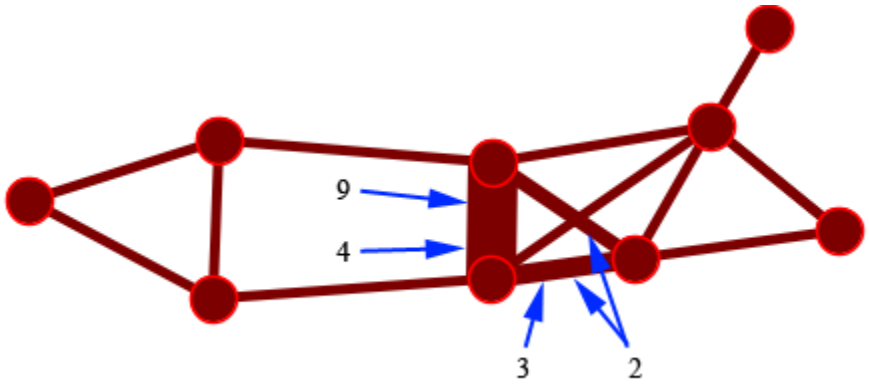


Using **Display > Link Appearance > Scale Link Width to Weight** will set the links to increasing widths depending on the link weight. But with the default link weight set to **1** the differences is negligible.

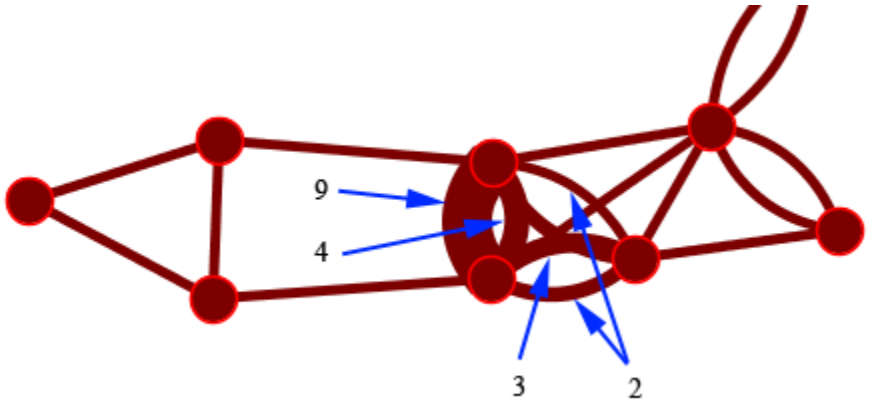


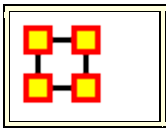
To be able to see these differences increase the default link weight up [here I set it to **20**. and now you can plainly see the differences in the link weight. But you must be aware that in a bidirectional network the links may have different weights.

The center wide link has one link weight of 4 and the other link weight of 9. In this mode only the weight of 9 is visible. The same goes for the bottom links which contain a 2 and a 3 weight.



Using the **Display > Link Appearance > Show Multiple LInks Between Nodes > Split Bidirectional Nodes** you can see that links between two nodes are different weights. Using this function displays all nodes with no overlapping.





Visualizer Contextual Menus

The Contextual Menu is displayed by right-clicking an a Node or Link. It contains many standard uses in manipulating nodes and links.

Node Menu

Pin SubMenu :

Pin All Nodes : Globally pins all nodes. Nodes are unaffected by the **[Play]** button or the movement of other nodes.

Unpin all Nodes : Frees all nodes from being pinned.

Pin Selected Node(s) : All selected nodes will become **pinned**

Unpin Selected Node(s) : All selected nodes will become **unpinned**.

URL SubMenu :

Attach URI : You can attach a URI to the selected node.

Go To URI : Activates your browser and goes to the URI associated with this node.

Appearance Submenu :

Set Picture : You can replace the node shape with a picture.

Set Node Size : You can numerically set the Node Size of an individual node.

Set Node Color :

Set Font Size : You can numerically set the Font Size for an individual node.

Enlarge : Increases the size of the selected node in the Visualizer

Shrink : Decreases the size of the selected node in the Visualizer

Brighten : Lightens the shade of the color of the selected node

Darken : Darkens the shade of the color of the selected node.

Hide Labels : Hides the label of the selected node.

Show Labels : Reveals the label of the selected node.

Show Ring(s) : Places a highly visible ring around the selected node(s).

Hide Rings(s) : Removes ring from selected node(s)

Visibility Submenu :

Hide Node(s) : Removes the selected node (along with all links) from view in the Visualizer.

NOTE : This does not delete the node from the Meta-Network.

Hide Adjacent Node(s) : Hides all nodes that are linked to the selected node. The selected node remains visible.

Other :

Color Adjacent Edges : Allows you to chose the color for all links associated with the selected node. Only works on one node at a time.

Select Node : Registers the node as **selected** when Ora affects multiple nodes.

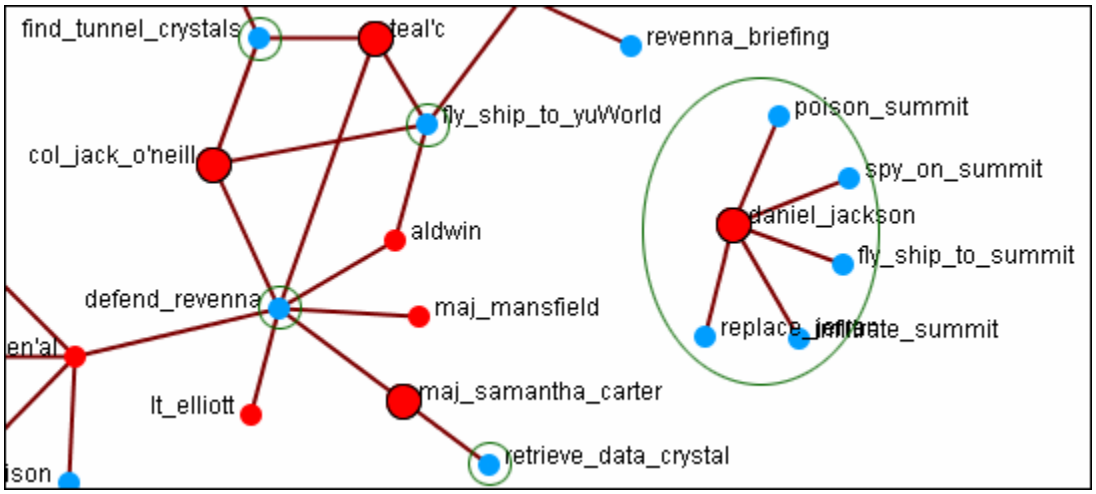
Center Node : Brings the selected node to the center of the visualizer.

Pin Node : Pins node to background so it is unaffected by the movement of other nodes.

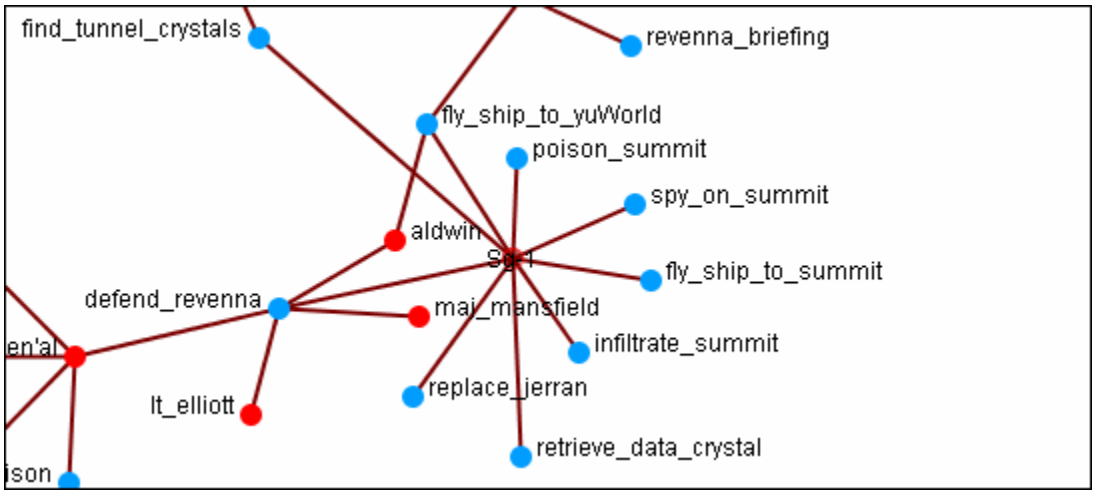
Expand Node : Shows all nodes and links connected to the selected node.

Combine into Meta-Node : Multiple nodes can be selected and combined into a **Meta-Node** which will contain links to all the nodes that the individual nodes had. The four large circles of SG-1 are selected. The and green circles show which tasks are associated with

these agents. Press, and hold, the Control key while selecting each node for the Meta-Node. Then **without releasing the Control key**, right-click one of the nodes to bring up the contextual menu. Select **Combine into Meta-Node**.



After combining the **task nodes** that were linked to the individual nodes are now linked to the **sg-1 Meta-Node**.



NOTE : If additions or deletions of Nodesets needs done expand the Meta-Node before proceeding.

Add Comment : Attaches a comment to the **currently selected node**. Good for making notes for display purposes. Comments can be toggled to be shown or hidden form the Display menu. The color and font of the comments are also controlled from the Display menu.

Spread Out : Finds the center for the currently selected nodes. Then calculates a ray from that center through the nodes current location, and pushes the node along that ray by (currently) 40 units.

Delete Selected Node(s) : Allows for the deletion of nodes form a Meta-Network from within the Visualizer.

NOTE : This deletion is permanent once the Meta-Network is saved. If there is any question regarding the deletion then remove the Meta-Network from ORA before saving and reload the Meta-Network.

Link Menu

Link Status : Brings up the Link Status box with information on its weight, the network, source and target nodes, source and target Nodeset.

Hide Link : Hides the link. This does not delete the link.

Set Value : Set a new value for a link.

Reverse Direction : Reverses the **Source** and **Target** aspects of the link.

Delete Link : Removed the link from the Network.

Empty Space

Pin All Nodes : Globally pins all nodes. Nodes are unaffected by the **[Play]** button or the movement of other nodes.

Unpin all Nodes : Frees all nodes from being pinned.

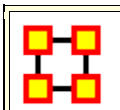
Pin Selected Node(s) : All selected nodes will become **pinned**

Unpin Selected Node(s) : All selected nodes will become **unpinned**.

Add Comment : Attaches a comment to the **currently selected node**. Good for making notes for display purposes. Comments can be toggled to be shown or hidden form the Display menu. The color and font of the comments are also controlled from the Display menu.

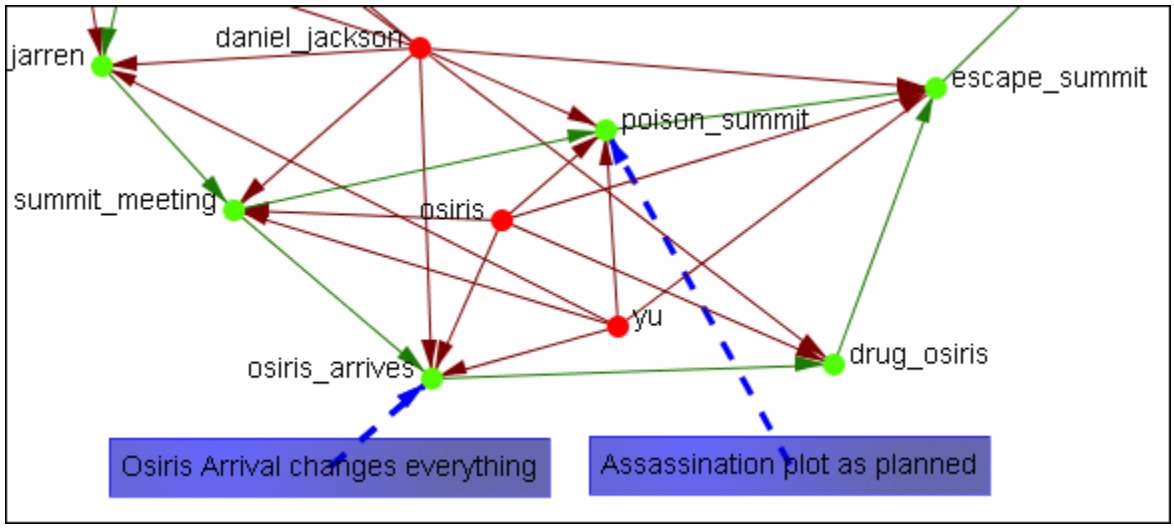
Spread Out : Finds the center for the currently selected nodes. Then calculates a ray from that center through the nodes current location, and pushes the node along that ray by (currently) 40 units.

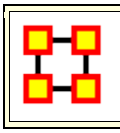
Format Nodes : Brings up the **Node Formatter** dialog box.



Comments

Add Comment : Attaches a comment to the **currently selected node**. Good for making notes for display purposes.





Node and Link Formatter

Node Formatter

There are two ways to select nodes. **1]** You can Control-Click on each node separately in the Visualizer. **2]** You can use the **Selector** tool and lasso a group of nodes. When you have the nodes selected righ-click to bring up the **Node Formatter** dialog box.

Appearance Tab : Controls the color, transparency, and labels of the Node(s) selected.

Node Color : Control the color of individual nodes.

Match Node Set Color : Resets the color of the node(s) back to the default color of the Nodeset.

Choose a Custom Color : Click the color box. From the color the selector palette select a new color and click [**OK**]. In the Node Formatter box click [**Apply**].

Node Transparency : Set the Node Transparency from 0 [transparent] to 1 [visible].

Node Size : Set the Node Size from 4 [small] to 25 [large]

Visibility Tab : Controls visibility of nodes.

Hide Node(s) button Removes nodes from the display.

Show Node(s) button puts the nodes back into the display. To bring back Nodes of a Nodeset which have been hidden you can toggle the check box in the Legend off and on and all nodes of a Nodeset will reappear.

Label Tab : Set the label size from 1 [small] to 25 [large]. You can also show or hide the labels of the selected Nodeset.

Label Size : Change the size of the label from 1 [small] to 25 [large].

Hide Node Label(s) button Removes label from the display.

Show Node Label(s) button Puts the label back into the display.

NOTE : The Node Formatter works only with the node(s) originally selected. To change the parameters for another node(s) you must close the Node Formatter dialog box, select another node(s), then perform your changes.

Link Formatter

Right-Clicking on a Link in the Visualizer brings up the **Link Formatter**.

Appearance Tab : You can color the selected links by Source node, Target node, or pick a custom color. You also have the option of using **solid or dashed lines**.

Node Color : Control the color of individual nodes.

Color by Source Node : Sets the color of the link(s) to the color of the **Source Node**.

Color by Target Node : Sets the color of the link(s) to the color of the **Target Node**.

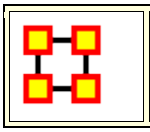
Choose a Custom Color : Click the color box. From the color the selector palette select a new color and click [**OK**]. In the Link Formatter box click [**Apply**].

Visibility Tab :

Hide Link(s) button Removes link from the display.

Show Link(s) button Puts the Link back into the display.

NOTE : If after you hide a link and close the Link Formatter dialog box the only way to bring that link back a link you have hidden is to use the menu item **Actions > Show All Nodes**. But remember, this will also undo any other hidden nodes and links you have.



Node Contextual Menu

Right clicking any node in the Visualizer brings up a menu of the most useful tasks concerning nodes.

The Pin Node Submenu : Allows you access various function involving **pinning and unpinning** nodes in the visualizer

The URI Submenu : Allows you to attach a URI to a node or go to a URI already attached to a node.

The Appearance submenu : You can enlarge or shink the size of a node, brighten or darken it's color, set its color or size, attach a picture to a node, or give it a display ring for easier visibility

Label submenu : Individual labels can be hidden or displayed and the font size can be altered

Visibility submenu : You can either hide the selected node or hide the adjacent nodes.

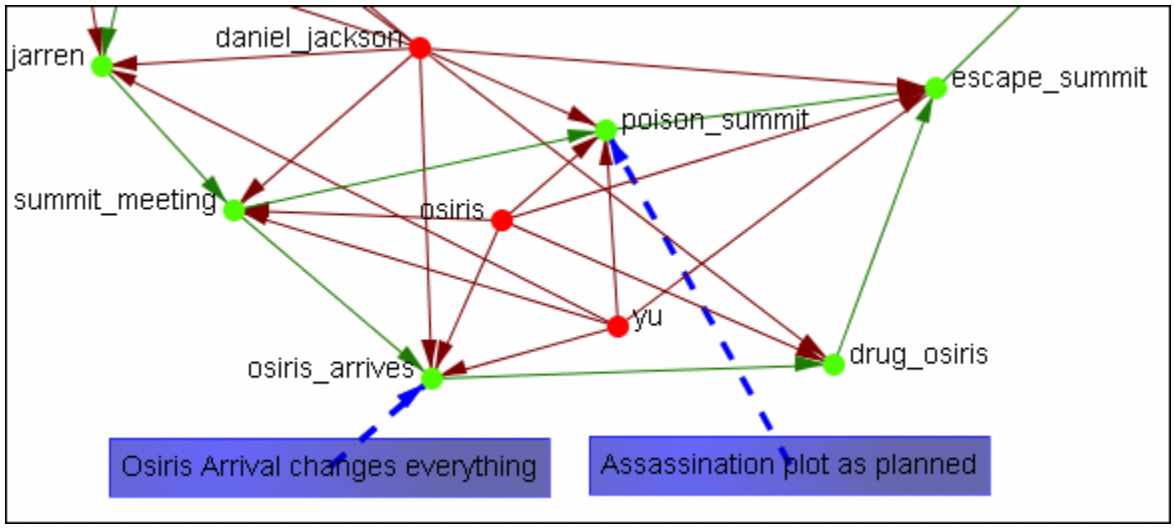
Color Adjacent Edges : Sets the color of adjacent links of the selected node.

Select Node : Makes the node **selected**.

Center Node : Center the selected node to the center of the window

Combine into Meta-Nodes : After selecting two or more nodes you can combine them into a single Meta-Node and give that Meta-Node a name. If necessary you can also Expand that Meta-Node into its individual nodes.

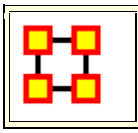
Add Comment : You can add or delete comments for any node in the Meta-Network.



Spread Out : Puts mode space between node around the selected node.

Delete Selected Node(s) : Removes selected node(s) from display

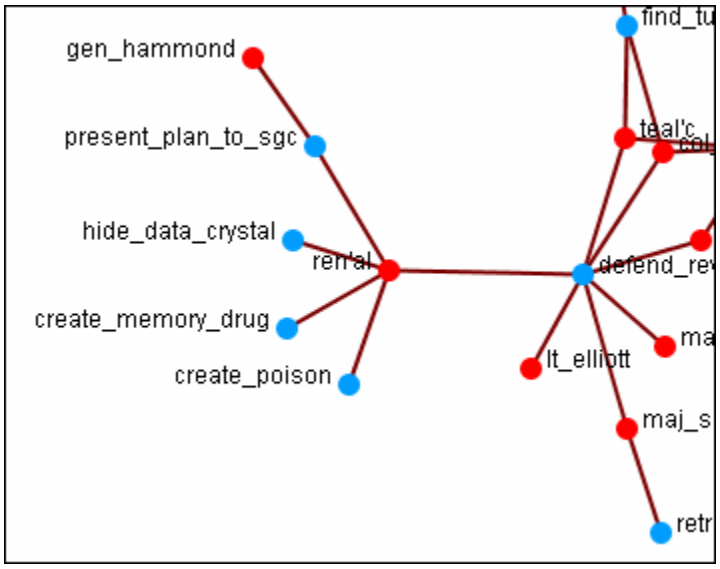
Format Nodes : Calls up the **Node Formatter**



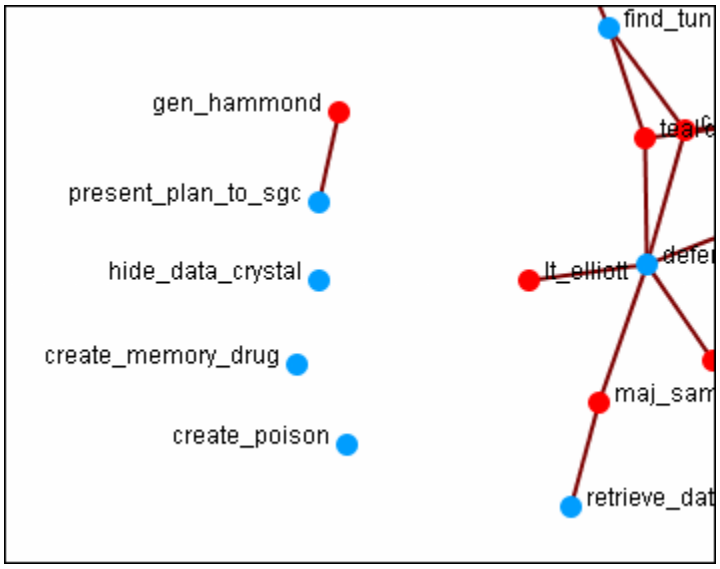
Removing Nodes In The Visualizer

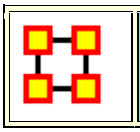
You can remove nodes directly from the ORA Visualizer by right clicking on a node and selecting **Hide Node**. Below is an example of removing an node using the Hide Node tool.

Find the node you want to hide. Here we will hide **ren'al**.



Place the cursor over the node and **right-click** on the node to bring up the contextual menu. Highlight **Hide node ren'al** and the four task nodes are now separated from the rest of the network.

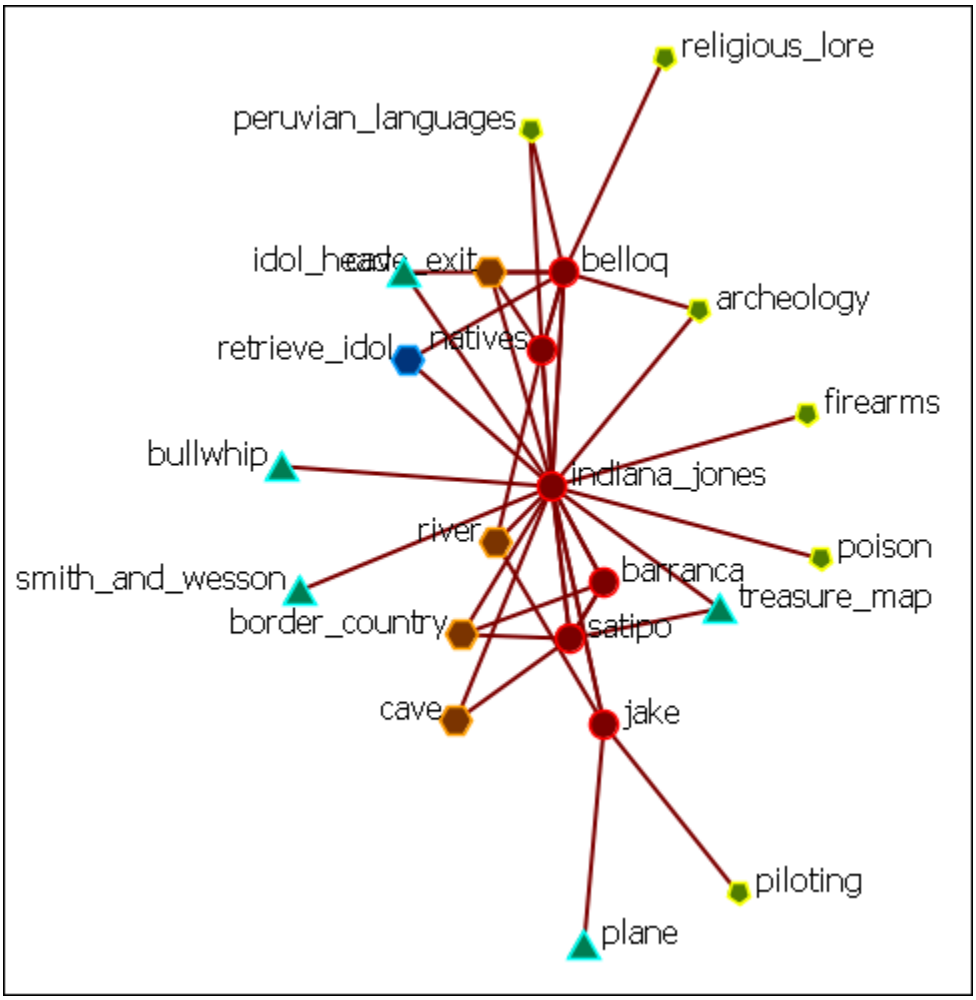




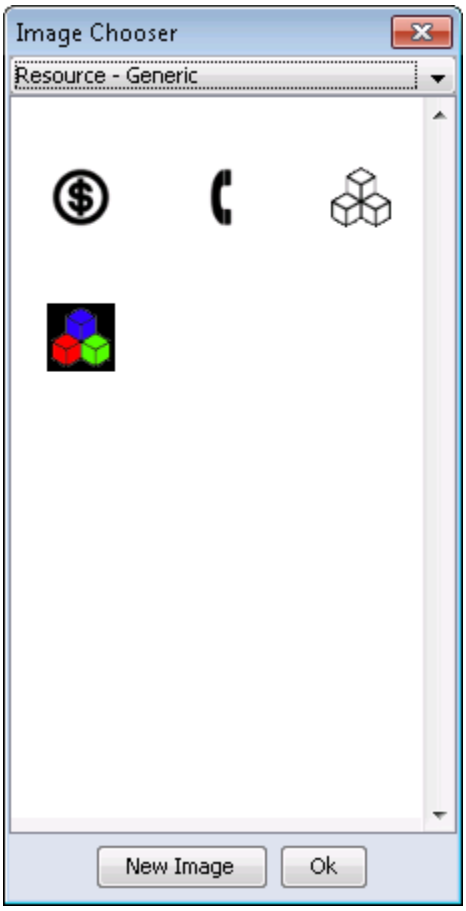
Set Node Picture

In addition to changing the size of nodes in the visualizer you can also assign nodes individual pictures. This example is my Raiders of the Lost Ark set from Peru.

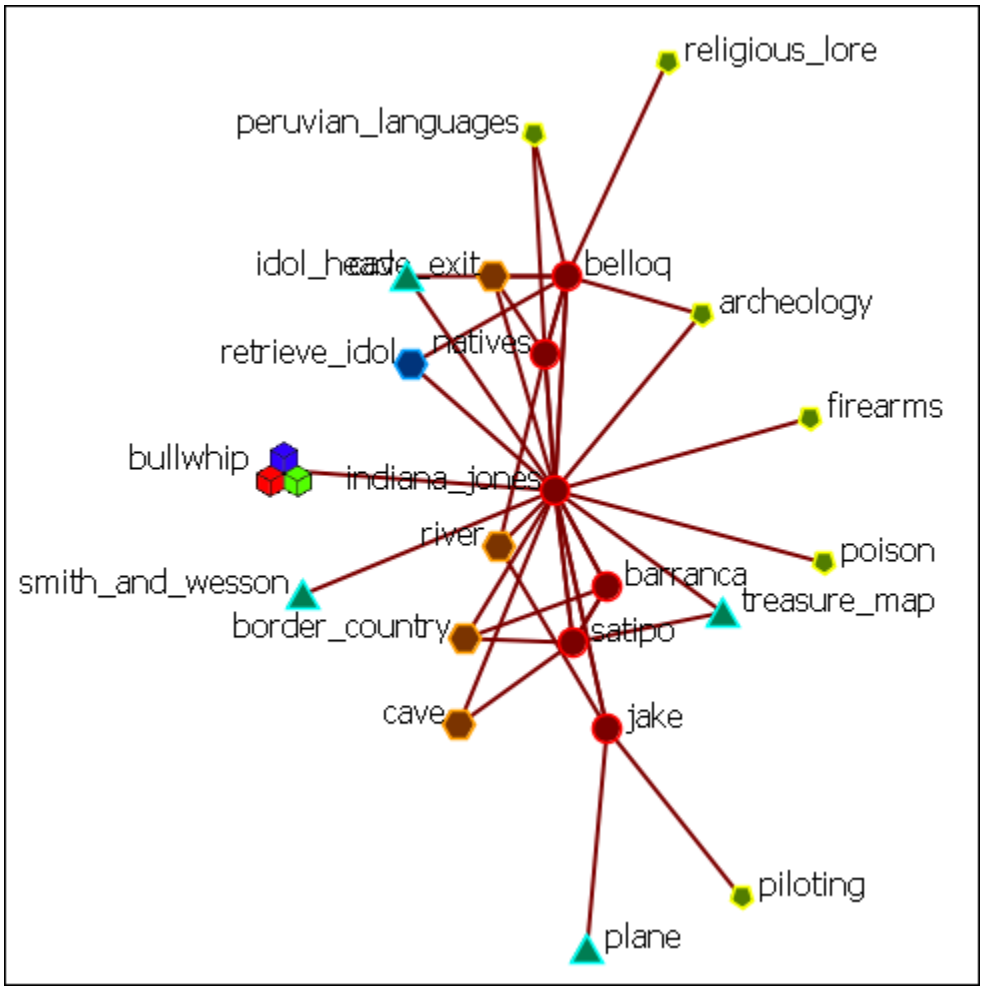
NOTE : This example uses only standard icons found in ORA.



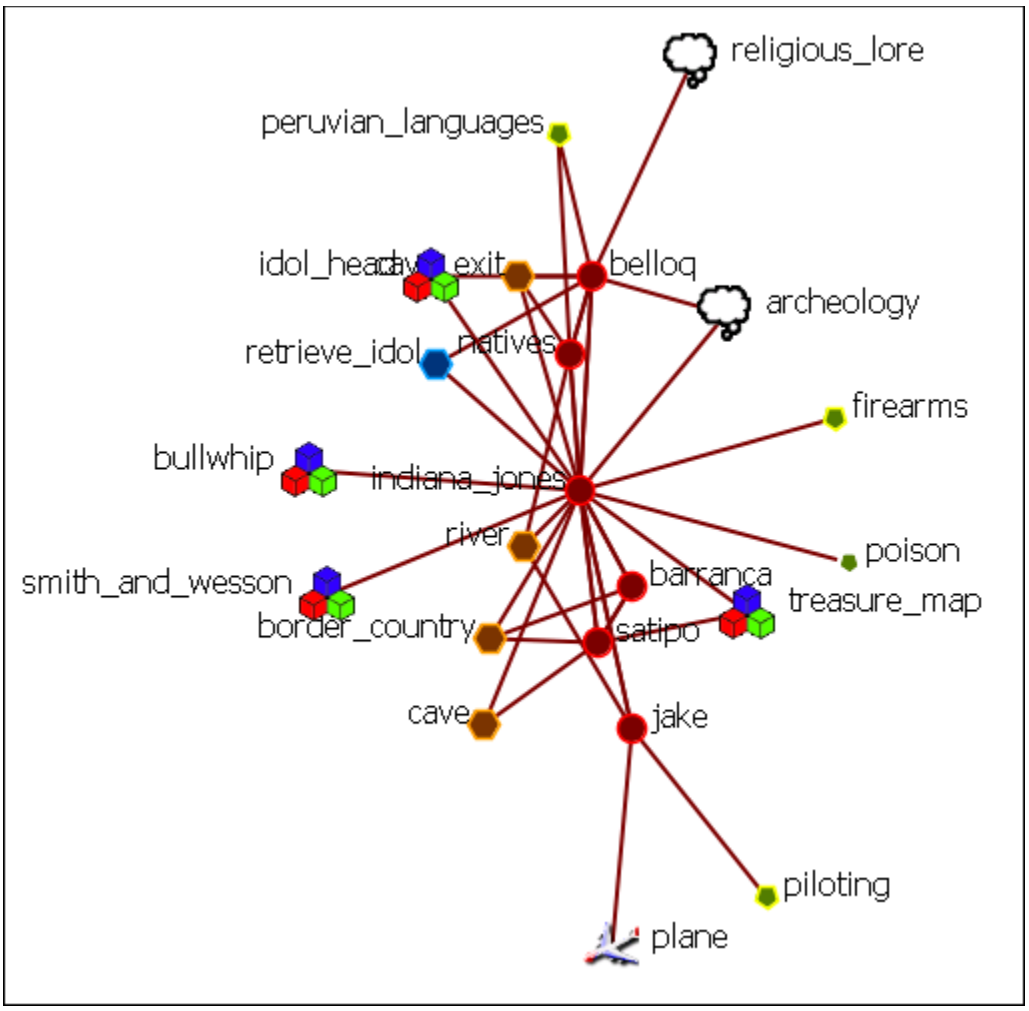
I Right-Clicked on The Bullship node and selected **Appearance Menu > Set Picture**. This brings up the Set Picture dialog. I clicked the downward triangle and selected the **Resource - Generic** folder. I then selected the colored cubes icon.



Clicking [**OK**] assigns that picture to the selected node.

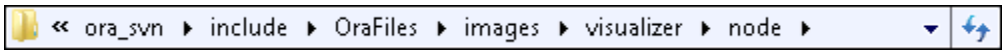


You can replace any number of nodes with icons.



Your Own Icon Set

You can create your own set of icons. Place all your personnal icons in a folder and place that folder in the following directory. The next time you use ORA you will be able to select icons from your own folder.

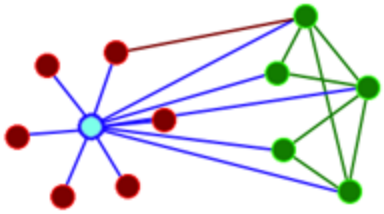
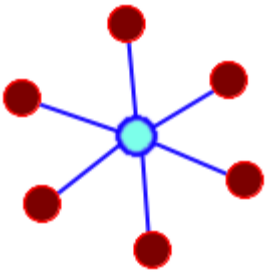
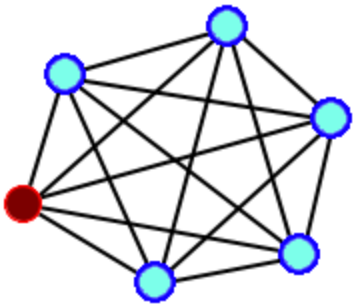
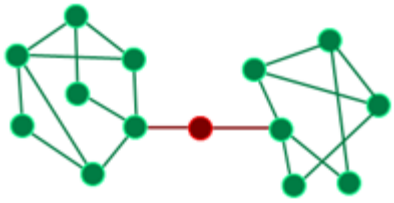
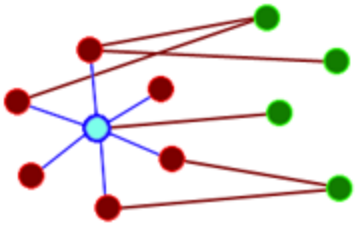


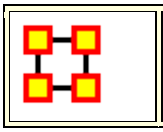
NOTE : Be aware that very large icons will make viewing the display difficult. Small distinct icons work better. If using pictures of individuals it's advised to resize them to **50 x 50 pixels**.

Motifs

This is a list of common motifs that can make it easier to find various clusters as the underlying structure of your network.

No Links		**2-Group**	
Bowtie		**Chain**	
Circle		**Star**	

Cognitive Demand		**Degree Centrality**	
Eigenvector Centrality		**High Betweenness and No Degree**	
Exclusivity			



Visualizer 3D

The 3D Visualizer uses the same Meta-Networks as the standard 2D Visualizer, only it projects them into a three dimensional setting. It can be called up either by selecting from the main menu **Visualizations > View Networks > 3D Visualizations** or in the editor by clicking the dowward triangle on the [**Visualize**] button. This will visualize the highlighted Meta-Network.

As with the 2D visualization the Legend controls which NodeClasses are visible in the display.

Controls

The display at the bottom of the visualizer denotes working with a three-button mouse. When working with trackpad the controls are similar, left button to rotate and righ tbutton to translate. The zoom is accessed by using your finger on the side of the trackpad to zoom in and out.

Three Button Mouse

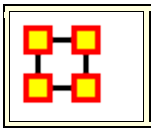
Rotate : Using the **Left Button** you can spins the display in whatever direction you move the mouse. You can move the mouse left/right and forward/backward.

Translate : Using the **Right Button** you can move the display laterally left/right or up/down. You can move the mouse left/right and forward/backward.

Zoom : Using the **Middle Button** you can affect how close-in or far away the display is. The zoom works by moving the mouse in the forward/backward direction only.

Using a Trackpad or a Two-Button Mouse

The **Rotate** and **Translate** function exactly the same. To use the **Zoom** function **press and hold the Alt key then click the Left Button**. Then move the mouse or your finger on the trackpad.n



3D Visualizer GUI

In the 3D visualizer - you can size nodes by standard social network metrics. This is one of the options under visualize nodes. You can also color the nodes by attribute. Performing measure-based operations is not dependent on having previously run a report.

The standard flow for using measures goes something like this.

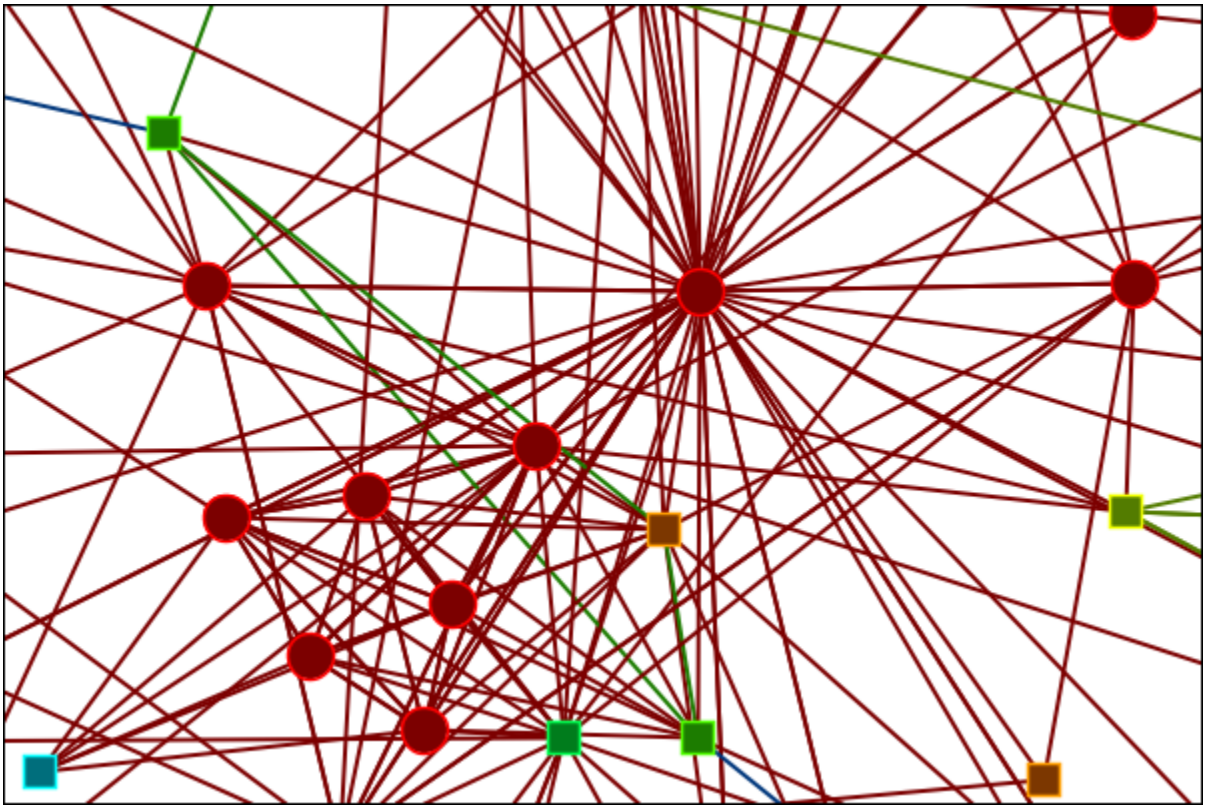
1) User calls size nodes by attribute/measure. Dialog loads in the current meta-network.

2) For each measure that's been defined, the Meta-Network asks if it can run it. If it can, it gets added to a list.

3) User selects the measure, runs, and the visualizer calls the ORA-backend to compute the measure.

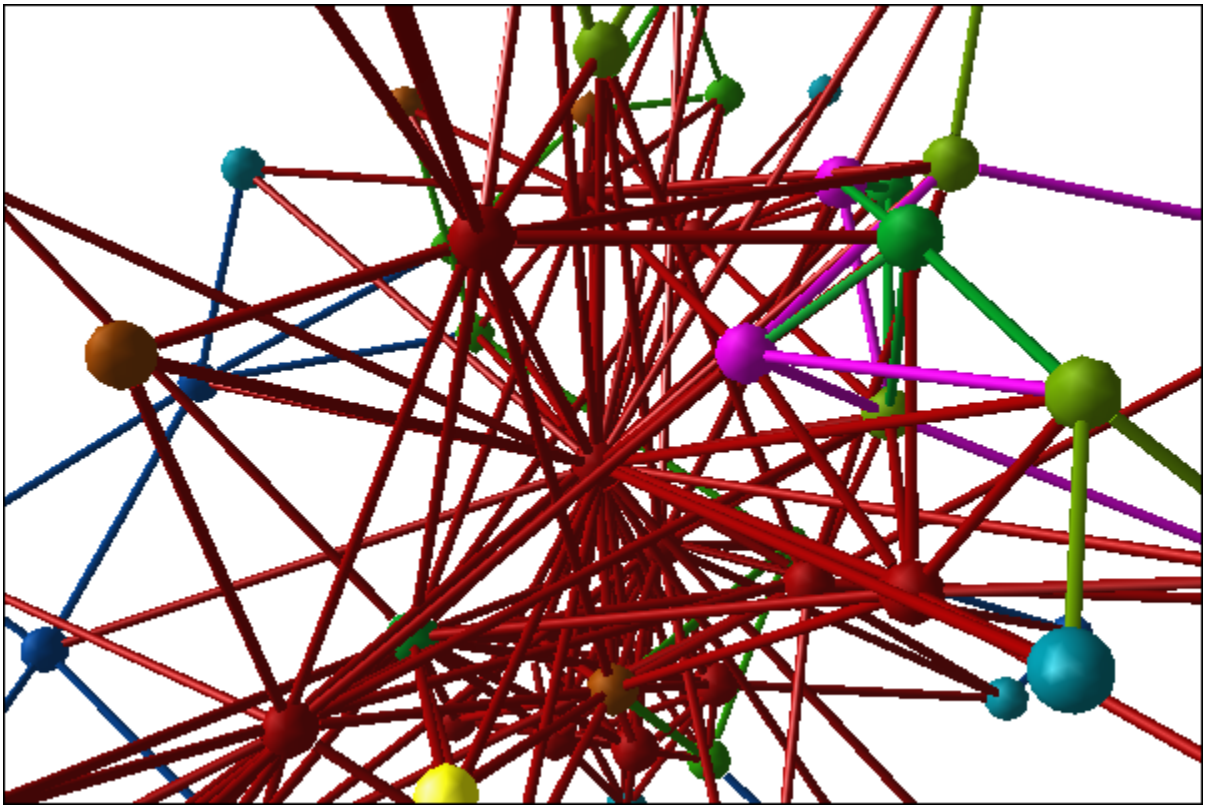
2D display

Herre is the normal view in the 2D Visualizaer.



3D display

Here is the same network viewed in the 3D Visualizer.



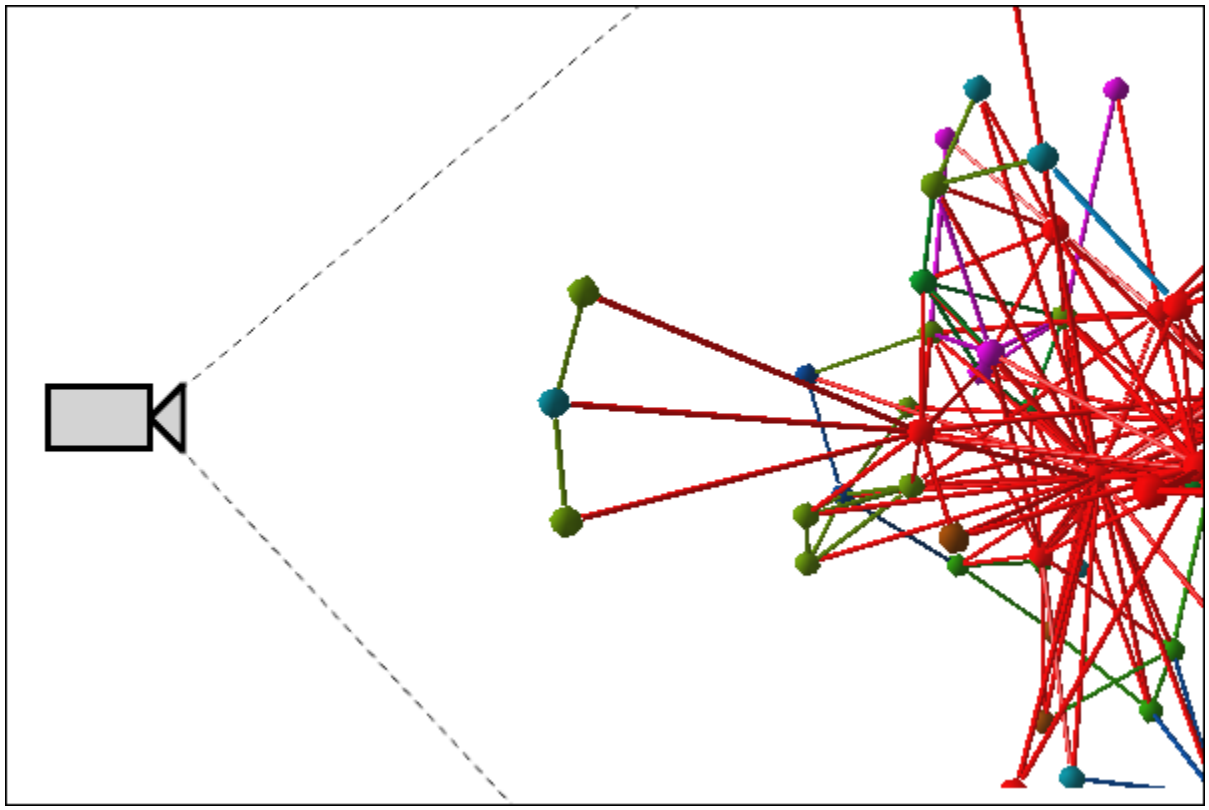
The menus for the 2D and 3D Visualizer are nearly identical. The Layout menu, as well as other selected controls, are disabled in the 3D version.

Pinning Nodes

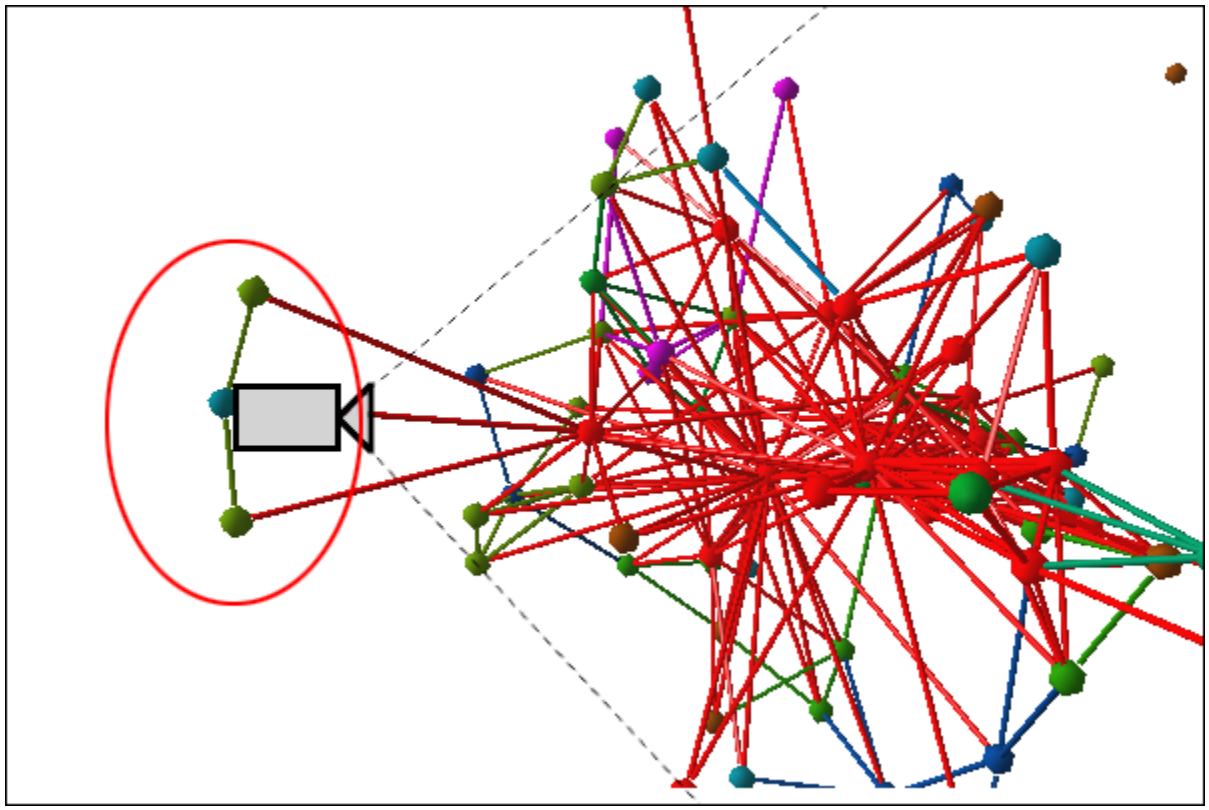
Currently pinning nodes in the 3D view is not available.

Nodes Hidden From View

As you move around your network you may notice some nodes disappear. In this view you need to be aware of working in 3D Space. In this first view the camera is far from the network and all the nodes are visible.



But as the camera is moved in it passes some nodes and they end up behind the camera.



2D 3D Differences

There are a number of functions available in the 2D Visualizer which are not available in the 3D Visualizer mostly due to being designed for the 2D space. Below is a list of these functions.

File

Open ORA-Image, Save Special, Add Grouping to Current Meta-Network, Add Meta-Nodes to Current Meta-Network, Visualize in 3D, GeoSpatial Networks

View

Change Font...

Actions

Pin All Nodes, Unpin All Nodes

Tools

Node Status, Backward Influence, Pie Nodes, Meta-Network Designer, Networks Over Time, Vector Maps

Layouts

All menu items inactive.

Meta-Nodes

Create Meta-Nodes by Grouping..., Create Meta-Nodes by Attribute/Measure, Meta-Nodes

Node Appearance

Label Style, Node Style, Node Color > Show Node Occurrence Transparencies

Link Appearance

Link Labels, Show Multiple LInks Between Nodes

Display

Allow Click to Edit Node Title

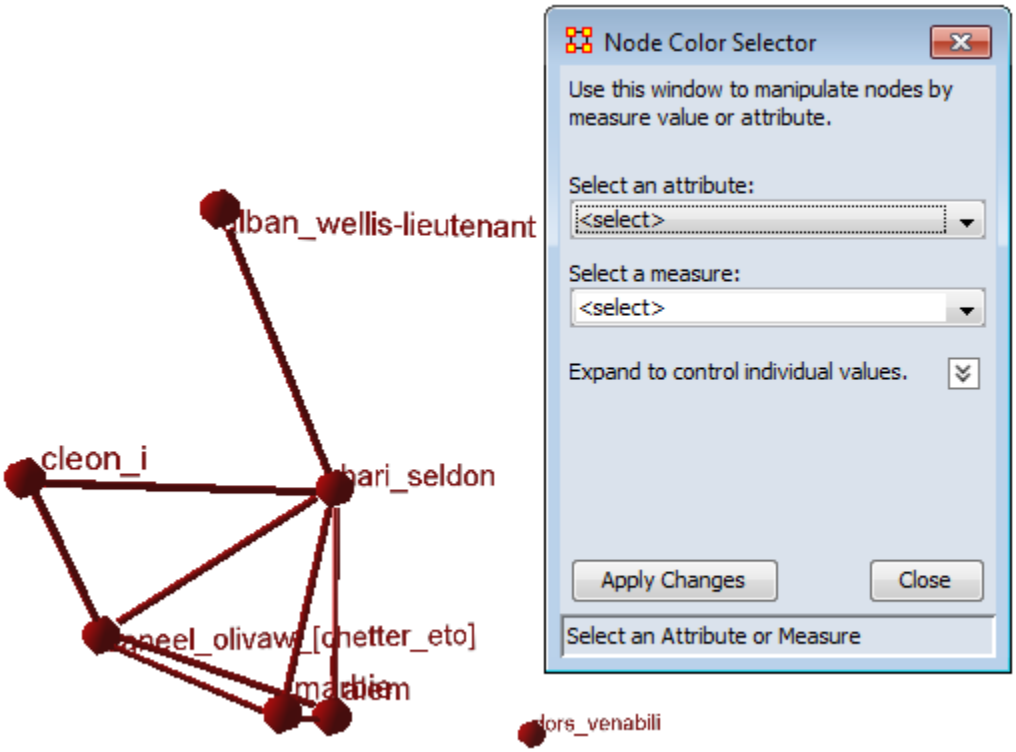


Color By Attribute or Measure

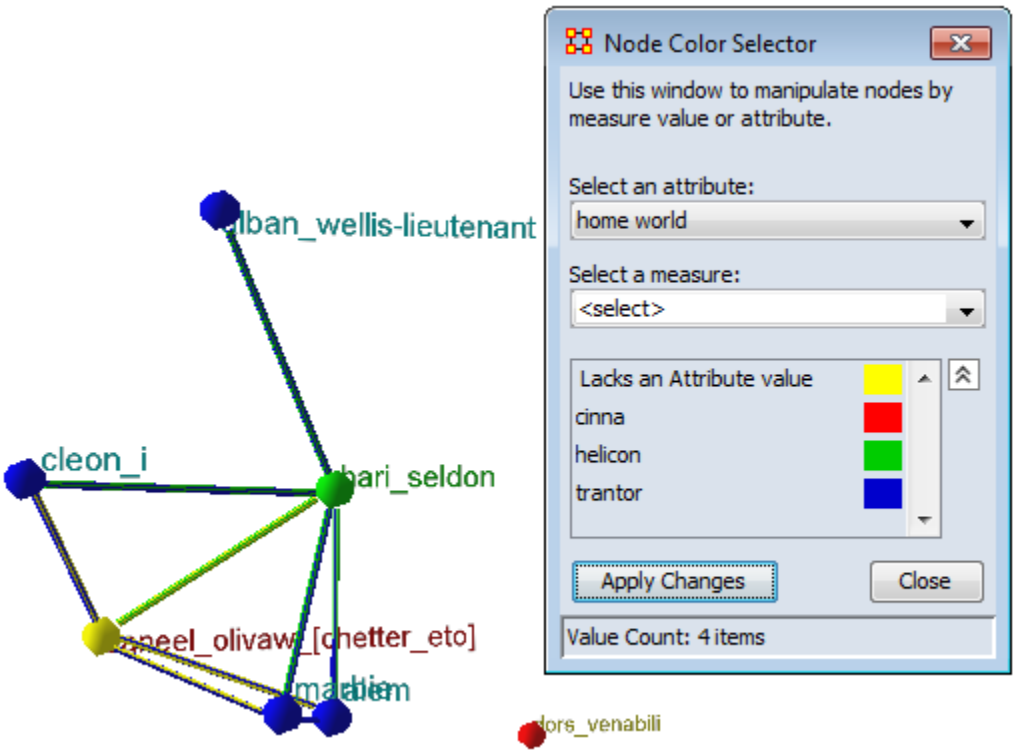
As in the 2D Visualizer nodes can accept coloring by various means.

I start out by hiding all Nodesets except Agents. If the Legend dialog is not visible select from the main menu **Tools > Legend** then from

the Legend menu **Control > Hide All Nodes**. Then select the Agents Nodeset. This will display all Agent nodes in their default red color.

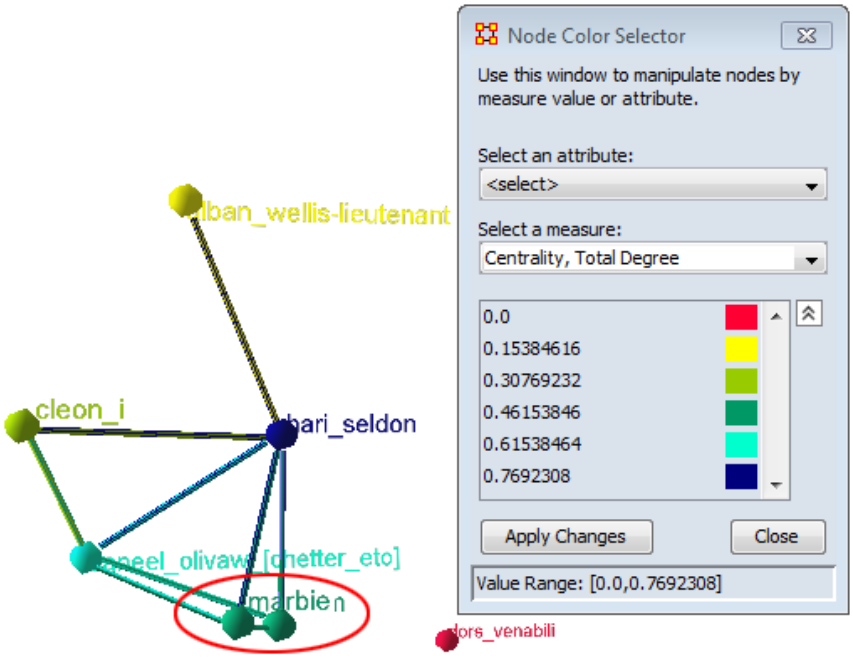


Using the **Select an attribute** will allow you to assign individual colors to each attribute. Click on color well and choose your colors. I assigned the three homeworlds **red, green, and blue** and the **Lacks an Attribute value** was set to **yellow**. Click the [**Apply Changes**] button.



From the **Select a measure:** drop down select a measure to run. This will assign values to each node some of which **could be equal**. As with the attributes you can assign individual colors to each value.

The two nodes in the red circles are the same color, **0.46153846**.



3D Contextual Menu

While in the 3D Visualizaer right-clicking brings up a different contextual menu. There are different menus for clicking a node or a link.

Right-Click a Node

Add Node : Clicking on a node will add a link to a new node

Add Link : Right-click a node and select Add Link. Click a second node and a link is created between those two nodes.

Center Node : Brings the selected node to the center of the screen and zooms in.

Delete : Deletes selected node from Nodeset

Drag : Selected node turns yellow indicating it is selected. Right-click and hold and you can drag the node to a new position. When you are finished click the [Done] button at the bottom of the visualizer.

Fixed Position : Sets a node's position in space while other functions are performed. The node turns light blue and a check mark indicates this is active. When finished selecting this function unselected the node.

Set Label... : Allows the user to give a node a new label.

Set Colour... : Calls up the color palette and allows the user to give the selected node a new color.

Set Radius : Allows the user to manually resize a node.

Hide : Hide the selected node form the display.

NOTE : Hidden nodes can only be recalled using the **Action > Show All Nodes** function.

Show Details... :

Right-Click a Link

Delete : Seletes selected link

Hide : Hides selected link

Radius... : Changes selected link to new radius

Weight... : Changes weight of the selected link.

NOTE : Weight of link can be set between 0 and1.0

Set Colour... : Calls up colour selector and sets link to that colour.

Reverse Direction : Reverses the direction of the link.

NOTE : To show the current direction of the links click the **Show Links button on the toolbar.**

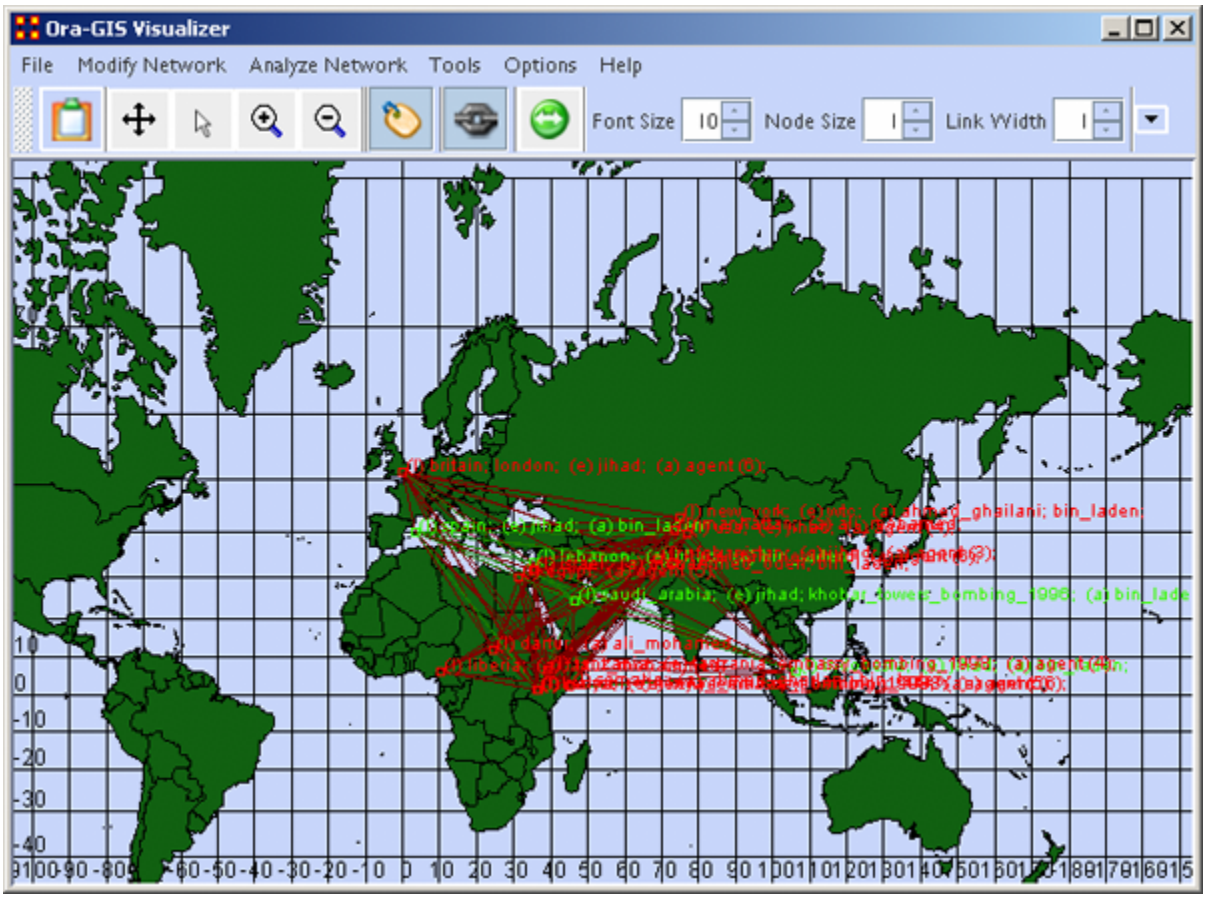
NOTE : If after reversing the direction of a link the direction does not change, toggle the **Show Links** button off and of

Show Details... :

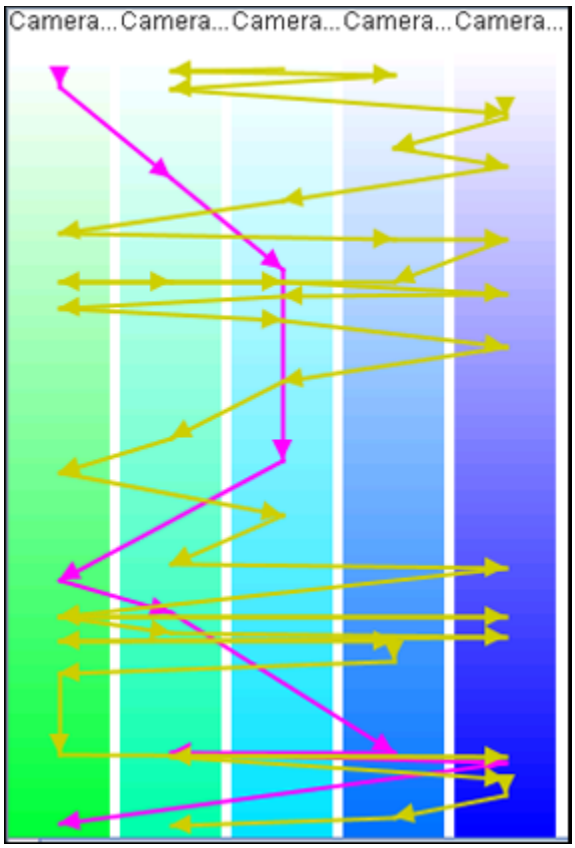
GeoSpatial Network

ORA provides tools to visualize Geospatial Information Systems: GIS Visualizer and GIS Visualizer 3D. When working with the GIS Visualizer your Meta-Network must include **location** information.

GeoSpatial is concerned with plotting who or what was where on a global basis. It plots nodes on a map and then connects those nodes.



Loom also deals with nodes in locations but is keyed on the timeframes in which nodes appear. There are locations in which two agents appear in but which were there at different times and never met.


Camera...
Camera...
Camera...
Camera...
Camera...

GIS

The GeoSpatial Visualizer differs from the 2D Visualizer as it places nodes on a representative map whereas the regular visualizer allows the nodes to float freely in a **non-space**.

Many **Geospatial information system (GIS)** products apply the term geospatial analysis in a very narrow context. In the case of vector-based GIS this typically means operations such as map overlay (combining two or more maps or layers according to predefined rules), simple buffering (identifying regions of a map within a specified distance of one or more features, such as towns, roads or rivers) and similar basic operations. The Geospatial Network tool in ORA allows for the plotting of a Meta-Network on a map of the globe using **longitude** and **latitude** for placing the nodes.

This **longitude** and **latitude** is associated with a **location** Node Class. Then other Node Classes are associated with the location Node Class. This information is used to place people and items on the map.

Below is the default map included with ORA's GIS tool.



NOTE : Other maps, or layers, can be added and loaded into the GIS Visualizer. The GIS Visualizer generally can load geospatial maps based on the **Shapefile** format.

The ORA Geospatial Visualizer can be accessed from either the main menu bar: **Main Menu Bar > Visualization > Geospatial Networks** or by clicking the triangle on the Visualizer button in the Editor.

Geospatial Networks attributes

The Meta-Network **MUST** contain a **location Node Class** and that Nodeset **MUST** contain **longitude** and **latitude** data. Below is an example of a **Location** Node Class information that contains Longitude and Latitude as attributes.

Location	COUNTRY	POP	CAP	LONGITUDE	LATITUDE
Murmansk	Russia	468000	N	33.0860405	68.96355
Arkhangelsk	Russia	416000	N	40.6461601	64.52067
Saint Petersburg	Russia	5825000	N	30.4533272	59.95189
Magadan	Russia	152000	N	150.780014	59.571
Perm'	Russia	1160000	N	56.2324638	58.00024
Yekaterinburg	Russia	1620000	N	60.6101303	56.84654
Nizhniy Novgorod	Russia	2025000	N	43.94067	56.28968
Glasgow	UK	1800000	N	-4.26994753	55.86281
Kazan'	Russia	1140000	N	49.1454659	55.73301

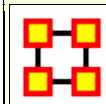
NOTE : The columns which are necessary to build a **Location Node Class** are highlighted in Blue. In this example below, COUNTRY, POP, and CAP are not necessary, though they can be added, as additional attributes. Further below this chart, we will display how a location Nodeset will appear in ORA's editor.

Longitude and Latitude Format : The longitude and latitude use the **degree.minute** format. **Longitude** begins at the prime meridian which runs through Greenwich Village and run eastward 360 degrees. You can also denote the longitude values with positive or negative (-)

numbers between 0 and 180. **Latitude** uses a 0-point which begins at the equator and runs to 90 to the north and -90 to the south.

Location data example

Node ID	Node Title	ethno-reli...	friendship	latitude	longitude	political-le...
<set filt...	<set filt...	<set filt...	<set filt...	<set filt...	<set filt...	<set filt...
afghanistan	afghanistan			34.28	69.11	
africa	africa					
airport	airport					
britain	britain	christian	friend	51.36	0.05	liberal
cape_town	cape_town					
dar_es_sal...	dar_es_sal...					
darfur	darfur		friend	12	24.45	
egypt	egypt	sunni	friend	30.01	31.14	
europe	europe		friend			liberal
farm	farm		friend			
indonesia	indonesia	sunni	friend	6.09	106.49	liberal
israel	israel	jewish	friend	31.71	35.1	
karachi	karachi					
kenya	kenya		friend	1.17	36.48	
lebanon	lebanon	sunni	friend	33.53	35.31	
liberia	liberia			6.18	10.47	
london	london	christian	friend	51.36	0.05	
manhattan	manhattan	christian	friend	40.47	73.58	liberal



GeoSpatial Network Toolbar


The GUI contains tools to work with the GIS maps. You can also customize the toolbar with functions from the menu.

Standard Toolbar

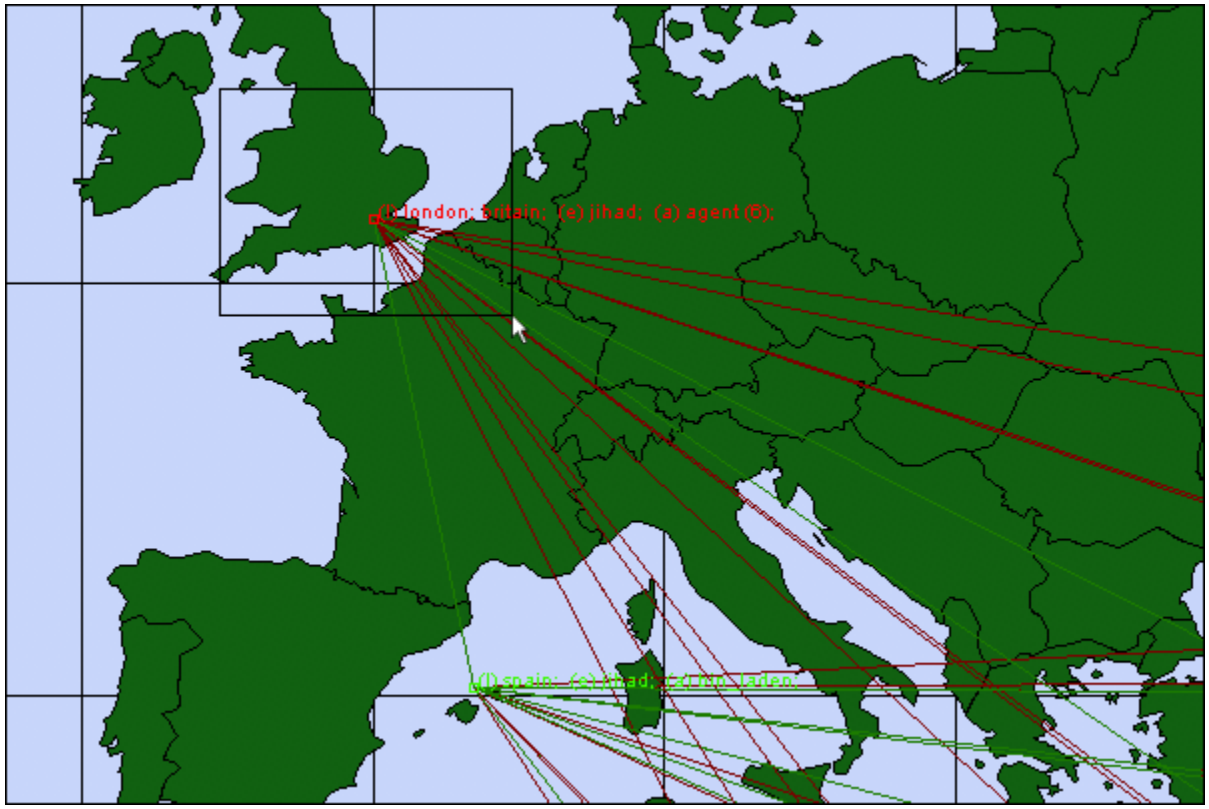

Copy Image to Clipboard : Places a copy of the current map in the clipboard which can be pasted into another program.


Pan Map : Place the cursor on the map and click the button. The

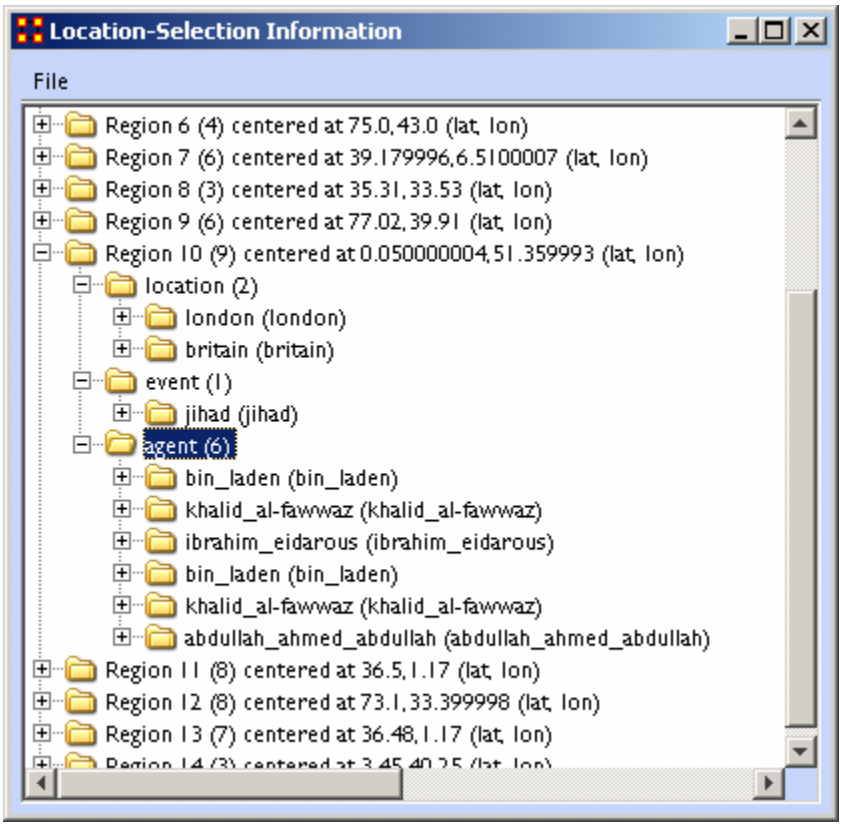
map will re-center on those co-ordinates.

NOTE : Right-Click on the map to center view on that area.

Select Place : Click and drag to capture nodes for information to display in an information window. This information will be displayed in an expanding tree format. Click and drag the cursor to include the nodes to display.



A pop-up window will display information for all the nodes captured by the cursor.





Zoom In : Zoom In works in two ways. 1) Click and drag to select the area you want to zoom in on. The selected area will fill the GIS window. 2) Click the map once and the view will zoom in centering on the clicked area. This can be repeated until you zoom in as close as needed.



Zoom Out : Place the cursor on the map and click the button. the map will zoom out and re-center on those co-ordinates.



Show Labels : Toggle the labels on & off.



Show Links : Toggle the links on & off.



Show Arrows : Toggle the arrows on & off.

Font Size : Increase or decrease font size using the up & down arrows.

Node Size : Increase or decrease node size using the up & down arrows. The size of the node is proportional to the number of

entities in a location.

Link Width : Increase or decrease link width using the up & down arrows.

GeoSpatial File Menu

The GeoSpatial file menu allows you to open, add, and save map data.

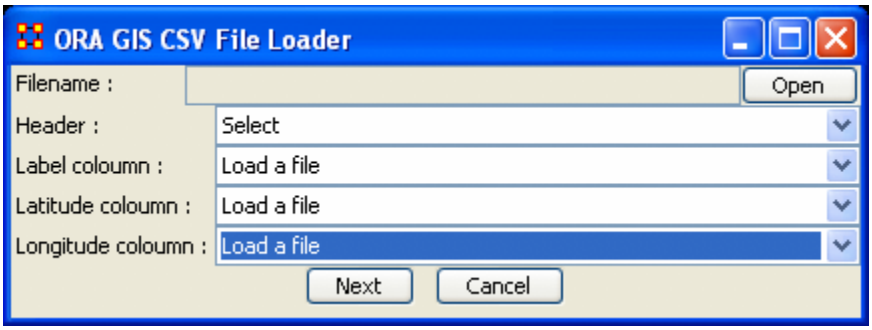
Open Meta-Network… : Opens a **NEW** Meta-Network file into the Geospatial map. REMEMBER: The new file needs to have both **longitude and latitude** data.

Open Trailset… :

Save Screenshot : Saves the currently map to the **.PNG** format.

Add GIS Data… :

Add CSV : You can load a **.csv** file and specify which columns contains the longitude/latitude data.



Add KML (Google Earth) : KML is a file format used to display geographic data in an earth browser (e.g. Google Earth). A KML file is processed in much the same way that HTML (and XML) files are processed by web browsers. Like HTML, KML has a tag-based structure with names and attributes used for specific display purposes.

Add e00 : Contains Geographic Information Systems (GIS) mapping data exported by ArcGIS software. ORA can import this style of vector data and convert it for use in the GeoSpatial tool.

Add ERSI Shapefile : An ERSI shapefile is a digital vector storage format for storing geometric location and associated attribute information. Shapefiles spatially describe geometries: points, polylines, and polygons.

NOTE : This format lacks the capacity to store topological information.

Add Shapefile (using Openmap) :

Add Shapefile (using Geotools) :

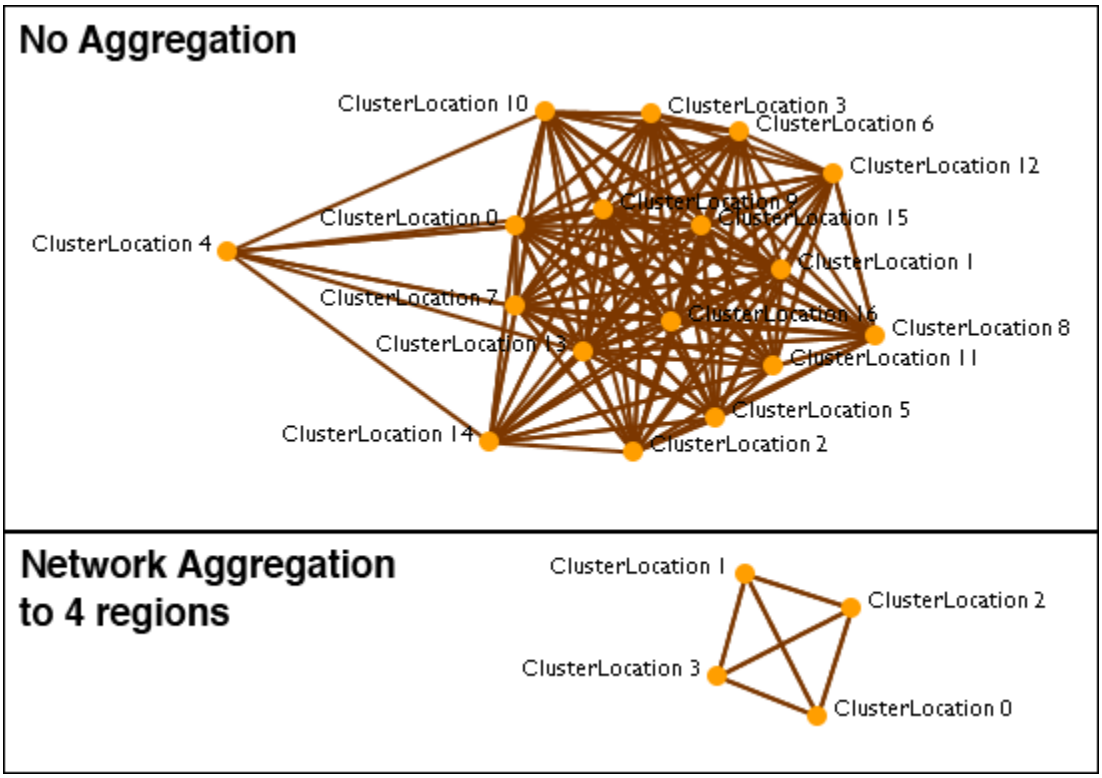
Save Map... :

Save Map To PNG : Saves the currently map to the **.PNG** format.

Save Map To SHP : Saves the currently map to the **.SHP** format.

Save Map To KML : Saves the currently map to the **.KML** format.

Save Map To DyNetML : Saves the current map to the **DyNetML** format with the added Node Class **ClusterLocation--ClusterLocation**. This records changes affected by the Network Aggregator in grouping locations into regions.



Save Map To Loom Trailset : Saves the currently map to the **Loom** format.

Current GIS Layers

Open From Defaults : Opens what is currently saved as the default Dynamic Network and GIS layers.

Open from a File : Uses the information saved in the choose file to set the Dynamic Network and GIS layers.

Save As Default : Saves the currently selected Dynamic Network and GIS layers as the default.

Save to a File : Saves the currently selected Dynamic Network and GIS layers to a file.

Current Meta-Network Locations Configurations



Open From a File :



Save to a File :

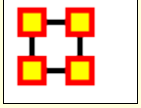


Create Meta-Network From Visible Network...



Copy Image To Clipboard : Saves a picture of the current map to the clipboard which can be pasted into another program for use in demonstration purposes.

Close



GeoSpatial Modify Menu



GeoSpatial Actions Menu.



Replace Current Meta-Network : Allows you to open a new geospatial file without closing the GIS visualizer.



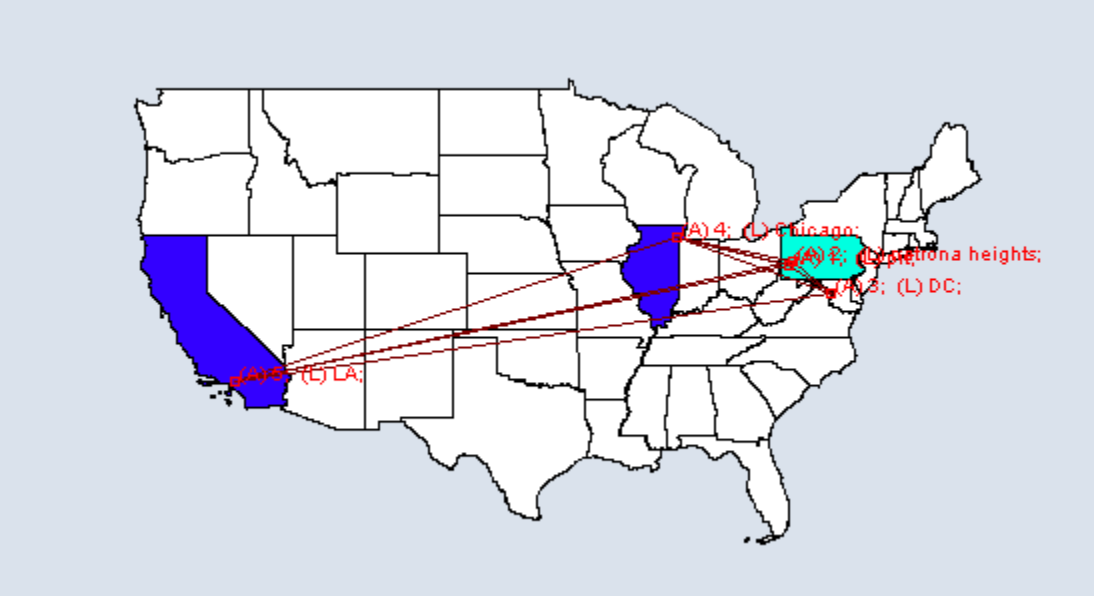
Create New Spatial Relation :



Create New Spatial Nodeset :

Generate Distance Network : Creates a new Network of distances in the selected Meta-Network using the location Nodeset.

	pit	natrona heights	DC	Chicago	LA
pit	0.0	19.25850677490...	190.20924377441406	410.607177734375	2120.249755859375
natrona h...	0.0	0.0	186.0699462890625	421.1796569824219	2134.662353515625
DC	0.0	0.0	0.0	595.1495971679688	2281.83447265625
Chicago	0.0	0.0	0.0	0.0	1729.1634521484375
LA	0.0	0.0	0.0	0.0	0.0



GeoSpatial Analyze Menu

GeoSpatial Actions Menu controls color and size of location nodes.

Reset Map Zoom : Reset the display of the map to it's default size.

Reset Nodes Colors and Size : Returns on nodes to their default colors and sizes.

NOTE : If the colors do not reset, click on the map with Pan tool to force the reset.

Size Nodes by Attribute or Measure : Sizes nodes using numerical data.

NOTE : You can not size by an attribute using non-numerical data.

Size Links by Value : Adjusts the weights of links in proportion to all links.

Color Nodes by Attribute or Measure : Currently the colors are assigned automatically, with "Blue" corresponding to a high value

and "Red" corresponding to a low value. The screen may not update automatically, so you may have to force a refresh by recentering/zooming/etc.

NOTE : If the display does not reflect your new colors you can force a re-evaluation by zooming in and out. Another method is using the **Get/Set View** which will not change your framing.

Color Nodes by Component :



Color Nodes by Concor Grouping : Colors nodes using **Concor Grouping***.

Color Nodes by Newman Grouping : Colors nodes using **Newman Grouping***

GeoSpatial Tools Menu

Tools is a set of controls for adjusting how nodes and links are displayed.

Layer Manager : Controls the visibility of the Nodeset(s), Network(s), and Shape layers on the map by checking or unchecking the boxes.

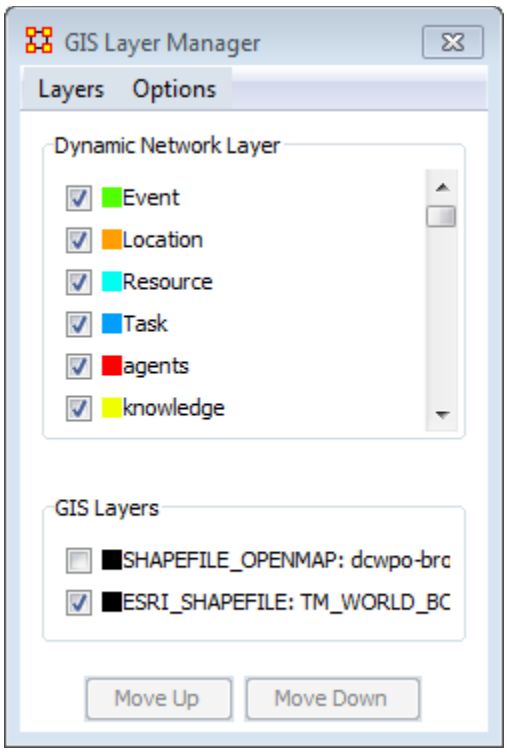
Network Aggregator : Controls the groupings of nodes which are displayed together as separate regions.

Get/Set View :

Configure Meta-Network Locations :

Layer Manager

The **GIS Layer Manager** controls what is displayed in the GeoSpatial Visualizer. This includes all Node Classes and Shape layers. It is similar to the Legend in the regular Visualizer.



Selecting or Unselecting a Node Class or GIS Layer will remove it from the display. It does not remove it from the dataset.

The **Move Up** and **Move Down** buttons adjust the display position of the SHAPE files. These buttons have no affect on the Network Layers.

Layer Manager Menus

Layers

Add New Layer : You can add additional map files to the display.

Remove Selected Layer : You can remove any selected map layer that has a checkmark next to it from the display.

Show All Network Layers : Displays all node information on the map

Hide All Network Layers : Removes all Network information form the map. The Information is still available through the Layer Manager.

NOTE : If you have more than one map layer loaded you can arrange how they are stacked.

Change Layer Position > Move Layer Forward :

Change Layer Position > Move Layer Backward :

Change Layer Position > Move Layer To Front :

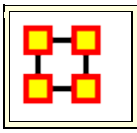
Change Layer Position > Move Layer To Back :

Add Layer As Nodeset :

Options

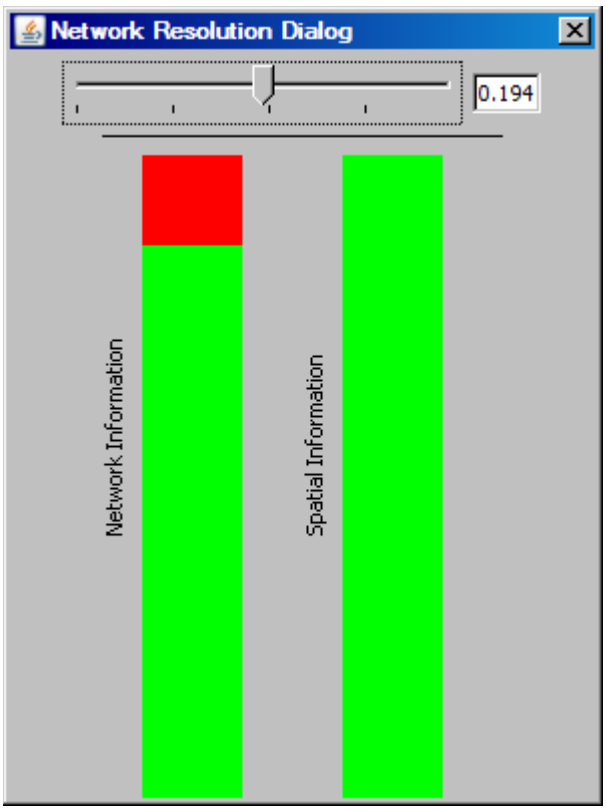
Set Current Map Data As Default :

Reset Map With Default Data :



Network Aggregator

The Network Aggregator looks at regions instead of individual locations. Using the slider you can control how dense each region will be. Increasing the density groups more locations into a region.



Using a sliding scale, which in turn represents network information retention (or loss) depending on the level of the adjusted slider. A value can also be entered manually in the numeric field box.

When the network bar is fully **red** it indicates full network resolution and therefore network information is preserved and displayed in the GIS Visualizer. Conversely, when lower network resolution figures are entered network detail can be sacrificed. This bar graph is intended to show the level of such loss.

Scrolling all the way to the left to a value of 0.0 will remove all but the most basic level of aggregation. Basic level being any time where two locations occupy the exact same point. By default, GIS loads up with a small level of aggregation in order to handle potential issues with rounding (in cases where data's generated by scripts). If the little bar doesn't do much, try typing the value (0.0) directly into the text field there and hitting enter. After a little wait as it recalculates things, absolutely all locations should be shown.

It is best to experiment with the slider at varying values and observing GIS visualization for optimum balance of data resolution and visual relevancy. This is a useful tool when you have many noisy

or cluttered locations. The grouping assists you in seeing the connections easier.

Keeping Separate Agents In The Same Location

If you are having problems with aggregating your data you should check your data. Depending on the source, you could have incidents where all locations within a city are given the same latitude/longitude, or even all locations within a country. It all depends on what the data origin thought the data would be used for. Sometimes they skimp on the details/accuracy to save time which could cause problems in the final display.

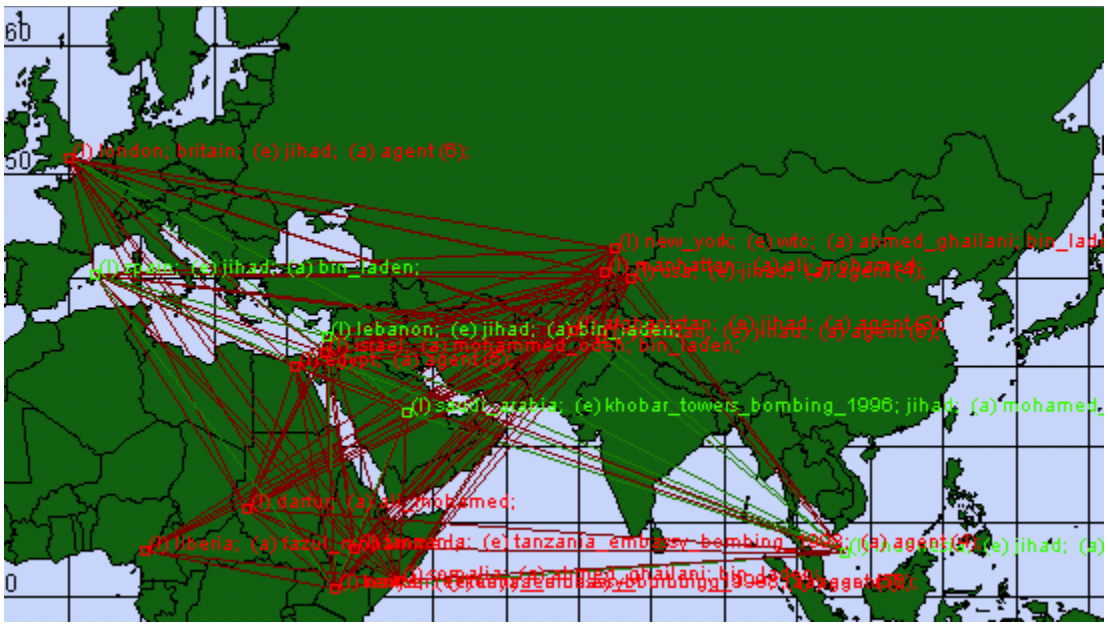
NOTE : You need to remember that in aggregation, ORA is plotting locations, not agents. If two agents have the same latitude/longitude, then ORA will plot then as one point on the map.

NOTE : And there is also the ability to view this in the 2D or 3D Visualizaer which will display all nodes regardless of the similar lat/long attributes.

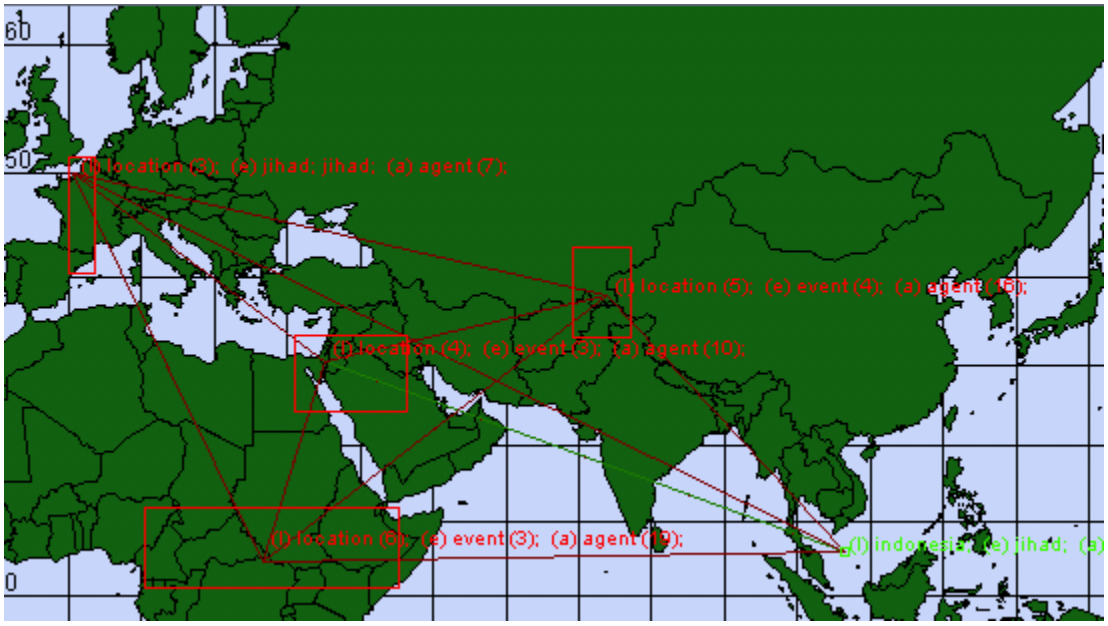
Example

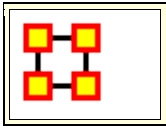
You have 15 agents in London and want to see the links between them. In order to see the individual agents they will all need different Latitude and Longitude values. The GIS is plots locations, and not Agents. Thus, if there is only a single location node for all 15 agents, they will be represented as a single node, with no links. The best way to do this would be to select these nodes out and visualize them in the regular network visualizer. Any perturbations to their Latitude and Longitude values would be random.

GeoSpatial with no aggregation



GeoSpatial using Network Aggregation





GeoSpatial Network Toolbar

Add... :

Add ESRI ShapeFile : Load a shapefile into the GIS Visualizer.

Add ShapeFile (using Openmap) :

Add ShapeFile (using Geotools) :

Color Shapes by Links... :

Color Shapes by Internal Links : Value determined by number of links within a single shape.

Color Shapes by External (Outgoing) Link Count : Color value deteremined by Out-Degree of Node.

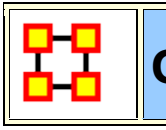
Color Shapes by External (Outgoing/Incoming) Link Count : Color value deteremined by Total-Degree of Node.

Color Shapes by Internal/External Link Ratio : Color value determined by

Color Shapes with No External Links : Colors shapes which contain no links

Color Shapes by Node Count : Color Value determined by number of nodes contained in a shape

Color Shapes by Attribute/Measure : Color Value deteremined by selected attribute or by results from measure.



General Content About ShapeFiles

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ShapeFiles are used in the GeoSpatial Visualizer and allow you to color code map details from data in your Meta-Networks.

NOTE : Geospatial Distance does calculate distances taking the curvature of the Earth into consideration.

Finding ShapeFiles

The GeoSpatial tool can use various ShapeFile formats. This shapefiles can be obtained from the following locations :

World Shape files :
http://thematicmapping.org/downloads/world_borders.php

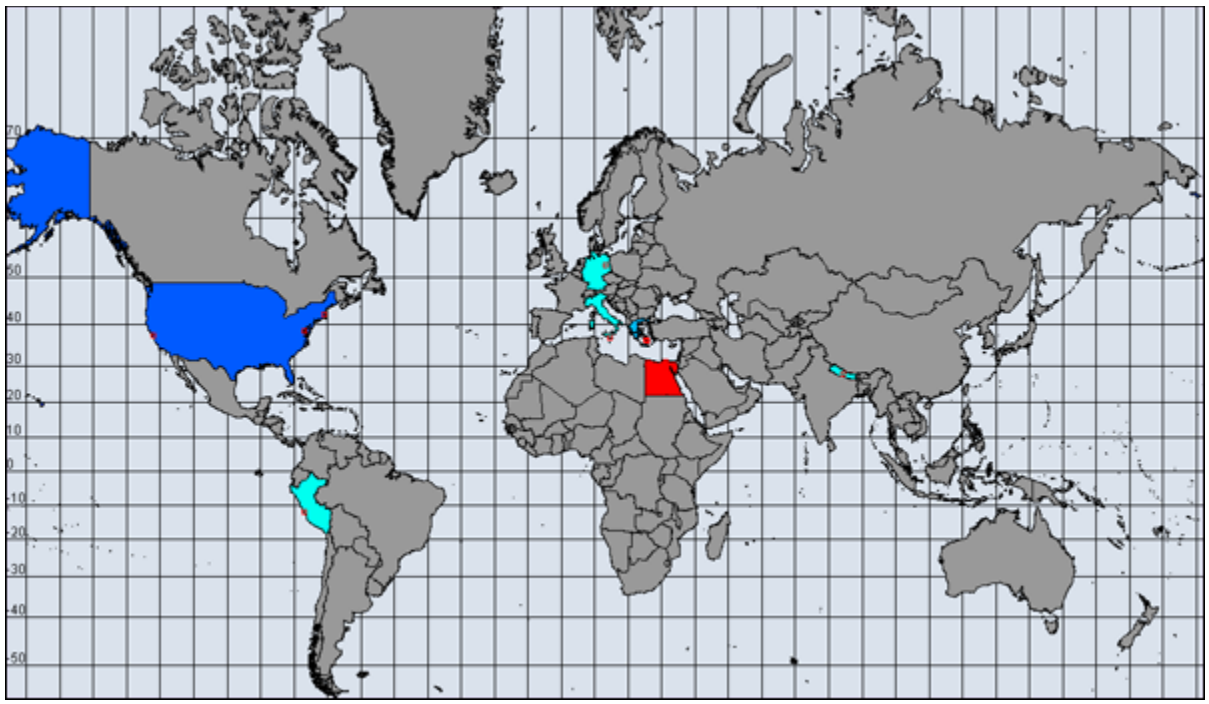
number of different USA based shapefiles :
http://www.census.gov/geo/www/tiger/shp.html

Other shapefiles : **http://maplibrary.org/**

Download, and if necessary, unzip these files. Place these files in a folder on your computer.

General Suggestions

Default Map Colors : Before using the coloring functions on shapefiles I have found it advantageous to set the default color of the shapes to a neutral grey. Go to the **Layer Manager**. If it is not visible call it up by selecting **Tools > Layer Manager**. Click on the colored box next to the checkbox. The dropdown allows you to change the fill color and the border color. When the color picker appears pick one of the middle grey tones (or any other color you prefer].



If you do not set a default color to your shapefile the color will be taken from the color spectrum range. This could possible be different each time you run and select your colors. Also the grey, being neutral, helps define shapes which are not included in the data. Below is the same map which was not given a default grey color. Makes some of the colors harder to distinguish.



ShapeFiles

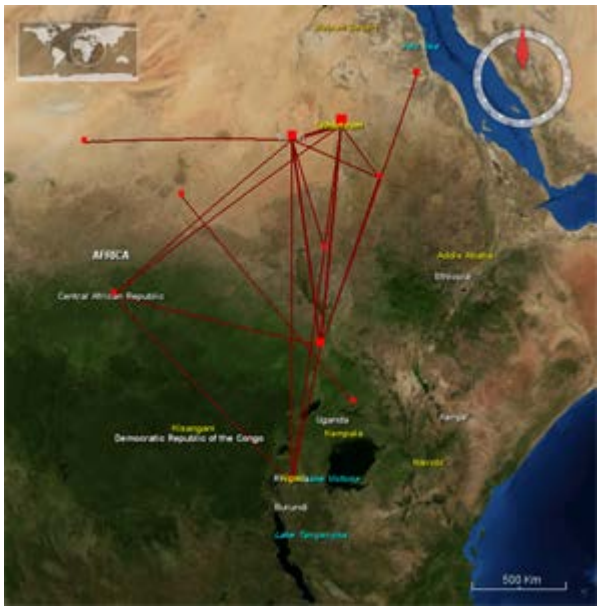
Default

The default GIS renderer is known as OpenMap. Through OpenMap you can aggregate locations, add shapefiles, and perform basic visualization.



NASA WorldWind

Once the data has been loaded into GIS, under options you can select the 3D visualization, which uses Nasa Worldwind. Any feature available in the 2D version is available in the 3D version, albeit it may operate a tad differently 3D Version operates primarily as a sphere, but a flat map version can be toggled on.



Google Earth

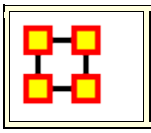
Google Earth is not integrated with ORA, but the GIS is capable of producing a **.kml file** for use with Google Earth. The command to do so is located under File -> Save Map. The output will have the same nodes and links.



Customizing

Shapefiles allow you to customize the map with custom political boundaries, highways, whatever you can find Shapefiles are imported via the File -> Add GIS Data. menu. Both the fill color and border color can be changed via the GIS Legend. All shapefiles must be in WGS84 Projection Screenshot shows a shapefile of the political boundaries of the states of Sudan, as downloaded from MapLibrary.org





Load ShapeFile

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Load Meta-Network Into GeoSpatial

You can load a Meta-Network into the GeoSpatial Visualizer in three ways.

In the Main Interface hightlight the Meta-Network. Select from the main menu **Visualizations > GeoSpatial Networks...**

In the Main Interface hightlight the Meta-Network. Click the downward triangle on the Visualize button and select **GeoSpatial Networks...**

From the GeoSpatial Visualizer select from the Main Menu **File > Open Meta-Network...**

Load ShapeFile Into GeoSpatial



When started the GeoSpatial tool will display a world map with, if selected, your Meta-Network locations shown. From the GIS Menu select **Shapefiles > Add... > Add ESRI Shapefile**. Navigate to the location to which you saved this file. Highlight the file and click [**Open**].

You will notice the outlines appear to have gotten bolder. This is due to the second set of country outlines. In the Layers Manager deselect the default shapefile leaving only your newly loaded shapefile.

Color A ShapeFile

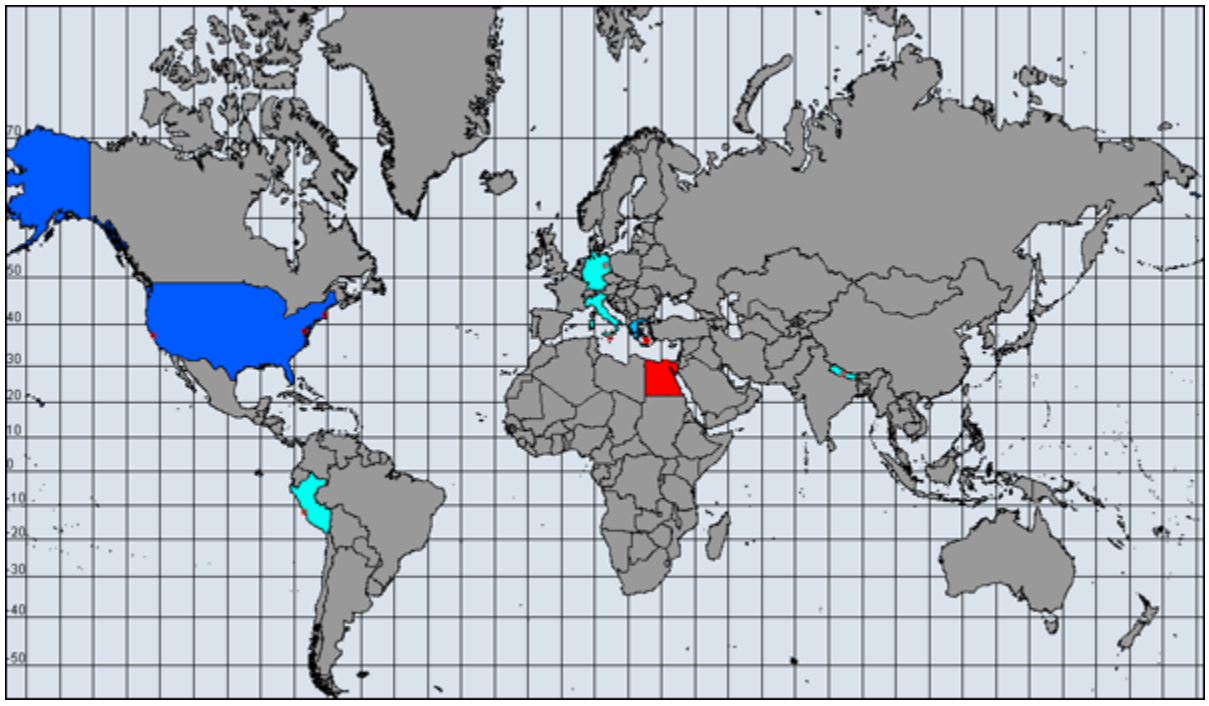
A ShapeFile can be colored by various methods. By Node Count, Link Count, and Attibute/Measure.

Color Shapes by Links...

There are three options for links, Color Shapes by Internal Link Count, Color Shapes by External Link Count, and Color Shapes by Internal/External Link Ratio.

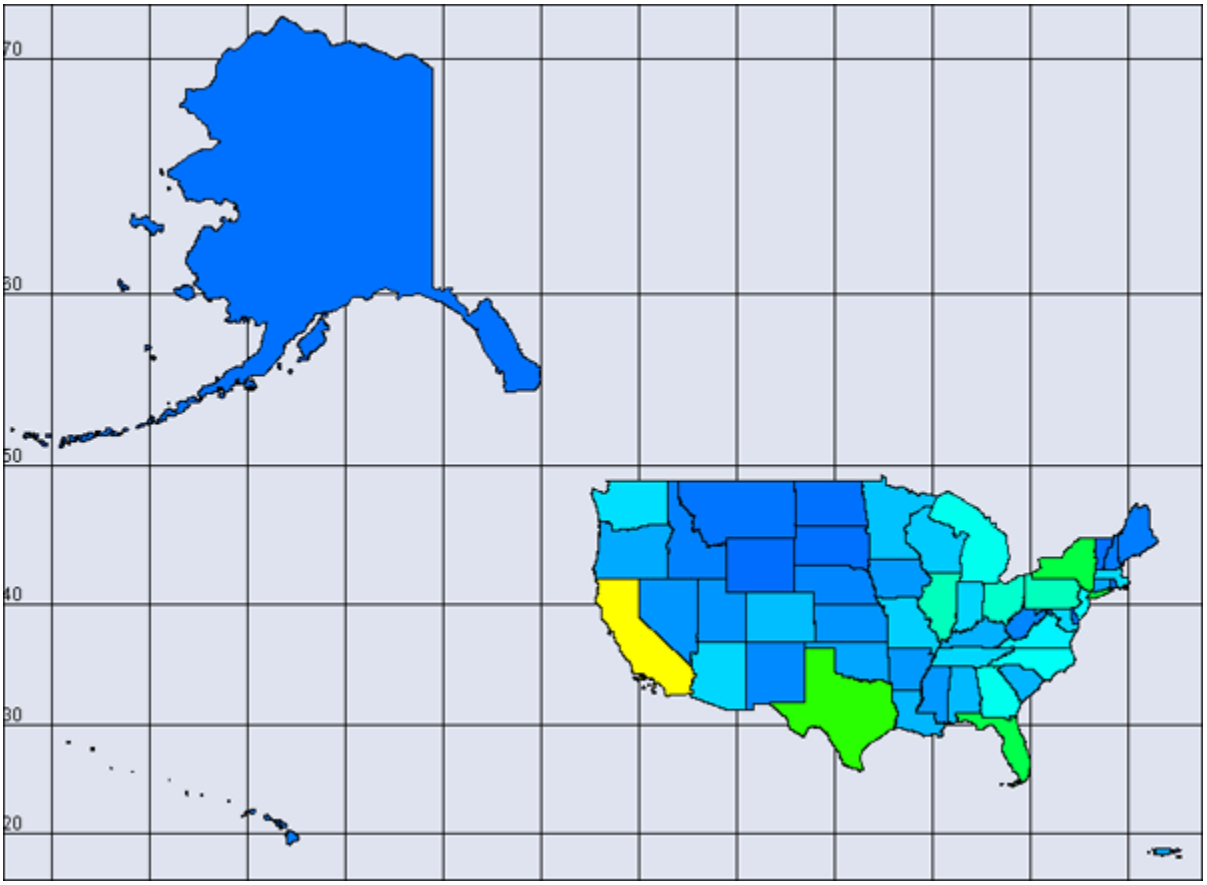
Color Shapes by Node Count

You can color the shapes accounting for the number of nodes in any location. The color bar allows you to set the color for the minimum and maximum. In this case I selected ultramarine for the minimum [which essentially means any country with zero nodes] up to the maximum which is colored orange.



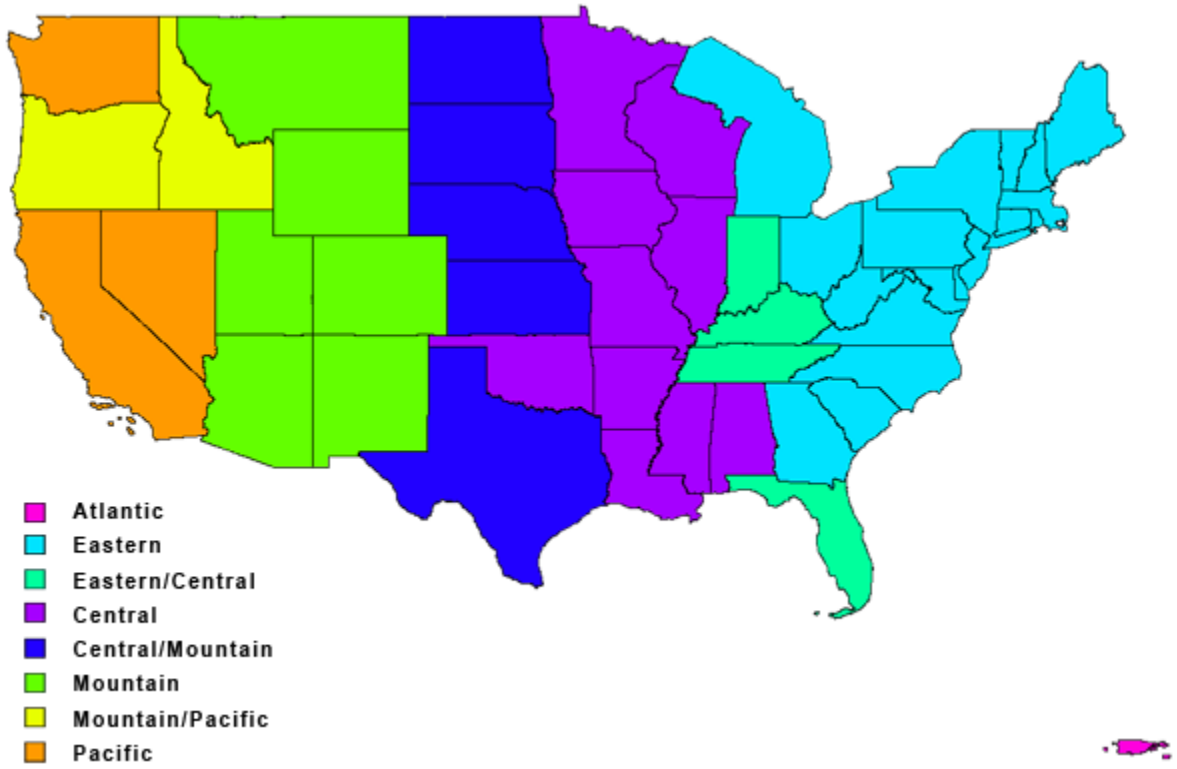
Color by Attribute / Measure

For this example I took the population numbers of the U.S. States and territories. I set the high number to be yellow, going through the dark to light blues to green and ending up at white for the least populated.

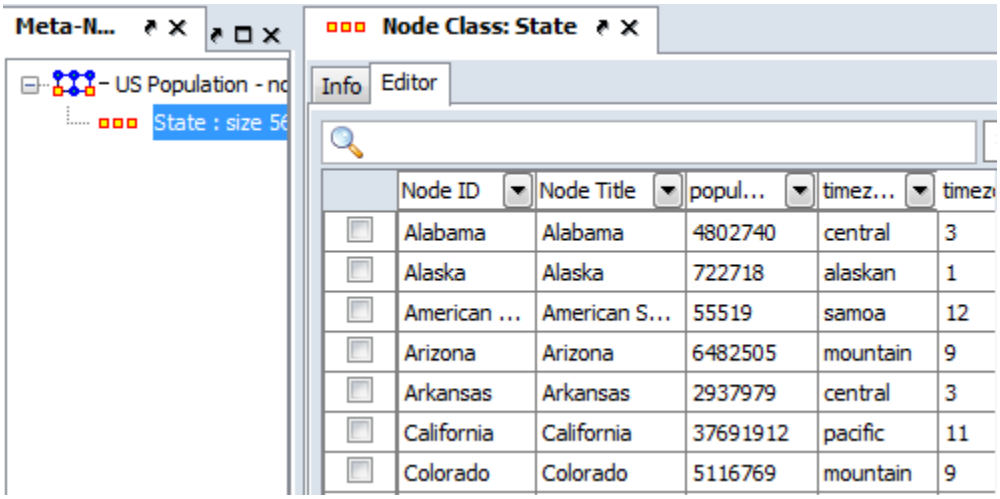


Next I added an attribute to the U.S. population file and called it **timezone** which includes the lower 48 states plus the Atlantic territories. I assigned a number for each timezone and added entries when a state used multiple timezones.

NOTE : When adding attributes to use in this manner you need to make sure they are created as numeric. Text attributes will not work.



Add GIS Data To Meta-Network



Node ID	Node Title	popul...	timez...	timez
Alabama	Alabama	4802740	central	3
Alaska	Alaska	722718	alaskan	1
American ...	American S...	55519	samoa	12
Arizona	Arizona	6482505	mountain	9
Arkansas	Arkansas	2937979	central	3
California	California	37691912	pacific	11
Colorado	Colorado	5116769	mountain	9

Open file in GeoSpatial Visualizer by selecting **Visualizations > GeoSpatial Networks...**. If there is no **Latitude/Longitude** data in

the Meta-Network ORA will inform you there is no location information. That's fine, just click [**OK**].

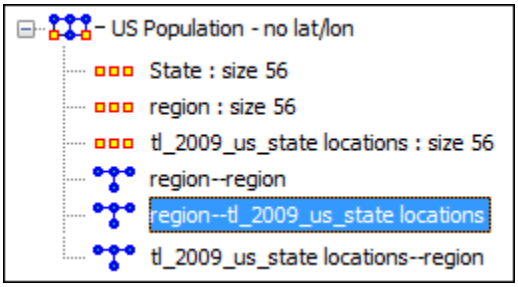
NOTE : How can ORA tell whether location data exists? It looks in the attributes for names which contain the substrings **lat** or **lon**. If so it will post those as possible geospatial attributes.

The **Configure Locations** dialog will appear asking you to select Nodesets and attributes to use as locations. Ignore this and click [**Next**]. A second Configure dialog will appear but you need to ignore this box also so click [**Finish**]. An empty GIS map will appear.

From the menu select **File > Add GIS Data... > Import locations from ERSI ShapeFile**. Navigate to the shapefile which contains the latitude/longitude data for your network. Your locations will now appear on the map.

NOTE : For this example my Meta-Network contained information on the population of states. The ERSI file I used contained the latitude/longitude for the U.S. states. Make sure that the ERSI file you use contained the lat/lon data for your Meta-Network.

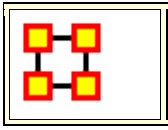
This procedure will add Nodesets and Networks as needed to your Meta-Network. The Nodeset will contain the location data from the ERSI ShapeFile



Things To Be Aware Of

To assure that the latitude and longitude data are properly imported into your Meta-Network the Node ID must match the information from the ERSI file. If not ORA will not match up the nodes and data will not be imported.

NOTE : For those so inclined this data is retrieved from the ShapeFile's **DBF** file which can be opened with Excel.



GeoSpatial Network Toolbar

Add... :

Add ESRI ShapeFile : Load a shapefile into the GIS Visualizer.

Add ShapeFile (using Openmap) :

Add ShapeFile (using Geotools) :

Color Shapes by Links... :

Color Shapes by Internal Links : Value determined by number of links within a single shape.

Color Shapes by External (Outgoing) Link Count : Color value deteremined by Out-Degree of Node.

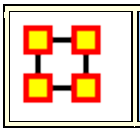
Color Shapes by External (Outgoing/Incoming) Link Count : Color value deteremined by Total-Degree of Node.

Color Shapes by Internal/External Link Ratio : Color value determined by

Color Shapes with No External Links : Colors shapes which contain no links

Color Shapes by Node Count : Color Value determined by number of nodes contained in a shape

Color Shapes by Attribute/Measure : Color Value deteremined by selected attribute or by results from measure.



Loom / View Trails

Description

Loom is primarily concerned with how specific entities move or evolve through other entities. In the most basic case, this involves Agents as they move through Locations. More abstract examples include Agents moving through Beliefs or Beliefs moving through Locations.

When you first start Loom, you are prompted for a Network. The target nodes in the Network dictate what they're moving through. The source nodes are who/what is doing the moving.

Once started, Loom goes through all timeslices, and looks at the connections in that network only. It sets up a series of waypoints based on what connections are made at that timeslice, upon which it constructs a trailset.

Classically, we restrained Loom such that for any timeslice, any source node could appear in at most one target, but now we allow for a source node to occupy multiple targets at a time (Agents having multiple beliefs, for example).

NOTE : Loom can also display things like **persons through beliefs** showing how a person make change their mindset over time.

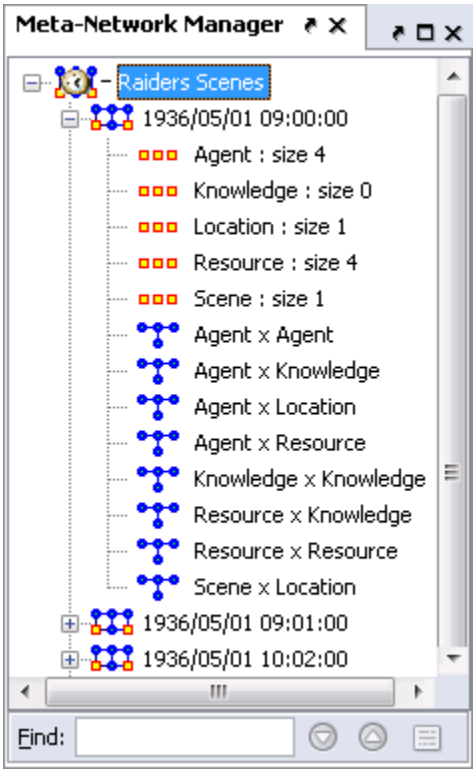
A **Loom file in .csv** is a bit of a misnomer. A loom dataset is a dynamic meta-network. A dynamic meta-network is just a bunch of single meta-networks. For a beginner, that's a good place to start. Take multiple csv's to bring in multiple meta-networks, combine them in ORA (select all meta-networks, right click, **Convert to Dynamic Meta-network**), and load in Loom.

Caveat : Loom works best when Agents or whatever occupy a single location at a time. It can handle multiple locations, it just gets messy.

Before you Start

Before starting you need a dataset that can be used within the Loom. One such dataset is the TAVI dataset. Use **File > Open Meta Network** to open TAVI.xml

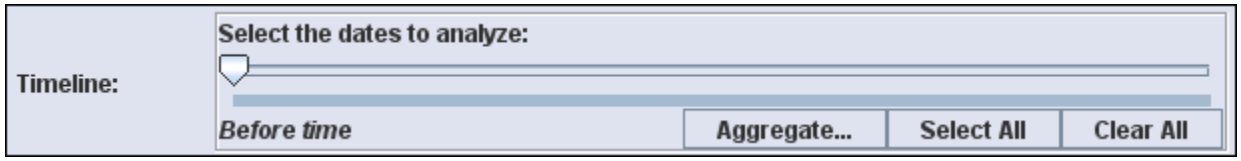
The clock icon in the Meta-Network Panel means that it is a dynamic meta network and that there are continuous-time updates **(deltas, which are listed below the top-level network)** indicating how the network changes over time.



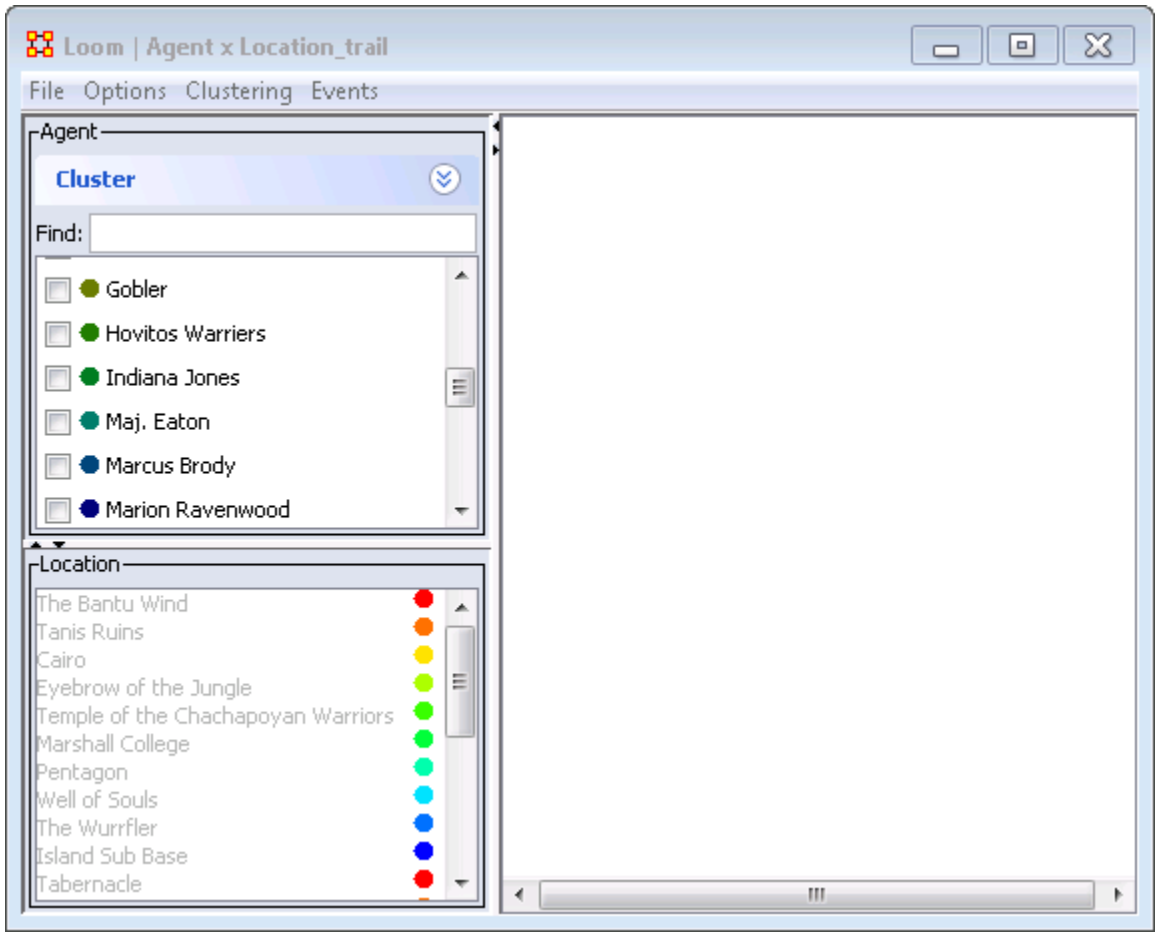
To analyze the data you must have a relation that **A)** changes over time and **B)** stays many:one (e.g., a person must have only one location at any given time). Usually this is Agent x Location, but in theory you can select other relations.

In the main ORA screen, open the **Visualizer > View Trails**. Select the **Person x Location** input network.

At the top left is a list of Agents; the bottom left is a list of locations. Activating the check-box next to an agent will cause its trail to appear in the right hand panel. The large vertical strips correspond to locations, and the path moving between them is the trail indicating the agent's location at each point in time.

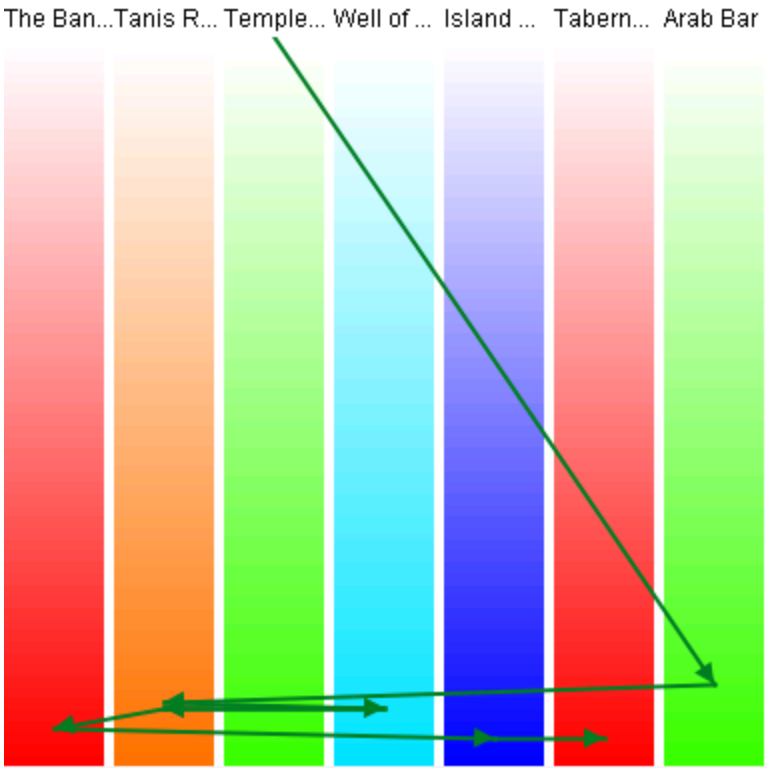


Open Loom : Highlight the TAVI dataset in the Meta-Network pane. From the drop down menu select **Visualizations > View Trailsets**. In the dialog box select **Persons x Locations**. The Loom window will appear with the chosen Network.

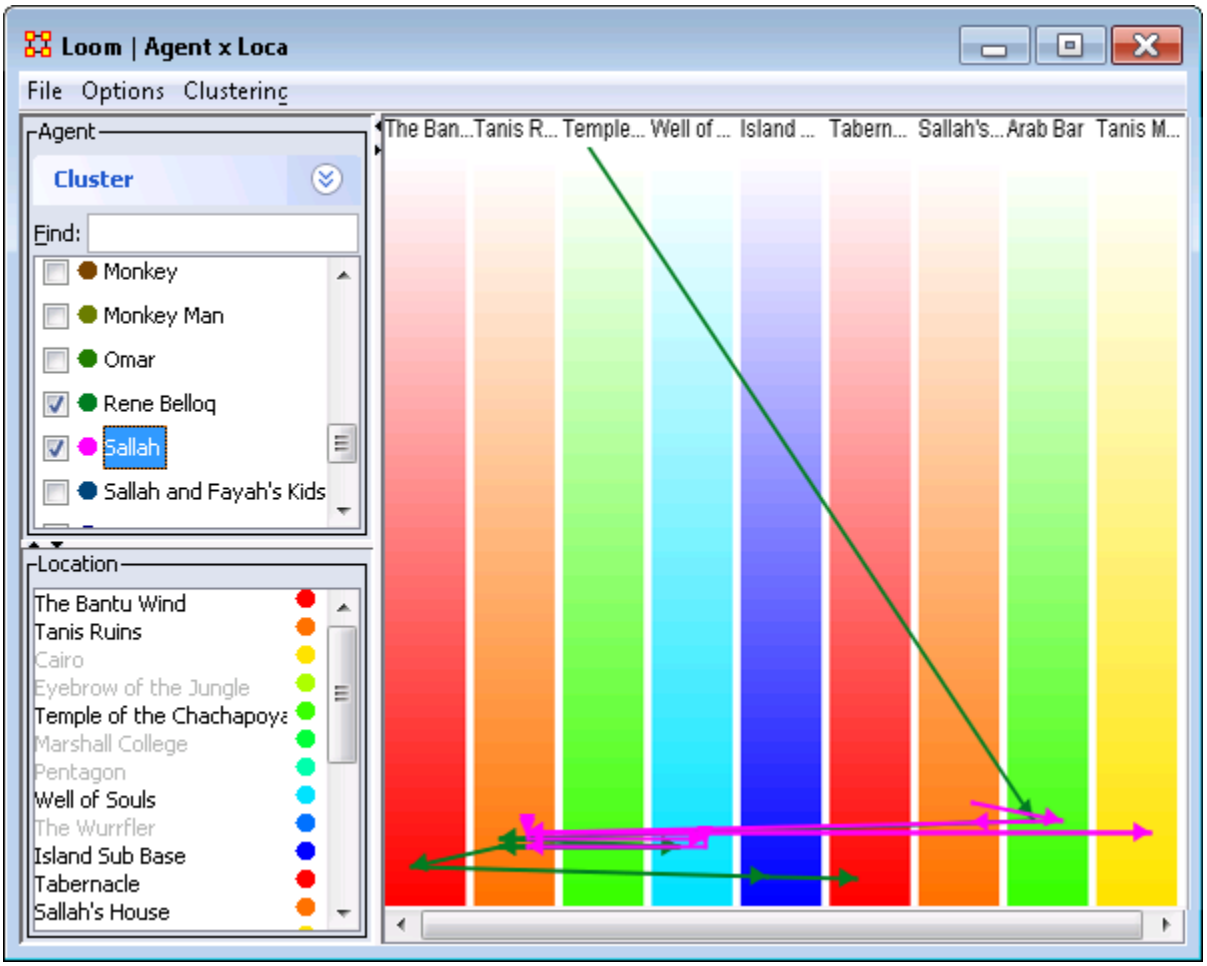


1. **Person Pane :** Lists all persons in the meta-networks. This pane contains a check box to the left of next to each person to control which persons are visible. To the right is a color designation
2. **Location Pane :** Lists the locations in the meta-networks. To the right is a color designation.
3. **Loom Pane :** Displays the persons as they travel through the locations.

Selecting one person you can easily see where they've been **(Left window)**. But when you select multiple people, it can quickly get impossible to view the trails **right window)**.



Making the Display more Readable : can be done in several ways. Clicking the color circle representing the individual node brings up the color changer. You can then select a color which stands out better for viewing.



Loom File

Loom File Menu

Open ... : Opens up DyNetML file which contains location and time data.

Save as... : Saves currently open DyNetML file under a new filename.

Export > DyNetML : Saves the Loom data as a DyNetML file.

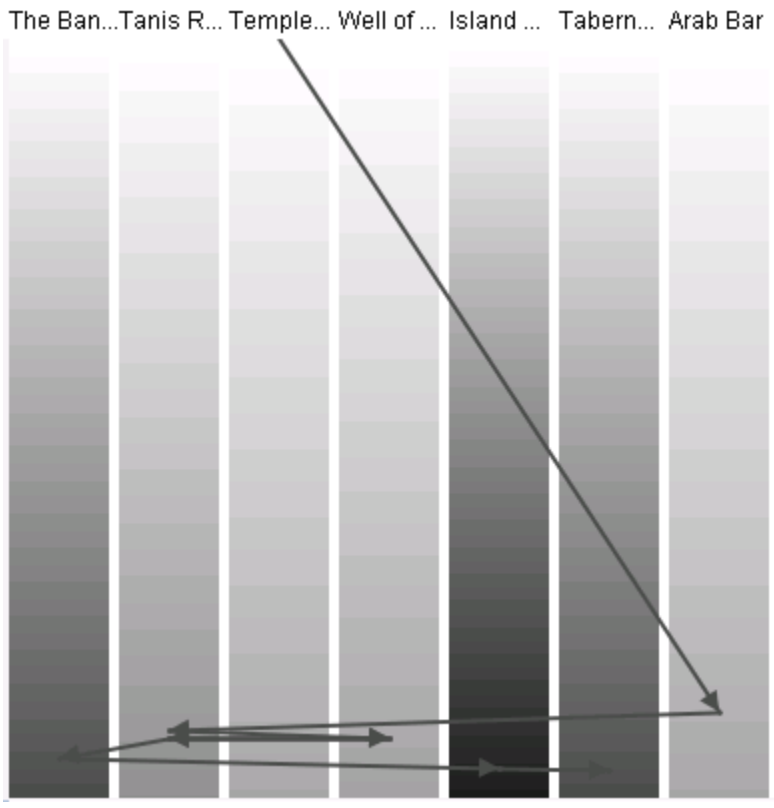
Save Image as... : Saves an image of the current Loom state. Can be saved as a **png, jpeg, pdf, svg, or tiff** file.

Loom Options

Loom Options Menu

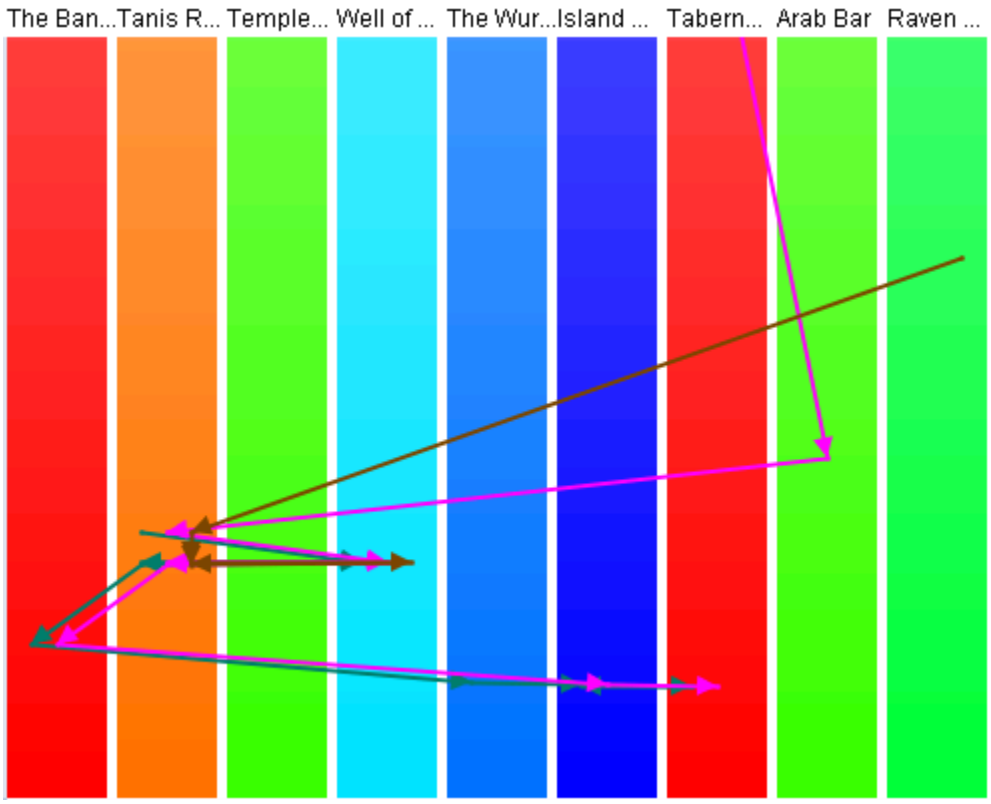
Anti-Aliasing : Used to smooth out rough edged lines.

Grayscale : Removes all colors from image and is good when printing black and white images.

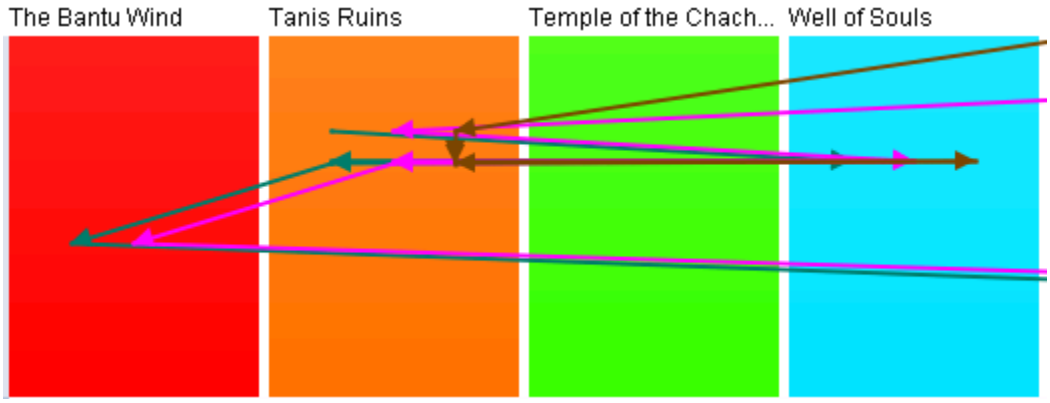


Show Timeline : Displays the timeline markers on the left of the Loom.

Stretch Vertical : You can select a percentage to enlarge the height of the Loom. Good when many nodes are situated in a small area.



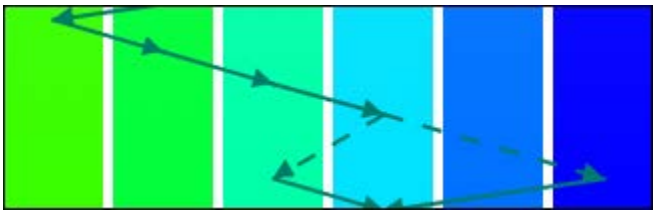
Bar Width : Widens the individual locations. Good when many nodes are situated in a small area.

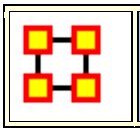


Allow Multiple Waypoints per Period : If unchecked a node will

appear **only** in the most weighted position. If checked then the node will be placed in all locations.
Example : A main location also contains three separate rooms. An agent can be listed to be in the main location but can also be listed as moving between the individual rooms. If this option is checked, the agent will be shown to be in all locations which can lead to it appearing an agent is in two places at once.

NOTE : The dotted line denotes a node which disappeared from all locations then reappeared later on.





Trail Clustering

What Trail Clustering can do:

Classification : Given a set of trails, the algorithm can classify trails based on the underlying patterns of observed location visits.

Level of Similarity : The degree of similarity in the classified trails can be increased or decreased according to user need by varying the specified depth of the PFSA.

Approximate similarity : Further, trails that have a subset of similar patterns of location visits, while also displaying differences by visiting other non common locations can also be identified by specifying a threshold for the similarity.

Noise Insensitivity : Approximate clustering also provides an inbuilt imperviousness to measurement noise in the trails. Occasional incorrectly identified location in a trail will not prevent it from being classified correctly according to the other correctly identified locations.

Pre-specification of number of clusters : The use of agglomerative clustering eliminates the need of pre-specifying the required number of clusters. Thus, this removes the risk of assigning trails to clusters they do not necessarily belong to (such as in cases where the number of final clusters is less than that necessitated by the dataset)

The Clustering Tool

The clustering tool clusters trails based on similar patterns of visitation to (specific) locations.

One trail that visits location A and B in the pattern **ABABAB** and another trail that visits location C and D in the pattern **CDCDCD** would both be clustered because of their alternating natures. But with no overlap the two trails would not be clustered together. But two trails that have the following visit patterns **ABCABCABC** and **BCABCABCA** will definitely get clustered.

Trail Pattern Depth

Consider two trails that have the following visit patterns **AABAABAAB** and **ABAABABAA**. For a pattern length of 1, the above two trails will definitely get clustered because of they both visit locations A and B with the same frequencies (2:1). When you increase the **pattern length**, you can get more specific with transitions. Now for a pattern length of two, the trails still have similar transitions AB, BA, AA but with slightly different frequencies of occurence. (Ex: AA occurs thrice in trail 1 and twice in trail 2).

They may still get clustered together. But when you increase the pattern length to three that's when things get interesting. You have in trail 2 the pattern BAB that never occurs in trail 1. So they will not get clustered together. This also is the reason why in the Star Wars dataset Han Solo and Chewbacca get grouped together for a trail pattern of 5 because they are almost always colocated throughout the movie.

Cluster Quality

With a value of 1.0, it will only return clusters where every sequence of entries is exactly the same. Lower that, it gives some wiggle room. 0.7, you'll get entries that are mostly alike, 0.3, you'll get entries that have a number of similar event strings.

Minimum Similarity

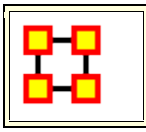
For a little more flexibility in the clustering algorithm you can use the **minimum similarity** feature. If that value is less than 1, for example 0.75, then the clustering algorithm will consider trails which have 75% of the locations in common, i.e. a trails that visits locations A,B,C,D and a trail that visits location B,C,D,E will be compared for similar patterns of visitation to locations B, C and D. If they visit these common locations similarly then they will be clustered together.

The Loom Dataset

A Loom dataset is a dynamic meta-network. A dynamic meta-network is a group of single meta-networks. For a beginner, that's a good place to start. Take multiple csv's to bring in multiple meta-networks,

combine them in ORA (select all meta-networks, right click, **Convert to Dynamic Meta-Network**), and load in Loom.

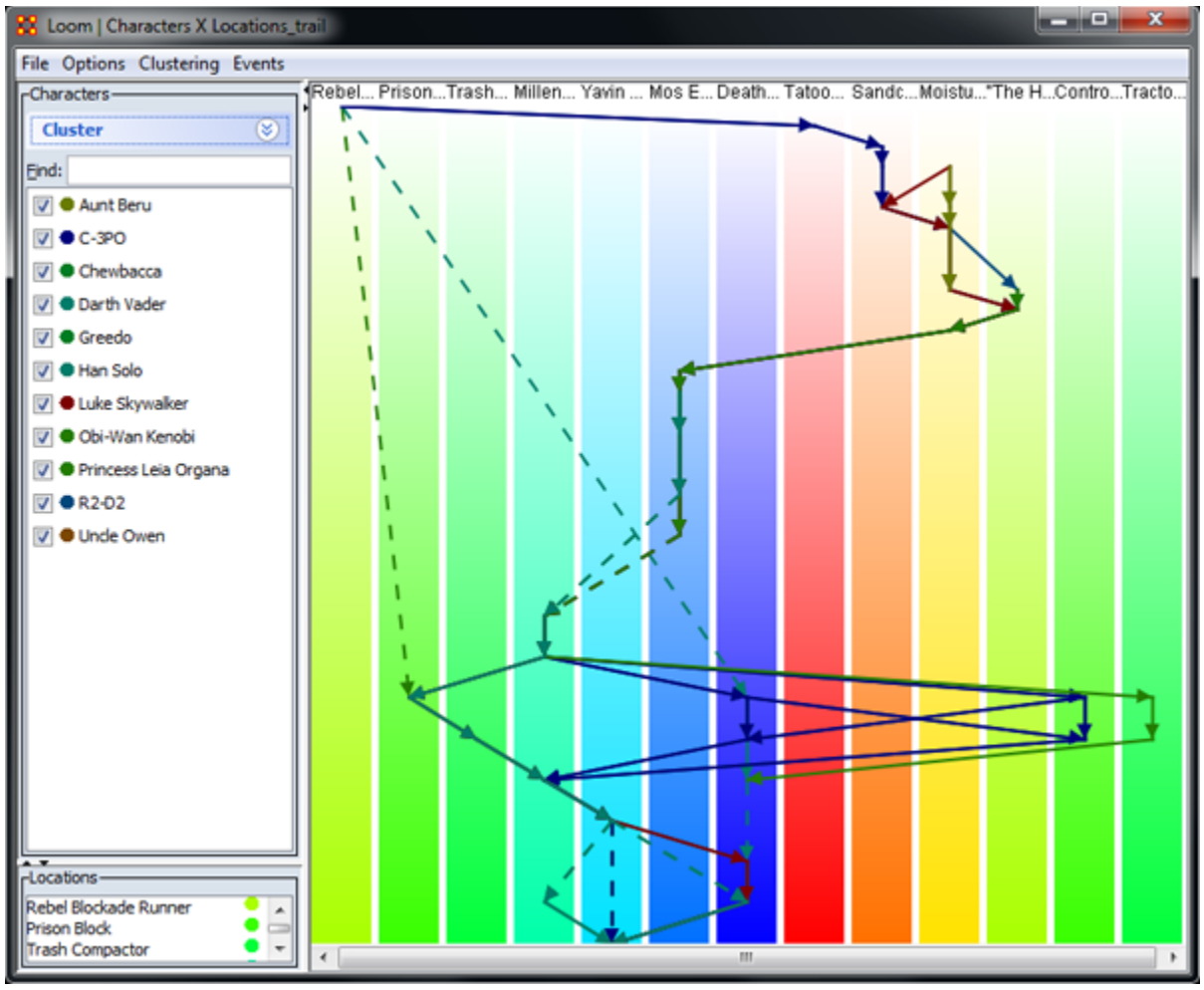
NOTE : Loom works best when Agents, or nodes, occupy a single location at a time. It can handle multiple locations, but you may encounter problems reading the display.



Trail Cluster Creation

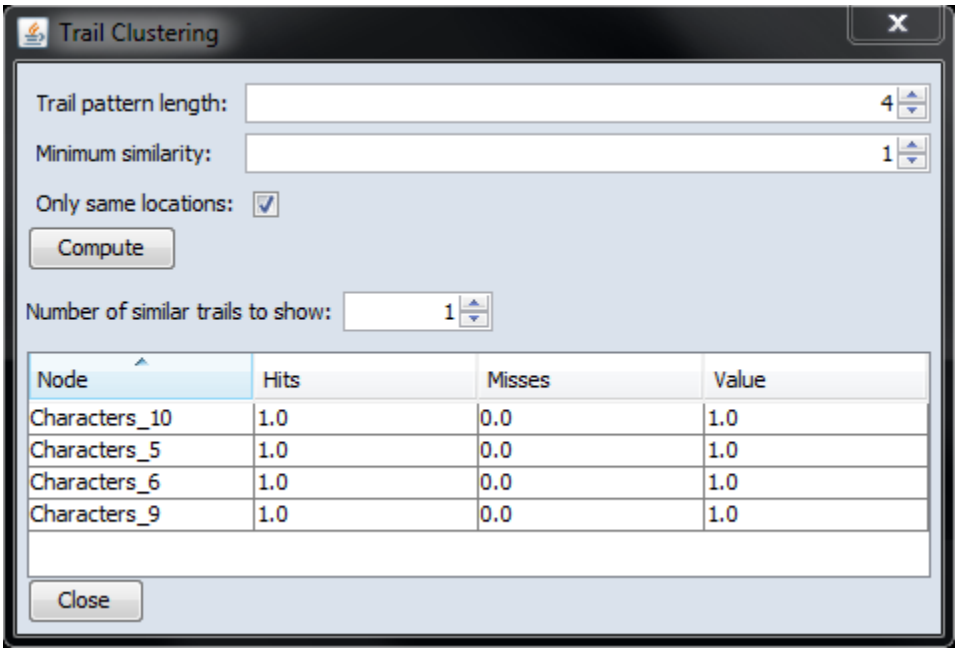
After loading a Loom ready DyNetML set (e.g. The Star Wars dataset) You can show how the characters are clustered. Below is the Loom with entire Star WArs characters set displayed. With this example we are interested in the Aunt Beru/Uncle Owen and Han Solo/Chewbacca pairings. Both pairs followed, for the most part, the similar path.

NOTE : The Loom lists characters in alphabetical order which may, or may not, correspond to the order of the characters in a dataset.

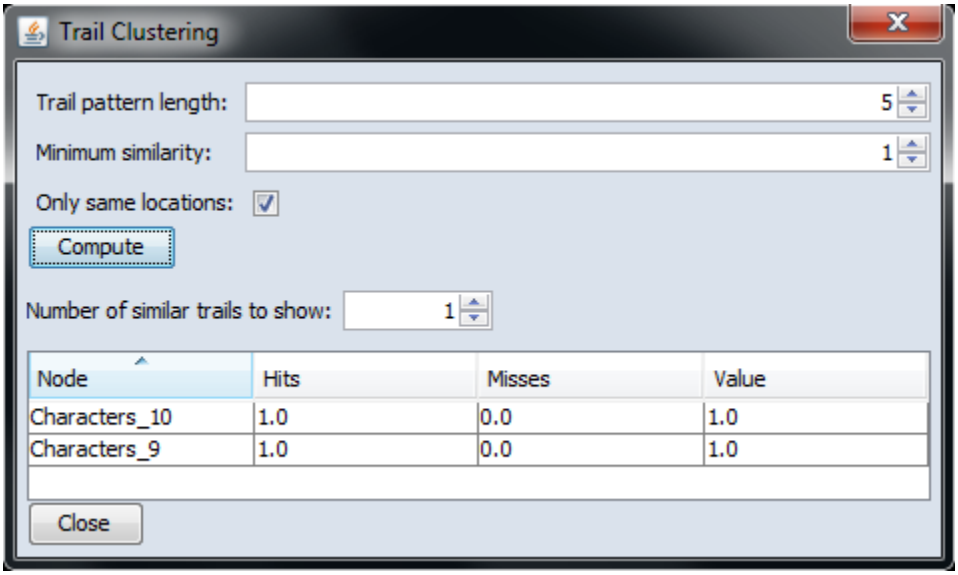


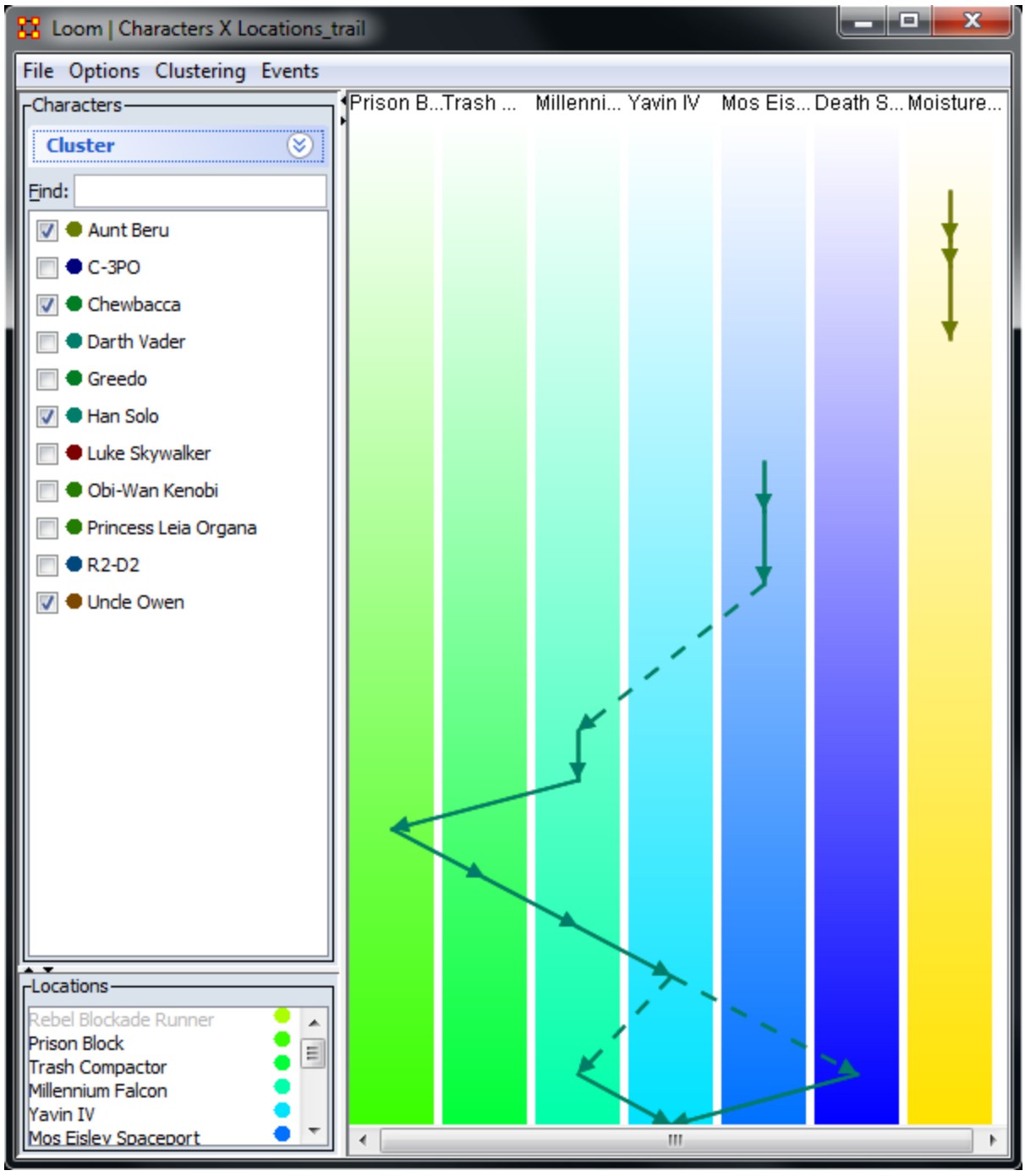
From the menu call up Trail Clustering by selecting **Clustering > Show Similar Trails**. Leaving most at their defaults I increase the **Trail pattern length** to four. Clicking [**Compute**] will display the four characters selecting in the Loom.

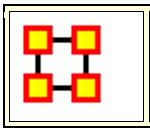
NOTE : In this example Uncle_Owen = character_5, Aunt_Beru = character_6, Han_Solo = character_9, and Chewbacca = character_10.



Increasing the Trail pattern length to five removes Uncle Owen (character_5) and Aunt Beru (character_6). If you look at the Loom image below both these nodes appear in only four time slices. When the length is increased to five they are removed form the display.




Loom | Characters X Locations_trail
File Options Clustering Events
Characters
Cluster
Find:
Aunt Beru
C-3PO
Chewbacca
Darth Vader
Greedo
Han Solo
Luke Skywalker
Obi-Wan Kenobi
Princess Leia Organa
R2-D2
Uncle Owen
Locations
Rebel Blockade Runner
Prison Block
Trash Compactor
Millennium Falcon
Yavin IV
Mos Eisley Spaceport
Prison B...
Trash ...
Millenni...
Yavin IV
Mos Eis...
Death S...
Moisture...



Trail Cluster Analysis

Trail Clustering using Symbolic Time Series Analysis

The objective of the Trails Cluster Analysis is to find similar behaviors in large networks. This can be described as a network trail generated by an agent over a period of time. This tracking can be used to predict that agent's behavior.

This methodology is fast and flexible and can be applied to several different Node Classes. It views each trail as a sequence of discrete symbols where each symbol is a visited location. Clustering is performed using a model based approach where a representative **Probabilistic Finite State Automata** model [PFSA] is derived for each trail. Each trail is treated as temporal sequence generated by an underlying Markovian process. The process is assumed to be Markovian of length D; the current location of each agent is influenced only by the past D locations visited by the agent

The trail clustering is a two-step approach. The first step is a coarse clustering stage where each trail's representative PFSA model is derived using the D-Markov algorithm [Ray, 2004]. The value of D significantly affects the granularity of the analysis. A value of 1 for the depth D implies that agents visit the same locations with similar frequencies, though not necessarily in the same order. A higher value of depth implies that agents are clustered based on visiting locations in the same order with similar frequencies. After the models are derived, the trails are grouped into coarse clusters where the cluster membership is determined based only on the locations that the agents visit and not on the frequencies with which these locations are visited. The second step of the trail clustering algorithm is cluster refinement where hierarchical clustering is performed on each of the coarse clusters to form groups of trails where each of the trails visit locations with similar visit probabilities.

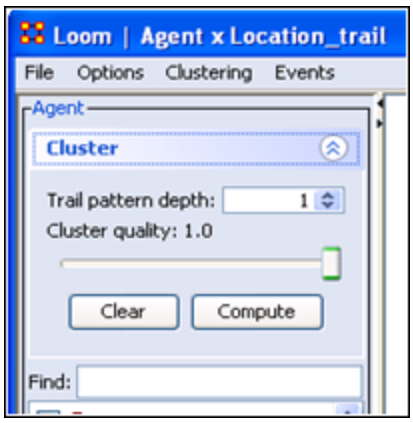


Figure 1 : Trail Clustering Menu in LOOM

Sometimes it's necessary to look beyond trails which do not visit **all** the same locations but do visit many of them. For this a **cluster quality index** is used. It finds which percentage of locations are common amongst the coarse trails.

A cluster quality of [**1**] implies that trails which visit the exact same locations are only grouped together into coarse clusters. A cluster quality of [**0.5**] implies that all the trails in a coarse cluster have at least 50% of locations in common. The cluster refining step then groups the trails in the coarse cluster based on probability of visiting these common locations with similar frequencies.

The Clustering Tool is integrated into the LOOM Visualization tool. It requires two inputs:

1 : The trail pattern depth for the generation of PFSA.

2 : The cluster quality.

Trail clustering allows for the extraction of groups of trails that demonstrate similar behavior. [i.e. visiting the location in the same order though **not** necessarily at the same time]. LOOM allows several different options for these visualizations.

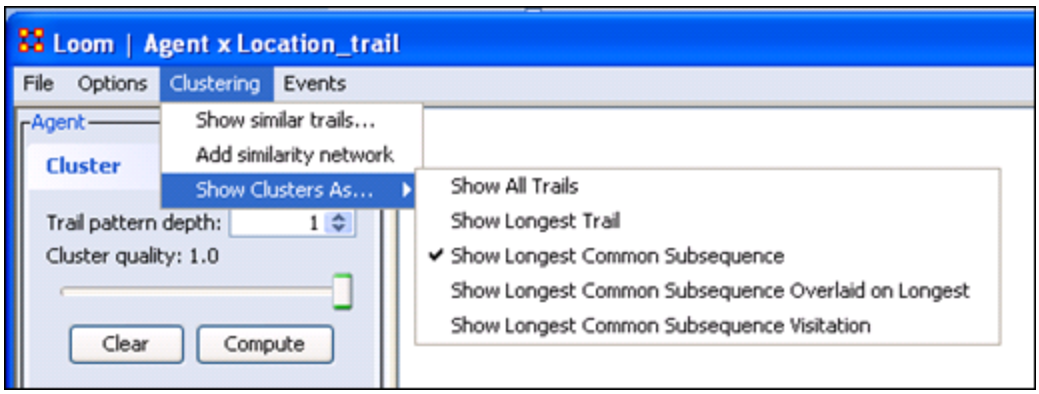


Figure 2 : Cluster Visualization Options

In addition to showing all the trails in each cluster and only the longest trail, LOOM also allows the visualization of the longest common subsequence amongst all the trails in a cluster. Trails belonging to the same cluster will have more sequences of locations visited in the same order (not necessarily consecutively) than trails belonging to different clusters. The longest common subsequence in a cluster depicts the most common behavior pattern amongst the agents that led to their being grouped together. The five different approaches to visualization of clusters provided by LOOM allows the end user different viewpoints of the clustered trails based on the analysis requirement.

Cluster Quality

First and foremost, it is only concerned with the sequence of transitions. It doesn't care when they occurred, only that they occurred. Trail depth indicates how many entries in a sequence it looks at.

Assuming trails **a->b->a->a->c->d->a->b->c**

Trails depth of two creates the following entries **(ab)(ba)(aa)(ac)(ad)(da)(bc)**. Trails depth of three create **(aba)(baa)(aac)(acd)(cda)(dab)(abc)** And so on, and so on.

Cluster Quality is likely where your issue is with creating clusters. With a value of 1.0, it will only return clusters where every sequence of entries is exactly the same. Lower that, it gives some wiggle room. 0.7, you'll get entries that are mostly alike, 0.3, you'll get entries that have a number of similar event strings.

References

Gullapalli A, Carley KM (2011) Extracting temporal trail clusters in networks using symbolic time series analysis, submitted to Social Network Analysis and Mining.

Ray A (2004) Symbolic dynamic analysis of complex systems for anomaly detection. Signal Processing 84(7):1115 - 1130.

Aaron Clauset, M. E. J. Newman, and Cristopher Moore (2004) Finding community structure in very large networks.

Loom Events

 Loom Events Menu

Load Events from File : Load csv file containing two columns (date,events)

Group Events By… :

Don't Group : Makes each line correspond to one event.

Day : Each line will correspond to a summation of all events for a day

Month : Each line will correspond to a summation of all events for a month

Year : Each line will correspond to a summation of all events for a year

Show Events : A toggle to show/hide event lines.

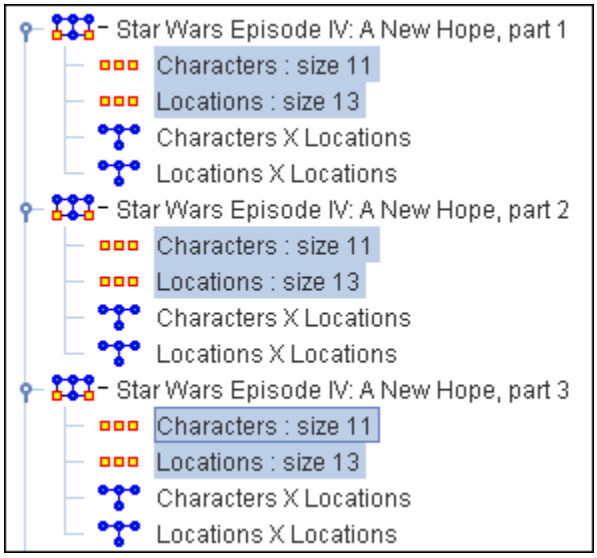
Make Loom Dataset

Multiple Meta-Networks can be combined into a single Meta-Network usable in Loom.

Pre-Requisites

To create a dataset usable in Loom it requires multiple Meta-Networks containing the exact same Nodes/Nodesets/Networks. What changes between the multiple Meta-Networks is which Nodes and Links are present in each timeslice.

NOTE : Every Nodeset needs to contain **identical nodes** in every Nodeset. **No exceptions**.



What differs is the Networks created from these agent and location Nodesets. Below shows the difference between the first three time slices of the Star Wars set. Identical characters and locations but each network changes as to which characters are listed in individual locations.

Star Wars - Time Slice 1

	Tatooine	Mos Eisley ...	Sandcrawler	Moisture Fa...	"The Hills"	Rebel Block...	Death Star
Princess Le...	☐	☐	☐	☐	☐	☑	☐
R2-D2	☐	☐	☐	☐	☐	☑	☐
C-3PO	☐	☐	☐	☐	☐	☑	☐
Luke Skywa...	☐	☐	☐	☐	☐	☐	☐
Uncle Owen	☐	☐	☐	☐	☐	☐	☐
Aunt Beru	☐	☐	☐	☐	☐	☐	☐
Obi-Wan Ke...	☐	☐	☐	☐	☐	☐	☐
Greedo	☐	☐	☐	☐	☐	☐	☐
Han Solo	☐	☐	☐	☐	☐	☐	☐
Chewbacca	☐	☐	☐	☐	☐	☐	☐
Darth Vader	☐	☐	☐	☐	☐	☑	☐

Star Wars - Time Slice 2

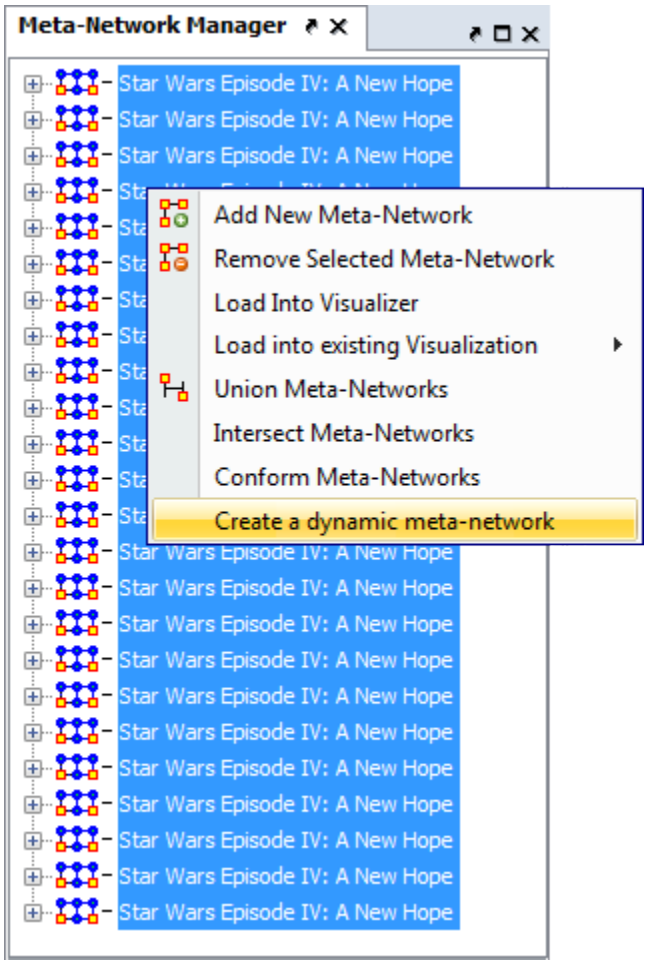
	Tatooine	Mos Eisley ...	Sandcrawler	Moisture Fa...	"The Hills"	Rebel Block...	Death Star
Princess Le...	☐	☐	☐	☐	☐	☐	☐
R2-D2	☑	☐	☐	☐	☐	☐	☐
C-3PO	☑	☐	☐	☐	☐	☐	☐
Luke Skywa...	☐	☐	☐	☐	☐	☐	☐
Uncle Owen	☐	☐	☐	☐	☐	☐	☐
Aunt Beru	☐	☐	☐	☐	☐	☐	☐
Obi-Wan Ke...	☐	☐	☐	☐	☐	☐	☐
Greedo	☐	☐	☐	☐	☐	☐	☐
Han Solo	☐	☐	☐	☐	☐	☐	☐
Chewbacca	☐	☐	☐	☐	☐	☐	☐
Darth Vader	☐	☐	☐	☐	☐	☐	☐

Star Wars - Time Slice 3

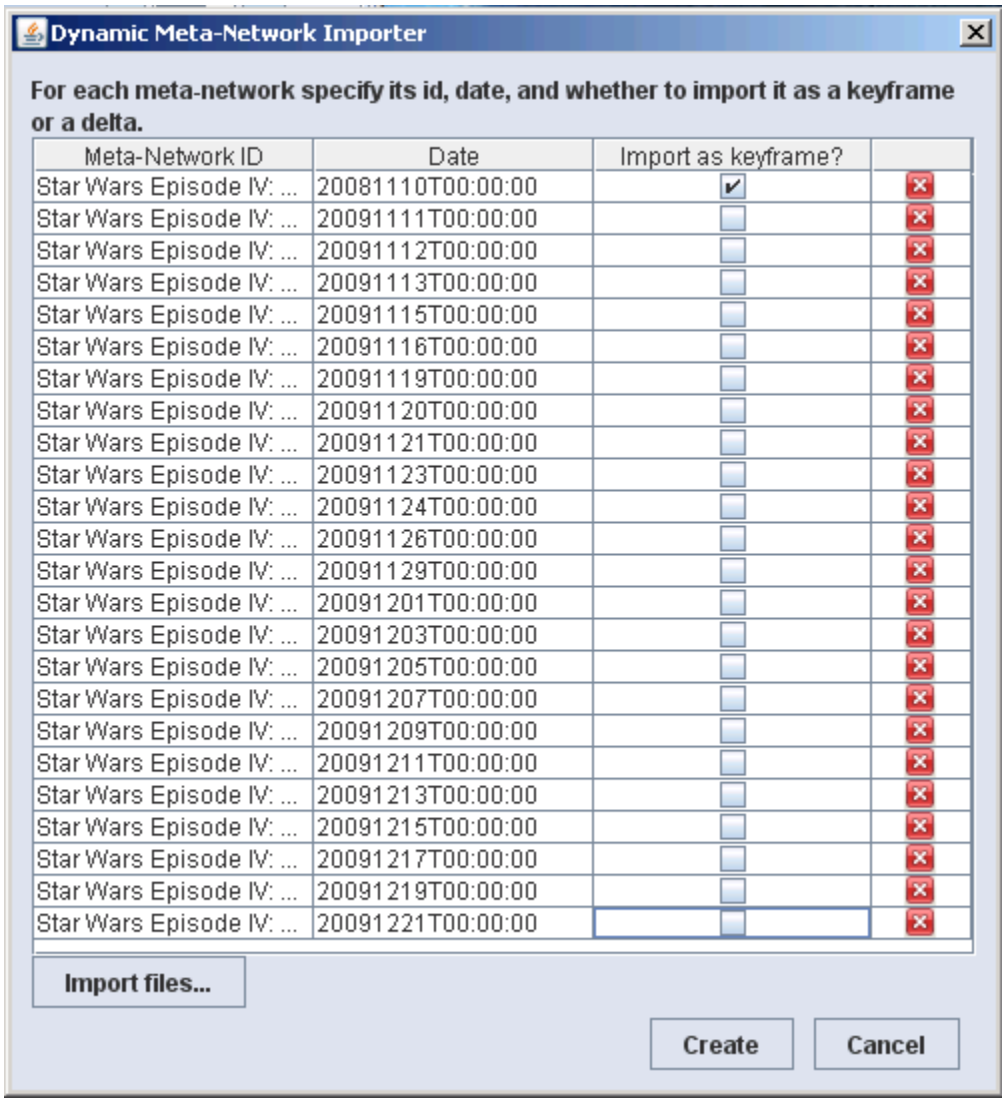
	Tatooine	Mos Eisley ...	Sandcrawler	Moisture Fa...	"The Hills"	Rebel Block...	Death Star
Princess Le...	☐	☐	☐	☐	☐	☐	☐
R2-D2	☐	☐	☑	☐	☐	☐	☐
C-3PO	☐	☐	☑	☐	☐	☐	☐
Luke Skywa...	☐	☐	☐	☐	☐	☐	☐
Uncle Owen	☐	☐	☐	☐	☐	☐	☐
Aunt Beru	☐	☐	☐	☐	☐	☐	☐
Obi-Wan Ke...	☐	☐	☐	☐	☐	☐	☐
Greedo	☐	☐	☐	☐	☐	☐	☐
Han Solo	☐	☐	☐	☐	☐	☐	☐
Chewbacca	☐	☐	☐	☐	☐	☐	☐
Darth Vader	☐	☐	☐	☐	☐	☐	☐

Creating a DataSet

Load all Meta-Networks into ORA. Highlight all these Meta-Networks. Right-Click to bring up the contextual menu.



Select Create Dynamic Meta-Network. This brings up the Create dialog box.



Clear check marks under ***Import as keyframe*** from all instance except the first. Then click the **Create** button.

Creates Meta-Network with Clock



Now you have a Dynamic Meta-Network that can be viewed in Loom.

MGRS Coordinates

MGRS coordinates consist of an even number of characters. It starts off identifying a Grid Zone, and then as more characters are added the location becomes more precise.

To implement, create an Attribute called the **Military Grid Reference System** [**MGRS**] in your location Node Class. Unlike Lat/Lon, it only requires a single attribute. Populate each location with it's corresponding MGRS, and so on. Apart from it's separate conventions, it operates much the same as the Lat/Lon, in terms of adding it to your data.

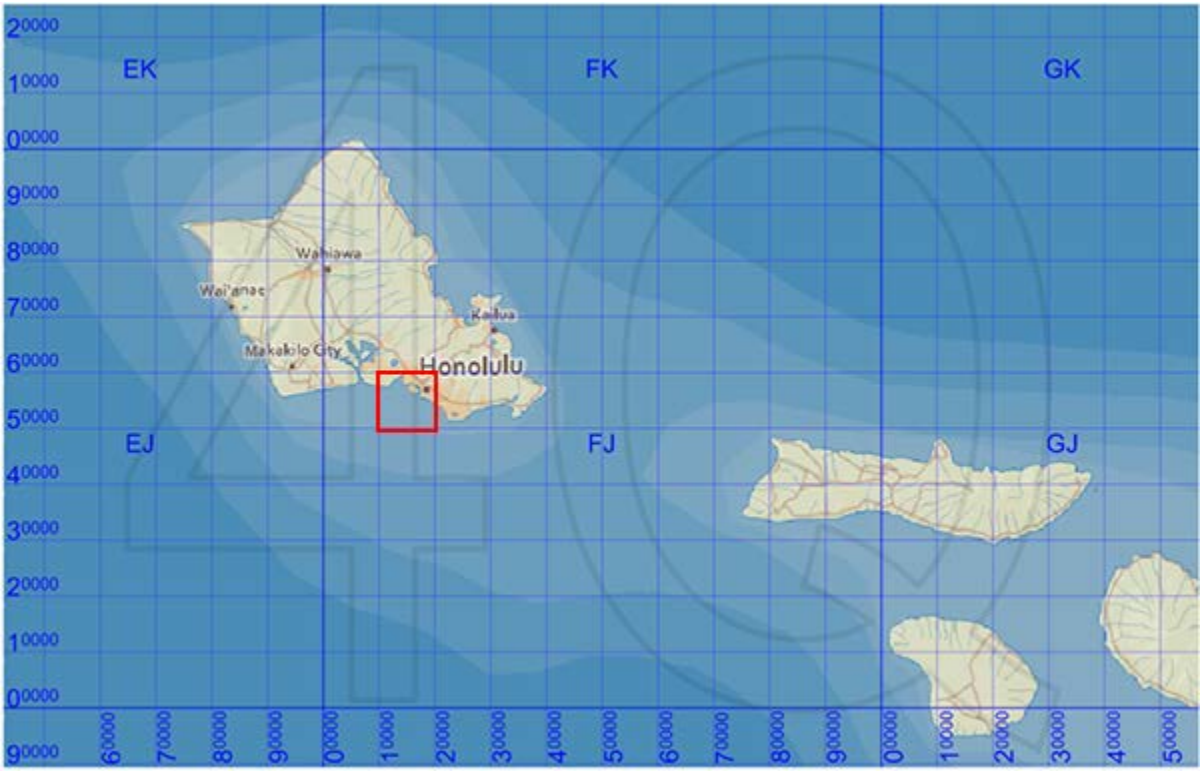
NOTE : In terms of Priorities, GIS looks for Lat/Lon data first, then attempts to find MGRS.

Example

An example of an MGRS coordinate, or grid reference, would be **4QFJ12345678**, which consists of three parts:

- 4Q (grid zone designator, GZD),
- FJ (the 100,000-meter square identifier), and
- 12345678 (numerical location; easting is**1**234 and northing is **5**678, in this case specifying a location with 10m resolution). These map coordinates are read from west to east first (easting), then from south to north (northing).

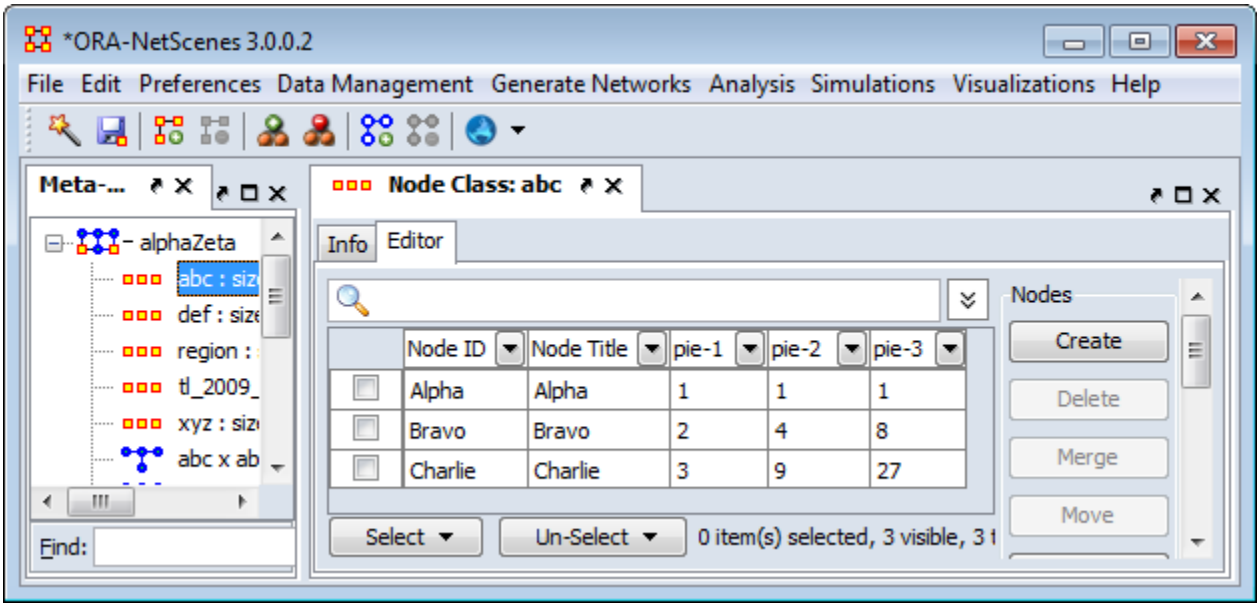
4QFJ15 is the square occupied by Honolulu. The **1 and 5** are the first digits of each of the four-digit combinations. The rest of the digits are used as refinement to the location.



NOTE : Common mnemonics include **in the house, up the stairs**, **left-to-right, bottom-to-top** and **Read Right Up**.

Image Licensing : Image map of Hawaii licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

Create Lat/Long Data From Shapefile



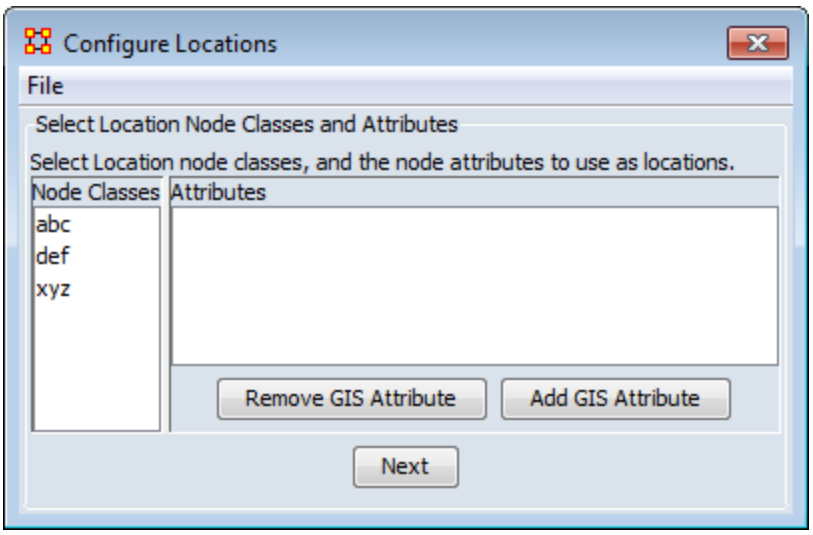
Select either a Network that does not contain location data or create a new Meta-Network. From the Editor main menu select **Visualizations > GeoSpatial Networks...** Using a network with no location data will bring up a n Alert telling you no location information was detected. Click [**OK**].

NOTE : Use the menu item not the dropdown in the button. This allows you to open up a Met-Network that does not contain lat/long data.

From the GeoSpatial menu select **File > Add GIS data... > Import Locations From ESRI Shapefile**. This will prompt you to select a shapefile. This focuses on the DBF file and its attributes. It find attributes with the saubstrings of **lat** and **lon** and makes them the location coordinate.

NOTE : The DBF file can be opened in Excel and examined if you are curious.

NOTE : If it finds no appropriate attribute ORA will prompt you to select one or you can skip and go to the next step.



Using the buttons you can either **Remove GIS Attribute** or **Add GIS Attribute**.

Add GIS Attribute : Click the Add button. From the dropdown menu select one of the four type of GIS data: **Latitude_Longitude, MGRS, UTM, or Carteesian**. Each of the types will ask you to select an attribute(s) to use as the GIS data.

NOTE : This only works if you have an attribute(s) in the correct numeric format. If you have no attributes that can be used keep the selection at **<Select Coordinate type>**

Remove GIS Attribute : This allows you to remove any GIS data which is currently in the Meta-Network.

Click [**Next**]

Next is **Select Location Node Classes and Attributes**.

Add GIS Data To Meta-Network

Open file in GeoSpatial Visualizer by selecting **Visualizations > GeoSpatial Networks...**. If there is no **Latitude/Longitude** data in the Meta-Network ORA will inform you there is no location information. That's fine, just click [**OK**].

NOTE : How can ORA tell whether location data exists? It looks in the attributes for names which contain the substrings **lat** or **lon**. If so it will post those as possible geospatial attributes.

The **Configure Locations** dialog will appear asking you to select Nodesets and attributes to use as locations. Ignore this and click [**Next**]. A second Configure dialog will appear but you need to ignore this box also so click [**Finish**]. An empty GIS map will appear.

From the menu select **File > Add GIS Data... > Import locations from ERSI ShapeFile**. Navigate to the shapefile which contains the latitude/longitude data for your network. Your locations will now appear on the map.

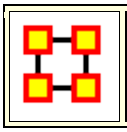
NOTE : For this example my Meta-Network contained information on the population of states. The ERSI file I used contained the latitude/longitude for the U.S. states. Make sure that the ERSI file you use contained the lat/lon data for your Meta-Network.

This procedure will add Nodesets and Networks as needed to your Meta-Network. The Nodeset will contain the location data from the ERSI ShapeFile

Things To Be Aware Of

To assure that the latitude and longitude data are properly imported into your Meta-Network the Node ID must match the information from the ERSI file. If not ORA will not match up the nodes and data will not be imported.

NOTE : For those so inclined this data is retrieved from the ShapeFile's **DBF** file which can be opened with Excel.



ORA Measures

ORA contains over **100 measures**.

What is a Measure

A measure is a function that takes as input a Meta-Network and outputs a single value or a vector of values. Consider the measure **Density**. The output for this measure is a single number used to analyze an organization. By default, all measures are run on a Meta-Network. To view which measures are available, go to the Tools menu and select the **Measures Manager**.

ORA Measures Manager

The Measures Manager categorizes measures in the following ways: **Entity Level, Graph Level, and Risk Category.**

Entity Level Measure is one that is defined for, and gives a value for, each entity in a network. If there are x nodes in a network, then the metric is calculated x once each for each node.

Examples are Degree Centrality, Betweenness, and Cognitive Demand.

Graph Level Measure is one that is defined for, and gives a value for, the network as a whole. The metric is calculated once for the network.

Examples are Centralization, Graph Hierarchy, and the maximum or average Betweenness

Some reports use a predefined set of measures, and these are not affected by the Measure Manager selections ***(for example, the***

Intel, Context, Located SubGroups, Sphere of Influence, *and* ***Immediate Impact*** *reports). The* ***Risk Report****, however, uses only the measures selected in the Measure Manager.*

*The following sets of entities (with their abbreviated symbol) are used throughout the document: Agent (**A**), Knowledge (**K**), Resource (**R**), and Task (**T**). The following networks defined on these entity sets are used throughout the documentation.*

Symbol	Entity Sets		Name
	U	V	
AA	Agent	Agent	Communication Network
AK	**Agent**	**Knowledge**	**Knowledge Network**
AR	Agent	Resource	Capabilities Network
AT	**Agent**	**Task**	**Assignment Network**
KK	Knowledge	Knowledge	Information Network
KR	**Knowledge**	**Resource**	**Training Network**
KT	Knowledge	Task	Knowledge Requirement Network
RR	**Resource**	**Resource**	**Resource Substitute Network**
RT	Resource	Task	Resource Requirement Network
TT	**Task**	**Task**	**Precedence Network**

Input:

This lists each of the Networks that are required as input to the measure. If a measure takes as input a specific network from the Meta-Network, such as the ***Agent x Knowledge (AK) matrix****, then it is listed. If the measure runs on any* ***square (unimodal) network then N is given****. A measure can require more than one input matrix.*

1. Each input matrix can have one or more of the following requirements:

a. **square:** the matrix must have the same number of rows as columns
b. **binary:** it must be binary data (i.e. any links in the network are assumed to have a weight of one)
c. **symmetric:** the network must be undirected

2. ORA does the following when a network does not meet one or more of the above requirements:
   a. **square:** measure is not computed
   b. **binary:** measure is computed, and edge weights are ignored (all edges are given value one)
   c. **symmetric:** measure is computed, and the matrix is first symmetrized using the union method

A complete list of all measures available in ORA, along with references, input and output specifications, can be found in the following ORA Measures sections.

Significant digits

By default ORA shows only three significant digits after the decimal place. With very large networks it is not uncommon for various measures, e.g. closeness to be quite small. As such, with only three significant digits after the decimal place they will appear as zero.

You can change the number of decimal places reported by setting your ORA preferences. From the main menu select ***Preferences > All preferences...****. In the* ***Ora Preferences*** *dialogue box that*

*opens: Select **Reports** in tree on the left then select the **Formatting** tab. Set **Decimal precision** dial widget to the precision you want.*

Measures Content Page

Significant Digits

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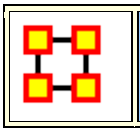
Link Weight as Distance vs. Strength

ORA defaults using link weights as distance so a larger link weight equals a farther distance. But in some instances you need to use link weights with closeness centrality and betweenness centrality to reflect that the relationship is **stronger** and the path **shorter**. This is different than the default calculation which treats weights as distance for closeness and betweenness.

As a general rule, can one simply use the convert links option in the matrix editor pane and invert the link weights in a matrix for those two centrality measures?

Network vs. Node Level Results

The **Network Level measures** in ORA are measures that output scalar values. The **Agent/Knowledge/Task level measures,** by contrast, produce vector output (one value per node) and that is why one must select individual nodes to get a line chart. For example the Betweenness Centralization measure produces a single value per network, and it measures (roughly) the variance of the Betweenness Centrality measure values across all the nodes. All of then Centralization measures are like this.



Mode Table

2-Mode Measures

Quantity : Quantity measures count or average the entries of a matrix.

Degree - Counting the row or column entries of a two mode network.
Level: Node Reference: Freeman (1979), Wasserman and Faust (1994), Borgatti and Everett (1997) Current ORA measures: columnDegreeCentrality, inDegreeCentrality, outDegreeCentrality, row-DegreeCentrality, columnCount, rowCount, edgeCount, capability
Load-On network level, a single value for the entire network is calculated through averaging link values.
Level: Network Reference: Carley (2002) Current ORA measures: knowledgeLoad, resourceLoad, density, rowBreadth, columnBreadth.

Variance : Variance measures create network level indices that describe the distribution of connections in networks.

Centralization - On way to describe the variance in a network is through calculating network centralizations based on the results of centrality measures.
Level: Network Reference: Freeman (1979) Current ORA measures: columnDegreeCentralization, inDegreeCentralization, outDegreeCentralization, rowDegreeCentralization
Diversity - Diversity is a group measure and results in a single value for the whole network.
Level: Network Reference: Hirschman (1945) Current ORA measures: knowledgeDiversity, resourceDiversity

Correlation : Correlation measures create a matrix A that describe similarities/dissimilarities between all pair of agents.

Similarity - The degree of similarity between two agents based on shared knowledge.
Level: Node Reference: Carley (2002) Current ORA measures: relativeCognitiveSimilarity, cognitiveSimilarity, relativeSimilarity, correlationSimilarity
Distinctiveness - Measures the degree to which each pair of agents (i; j) has complementary knowledge, expressed as the percentage of total knowledge.
Level: Dyad Reference: Carley (2002) Current ORA measures: relativeCognitiveDistinctiveness, cognitiveDistinctiveness, correlationDistinctiveness
Resemblance - Measures the degree to which each pair of agents has the exact same knowledge.
Level: Dyad Reference: Carley (2002) Current ORA measures: relativeCognitiveResemblance, cognitiveResemblance, correlationResemblance
Expertise - The degree of dissimilarity between agents based on shared knowledge. Each agent computes to what degree the other agents know what they do not know.
Level: Node Reference: Carley (2002) Current ORA measures: relativeCognitiveExpertise, cognitiveExpertise, relativeExpertise, correlationExpertise

Specialization : These measures identify agents that have either exclusive or redundant connections to other node class entities.

Exclusivity - Detects agents who are exclusively connected to elements of other node classes.
Level: Node Reference: Ashworth and Carley (2006) Current ORA measures: knowledgeExclusivity, resourceExclusivity, taskExclusivity, exclusivityComplete, exclusivity

Redundancy - Knowledge is redundant if there are di erent agents sharing the same knowledge.
Level: Network Reference: Carley (2002) Current ORA measures: columnRedundancy, rowRedundancy, knowledgeRedundancy, accessRedundancy, resourceRedundancy, assignmentRedundancy
Access - An access index identifes connections to critical knowledge, resources, etc.
,td>Level: Node Reference: Ashworth and Carley (2006) Current ORA measures: knowledgeAccessIndex, resourceAccessIndex

Multi-Mode Measures

Quantity :

Degree - Total number of people reporting to an agent, plus its total knowledge, resources, and tasks can be considered as Personnel Costs.
Level: Network Reference: Wasserman and Faust (1994) Current ORA measures: complexity

Coherence : Coherence measures analyze to what extent requirements are accomplished by the actual allocation of agents to tasks.

Congruence - Measures the similarity between what Knowledge is assigned to tasks via agents, and what Knowledge is required to do Tasks. Perfect congruence occurs when Agents have Knowledge when and only when it is needful to complete their Tasks.
Level: Network Reference: Carley (2002) Current ORA measures: communicationCongruence, knowledgeCongruence, resourceCongruence, socialTechnicalCongruence (2 mode)
Needs - Task Knowledge Needs compares the Knowledge requirements of each Task with the Knowledge available to the Task via Agents assigned to it.

Level: Node, Network
Reference:Lee and Carley (2004)
Current ORA measures: communicativeNeeds (communication), congruenceAgentKnowledgeNeeds, congruenceOrgAgentKnowledgeNeeds, congruenceOrgTaskKnowledgeNeeds, congruenceTaskKnowledgeNeeds, congruenceAgentResourceNeeds, congruenceOrgAgentResourceNeeds, congruenceOrgTaskResourceNeeds, congruenceTaskResourceNeeds, knowledgeUnderSupply, resourceUnderSupply

Waste - Waste measures focus on the missing part of congruence.

Level: Node, Network
Reference: Lee and Carley (2004)
Current ORA measures: congruenceAgentKnowledgeWaste, congruenceOrgAgentKnowledgeWaste, congruenceOrgTaskKnowledgeWaste, congruenceTaskKnowledgeWaste, congruenceAgentResourceWaste, congruenceOrgAgentResourceWaste, congruenceOrgTaskResourceWaste, congruenceTaskResourceWaste

Performance - Knowledge Based Task Completion calculated the percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite Knowledge to do the Tasks.

Level: Network
Reference: Carley (2002)
Current ORA measures: resourceTaskCompletion, overallTaskCompletion, knowledgeTaskCompletion, performanceAsAccuracy

Workload - Workload measures look for the Knowledge or Resource an Agent uses to perform Tasks to which it is assigned.

Level: Node
Reference: Carley (2002)
Current ORA measures: knowledgeActualWorkload, resourceActualWorkload, actualWorkload, knowledgePotentialWorkload, resourcePotentialWorkload, potentialWorkload

Substitution : This group is rather diverse and include concepts and measures describing to which extent Agents can be substituted base on identical Roles or Agents need to negotiate with each other as well as Knowledge and Resources that is used or reused to perform Tasks.

Availability - Availability measures use the node class Roles. Role Based Knowledge Availability computes the number of roles that an agent is qualiied to have based on knowledge requirements.

Level: Network Reference: Behrman Current ORA measures: roleKnowledgeAvailability, roleResourceAvailability, knowledgeBasedRoleAvailability, organizationalAvailability, resourceBasedRoleAvailability, overallRoleAvailability
Reuse - Knowledge utilization can be calculated with Reuse measures of Knowledge or Resources.
Level: Network Reference: Carley et al. (2000) Current ORA measures: knowledgeOmega, resourceOmega
Negotiation - The extent to which Agents need to negotiate with each other because they lack the Knowledge to complete their assigned Tasks.
Level: Network Reference: Carley (2002) Current ORA measures: knowledgeNegotiation, resourceNegotiation

Control : Control measures are the most complex measures as they combine a couple of calculations into a single measure. Control measures describe to which extent an Agent is either important (central) for an entire meta-network or Agents have similar perspectives of the network.

Demand - Cognitive Demand measures total amount of cognitive effort expended by each agent to communicate, performs its tasks, etc.
Level: Node Reference: Carley (2002) Current ORA measures: cognitiveDemand
Awareness - A dyadic cognitive concept is Awareness. Share Situation Awareness measures the degree to which an Agents as similar, based on social interaction, physical distance, and socio-demographic data.
Level: Node, Dyad Reference: Graham et al. (2004) Current ORA measures: sharedSituationAwareness

Computational Speeds

Measure Speeds

Slow : These measures do geodesic computations or multiple matric multiplcations.
e,g, Betweenness measures, Closeness measures, and Relative Cognitive measures.

Medium : These multiply matrices
e.g. Cognitive Demand, Congruence measures, and Workload measures.

Fast : Are usually measures that basically count very fast
e.g. In-Degree Centrality, Row and Columns Count, and Capability .

Fast Measures

Measure	Level	Uses Link Weights
Access Redundancy	Network	False
Agent Socio Economic Power	Node	False
Assignment Redundancy	Network	False
Burt Effective Network Size	Node	True
Capability	Node	True
Classic SNA Density	Network	False
Column Breadth	Network	False
Column Count	Network	False
Column Degree Centrality	Node	True
Column Redundancy	Network	False
Complexity	Network	False
Density	Network	False

Diagonal	Node	True
Efficiency	Network	False
Exclusivity	Node	False
Exclusivity Complete	Node	False
Gini Means Difference Column	Node	True
In-Degree Centrality	Node	True
In-Degree Network Centralization	Network	True
Interdependence	Network	False
Interlockers	Node	False
Isolate Count	Network	False
Knowledge Based Access Index	Node	False
Knowledge Diversity	Network	False
Knowledge, Exclusivity	Node	False
Knowledge Load	Network	False
Knowledge Redundancy	Network	False
Lateral Link Count	Network	False
Link Count	Network	False
Node Count	Network	False
Out-Degree Centrality	Node	True
Out-Degree Network Centralization	Network	True
Personnel Cost	Node	False
Pooled Link Count	Network	False
Radials	Node	False
Reciprocal Link Count	Network	False
Resource Based Access Index	Node	False
Resource Diversity	Network	False
Resource Exclusivity	Node	False
Resource Load	Network	False
Resource Redundancy	Network	False

Row Breadth	Network	False
Row Count	Network	False
Row Degree Centrality	Node	True
Row Redundancy	Network	False
Sequential Link Count	Network	False
Span of Control	Network	False
Task Exclusivity	Node	False
Total Degree Centrality	Node	True
Total Degree Network Centralization	Network	False

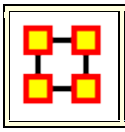


Medium Measures

Measure	Level	Uses Link Weights
Actual Workload	Node	False
Agent Knowledge Needs Congruence	Node	False
Agent Knowledge Waste Congruence	Node	False
Agent Resource Needs Congruence	Node	False
Agent Resource Waste Congruence	Node	False
Authority Centrality	Node	True
Average Distance	Network	True
Average Speed	Network	True
Bonacich Power Centrality	Node	True
Boundary Spanner	Node	False
Burt Constraint	Node	True
Cognitive Demand	Node	False
Communication	Node	False

Communication Congruence	**Network**	**False**
Connectedness	**Network**	**False**
Diameter	**Network**	**True**
Eigenvector Per Component Centrality	**Node**	**True**
Fragmentation	**Network**	**False**
Geodesic Distance	Dyad	**False**
Hub Centrality	**Node**	**True**
Knowledge Actual Workload	**Node**	**False**
Knowledge Negogiation	**Network**	**True**
Knowledge Omega	**Network**	**False**
Knowledge Potential Workload	**Node**	**False**
Knowledge Based Task Completion	**Network**	**False**
Knowledge Under Supply	**Network**	**False**
Minimum Speed	**Network**	**True**
Network Levels	**Network**	**True**
Organization Agent Knowledge Needs Congruence	**Network**	**False**
Organization Agent Knowledge Waste Congruence	**Network**	**False**
Organization Agent Resource Needs Congruence	**Network**	**False**
Organization Agent Resource Waste Congruence	**Network**	**False**
Organization Task Knowledge Need Congruence	**Network**	**False**
Organization Task Knowledge Waste Congruence	**Network**	**False**
Organization Task Knowledge Need Congruence	**Network**	**False**
Organization Task Knowledge Waste Congruence	**Network**	**False**

Overall Task Completion	**Network**	**False**
Performance As Accuracy	**Network**	**False**
Potential Workload	**Node**	**False**
Relative Expertise	**Node**	**False**
Relative Similarity	**Node**	**False**
Resource Actual Workload	**Node**	**False**
Resource Negiogiation	**Network**	**False**
Resource Potential Workload	**Node**	**False**
Resource Based Task Completion	**Network**	**False**
Resource Under Supply	**Network**	**False**
Shared Situation Awareness	**Node, Dyad**	**False**
Simmelian Ties	**Node**	**False**
Skip Link Count	**Network**	**False**
Social Technical Congruence	**Network, Dyad**	**False**
Strict Knowledge Congruence	**Network**	**False**
Strict Resource Congruence	**Network**	**False**
Strong Component Count	**Network**	**False**
Task Knowledge Needs Congruence	**Node**	**False**
Task Knowledge Waste Congruence	**Node**	**False**
Task Resource Needs Congruence	**Node**	**False**
Task Resource Waste Congruence	**Node**	**False**
Transitivity	**Network**	**False**
Triad Count	**Node**	**False**
Weak Component Count	**Network**	**False**
Weak Component Members	**Node**	**False**



Slow Measures

Measure	Level	Uses Link Weights
Betweenness Centrality	Node	True
Betweenness Centrality Spatial	Node	True
Betweenness Network Centralization	Network	True
Clique Count	Node	False
Closeness Centrality	Node	True
Closeness Network Centralization	Network	True
Closeness Centrality Spatial	Node	True
Clustering Coefficient Density	Network, Node	False
Cognitive Distrinctiveness	Node, Dyad	False
Cognitive Expertise	Node, Dyad	False
Cognitive Resemblance	Node, Dyad	False
Cognitive Similarity	Node, Dyad	False
Degree Centrality Spatial	Node	True
Diffusion	Network	False
Distinctiveness Correlation	Node, Dyad	False
Eigenvector Centrality Spatial	Node	True
Expertise Correlation	Node, Dyad	False
Global Efficiency	Network	False
Hierarchy	Network	False
In-Closeness Centrality	Node	True
In-Closess Network Centralization	Network	True
Information Centrality	Node	True
Inverse Closeness Centrality	Node	True
Local Efficiency	Network	False
Location Relevance	Node	True
Potential Boundary Spanner	Node	False

Relative Cognitive Distinctiveness	Dyad	**False**
Relative Cognitive Expertise	Dyad	**False**
Relative Cognitive Resemblance	Dyad	**False**
Relative Cognitive Similarity	Dyad	**False**
Resemblance Correlation	**Node, Dyad**	**False**
Resource Omega	**Network**	**False**
Role Based Knowledge Availability	**Node**	**False**
Role Resource Availability	**Node**	**False**
Similarity Correlation	**Node, Dyad**	**False**
Upper Boundedness	**Network**	**False**

Access Redundancy

Go To Measures by Report

Description

Average number of redundant agents per resource. An agent is redundant if there is already an agent that has access to the resource.

NOTE : This measure works on the **Agent x Resource** matrix and needs to be in the binary format [**0 or 1**].

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $\Re \in [0,(|A|-1*|R|]$.

Computational Time

Fast

Input and Output

Input :

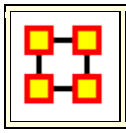
Network	Data Type
Agent by Resource	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,(|A|-1)*|R|]$$

This is the Column Redundancy of matrix AR.



Actual Workload

Go To Measures by Report

Description

The knowledge and resources an agent uses to perform the tasks to which it is assigned. Individuals or organizations that are high in workload are those that are doing more complex tasks and have the resources and knowledge or expertise to do those tasks. Tasks are more complex if they require more expertise and/or more resources.

NOTE : This measure works on the **Agent x Knowledge, Agent x Resource, Agent x Task, Knowledge x Task, Resource x Task** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, employees have access to certain knowledge (e.g., fix computers) and resources (e.g., computer parts). This

measure would compute a value to reflect the overall level of organizational access within the network.

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

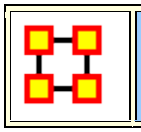
Network	Data Type
Agent by Knowledge	Binary
Agent by Resource	Binary
Agent by Task	Binary
Knowledge by Task	Binary
Resource by Task	Binary

Output :

Level	Type	Data Type
Node Level	Agent	Real

Actual Workload for agent i is defined as follows:

$$[AK * KT * AT'](i,i) / sum(KT)$$



Agent Knowledge Needs Congruence

Go To Measures by Report

Description

The number of knowledge that an agent lacks to complete its assigned tasks expressed as a percentage of the total knowledge required for the assigned tasks.

Works primarily on the Agent x Knowledge matrix and also uses those two Node Classes working with the task Node Class.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making.

Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$\Re \in [0,1]$

Agent Knowledge Needs compares the knowledge needs of the agent to do its assigned tasks, with the actual knowledge of the agent.

Let **N = AT*KT' = knowledge** needed by agents to do assigned tasks.

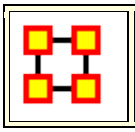
for Resource replace KT with RT

We need to sum the knowledge needed but not available.

Then, Agent Knowledge Needs for

$$\text{agent i} = \frac{\sum_{j=1}^{|K|} N_{i,j} * (\sim AK_{i,j})}{\sum_{j=1}^{|R|} N_{i,j}}$$

Agent Resource Needs is analogous, replacing AK with AR, and KT with RT.



Agent Knowledge Waste Congruence

Go To Measures by Report

Description

The number of knowledges that an agent has that are not needed by any of its tasks expressed as a percentage of the total knowledge of the agent.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$\Re \in [0,1]$

Agent Knowledge Waste compares the knowledge of the agent with the knowledge it actually needs to do its tasks. Any unused knowledge is considered wasted.

Let N = AT*KT' = knowledge needed by an agent to do its assigned tasks.

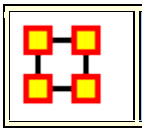
for Resource replace KT with RT

We need to sum the knowledge the agent has but which is not needed.

Then, Agent Knowledge Waste for

$$\text{agent i} = \frac{\sum_{j=1}^{|K|} AK_{i,j} * (N_{i,j} = 0)}{\sum_{j=1}^{|R|} AK_{i,j}}$$

The equation for Agent Resource Waste replaces AK with AR, and KT with RT.



Agent Resource Needs Congruence

Go To Measures by Report

Description

The number of resources that an agent lacks to complete its assigned tasks expressed as a percentage of the total resources required for the assigned tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Agent Knowledge Needs compares the knowledge needs of the agent to do its assigned tasks, with the actual knowledge of the agent.

Let **N = AT*KT' = knowledge** needed by agents to do assigned tasks.

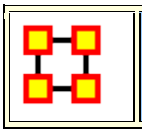
for Resource replace KT with RT

We need to sum the knowledge needed but not available.

Then, Agent Knowledge Needs for

$$\text{agent i} = \frac{\sum_{j=1}^{|K|} N_{i,j} * (\sim AR_{i,j})}{\sum_{j=1}^{|R|} N_{i,j}}$$

Agent Resource Needs is analogous, replacing AK with AR, and KT with RT.



Agent Resource Waste Congruence

Go To Measures by Report

Description

The number of resources that an agent has that are not needed by any of its tasks expressed as a percentage of the total resources of the agent.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Agent Knowledge Waste compares the knowledge of the agent with the knowledge it actually needs to do its tasks. Any unused knowledge is considered wasted.

Let N = AT*KT' = knowledge needed by an agent to do its assigned tasks.

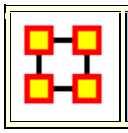
for Resource replace KT with RT

We need to sum the knowledge the agent has but which is not needed.

Then, Agent Knowledge Waste for

$$\text{agent } i = \frac{\sum_{j=1}^{|K|} AR_{i,j} * (N_{i,j} = 0)}{\sum_{j=1}^{|R|} AR_{i,j}}$$

The equation for Agent Resource Waste replaces AK with AR, and KT with RT.



Agent Socio Economic Power

Go To Measures by Report

Description

A measure of actor power based on access to knowledge, resources, and tasks in the organization.

NOTE : This measure works on the **Agent x Knowledge, Agent x Resource, and Agent x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

An individual within an organization that has the most connections, hence access, to knowledge (special skills), resources (unlimited funding) and tasks (has the most important tasks). Such an agent would rank high in the SocioEconomic Power measure.

Informal Name

None

Citation

Kathleen M. Carley, 2004

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Resource	Binary
Agent by Task	Binary

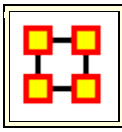
Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Let N = [AK AR AT], that is, the concatenation of the input matrices.

Then, Agent Socio Economic Power is the row degree centrality of N.



Assignment Redundancy

Go To Measures by Report

Description

Average number of redundant agents assigned to tasks. An agent is redundant if there is already an agent assigned to the task.

NOTE : This measure works on the **Agent x Task** matrix.

Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $\Re \in [0,(|A|-1*T]$

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,(|A|-1)*T]$$

This is the Column Redundancy of matrix AT.

Authority Centrality

Go To Measures by Report

Description

A node is authority-central to the extent that its in-links are from nodes that have many out-links. Individuals or organizations that act as authorities are receiving information from a wide range of others each of whom sends information to a large number of others. Technically, an agent is authority-central if its in-links are from agents that have are sending links to many others. The scientific name of this measure is authority centrality and it is calculated on agent by agent matrices.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc].

Informal Name

None

Citation

Kleinberg, Jon M. (1998). Authoritative sources in a hyperlinked environment. Paper presented at the SODA '98 Ninth Annual ACM-SIAM Symposium on Discrete Algorithms, San Francisco, CA. Latria and Marchiori, 2001

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

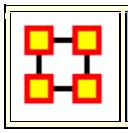
Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Node	Real



Average Communication Speed

Go To Measures by Report

Description

The average speed with which any two nodes can interact. This is based on the inverse of the shortest path lengths between node pairs.

NOTE : This measure works **Square Matrices** [i.e. Agent x Agent, Location x Location, etc.] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In an organization that any two individuals have an average of 3.4 connections between them would approximate the average speed at which an a communication might spread throughout the organization. Naturally, the lower the average links, the higher the organizational speed.

Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

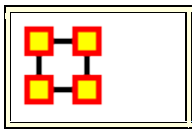
Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Average Speed is the average of the Inverse Closeness Centrality for the network entities.



Betweenness Centrality

Go To Measures by Report

Description

The Betweenness Centrality of node v in a network is defined as: across all node pairs that have a shortest path containing v, the percentage that pass through v. Individuals or organizations that are potentially influential are positioned to broker connections between groups and to bring to bear the influence of one group on another or serve as a **gatekeeper between groups**. This agent occurs on many of the shortest paths between other agents. The scientific name of this measure is betweenness centrality and it is calculated on agent by agent matrices.

NOTE : This measure works **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

This measure indicates the extent that an individual is a broker of indirect connections among all others in a network. Someone with high Betweenness could be thought of as a gatekeeper of information

flow. People that occur on many shortest paths among other People have highest Betweenness value. Betweenness is one of the key measures used by those interested in networks.

Informal Name

None

Citation

Freeman, Linton C. (1979). Centrality in social networks I: Conceptual clarification. Social Networks, 1(3), 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type<
Square	Real

Name	Data Type	Label<
Radius	RealNeighbor Radius	

Output :

Level	Data Type
Node	Real

Let G=(V,E) be the graph representation for the network. Let **n=|V|**, and fix an entity $v \in V$.

For $(u,w) \in VxV$, let $n_G(u,w)$ be the number of geodesics in G from u to w.

If $(u,w) \in E$, then set $n_G(u,w)=1$.

Define the following:

let

$$S = \{(u,w) \in VxV \mid d_G(u,w) = d_G(u,v) + d_G(v,w)\}$$

let

$$between = \sum_{(u,w) \in S} (n_G(u,v) * n_G(v,w)) / n_G(u,w)$$

Then **Betweenness Centrality** of the entity v = between / ((n-1)(n-2)/2).

NOTE : If G is not symmetric, then between is normalized by (n-1)(n-2).

Betweenness Network Centralization

Go To Measures by Report

Description

Network centralization based on the betweenness score for each node in a square network. This measure is defined for directed and undirected networks.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Freeman, Linton C. (1979). Centrality in social networks I: Conceptual clarification. Social Networks, 1(3), 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Real

$$\Re \in [0,1]$$

Let G=(V,E) represent the square network, and let n = |V|

let d_i = Betweenness Centrality of node i

let d = max{d_i | 1 $\leq$ i $\leq$ n }

Then Network Betweenness Cent. = $\left(\sum_{1 \leq i \leq n} \overline{d} - d_i \right) / (n-1)$.

Biological Diversity Index

Go To Measures by Report

Description

The mathematical knowledge that helps is that the log of a product is the sum of the logs, e.g. **ln(4!) = ln(1)+ln(2)+ln(3)+ln(4)**. Otherwise it is impossible to calculate the index for larger data. So, the implementation is just simple loops:

Informal Name

None

Citation

Anne E. Magurran, Measuring Biological Diversity. Wiley-Blackwell, 2003.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

```
float brillouin=0;

for (int i=1; i<=N; i++)

   brillouin = brillouin + log(i);


for (int s=1; s<=number_of_groups; s++)
```

```
for (int i=1; i<=n[s]; i++)
    brillouin = brillouin - log(i);
brillouin = brillouin / N
```

[ln(N!) - Σ ln(ni!)] / N where ni is the number of elements in a specific group and N is the sum of all ni.

An issue of the Brillouin index is the lack of normalization, so there is no defined value range. The idea is that larger environments are more diverse even if the distribution of the elements is the same. Nevertheless the results look always similar because of the /N.

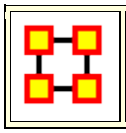
Input and Output

Input :

Data Type
Binary

Output :

A Single Value Showing Distribution



Bonacich Power Centrality

Go To Measures by Report

Description

The Bonacich Power Centrality computes the centrality of each entity based on the centrality of its neighbors. Beta should be chosen such

that its absolute value is less than the reciprocal of the larges eigenvalue of N.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, this meausre can tell us who is connected to the most powerful (e.g., other highly connected agents) people.

Informal Name

None

Citation

Bonacich P., 1987 "Factoring and weighing approaches to clique identification" Journal of Mathematical Sociology, 2 (January, 1972), 113-120.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type	Directed
Square	Real	No

$$\text{beta} \in \Re$$

Output :

Level	Data Type
Node	Real

$$\Re \in [0,1]$$

Let A = adjacency representation of the network N. Then Bonacich Power Centrality for the network is the solution c to the following system of linear equations:

$(I - \beta A)^{-1} c = Ae$, where I is the identity matrix, and e a vector of ones.

NOTE : If beta is 0, then c is simply equal to the row degree of each entity.

The values of c are not normalized.

Boundary Spanner

Go To Measures by Report

Informal Name

None

Citation

Cormen, Leiserson, Rivest, Stein 2001. "Introduction to Algorithms" Second Edition. Cambridge, MA: MIT Press, 2001.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Description

An node which, if removed from a network, creates a new component.

This is often called a **Gate Keeper** node. It consists of **High Betweeness and Low Centrality**. A Boundary Spanner is **an articulation point of N**, as defined in the referenced book.

Example : An employee with few direct connections, but if removed from the network will result in an unconnected sub-group.

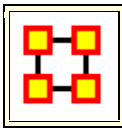
Input :

Agent by Agent : DataType=binary and Direction=No.

Output

Node Level : DataType=Binary.

A Boundary Spanner is **an articulation point of N**, as defined in the referenced book.



Burt Constraint

Go To Measures by Report

Description

The degree to which each node in a square network is constrained from acting because of its existing links to other nodes.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

Bob is given a certain task, but that task requires certain links, which Bob does not have. Bob is constrained in the sense he does not have the links to complete the task. This measure computes a value for such relationships as they distributed across the whole network.

Informal Name

None

Citation

Burt, Ronald. Structural Holes: The Social Structures of Competition. Cambridge, MA: Harvard University Press, 1992.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Real

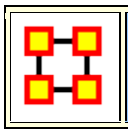
Output :

Level	Data Type
Node	Real

$\Re \in [0,1]$

This is the Constraint measure described by Equ. 2.4 on pg. 55 of Burt, 1992.

NOTE : The matrix Z is the adjacency matrix representation of the network N.



Capability

Go To Measures by Report

Description

Detects entities with high or low degree relative to other entities. The formula discounts for the fact that most agents have some connections and assumes that there is a general discount to having large numbers of connections.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Kathleen M. Carley, Dave Columbus, Matthew DeReno, Jeff Reminga and Il-Chul Moon, 2007, "ORA User's Guide 2007," Carnegie Mellon University, School of Computer Science, Institute for Software Research, Technical Report, CMU-ISRI-07-115.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Real

Output :

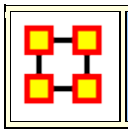
Level	Data Type	Type
Node	Real	Row

$$\Re \in [0,1]$$

Let RD = the vector of row degrees for each entity in the network. Scale RD by dividing each element by the largest value in RD.

Then the Capability of node i is: $\frac{1}{(1.0+e^{-(RD_i-0.5)*10})}$

NOTE : For the most connected entity, this value tends to 1.0, for the least connected node it tends to 0, and for the average connected entity it tends to 0.5.



Characteristic Path Length

Go To Measures by Report

Description

The average shortest path length between nodes, excluding infinite distances.

Example

In a given organization, this measure computes the average amount of connections between any two members in the organization.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and N**], inclusive.

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0, N]$$

Let G=(V,E) represent a square network. Define a set S of all pairs (i,j) of entities such that i can reach j. Then average the shortest paths.

let **S = {(i,j) | j is reachable in G from j }**

Then,

$$\text{Average Distance} = \frac{\sum_{(i,j)\in S} d_G(i,j)}{|S|}$$

Closeness Centrality

Go To Measures by Report

Description

The average closeness of a node to the other nodes in a network. Closeness is the inverse of the average distance in the network between the node and all other nodes.

Closeness reveals how long it takes information to spread from one individual to others in the network. High scoring individuals in Closeness have the shortest paths to all others in the network. It would follow such individuals could monitor the information flow in an organization better than most others that have a lesser Closeness value. The ones with the highest value in this measure will often times have the best picture of what is happening in the network as a whole.

In short, Closeness is the inverse of the average distance in the network between any given node and all other nodes.

NOTE : This measure uses both link weights and link direction in its calculations.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

Closeness reveals so-called people in the know. Closeness measures the path length from one person to another in a network. It tells us which person is central to an organization.

Informal Name

None

Citation

Freeman, L.C. (1979). "Centrality in Social Networks I: Conceptual Clarification." Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input :

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Node	Real

Let **G=(V,E)** be the graph representation of the square network.

Fix

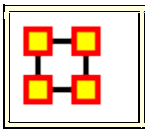
$v \in V$

let

$$\text{dist} = \sum_{i \in V} d_G(v,i) \quad \text{with } d_G(v,i) = |V|$$

if i is unreachable from v.

Then Closeness Centrality of node $v = (|V|-1)/\text{dist}$.



Closeness Network Centralization

Go To Measures by Report

Description

Network centralization based on the closeness centrality of each node in a square network. This is defined only for connected, undirected networks.

Example

An organization has employees, computers, benchmarks, and products. How central these entities exist within the connections of the network, which is defined by the connections they have throughout the network, is loosely what is network centralization. This measure computes a value for the centrality of these entities.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Freeman, L.C. (1979). Centrality in Social Networks I: Conceptual Clarification. Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

(if N connected)

Let **G=(V,E)** represent the square network, and let **n = |V|**

let

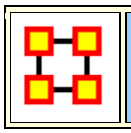
d_i = Closeness Centrality of node i

let

$$\bar{d} = \max\{d_i \mid 1 \le i \le n\}$$

Then

$$\text{Network Closeness Cent.} = \left(\sum_{1 \le i \le n} \bar{d} - d_i \right) / ((n-2)(n-1)/(2n-3))$$



Clustering Coefficient

Go To Measures by Report

Description

Measures the degree of clustering in a network by averaging the clustering coefficient of each node, which is defined as the density of the node's ego network.

The clustering coefficient gives a sense of the local characteristics of the network--how information spreads by means of employee groups. A higher clustering coefficient supports local information diffusion as well as a decentralized infrastructure because employees are likely to share information and know what is happening in their work group.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

The average of the proportion of links between each employee and his or her direct neighbors divided by the number of links that could possibly exist between them.

Informal Name

None

Citation

Watts DJ, Strogatz SH "Collective dynamics of 'small-world' networks" NATURE 393 (6684): 440-442 JUN 4 1998.

Minimum and Maximum Values

Values for both Graph Level and Node Level

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Real
Graph	Real

Graph Level: $\Re \in [0,1]$

Entity Level: $\Re \in [0,1]$

let **G=(V,E)** be the graph representation of a square network.

Define for each node $v \in V$ its Clustering Coefficient cc_v:

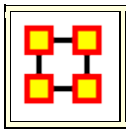
let **Gv = ego network of entity v**

Then Clustering Coefficient for entity:

$$\text{entity } v = cc_v = \text{density}(Gv)$$

Then Clustering Coefficient for graph:

$$\text{graph} = \frac{\sum_{v \in V} cc_v}{|V|}$$



Cognitive Demand

Go To Measures by Report

Description

Measures the total amount of cognitive effort expended by each agent to do its tasks, need to move, connecting others, and so on. Such individuals may never become the formal leader of a group. Emergent leaders are identified in terms of the amount of cognitive effort that is inferred to be expended based on the individual's position in the meta-network. Individuals who are strong emergent leaders are likely to be not just connected to many people, organizations, tasks, events, areas of expertise, and resources; but also, are engaged in complex tasks where they may not have all the needed resources or knowledge and so have to coordinate with others, or have other reasons why they need to coordinate or share data or resources.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

Emergent Leader

Citation

Carley, Kathleen M. & Yuqing Ren, 2001, "Tradeoffs Between Performance and Adaptability for C3I Architectures." In Proceedings of the 2001 Command and Control Research and Technology Symposium, Annapolis, Maryland, June, 2001.

Carley, 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary

Output :

Level	Type	Data Type
Node	Agent	Real

$$\Re \in [0,1]$$

The Cognitive Demand for an agent i is an average of terms, each of which measures an aspect of its cognitive demand. Each term is normalized to be in [0,1]. The number of terms depends on the input networks. The computation of each term for agent i is detailed below:

x1 = normailzed count of all agents with which agent i interacts.

$$x_1 = \frac{\sum[AA]_i}{|A| - 1}$$

x2 = normalized count of tasks to which i is assigned

$$x_2 = \frac{\sum[AT]_i}{|T|}$$

x3 = normalized sum of agents assigned to the same tasks as i

$$[ATA] = [AT] \cdot [AT]'$$

$$x_3 = \frac{\sum[ATA]_i - \sum_j[ATA]_{i,j}}{|T|(|A| - 1)}$$

x4 = normalized count of resources managed by i

$$x_4 = \frac{\sum[AR]_i}{|R|}$$

x5 = normalized count of total knowledge known by i

$$x_5 = \frac{\sum[AK]_i}{|K|}$$

x6 = normalized sum resources needed by i for all of its tasks

$$[ATR] = [AT] \cdot [RT]'$$

$$x_6 = \frac{\sum[ATR]_i}{|T||R|}$$

x7 = normalized sum of knowledge i needs for all its tasks

$$[ATK] = [AT] \cdot [KT]'$$

$$x_7 = \frac{\sum [ATK]_i}{|T||K|}$$

x8 = normalized sum of resource negotiation needs i has for its tasks

$$x_8 = \frac{\mathrm{HD}([AR]_i, [ATR]_i)}{|R|}$$

x9 = normalized sum of knowledge negotiation needs

$$x_9 = \frac{\mathrm{HD}([AK]_i, [ATK]_i)}{|K|}$$

x10 = normalized sum of agents that i depends on or that depend on i

w = colsum([AT])

s = (T+T')•w

v = [AT]•s

$$x_{10} = \frac{v_i}{|A||T|(|T|-1)}$$

Then Cognitive Demand for agent i is the average of the above terms.

Cognitive Distinctiveness

Go To Measures by Report

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as the percent of total knowledge.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Node	Real	Agent
Dyad	Real	Agent by Agent

$$\Re \in [0,1]$$

For each pair of agents (i,j) compute the number of knowledge bits they have exactly opposite. Then normalize this sum by the total number of knowledge bits. In effect, this is the exclusive-OR of their knowledge vectors.

$$CD_{i,j} = \frac{\sum_{k=1}^{|K|} (AK_{i,k} * \sim AK_{j,k}) + (\sim AK_{i,k} * AK_{j,k})}{|K|}$$

$$CD_{i,i} = 0$$

NOTE : The CD output matrix is symmetric.

Cognitive Expertise

Go To Measures by Report

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as a percentage of the knowledge of the first agent.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

If one person in an organization knows how do perform X but can't do Y. Whereas another individual can do Y but not X, such individuals would rank highly in this measure.

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Node	Real	Agent
Dyad	Real	Agent by Agent

$$\Re \in [0,1]$$

For each pair of agents (i,j) compute the number of knowledge bits that j knows that i does not know. Then normalize this sum by the total number of knowledge bits that agent i does not know.

$$CE_{i,j} = \frac{\sum_{k=1}^{|K|} (\sim AK_{i,k} * AK_{j,k})}{(|K| - \sum_{k=1}^{|K|} AK_{i,k})}$$

$$CE_{i,i} = 0$$

NOTE : The CD output matrix is NOT-symmetric.

Cognitive Resemblance

Go To Measures by Report

Description

Measures the degree to which each pair of agents has the exact same knowledge. Each value is normalized by the row sum.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In an given organizational network, let us say that Bob has the knowledge to perform X, Y, and Z. Whereas Sally also has the knowledge to perform X, Y and Z. This measure would rank this pair (i.e., dyad) high in Cognitive Resemblance.

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Node	Real	Agent
Dyad	Real	Agent by Agent

$$\Re \in [0,1]$$

For each pair of agents (i,j) compute the number of knowledge bits they have in common - whether known or unknown. Then normalize this sum by the total number of knowledge bits.

$$CR_{i,j} = \frac{\sum_{k=1}^{|K|} (AK_{i,k} * AK_{j,k}) + (\sim AK_{i,k} * \sim AK_{j,k})}{|K|}$$

$$CR_{i,i} = 1$$

NOTE : The CR output matrix is symmetric.

Cognitive Similarity

Go To Measures by Report

Description

Measures the degree to which each pair of agents have overlapping knowledge.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

Example

With an organization where Bob has the knowledge of X, Y and Z and Sally has the knowledge of Q, R and Z. The Cognitive Similarity mesure would compute a value for Bob and Sally's overlapping knowledge of Z.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M. 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Node	Real	Agent
Dyad	Real	Agent

$$\Re \in [0,1]$$

For each pair of agents (i,j) compute the number of knowledge bits they have in common. Then normalize this sum by the total knowledge between them.

$$CS_{i,j} = \frac{\sum_{k=1}^{|K|}(AK_{i,k} * AK_{j,k})}{\sum_{k=1}^{|K|}(AK_{i,k} + AK_{j,k})}|$$

$$CS_{i,i} = 1$$

NOTE : The CS output matrix is symmetric.

Column Breadth

Go To Measures by Report

Description

The fraction of entities with column nodes with degree greater than one.

NOTE : This measure works on **all Networks** and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, we have the following entities: employees (agents), computers (resources), benchmarks (tasks). This measure tells us on how many links greater than one exist within these entity types.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let d = the Column degree vector of the network N

Then, the Column Breadth of N is:

$$\frac{\sum_{i=1}^{|d|}(d_i > 1)}{|d|}$$

NOTE : Row breadth is identical, except that d is defined using the row degree, rather than the column degree.

Column Count

Go To Measures by Report

Description

The number of column nodes in a network.

NOTE : This measure works on **a Network** and needs to be in the binary format [**0 or 1**].

The result will be a integer between [**0 and the total number of columns**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of Columns

Computational Time

Fast

Input and Output

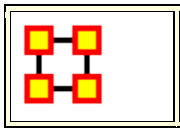
Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Integer

Result: Z ≥ 0

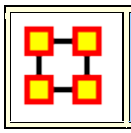


Column Degree Centrality

Go To Measures by Report

Informal Name

See **In Degree Centrality**



Column Degree Network Centralization

Go To Measures by Report

Description

A centralization based on the degree of the column nodes of a network.

NOTE : This measure works on **Any Matrix** and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

Also called InDegree Network Centralization

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let N be a network with n column entities.

let

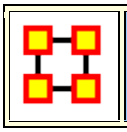
$$d_j = \text{degree of column node j, } 1 \leq j \leq n$$

let

$$\bar{d} = \max\{d_j \mid 1 \le j \le n\}$$

Then

$$\text{Column Degree Network Centralization} = \left(\sum_{1 \le j \le n} \bar{d} - d_j \right) / (n)$$



Column Rendundancy

Go To Measures by Report

Description

The mean number of column node links in excess of one.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and the number of redundant columns**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M. 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $\Re \in [0,(m\text{-}1)*n]$

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,(m-1)*n]$$

Let M be the matrix representation for a network N of dimension m x n.

let

$$d_j = \max\{0, \text{sum}(M(:, j)) - 1\}$$

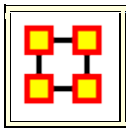
for

$$1 \le j \le n$$

this is the number of column entries in excess of one for column j.

Then

$$\text{Column Redundancy} = \left(\sum_{j=1}^{n} d_j \right) / n$$



Communication

Go To Measures by Report

Description

Measures the communication need of agents to complete their assigned tasks.

NOTE : This measure works on the **Agent x Agent, Agent x Task, Agent x Resource, Resource x Task, and Task x Task** matrices and needs to be in the binary format [**0 or 1**].

Example :

In a given organization **Bob** is assigned a task which is dependant upon his social links to other individuals in the network. The measure would compute a value for how dependent Bob is on the links to the other individuals to complete the task. A higher value would indicate Bob must possess a greater number of connections to complete any given task he is assigned. Conversely, a low value would indicate relatively few linkages are necessary to complete certain tasks.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Manju K. Ahuja, Dennis F. Galletta and Kathleen M. Carley, 2003, "Individual Centrality and Performance in Virtual R&D Groups: An Empirical Study," Management Science, 49.1:21-38.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Task	Binary
Agent by Resource	Binary
Resource by Task	Binary
Task by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Communication uses the concepts from Communication Congruence: **Handoff, Co-Assignment, and Negotiation.**

let H, C, and N be defined as in Communication Congruence.

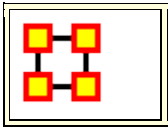
let M(i,j) = [AA + (H+H') + C + (N+N')](i,j) > 0, and M(i,i) = 0

NOTE : The transpose of H and N is used to make the communication reciprocal.

let d = sum(M(i,:))

let d = d / (|A|-1), normalizing d to be in [0,1]

Then Communication for agent i is d.



Communication Congruence

Go To Measures by Report

Description

Measures to what extent the agents communicate when and only when it is needful to complete tasks. Perfect congruence requires a symmetric Agent x Agent network.

One of the following pairs of matrices must exist: **Agent x Knowlage/Knowledge x Task -OR- Agent x Resource/Resource x Task**. If both exist, then the measure first concatenates them into **[Agent x Knowledge/Agent x Resource], [Knowledge x Task/Resource x Task]** and uses them.

Communication Congruence = 1 if agents communicate when and only when it is needful to complete their tasks. There are three task related reasons when agents i and j need to communicate:

(a) **Handoff:** if i is assigned to a task s and j is assigned to a task t and s directly precedes task t.

(b) **Co-Assignment:** if i is assigned to a task s and j is also assigned to s.

(c) **Negotiation:** if i is assigned to a task s and j is not, and there is a resource r to which agents assigned to s have no access but j does.

The three cases are computed as follows:

(a) let Handoff = Agent x Task * Task x Task * Agent x Task'

(b) let Co-Assignment = Agent x Task * Agent x Task'

(c) let Negogiation = Agent x Task * Z * Agent x Resource', where Z(t,r) = [Agent x Task * Agent x Resource - Resource x Task](t,r)<0

NOTE : Co-Assignment is always symmetric, but Handoff and Negogiation are not necessarily symmetric.

NOTE : This measure works on the **Agent x Agent, Agent x Task, Agent x Resource, Resource x Task, and Task x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

let Q(i,j) = [(H+H') + C + (N+N')](i,j) > 0.

Communication Congruence requires reciprocal communication, explaining the transposes of H and N to make them symmetric.

let d = hamming distance between Q and AA, which measures the degree to which communication differs from that which is needed to do tasks.

The maximum value for d is d_max = |A|*(|A|-1)

Then Communication Congruence = 1 - (d /d_max), which is in [0,1].

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Task	Binary
Agent by Resource	Binary
Resource by Task	Binary
Task by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Communicative Need

Go To Measures by Report

Description

Measures the percentage of reciprocal links in a network. This is also called Reciprocity.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

See Reciprocal Link Count for full description

Citation

Carley Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

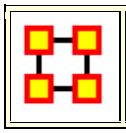
Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real



Complexity

Go To Measures by Report

Description

The density of the meta-network as a whole.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Wasserman, Stanley, & Faust, Katherine. (1994). Social Network Analysis: Methods and Applications: Cambridge University Press.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

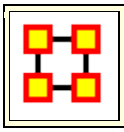
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real



Connectedness

Go To Measures by Report

Description

Measures the degree to which a square network's underlying (symmetrized) network is connected. Individuals or organizations that connect groups are those that are connecting disconnected groups. The individual or organization may be connected to only one

or a few members of each groups. This is a composite measure that is high when the agent is potentially influential but is not in the know. This is calculated as the ration of betweenness centrality to total degree centrality and is calculated on agent by agent matrices.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

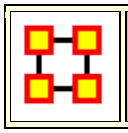
Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real



Distinctive Correlation

Go To Measures by Report

Description

Measures the degree to which each pair of rows has complementary data, expressed as the percent of total data.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

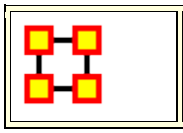
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row
Dyad	Real	Row by Row



Degree Centrality Spatial

Go To Measures by Report

Description

The total distance from a node to its neighbors

NOTE : This measure works on the **Agent x Agent and Agent x Location** matrices and needs to be [**any number**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Malloy, Eric, Olson, Jamie, & Carley, Kathleen M. (2009). Geographic and Network Analysis of Drug Interdiction Information. Paper

presented at the Twenty Ninth International Sunbelt Social Network Conference, San Diego, CA.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

<

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Location	Binary

Output :

Level	Data Type
Node	RealAgent

Density

Go To Measures by Report

Description

The ratio of the number of links versus the maximum possible links for a network.

Density compares existing links to all possible links in the employee communication network. It reflects the social level of organizational cohesion. This measure must be interpreted in relation to the size of the group and the type of work performed.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

NOTE : There can not be any self-loops in any of the matrices

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Unimodel	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let M be the adjacency matrix for the network of dimension m x n.

If the network is unimodal, then m=n and M has a zero diagonal, and therefore

Density = sum(M)/(m*(m-1)).

For rectangular networks

Density = sum(M)/(m*n).

Density Classic SNA

Go To Measures by Report

Description

The ratio of the number of links versus the maximum possible links for a square network. Self-loops are ignored.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

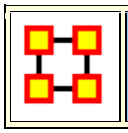
$$\Re \in [0,1]$$

Let M be the adjacency matrix for the network of dimension m x n.

If the network is unimodal, then m=n and M has a zero diagonal, and therefore

Density = sum(M)/(m*(m-1)).

For rectangular networks, Density = sum(M)/(m*n).



Diameter

Go To Measures by Report

Description

The maximum shortest path length between any two nodes in a unimodal network G=(V,E). If there exist i,j in V such that j is not reachable from i, then |V| is returned.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and Total Number of Nodes**], inclusive.

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Integer

$$Z \in [0, |V|]$$

The diameter of G=(V,E) is defined as:

$$\max\{d_G(i,j) \mid i,j \in V\}$$

That is, the maximum shortest directed path between any two vertices in G. If there exists i and j such that j is not reachable from i, then |V| is returned.

Diffusion

Go To Measures by Report

Description

Computes the degree to which something could be easily diffused (spread) throughout the network. This is based on the distance between nodes. A large diffusion value means that nodes are close to each other, and a smaller diffusion value means that nodes are farther apart.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M. (2002). Smart agents and organizations of the future. In Leah Lievrouw, and Sonia Livingstone (Ed.), The Handbook of New Media (pp. Chapter 12, 205-220). Thousand Oaks, CA: Sage.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

Let N = number of nodes.

Let K = number of pairs of nodes that are unreachable (note that G is not required to be symmetric.

For each pair of unreachable nodes we record a distance of N, which is beyond the maximum distance for a binary network.

Let TotalDistance = $\sum_{i \neq j} d_G(i,j) + K*N$

Let AverageDistance = TotalDistance / (N*(N-1)), which is the average distance between nodes

Then Diffusion = N/(N-1) * [1 - AverageDistance/N], which is the average distance from 1 and normalized so that cliques get a score of 1

Distinctive Correlation

Go To Measures by Report

Description

Measures the degree to which each pair of rows has complementary data, expressed as the percent of total data.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

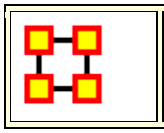
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row
Dyad	Real	Row by Row



Edge Betweenness Centrality

Go To Measures by Report

Description

The Edge Betweenness Centrality of an edge e in a network is defined as: across all node pairs that have a shortest path containing e, the percentage that pass through e.

NOTE : This measure works on the **Agent x Resource** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Freeman, Linton C. (1979). Centrality in social networks I: Conceptual clarification. Social Networks, 1(3), 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Real

Name	Data Type	Label<
Radius	RealNeighbor Radius	

Output :

Level	Data Type
Dyad	Real

$$\Re \in [0,(|A|-1)*|R|]$$

This is the Column Redundancy of matrix AR.

Efficiency

Go To Measures by Report

Description

The degree to which each component in a network contains the minimum links possible to keep it connected.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In an organization, let us say Bob has a connection to the computer, Sales, Event, and Goal. This measure computes a value for the minimum number of links entities such as Bob must have for the network to maintain its network status. Therefore, this is a network level measure. In other words, if Bob had one less link, then then the entities would cease to constitute the original network.

Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type	Directed
Square	Binary	No

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let **G=(V,E)** be the graph representation of a square, undirected network.

let

$$n = \text{number of components in } G$$

let

$$c_i = \text{number of nodes in component } i$$

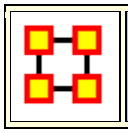
let

$$\text{penalty} = |E| - |V| + C$$

let

$$\text{maxPenalty} = C - |V| + \sum_i c_i (c_i - 1)/2$$

Then **Efficiency = 1 - penalty / maxPenalty**



Eigenvector Centrality

Go To Measures by Report

Description

Calculates the principal eigenvector of the network. A node is central to the extent that its neighbors are central. Leaders of strong cliques are individuals or organizations who are connected to others that are themselves highly connected to each other. In other words, if you have a clique then the individual most connected to others in the clique and other cliques, is the leader of the clique. Individuals or organizations who are connected to many otherwise isolated individuals or organizations will have a much lower score in this measure then those that are connected to groups that have many connections themselves. This would be true even if such a **WHO** might have a high amount of actual connections **(i.e. high degree centrality)**.

It calculates the eigenvector of the largest positive eigenvalue of the adjacency matrix representation of a square network. A Jacobi method is used to compute the eigenvalues and vectors.

Hub-Centrality and Authority-Centrality measures are generalizations of the Eigenvector Centrality measure and take into account directed links.

NOTE : This measure works on the **Agent x Agent** matrix and can be in [**any number**]. The result will be a number between [**0 and 1**], inclusive.

NOTE : When a network has multiple components the Eigenvector Centrality measure is known to behave at times unintuitively. For example, all nodes in one component might get value zero.

NOTE : Eigenvector centrality and Eigenvector Centrality Per Component both operate on a symmetric network with no self-loops,

and all values are output in the range [0,1].

NOTE : Eigenvector never uses self-loops.

NOTE : If multiple components are involved, the default is to do each component separately and if the user wants these adjusted by component size it adjusts to keep the value between 0 and 1.

Example

It follows that a person well-connected to well-connected people can spread information much more quickly than one who only has connections to lesser important people in a network. People with higher scores of Eigenvector Centrality could be critical when rapid communication is needed.

Furthermore, individuals or organizations that are connected to man other otherwise isolated groups will have a much lower score in this measure than those that are connected to groups that have many connections themselves.

Informal Name

None

Citation

Bonacich, Phillip. (1972). Factoring and weighting approaches to status scores and clique detection. Journal of Mathematical Sociology, 2, 113-120.

Bonacich, Phillip. (1972). Technique for Analyzing Overlapping Memberships. In H. Costner (Ed.), Sociological Methodology (pp. 176-185). San Francisco: Jossey-Bass.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Medium

Input and Output

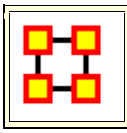
Input :

Network	Data Type	Directed
Square	Real	No

Output :

Level	Data Type
Node	Real

Calculates the eigenvector of the largest positive eigenvalue of the adjacency matrix representation of a square network. A Jacobi method is used to compute the eigenvalues and vectors.



Eigenvector Centrality Per Component

Go To Measures by Report

Description

Calculates the principal eigenvector of the network. A node is central to the extent that its neighbors are central. Each component is extracted as a separate network, Eigenvector Centrality is computed on it and scaled according to the component size. The scores are then combined into a single result vector.

Eigenvector Centrality Per Component runs the Eigenvector Centrality metric on each component of the network individually, scales the

values according to the number of nodes in the component (larger components get larger values), and then combines the values into a single vector to return. The final vector has all values in the range [0,1].

NOTE : Eigenvector centrality and Eigenvector Centrality Per Component both operate on a symmetric network with no self-loops, and all values are output in the range [0,1].

Informal Name

None

Citation

Bonacich, Phillip. (1972). Factoring and weighting approaches to status scores and clique detection. Journal of Mathematical Sociology, 2, 113-120.

Bonacich, Phillip. (1972). Technique for Analyzing Overlapping Memberships. In H. Costner (Ed.), Sociological Methodology (pp. 176-185). San Francisco: Jossey-Bass.

Minimum and Maximum Values

Minimum : 0

Maximum : 1

Computational Time

Unknown

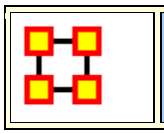
Input and Output

Input :

Network	Data Type	Directed
Square	Real	No

Output :

Level	Data Type
Node	Real



Eigenvector Centrality Spatial

Go To Measures by Report

Description

The sum of the eigenvector centralities of all nodes located at a place. Intuitively, the likelihood of arriving at a node at a particular location in a random walk.

NOTE : This measure works on the **Agent x Resource, Agent x Agent and Agent x Location** matrices and can be [**Any Number**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Malloy, Eric, Olson, Jamie, & Carley, Kathleen M. (2009). Geographic and Network Analysis of Drug Interdiction Information. Paper presented at the Twenty Ninth International Sunbelt Social Network Conference, San Diego, CA.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

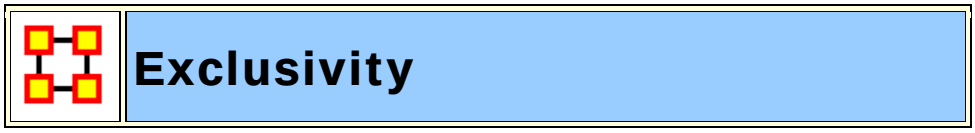
Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Location	Binary

Output :

Level	Data Type	Type
Node	Real	Location



Go To Measures by Report

Description

Detects entities that have ties that comparatively few other entities have. Individuals or organizations that are high in complete exclusivity for knowledge are those that have expertise or are connected to types of knowledge that no one else has. The scientific name of this measure is complete exclusivity and it is calculated on agent by knowledge matrices.

- Individuals or organizations that are high in complete exclusivity for location are those that have frequented locations that no one else has.
- Individuals or organizations that are high in complete exclusivity for resources are those that have resources or are connected to types of resources that few others have.
- Individuals or organizations that are high in complete exclusivity for tasks are those that are engaged in or assigned to tasks or activities for which no one else is engaged in or assigned to.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Ashworth, Michael J., & Louie, Marcus A. (2002). Alignment of the Garbage Can and NK Fitness Models: A Virtual Experiment in the Simulation of Organizations.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

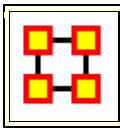
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row



Exclusivity Complete

Go To Measures by Report

Description

Detects entities that have ties that no other entity has. Individuals or organizations that are high in complete exclusivity for events are those that attend or are supposed to attend an event that no one else does. The scientific name of this measure is complete exclusivity and it is calculated on agent by event matrices.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Individuals or organizations that are high in complete exclusivity for events are those that attend or are supposed to attend an event that no one else does.

Informal Name

None

Citation

Ashworth, M. and Carley, K. (2006). Who you know vs. what you know: The impact of social position and knowledge on team performance. Journal of Mathematical Sociology, 30(1):43{75.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row

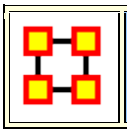
$$\Re \in [0,1]$$

This is a variation of the Exclusivity measure that weights the edges of an entity as follows: if no other entity has a connection to the entity, then its weight is one, otherwise it is zero.

Thus, the Complete Exclusivity value for node i is:

$$\sum_{j=1}^{|K|} AK(i,j) * [sum(AK(:,j) == 0]$$

The value is then normalized by dividing by |K|.



Expertise Correlation

Go To Measures by Report

Description

Measures the degree to which each pair of rows has complementary data, expressed as a percentage of the data of the first row.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

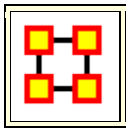
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row
Dyad	Real	Row by Row



Fragmentation

Go To Measures by Report

Description

The proportion of nodes in a network that are disconnected.

Example

In a given organization 25 out of 400 sales agents are disconnected from the resources and knowledge that exists at the company headquarters because they travel more frequently and are thus disconnected from the rest of the network. The attribute of this disconnection expressed as a property of the entire organization is its computed disconnected measure.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Borgatti, S.P. 2003. The Key Player Problem. Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, R.

Breiger, K. Carley, & P. Pattison (Eds.) Committee on Human Factors, National Research Council, 241-252.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type	Directed
Square	Binary	No

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Consider a square, symmetric network G=(V,E).

let

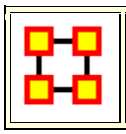
$$n = |V|$$

let

$$s_k \text{ be the number of nodes in the } k^{th} \text{ component of G, } 1 \leq k \leq n$$

Then,

$$\text{Fragmentation} = 1 - \frac{\sum_k s_k (s_k - 1)}{n(n-1)}$$



Geodesic Distance

Go To Measures by Report

Description

Computes the length of the shortest path between all node pairs, where length is the number of links, ignoring link weights. If no path exists between two nodes, then a distance of zero is given. The distance from a node to itself is also zero.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number a between [**0 and the number of columns - 1**].

Informal Name

None

Citation

Wasserman, Stanley, & Faust, Katherine. (1994). Social Network Analysis: Methods and Applications: Cambridge University Press.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of columns - 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Dyad	Integer

Hierarchy

Go To Measures by Report

Description

The degree to which a unimodal network exhibits a pure hierarchical structure.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

Let us say in an organization Sue is the president. Under Sue, we have 4 vice presidents, whom all in turn have 5 or 10 direct reports, who all have 2 or 3 managers working for them. To such a degree that this architecture is present in the organzation is its computed Krackhardt Hierarchy value.

Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

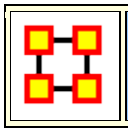
Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let N be a square network. The Hierarchy of N is the Reciprocity of the Reachability Network for N.



Hub Centrality

Go To Measures by Report

Description

A node is hub-central to the extent that its out-links are to nodes that have many in-links. Individuals or organizations that act as hubs are sending information to a wide range of others each of whom has many others reporting to them. Technically, an agent is hub-central if its out-links are to agents that have many other agents sending links to them. The scientific name of this measure is hub centrality and it is calculated on agent by agent matrices.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Kleinberg, Jon M. (1998). Decision algorithms for unsplittable flow and the half-disjoint paths problem. Paper presented at the Thirtieth Annual ACM symposium on Theory of Computing, Dallas, TX.

Kleinberg, Jon M. (1998). Authoritative sources in a hyperlinked environment. Paper presented at the SODA '98 Ninth Annual ACM-SIAM Symposium on Discrete Algorithms, San Francisco, CA. Latria and Marchiori, 2001

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Real

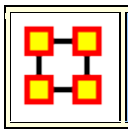
Output :

Level	Data Type
Node	Real

Let G be the adjacency matrix.

Hub Centrality = eigenvectorCentrality(G*G')

Authority Centrality = eigenvectorCentrality(G'*G)



In Degree Centrality

Go To Measures by Report

Description

The In Degree Centrality of a node is its normalized in-degree. For any node, e.g. an individual or a resource, the in-links are the connections that the node of interest receives from other nodes. For example, imagine an agent by knowledge matrix then the number of in-links a piece of knowledge has is the number of agents that are connected to. The scientific name of this measure is in-degree and it is calculated on the agent by agent matrices.

For any node, e.g. an individual or a resource, the in-links are the connections that the node of interest receives from other nodes.

NOTE : This measure works on the **Agent x Agent** matrix and can be [**Any Number**].

The result will be a number between [**0 and 1**], inclusive.

Example

An agent by knowledge matrix with a number of in-links. A piece of knowledge has is the number of agents that are connected to.

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Real

Output :

Level	Data Type	Type
Node	Real	Column

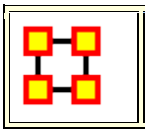
$$\Re \in [0,1]$$

Consider the matrix representation X of a network with m rows and n columns. Each column j is assigned an in-degree centrality based on the sum of entries in its column.

The In-Degree Centrality for column j

$$\text{column } j = \frac{1}{m} \sum_{i=1}^{m} X(i, j)$$

NOTE : This measure is also called Column Degree Centrality.



In Degree Network Centralization

Go To Measures by Report

Description

A centralization of a square network based on the In-Degree Centrality of each node.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, all employees have many incoming links to other employees. This is their **In degree** connections. This measure computes a value for the entire organization as a whole as to how central these connections are within the organization.

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let **N be a unimodal network with n entities**.

let

$$d_i = \text{In Degree Centrality of node } i$$

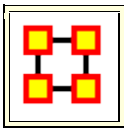
let

$$\overline{d} = \max\{d_i \mid 1 \le i \le n\}$$

Then

$$\text{In Degree Network Centralization} = \left(\sum_{1 \le i \le n} \bar{d} - d_i \right) / D$$

where D = (n-2) if N is undirected, and (n-1) otherwise.



Information Centrality

Go To Measures by Report

Description

Information centrality is a network metric that accounts for indirect as well as shortest (geodesic) paths among entities. Information centrality is similar to betweenness, except that betweenness considers only shortest paths **geodesics**, whereas information centrality also considers more circuitous paths weighted by the inverse of the path length **(the number of links along the path)**.

Calculates the Stephenson and Zelen information centrality measure for each entity.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

Entities high in information centrality are more likely to get more information and to get information faster.

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow, with High Space requirements

Input and Output

Input :

Network	Data Type	Directed
Square	Real	No

Output :

Level	Data Type
Node	Real

$$\Re \in [0,1]$$

Calculates the measure described on pg 195-6 of Wasserman and Faust. Isolates **(entities with no edges)** are first removed from the network, and the measure computed on the resulting sub-graph. The isolates are given centrality value 0.

Interdependence

Go To Measures by Report

Description

The percentage of links in a unimodal network that are Pooled or Reciprocal.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

A reciprocal link is one that is bidirectional. Let us say Bob has a link to Sue and Sue has a link back to Bob This is a reciprocal link. However, if Bob had a lot of links to Sue and others, which were not reciprocated, that is bidirectional, than Bob would be said to rank higher in radial links, which linked in one direction. The extent that a network exhibits these relationships is computed as the Interdependence and Radial value for the network.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

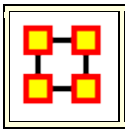
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let **G=(V,E)** be the graph representation of a square network.

Let **a = Pooled Edge Count** and **b = Reciprocal Link Count** of the network.

Then **Interdependence = (a+b)/|E|**



Interlockers

Go To Measures by Report

Description

Interlocker are nodes that have a triad count (the number of triads each node is in) that is greater than the mean plus one standard deviation.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be in the binary format [**0 or 1**].

Example

A typical corporate board of directors is a good example of an interlocking architecture. Whereas a predominant amount of board members - perhaps close to 70-percent - might serve on one board only, it is often common that the remaining 30-percent may serve on 3 or more other boards. These directors that serve on the other boards constitute the interlocking agents that connect all these typical boards together. The Interlockers and radial measures compute a value for such relationships as they exist in the network at the entity, that is agent (e.g., "board member"), level.

Informal Name

None

Citation

Laumann, 1973 Edward O. Laumann, Bonds of Pluralism: The Form and Substance of Urban Social Networks, Wiley-Interscience, New York (1973).

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Binary

Let **N=(V,E)** be a square network.

Let

t_i = Triad Count for node i, $1 \le i \le |V|$

Let

u = the mean of $\{ t_i \}$

Let

d = the variance of $\{ t_i \}$

Then,

if $t_k \ge (u+d)$, then agent k is an *interlocker*.

If $t_k \le (u-d)$, then agent k is a *radial*.

Inverse Closeness Centrality

Go To Measures by Report

Description

The average closeness of a node to the other nodes in a network. Inverse Closeness is the sum of the inverse distances between a node and all other nodes. Nodes high in closeness centrality are more likely to communicate faster and operate more efficiently.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. Social Network Analysis: Methods and Applications. Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Node	Real

$\Re \in [0,1]$

Let **G=(V,E)** be the graph representation of the square network.

For $v \in V$

let

$$\text{dist} = \sum_{i \in V} \frac{1}{d_G(v,i)}, \text{ where } \frac{1}{d_G(i,i)} = 0 \text{ and } \frac{1}{d_G(v,i)} = 0$$

if i is not reachable from v.

Then, **Inverse Closeness Centrality of entity v = dist / (|V|-1)**.

Isolate Count

Go To Measures by Report

Description

The number of isolate nodes in a unimodel network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be [**the total number of isolates**].

Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of nodes in the network

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

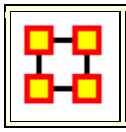
Output :

Level	Data Type
Graph	Integer

$$Z \in [0, |V|]$$

Let N=(V,E) be a square network.

An isolate is a node v in V such that no edges are incident upon it. The number of such nodes is returned.



Knowledge Actual Workload

Go To Measures by Report

Description

The knowledge an agent uses to perform the tasks to which it is assigned.

NOTE : This measure works on the **Agent x Knowledge, Knowledge x Task, and Agent x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Knowledge by Task	Binary
Agent by Task	Binary

Output :

Level	Type	Data Type
Node Level	Agent	Real

Knowledge Based Access Index

Go To Measures by Report

Description

Boolean value which is true if an agent is the only agent who knows a piece of knowledge and who is known by exactly one other agent. The one agent known also has its KAI set to one.

An node level measure that computes the average shortest path length between entities, excluding infinite distances. This is known as the Knowledge Access Index (KAI) value.

NOTE : This measure works on the **Agent x Agent and Agent x Knowledge** matrices and needs to be in the binary format [**0 or 1**].

The result will be a binary number [**0 or 1**].

Example

Let us imagine a social network where 50 employees have many connections to each other. The average number of connections per employee is the Access Index.

Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen M., 2003, "Critical Human Capital", Working Paper, CASOS, Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Knowledge	Binary

Output :

Level	Type	Data Type
Node Level	Agent	Binary

The Knowledge Access Index (KAI) for agent i is defined as follows:

let

$$S_i = \{s \mid AK(i,s) \wedge (sum(AK(:,s)) = 1) \wedge (sum(A(i,:)) = 1)\}$$

Then

$$KAI_i = ((S_i \neq \varnothing) \vee (\exists j \mid S_j \neq \varnothing \wedge A(j,i) = 1))$$

Knowledge Task Completion

Go To Measures by Report

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite knowledge to do the tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Bob is assigned 10 Tasks to complete which require a certain amount of knowledge to finish. However, on average only 10-percent of this knowledge will be available to Bob for him to complete the tasks given. This measure would compute a value for the likelyhood that Bob would be able to complete any given task.

NOTE : Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Find the tasks that cannot be completed because the agents assigned to the tasks lack necessary knowledge.

let

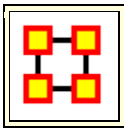
$$\text{Need} = [(\text{AT'}*\text{AK}) - \text{KT'}]$$

let

$$S = \{ i \mid 1 \le i \le |T|, \exists j : \text{Need}(i,j) < 0 \}$$

Knowledge Based Task Completion is the percentage of tasks that could be completed = (|T|-|S|) / |T|

Resource Based Task Completion is analogous, replacing AK with AR and KT with RT.



Knowledge Diversity

Go To Measures by Report

Description

The distribution of difference in idea sharing. This is the Herfindahl-Hirshman index applied to column sums of AK.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Characterizes the network in terms of how the items in a knowledge network **(who knows what)** are non-uniformly distributed across employees

Informal Name

None

Citation

Hirschman A. O., 1945. National Power and the Structure of Foreign Trade. Berkeley: University of California Press.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

This is the Herfindahl-Hirshman index (economics: sum of the squares of each firm's market share) applied to the normalized column sums of AK. This measures the degree to which knowledge is equally known.

let

$$w_k = \sum_{i=1}^{|A|} AK(i,k) \text{ , for } 1 \le k \le |K|$$

let

$$W = \sum_{k=1}^{|K|} w_k$$

Then

$$\text{Knowledge Diversity } = 1 - \sum_{k=1}^{|K|} (w_k / W)^2$$

Knowledge Exclusivity

Go To Measures by Report

Description

Detects agents who have singular knowledge.

Example

A key piece of knowledge that supports an entire organization is only accessible through one person.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Ashworth, M. and Carley, K. (2006). Who you know vs. what you know: The impact of social position and knowledge on team performance. Journal of Mathematical Sociology, 30(1):43{75.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

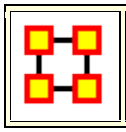
Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

The **Knowledge Exclusivity Index (KEI)** for agent i is defined as follows:

$$\sum_{j=1}^{|K|} AK(i, j) * \exp(1 - sum(AK(:, j)))$$

The **Knowledge Exclusivity Index** (KEI) for agent i is defined exactly as for Knowledge Based Exclusivity.



Knowledge Load

Go To Measures by Report

Description

Average number of knowledge per agent.

NOTE : This measure works on the **Agent x Knowledge** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

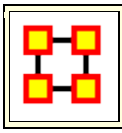
Output :

Level	Data Type
Graph	Real

$$\Re \in [0, |K|]$$

$$\mathrm{I} = \frac{\sum AK}{|A|}$$

Resource Load is defined analogously, replacing AK with AR.



Knowledge Negotiation

Go To Measures by Report

Description

The extent to which agents need to negotiate with each other because they lack the knowledge to complete their assigned tasks.

NOTE : This measure works on the **Agent x Task, Agent x Knowledge, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, Bob does not have knowledge needed to complete a certain task but Sue does have it. Bob must negotiate with Sue to gain that knowledge to complete the task. The extent to which others in the organization must negotiate for knowledge that others have is the organization's knowledge negotiation value.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Task	Binary
Agent by Knowledge	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Compute the percentage of tasks that lack at least one knowledge *(or Resource)*:

let

$$\text{Need} = (\text{AT'}*\text{AK}) - \text{KT'}$$

for Resource replace AK with AR and KT with RT

let

$$S = \{\, i \mid 1 \le i \le |T|,\ \exists\ j : \text{Need}(i,j) < 0 \,\}$$

Then **Knowledge (or Resource) Negotiation = |S| / |T|**

Knowledge Omega

Go To Measures by Report

Description

The degree to which agents reuse knowledge while doing their tasks.

NOTE : This measure works on the **Agent x Task, Knowledge x Task, and Task x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Sue has X amount of tasks within her company. How many of those tasks that require a knowledge that can be used for one or more of her other tasks is omega knowledge. This measure computes a value for such relations to knowledge sets at the network level.

Informal Name

None

Citation

Carley, K, Dekker, D., Krackhardt, D (2000). How Do Social Networks Affect Organizational Knowledge Utilitization.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Task	Binary
Knowledge by Task	Binary
Task by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let **TAT = TA*TA'**

Let **N = ((T'@TAT)*KT')@KT'**

for resource replace KT with RT

Then **Knowledge Based Omega = sum(N)/sum(KT)**

for resource replace KT with RT

Knowledge Potential Workload

Go To Measures by Report

Description

Maximum knowledge an agent could use to do tasks if it were assigned to all tasks.

NOTE : This measure works on the **Agent x Knowledge and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, let us say Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible: 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Knowledge by Task	Binary

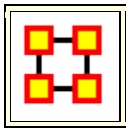
Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Potential Knowledge Workload for agent i = sum((AK*KT)(i,:))/sum(KT)

for Resource replace AK with AR and KT with RT



Knowledge Rendundancy

Go To Measures by Report

Description

Average number of redundant agents per knowledge. An agent is redundant if there is already an agent that has the knowledge.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $\Re \in [0,(|A|-1)*|K|]$

Computational Time

Fast

Input and Output

Input :

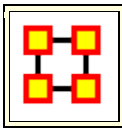
Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,(|A|-1)*|K|]$$

This is the Column Redundancy of matrix AK.



Knowledge Under Supply

Go To Measures by Report

Description

The extent to which the knowledge needed to do tasks are unavailable in the entire organization.

NOTE : This measure works on the **Agent x Task, Agent x Knowledge, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Task	Binary
Agent by Knowledge	Binary
Knowledge by Task	Binary

Output :

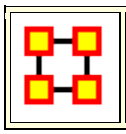
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

This is the number of required knowledge not available to tasks based on the current agent task assignments normalized by the number of tasks.

Knowledge Under Supply = sum(dich(KT - AK'*KT)) / |T|

Under Resource Supply is analogous, replacing AK with AR, and KT with RT.



Lateral Link Count

Go To Measures by Report

Description

The percentage of lateral links in a unimodal network. Fixing a root node x, a lateral link (i,j) is one in which the distance from x to i is the same as the distance from x to j.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Fixing a root entity x, a lateral edge (i,j) is one in which the distance from x to i is the same as the distance from x to j.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible: 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

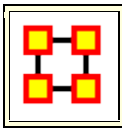
$$\Re \in [0,1]$$

Let **G=(V,E)** be the graph representation of a network. And fix an node **x∈V** to be the root node.

Let

$$\text{Let } S = \{(i,j) \in E \mid d_G(x,i) = d_G(x,j)\}$$

Then **Lateral Edge Count = |S| / |E|**



Local Efficiency

Go To Measures by Report

Description

Normalized sum of the Global Efficiency of each node's ego network (here, the ego network for entity i does not include entity i).

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In an organization, Bob has a connection to the computers, Sales Data, Events, Goals. This measure computes a value for the minimum number of links to entities such as Bob must have for the network to maintain its network status. Therefore, this is a network

level measure. If Bob had one less link, then then the entities would cease to constitute the original network.

Informal Name

None

Citation

Latria and Marchiori (2001), Efficient behavior of small-world networks. Physical Review Letters, volume 87, issue 19, The American Physical Society.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Local Efficiency is the normalized sum of the inverse closeness of the ego networks (here, the ego network for entity i does not include entity i).

Let **G = (V,E)** be any square, symmetric network with **|V| = N entities**.

let

$$V_i = \text{set of nodes adjacent to } i = \{ j \mid (i,j) \in E \}$$

let

$$E_i = \text{edges between nodes adjacent}$$

to

$$i = \{ (j,k) \mid (j,k) \in E;\ i,j \in V_i \}$$

define

$$G_i = (V_i, E_i)$$

Then,

$$\text{Local Efficiency} = \frac{1}{N} \sum_{i=1}^{N} \text{GlobalEfficiency}(G_i)$$

Location Relevance

Go To Measures by Report

Description

The extent to which location influences a particular persons connections.

NOTE : This measure works on the **Agent x Agent, and Agent x Location** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Malloy, Eric, Olson, Jamie, & Carley, Kathleen M. (2009). Geographic and Network Analysis of Drug Interdiction Information. Paper presented at the Twenty Ninth International Sunbelt Social Network Conference, San Diego, CA.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

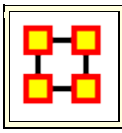
Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Location	Binary

Output :

Level	Data Type	Type
Node	RealLocation	



Minimum Speed

Go To Measures by Report

Description

The maximum shortest path length between node pairs (i,j) where there is a path in the network from i to j. If there are no such pairs, then Minimum Speed is zero.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

In an organization, we have Bob and Sue with numerous paths between them. The shortest path between this entity pair would be Bob and Sues (Bob/Sue) minimum speed. One might also say that if there were numerous links between Bob and Sue and that the average linkage was in the neighborhood of 5 paths (e.g., links) when every person in the organization is taken as a whole, the shortest linkage between them would be the minimum speed at

which Bob and Sue might communicative. If Bob and Sue had direct links, minimum speed would be 0.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

NOTE : Minimum Speed = 1 / (Levels for the Network)

Computational Time

Medium

Input and Output

Input :

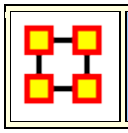
Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Minimum Speed = 1 / (Levels for the Network)



Network Levels

Go To Measures by Report

Description

The Network Level of a square network is the maximum Node Level of its nodes.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and the number of node levels - 1**].

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $Z \in [0, |V|-1]$

Computational Time

Medium

<

Input and Output

Input :

Network	Data Type
Square	Real

Output :

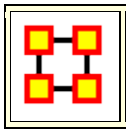
Level	Data Type
Graph	Real

$$Z \in [0, |V| - 1]$$

Let **G=(V,E)** be the graph representation of a square network and fix an entity v.

Then

$$\text{the Levels of } G = \max \{ d_G(i,j) \mid i,j \in V; j \text{ reachable from } i \text{ in } G \}$$



Node Count

Go To Measures by Report

Description

The number of nodes in a unimodal network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and the number of nodes in the Network**].

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of nodes in the network

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Integer

Node Levels

Go To Measures by Report

Description

The Node Level for a node v in a square network is the longest shortest path from v to every node v can reach. If v cannot reach any node, then its level is 0.

The Network Level of a square network is the maximum Node Level of its nodes.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and the number of nodes - 1**].

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of nodes in the network - 1

Computational Time

Medium

Input and Output

Input :

Square matrix : DataType=real.

Output :

Graph Level : DataType=integer.

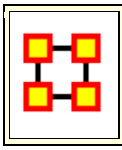
$$Z \in [0, |V| - 1]$$

Let **G=(V,E)** be the graph representation of a square network and fix a node v.

Node Level : DataType=integer

$$\text{for } v = \max \{ d_G(v, j) \mid j \in V; j \text{ reachable from } v \text{ in } G$$

If v cannot reach any nodes, then its level is 0.



Organization Agent Knowledge Needs Congruence

Go To Measures by Report

Description

Across all agents, the knowledge that agents lack to do their assigned tasks expressed as a percentage of the total knowledge needed by all agents.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Agent Needs, let N = AT*KT'

Then

$$\text{Organization Agent Needs} = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|K|} N_{i,j} * (\sim AK_{i,j})}{\text{sum}(N)}$$

Organization Agent Knowledge Waste Congruence

Go To Measures by Report

Description

Across all agents, the knowledge that agents have that are not required to do their assigned tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input :

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Agent Waste, let N = AT*KT'

Then

$$\text{Organization Agent Needs} = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|K|} AK_{i,j} * (N_{i,j} = 0)}{\text{sum}(AK)}$$

Organization Agent Resource Needs Congruence

Go To Measures by Report

Description

Across all agents, the resource that agents lack to do their assigned tasks expressed as a percentage of the total resources needed by all agents.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

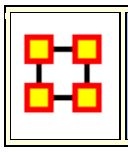
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Agent Needs, let N = AT*RT'

Then

$$\text{Organization Agent Needs} = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|R|} N_{i,j} * (\sim AR_{i,j})}{\text{sum}(N)}$$



Organization Agent Resource Waste Congruence

Go To Measures by Report

Description

Across all agents, the resources that agents have that are not required to do their assigned tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

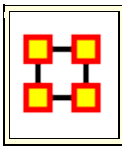
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Agent Waste, let N = AT*RT'

Then

$$\text{Organization Agent Needs} = \frac{\sum_{i=1}^{|A|} \sum_{j=1}^{|R|} AR_{i,j} * (N_{i,j} = 0)}{\text{sum}(AR)}$$



Organization Task Knowledge Needs Congruence

Go To Measures by Report

Description

Across all tasks, the knowledge that tasks lack expressed as a percentage of the total knowledge needed by all tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making.

Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Example : An organization needs many skills to meet it's organizational objectives. However, not all of the skills are present within the organizational network. This measure computes a value for this lack of skills as it is distributed across the organization as a whole.

Output :

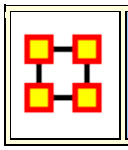
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Task Needs, let S = AT'*AK

Then

$$\text{Organization Task Needs} = \frac{\sum_{i=1}^{|T|} \sum_{j=1}^{|K|} KT^{t}_{i,j} * (S_{i,j} = 0)}{\text{sum}(KT)}$$



Organization Task Knowledge Waste Congruence

Go To Measures by Report

Description

Across all agents, the knowledge that agents have that are not required to do their assigned tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Task Waste, let S = AT'*AK

Then

$$\text{Organization Task Waste} = \frac{\sum_{i=1}^{|T|} \sum_{j=1}^{|K|} S_{i,j} * (\sim KT_{i,j})}{\text{sum}(S)}$$

Organization Task Resource Needs Congruence

Go To Measures by Report

Description

Across all tasks, the resources that tasks lack expressed as a percentage of the total resource needed by all tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

An organization needs many resources to meet it's organizational objectives. However, not all of the resources are present within the organizational network. This measure computes a value for this lack of resources as it is distributed across the organization as a whole.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

MediumFast

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Task Needs, let S = AT'*AR

Then

$$\text{Organization Task Needs} = \frac{\sum_{i=1}^{|T|} \sum_{j=1}^{|R|} RT^{t}_{i,j} * (S_{i,j} = 0)}{\text{sum}(RT)}$$

Organization Task Resource Waste Congruence

Go To Measures by Report

Description

Across all agents, the resources that agents have that are not required to do their assigned tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

As in Task Waste, let S = AT'*AR

Then

$$\text{Organization Task Waste} = \frac{\sum_{i=1}^{|T|} \sum_{j=1}^{|R|} S_{i,j} * (\sim RT_{i,j})}{\text{sum}(S)}$$

Organizational Availability

Go To Measures by Report

Description

An organization is available to do a task if it has the required agents and the required resources.Computes the degree to which organizations are available to do tasks based on their access to resources and roles that are needed to do the tasks.

NOTE : This measure works on the **Agent x Organization, Agent x Task, Organization x Resource, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Organization	Binary
Agent by Task	Binary
Organization by Resource	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Organization



Out Degree Centrality

Go To Measures by Report

Description

For any node, (e.g. an individual or a resource), the out-links are the connections that the node of interest sends to other nodes. For example, imagine an agent by knowledge matrix then the number of out-links an agent would have is the number of pieces of knowledge it is connected to.

The scientific name of this measure is out-degree and it is calculated on the agent by agent matrices. Individuals or organizations who are high in most knowledge have more expertise or are associated with more types of knowledge than are others. If no sub-network connecting agents to knowledge exists, then this measure will not be calculated. The scientific name of this measure is out degree centrality and it is calculated on agent by knowledge matrices. Individuals or organizations who are high in "most resources" have more resources or are associated with more types of resources than

are others. If no sub-network connecting agents to resources exists, then this measure will not be calculated. The scientific name of this measure is out degree centrality and it is calculated on agent by resource matrices.

NOTE : This measure works on the **Agent x Agent** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Real

Output :

Level	Data Type	Type
Node	Real	Row

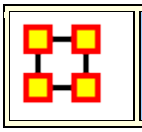
$\Re \in [0,1]$ (If N is binary)

Consider the matrix representation X of a network with m rows and n columns. Each row i is assigned an out-degree centrality based on the sum of entries in its row.

The Out-Degree Centrality

$$\text{row i} = \frac{1}{n}\sum_{j=1}^{n} X(i,j)$$

NOTE : This measure is also called Row Degree Centrality.



Out Degree Network Centralization

Go To Measures by Report

Description

A centralization of a square network based on the Out-Degree Centrality of each node.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be any number.

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, all employees have so many links to other employees. This is their out degree connections. This measure computes a value for the entire organization as a whole as to how central these connections are within the organization.

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let N be a unimodal network with n nodes.

let

$$d_i = \text{Out Degree Centrality of entity i}$$

let

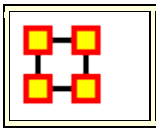
$$\bar{d} = \max\{d_i \mid 1 \le i \le n\}$$

Then

$$\text{Out Degree Network Centralization} = \left(\sum_{1 \le i \le n} \bar{d} - d_i \right) / D$$

,

where D = (n-2) if N is undirected, and (n-1) otherwise.



Overall Role Based Availability

Go To Measures by Report

Description

Computes the degree to which agents are available to do tasks based on their access to knowledge and resources and roles that are needed to do the tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Resource, Knowledge x Role, Resource x Role, and Task x Role** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Knowledge	Binary
Resource by Role	Binary
Knowledge by Role	Binary
Task by Role	Binary

Output :

Level	Data Type	Type
Node	Real	Agent



Go To Measures by Report

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite knowledge and resources to do the tasks.

NOTE : Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.

NOTE : This measure works on the **Agent x Knowledge, Agent x Resource, Agent x Task, Knowledge x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible: 0

Maximum Possible: 1

Computational Time

Medium

Input and Output

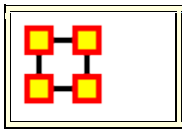
Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Resource	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Resource by Task	Binary

Output :

Level	Data Type
Graph	Real



Performance as Accuracy

Go To Measures by Report

Description

Measures how accurately agents can perform their assigned tasks based on their access to knowledge and resources.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, Agent x Resource, Knowledge x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible: 0

Maximum Possible: 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Agent by Resource	Binary
Knowledge by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

One of the following pairs of matrices must exist: AK/KT, AR/RT. If both exist, then the measure first concatenates them into [AK AR], [KT RT] and uses them.

Accuracy is computed based on the binary classification problem. It is computed in one of two ways:

(1) Knowledge based: Let b be a binary string of length |K|, let N=KT', and let S=AK. Fix a task t.

let

$$\text{answer} = \left(\sum_{1 \le k \le |K|} N_{t,k} b_k \Big/ \sum_{1 \le k \le |K|} N_{t,k} > .5 \right)$$

which is the correct classification of b with respect to task t.

Now, let I={ i | AT(i,t)=1}.

let

$$\text{answer}(i) = \left(\sum_{1 \le k \le |K|} N_{t,k} S_{i,k} b_k \Big/ \sum_{1 \le k \le |K|} N_{t,k} S_{i,k} > .5 \right), i \in I.$$

This is agent i's classification of b with respect to t.

The group of agents classify b using majority voting.

That is,

$$\text{group_answer} = \left(\frac{1}{|I|} \sum_{i \in I} \text{answer}(i) > .5 \right).$$

Then, if group_answer = answer, then the group was accurate, otherwise not.

This is repeated multiple times for each task, and across all tasks. The percentage correct is Performance as Accuracy.

(2) Resource based: let N=RT' and S=AR in the analysis of case (1).

Personnel Cost

Go To Measures by Report

Description

Total number of people reporting to an agent, plus its total knowledge, resources, and tasks.

Personnel Cost is the sum of the in-degree centrality of all AA matrices in the graph (this computes the number of agents reporting to each agent), plus the out-degree centrality of any AK, AR, and AT graphs.

NOTE : This measure works on the **Agent x Agent, Agent Knowledge, Agent x Resource, and Agent x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, five employees report to Sue. All of the knowledge, resource and tasks connections attributed all the employees and Sue constitute Personnel Cost. This measure then computes a value for Sue based on all these connections of her employees.

Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen, M., 2003, "Critical Human Capital, Working Paper, CASOS" Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum Possible: 0

Maximum Possible: 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Knowledge	Binary
Agent by Resource	Binary
Agent by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Personnel Cost is the sum of the in-degree centrality of all AA matrices in the graph (this computes the number of agents reporting to each agent), plus the out-degree centrality of any AK, AR, and AT graphs.

This sum is scaled so that each entity gets a score in [0,1].

Potential Boundary Spanner

Go To Measures by Report

Description

Individuals or organizations that connect groups are those that are connecting disconnected groups. The individual or organization may be connected to only one or a few members of each group. This is a composite measure that is high when the agent is potentially influential but is not in the know. This is calculated as the ration of betweenness centrality to total degree centrality and is calculated on agent by agent networks.

Locates nodes that are **high in betweenness centrality, but low in total degree centrality**, and therefore potentially act as links between groups of entities.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

This measures finds an individual who could likely have great potential to interact with other parts of an organization based on their exisiting connections.

Informal Name

None

Citation

Cormen, Leiserson, Rivest, Stein 2001. "Introduction to Algorithms" Second Edition. Cambridge, MA: MIT Press, 2001.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type	Directed
Square	BinaryNo	

Output :

Level	Data Type
Node	Real

For each node in the network, its Potential Boundary Spanner is its Betweenness Centrality divided by its Total Degree Centrality.

Potential Workload

Go To Measures by Report

Description

Maximum knowledge and resources an agent could use to do tasks if it were assigned to all tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Resource, Knowledge x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

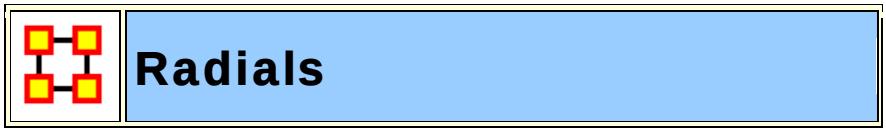
Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Resource	Binary
Knowledge by Task	Binary
Resource by Task	Binary

Example : In a given organization, Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Output :

Level	Data Type
Node	Real



Go To Measures by Report

Description

Radial are nodes that have a triad count (the number of triads each node is in) that is less than the mean minus one standard deviation.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be in the binary format [**0 or 1**].

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Binary

Reciprocal Link Count

Go To Measures by Report

Description

The percentage of links in a unimodal network that are reciprocated. A link (i,j) in the network is reciprocated if link (j,i) is also in the network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

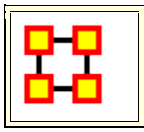
Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let G=(V,E) be the graph representation of a network.

Let S=card{(i,j)∈E|i<,(j,i)∈E}

Then **Reciprocral Link Count = |S| / |E|**



Relative Cognitive Distinctiveness

Go To Measures by Report

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as the percent of total knowledge. Each value is normalized by the row sum.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Dyad	Real	Agent by Agent

For each pair of agents (i,j) compute the number of knowledge bits they have exactly opposite. Then normalize this sum by the total number of knowledge bits. In effect, this is the exclusive-OR of their knowledge vectors.

$$CD_{i,j} = \frac{\sum_{k=1}^{|K|} (AK_{i,k} * \sim AK_{j,k}) + (\sim AK_{i,k} * AK_{j,k})}{|K|}$$

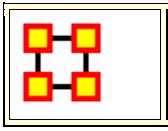
$$CD_{i,i} = 0$$

NOTE : Note that the CD output matrix is symmetric.

Relative Cognitive Distinctiveness normalizes each element of CD as follows:

$$RCD_{i,j} = \frac{CD_{i,j}}{\sum_{j=1}^{|K|} CD_{i,j}}$$

Thus, the elements of the ith row are normalized by the ith row sum.



Relative Cognitive Expertise

Go To Measures by Report

Description

Measures the degree to which each pair of agents has complementary knowledge, expressed as a percentage of the knowledge of the first agent. Each value is normalized by the row sum. Individuals or organizations that are high in specialized knowledge are those that have expertise or are connected to types of knowledge that few others have.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Dyad	Real	Agent by Agent

For each pair of agents (i,j) compute the number of knowledge bits that j knows that i does not know. Then normalize this sum by the total number of knowledge bits that agent i does not know.

$$CE_{i,j} = \frac{\sum_{k=1}^{|K|} (\sim AK_{i,k} * AK_{j,k})}{(|K| - \sum_{k=1}^{|K|} AK_{i,k})}$$

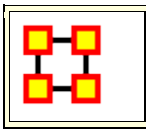
$$CE_{i,i} = 0$$

NOTE : Note that the CD output matrix is NOT-symmetric.

Relative Cognitive Expertise normalizes each element of CE as follows:

$$RCE_{i,j} = \frac{CE_{i,j}}{\sum_{j=1}^{|K|} CE_{i,j}}$$

Thus, the elements of the ith row are normalized by the ith row sum.



Relative Cognitive Resemblance

Go To Measures by Report

Description

Measures the degree to which each pair of agents has the exact same knowledge. Each value is normalized by the row sum.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Dyad	Real	Agent by Agent

$$\Re \in [0,1]$$

For each pair of agents (i,j) compute the number of knowledge bits they have in common - whether known or unknown. Then normalize this sum by the total number of knowledge bits.

$$CR_{i,j} = \frac{\sum_{k=1}^{|K|} (AK_{i,k} * AK_{j,k}) + (\sim AK_{i,k} * \sim AK_{j,k})}{|K|}$$

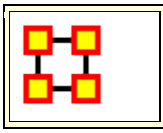
$$CR_{i,i} = 1$$

NOTE : The CR output matrix is symmetric.

Relative Cognitive Resemblance normalizes each element of CR as follows:

$$RCR_{i,j} = \frac{CR_{i,j}}{\sum_{j=1}^{|K|} CR_{i,j}}$$

Thus, the elements of the i***th*** row are normalized by the i***th*** row sum.



Relative Cognitive Similarity

Go To Measures by Report

Description

Measures the degree to which each pair of agents have overlapping knowledge. Each value is normalized by the row sum.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary

Output :

Level	Data Type	Type
Dyad	Real	Agent by Agent

For each pair of agents (i,j) compute the number of knowledge bits they have in common. Then normalize this sum by the total knowledge between them.

$$CS_{i,j} = \frac{\sum_{k=1}^{|K|}(AK_{i,k} * AK_{j,k})}{\sum_{k=1}^{|K|}(AK_{i,k} + AK_{j,k})}|$$

$$CS_{i,i} = 1$$

NOTE : The CS output matrix is symmetric.

Relative Cognitive Similarity normalizes each element of CS as follows:

$$RCS_{i,j} = \frac{CS_{i,j}}{\sum_{j=1}^{|K|} CS_{i,j}}$$

Thus, the elements of the i***th*** row are normalized by the i***th*** row sum.

Relative Expertise

Go To Measures by Report

Description

The degree of dissimilarity between agents based on shared knowledge. Each agent computes to what degree the other agents know what they do not know. Individuals or organizations that are high in specialized knowledge are those that have expertise or are connected to types of knowledge that few others have. The scientific name of this measure is relatively unique and it is calculated on agent by knowledge matrices.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen. (2003). Dynamic Network Analysis. 133-145. Committee on Human Factors, National Research Council. http://www.casos.cs.cmu.edu/publications/temp/hope110922160731/carley_2003_dynamicnetwork.pdf.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

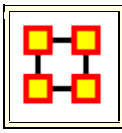
Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Graph	Real	Agent



Relative Similarity

Go To Measures by Report

Description

The degree of similarity between two agents based on shared knowledge. Each agent computes to what degree the other agents know what they know.

NOTE : This measure works on the **Agent x Knowledge** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen. (2003). Dynamic Network Analysis. 133-145. Committee on Human Factors, National Research Council.

http://www.casos.cs.cmu.edu/publications/temp/hope110922160731/carley_2003_dynamicnetwork.pdf.

Minimum and Maximum Values

Minimum : Possible 0

Maximum : Possible 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary

Output :

Level	Data Type	Type
Graph	Real	Agent

Resource Actual Workload

Go To Measures by Report

Description

The resources an agent uses to perform the tasks to which it is assigned.

NOTE : This measure works on the **Agent x Resource, Resource x Task, and Agent x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

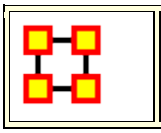
Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Resource by Task	Binary
Agent by Task	Binary

Output :

Level	Type	Data Type
Node Level	Agent	Real



Resource Based Access Index

Go To Measures by Report

Description

Boolean value which is true if an agent has exclusive access to a resource and who is known by exactly one other agent. The one agent known also has its KAI set to one.

An node level measure that computes the average shortest path length between entities, excluding infinite distances. This is known as the Resource Access Index (RAI) value.

NOTE : This measure works on the **Agent x Agent and Agent x Resource** matrices and needs to be in the binary format [**0 or 1**].

The result will be in the binary format [**0 or 1**].

Example

Let us imagine a social network where 50 employees have many connections to each other. The average number of connections per employee is the Access Index.

Informal Name

None

Citation

Ashworth, M. and Carley, Kathleen M., 2003, "Critical Human Capital", Working Paper, CASOS, Carnegie Mellon, Pittsburgh PA.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Resource	Binary

Output :

Level	Type	Data Type
Node Level	Agent	Binary

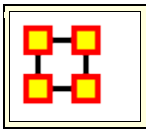
The Resource Access Index (RAI) for agent i is defined as follows:

$$S_i = \{s \mid AR(i,s) \wedge (sum(AR(:,s)) = 1) \wedge (sum(A(i,:)) = 1)\}$$

let

Then

$$RAI_i = ((S_i \neq \varnothing) \vee (\exists j \mid S_j \neq \varnothing \wedge A(j,i) = 1))$$



Resource Based Task Completion

Go To Measures by Report

Description

The percentage of tasks that can be completed by the agents assigned to them, based solely on whether the agents have the requisite resources to do the tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Bob is assigned 10 Tasks to complete which require a certain amount of resources to finish. However, on average only 10-percent of those resources will be available to Bob for him to complete the tasks given. This measure would compute a value for the likelyhood that Bob would be able to complete any given task.

NOTE : Task Completion Overall is a combination of the Task Completion Knowledge and the Task Completion Resource.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

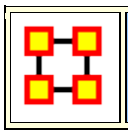
Level	Data Type
Graph	Real

Find the tasks that cannot be completed because the agents assigned to the tasks lack necessary knowledge.

let Need = [(AT'*AR) - KT']

let S = { i | , j : Need(i,j) < 0 }

Knowledge Based Task Completion is the percentage of tasks that could be completed = (|T|-|S|) / |T|



Resource Diversity

Go To Measures by Report

Description

The distribution of difference in resource sharing. This is the Herfindahl-Hirshman index applied to column sums of AR.

NOTE : This measure works on the **Agent x Resource** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Characterizes the network in terms of how the items in a resource network **(who has what)** are non-uniformly distributed across employees

Informal Name

Who Has What

Citation

Hirschman A. O., 1945. National Power and the Structure of Foreign Trade. Berkeley: University of California Press.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

This is the Herfindahl-Hirshman index (economics: sum of the squares of each firm's market share) applied to the normalized column sums of AK. This measures the degree to which knowledge is equally known.

let

$$w_k = \sum_{i=1}^{|A|} AR(i,k) \text{ , for } 1 \le k \le |R|$$

let

$$W = \sum_{k=1}^{|R|} w_k$$

Then

$$\text{Resource Diversity} = 1 - \sum_{k=1}^{|K|} \left(w_k / W \right)^2$$

Resource Exclusivity

Go To Measures by Report

Description

Detects agents who have singular resource access.

NOTE : This measure works on the **Agent x Resource** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

A key resource that supports an entire organization is only accessible through one person.

Informal Name

None

Citation

Ashworth, M. and Carley, K. (2006). Who you know vs. what you know: The impact of social position and knowledge on team performance. Journal of Mathematical Sociology, 30(1):43{75.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

The **Resource Exclusivity Index (REI)** for agent i is defined as follows:

$$\sum_{j=1}^{|K|} AR(i, j) * \exp(1 - sum(AR(:, j)))$$

The **Resource Exclusivity Index** (REI) for agent i is defined exactly as for Resource Based Exclusivity.

Resource Negotiation

Go To Measures by Report

Description

The extent to which agents need to negotiate with each other because they lack the resources to complete their assigned tasks.

NOTE : This measure works on the **Agent x Task, Agent x Resource, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, Bob does not have access to the resources needed to complete a certain task but Sue does have it. Bob must negotiate with Sue to gain those resources. The extent to which others in the organization must negotiate for resources that others have is the organization's resource negotiation value.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

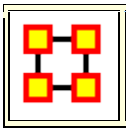
Input and Output

Input :

Network	Data Type
Agent by Task	Binary
Agent by Resource	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real



Resource Omega

Go To Measures by Report

Description

The degree to which agents reuse resources while doing their tasks.

NOTE : This measure works on the **Agent x Task, Resource x Task, and Task x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Sue has X amount of tasks within her company. How many of those tasks that require a resource that can be used for one or more of her other tasks is omega knowledge. This measure computes a value for such relations to the resources at the network level.

Informal Name

None

Citation

Carley, Kathleen M., Dekker, D., Krackhardt, D (2000). How Do Social Networks Affect Organizational Knowledge Utilitization.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

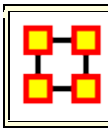
Network	Data Type
Agent by Task	Binary
Resource by Task	Binary
Task by Task	Binary

Output :

Level	Data Type
Graph	Real

Let TAT = TA*TA'

Let N = ((TT'@TAT)*KT')@KT'



Resource Potential Workload

Go To Measures by Report

Description

Maximum resources an agent could use to do tasks if it were assigned to all tasks.

NOTE : This measure works on the **Agent x Resource and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, let us say Bob is assigned all task that exist in the organization. This measure would compute a value expressing Bob's potential to carry out all the tasks based on his connections to the resources and knowledge needed for the tasks.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible: 1

Computational Time

Medium

Input and Output

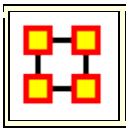
Input :

Network	Data Type
Agent by Resource	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Graph	Real	Agent

Potential Knowledge Workload for agent i = sum((AK*KT)(i,:))/sum(KT)



Resource Rendundancy

Go To Measures by Report

Description

Average number of redundant agents per resource. An agent is redundant if there is already an agent that has the resource.

NOTE : This measure works on the **Agent x Resource** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. "Summary of Key Network Measures for Characterizing Organizational Architectures." Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : [(|*R*|-1)*|*T*|]

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0, (|R| - 1) * |T|]$$

This is the Column Redundancy of matrix RT.

Resource Under Supply

Go To Measures by Report

Description

The extent to which the resources needed to do tasks are unavailable in the entire organization.

NOTE : This measure works on the **Agent x Task, Agent x Resource, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In an organization where Bob needs to complete Task A, he needs access to Resource B, which in this case might be a computer. However, what would happen if Resource B were simply unavailable? Say the computer was offline 50-percent of the time. This computer would likely under supply the task of completing Task A. This measure would compute a value to the effect that this under supply factor affected the ability to perform the task at hand.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real

This is the number of required knowledge not available to tasks based on the current agent task assignments normalized by the number of tasks.

Resource Under Supply = sum(dich(RT - AR'*RT)) / |T|

Role Based Knowledge Availability

Go To Measures by Report

Description

Computes the number of roles that an agent is qualified to have based on knowledge requirements.

Agent by Knowledge x Knowledge by Role = Agent by Role$_{resource}$ subject to the additional constraint:

> If **Max(Knowledge by Role*j*)=0** (i.e. role *j* requires no knowledge) then **Agent by Role$_j$**=1

A link **Agent by Role$_{ij}$** indicates that agent *i* has no access to the knowledge needed for role *j*.

NOTE : This measure works on the **Agent x Knowledge and Knowledge x Role** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Behrman, Robert; forthcoming; "Network Analysis of the Structure and Capacity of Brigade Level Military Organizations"; Chapter 3; PhD Thesis

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

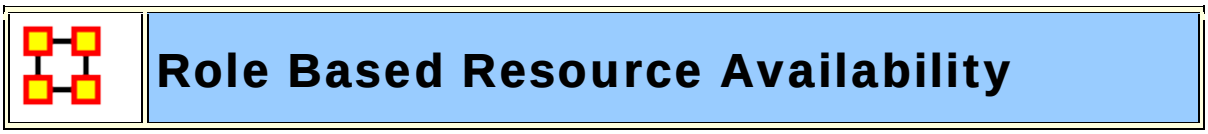
Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Knowledge by Role	Binary
Task by Role	Binary

Output :

Level	Data Type	Type
Node	Real	Agent



Go To Measures by Report

Description

Computes the number of roles that an agent is qualified to have based on Resource requirements.

Agent by Resource x Resource by Role = Agent by Role$_{resource}$

A Link **Agent by Role$_{ij}$** indicates that agent *i* has the skills to use the resource required by role *j*.

NOTE : This measure works on the **Agent x Resource and Resource x Role** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Behrman, Robert; forthcoming; "Network Analysis of the Structure and Capacity of Brigade Level Military Organizations"; Chapter 3; PhD Thesis

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Resource by Role	Binary
Task by Role	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

Role Based Knowledge

Go To Measures by Report

Description

Computes the degree to which agents are available to do tasks based on their access to knowledge and roles that are needed to do the tasks.

NOTE : This measure works on the **Agent x Knowledge, Knowledge x Role, and Task x Role** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Behrman, Robert; forthcoming; "Network Analysis of the Structure and Capacity of Brigade Level Military Organizations"; Chapter 3; PhD Thesis

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Knowledge by Role	Binary

Output :

Level	Data Type	Type
Node	Real	Agent



Role Resource Availability

Go To Measures by Report

Description

Computes the number of roles that an agent is qualified to have based on resource requirements.

NOTE : This measure works on the **Agent x Resource and Resource x Role** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Behrman, Robert; forthcoming; "Network Analysis of the Structure and Capacity of Brigade Level Military Organizations"; Chapter 3; PhD Thesis

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

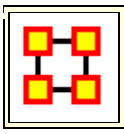
Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Resource by Role	Binary

Output :

Level	Data Type
Node	Real



Row Breadth

Go To Measures by Report

Description

The fraction of entities with row nodes with degree greater than one.

Example : In a given organization, we have the following entities: employees (agents), computers (resources), benchmarks (tasks). This measure tells us on how many links greater than one exist within these entity types.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

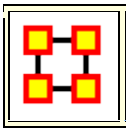
$\Re \in [0,1]$

Let d = the Row degree vector of the network N

Then, the Row Breadth of N is:

$$\frac{\sum_{i=1}^{|d|}(d_i > 1)}{|d|}$$

NOTE : Column breadth is identical, except that d is defined using the column degree, rather than the row degree.



Row Count

Go To Measures by Report

Description

The number of row nodes in a network.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be [**The number of rows in a matrix**].

Informal Name

None

Citation

Carley, Kathleen M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Number of rows in the network

Computational Time

Fast

Input and Output

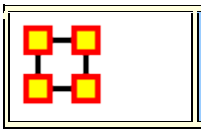
Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Integer

Result: Z ≥ 0

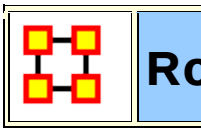


Row Degree Centrality

Go To Measures by Report

Informal Name

see **Out Degree Centrality**



Row Degree Network Centralization

Go To Measures by Report

Description

A centralization based on the degree of the row nodes of a network.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

Also called OutDegree Network Centralization

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let N be a network with n row nodes.

let

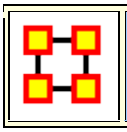
$$d_j = \text{degree of row node j},\ 1 \le j \le n$$

let

$$\bar{d} = \max\{d_j \mid 1 \le j \le n\}$$

Then

$$\text{Row Degree Network Centralization} = \left(\sum_{1 \le j \le n} \bar{d} - d_j \right) / (n)$$



Row Redundancy

Go To Measures by Report

Description

The mean number of row node links in excess of one.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be [**the average of links**].

Example

Let us say in our organizational matrix, we have Bob who multiple links to Sue. Let us say this is multiple linkages has an average of 2.5 per employee to the same manager Sue or another. The measure computes a value for this average which is considering row redundancy.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : [(N-1)*M]

Computational Time

Fast

Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type
Graph	Real

$\Re \in [0,(n-1)*m]$ for N dimension m x n

Let M be the matrix representation for a network N of dimension m x n.

let

$$d_i = \max\{0, \text{sum}(M(j,:)) - 1\}$$

for

$1 \leq i \leq m$;

this is the number of column entries in excess of one for row i.

Then

$$\text{Row Redundancy} = \left(\sum_{j=1}^{m} d_j \right) / m$$



Sequential Link Count

Go To Measures by Report

Description

The percentage of links in a network that are neither Reciprocal Links nor Pooled Links. Note that an link can be both a Pooled and a Reciprocal link.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

The percentage of edges in a network that are neither Reciprocal Edges nor Pooled Edges. Note that an edge can be both a Pooled and a Reciprocal edge. Self-loops are ignored.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let **G=(V,E)** be the graph representation of a network, and let **X = set of Pooled edges of G**, and **let Y = set of Reciprocal edges of G**.

Then **Sequential Edge Count = | E-X-Y| / |E|**

Shared Situation Awareness

Go To Measures by Report

Description

Individuals or organizations that are high in group awareness are those that by virtue of their connections to others, what resources they use, what knowledge there is, what tasks there are - have a better understanding of what others are doing.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number of [**shared assets with other nodes**].

Example

If we take any given pair of actors in an organization, this measure computes a value for how similar they are to each other based on their relationships (i.e., links) to others in the same organization.

Informal Name

None

Citation

Graham, J. M., Schneider, M., & Gonzalez, C. (2004). Report Social Network Analysis of Unit of Action Battle Laboratory Simulations: Ft Leavenworth 2003 & Ft Lee 2004 (No. DDML Technical Report CMU-SDS-DDML-04-01): Carnegie Mellon University, Social & Decision Sciences, Dynamic Decision Making Laboratory.

John Graham, 2005, "Dynamic Network Analysis of the Network-Centric Organization: Towards an Understanding of Cognition & Performance," Carnegie Mellon University, School of Computer Science, Institute for Software Research, Computation, Organizations and Society, June 20, 2005. Doctor of Philosophy.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Unscaled real number

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary

Output :

Level	Data Type	Type
Node	Real	Agent
Dyad	Real	Agent

Both Node and Dyad are not scaled: $\Re$, not scaled

Formula :

Let

$\alpha, \beta, \gamma, \delta, \mu$ be Real number (these are weights).

Let A = Agent x Agent interaction/communication network.

Let P = Agent x Agent physical proximity network.

Let S = Agent x Agent social demographic similarity network.

Let e = eigenvector centrality measure computed on A.

Let G = geodesics between agents computed on A.

Then the SSA measure between agents i and j is:

$$SSA(i,\ j) = \alpha e(i)\, e(j) + \beta P(i,\ j) + \frac{\delta S(i,\ j)}{\gamma G(i,\ j)} + \mu A(i,\ j)\, A(j,i)$$



Similarity Correlation

Go To Measures by Report

Description

Measures the degree to which each pair of rows have overlapping data.

NOTE : This measure works on **Any Matrix** and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen, M., 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

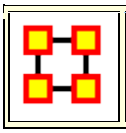
Input and Output

Input :

Data Type
Binary

Output :

Level	Data Type	Type
Node	Real	Row
Dyad	Real	Row by Row



Simmelian Ties

Go To Measures by Report

Description

The normalized number of Simmelian ties of each node.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

Described informally as ties embedded in cliques and are often associated with **brokers** inside such cliques such that if **Bob** and **Susan** only know of each other becuase of **Chan** and now all of them, Bob, Susan and Chan, now know each other. Chan, Bob, Susan now have **simmelian ties** to each other.

Informal Name

None

Citation

Krackhardt, David. 1998. "Simmelian Tie: Super Strong and Sticky." In Power and Influence in Organizations., edited by Roderick M. Kramer and Margaret Neale, pp. 21/38. Thousand Oaks, CA: Sage.

Simmel, Georg. 1950. "The Sociology of Georg Simmel." New York: Free Press, 1st free press paperback edition.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Real

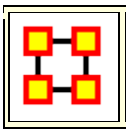
$\Re \in [0,1]$

let N be a square network with n entities. The Simmelian Tie value for entity i is computed as follows:

let NS = network N symmetrized using the Intersect (Minimum) method.

All cliques of size >= 3 are computed on NS and clique membership is recorded. Let c_i be the number of entities that are in a clique with entity i.

Then the Simmelian Ties value for emtity i is c_i.



Skip Link Count

Go To Measures by Report

Description

The fraction of links in a unimodal network that skip levels. An link (i,j) is a skip link if there is a path from node i to node j even after the link (i,j) is removed.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

The fraction of edges in a unimodal network that skip levels. An edge (i,j) is a skip edge if there is a path from entity i to entity j even after the edge (i,j) is removed.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible: 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

A skip link in a network **G=(V,E)** is an link (i,j)∈E such that j is reachable from i in the **graph G'=(V,E\(i,j))**, that is, the graph G with link (i,j) removed. Skip Count is simply the number of such links in G normalized to be in [0,1] by dividing by |E|.

Social Technical Congruence

Go To Measures by Report

Description

Social technical congruence represents the proportion of coordination requirements that were satisfied through some type of actual coordination activity carried out through some means of communication.

NOTE : This measure works on the **Agent x Agent, Agent x Task, and Task x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Cataldo, Marcelo, Wagstrom, Patrick, Herbsleb, James, & Carley, Kathleen M. (2006). Identification of Coordination Requirements: implications for the design of collaboration and awareness tools. Paper presented at the 2006 Conference on Computer Supported Cooperative Work, Banff, Alberta.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

A representation of the coordination requirements among the different workers is obtained by multiplying AT, TT and transpose of AT matrices. This product results in a people by people matrix where a cell ij indicates the extent to which person i works on tasks that share dependencies with the tasks worked on by person j. In other words, the resulting matrix represents the Coordination Requirements or the extent to which each pair of people needs to coordinate their work.

Formally, the Coordination Requirements (CR) matrix is determined by the following product:

Let, **CR = AT * TT * transpose(AT)**

Given a particular CR matrix constructed from relating product dependencies to work dependencies, we can compare it to an Actual Coordination (CA) matrix that represents the interactions workers engaged in through different means of coordination.

$$Diff\ (CR, CA) = card\ \{\ diff_{ij}\ |\ crij > 0\ \&\ caij > 0\ \}$$

$$|CR| = card\ \{\ crij > 0\ \}$$

We have,

$$Congruence(CR, CA) = Diff\ (CR, CA)\ /\ |CR|$$

Input and Output

Input :

Network	Data Type
Agent by Agent	Binary
Agent by Task	Binary
Task by Task	Binary

Output :

Level	Data Type	Type
Graph	Real	

Dyad	Real	Agent

$$\Re \in [0,1]$$

The Coordination Requirements (CR) matrix is determined by the following product:

Let, **CR = AT * TT * transpose(AT)**

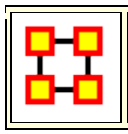
Given a particular CR matrix constructed from relating product dependencies to work dependencies, we can compare it to an Actual Coordination (CA) matrix that represents the interactions workers engaged in through different means of coordination.

Diff (CR, CA) = card { $diff_{ij}$ | crij > 0 & caij > 0 }

|CR| = card { crij > 0 }

We have,

Congruence(CR, CA) = Diff (CR, CA) / |CR|



Span of Control

Go To Measures by Report

Description

The average number of out links per node with non-zero out degrees.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be the [**average number of out links for all non isolate nodes**].

Example

Bob has 5 out degree links to 5 other personnel in his company and of those 5 personnel, the average non-zero (i.e., people that make up that personnel that have out-degree links of there own) is 4. Whereas Sue might have 5 personnel out degree links, but those personnel have 3 out-degree links themselves on average. It would figure that Sue might have a greater span of control, since the people she connects do, don't have as many connections as those that Bob connects to does. This measure would compute a value for such relationships called Span of Control.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : $\in \Re$ [0,|V|-1]

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type

Graph	Real

$$\Re \in [0, |V| - 1]$$

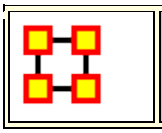
let S = set of entities in V that have positive out-degree

let

$$K = \sum_{i \in S} \text{outDegree}(i)$$

Then

$$\text{Span of Control} = K / |S|$$



Strict Knowledge Congruence

Go To Measures by Report

Description

Measures the similarity between what knowledge are assigned to tasks via agents, and what knowledge are required to do tasks. Perfect congruence occurs when agents have access to knowledge when and only when it is needful to complete tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Knowledge Congruence = 1 if agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the knowledge assigned to tasks via agents, and compare it with the knowledge needed for tasks.

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type
Graph	Real

Knowledge Congruence = 1 iff agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the

knowledge assigned to tasks via agents, and compare it with the knowledge needed for tasks.

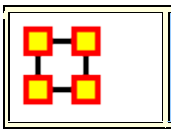
let **KAT = dich(AK'*AT)**

let

$$d = \sum_{i=1}^{|K|} \sum_{j}^{|T|} KAT(i, j) * KT(i, j)$$

let <**d = d / (|K|*|T|)**, which normalizes d to be in [0,1]

Then Knowledge Congruence = 1 - d



Strict Resource Congruence

Go To Measures by Report

Description

Measures the similarity between resources assigned to tasks via agents, and what resources are required to do tasks. Perfect congruence occurs when agents have resources when and only when it is needful to complete tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Carley, Kathleen M., 2002. Summary of Key Network Measures for Characterizing Organizational Architectures. Unpublished Document: CMU 2002.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Knowledge Congruence = 1 if agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the knowledge assigned to tasks via agents, and compare it with the knowledge needed for tasks.

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type
Graph	Real

Resource Congruence = 1 iff agents have knowledge when and only when it is needful to complete their tasks. Thus, we compute the resource assigned to tasks via agents, and compare it with the resource needed for tasks.

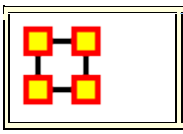
let **RAT = dich(AK'*AT)**

let

$$d = \sum_{i=1}^{|R|} \sum_{j}^{|T|} RAT(i, j) * RT(i, j)$$

let <**d = d / (|K|*|T|)**, which normalizes d to be in [0,1]

Then Resource Congruence = 1 - d



Strong Component Count

Go To Measures by Report

Description

The number of strongly connected components in a network. The network can be directed or undirected.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**].

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Given a square network G=(V,E), the Strong Component Count is the number of strongly connected components in G. This is computed directly on G, whether or not G is directed.

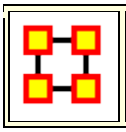
Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Integer

$$Z \in [0, |V|]$$

Given a square, symmetric network **G=(V,E)**, the Strong Component Count is the number of strongly connected components in G. This is computed directly on G, whether or not G is directed.



Task Exclusivity

Go To Measures by Report

Description

Detects agents who exclusively perform tasks. Individuals or organizations that are high in complete exclusivity for tasks are those that are engaged in or assigned to tasks or activities for which no one else is engaged in or assigned to. The scientific name of this measure is complete exclusivity and it is calculated on agent by task matrices.

NOTE : This measure works on the **Agent x Task** matrix and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

A key task that supports an entire organization is only accessible through one person.

Informal Name

None

Citation

Ashworth, M. and Carley, K. (2006). Who you know vs. what you know: The impact of social position and knowledge on team performance. Journal of Mathematical Sociology, 30(1):43{75.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Agent by Task	Binary

Output :

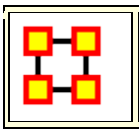
Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

The **Task Exclusivity Index (KEI)** for agent i is defined as follows:

$$\sum_{j=1}^{|K|} AT(i,j) * \exp(1 - sum(AT(:,j)))$$

The **Task Exclusivity Index** (TEI) for agent i is defined exactly as for Task Based Exclusivity.



Task Knowledge Needs Congruence

Go To Measures by Report

Description

The number of knowledge not supplied to a task, but required to do the task, expressed as a percentage of the total knowledge required for the task.

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

Let **S = AT'*AK = knowledge** supplied to tasks via assigned agents

We need to sum the knowledge required but not supplied.

Thus,

$$\text{Task Knowledge Needs for task i} = \frac{\sum_{j=1}^{|K|} KT^{t}_{i,j} * (S_{i,j} = 0)}{\sum_{j=1}^{|K|} KT^{t}_{i,j}}$$

The equation for Agent Resource Needs replaces AK with AR, and KT with RT.



Task Knowledge Waste Congruence

Go To Measures by Report

Description

The number of knowledge supplied to a task via agents that are not required by it expressed as a percentage of the total knowledge required for the task.

Task Knowledge Waste compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the over supply of knowledge to tasks.

NOTE : This measure works on the **Agent x Knowledge, Agent x Task, and Knowledge x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Knowledge	Binary
Agent by Task	Binary
Knowledge by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Task

$$\Re \in [0,1]$$

Task Knowledge Waste compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the over supply of knowledge to tasks.

Let **S = AT'*AK = knowledge** supplied to tasks via assigned agents

We need to sum the knowledge supplied but not required.

Thus,

$$\text{Task Knowledge Waste for task i} = \frac{\sum_{j=1}^{|K|} S_{i,j} * (\sim KT^{t}_{i,j})}{\sum_{j=1}^{|K|} S_{i,j}}$$

The equation for Agent Resource Waste replaces AK with AR, and KT with RT.



Task Resource Needs Congruence

Go To Measures by Report

Description

The number of resources not supplied to a task, but required to do the task, expressed as a percentage of the total resources required for the task.

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Agent

$$\Re \in [0,1]$$

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

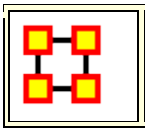
Let **S = AT'*AR = resource** supplied to tasks via assigned agents

We need to sum the resources required but not supplied.

Thus,

$$\text{Task Resource Needs for task i} = \frac{\sum_{j=1}^{|R|} RT^{t}_{i,j} * (S_{i,j} = 0)}{\sum_{j=1}^{|R|} RT^{t}_{i,j}}$$

The equation for Agent Resource Needs replaces AR with AK, and RT with KT.



Task Resource Waste Congruence

Go To Measures by Report

Description

The number of resources supplied to a task via agents that are not required by it expressed as a percentage of the total resources required for the task.

Task Knowledge Waste compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the over supply of knowledge to tasks.

NOTE : This measure works on the **Agent x Resource, Agent x Task, and Resource x Task** matrices and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Informal Name

None

Citation

Lee, Ju-Sung, & Carley, Kathleen M. (2004). OrgAhead: A Computational Model of Organizational Learning and Decision Making. Pittsburgh, PA: Carnegie Mellon University, School of Computer Science, Institute for Software Research International, Technical Report, CMU-ISRI-04-117.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Agent by Resource	Binary
Agent by Task	Binary
Resource by Task	Binary

Output :

Level	Data Type	Type
Node	Real	Task

$$\Re \in [0,1]$$

Task Knowledge Needs compares the knowledge requirements of each task with the knowledge available to the task via agents assigned to it. It is similar to Knowledge Congruence, but quantifies only the under supply of knowledge to tasks.

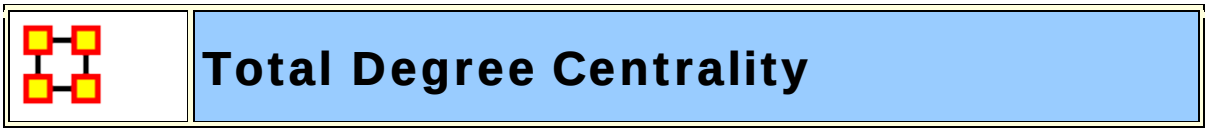
Let **S = AT'*AK = knowledge** supplied to tasks via assigned agents

We need to sum the knowledge required but not supplied.

Thus,

$$\text{Task Resource Waste for task i} = \frac{\sum_{j=1}^{|R|} S_{i,j} * (\sim RT^{t}_{i,j})}{\sum_{j=1}^{|R|} S_{i,j}}$$

The equation for Agent Resource Needs replaces AK with AR, and KT with RT.



Total Degree Centrality

Go To Measures by Report

Description

The Total Degree Centrality of a node is the normalized sum of its row and column degrees. Individuals or organizations who are "in the know" are those who are linked to many others and so, by virtue of their position have access to the ideas, thoughts, beliefs of many others. Individuals who are **In the know** are identified by degree centrality in the relevant social network. Those who are ranked high on this metrics have more connections to others in the same network. The scientific name of this measure is total degree centrality and it is calculated on the agent by agent matrices.

Individuals or organizations who are **In the know** are those who are linked to many others and so, by virtue of their position have access to the ideas, thoughts, beliefs of many others. Individuals who are "in the know" are identified by degree centrality in the relevant social network.

Square Matrices [binary] - between 0,1

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be **any number**.

The result will be a number between [**0 and 1**], inclusive.

Informal Name

In The Know

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Node	Real

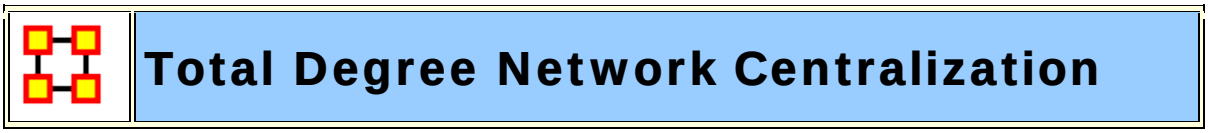
$$\Re \in [0,1]$$

Consider the matrix representation X of a square network with n entities. Each entity is assigned a value based on the sum of its row and columns.

The Total Degree Centrality for

$$\text{entity } i = \frac{1}{2(n-1)} \sum_{i=1}^{n} \sum_{\substack{j=1 \\ i \neq j}}^{n} X(i, j)$$

NOTE : The diagonal values are ignored.



Total Degree Network Centralization

Go To Measures by Report

Description

A centralization of a square network based on the Total-Degree Centrality of each node.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and can be **any number**.

The result will be a number between [**0 and 1**], inclusive.

Example :

An organization has a sales team, computers, sales data and a marketing team. How central all of these entities are within the organization is its total degree network centralization value.

Informal Name

None

Citation

Freeman, L.C. (1979). Centrality in Social Networks I: Conceptual Clarification. Social Networks, 1, 215-239.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Fast

Input and Output

Input :

Network	Data Type
Square	Real

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Let N be a unimodal network with n entities.

let

$$d_i = \text{Total Degree Centrality of entity } i$$

let

$$\overline{d} = \max\{d_i \mid 1 \le i \le n\}$$

Then

$$\text{Total Degree Network Centralization} = \left(\sum_{1 \le i \le n} \bar{d} - d_i \right) / (n - 2)$$

Triad Count

Go To Measures by Report

Description

The number of triads centered at each node in a square network. A triad is a relationship amongst three nodes such that they constitute a distinct and important relationship which is deemed relevant to network architecture.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and the number of triads**].

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Integer (N-1) (N-2)

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Node	Integer

$Z \in [0,(n-1)(n-2)]$ for N dimension n.

Let G=(V,E) represent a square network with n entities.

And let Triad be a matrix of dimension n x n.

$$\text{Triad}(i,i) = 0$$

$$\text{Triad}(i,j) = \text{card}\{\ k\ \mid k\ !=\ i,\ k\ !=\ j;\ AA(i,j) \wedge AA(i,k) \wedge AA(k,j)\ \},\ i \neq j$$

Then

$$\text{the Triad count for agent } i = \text{sum}(\text{Triad}(i,:))$$

Transitivity

Go To Measures by Report

Description

The percentage of link pairs {(i,j), (j,k)} in the network such that (i,k) is also an link in the network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

The percentage of pairs in the employee communication network where employee **A** is linked to **B** and **B** is linked to **C** and **C** is also linked to **A**

Informal Name

None

Citation

NetStat

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type

Graph	Real

$\Re \in [0,1]$

Let G = (V,E) be the graph representation of the square network.

let

$$I = \{(i,j,k) \in V^3 \mid i,j,k \text{ distinct } \}$$

let

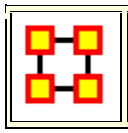
$$\text{Potential} = \{ (i,j,k) \in I \mid (i,j) \in E, \text{ and } (j,k) \in E \}$$

let

$$\text{Complete} = \{ (i,j,k) \in \text{Potential} \mid (i,k) \in E \}$$

Then

$$\text{Transitivity} = |\text{Complete}| \,/\, |\text{Potential}|$$



Upper Boundedness

Go To Measures by Report

Description

The degree to which pairs of agents have a common ancestor.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and 1**], inclusive.

Example

In a given organization, if Bob and Ahmed were both hired by Pedro this measure would compute a value correlating to this shared ancestry or linkage that both have to Pedro.

Informal Name

None

Citation

Krackhardt, D. 1994. Graph Theoretical Dimensions of Informal Organizations. In Computational Organization Theory, edited by Carley, Kathleen M. and M.J. Prietula. Hillsdale, NJ: Lawrence Erlbaum Associates, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Slow

Input and Output

Input :

Network	Data Type
Square	Binary

Output :

Level	Data Type
Graph	Real

$$\Re \in [0,1]$$

Weak Boundary Spanner

Go To Measures by Report

Description

A node which if removed from a network creates a new component.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be in the binary format [**0 or 1**].

Informal Name

None

Citation

Corman, Thomas H., Leiserson, Charles E., Rivest, Ronald L., & Stein, Clifford. (2001). Introduction to Algorithms (2 ed.). Cambridge, MA: The MIT Press.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : 1

Computational Time

Medium

Input and Output

Input :

Network	Data Type	Directed
Square	Binary	No

Output :

Level	Data Type
Node Level	Binary

Input :

Square matrix : DataType=binary and Directed=No.

Output :

Node Level : DataType=binary.



Weak Component Count

Go To Measures by Report

Description

The number of weakly connected components in an undirected (symmetric) network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and the number weakly connected nodes**].

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Integer Value

Computational Time

Medium

Input and Output

Input :

Network	Data Type	Directed
Square	Binary	No

Output :

Level	Data Type
Graph	Integer

$$Z \in [0, |V|]$$

Given a square, symmetric network **G=(V,E)**, the Weak Component Count is the number of connected components in G. Such components are called **weak** because the graph G is undirected.



Go To Measures by Report

Description

Computes the component to which each node belongs in the underlying, undirected network.

NOTE : This measure works on **Square Matrices** [i.e. Agent x Agent, Location x Location, etc] and needs to be in the binary format [**0 or 1**].

The result will be a number between [**0 and the number of weak components**].

Example

Given a square, **symmetric network G=(V,E)**, the Weak Component Member for a entity is the weak component to which the entity belongs. The components are numbered from 1 to the number of weak components (Weak Component Count).

Informal Name

None

Citation

Wasserman, Stanley and Katherine Faust. "Social Network Analysis: Methods and Applications." Cambridge: Cambridge University Press, 1994.

Minimum and Maximum Values

Minimum Possible : 0

Maximum Possible : Any Integer Value

Computational Time

Medium

Input and Output

Input :

Network	Data Type

Square	Binary

Output :

Level	Data Type
Node	Integer

$$Z \in [0, |V|]$$

Given a square, **symmetric network G=(V,E)**, the Weak Component Member for a entity is the weak component to which the entity belongs. The components are numbered from 1 to the number of weak components (Weak Component Count).

Reports and Measures Tables

Go to Reports by Measure Table

Measures by Report

To use this table look up the **Report** in the left hand column and the **Measures** used in that report are listed in the right hand column. Some of the Reports list no measures as they are calculated using other means.

Report	Measures
All Measures **Computes a collection of measures and generates output in categories. Each category analyzes a particular aspect of the meta-network structure.**	Does not used predefined measures. This report allows you to choose which measures to run.
Assessing Change In Plan **Analyzes the similarity between a given network and a collection of other networks.**	Communication Congruence
Belief Propagation **Estimates belief propagation through social networks**	Betweenness Centrality, Closeness Centrality, Total Degree Centrality
Capabilities **Analyzes the knowledge, resource, and task capabilities of agents and organizations in the network.**	Communication Congruence, Organization Agent Knowledge Needs Congruence, Organization Agent Knowledge Waste Congruence, Organization Agent Resource Needs Congruence, Organization Agent Resource Waste Congruence, Organization Task Knowledge Needs Congruence, Organization Task Knowledge Waste Congruence, Organization Task Resource Needs Congruence, Organization Task Resource Waste Congruence, Socio Technical Congruence, Strict

	Knowledge Congruence, Strict Resource Congruence
Change in Key Entities **Analyzes the changes over time of the agents that score highest in measure values**	**Agent Level :** Actual Workload, Betweenness Centrality, Clique Count, Cognitive Demand, Eigenvector Centrality, Eigenvector Centrality Per Component, Exclusivity, Exclusivity Complete, Potential Boundry Spanner, Row Degree Centrality, Total Degree Centrality
Communication Network Assessment **This report assesses a Communications network. As information on speed of information transmittal becomes available it will be updated. This report takes a resource by resource network (preferably one where the nodes are Communications devices and the links are the speed or reliability of the link).**	**Failure :** Boundry Spanner, Potential Boundry Spanner, Exclusivity **Reliability Injected :** Eigenvector Centrality, Total Degree Centrality **Reliability Relaying :** Betweenness Centrality
Communicative Power **Analyzes one or more semantic networks to classify concepts by measure values.**	Betweenness Centrality, Density, Link Count, Node Count, Total Degree Centrality
Communicators **Analyzes the Communication network (agent by agent) and gives high level statistics on its structure.**	**Node Level :** Betweenness Centrality, In Degree Centrality, Out-Degree Centrality **Graph Level :** Clique Count, Clustering Coefficient, Density, Node Count
Context **Compares measured values against various stylized forms of networks in an effort to characterize network topology.**	Average Distance, Betweenness Centrality, Burt Constraint, Closeness Centrality, Clustering Coefficient, Cognitive Demand, Connectedness, Efficiency, Fragmentation, Hierarchy, Information Centrality, Inverse

	Closeness Centrality, Total Degree Centrality, Upper Boundedness
Core Network **Computes the core network and reports general statistics.**	Betweenness Centrality, Density, Node Count, Total Degree Centrality
CPOF **Analyzes the creation and modification of events and tasks and agent collaboration over time.**	Complexity, Density, In-Degree Centrality
Critical Sets **Finds critical sets of nodes in a network that best reach all other nodes, or whose removal maximally disrupts a network.**	Fragmentation
Custom **Computes a custom report with user selected measures and output tables, pictures, and figures.**	Whatever measures are selected by the user.
Detect Spatial Patterns **Find out whether a node attribute is clustered spatially, such that nodes are similar to nearby others.**	
Drill Down **Computes the drill down from a selected organization and then to a selected agent.**	
GeoSpatial Assessment **Finds nodes that are co-located based, and counts the number of nodes that appear at location pairs.**	Degree Centrality, Location Relevance, Spatial Betweenness Centrality, Spatial Closeness Centrality, Spatial Degree Centrality
Group Talk **Analyzes the relationship between agents and knowledge.**	Row Degree Centrality
Hot Topics (Content Analysis) **Analyzes semantic network**	

output from AutoMap.	
Immediate Impact **Computes the key actors of the network, and then isolates them individually to determine the effect on measure values.**	**Node Level :** Betweenness Centrality, Cognitive Demand, Total Degree Centrality **Impact :** Average Distance, Average Speed, Clustering Coefficient, Communicaton Congruence, Complexity, Density, Diffusion, Fragmentation, Isolate Count, Knowledge Congruence, Overall Fragmentation, Overall Node Count, Performance as Accuracy
Influence Net **Displays the influence network and gives high level statistics on its structure.**	Betweenness Centrality, In Degree Centrality
K-Centrality **Calculates the geodesic centrality measures for various rdius values k, which approximates the geodesic computation by only considering neighbors within the radius distance.**	
Key Entity **Identifies key entities and groups who by virtue of their position in the network are critical to its operation.**	**Agent Level :** Actual Workload, Authority Centrality, Betweenness Centrality, Clique Count, Cognitivie Demand, Edge Betweenness Centrality, Eigenvector Centrality, Eigenvector Centrality Per Component, Exclusivity, Exclusivity Complete, Hub Centrality, Potential Boundry Spanner, Row Degree Centrality, Shared Situation Awareness, Total Degree Centrality **Organizational Level :** Authority Centrality, Betweenness Centrality, Column Degree

	Centrality, Eigenvector Centrality, Exclusivity, Exclusivity Complete, Hub Centrality, Potential Boundry Spanner, Row Degree Centrality, Total Degree Centrality **Knowledge Level :** Betweenness Centrality, In-Degree Centrality, Row Degree Centrality, Total Degree Centrality **Resource Level :** Row Degree Centrality, Total Degree Centrality **Location Level :** Authority Centrality, Column Degree Centrality, Exclusivity Complete, Hub Centrality, Location Relevance, Row Degree Centrality, Spatial Eigenvector Centrality, Total Degree Centrality **Event Level :** Authority Centrality, Column Degree Centrality, Exclusivity Complete, Hub Centrality, Row Degree Centrality, Total degree Centrality **Task Level :** Authority Centrality, Column Degree Centrality, Exclusivity Complete, Hub Centrality, Row Degree Centrality, Total degree Centrality **Performance Level :** Average Speed, Communication Congruence, Complexity, Density, Fragmentation, Knowledge Congruence, Performance as Accuracy
Large Scale **Computes all network analysis measures.**	
Local Patterns **Find link patterns in a network, such as Star, Checkerboard, and Clique.**	Special, Clique Count
Locate Subgroup	Betweenness Centrality, Clique

Identifies the subgroups present in the network using various grouping algorithms.	Count, Clustering Coefficient, Density, Total Degree Centrality
Management **Identifies over- and under-performing individuals and assesses the state of the network as a functioning organization.**	**Agent Level :** Actual Workload, Authority Centrality, Cognitive Demand, Exclusivity, Exclusivity Complete, Hub Centrality, Shared Situation Awareness **Knowledge Level :** In-Degree Centrality **Resource Level :** In-Degree Centrality **Location Level :** In-Degree Centrality **Performance Level :** Column Breadth, Complexity, Knowledge Congruence, Resource Congruence, Shared Situation Awareness **Potential Problems :** Actual Workload, Cognitive Demand, In-Degree Centrality, Shared Situation Awareness, Simmelian Ties
MedHealth **Analyzes health department data to find potential problems.**	**Interaction :** Density, Clustering Coefficient, Clique Count, Diffusion, Eigenvector Centrality, Hierarchy, In-Degree Centrality, Node Count, Out Degree Centrality, Simmelian Ties, Total Degree Centralization, Triad Count **Node Level :** Boundry Spanner, Total Degree Centrality
Merchant Marine Vessel **Analyzes the relationships between crew members, owners, vessels and locations of the Merchant Marine Vessel data.**	Betweenness Centrality, Column Degree Centrality, Eigenvector Centrality, Row Degree Centrality, Total Degree Centrality
Missing Links **Compute possible missing links in a network.**	**Node Level :** Betweenness Centrality, Total Degree Centrality **Impact :** Average Distance,

	Average Speed, Clustering Coefficient, Communication Congruence, Density, Diffusion, Fragmentation, Isolate Count, Overall Complexity, Overall Fragmentation, Performance as Accuracy
Network Distribution **Analyzes a collection o Meta-Networks and calculates their common nodes and links**	
Optimizer **Adapt the link structure of a meta-network to maximize or minimize selected measure values.**	User selects the Measures to run
Part Of Speech **Describe the distribution of concepts by part of speech in one or more networks.**	Betweenness Centrality, Total Degree Centrality
Potential Errors **Detects potential errors in agent to agent interactions based on the expected interactions from Cognitive Similarity and expertise.**	Cognitive Expertise, Cognitive Similarity
Public Health **Anayzes health department data to find potential problems.**	Access Redundacy, Assignment Redundacy, Average Distance, Clustering Coefficient, Density, Total Degree Centralization
QAP/MRQAP Analysis **Computes QAP and MRQAP Correlation and Regression (Dekker and Y-Permutation methods) on input networks.**	
Role View **For each individual, finds some important measures and facts about the actor in relation to their network**	Betweenness Centrality, Closeness Centrality, Complete Exclusivity, Eigenvector Centrality, Exclusivity, In-Degree Centrality, Out-Degree Centrality, Row Redundancy

Rules of Engagement **This report analyzes the trails that are found in the Trails Viewer.**	Special
Semantic Network **Analyzes one or more semantic networks, computing the central networks and key concepts and links.**	Betweenness Centrality, Clustering Coefficient, Density, Diameter, Link Count, Node Count
Shortest Path **Computes the shortest path between two entities and general statistics on the paths. The sphere of influence of each entity is also computed.**	In Degree Centrality, Out Degree Centrality, Total degree Centrality
Simmelian Ties **Calculates the number of Asymmetric, Sole-Symmetric, and Simmelian Ties in unimodal networks computes standard measures on them.**	**Node Level :** Betweenness Centrality, Potential Boundry Spanner, Total Degree Centrality **Graph Level :** Density, Connectedness, Efficiency, Hierarchy, Link Count, Upper Boundedness
Sphere of Influence **For each individual, identifies the set of actors, groups, knowledge, resources, etc. that influence and are influenced by that actor.**	Actual Workload, Betweenness Centrality, Clique Count, Cognitive Demand, Eigenvector Centrality, Exclusivity, Exclusivity Complete, Potential Boundry Spanner, Shared Situation Awareness, Total Degree Centrality
Standard Network Analysis **Calculates the standard network analysis measures (Degree Centrality, Betweenness Centrality, etc).**	**Node Level :** Authority Centrality, Betweenness Centrality, Closeness Centrality, Eigenvector Centrality, Clique Count, Clustering Coefficient, Hub Centrality, In Closeness Centrality, Information Centrality, In-Degree Centrality, Out Degree Centrality, Simmelian Ties, Total Degree Centrality **Graph Level :** Average Distance, Betweenness Centrality, Clique Count, Closeness Centrality,

	Clustering Coefficient, Column Count, Communicative Need, Connectedness, Density, Efficiency, Eigenvector Centrality, Fragmentation, Hierarchy, Isolate Count, Link Count, Network Levels, Row Count, Total Degree Centralition, Upper Boundedness, Weak Component Count **Table :** Betweenness Centrality, Closeness Centrality, Eigenvector Centrality, In-Degree Centrality, Out Degree Centrality, Total Degree Centrality
Statistical Change Detection **Analyzes the changes in network-level measures over time using a Statistical Process Monitoring (SPM) control chart. Control limits are determined based on a user defined level of risk.**	Betweenness Centrality, Closeness Centrality, Density
Statistical Distribution	User selects the measure to run for the analysis
Tactical Insight **Fits statistical distributions to a network based on measure values. Analyzes the top agent nodes across time periods, tracking locations and measure values.**	Betweenness Centrality, Total Degree Centrality
Topic Analysis **Finds topic clusters in a collection of text meta-networks using the LDA and LSA algorithms.**	
Trails **Analyzes the trails that an entity class makes through another entity class, for example, how**	

vessels pass through ports.	
Trails Analysis **This report analyzes the trails that are found in the Trails Viewer.**	**Agent Level :** Betweenness Centrality, Clique Count, Eigenvector Centrality, Exclusivity, Potential Boundry Spanner, Row Degree Centrality, Total Degree Centrality

Go to Measures by Report Table

Reports by Measure

To use this table look up the **Measure** in the left hand column and the **Reports** it is used in are in the right hand column. Some of the measures list All Measures meaning they are not standard in any report but can be be **optionally** selected.

Measure	Used by Report
Access Redundancy	All Measures
Actual Workload	All Measures, Changes in Key Entities, Key Entity, Management, Sphere of Influence
Agent Knowledge Needs Congruence	All Measures
Agent Knowledge Waste Congruence	All Measures
Agent Resource Needs Congruence	All Measures
Agent Resource Waste Congruence	All Measures
Agent Socio Economic Power	All Measures
Assignment Redundancy	All Measure
Authority Centrality	All Measures, Key Entity, Management, Standard Network Analysis
Average Speed	All Measures, Immediate Impact, Key Entity, Missing Links

Betweenness Centrality	All Measures, Changes in Key Entities, Communication Net Health, Communications Network Assessment, Communicative Power, Communicators, Core Networks, Immediate Impact, Influence Net, K-Centrality, Key Entity, Missing Links, Part of Speech, Role View, Semantic Network, Simmelian Ties, Sphere of Influence, Standard Network Analysis, Statistical Change Detection, Tactical Insight, Trails Analysis
Bonacich Power Centrality	All Measures
Boundary Spanner	All Measures
Burt Constraint	All Measures
Capability	All Measures
Characteristic Path Length	All Measures, Immediate Impact, Missing Links, Standard Network Analysis
Classic SNA Density	All Measures
Clique Count	All Measures, Changes in Key Entities, Communication Net Health, Communicators, Key entities, Sphere of Influence, Standard Network Analysis, Trails Analysis
Closeness Centrality	All Measures, K-Centrality, Role View, Standard Network Analysis, Standard Network Analysis, Statistical Change Detection
Closeness Network Centralization	All Measures, K-Centrlaity, Standard Network Analysis
Clustering Coefficient	AllMeasures, Communicators, Immediate Impact, Missing Links, Semantic Network, Standard Network Analysis
Cognitive Demand	All Measures, Changes in Key Entities, Immediate Impact, Key Entity, Management, Role View, Sphere of Influence
Cognitive Distinctiveness	All Measures
Cognitive Expertise	All Measures, Potential Errors

Cognitive Resemblance	All Measures
Cognitive Similarity	All Measures, Potential Errors
Column Breadth	All Measures, Management
Columns Count	All Measures, Standard Network Analysis
Column Degree Centrality	All Measures, Key Entity
Column Degree Network Centralization	All Measures
Column Redundancy	All Measures
Communication	All Measures
Communication Congruence	All Measures, Immediate Impact, Key Entity, Missing Links
Communicative Need	All Measures, Standard Network Analysis
Complexity	All Measures, Immediate Impact, Key Entity, Management
Connectedness	All Measures, Simmelian Ties Analysis, Standard Network Analysis
Correlation Distinctiveness	All Measures
Correlation Expertise	All Measures
Correlation Resemblance	All Measures
Correlation Similarity	All Measures
Density	All Measures, Communicative Net Health, Communicative Power, Communicators, Core Networks, Immediate Impact, Key Entity, Missing Links, Semantic Network, Simmelian Ties, Standard Network Analysis, Statistical Change Detection
Diameter	All Measures, Key Entity, Semantic Network
Diffusion	All Measures, Immediate Impact, Missing

	Links
Edge Betweenness Centrality	All Measures, Key Entity
Effective Network Size	All Measures
Efficiency	All Measures, Simmelian Ties Analysis, Standard Network Analysis
Eigenvector Centrality	All Measures, Changes in Key Entities, Communications Net Health, Communications Network Assessment, Key Entity, Sphere of Influence, Standard Network Analysis, Trails Analysis
Eigenvector Centrality Per Component	All Measures, Changes in Key Entities, Key Entity, Standard Network Analysis
Exclusivity	All Measures, Changes in Key Entities, Communications Network Assessment, Key Entity, Management, Role View, Sphere of Influence, Trails Analysis
Exclusivity Complete	All Measures, Changes in Key Entities, Key Entity, Management, Role View, Sphere of Influencev
Fragmentation	All Measures, Immediate Impact, Key Entity, Missing Links, Standard Network Analysis
Geodesic Distance	All Measures
Global Efficiency	All Measures
Hierarchy	All Measures, Simmelian Ties, Standard Network Analysis
Hub Centrality	All Measures, Key Entity, Management, Standard Network Analysis
In Degree Centrality	All Measures, Communication Net Health, Communicators, Influence Net, Key Entity, Management, Role View, Standard Network Analysis
In Degree Network Centralization	All Measures

Information Centrality	All Measures, Standard Network Analysis
Interdependence	All Measures
Interlockers	All Measures
Inverse Closeness Centrality	All Measures
Isolate Count	All Measures, Immediate Impact, Missing Links, Standard Network Analysis
Knowledge Acess Index	All Measures
Knowledge Actual Workload	All Measures
Knowledge Congruence	All Measures, Immediate Impact, Key Entity, Management
Knowledge Diversity	All Measures
Knowledge Exclusivity	All Measures
Knowledge Load	All Measures
Knowledge Negotiation	All Measures
Knowledge Omega	All Measures
Knowledge Potential Workload	All Measures
Knowledge Redundancy	All Measures
Knowledge Task Completion	All Measures
Knowledge Under Supply	All Measures
Lateral Link Count	All Measures
Link Count	All Measures, Communicative Power, Semantic Network, Simmelian Ties, Standard Network Analysis
Local Efficiency	All Measures

Location Relevance	GeoSpatial Assessment, Key Entity
Minimum Speed	All Measures
Network Levels	All Measures, Standard Network Analysis
Node Count	All Measures, Communcation Net Health, Communicative Power, Communicators, Core Networks, Semantic Network
Organization Agent Knowledge Needs Congruence	All Measures
Organization Agent Knowledge Waste Congruence	All Measures
Organization Agent Resource Needs Congruence	All Measures
Organization Agent Resource Waste Congruence	All Measures
Organization Task Knowledge Needs Congruence	All Measures
Organization Task Knowledge Waste Congruence	All Measures
Organization Task Resource Needs Congruence	All Measures
Organization Task Resource Waste Congruence	All Measures
Out Degree Centrality	All Measures, communcation Net Health, Communicators, Role View, Standard Network Analysis
Out Degree Network Centralization	All Measures
Overall Task	All Measures

Completion	
Performance as Accuracy	All Measures, Immediate Impact, Key Entity, Missing Links
Personnel Cost	All Measures
Pooled Link Count	All Measures
Potential Boundary Spanner	All Measures, Changes in Key Entities, Communication Net Health, Communications Network Assessment, Key Entity, Simmelian Ties, Sphere of Influence, Trails Analysis
Potential Workload	All Measures
Radials	All Measures
Reciprocity	All Measures, Standard Network Analysis
Relative Cognitive Distinctiveness	All Measures
Relative Cognitive Expertise	All Measures
Relative Cognitive Resemblance	All Measures
Relative Cognitive Similarity	All Measures
Relative Expertise	All Measures
Relative Similarity	All Measures
Resource Access Index	All Measures
Resource Actual Workload	All Measures
Resource Congruence	All Measures, Management
Resource Diversity	All Measures
Resource Exclusivity	All Measures
Resource Load	All Measures
Resource Negotiation	All Measures

Resource Omega	All Measures
Resource Potential Workload	All Measures
Resource Redundancy	All Measures
Resource Task Completion	All Measures
Resource Under Supply	All Measures
Row Breadth	All Measures
Row Count	Standard Network Analysis
Row Degree Centrality	All Measures, Changes in Key Entities, Group Talk, Key Entity, Trails Analysis
Row Degree Network Centraliztion	All Measures
Row Redundancy	**All Measures, Role View**
Sequential Link Count	All Measures
Shared Situation Awareness	All Measures, Key Entity, Management, Sphere of Influence
Simmelian Ties	Management, MedHealth, Standard Network Analysis
Skip Link Count	All Measures
Social Technical Congruence	Capabilities
Span of Control	All Measures
Spatial Betweenness Centrality	GeoSpatial Assessment
Spatial Closeness Centrality	GeoSpatial Assessment
Spatial Degree Centrality	GeoSpatial Assessment
Spatial Eigenvector Centrality	Key Entity

Strict Knowledge Congruence	Capabilities
Strict Resource Congruence	Capabilities
Strong Component Count	All Measures
Task Exclusivity	All Measures
Task Knowledge Needs Congruence	All Measures
Task Knowledge Waste Congruence	All Measures
Task Resource Needs Congruence	All Measures
Task Resource Waste Congruence	All Measures
Total Degree Centrality	All Measures, Changes in Key Entities, Communication Net Health, Communications Network Assessment, Communicative Power, Core Networks, Immediate Impact, Key Entity, Missing Links, Part of Speech, Simmelian Ties, Sphere of Influence, Standard Network Analysis, Tactical Insight, Trails Analysis
Total Degree Network Centralization	All Measures, Standard Network Analysis
Transitivity	All Measures
Triad Count	All Measures, Communication Net Health
Upper Boundedness	All Measures, Simmelian Ties Analysis, Standard Network Analysis
Weak Boundary Spanner	All Measures
Weak Component Count	All Measures, Communicators, Standard Network Analysis
Weak Component Members	All Measures

Report General Content

This section contains content relevant to the reports but not specific to any one report. New information will be added as it received.

Statistical Comparison

Some reports support Statistical Comparison. For example, in the Key Entity report and the Standard Network Analytic reports bootstrapping techniques are used to assess statistical differences between statistics drawn from different networks. Two techniques are used:

1. **Random Reassignment :** "Shuffle" the links in a network around - and thereby keep same size and density.
2. **Bootstrapping :** Remove a small percentage of nodes and their attached links.

To compare the metrics a t-statistic[1] is then calculated. Note that when the number of samples is large (> 100) the distribution for the t-statistic becomes the normal distribution.

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[1] **t-statistic** is a ratio of the departure of an estimated parameter from its notional value and its standard error.

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Context In Reports

Context attempts to address the question, "**There's the measure values, but are they what I should expect? Are they low or high? I'm not sure what I should be seeing.**".

The **Context** the user needs from their measure values is comparing their measure values with the measure values that would result from a random network of the same size and density. This is somewhat helpful in addressing the questions, but by no means complete. It essentially answers how different the user's network is from a random network, and this may, or may not, be that useful to some users.

Most reports that use tables, which is nearly all of them, would show Context.

If you run a report on a single meta-network, then the some of the tables you see would show the Context. Not all measures have it, only some of them.

Example

In-the-Know (total degree centrality)

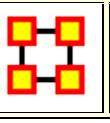
The Total Degree Centrality of a node is the normalized sum of its row and column degrees. Individuals or organizations who are "in the know" are those who are linked to many others and so, by virtue of their position have access to the ideas, thoughts, beliefs of many others. Individuals who are "in the know" are identified by degree centrality in the relevant social network. Those who are ranked high on this metrics have more connections to others in the same network. The scientific name of this measure is total degree centrality and it is calculated on the agent by agent matrices.

Input network: characters x characters (size: 6, density: 0.466667)

Rank	Characters	Value	Unscaled	Context*
1	indiana_jones	1.00	5.00	2.62
2	barranca	0.40	2.00	-0.33
3	belloq	0.40	2.00	-0.33
4	natives	0.40	2.00	-0.33
5	satipo	0.40	2.00	-0.33
6	jake	0.20	1.00	-1.31

* Number of standard deviations from the mean of a random network of the same size and density

Mean:	0.47	Mean in random network:	0.47
Std.dev:	0.25	Std.dev in random network:	0.20



Why Use A Report

NOTE : Red shaded reports are available only in the full version.

Assessing Change in Plan	Use this report to compare the Meta-Network of a plan [i.e. the anchor Meta-Network] with Meta-Network that occur during the execution of the plan.
Belief Propagation	This report runs a simulation of the belief (or attitude) propagation based on the Friedkin model from the social influence theory.
Capabilities	This is used to assess an individuals' or organizations' capability to perform tasks.
Change in Key Entities	This report provides information on the overall structure of a complex network and identifies, for each type of node, which nodes stand out.
Communications Network Assessment	This report evaluates the effectiveness of a computer network, with the computer nodes being represented as resources. The computer network represents the physical layer of connections between machines. Effectiveness takes into account the placement of nodes in the network
Communicative Power	---
Communicators	When characterizing network topologies, it is important to consider the role of errors and incomplete data in the network. This report will provide additional analysis on network topologies and actors, respectively.
Context	This report uses the **Context function** as a comparison of the user's input network with that

	of a random network of the same number of nodes and density. This is an attempt to address a frequent user question, "**Well, okay, I see the measure values, but are they what I should expect? Are they low or high? I don't know what I should be seeing**".
Core Network	Good for extracting the big giant connected component in real life networks that have multiple disconnected small subcomponents and a big, giant connected component.
CPOF	Use this to analyze the creation and modification of events and tasks and agent collaboration over time.
Critical Sets	This report has two functions. Find a set which 1) would fracture the Meta-Network the most or 2) which reaches the maximum number of nodes.
Custom	The custom report allows a user to be able to design a report to meet a specific need by identifying the metrics that should be calculated on an input network. The custom report would be used when a specific set of metrics or measures are needed routinely as opposed to simply producing the metrics directly each time.
Detect Spatial Patterns	---
Drill Down	---
Geospatial Assessmenet	---
Group Talk	---
Hot Topics	This report will identify the most frequently mentioned concepts in a text set. The networks are typically formed from AutoMap with a frequency attribute on each concept node. It can operate on any network (meta-network, semantic network, or concept network) as it makes use of only the nodes of the network.
Immediate Impact	This report to allow you to perform one of two types of evaluation against the base network.

	The two types of analysis are : Impact analysis and Replication analysis. Impact analysis : One or more of the nodes identified in the Key Entities report are deleted as part of an assessment of the degradation in the network if those nodes were no longer in the network. This is a more precise version of impact analysis for node removal than random node removal. The report then shows the differences in values between the original and modified networks' at both the node and network measure levels. Replication analysis : Set a random number of nodes to delete, then the report will show the differences in values between the original and modified network's. Unlike impact analysis, the nodes are selected at random. The user also selects the number of iterations to execute, allowing a research to assess the vulnerability of a network to random node deletions. This is the more general impact analysis than the impact analysis discussed above.
Influence Net	---
Key Entity	This is a go-to report to identify the important (or "key") who, what, where, when, and why. The input would be a social network in meta-network form using all of the ORA ontological categories (agents, organizations, etc.). If only a subset of the categories are represented, the key entity report will show a subset of the who, what, where, when, and why.
K-Centrality	---
Large Scale	---
Local Patterns	---
Locate Subgroups	---
Management	Use this report to locate strongest and weakness parts of a Meta-Network and also the most well connected nodes.
MedHealth	---

Merchant Marine	---
Missing Links	---
Network Distribution	---
Optimizer	---
Parts of Speech	This report will identify the part of speech from the concepts in a text set. The networks are typically formed from AutoMap with a part of speech (pos) attribute on each concept node. It can operate on any network (meta-network, semantic network, or concept network) as it makes use of only the nodes of the network.
Potential Errors	---
Public Health	---
QAP / MRQAP	Compares multiple networks to understand how two different networks relate using one network as dependent and the other as an independent network. Also useful for predicting the future of a network if there are multiple snapshots of the same network.
Role View	---
Rules of Engagement	This report is used to aid individuals in understanding rules of engagement. A rule of engagement (ROE) is a document describing how to behave in an engagement situation. This ROE report can operate on a law document as well as an ROE.
Semantic Network	The report outputs the nodes and edges in the intersection, offset, and union. Performing map comparison can help to answer questions such as: Do different people use the same words and themes in the same way? Do different people link concepts and themes in the same way? Do different people share the same knowledge? How similar or different are the analyzed texts?
Shortest Path	---

Simmelian Ties Analysis	---
Sphere of Influence	The Sphere of Influence report will provide information relative to one particular node in the network. This report is used when the impact of an individual (person, organization, location, etc.) and what the individual is directly connected to.
Statistical Network Analysis	This report calculates the standard network analysis subset of all the measures possible for a network. This report is often used for convenience of calculating the measures that may be reported separately from the report, such as when writing a journal paper. Unlike many of the other reports that put the measure into the context of the need, this report produces measures suitable only for people who understand social network analysis.
Statistical Change Detection	---
Statistical Distribution	---
Tactical Insight	---
Topic Analysis	---
Trails	---
Trails Analysis	Good for tracking and visualizing individual actors' geographic movements across a discrete space set over discrete time steps. Good for identifying trends like 1) is there any resemblence between different actors' moves? 2) are some locations more popular than others? 3) Is there a certain time range during which a big movement was triggered?

All Measures

Description :

Computes a collection of measures and generates output in categories. Each category analyzes a particular aspect of the meta-network structure.

Why Use This Report

This report calculates all the measures possible on a network. This report is often used for convenience of calculating the measures that may be reported separately from the report, such as when writing a journal paper. Unlike many of the other reports that put the measure into the context of the need, this report produces measures suitable only for people who understand the measures calculated by ORA.

Input :

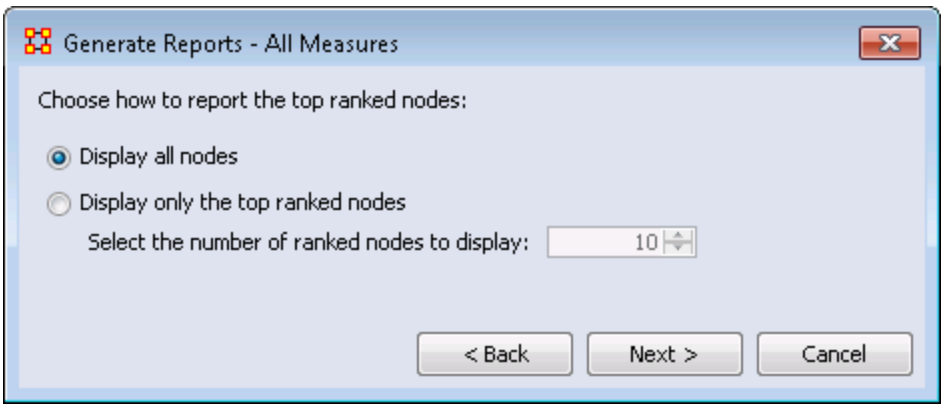
Uses Nodesets and Networks from selected Meta-Networks.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Choose to either **Display all nodes** or **select the number of top ranked nodes**.



Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.

Assessing Change in Plan

NOTE : This report only available in the full version.

Why Use This Report

Use this report to compare the Meta-Network of a plan [i.e. the anchor Meta-Network] with Meta-Network that occur during the execution of the plan.

Analyzes a collection of Meta-Networks and show what has changed in terms of nodes and links when going from A to B. It is summerized in the following table.

Uninvolved/Unattached	nodes and links in A that are not in B	A - B
Common	nodes and links in A and are also in B	B intersect A
New	nodes and links not in A and in B	B - A

Actor Analysis	agent x agent, agent x organization, organization x organization
Expertise and Resource Analysis	agent x knowledge, agent x resource, organization x knowledge, organization x resource
Task and Event Analysis	agent x event, agent x task, organization x event, organization x task

Input

Requires at least two networks. To obtain a complete report the following Networks need to be in the Meta-Network.

Parameters

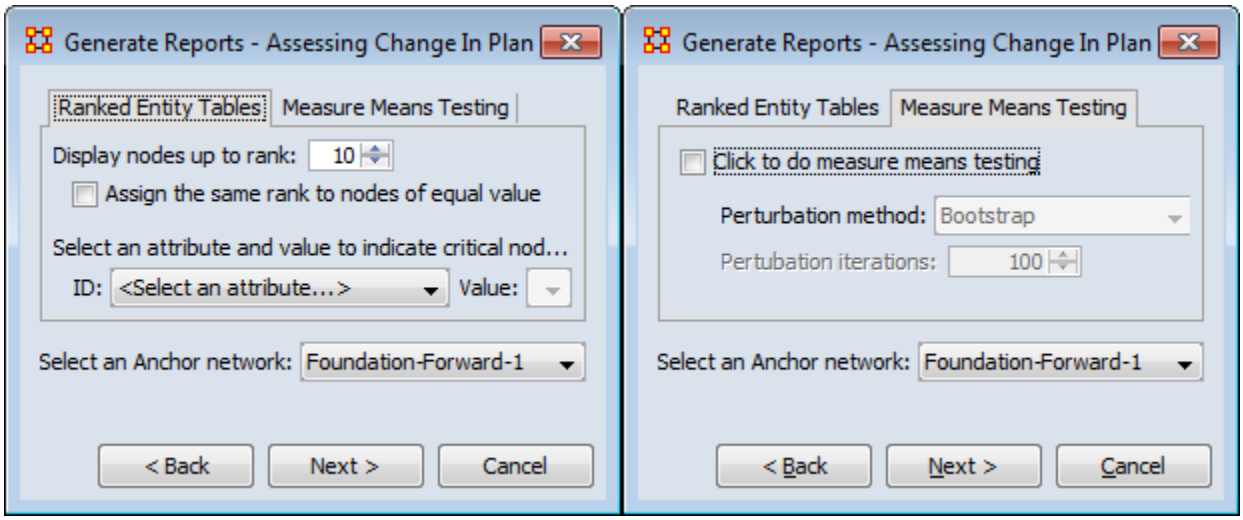
Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : This contains two tabs:

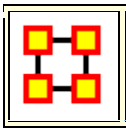
Ranked Entity Table :

Measure Means Testing :



Output :

Single Meta-Network, multiple Meta-Network comparison.



Belief Propagation

Why Use This Report

This report runs a simulation of the belief (or attitude) propagation based on the Friedkin model from the social influence theory.

Estimates belief propagation through social networks. This report contains the most common beliefs shared by most people, the beliefs with the highest GINI coefficient, the most strongly held beliefs, the most likely to change beliefs, the most neutral individuals, and the most opinionated individuals.

Betweenness Centrality
Closeness Centrality
Total Degree Centrality

NOTE : This report requires the Meta-Network to analyze contains a Belief Node Class.

Input

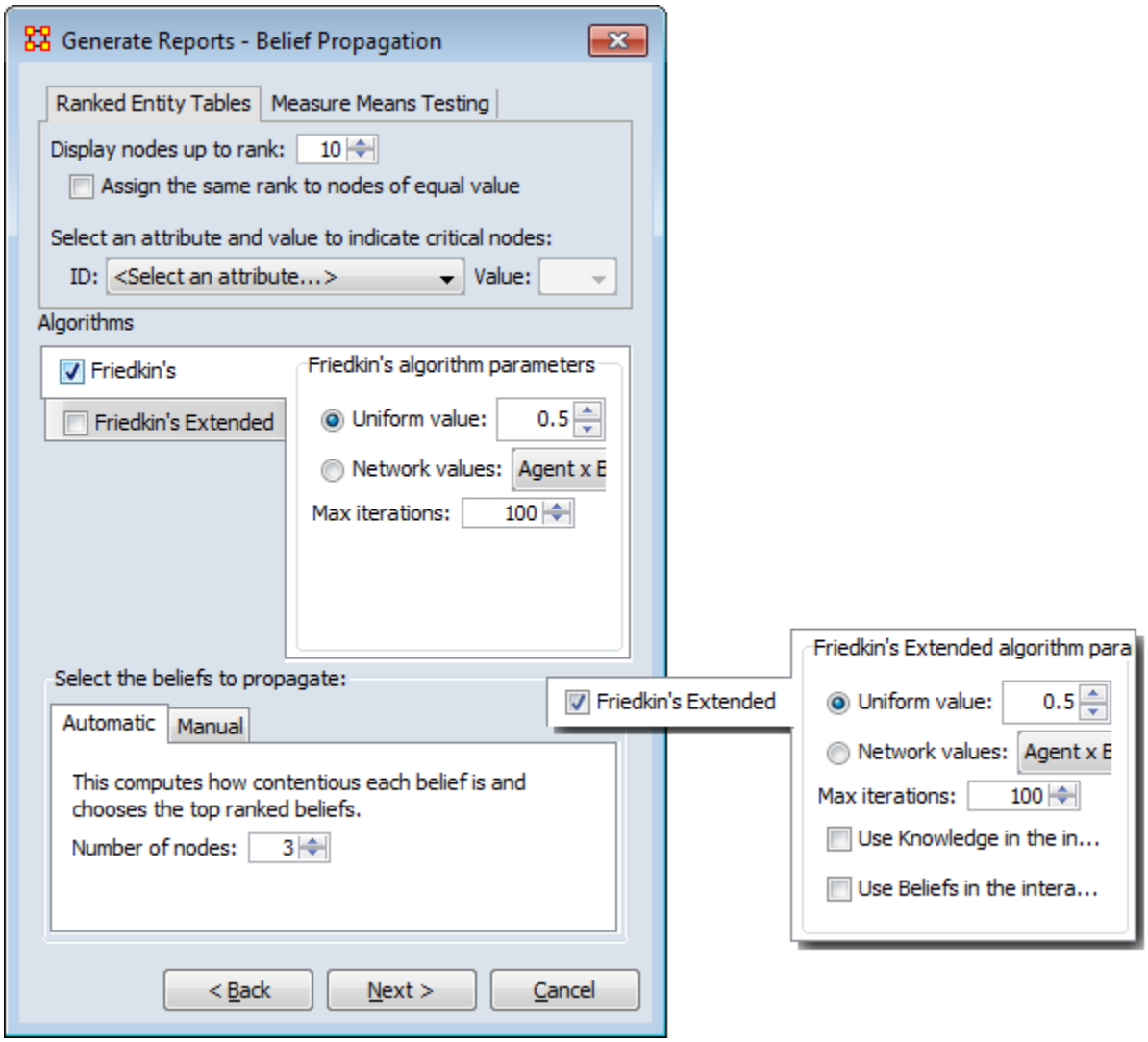
Requires a Belief Node Class

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



In addition you can set the **Friedkin Algorithm Parameters** and select the **alpha measure**.

Finally you can set how **contentious** (likely to cause an argument) a belief is and choose the top ranked nodes.

Output :

Single Meta-Network, multiple Meta-Network comparison.

Capabilities

NOTE : This report only available in the full version.

Why Use This Report

This is used to assess an individuals' or organizations' capability to perform tasks.

Analyzes the knowledge, resource, and task capabilities of agents and organizations in the network.

Congruence	
Communication Congruence, Organization Agent Knowledge Needs Congruence, Organization Agent Knowledge Waste Congruence, Organization Agent Resource Needs Congruence, Organization Agent Resource Waste Congruence, Organization Task Knowledge Needs Congruence, Organization Task Knowledge Waste Congruence, Organization Task Resource Needs Congruence, Organization Task Resource Waste Congruence, Strict Knowledge Congruence, Strict Resource Congruence, Social Technical Congruence	agent x knowledge, agent x resource, agent x task, agent x resource, knowledge x task, resource x task, task x task,
Agent Capability Analysis	
Overall Capability Index	agent x knowledge, agent x resource, agent x task
Capability Index in Expertise	agent x knowledge
Capability Index in Resources	agent x resource
Capability Index in Tasks	agent x task
Organization Capability Analysis	
Overall Capability Index	organization x resource
Capability Index in Resources	organization x resource
Task Requirement Analysis	

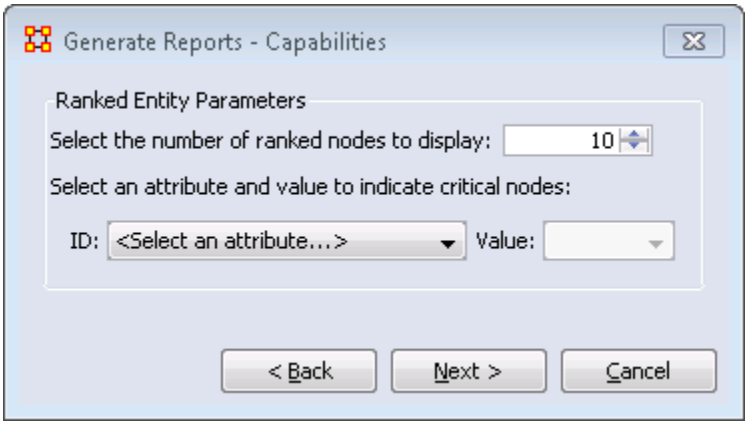
Overall Requirement Index	task x knowledge, task x resource
General Requirement Index in Expertise	task x knowledge
General Requirement Index in Resources	task x resource

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis.



Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.

Change In Key Entities

Why Use This Report

This report provides information on the overall structure of a complex network and identifies, for each type of node, which nodes stand out.

Analyzes the changes over time of the agents that score highest in measure values.

A complex network typically is a meta-network with multiple types of entities such as people, expertise, resources and locations. Overall structure is defined using meta-network metrics such as Overall Complexity, Social Density, Social Fragmentation, Communication Congruence, Knowledge Congruence, Performance as Accuracy, and Average Communication Speed. Key entities within each of the component networks are identified in terms of metrics such as Degree Centrality, Cognitive Demand, Specialization, and Redundancy. Separate key-entity pages are produced for each type of entity. For example, if there are people and resources - then key people and key resources are both identified. If the user selects two or more networks, this report will compare the results.

Workload	agent x knowledge, agent resource, agent x task, knowledge x task, resource x task
Betweenness Centrality [Potentially Influential]	agent x agent
Clique Count	agent x agent
Cognitive Demand [Emergent Leader]	agent x agent
Eigenvector Centrality [Leader of Strong Clique]	agent x agent
Relatively Unique [Knowledge]	agent x agent
Complete Exclusivity [Knowledge]	agent x knowledge

High Betweenness/Low Degree	agent x knowledge
Row Degree Centrality	agent x agent
Total Degree Centrality	agent x knowledge

Input

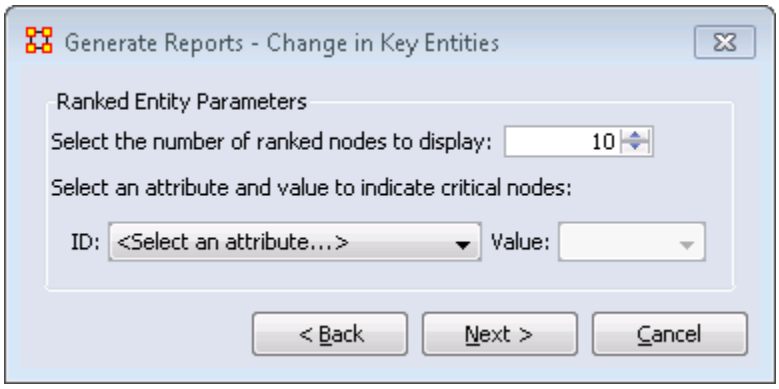
At least two Meta-Networks.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

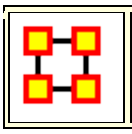
Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis.



Output :

Single Meta-Network.



Communications Network Assessment

Why Use This Report

This report evaluates the effectiveness of a computer network, with the computer nodes being represented as resources. The computer network represents the physical layer of connections between machines. Effectiveness takes into account the placement of nodes in the network.

This report assesses a communications network. As information on speed of information transmittal becomes available it will be updated. This report takes a resource by resource network (preferably one where the nodes are communications devices and the links are the speed of reliability of the link).

All reports | resource x resource

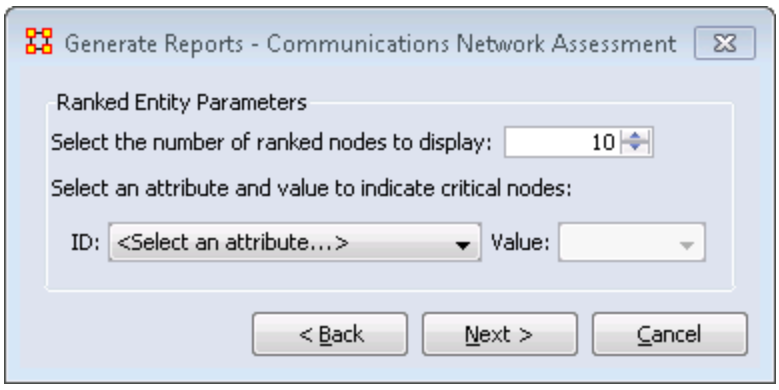
NOTE : This report uses the **Context function** as a comparison of the user's input network with that of a random network of the same number of nodes and density. This is an attempt to address a frequent user question, "**Well, okay, I see the measure values, but are they what I should expect? Are they low or high? I don't know what I should be seeing**".

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



Output :

Single Meta-Network

Communicative Power

Why Use This Report :

Use this report to analyze one or more semantic networks to classify concepts by measure values.

NOTE : Also see **Cube Analysis** in General Content section.

Betweenness Centrality
Density
Link Count
Node Count
Total Degree Centrality

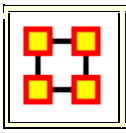
Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.



Communicators

Why Use This Report

When characterizing network topologies, it is important to consider the role of errors and incomplete data in the network. This report will provide additional analysis on network topologies and actors, respectively.

Analyzes the communication network (agent by agent) and gives high level statistics on its structure.

In-Degree Centrality	agent x agent
Out-Degree Centrality	agent x agent
Betweenness Centrality	agent x agent
Node Count"	agent x agent
Weak Component Count	agent x agent
Clique Count	agent x agent
Density	agent x agent
Clustering Coefficient	agent x agent

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

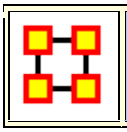
Output :

Single Meta-Network, side-by-side comparison.

References

"Relating Network Topology to the Robustness of Centrality Measures", CASOS Technical Report, Terrill L. Frantz, Kathleen M. Carley May 2005.

"On the robustness of centrality measures under conditions of imperfect data", Borgatti, Carley, Krackhardt. /Social Networks/ 28 (2006) 124-136.



Context

Why Use This Report

NOTE : This report uses the **Context function** as a comparison of the user's input network with that of a random network of the same number of nodes and density. This is an attempt to address a frequent user question, "**Well, okay, I see the measure values, but are they what I should expect? Are they low or high? I don't know what I should be seeing**".

Input

Compares measured values against various stylized forms of networks in an effort to characterize network topology.

NOTE : Works on Square Networks Only

Summary	
Erdos-Remy, Core Perophery, Cellular	All Square Networks
Topology	
Betweenness Centrality, Closeness	random networks of various

Centrality, Inverse Closeness Centrality	topologies with identical size and density
Values Context	
Average Distance	agent x agent
Betweenness Centrality	
Closeness Centrality	
Clustering Coefficient Density	
Cognitive Demand	
Connectedness	
Burt Constrain	
Efficiency	
Fragmentation	
Hierarchy	
Information Centrality	
Inverse Closeness Centrality	
Total Degree Centrality	
Upper Boundedness	

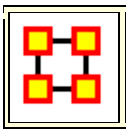
Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network.



Core Network

Why Use This Report

Good for extracting the big giant connected component in real life networks that have multiple disconnected small subcomponents and a big, giant connected component.

Computes the core network and reports general statistics. The **Core Network** is the largest component (sub-graph) in the graph.

Centrality	Set of selected networks
Potentially Influential (Betweenness Centrality)	

NOTE : This report uses the **Context function** as a comparison of the user's input network with that of a random network of the same number of nodes and density. This is an attempt to address a frequent user question, "**Well, okay, I see the measure values, but are they what I should expect? Are they low or high? I don't know what I should be seeing**".

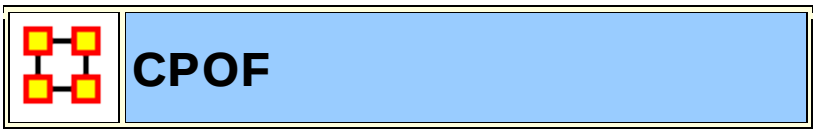
Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, side-by-side comparison.



NOTE : This report only available in the full version.

Why Use This Report

Use this to analyze the creation and modification of events and tasks and agent collaboration over time.

This report finds out:

Who are the top two busiest agents across time in terms of the total number of events and tasks modified or created?

What is the busiest time period in terms of average agent activity?

Which pairs of events are most likely to occur together?

The co-occurence analysis requires that the networks be conformed so that entity sets are identical across networks.

Which pairs of tasks are most likely to occur together? The co-occurence analysis requires that the networks be conformed so that entity sets are identical across networks.

Key Geo-Stickies	
In-Degree Centrality	event x location
Overall Complexity	
Collaboration Density	agent x agent

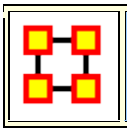
Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, multiple Meta-Network comparison.



Critical Sets

NOTE : This report only available in the full version.

Why Use This Report

This report has two functions. Find a set which 1) would fracture the Meta-Network the most or 2) which reaches the maximum number of nodes.

Finds critical sets of nodes in a network that best reach all other nodes, or whose removal maximally disrupts a network.

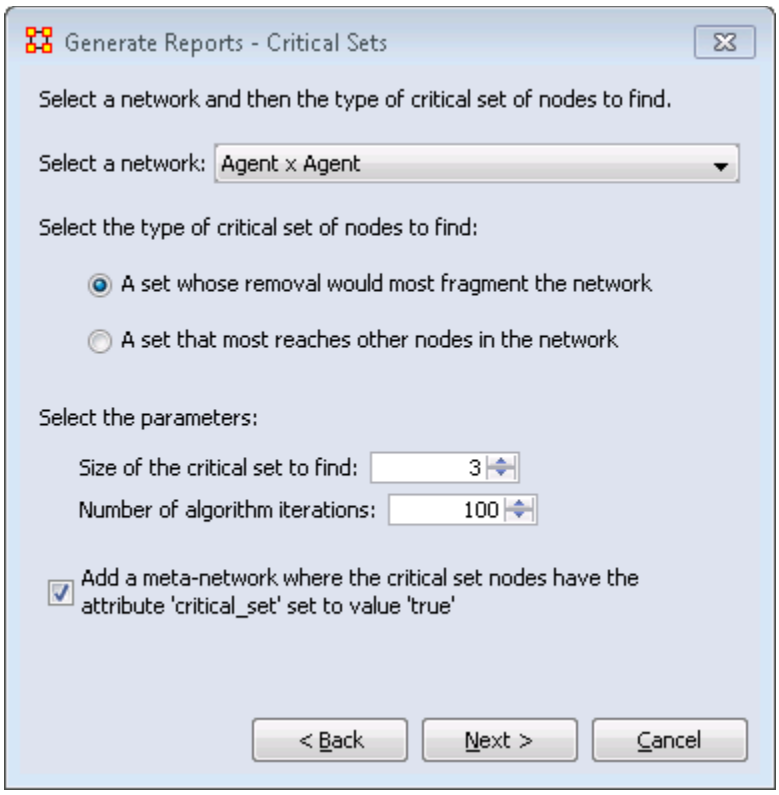
Parameters



Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : The main items to choose here are the network to explore and the type of critical set you want to find. These are **1)** A set whose removal will most fragment the network or **2)** A set that most reaches other nodes in the network.



Secondly you need to set the size of your critical set and the number of iterations to perform.

Lastly place a check mark in the box if you want to create a new Meta-Network based on this critical set.

Output :

Single Meta-Network.

Custom

Why Use This Report

The custom report allows a user to be able to design a report to meet a specific need by identifying the metrics that should be calculated on an input network. The custom report would be used when a specific set of metrics or measures are needed routinely as opposed to simply producing the metrics directly each time.

Computes a custom report with user selected measures and output tables, pictures, and figures.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

A single Meta-Network.



Detect Spatial Patterns

Why Use This Report

This report will find out whether a node attribute is clustered spatially, such that nodes are similar to nearby others.

Network Properties	Set of Selected Networks

Input

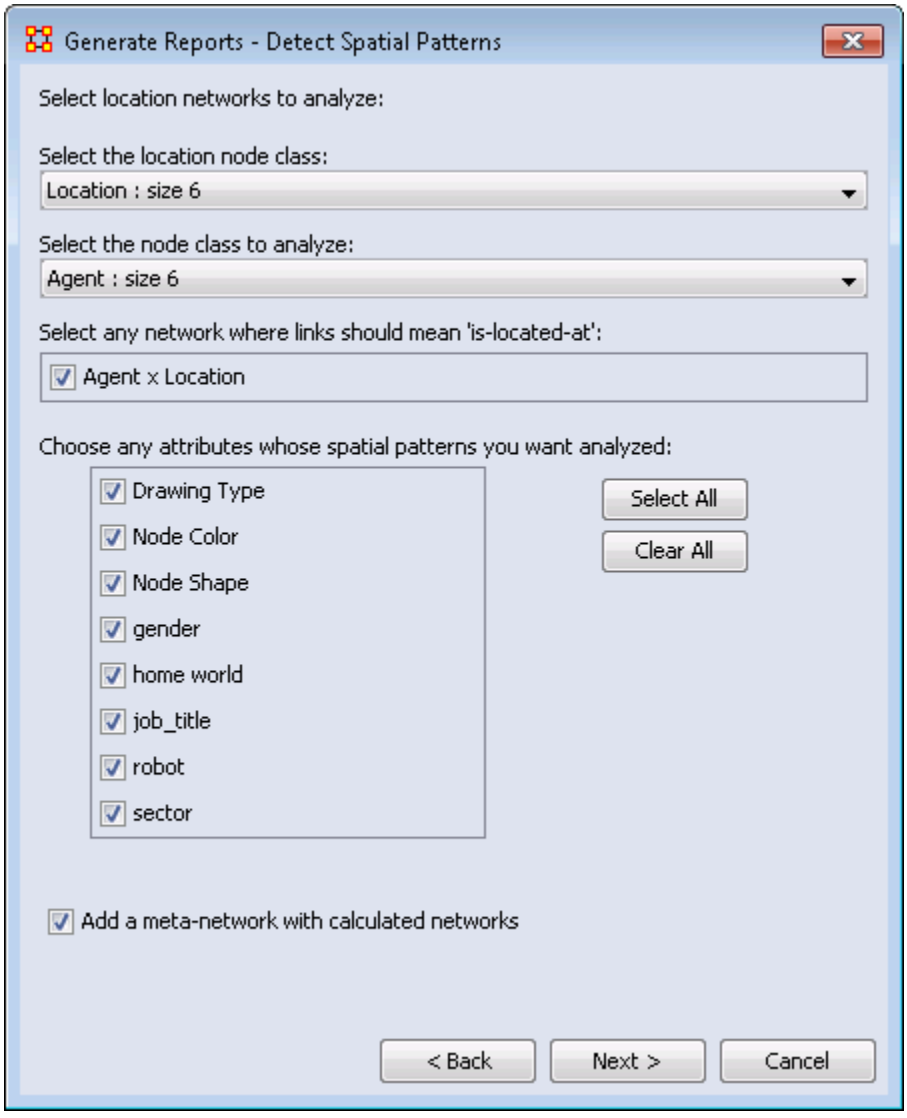
NOTE : Requires a Location Node Class with Latitude and Longitude attributes.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select a Location and an Agent Nodeset and the Network where links are located at.

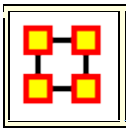


Place a check mark next to any of the attributes you want analyzed.

Place a check mark in the **Add a meta-network** box to add this new meta-network to ORA.

Output :

Single Meta-Network



Drill Down

Why Use This Report

Computes the drill down from a selected organization and then to a selected agent.

Input

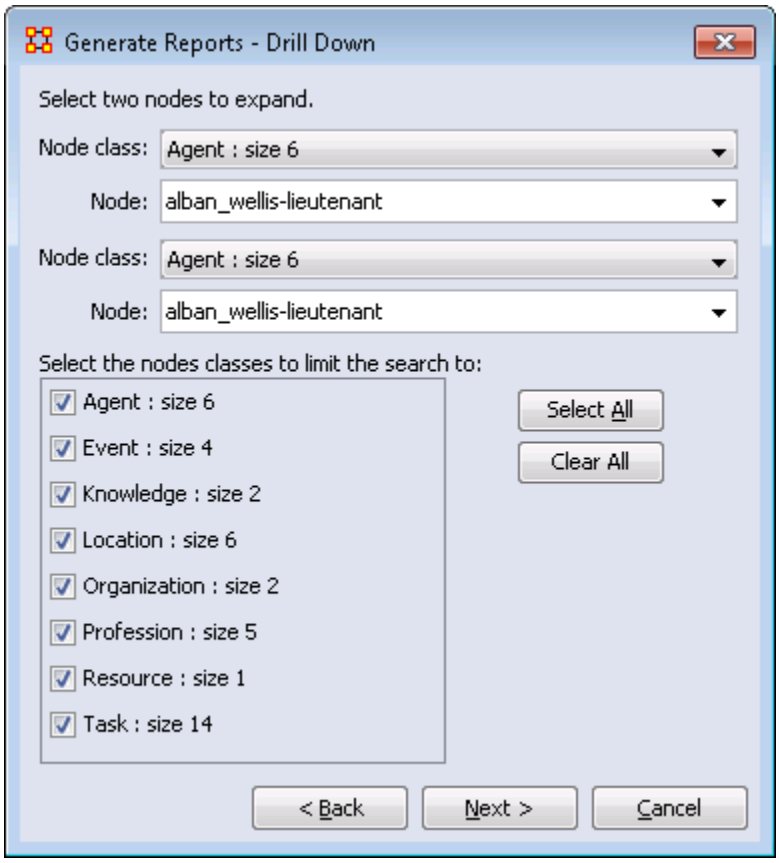
Whatever node(s) you want to analyze.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

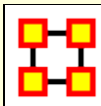
Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select two nodes from any Nodeset to expand. In the bottom section you can limit which Nodeset will be displayed in the display by removing any of the check marks.



Output :

A single Meta-Network.



Geospatial Assessment

Why Use This Report

This report finds nodes that are co-located based, and counts the number of nodes that appear at location points.

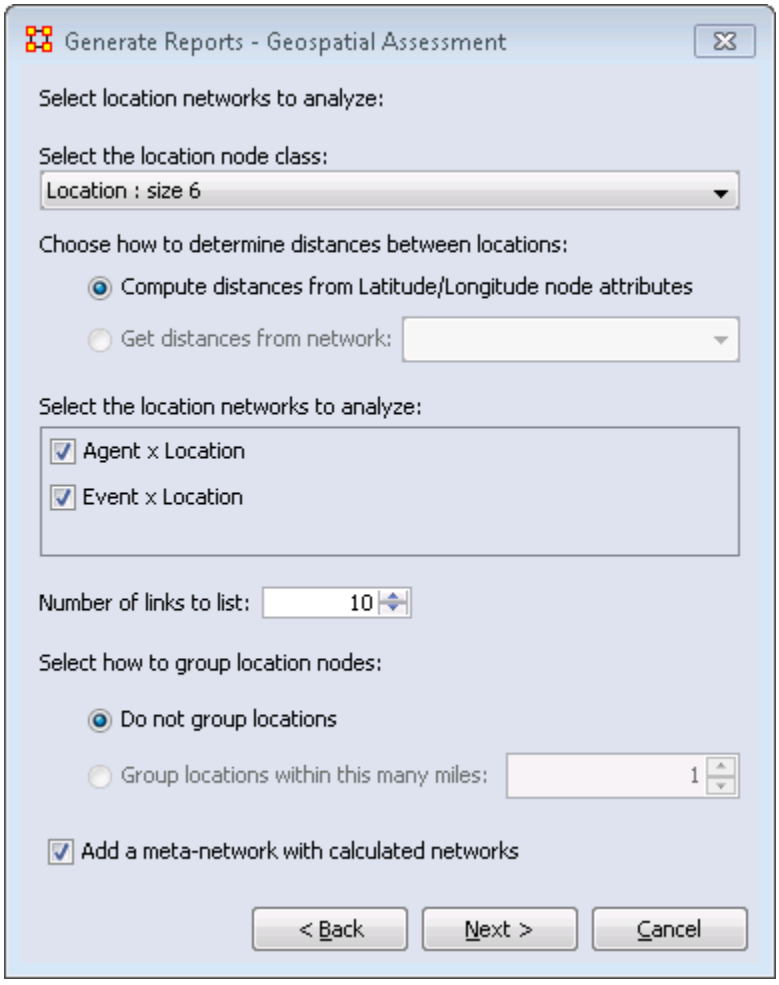
agent x location

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select a Location Nodeset.



You have two choices for determining the distance between locations. **1)** distances from Latitude/Longitude and **2)** Distance from attribute in Nodeset.

All Networks containing the Location Nodeset will appear. Select the one(s) to analyze by placing a check mark next to their name.

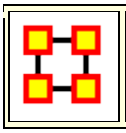
Select the number of links to list.

Select whether or not to group the links.

Finally place a check mark in the box if you want to create a new Meta-Network.

Output :

A single Meta-Network.



Group Talk

Why Use This Report

When you need to find either the most prevelant knowledge or the greatest amount of agents discussing one particular knowledge.

Analyzes the relationship between agents and knowledge.

agent x agent, agent x knowledge, agent x role

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

A single Meta-Network.

X[i] = X[i] / sum(X)

Then the entropy is computed as:

Entropy is (-1 * (sum of (X[i] * log(X[i]))/ log (2.0)

Entropy:

Entropy is measured using Shannon's Entropy measure (Shannon, 1948; Shannon, 1951). It is a measure of uncertainty. ORA takes the data vector, converts in to a probability distribution and then applies Shannon's formula.

Given a vector X (e.g. the vector of out-degrees for the AK graph)

NOTE : It only applies to measures with non-negative values.

The overall approach used is to:

1. compute a measure with non-negative values: x1, x2, ..., xN

2. divide each xi by the sum(x1, x2, ..., xN) - to create a probability distribution - and so create: p1, p2, ..., pN

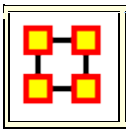
3. Shannon Entropy is then calculated as the -sum_over_i(pi * log_base_2(pi)).

The density of a network is defined as: **The number of edges divided by the number of possible edges**.

References:

Shannon, Claude E.. A Mathematical Theory of Communication. Bell System Technical Journal, July/October 1948.

Shannon, Claude E.: Prediction and entropy of printed English, The Bell System Technical Journal, 30:50-64, January 1951.



Hot Topics

Why Use This Report

This report will identify the most frequently mentioned concepts in a text set. The networks are typically formed from AutoMap with a frequency

attribute on each concept node. It can operate on any network (meta-network, semantic network, or concept network) as it makes use of only the nodes of the network.

This report analyzes semantic network output from AutoMap and provides standard content analysis information. When you have semantic network data or lists of concepts, networks derived from email content, or texts or documents of any sort.

It outputs the most frequent concepts and the least frequent concepts. Given a semantic network, this report displays statistics on the concepts and links in the map, and the distribution of concept frequencies. This report takes unstructured information into account. Running the hot topics report is similar to performing content analysis [1]. The user can vary the number of highest scoring terms to output.

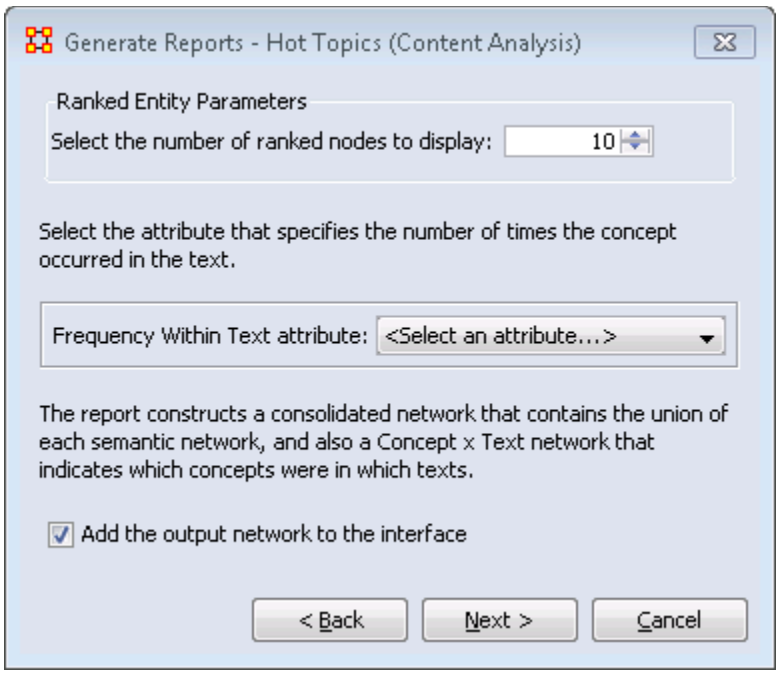
Concept Frequency	one attribute

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of Ranked Entities to display



Select an attribute that specifies the number of times the concept occurred in the text.

Finally place a check mark in the box if you want to add this new network.

Output :

Single Meta-Network, multiple Meta-Network comparison.

[1] Carley, K.M., Content Analysis, in The Encyclopedia of Language and Linguistics, R.E. Asher, Editor. 1990, Pergamon Press: Edinburgh. p. 725-730.

Immediate Impact

Why Use This Report

This report to allow you to perform one of two types of evaluation against the base network. The two types of analysis are : **Impact analysis and Replication analysis**.

Impact analysis : One or more of the nodes identified in the Key Entities report are deleted as part of an assessment of the degradation in the network if those nodes were no longer in the network. This is a more precise version of impact analysis for node removal than random node removal. The report then shows the differences in values between the original and modified networks' at both the node and network measure levels.

Replication analysis : Set a random number of nodes to delete, then the report will show the differences in values between the original and modified network's. Unlike impact analysis, the nodes are selected at random. The user also selects the number of iterations to execute, allowing a research to assess the vulnerability of a network to random node deletions. This is the more general impact analysis than the impact analysis discussed above.

Computes the key actors of the network, and then isolates them individually to determine the effect on measure values.

This report allows the user to engage in **what if** analysis about the immediate impact of removing one or more nodes. Comparative statistic techniques are used to assess the network with and without the nodes in question.

The user identifies a network, identifies which node or nodes to remove, and then ORA computes the consequent changes in the network by removing those nodes in terms of overall network structure and key entities. A feature of this report is that the user can save the meta-network with the removed nodes and then assess the modified network with any of the other reports.

The Immediate Impact report is designed to help users understand how the removal of certain nodes, or a certain number of nodes, can effect a network. An **Impact Analysis** allows users to select specific nodes in the network to remove, and then compare various metrics between the original network and the network where these specific nodes are removed. In a **Replication Analysis**, users specify a specific number of random nodes to remove from a network. Users can then compare metrics of the original network with the average of a series of networks from which the set number of random nodes has been removed.

Betweenness Centrality	agent x agent

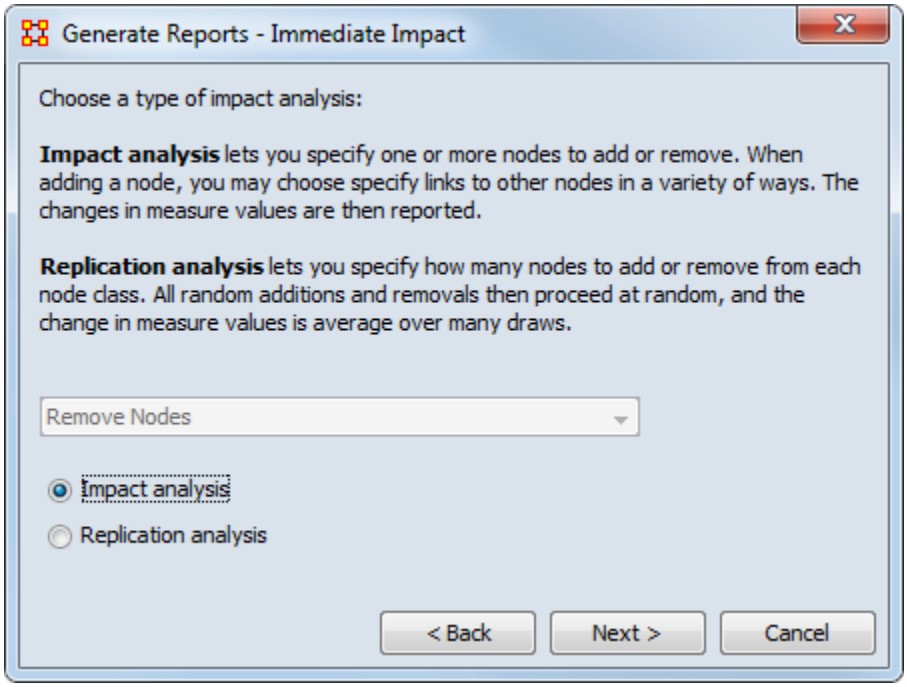
Total Degree Centrality	agent x agent

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.

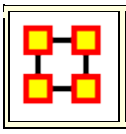


Impact Network [optional] : Specify one or more nodes to add or remove from a Meta-Network.

Replication Analysis [Number of Replications] : Repeatedly remove a specified number of nodes uniformly at random from the meta-network.

Output :

Single Meta-Network.



Influence Net

Why Use This Report

Displays the influence network and gives high level statistics on its structure.

NOTE : This report uses the **Context function** as a comparison of the user's input network with that of a random network of the same number of nodes and density. This is an attempt to address a frequent user question, "**Well, okay, I see the measure values, but are they what I should expect? Are they low or high? I don't know what I should be seeing**".

Input

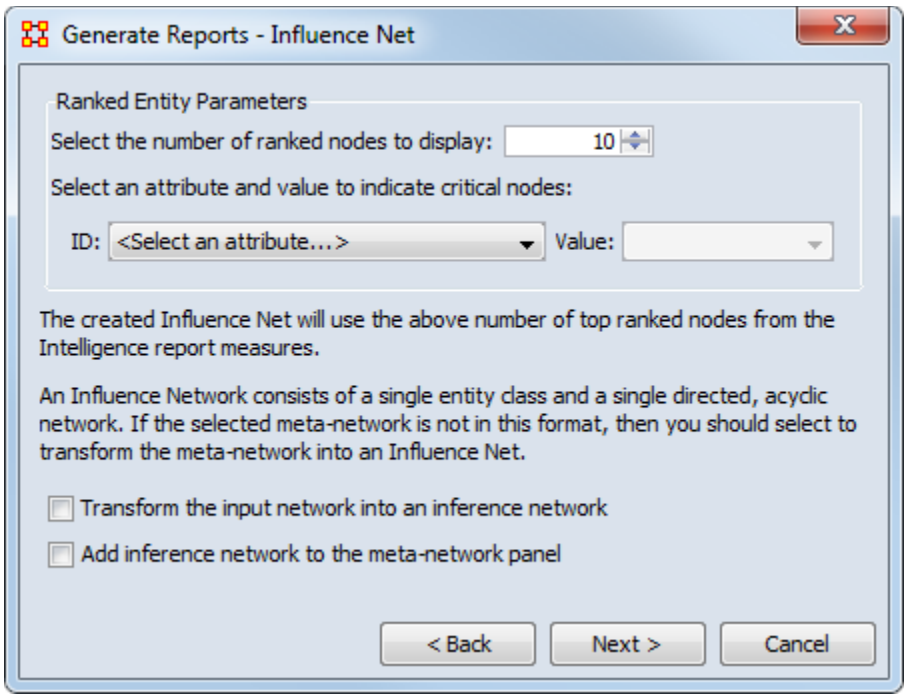
Betweenness Centrality	agent x agent, task x task
In Degree Centrality	agent x agent, agent x location, agent x profession, agent x task, agent x event, agent x knowledge, event x location, knowledge x task, task x event, agent x organization, atsk x task, knowledge x profession, task x profession, organization x resource, resource x task, resource x profession, agent x resource

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



IMPORTANT : If your Network consists of more than one Nodeset and one Network you must place a check mark in the **Transform the input network into an inference network** before proceeding.

Lastly place a check mark in the **Add inference network** to create a new Metw-Network.

Output :

Single Meta-Network.

Key Entity

Why Use This Report

This is a go-to report to identify the important (or "key") who, what, where, when, and why. The input would be a social network in meta-network form using all of the ORA ontological categories (agents, organizations, etc.). If only a subset of the categories are represented, the key entity report will show a subset of the who, what, where, when, and why.

Identifies key entities and groups who by virtue of their position in the network are critical to its operation.

This report performs a network-level report to find Overall Complexity, Social Density, Social Fragmentation, Communication Congruence, Knowledge Congruence, Performance as Accuracy, and Avg Communication Speed. (Replaces the Event Analysis, Intelligence, and Location Analysis Reports).

Input

Who Analysis	
Cognitive Demand [Emergent Leader]	agent x agent
Total Degree Centrality [In-The-Know Leader]	agent x agent
Clique COunt [Number of Cliques}	agent x agent
Row Degree Centrality [Most Knowledgable}	agent x knowledge
Row Degree Centrality [Most Resources]	agent x resource
Eigenvector Centrality per Component [Leader of Strong Cliques]	agent x agent
Hub Centrality [Act as a Hub]	agent x agent
Authority Hub [Act as an authority]	agent x agent
Betweenness Centrality [Potenitally Influential Leader]	agent x agent
High Betweenness/Low Degree [Connects Groups]	agent x agent
Relatively Unique [Specialization - Knowledge]	agent x knowledge
Complete Exclusivity [Knowledge]	agent x knowledge
Relatively Unique [Resource]	agent x resource
Complete Exclusivity [Resource]	agent x resource

Relatively Unique [Task]	agent x task
Complete Exclusivity [Task]	agent x task
Relatively Unique [Event]	agent x event
Complete Exclusivity [Event]	agent x event
Relatively Unique [Location]	agent x location
Complete Exclusivity [Location]	agent x location
Actual Workloads	agent x knowledge, agent x resource, agent x task, knowledge x task, resource s task
Shared Situation Awareness [Group Awareness]	agent x agent

How Analysis - Knowledge	
Total Degree Centrality [Dominant Knowledge]	All networks based on knowledge
Row Degree Centrality [Most Needed]	knowledge x task
Betweenness Centrality [Supply Chain Criticality]	knowledge x knowledge

How Analysis - Resource	
Total Degree Centrality [Dominant Knowledge]	All networks based on resource
Row Degree Centrality [Most Needed]	resource x task

What Analysis - Event	
High Concentration of Actors	agent x event
High Concentration of Tasks	task x event

Actors at the Most events	agent x event
Tasks at the Most events	task x event
Events Where There Are Actors That Are Not At Other Events	agent x event
Events Where There Are Tasks That Are Not At Other Events	tasks x event

What Analysis - Task	
Central Tasks	task x task
Acts as a Hub	task x task
Acts as an Authority	task x task
High Concentration of Actors	agent x task
High Concentration of Knowledge	knowledge x task
High Concetration of Resources	resource x task
High Concentration of Tasks	task x task
High Knowledge Complexity	knowledge x task
High Resource Consumption	resource x task
Actors at the Most Tasks	agent x task
Knowledge at the Most Tasks	knowledge x task
Resource at the Most Tasks	resource x task
Tasks at the Most Tasks	task x task
Tasks Where There Are Actors That Are Not at Other Tasks	agent x task
Tasks Where There Are Knowledge That Are Not at Other Tasks	knowledge x task
Tasks Where There Are Resources That Are Not at Other Tasks	resource x task

Tasks Where There Are Tasks That Are Not at Other Tasks	tasks x task

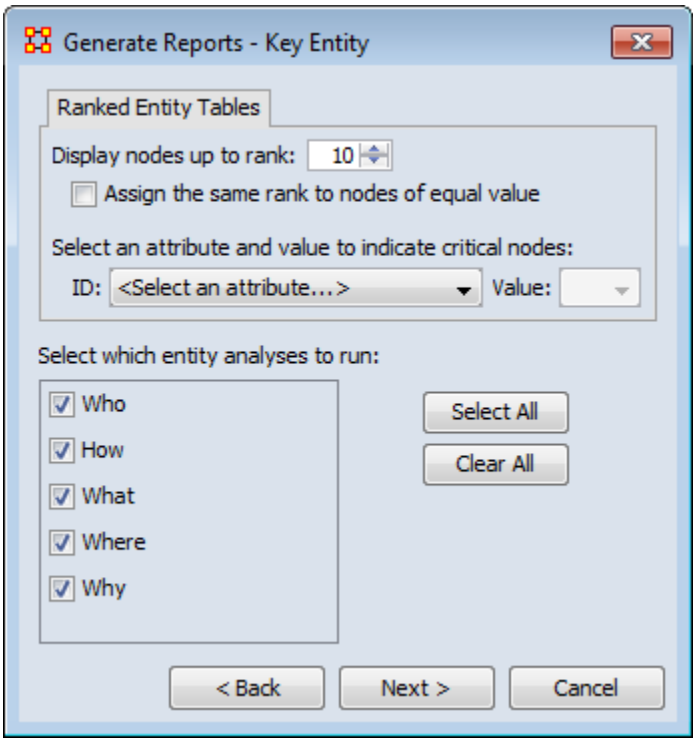
Where Analysis	
Most Active Locations For Events	event x location
Highest Concentration Of Actors	agent x location
Actors At The Most Locations	agent x location
Locations Where There are Groups Of Actors	agent x agent, agent x location

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



In addition you can select which entity to analyze: **Who, How, What, or Where**.

Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.

K-Centrality

Why Use This Report

When working with large networks this measure limits the surrounding neighborhood.

Calculates the geodesic centrality measures for various radius values k, which approximates the geodesic computation by only considering neighbors within the radius distance.

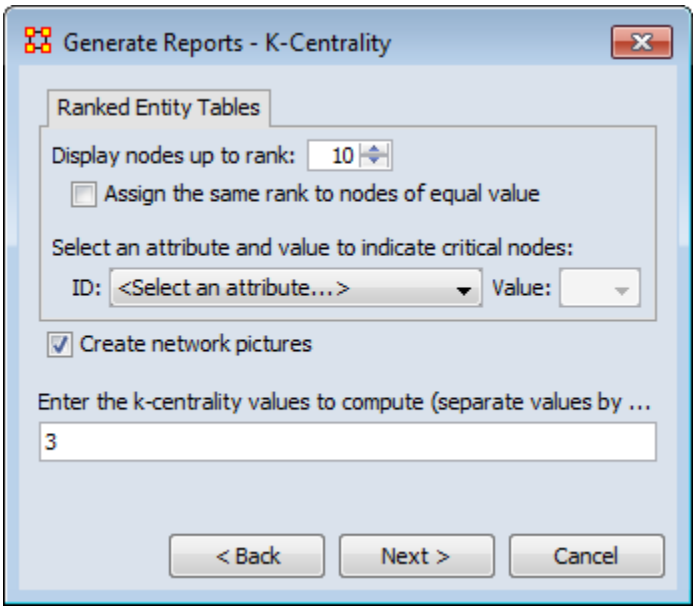
Input

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

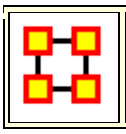
Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis.



Output :

Single Meta-Network.



Large Scale

Why Use This Report

Computes all network analysis measures.

Input

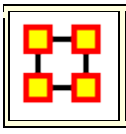
Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network.



Local Patterns

Why Use This Report

Helps reveal which nodes are in which pattern motifs and also shows the number of motifs in a Meta-Network.

Finds link patterns in a network, such as Star, Checkerboard, and Clique.

Input

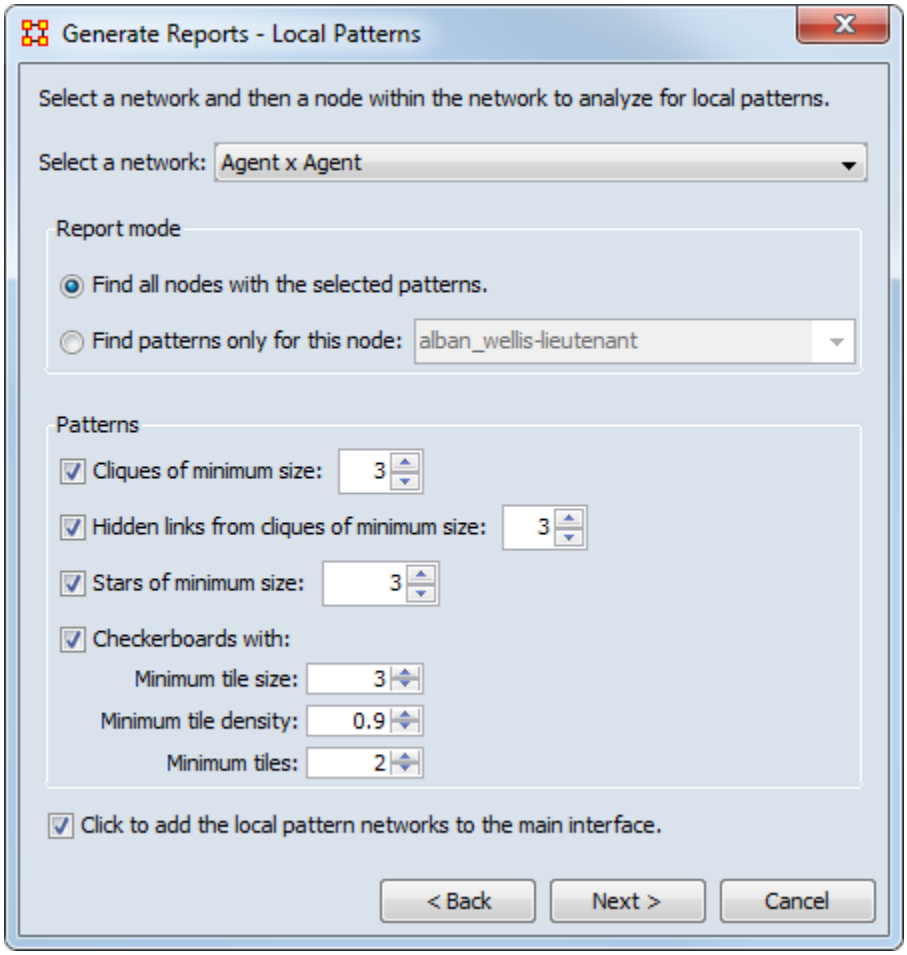
Clique Count	agent x agent

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select one Network to analyze.



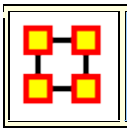
In the **Report mode** you can choose to find selected patterns or only the patterns for a single selected node.

In the bottom section define your pattern using the four parameters.

Finally place a check mark in the box if you want to add the networks to Meta-Networks to the Meta-Network Manager pane.

Output :

Single Meta-Network.



Locate SubGroups

Why Use This Report

Identifies the subgroups present in the network using various grouping algorithms. Most algorithms only work on a single network at a time

Input

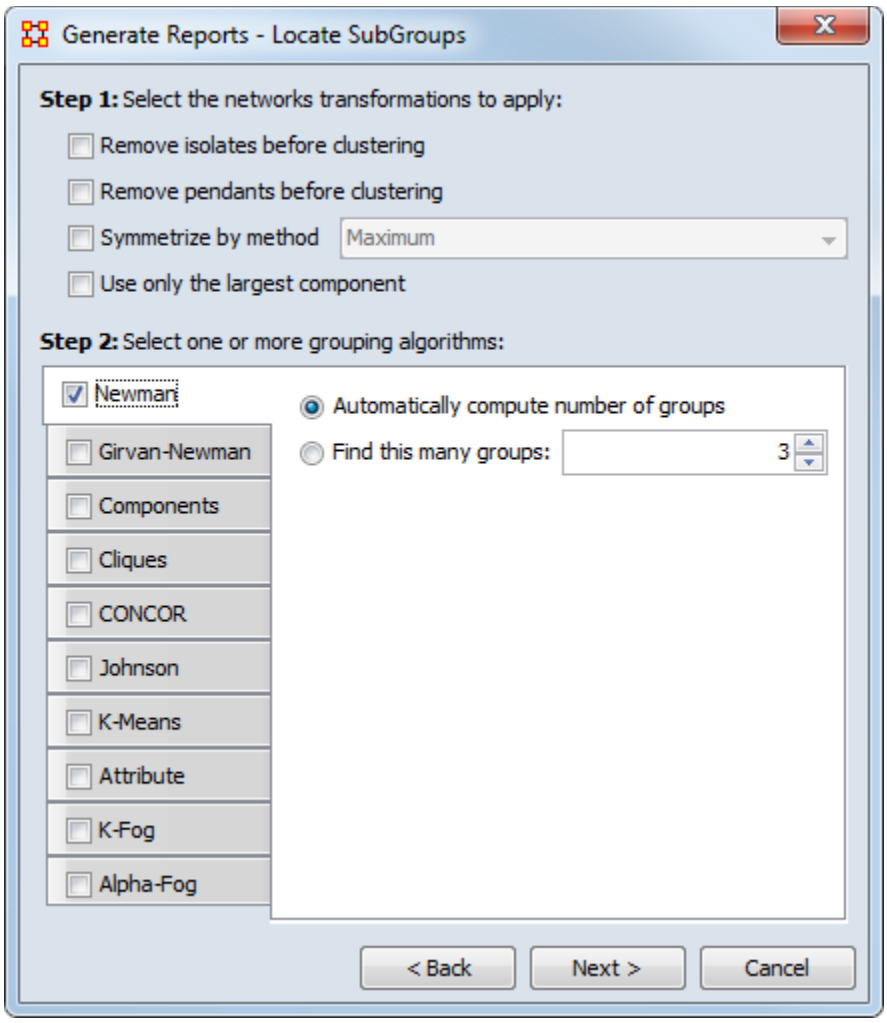
Will analyze the networks selected by the user.

Parameters

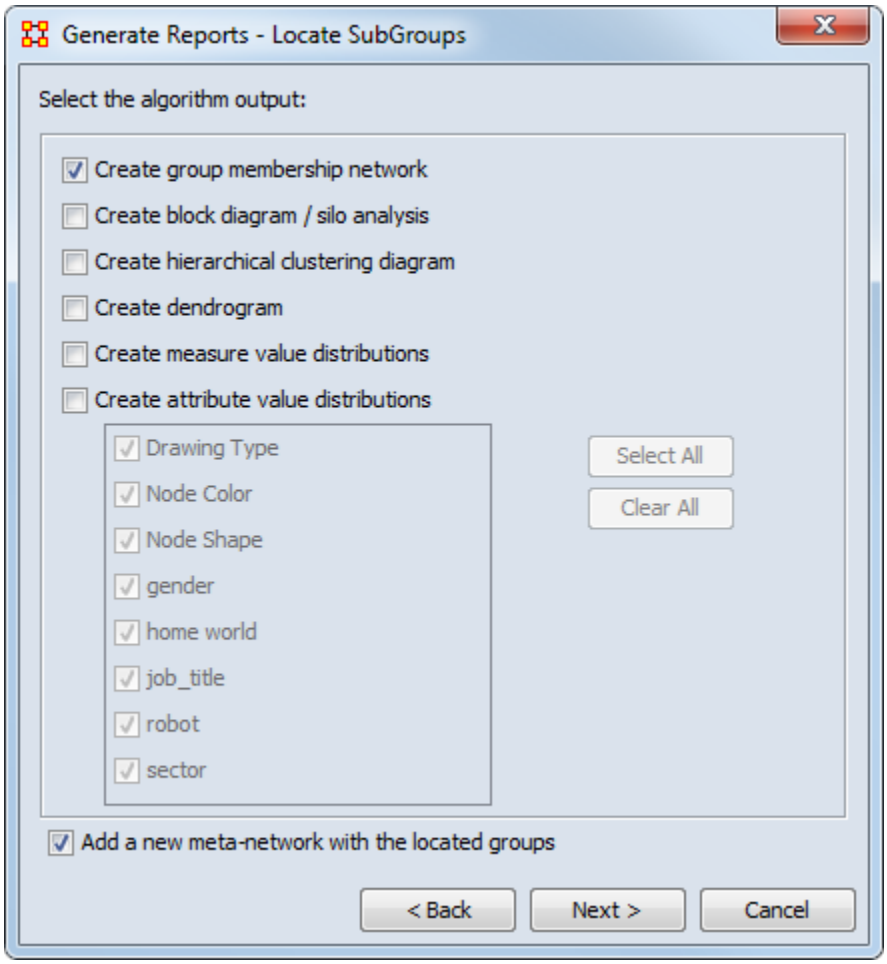
Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : In **Step 1** select the types of transformation to apply. This deals with, among other paramters, isolates and pendants. Place a check mark next to all the transformations you want to apply.



In **Step 2** you can choose any or all algorithms to run. Each will have it's own parameters such as the number of groups in Newman, the minimum number of cliques in Cliques, or the relationship types and link method in Johnson.



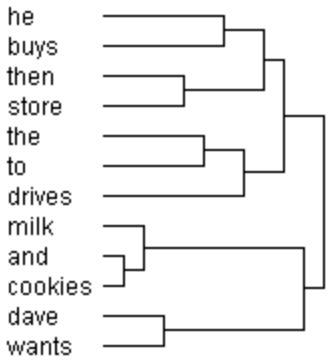
Dialog Box 4 : Finally you select the type of output you want. Again, place a check mark next to all the algorithms you want in the output.

Create group membership network : Divides nodes into groups based on the algrithm selected.

Create block diagram - silo betwork : A diagram of a system, in which the principal parts or functions are represented by blocks connected by lines, that show the relationships of the blocks.

Create Hierarchical clustering diagram : Place objects into group suggested by the data such that objects in a given cluster tend to be similar to each other in some sense, and objects in different clusters tend to be dissimilar.

Create dendrogram : A tree diagram frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering.



Create measure value distribution : Computes and displays information about each group. Measure calculations are performed on the sub-network defined the group, e.g. the group member nodes and the links between them.

Create attribute value distributions : This table shows the percentage of group members that have each attribute value. These are categorical attributes, which means they are text or numeric category values, such as 'Gender' or 'Years Experience'.

Group Sub-Network Measures

This section computes and displays information about each group. Measure calculations are performed on the sub-network defined the group, e.g. the group member nodes and the links between them. Information for each group includes **Size, Density, EI-Index, Clustering Coefficient, and Characteristic Path Length**.

Cluster Analysis Metrics

Newman Modularity Value : Measure the strength of division of a network into groups. High modularity means dense connections between nodes within the groups but sparse connections between different groups.

Davis-Bouldin Index : Evaluates clustering algorithms where validation of the clustering i smade using quantities and features inherent to the dataset. NOTE: This doesn't necessarily imply the best information was used in the dataset.

Dunn Index : Identifies sets of clusters that are compact with small variance between members of the cluster and the mean of different clusters is far apart.

Output :

Single Meta-Network



Why Use This Report

Use this report to locate strongest and weakness parts of a Meta-Network and also the most well connected nodes.

Identifies over- and under- performing individuals and assesses the state of the network as a functioning organization.

Like some of the other key-entity reports, the Management Report uses a multi-modal network to consider various aspects of an organization and report both organizational-level metrics as well as node-measures. This report includes identification of both top-ranked actors and knowledge, but also least-ranked actors. Thus, this report provides answers to questions such as:

Which actors are most central to the organization?

What knowledge comprise the organization's core competencies?

Which actors have access to the least knowledge?

Which actors are not well-integrated socially?

How much of the knowledge is unique to only one actor (across all actors)?

Input

Key Entities: Agent - Who	
Cognitive Demand	agent x agent
Hub Centrality	agent x agent
Authority Centrality	agent x agent

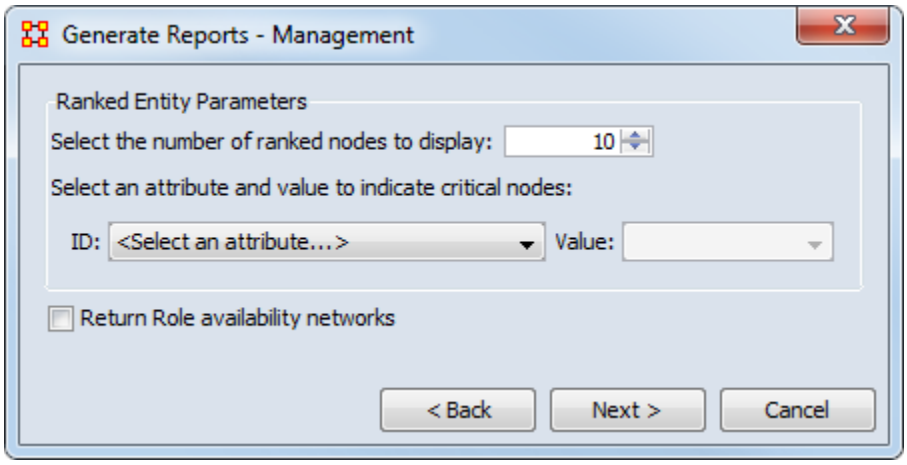
Workload	agent x knowledge, agent x resource, agent x task, knowledge x task, resource x task
Shared Situtation Awareness	agent x agent
Role Knowledge Availability	agent x knowledge, knowledge x profession
Role Resource Knowledge	agent x resource, resource x profession
Specialization - Knowledge (Relatively Unique)	agent x knowledge
Complete Exclusivity - Knowledge	agent x knowledge
Specialization - Resource (Relatively Unique)	agent x resource
Complete Exclusivity - Resource (Complete Exclusivity)	agent x resource
Specialization - Task (Relatively Unique)	agent x task
Complete Exclusivity - Task (Complete Exclusivity	agent x task
Simmelian Ties	
Core Competency	
Knowledge	agent x knowledge
Resource	agent x resource
Tasks	agent x task
Performance Indicators	
	agent x agent, agent x knowledge, agent x task, knowledge x task, agent x resource, resource x task

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



Output :

Single Meta-Network, multiple Meta-Network comparison.

MedHealth

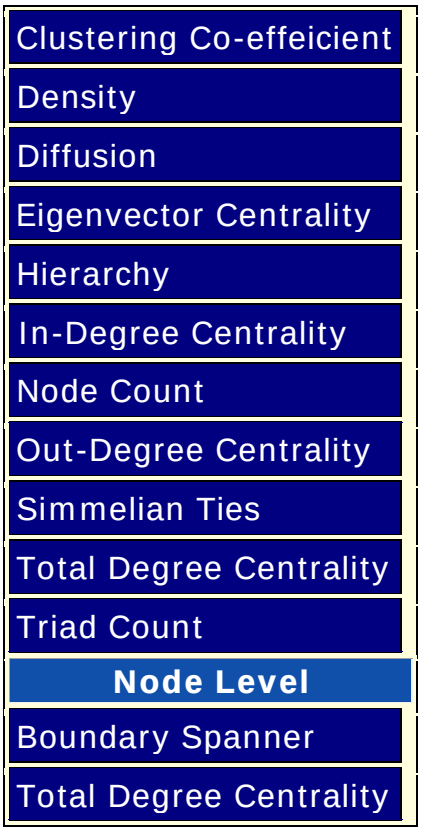
NOTE : This report only available in the full version.

Why Use This Report

Analyzes a collection of Meta-Network that represent nursing units.

Input

Interaction
Betweenness Centrality
Clique Count



Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, multiple Meta-Network comparison

Merchant Marine

NOTE : This report only available in the full version.

Why Use This Report

Analyzes the relationship between crew members, owners, vessels, and locations of the Merchant Marine Vessel data. It is used with a special data-set developed by CASOS.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.

The bottom box contains two tabs: [**Crew**] all of the agents in the Meta-Networks and [**Vessels**] placed in the Resource Node Class.

Output :

Single Meta-Network.

Missing Links

NOTE : This report only available in the full version.

Why Use This Report

Compute possible missing links in a network

Any one chosen **square network** in the Meta-Network. If multiple Meta-Networks are chosen then your choice is only from the networks they have in common.

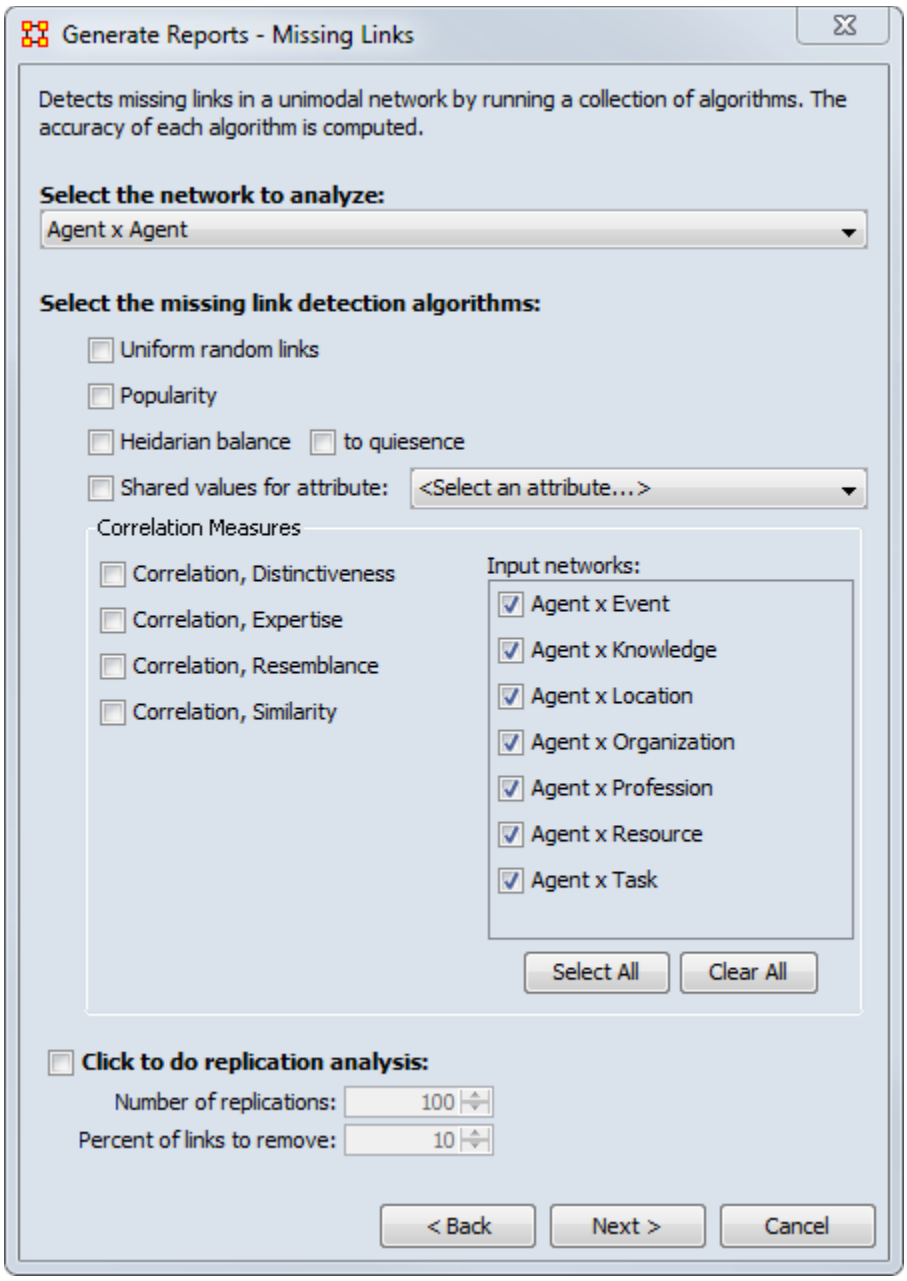
Network Level Measures [square network]	Average Communication Speed, Betweenness Centrality, Characteristic Path Length, Clustering Coefficient, Communication Congruence, Diffusion, Fragmentation, Isolated Agents, Social Density, Overall Complexity, Overall Fragmentation, Performance As Accuracy, Total Degree Centrality

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select a network to analyze.



Next choose the algorithms to run on the network.

Select the input networks.

If you desire to run multiple replication analysis place a check mark in the bottom box. Then select the **Number of replications** and the **Percent of links to remove**.

Output :

Single Meta-Network.



Network Distribution

Why Use This Report

Analyzes a collection of Meta-Networks and calculates their common nodes and links

Input :

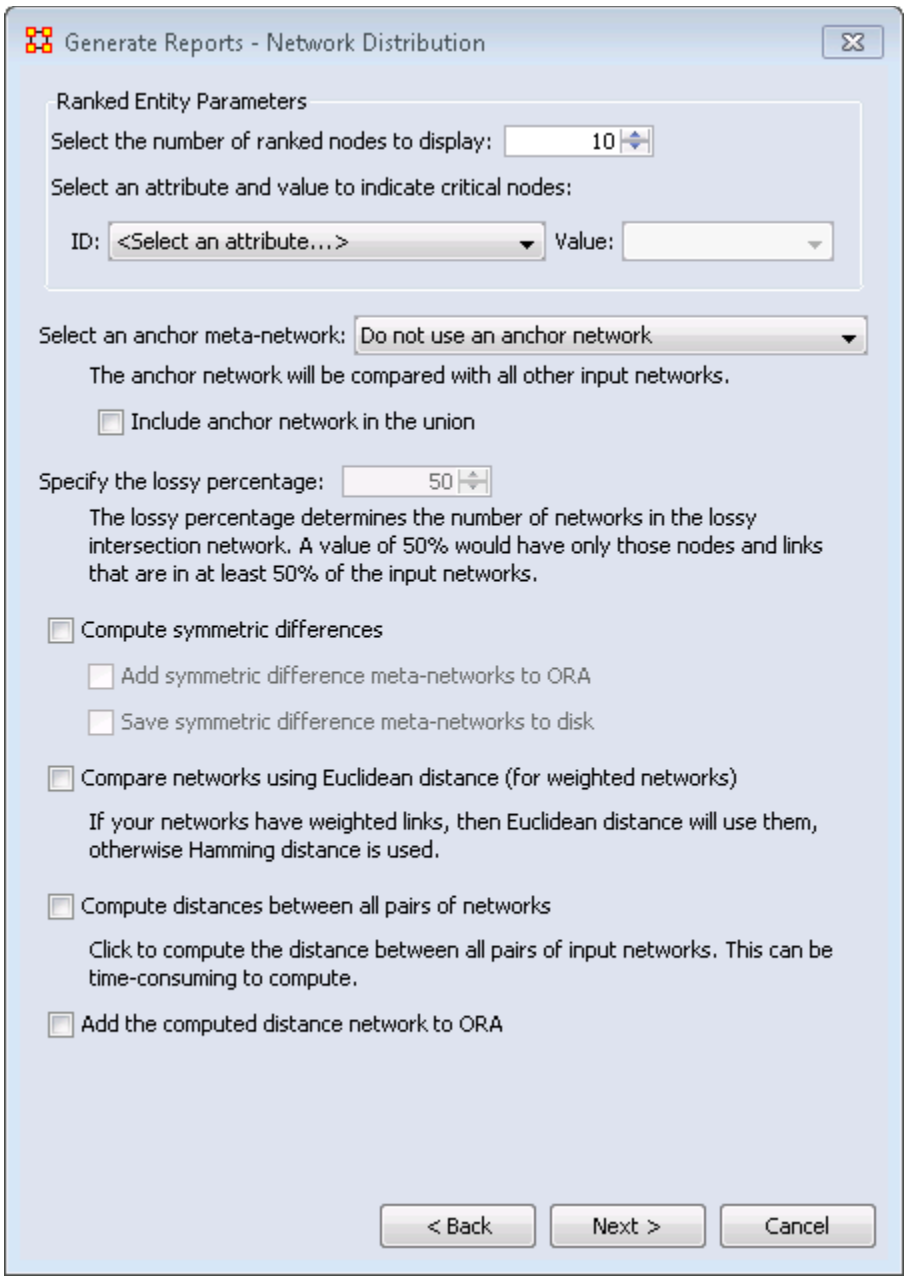
At least two networks.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis. Lastly select which Meta-Network to use as an anchor.



You can choose an **anchor network** which can be included or excluded in the comparison.

The **lossy percentage** sets the threshold for ndoes and links to be included.

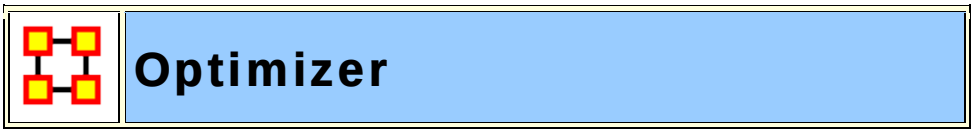
Symmetric Differences allows you to add these to either the ORA Meta-Network pane or write to disk.

Next is whether to use Euclidean or Hamming distance.

Computing the distances between all pairs of input networks can be a time-consuming process.

Output :

Single Meta-Network, side-by-side comparson, multiple Meta-Network comparison.



Optimizer

Why Use This Report

Adapt the link structure of a Meta-Network to maximize or minimize selected measure values.

Input :

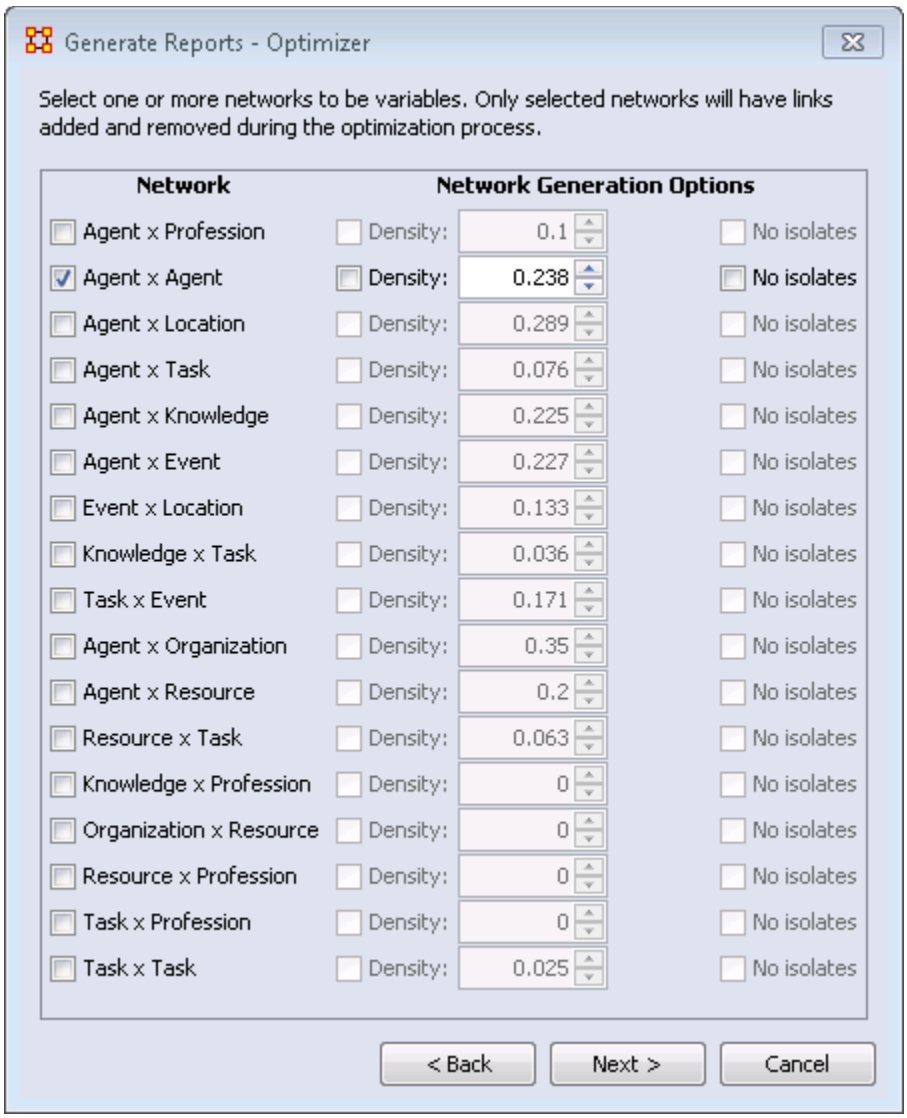
Any network in the selected Meta-Networks, with or without isolates.

Parameters :

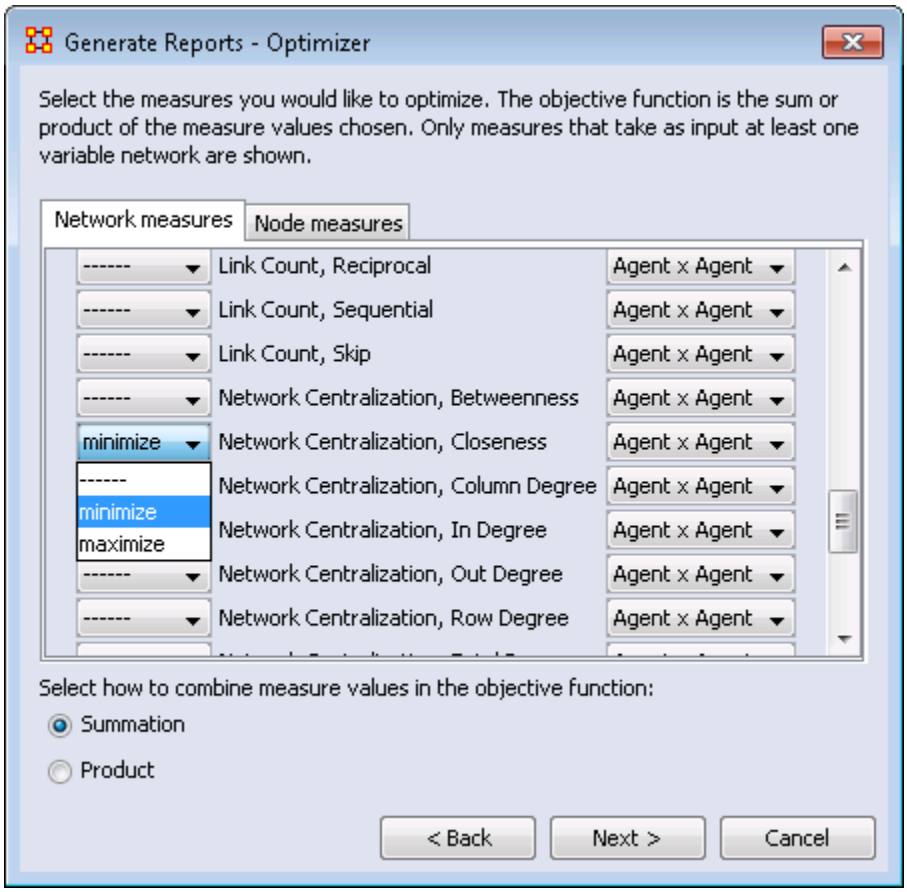
Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the networks to optimize.



Next select the Network and Node measures to run. For each you can choose either **minimum or maximum**.



Output :

Single Meta-Network.

Part of Speech

Why Use This Report

This report will identify the part of speech from the concepts in a text set. The networks are typically formed from AutoMap with a part of speech (pos) attribute on each concept node. It can operate on any network (meta-network, semantic network, or concept network) as it makes use of only the nodes of the network.

Describe the distribution of concepts by part of speech in one or more networks.

Semantic Network	Betweenness Centrality and Total Degree Centrality

Input :

Any network in the selected Meta-Networks which contains an attribute named **Frequency** and that that attribute contains numeric values.

NOTE : The Nodeset to analyze needs an attribute which contains the parts of speech. This is usually titles **pos**.

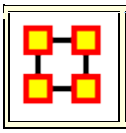
Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, multiple Meta-Network comparison.



Potential Errors

NOTE : This report only available in the full version.

Why Use This Report

Detects potential errors in agent to agent interactions based on the expected interactions from cognitive similarity and expertise.

Homophilly	Cognitive Similarity, Cognitive Expertise

Input :

agent x agent

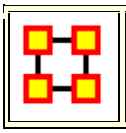
Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network.



Public Health

NOTE : This report only available in the full version.

Why Use This Report

Analyzes health department data to find potential problems.

Input :

Organizational Level Measures	
Communication Centralization, Communication Density, Clustering Coefficient, Characteristic Path Length,	agent x agent
Ranked Centrality Measures	
Betweenness Centrality, Degree Centrality, Potential Boundary Spanner	agent x agent
Task, Knowledge, Resource Networks	

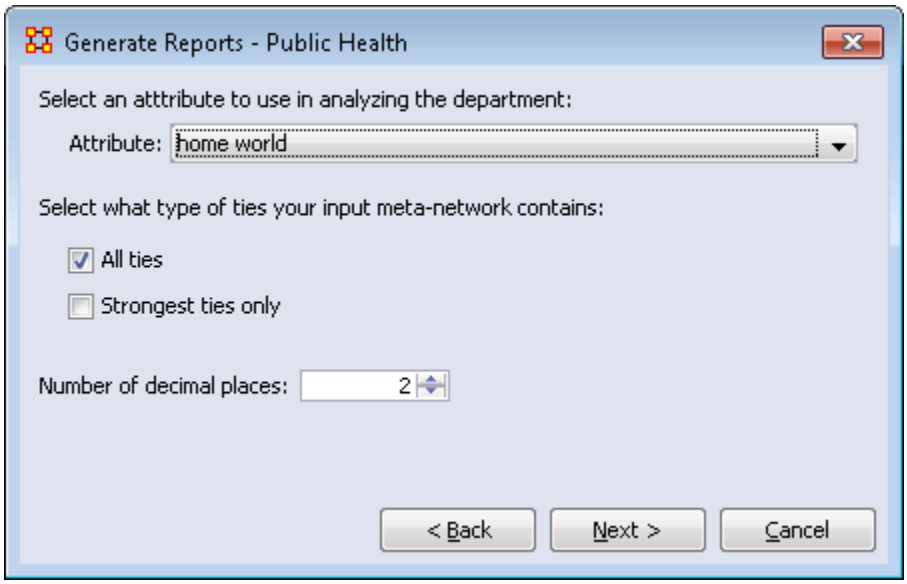
Silo Analysis	
Internal Links (same group) and External (different groups)	agent x agent

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select an attribute to use for the analysis.



Next select the tis for you input network.

Output :

Single Meta-Network.

QAP / MRQAP Analysis

Why Use This Report

Compares multiple networks to understand how two different networks relate using one network as dependent and the other as an independent network. Also useful for predicting the future of a network if there are multiple snapshots of the same network.

Computes QAP and MRQAP Correlation and Regression (Dekker and Y-Permutation methods) on input networks.

MRQAP : Used for multivariate cases if your dependent variable is continuous or count data (like in a negative binomial case), you should use MRQAP. If your dependent variable is binary, you should use ERGM (P*) which is forthcoming in ORA. One can perform MRQAP on data that have a dichotomous dependent variable (basically, this is equivalent to using a linear probability model). You do need to interpret your results accordingly.

The MRQAP report is setup to compare the networks within a single MetaNetwork: e.g. communication vs department membership. However, you can also select multiple MetaNetworks for MRQAP, but you can not do regression of a network in one MetaNetwork vs a network in a different MetaNetwork.

You can do a regression using networks in the same and or different meta-networks. Moreover, you can take a vector and create a repeated column or repeated row network and use that network in the regression as well.

QAP Analysis : Computes QAP Correlation and Regression (Dekker and Y-Permutation methods) on input matrices. QAP is designed as a bivariate test (only two variables). Generally, QAP is perfectly fine for almost any bivariate network problem.

Input :

Define the independent matrices as well as the dependent network used in the QAP calculations. This is also given a random number seed and number of permutations to run.

Lastly you can set to run any of the following: QAP Correlation, Dekker Regression, or Y-Permutation Regression analysis.

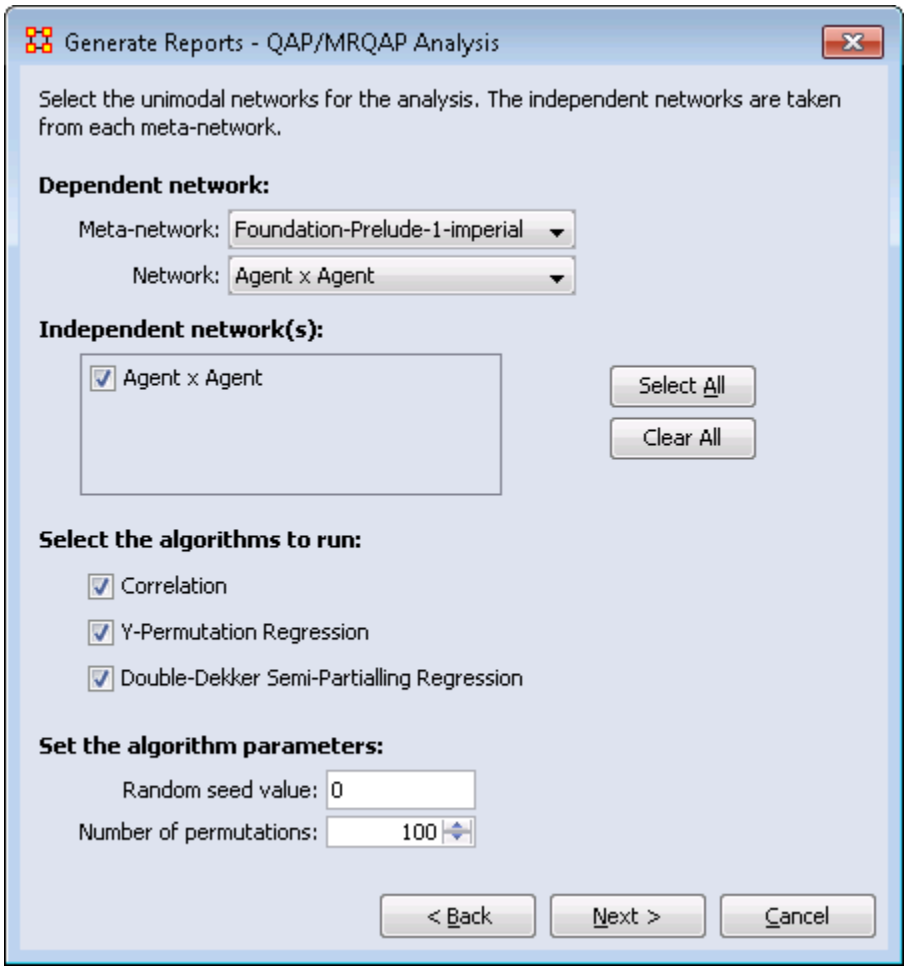
NOTE : QAP can use either directed or undirected data.

NOTE : When comparing Networks both Networks seend to be the same size.

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

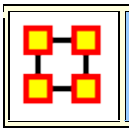


Output :

Single Meta-Network.

See Also

Regression



Role View

Why Use This Report

For each individual, finds some important measures and facts about the actor in relation to thier network.

Input

In-Degree Centrality	agent x agent
Out-Degree Centrality	agent x agent
Betweenness Centrality	agent x agent
Eigenvector Centrality	agent x agent
Exclusivity [knowledge]	agent x knowledge
Exclusivity [resource]	agent x resource
Exclusivity [task]	agent x task
Exclusivity [location]	agent x location
Closeness Centrality	agent x agent
Complete Exclusivity [knowledge]	agent x knowledge
Complete Exclusivity [resource]	agent x resource
Complete Exclusivity [task]	agent x task
Complete Exclusivity [location]	agent x location
Row Redundancy [agent]	agent x agent

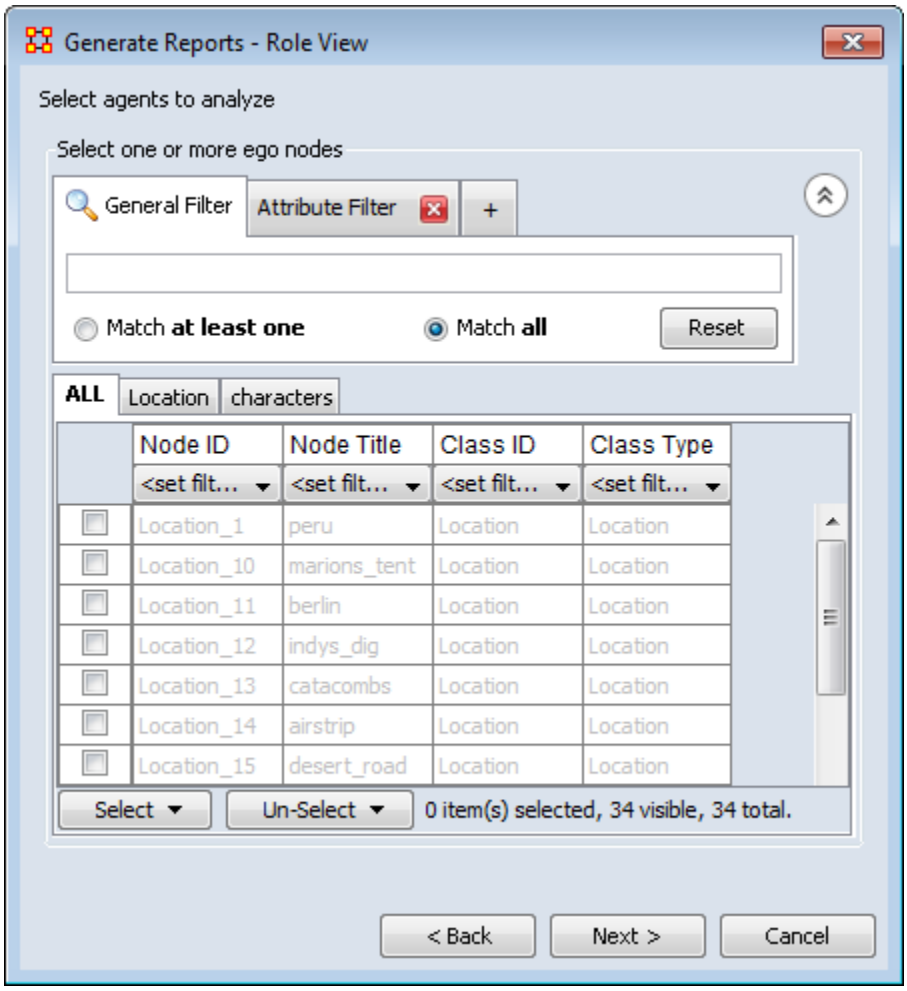
Row Redundancy [task]	agent x task
Row Redundancy [resource]	agent x resource
Row Redundancy [knowledge]	agent x knowledge
Row Redundancy [organization]	agent x organization

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the node(s) to analyze. You can use the **Attribute Filter** tab to select nodes with only certain attributes. When finished click [**Next >**].



Output :

Single Meta-Network, multiple meta-network comparison.

Rules of Engagement

NOTE : This report only available in the full version.

Why Use This Report

This report is used to aid individuals in understanding rules of engagement. A rule of engagement (ROE) is a document describing how to behave in an engagement situation. This ROE report can operate on a law document as well as an ROE.

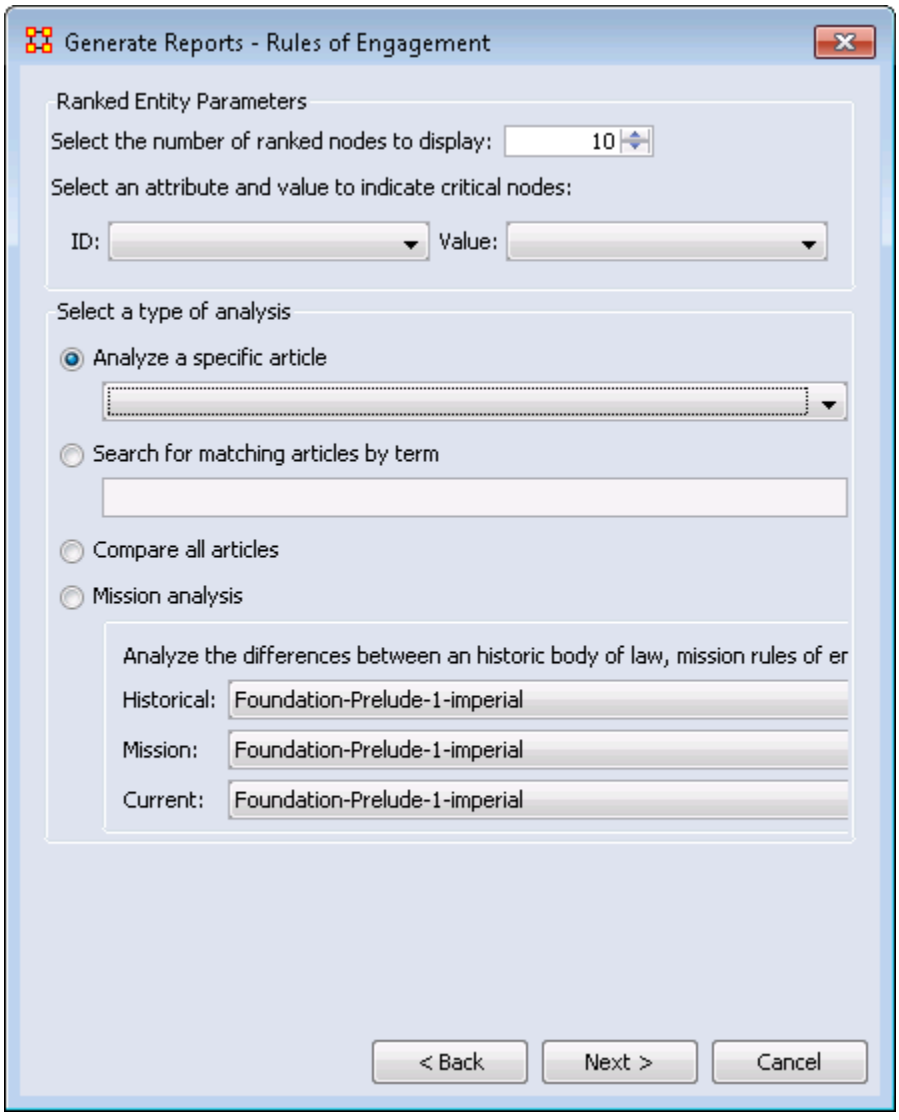
Analyzes the Rules of Engagement network and gives high level statistics on its structure.

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display. You can also select an **attribute** and **value** to further refine you analysis.



Select from one of the options for the **type of analysis**

Select a type of analysis :

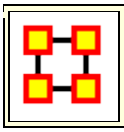
Search for a matching article by term :

Compare all articles :

Mission analysis : Analyze the difference between an historic body of law, mission rules of engagement, and current applicable laws of the sea.

Output :

Single Meta-Network, multiple Meta-Network comparison



Semantic Network

Why Use This Report

The report outputs the nodes and edges in the intersection, offset, and union. Performing map comparison can help to answer questions such as:

This report analyzes one or more semantic networks, computing central networks and key concepts and links. It assesses the connection among concepts. Will derive networks from email content, texts, or documents of any sort.

The semantics networks report analyzes one or more semantic networks, computes the central graphs, and key concepts and links. This is a comparison of two or more semantic networks. Each node in the network is considered a concept, and each link connects two concepts. Link weights are interpreted as the number of times it occurred in the underlying input text.

The report includes tests whether the two semantic networks are statistically different using four different T-tests, based on the number of nodes, the number of links, betweenness centrality, and degree centrality.

The symmetric distance of network A to network B is the number of concepts and links in A that are not in B. In set theoretic terms, this is the set difference (A - B).

This report also provides communicative power analysis. Concepts are classified according to whether they have high and low values for the measures :

Total Degree Centrality
Betweenness Centrality
Consensus

The semantic network report will perform analysis on a semantic network of concept colocations in a sentence generated by AutoMap. It will characterize the usage of words, such as a buzzword which is used but not described such as is often found in law documents. There are other word types based on how they exist within the semantic network.

Ordinary (low degree, low betweenness, low consensus)

Factoids (low degree, low betweenness, high consensus)

Buzzwords (low degree, high betweenness, low consensus)

Emblems (low degree, high betweenness, high consensus)

Allusions (high degree, low betweenness, low consensus)

Stereotypes (high degree, low betweenness, high consensus)

Placeholders (high degree, high betweenness, low consensus)

Symbols (high degree, high betweenness, high consensus)

The report also creates new networks that represent different levels of agreement between the loaded networks. The set-theoretic intersection on the 25, 50, 75% percent level is considered for this comparison. More precisely, the following outputs are computed:

The union of compared links.

The consensus between networks as it is represented by the intersection of links.

The dissension between networks as it is represented as the difference.

Do different people use the same words and themes in the same way?

Do different people link concepts and themes in the same way?

Do different people share the same knowledge?

How similar or different are the analyzed texts?

Input :

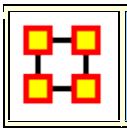
Set the percentage of maps a link must be in in order to be included in the central network.

Output :

Single Meta-Network, side-by-side comparison.

Select whether to generate hamming distances between Meta-Networks.

[1] Carley, K.M., Network text analysis: The network position of concepts, in Text Analysis for the Social Sciences: Methods for Drawing Statistical Inferences from Texts and Transcripts, C.W. Roberts, Editor. 1997, Lawrence Erlbaum Associates, Inc.: Mahwah, NJ, USA. p. 79-100.



Shortest Path

Why Use This Report

Computes the shortest path between two entities and general statistics on the paths. The sphere of influence of each entity is also computed.

Input :

Organizational Level Measures	agent x agent
Ranked Centralizty Measures	agent x agent

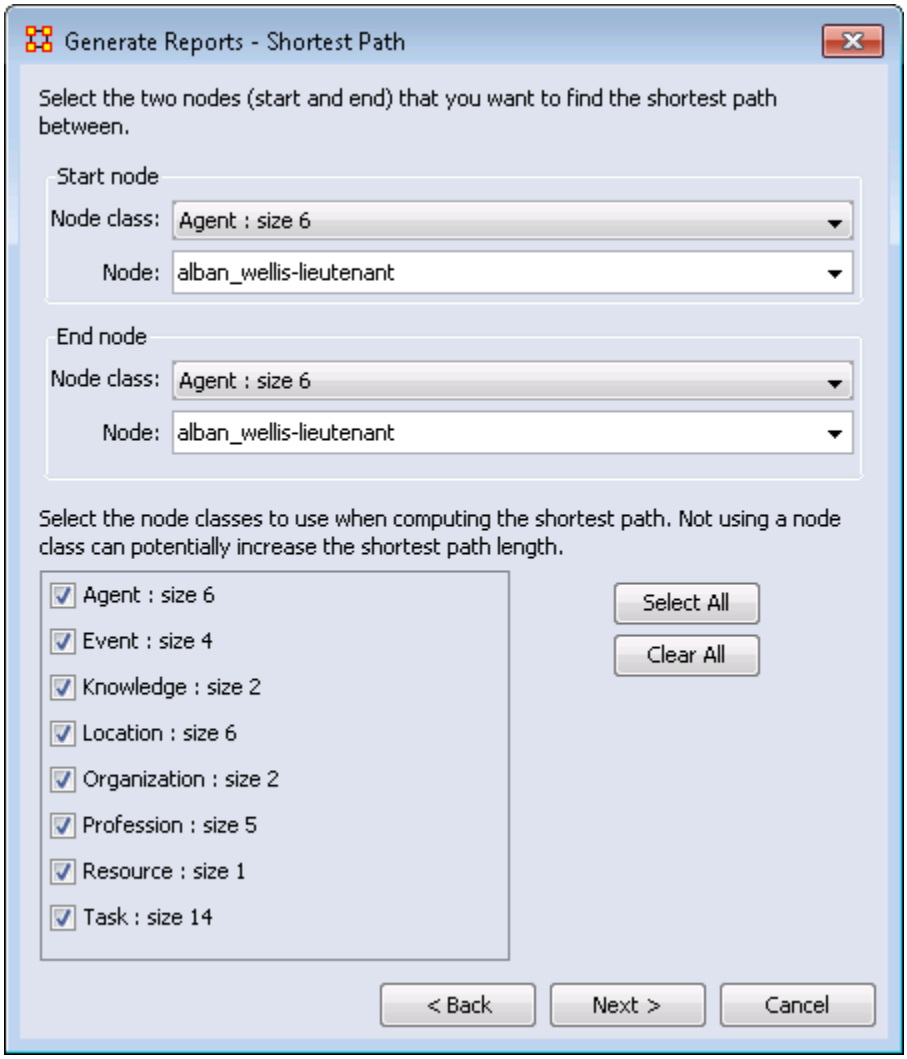
Task, Knowledge, Resource Networks	
Silo Analysis	agent x agent

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

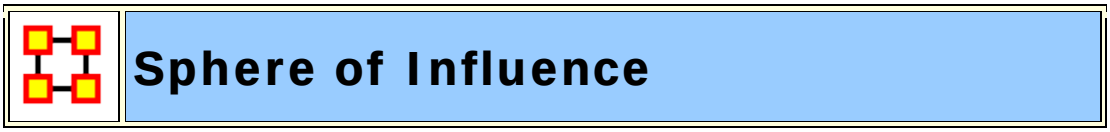
Dialog Box 3 : Select a **Start** and **End** node.



In the bottom section place a check mark next to all Nodesets that can be used when computing the shortest path.

Output :

Single Meta-Network.



Sphere of Influence

Why Use This Report

The Sphere of Influence report will provide information relative to one particular node in the network. This report is used when the impact of an individual (person, organization, location, etc.) and what the individual is directly connected to.

For each individual, identifies the set of actors, groups, knowledge, resources, etc. that influence, and are influenced, by that actor.

Any network. But it's most interpretable if you have an agent by agent and also have another network such as agent by knowledge or agent by resources or agent by location.

Input :

Cognitive Demand	agent x agent
Centrality, Total Degree	agent x agent
Clique Count	agent x agent
Centrality, Row Degree	agent x knowledge
Centrality, Row Degree	agent x resource
Centrality, Eigenvector	agent x agent
Centrality, Hub	agent x agent
Centrality, Authority	agent x agent
Centrality, Betweenness	agent x agent

Boundary Spanner, Potential	agent x agent
Exclusivity	agent x knowledge
Exclusivity, Complete	agent x knowledge
Exclusivity	agent x resource
Exclusivity, Complete	agent x resource
Exclusivity	agent x task
Exclusivity, Complete	agent x task
Exclusivity	agent x event
Exclusivity, Complete	agent x event
Exclusivity	agent x location
Exclusivity, Complete	agent x location
Actual Workload	agent x knowledge
Shared Situation Awareness	agent x agent

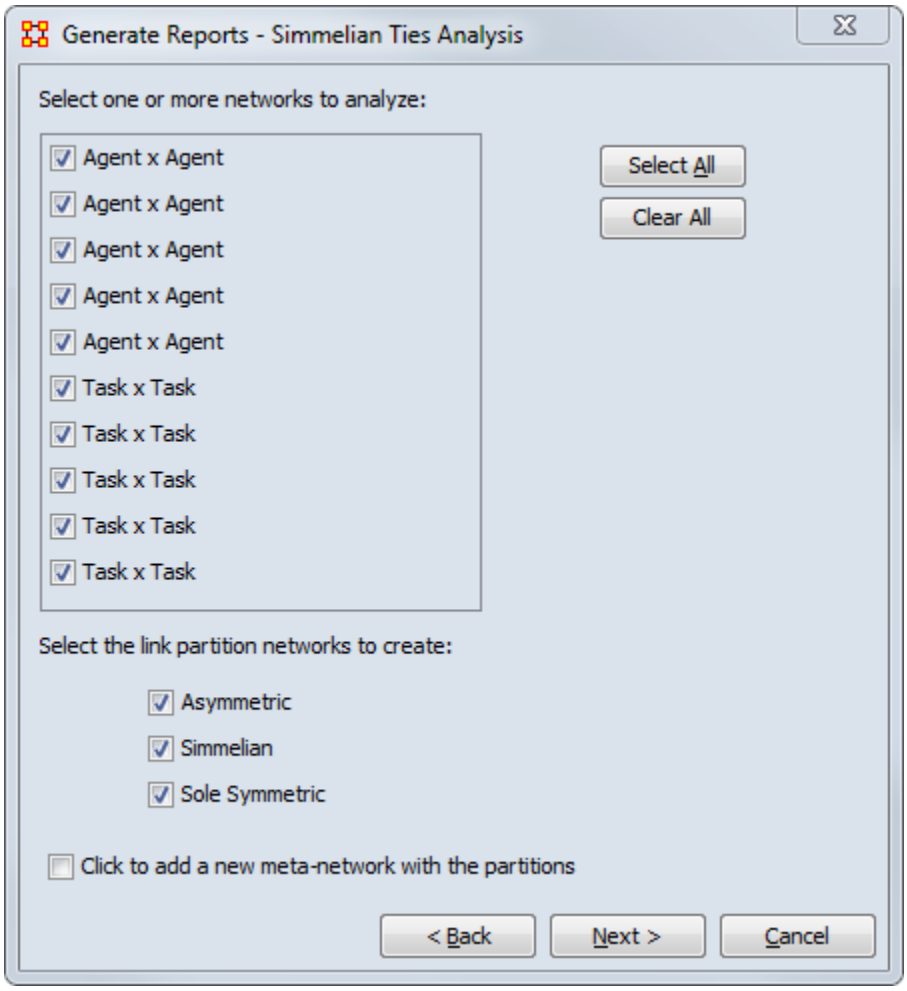
Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select a **Start** and **End** node.

Place a check mark next to all Networks to analyze.



Select all, some, or none of the following options:

Output :

Single Meta-Network.

Standard Network Analysis

Why Use This Report

This report calculates the standard network analysis subset of all the measures possible for a network. This report is often used for convenience of calculating the measures that may be reported separately from the report, such as when writing a journal paper. Unlike many of the other

reports that put the measure into the context of the need, this report produces measures suitable only for people who understand social network analysis.

Calculates the standard network analysis measures (Degree Centrality, Betweenness, etc).

This report calculates the standard network analysis measures such as Degree Centrality, Betweeness Centrality, etc. This report can be used on any "square network" where all the nodes are of one type; e.g., a people x people or resource x resource network. The standard network analysis measures typically provide an analyst with a broad overall picture of the structure of the network. If the user selects two or more networks, this report will compare the results.

Input :

A Single Meta-Network with any number of Nodesets and Networks. All applicable measures will be run on these networks.

Measure	Level
Authority centrality	**Node**
Betweenness centrality	**Node**
Betweenness centrality	Network
Characteristic path length	Network
Clique count	Network
Clique membership count	**Node**
Closeness centrality	Network
Closeness centralization	Network
Clustering coefficient	**Node**
Column count	Network
Component count	Network
Connectedness	Network
Degree centralization	Network
Density	Network
Efficiency	Network

Eigenvector centrality	**Node**
Hierarchy	Network
Hub centrality	**Node**
In-degree centrality	Network
Information centrality	**Node**
Isolate count	Network
Link count	Network
Network levels (diameter)	Network
Network fragmentation	Network
Out-degree centrality	Network
Reciprocity	Network
Row count	Network
Simmelian ties	**Node**
Total degree centrality	**Node**
Upper Boundedness	Network

Output :

Single Meta-Network, side-by-side comparison. The report will be split into individual pages for each Network and how the results of the measures on each.



Statistical Change Detection

Why Use This Report

Analyzes the changes in network-level measures over time using a Statistical Process Monitoring (SPM) control chart. Control limits are determined based on a user defined level of risk.

Statistical Change Detection	The entire Meta-Network OR agent x agent **-or-** task x task

Input :

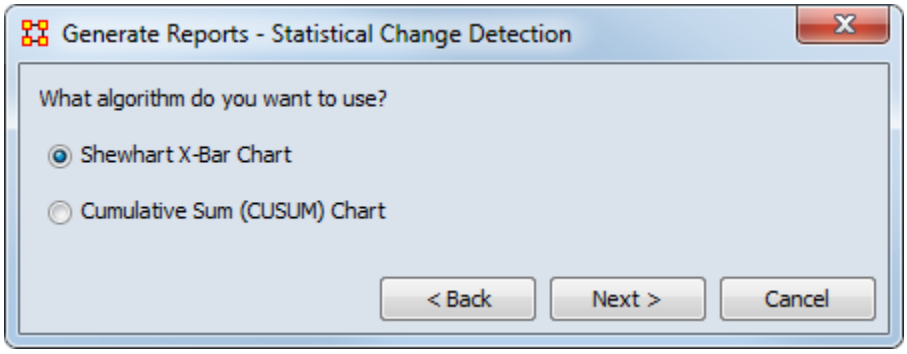
At least three Networks.

Parameters :

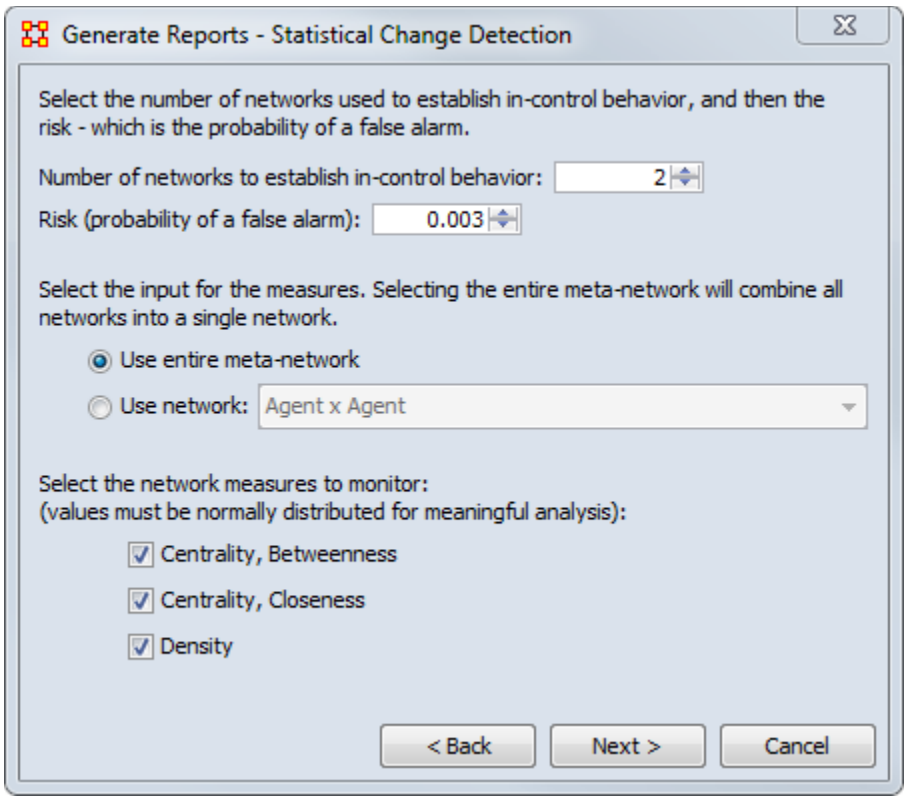
Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select an algorithm: **Shewhart X-Bar Chart** or **Cumulative Sum (CUSUM) Chart**.



Dialog Box 3 : Next set the Number of Networks and the Risk Probability of False Alarm.



Choose whether to use the entire Meta-Network of one individual Network.

Finally select all, some, or none of the following measures to run: **Betweenness Centrality, Closeness Centrality, or Density**.

Output :

Single Meta-Network, multiple Meta-Networks.

Statistical Distribution

Why Use This Report

Fits statistical distributions to a network based on measure values.

When characterizing network topologies, it is important to consider the role of errors and incomplete data in the network. The Statistical Context and Communicators reports will provide additional analysis on network

topologies and actors, respectively. For additional work on this subject, please refer to:

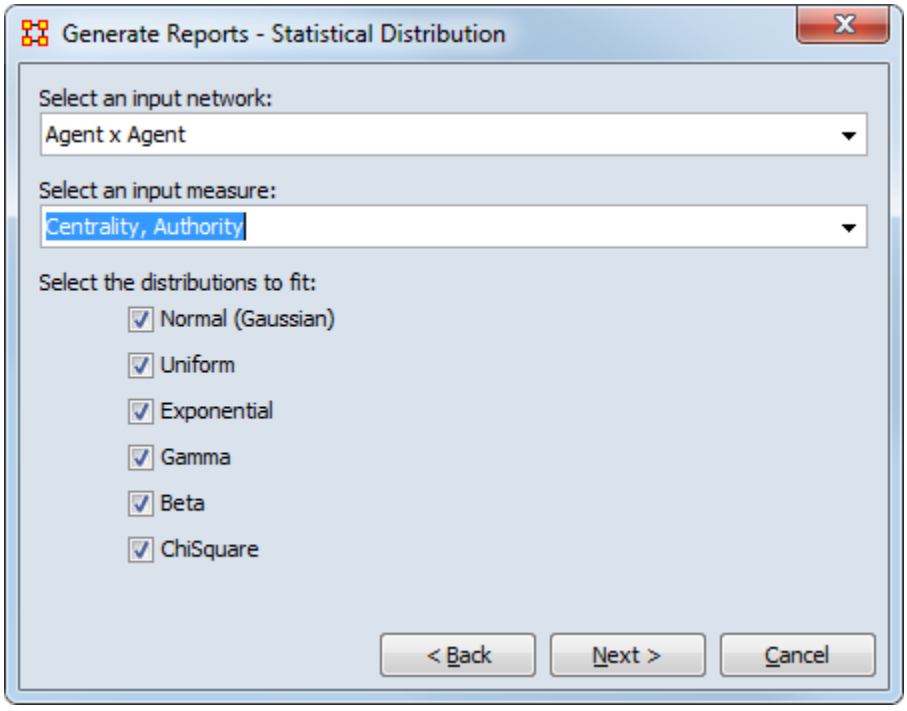
Method of Least Square Error [LSE], Method of Maximum Likelihood Estimation [MLE], Method of Moments [MOM]	Centrality Authority

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select a **Input Network** and an **Input Measure**.



Select all, some, or none of the following distributions:

Normal (Gaussian) :

Uniform :

Exponential :

Gamma :

Beta :

ChiSquare :

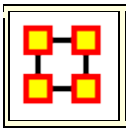
Output :

Single Meta-Network.

References

"Relating Network Topology to the Robustness of Centrality Measures", CASOS Technical Report, Terrill L. Frantz, Kathleen M. Carley May 2005.

"On the robustness of centrality measures under conditions of imperfect data", Borgatti, Carley, Krackhardt. /Social Networks/ 28 (2006) 124-136.



Tactical Insight

NOTE : This report only available in the full version.

Why Use This Report

Use this to identify the important agents, locations and time periods in scenario data where you have geospatially located agents communicating over time.

Analyzes the top agent nodes across time periods, tracking locations and measure values.

Top Agenet, Common Locations, Final Location	Total egree Centrality, Betweenness Centrality

Input :

At least three networks.

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Output :

Single Meta-Network, Multiple Meta-Network comparison.



Topic Analysis

Why Use This Report

Finds topic clusters in a collection of text meta-networks using the LDA and LSA algorithms.

Concept vs. Frequency, Topic Membership, Latent Semantic Analysis	Concept(s) with Maximum Value, Concepts with Top-Ranked Membership Values

Input

Every node is included and considered as a concept. The frequency of each concept is determined by the value of its frequency attribute.

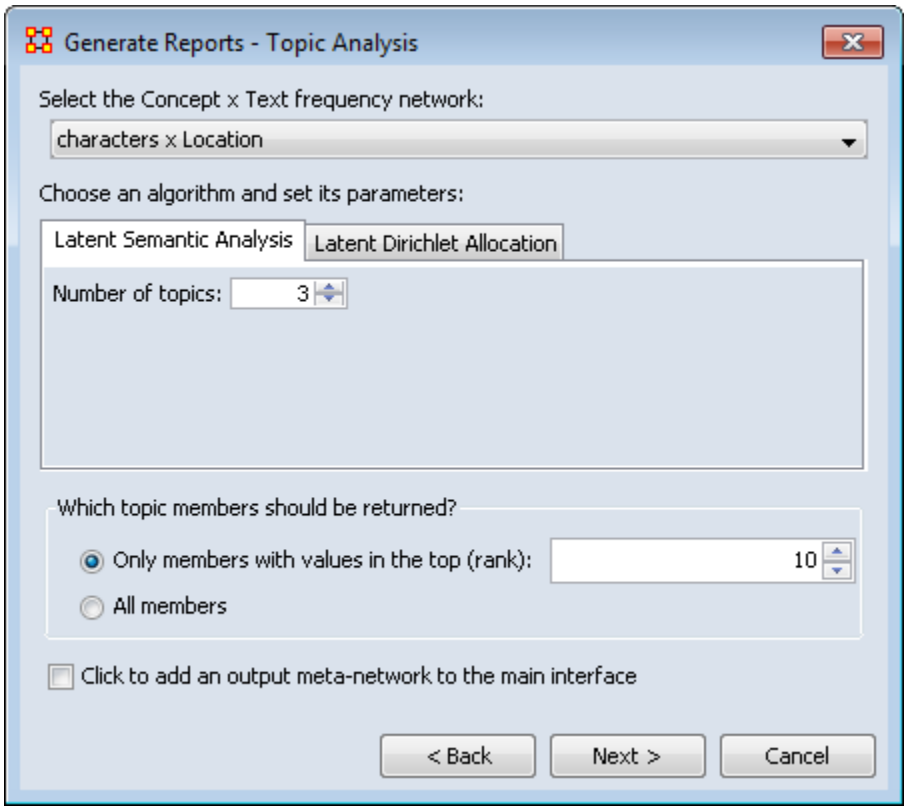
NOTE : Requires an attribute **Frequency** to exist in the Meta-Network

Parameters

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first Dialog Box also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select Latent Semantic Analysis [LSA] or Latent Dirichlet Allocation [LDA]. LSA request the number of topics. LDA adds to this he Number of Iteratins, Step Size, anbd Beta.



Output :

Single Meta-Network, side-by-side comparison, multiple Meta-Network comparison.

Trails

Why Use This Report

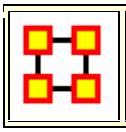
Analyzes the trails that an entity class makes through another entity class, for example, how vessels pass through ports.

Input :

At least two networks. Also requires data in trails format so the report can show **who or what** was **where or when**. Could also be **who or what** interacted with **who or what** when.

Output :

Single Meta-Network.



Trails Analysis

Why Use This Report

Good for tracking and visualizing individual actors' geographic movements across a discrete space set over discrete time steps. Good for identifying trends like 1) is there any resemblence between different actors' moves? 2) are some locations more popular than others? 3) Is there a certain time range during which a big movement was triggered?

Analyzes the trails that are found in the Trails Viewer. It does this by analyzing the trails of one Nodeset as it makes its way through another Nodeset (e.g. how vessels pass through ports).

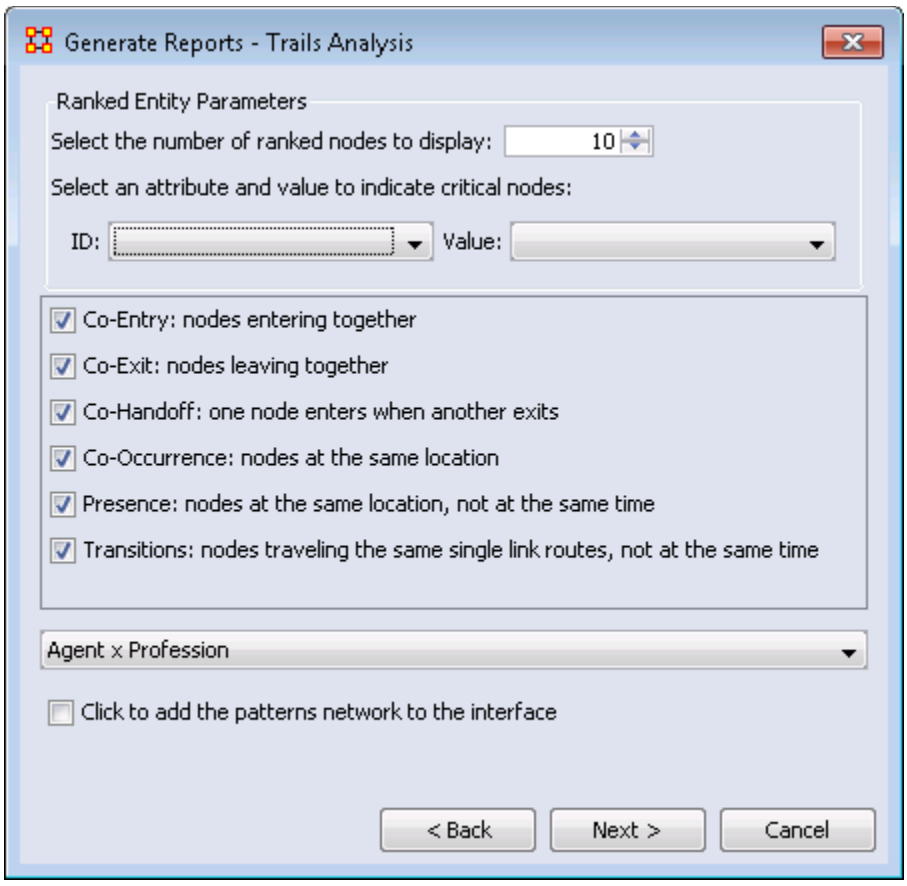
Betweenness Centrality, Clique Count, Co-Exit Analysis, Co-Location Analysis, Co-Movement Analysis, Co-Occurrance Analysis, Eigenvector Centrality, Presence, Total Degree Centrality, Transitions, Unique Links

Parameters :

Dialog Box 1 : Select the Meta-Networks to use in the analysis. The first panel also gives you **Transformation** options for the final results.

Dialog Box 2 : Next select both the **Nodesets** and the **Networks** to analyze. Placing a check mark in the box at the bottom will create a new Meta-Network.

Dialog Box 3 : Select the number of nodes to display.



The bottom section allows you to refine your analysis. Place a check mark next to each option desired.

Co-Entry : Nodes entering another node together.

Co-Exit : Nodes leaving a node together.

Co-Handoff : One node enters when another node exits.

Co-Occurrance : Nodes at the same location.

Presence : Nodes at the same location but not at the same time.

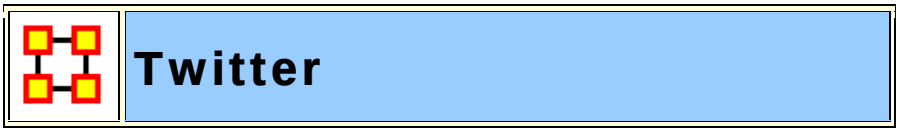
Transtitions : Nodes traveling along the same link route but not at the same time.

From the drop down menu choose the Network to analyze.

Finally, place a check mark in the bottom box to add this new pattern network to the Meta-Network.

Output :

Single Meta-Network with multiple Meta-Network comparison.



Twitter

Why Use This Report

Finds tweeters of influence.

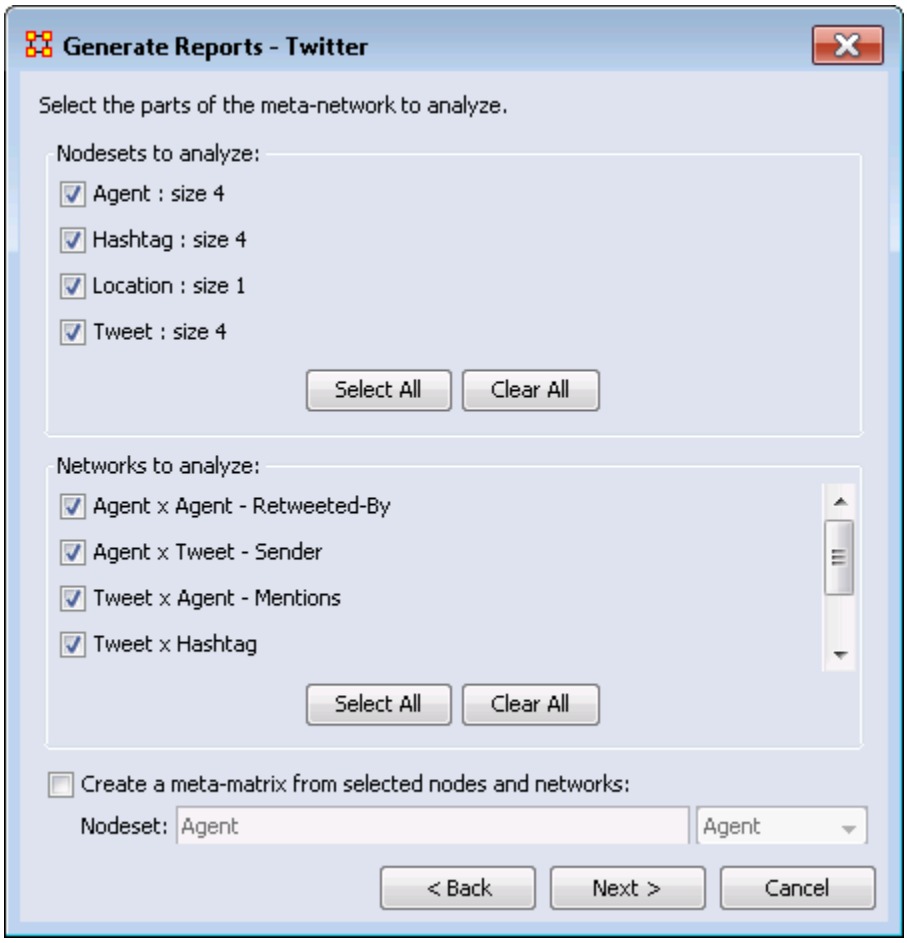
Input :

Identifies key tweeters and tweets in a meta-network derived from twitter data.

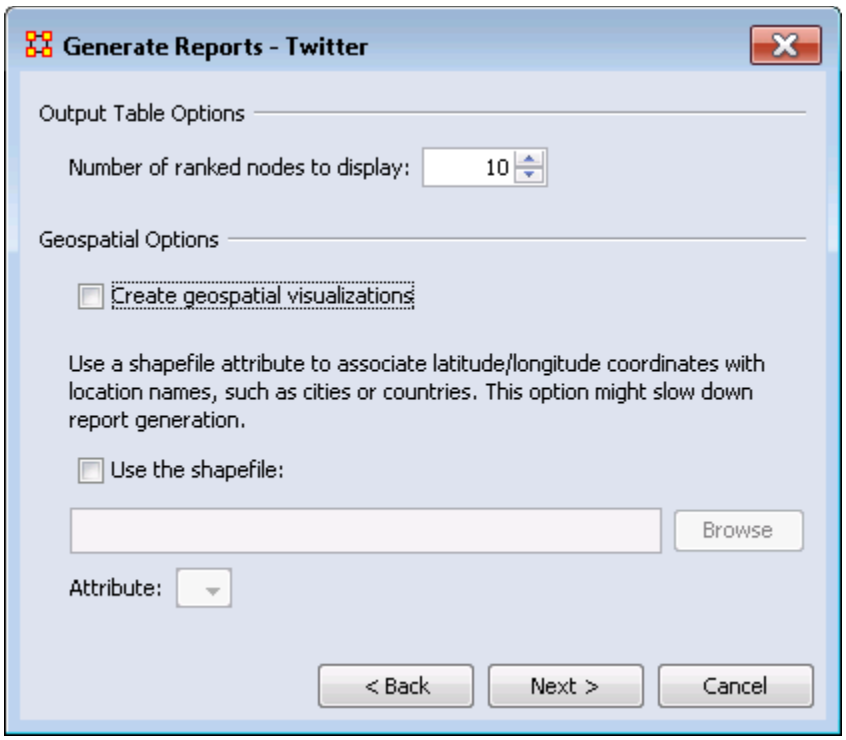
Parameters :



Dialog Box 1 : Select the Meta-Networks to use in the analysis. For Dynamic Networks, click [**Select All**] underneath the Meat-Network then click [**Next >**]



Dialog Box 2 : Select the **Nodesets** and the **Networks** to analyze. Place a check mark in the box at the bottom will create a new Meta-Network. Click [**Next >**]



Dialog Box 3 : Select the number of nodes to display. You can create a **GeoSpatial Visualization** by placing check marks in the to boxes then click [**Browse**]. This allows you to select a ShapeFile for the GeoSpatial Visualizer. click [**Next >**]

Select the format types for the reports, set the folder to save them in and enter a report prefix. click [**Finish**]

Output :

Single Meta-Network with side-by-side comparisons.

The report lists an analysis of: Tweeters, Hashtags, Locations, and Tweets.

AboutThe Twitter Report

It identifies key influencers, their target audience, and the connection of key influencers to the target audience

We need in the report a list of key influencers and then for each a separate page for each actor (each key influencer) listing number of direct followers, secondary followers (followers of followers) number of direct retweeters, secondary retweeters (number of those retweet the retweet)

Where is the influencer : The city and country or just country

Their region of influence : What geographic region they and their retweeters and followers are in - i.e. show a shape file with the region colored shaded over in a polygon or the snake circles

What topics/hashtags do they tweet about : Show their hashtag network and the hashtags in the retweets. Plus the connections among the hashtags in their messages [in one color] and the connections to other hashtags in the retweets [in another color].

Fraction pf follower/retweet : Of all tweeters on those hashtags, what fraction is in the follower/retweet network of the high influence individual

Trend of Influence : Trend line with change in that person's influence (number of retweeters, number of followers) by day

Trend of Hashtags : Trend line with change in number of hashtags that person tweets by day

Power Brokers : Who are the power brokers in the networks and social networks. List top tweeters in k-betweenness (k=3), degree centrality, and k-closeness (k=3).

Sub-Networks : Find sub-networks that are consistent through time i.e. a group of tweeters and retweeters that are connected in multiple time periods -- note this is less critical than the other things

Wants to be an Influencer (high outdegree) : These sites tend to retweet frequently. However, they may not actually influence others as their follower circles or likelihood of being retweeted may be small. Those sites that are verified are likely to be more influential. Top n individuals in outdegree (show rank, absolute value, normalized for all, just verified, and just unverified)

> **Use :** AA : "Retweets" - link(i,j) is the number of times that agent i retweeted agent j. Out-degree therefore measures the degree that an agent retweets (is a retweeter). Then use those i that retweet the most j - not weighted => link count only.

Actual Influencer (high weighted out-degree) : These sites send messages which are reaching a large number of others either directly due to their followership or indirectly due to the followership of those that retweet or mention them.

Use : AA : "Retweets" - link(i,j) is the number of times that agent i retweeted agent j PLUS AA : "Mentions" - link (i,j) is the number of times that agent i mentions agent j in his tweets. then use the top n j such that sum of number of followers of j, number of i who retweet j multiplied by followers of i sum of number of mentions of j multiplied by followers of i

Directly Influential (high degree in followers) : These sites have the most followers. Top n sites with the most followers

Trusted or Interesting Source (high in-degree) : These sites tend to be retweeted frequently. This suggests widespread trust or interest in what they say. Those sites that are verified are likely to be very trusted sites; whereas, frequently retweeted unverified sites may be emergent or locally trusted sites. Top n individuals in outdegree (show rank, absolute value, normalized for all, just verified, and just unverified)

Use : AA : "Retweets" - link(i,j) is the number of times that agent i retweeted agent j then identify those j that have the most i

Potential Reach (K-closeness using weighted data) : These sites have disproportionate influence as they are relatively close to a large audience and can reach them quickly. These sites on average frequently tweet, retweet or mention others in their tweets, and their tweets are frequently retweeted or mentioned and then those retweets are frequently retweeted and so on. Top n individuals in k-closeness using weighted data (show rank, absolute value, normalized for all, just verified, and just unverified)

Use the union of these networks : AA : "Retweets" - link(i,j) is the number of times that agent i retweeted agent j - multiplied by followers of i **PLUS** AA : "Mentions" - link (i,j) is the number of times that agent i mentions agent j in his tweets - multiplied by followers of i and find k-closeness in that.

Potential Connectors (high k-betweenness) : These sites are disproportionately active in disseminating information. These sites on average frequently retweet or mention messages and are are then frequently retweeted or mentioned. Top n individuals in k-betweenness using weighted data and k= 4 (show rank, absolute value, normalized for all, just verified, and just unverified)

Use the union of these networks : AA : "Retweets" - link(i,j) is the number of times that agent i retweeted agent j - multiplied by followers of i **PLUS** AA : "Mentions" - link (i,j) is the number of times that agent i

mentions agent j in his tweets - multiplied by followers of i and find k-betweenness in that

Most Mentioned (high in-degree in mentions network) : These sites are mentioned the most. This may indicate a dialogue, strong agreement or strong disagreement.

Use : AA : "Mentions" - link (i,j) is the number of times that agent i mentions agent j in his tweets provide those j that are mentioned in the most tweets

Potential Consensus Leaders (high total degree in common hashtag network) : These are the sites that tweet about the most items also tweeted about by others.

Use : AA : "Common HashTags" - link(i,j) number of common hashtags that agents i and j used

Weighted Potential Consensus leaders : These are the sites that tweet about the most items also tweeted about by others s.t. those topics directly reach the largest audience.

Lessons

Below are links to lessons on how to perform many common dynamic network analysis tasks as well as using ORA in general:

An Overview of the ORA GUI panels

Meta-Networks: From the beginning

Running a Key Entity Report

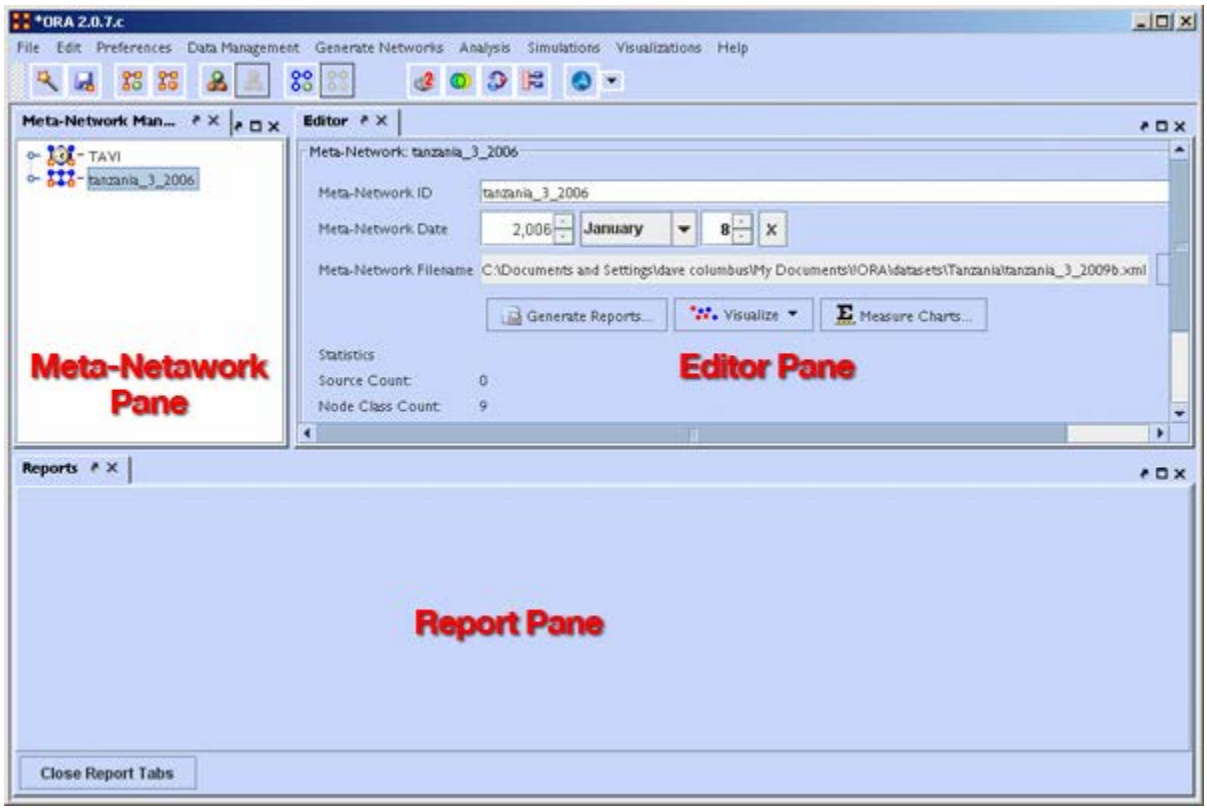
Using The Over-Time Viewer

Working with The Network Converter

Change Detection

Working With Attributes

ORA Overview



The **Main Menu** runs across the top of the window, and the rest of the screen is divided into three panels.

Below the menu is the **Toolbar**. ORA starts with buttons to add and remove Meta-Networks, Nodesets and Networks. Using the inverted triangle you can add or delete buttons from this strip.

The Meta-Network Pane displays a list of the Meta-Networks that has been loaded into ORA, its components and sub-networks. To view information about a particular meta-network or sub-network, single-click on it.

The Editor Pane displays information about the meta-network or sub-network highlighted in Panel 1.

The Report Pane displays information about the results of analyses run on your meta-network.

Loading a meta-network into ORA

You have three options for opening your meta-network in ORA:

- From the main menu select **File ⇒ Open Meta-Network**. A small window titled **Help: Opening meta-network** pops up. Your data should already be in the correct format, so click **[OK]**.
- Next, a file chooser titled **Open** pops up. Browse to the location of your dataset, **single-click on it**, and **click the Open button** in the bottom right corner.
- **Click** the first icon in the row directly below the menu bar. It looks like a half-open file folder. A window titled **Import Data into ORA** will pop up. **Click** the Select Files button. A file chooser titled **Open** pops up. Browse to the location of your dataset, single-click on it, and click the Open button in the bottom right corner. You will be returned to the **Import Data into ORA** window. Click the Finish button in the bottom right corner.
- **In panel 2**, click the **Load button** on the far right. A window titled **Import Data into ORA** pops up. Click the Select Files button. A file chooser titled **Open** pops up. Browse to the location of your dataset, single-click on it, and click the Open button in the bottom right corner. You will be returned to the **Import Data into ORA** window. Click the Finish button in the bottom right corner.

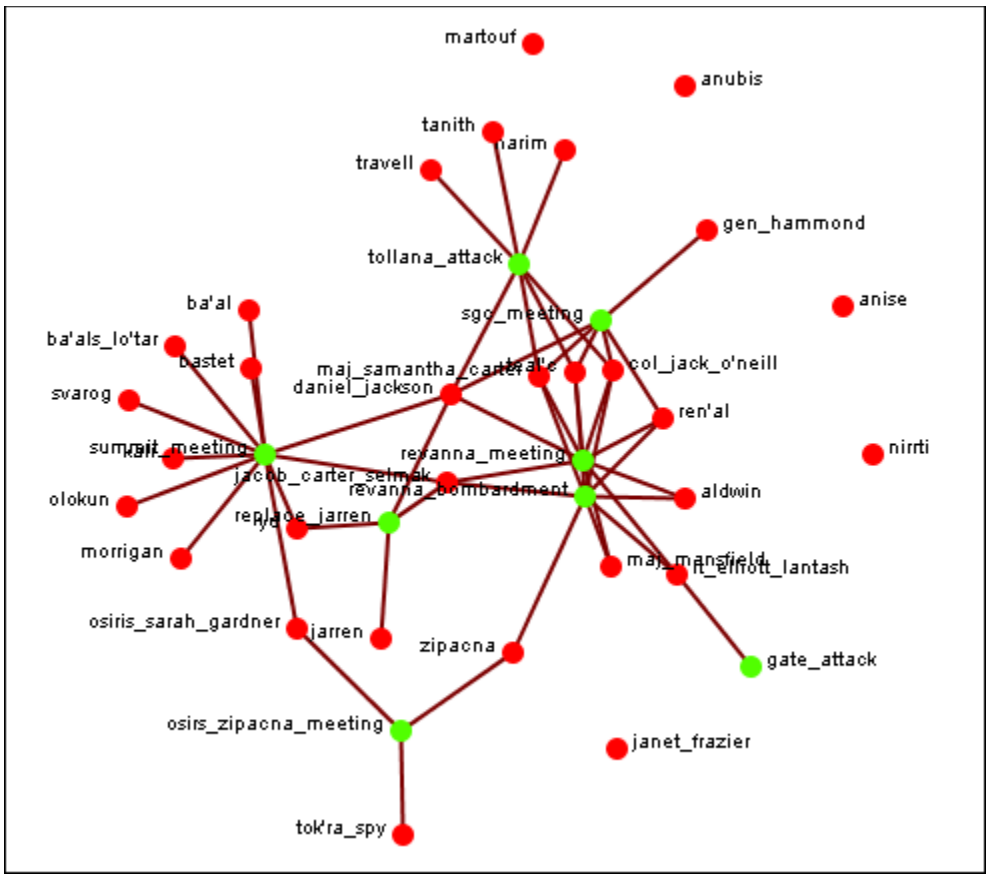
A list of your meta-network and sub-categories in Panel 1, as well as the location and basic statistics of your meta-network in Panel 2 will appear. ORA is ready to begin analyzing the meta-network.

The Visualizer

To visualize a meta-network, first make sure the meta-network you wish to visualize is highlighted in Panel 1. If it is not highlighted, single-click on it.

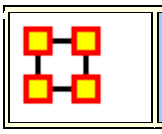
In Panel 2, click the Visualize this Meta-Network button. A new window will pop up displaying your meta-network graphically. A small legend also appears.

Below is a screen capture showing the visualization of the **agent x event** graph from the Stargate Summit Meta-Network.



The visualization displays the connections between all items in the **Stargate Summit Meta-Network**. The red circles represent the agents, the green circles represent individual events in the scenario, and the lines represent the connections between the agents and the events.

You'll notice there are agents with no connections to any events. They represent nodes that were connected to the scenario but not to the particular events of the Summit timeline.



Creating a New Meta-Network

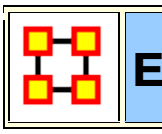
These lessons will give you the information in order to create a **Meta-Network** from data you have on-hand.

Lesson - 101

This section describes the process of looking over your data and deciding what is relevant for inclusion into a Meta-Network. It takes the examples I used for the Stargate dataset.

lessons - 201-207

A step by step run through of creating the Meta-Network from working with Excel, exporting data to csv files and finally building a complete Meta-Network.



Examine Your Data

General Thoughts

When you first open up ORA you need to construct a Meta-Network. But the question is, how do you go about this task?

First, you need to understand what constitutes a Meta-Network. The basic building blocks of all Meta-Networks is a **Node***. Similar nodes are combined to build **Nodesets***. Nodesets are combined to make **Networks***. Multiple networks are combined to create a **Meta-Network.***.

It is up to you on **HOW** to construct the individual Nodesets and Networks and how to combine the Networks into a Meta-Network. This means you need to gather as much information regarding the scenario as possible **(who, what, when, where, and how)**

Knowing as much about the scenario as possible is important. Information about the people involved, where these people were seen, what items they had available and used, what they knew, what tasks they performed, what

resources are needed to perform those tasks, etc. The more relevant information you collect the better your final Meta-Network. will be.

NOTE : For this lesson I will be using the Foundation Trilogy-1 dataset.

I found that for the help file using a set of data where you **know all the answers** helps. But that won't always be the case. If you already know what the results are supposed to be then it's easy to build a correct Meta-Network.

But the most important part of this is it helps you to learn what to look for. You'll initially make mistakes but if you instantly jump into creation mode then, well, since you're not sure how to build this in the first place then how can you be sure your Meta-Networks are built correctly in the first place?

What's a Nodeset Class

There are **ten Nodeset Classes** used in Foundation: **Agent, Resource, Knowledge, Task, Organization,, Location, Event, Action, Belief, and Role**. ORA contains the ability to create new Nodeset Classes but in most cases that's entirely unnecessary because most of ORA measures are designed to work with most common eight classes mentioned above.

With **Foundation** the agents were easy - find the important characters in the story. The locations were also easy using scenes form the story. It was the events, knowledge, resources, and tasks which became slightly harder to discern. I'll admit there were multiple **false starts** *(missing some events, unnecessary locations, misplaced knowledge/resources)* before I came to a proper conclusions.

Nodesets can be either **binary (0 or 1)** or **numbered (negative #, 0 or positive #)**. A Meta-Network. can contain a combination of the two types.

When building Nodesets and Networks (and then onward to Meta-Networks) you'll discover that many networks are are very apparent while others were almost invisible. You'll have some large networks while others may be extremely small. But all networks are necessary to produce the complete Meta-Network.

And the depth of the Nodesets can be extended by affixing **attributes*** to them.

Foundation uses attributes to give extra information such as an agent's **gender or job title**. Any addition information can be placed into an attribute.

Agents (Who)

It's usually best to start out by constructing the **Agent Nodeset**. This helps reveal many facets of the rest of the Meta-Network. Gather all possible information about the **Agents** involved. If a new piece of information appears for an Agent then fill in the blanks for the rest of the Agents.

The **Foundation Agent Nodeset** contains a mere 10 agents. The information I deemed important for attributes were **gender, home world, and Job Title**.

After you've collected all the agents involved you can proceed to creating your first network. Figure out which agents had any contact with each other and place a **1** in the corresponding cell. Depending on the particular circumstances you will have to establish criteria for an association. An **Agent x Agent** network creates a **Square Network** meaning the names in the rows are identical to the columns.

The **Foundation Meta-Network** was fairly easy to construct the agent Nodeset and Agent by Agent Network. But Remember, real life data doesn't always come with such an **easy to see** diagram. After a Meta-Network is constructed it very likely that new information will surface which will change the face of the current Meta-Network. and, thusly, the results of any reports.

There are three modes of thought in creating connections. **1)** The most common would be to say if one agent knows another agent then place a 1 in the cell. **2)** Next would be to use the preceding criteria but to weight the ties where one person could have a **higher regard** for a person more than there are reciprocal feelings. **3)** The third would be to use a hierarchical style showing who reports to who in a organizational tree situation. It's important that the person creating the Meta-Network makes a call whether there is and and how strong a tie will be. Multiple variations were gone through in the creation of the **Foundation Meta-Network**.

As you learn more about Meta-Networks it becomes easier to see which mode you need to use.

You might not create a Meta-Network. correctly the first time **(or the second or the third time)** if you rush into it. Best to take a little time and review the information before heading straight into the creation process.

Sometimes **too much information** will find it's way into your Meta-Network.

A little time spent on reviewing the data and any reports will greatly improve your chances of getting it **somewhat** right in the first place. It will also help in your deciding the best way to build your Networks.

NOTE : Remember, you'll always find **something** that you think needs tweaked as more and more information is uncovered.

Events (When)

Creating an **Events Nodeset** is a little more difficult than for either agents or locations. Agents and locations are **tangible items** whereas events are **intangible**. They also depend on the interpretation of the individual creating the Nodeset. Events can include items like Foundation's **Hari Seldon meeting Gaal Dornick and The trial of Hari Seldon**.

Many of the events in **first part of Foundation** were easy *(the meetings, the trial, the funeral)*. You may find events in your dataset a little more difficult to discern.

When plotting events it may be necessary to show **what order** they occurred. What happened first, second, third, and so on. This helps discern which agents are needed in which parts of the scenario. One method would be to give it an attribute with a numbering system.

Another would be to link one event to the next event in line. To create an ordered **event x event** network start with the row of earliest event. Place a check mark in the column for the next event. Find the row for the column you just check marked. Follow that to the column with the next event. Proceed in this manner till you have all your events. You may, as happened in the Stargate Network, that two events sprout from a single event. They may, or may not. converge back to an ending.

Knowledge (What)

Many times more than one person knows the same thing. And other times there is a single person who has some vital knowledge. This is a way to help find out if one person is completely indispensable or whether there are other pathways to accomplishing the goal.

In **Foundation** the knowledge **mathematics** is known by **Hari Seldon, Gaal Dornick, and Wanda Seldon**. But only **Hari Seldon and Wanda Seldon** have the knowledge **psychohistory**. But only Bor Alurin knows **Psychology**.

Locations (Where)

Next create a **Nodeset** of all the **locations** involved in the scenario. Locations are places like Foundation's **Streeling University and the Imperial Palace**

For the **Foundation Meta-Network** it was a simple matter of following the book and marking down who was in what scene. Not quite a simple when you've got less than perfect data.

Create a list of all possible locations and use your best guess as to whether that location is important. Remember, just because people are seen in a location doesn't mean it's important to the Meta-Network. You may have a location you think is important initially but come to find that nothing happened of interest there (or visa versa).

For the **Foundation Meta-Network.** it was difficult to focus in on the exact **locations** necessary. The first time only the major locations were used, but it was difficult defining specific tasks. Then all locations were added but it ended up have many isolates and pendants that became unnecessary. I finally settled five important locations.

Organization

Organizations usually consist of groups of people banded together for a common goal. This can range from a large political group [**Republicans or Democrats**] to The Three Musketeers [**Athos, Porthos, and Aramis**]

In **Foundation** these organizations were mostly specialty groups like **The First and Second Foundations and the Empire**.

Profession

Professions can define any activity an agent partakes in **i.e. Federal Judge, Fireman, or Crack Dealer**.

For **Foundation** I had mostly normal professions like **Attorney, Judge, and Psychologist** but also the story contained some special ones like

Psychohistorian and Aristocrat. You list whatever jobs the agents are doing.

Resources (What)

Resources can be very similar to **knowledge** and many times these two overlap. It's not necessary to always have both.

You may find that it is necessary for a node to have a certain knowledge before they can use a certain resource. In **Foundation** it is necessary to have knowledge of **mathematics** before you can use the resource **prime radiant**. There is no special knowledge necessary to listen to the **Seldon Psychohistory recordings**.

Tasks (How)

Tasks are things that are done by the agents such as Foundation's **preside over Seldon's trial or force exile of encyclopedians**.

A task network can be set up to show the order that tasks need to be done in order for the scenario to be played out. For example, *procuring materials to build something* is always necessary before *building something* but not necessarily before *planning*. This is usually done with a directed graph **(i.e. a link from procuring to building but not the other way around)**.

As in the example of **Events** above certain tasks need to be completed before others can be started. **Foundation** uses a **binary, directed** network showing a pathway of which tasks **are required** to be completed before the next task can be started. **spy on Gaal Dornick for emperor and deliver message for Seldon lead to preside over Seldon's trial which then leads to force exile of encyclopdians**. Other networks can be much more complicated than this.

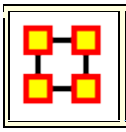
Tasks are exclusively attached to agents. You can't have a **location, event, etc. performing a task**. But this is not to say that you can't have a task attached to a location as it might necessarily need to be done at a certain location or a resource necessary to complete a task.

Linge Chen could only **preside over Seldon's trial** at **the Imperial Palace**. Nor could **Gaal Dornick** do the task **seal Seldon recordings in Vault** anywhere but on **Terminus**.

Networks

After creating all your **Nodesets** you then move on to creating **Networks**. Every Meta-Network. will require a slightly different set of **Nodesets and Networks**. Below are the **Foundation** Nodesets.

The **Foundation Nodesets** consist of: agent x agent, agent x event, agent x knowledge, agent x location, agent x organization, agent x profession, agent x task, event x event, event x location, knowledge x knowledge, knowledge x profession, knowledge x resource, knowledge x task, organization x event, organization x resource, organization x task, profession s knowledge, resource x event, resource x location, resource x organization, resource x profession, resource x resource, resource x task, task x event, task x location, task x profession, and task x task.



Excel and CSV

You learned from **Meta-Network 101** about how to survey your data, the different forms it can take, and how to make it a fit for ORA. In this lesson we'll go through the procedure of creating a Meta-Network using the Foundation dataset in some practical examples.

Your first Nodeset

Your first Nodeset will more than likely be an **Agent Nodeset** since all other Nodesets are either referred to/or by the Agent Nodeset Review you data and make a list of the people involved.

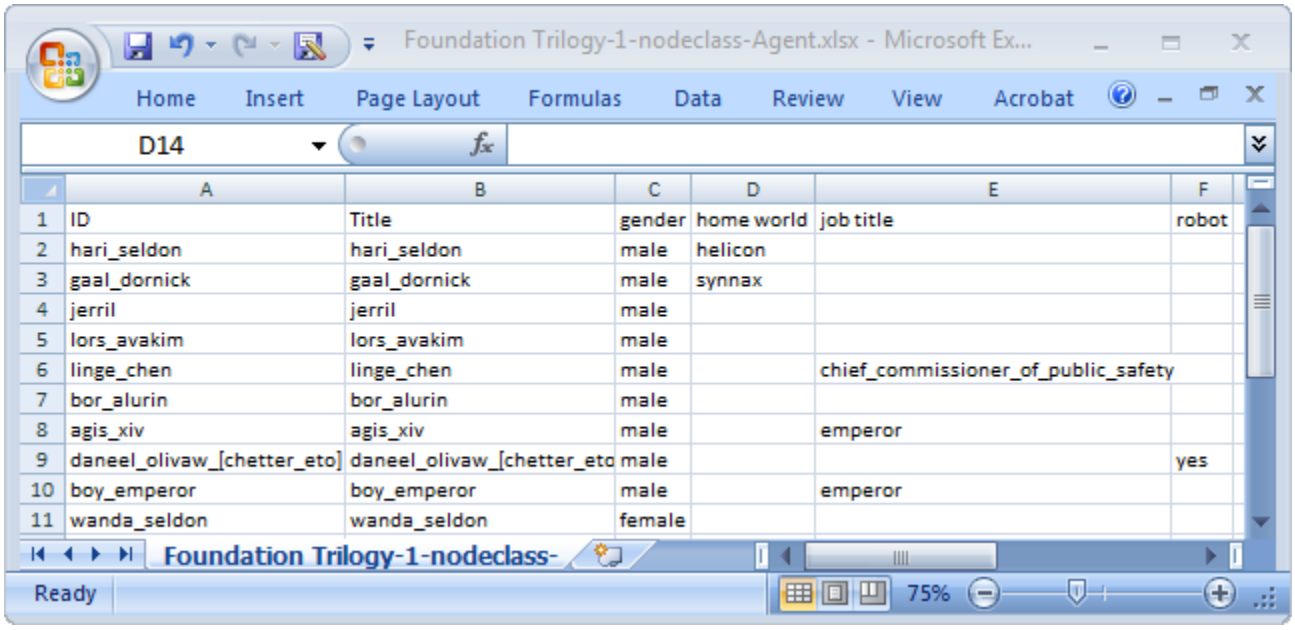
After reading **The Foundation Trilogy** I decided to break it up into 9 sections. In the first section I came up with 10 important Agent nodes.

What program should be used to create the information?

You need a program that can create **.csv** files that your system can read. **Microsoft Excel is an excellent choice** as it has good copy/paste features, multiple spreadsheets in one files, and known compatibility with ORA.

The Agent Nodeset was created with names of the characters which were used for both the **Node ID and the Node Title**. Some people use anoynomous Node IDs like **A1, A2, A3...**. The order of the Agents is unimportant as long as you keep the relationship between IDs and Agents consistent throughout your work. The IDs are what allows ORA to match information in various files.

NOTE: If using IDs like **A1** I've found prefixing 0 or 00 to the number helps when sorting. **i.e. A01-A99 for up to 100 Agents**.



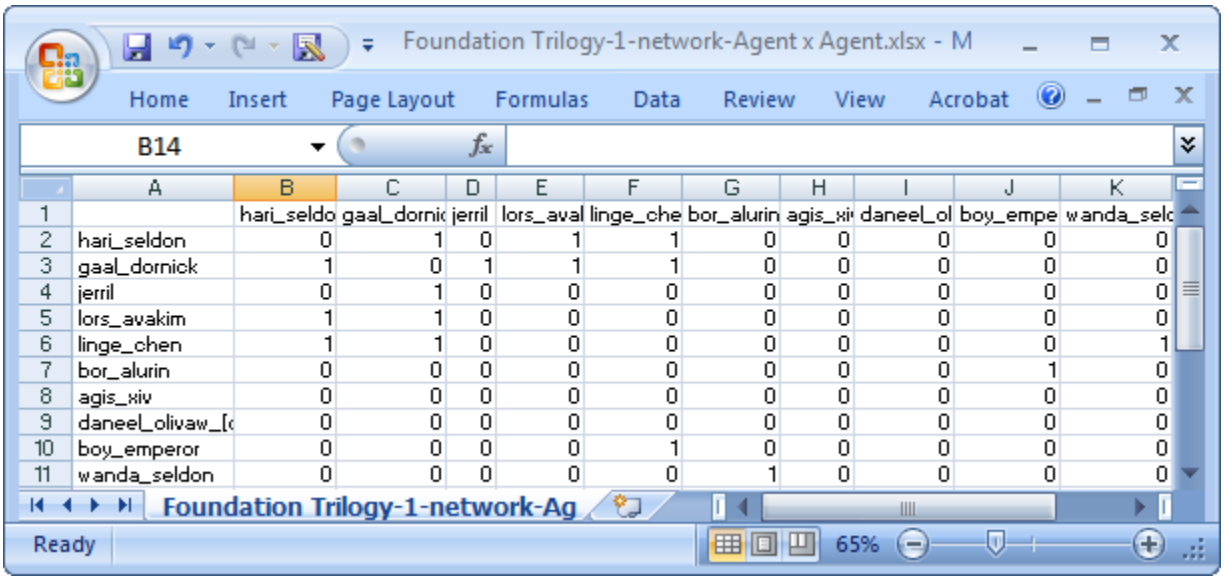
	A	B	C	D	E	F
1	ID	Title	gender	home world	job title	robot
2	hari_seldon	hari_seldon	male	helicon		
3	gaal_dornick	gaal_dornick	male	synnax		
4	jerril	jerril	male			
5	lors_avakim	lors_avakim	male			
6	linge_chen	linge_chen	male		chief_commissioner_of_public_safety	
7	bor_alurin	bor_alurin	male			
8	agis_xiv	agis_xiv	male		emperor	
9	daneel_olivaw_[chetter_eto]	daneel_olivaw_[chetter_eto	male			yes
10	boy_emperor	boy_emperor	male		emperor	
11	wanda_seldon	wanda_seldon	female			

Your first Network

Now that the Agent Nodeset is done the next item is to create an **Agent x Agent** Network. As described in **Meta-Network 101** just how your Agents interact with one another is subjective to the type of Network you have.

Create a new spreadsheet in Excel and copy the Agent IDs in column A starting with row 2. Then paste the same IDs in row one, starting at column 2, using the Transpose function. In Excel 2010 **Copy the information; Click the Home tab; click the downward triangle under the Paste icon; select Transpose.**. The same set of Agent IDs will be placed in row 1. Now you can begin constructing your links by placing your values for the **Agent by Agent** connexions in this matrix.

The **Foundation** made a connection whenever any two Agents met face-to-face. This is often the way networks are constructed but there are other ways to make connections **i.e. hierarchical command structure or weighted importance of the connection**.



	A	B	C	D	E	F	G	H	I	J	K
1		hari_seldo	gaal_dornic	jerril	lors_aval	linge_che	bor_alurin	agis_xi	daneel_ol	boy_empe	wanda_selc
2	hari_seldon	0	1	0	1	1	0	0	0	0	0
3	gaal_dornick	1	0	1	1	1	0	0	0	0	0
4	jerril	0	1	0	0	0	0	0	0	0	0
5	lors_avakim	1	1	0	0	0	0	0	0	0	0
6	linge_chen	1	1	0	0	0	0	0	0	0	1
7	bor_alurin	0	0	0	0	0	0	0	0	1	0
8	agis_xiv	0	0	0	0	0	0	0	0	0	0
9	daneel_olivaw_[	0	0	0	0	0	0	0	0	0	0
10	boy_emperor	0	0	0	0	1	0	0	0	0	0
11	wanda_seldon	0	0	0	0	0	1	0	0	0	0

The rest of the Nodesets and Networks

Next you have to decide what other Nodesets you need...

I created Foundation Nodesets for **Events :** important Events during the course of the story, **Knowledge :** important information known by individual Agents, **Location :** where particular Events took place, **Organization :** larger bodies which the individual Agents belonged to, **Profession :** jobs the individual Agents were placed in, **Resource :** material objects important to the story, and **Task:** specific jobs Agents accomplished, or tried to accomplish.

Then I had to decide how these Nodesets interacted with each other. Also, how important any particular Network was to the overall story.

For Foundation I decided I created a wide range of Networks. Many of these were created for specific display purposes and may not be entirely necessary in your particular ciscumstance.

Agent x Agent, Agent x Event, Agent x Knowledge, Agent x Location, Agent x Organization, Agent x Profession, Agent x Resource, Agent x Task, Event x Event, Event x Location, Knowledge x Knowledge, Knowledge x Profession, Knowledge x Resource, Knowledge x Task, Organization x Event, Organization x Resource, Organization x Task, Profession x Knowledge, Resource x Event, Resource x Location, Resource x Organization, Resource x Profession, Resource x Task, Task x Event, Task x Location, Task x Profession and Task x Task.

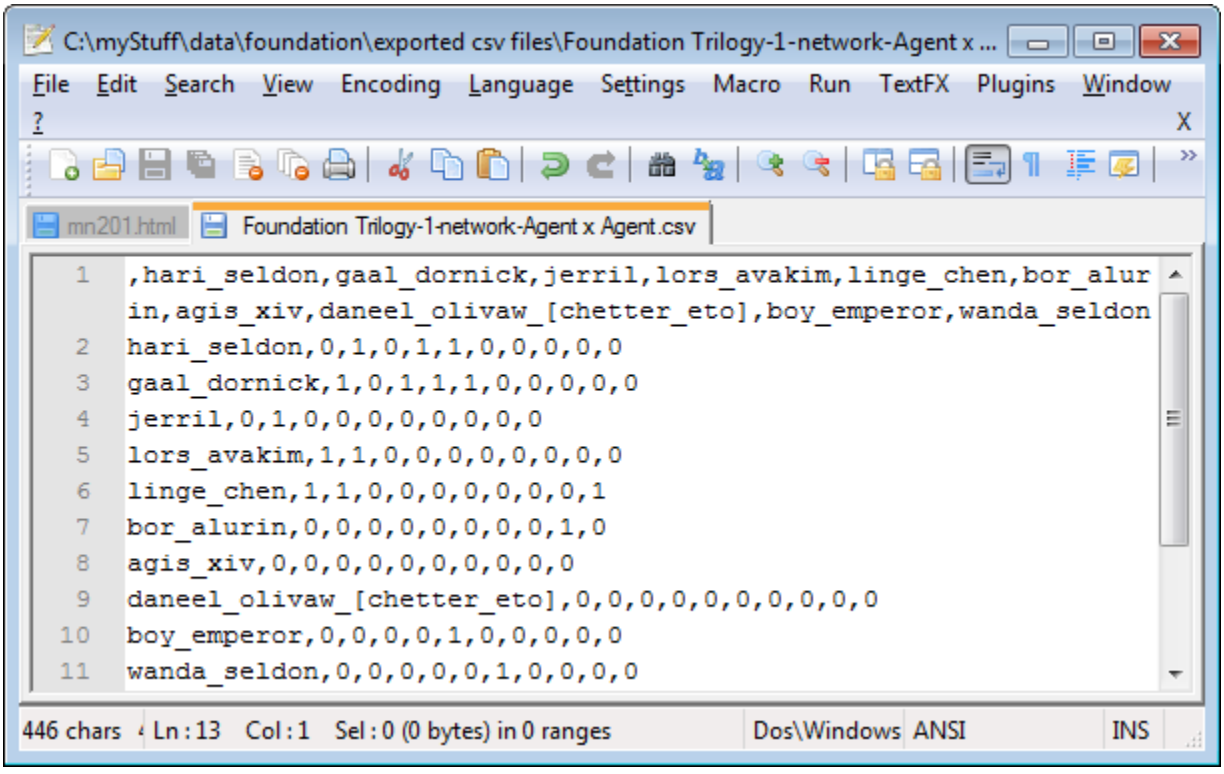
Each Meta-Network will require different handling and may require more or less networks.

Then, as done in the Agent x Agent network, decide how the various nodes interact with each other for each Network. When finished you will have spreadsheets from which you can create all your **.csv** files.

NOTE: You can keep these as separate spreadsheets or combine them in a single spreadsheet. This is a personnal preference.

Saving as .CSV files

The next step is to convert these Excel file to a format that ORA can import, namely the .csv format. This is easily done with Excel's **Save As** function. Select the Excel spreadsheet you want to convert to CSV. From the Excel main menu select **Save As**; scroll down to **Other Formats**; Navigate to the directory to save your file; from the **Save as type** select **CSV (Comma-delimited) (*.csv)** and click **Save**.



You can now convert all your Excel spreadsheets to CSV files in preparation for importing into ORA.

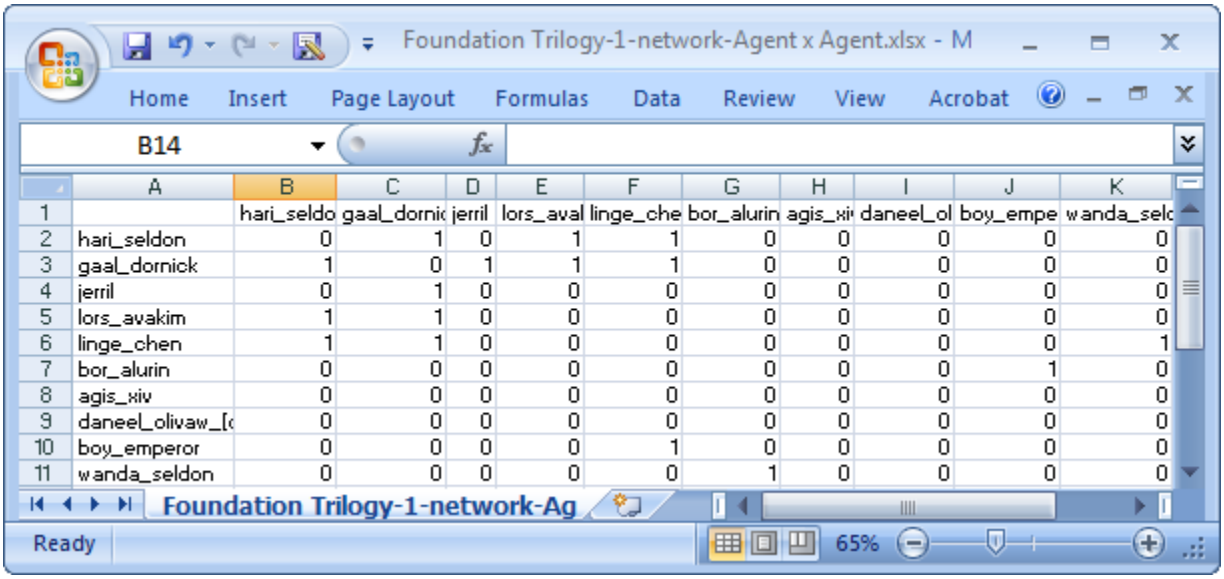
Import into ORA

NOTE : If you are visiting this page from the help section on the **Data Import Wizard**, what follows is a series of lessons using the Data Import tool with the Foundation sample data set. You can start from the very beginning of this lesson by going to the preceding **Meta-Networks 101** lesson)

Now that we've got the Excel spreadsheets created and converted to **.csv** files it's time to learn about **importing a CSV file into ORA**.

The Datasets

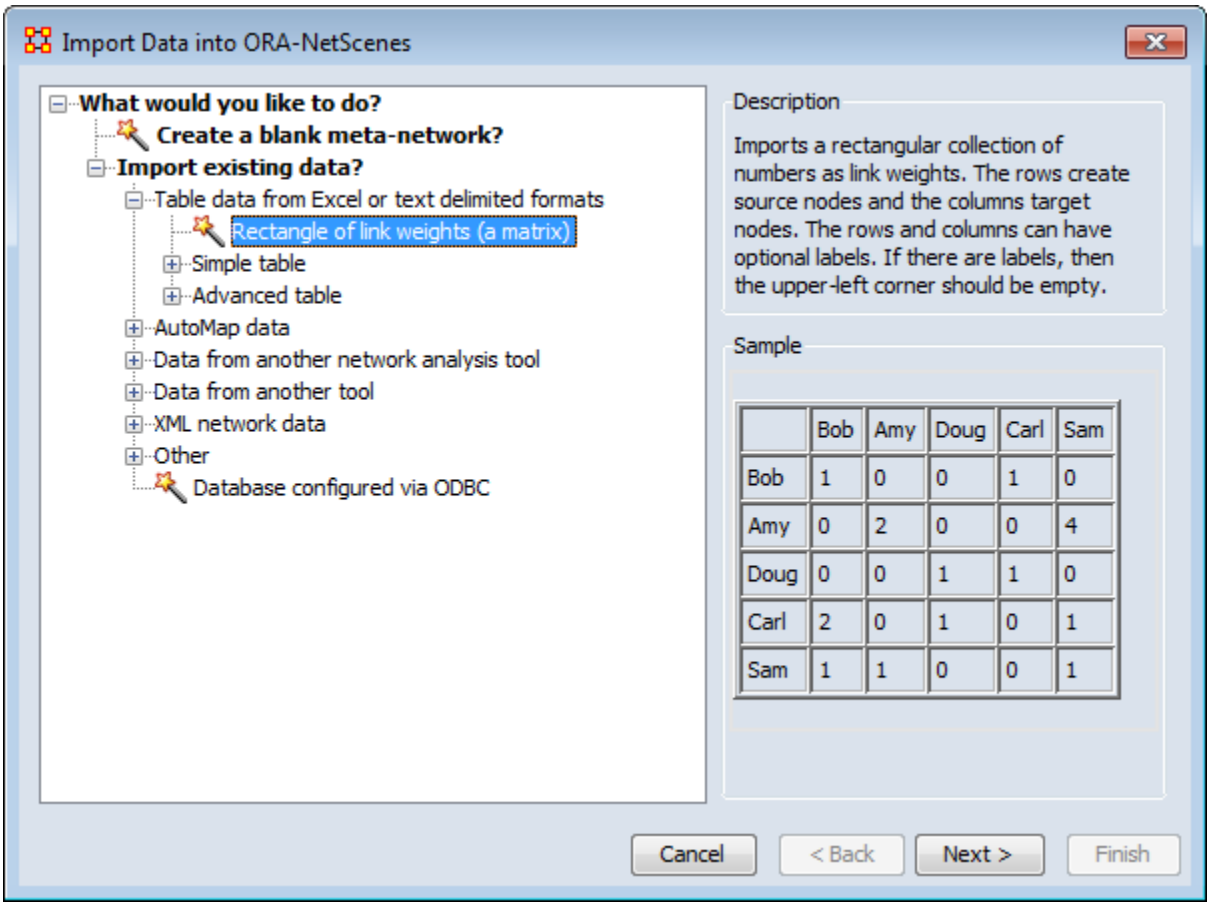
Below is the file we will be importing. It denotes **who has met who** in the first Foundation section.



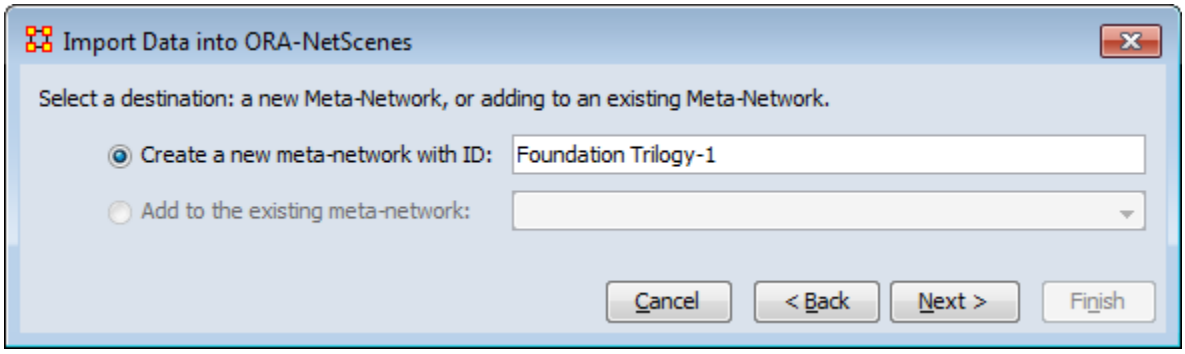
	A	B	C	D	E	F	G	H	I	J	K
1		hari_seldo	gaal_dornic	jerril	lors_aval	linge_che	bor_alurin	agis_xi	daneel_ol	boy_empe	wanda_selc
2	hari_seldon	0	1	0	1	1	0	0	0	0	0
3	gaal_dornick	1	0	1	1	1	0	0	0	0	0
4	jerril	0	1	0	0	0	0	0	0	0	0
5	lors_avakim	1	1	0	0	0	0	0	0	0	0
6	linge_chen	1	1	0	0	0	0	0	0	0	1
7	bor_alurin	0	0	0	0	0	0	0	0	1	0
8	agis_xiv	0	0	0	0	0	0	0	0	0	0
9	daneel_olivaw_[	0	0	0	0	0	0	0	0	0	0
10	boy_emperor	0	0	0	0	1	0	0	0	0	0
11	wanda_seldon	0	0	0	0	0	1	0	0	0	0

Starting a new Meta-Network

From the main menu of ORA, select **File > Data Import Wizard** or hit **Ctrl-W**. The Data Import dialog asks **What would you like to do?**. For this example we will be importing a network comprised of links so select **Rectangle of link weights (a matrix)**. Then click **[Next >]**.

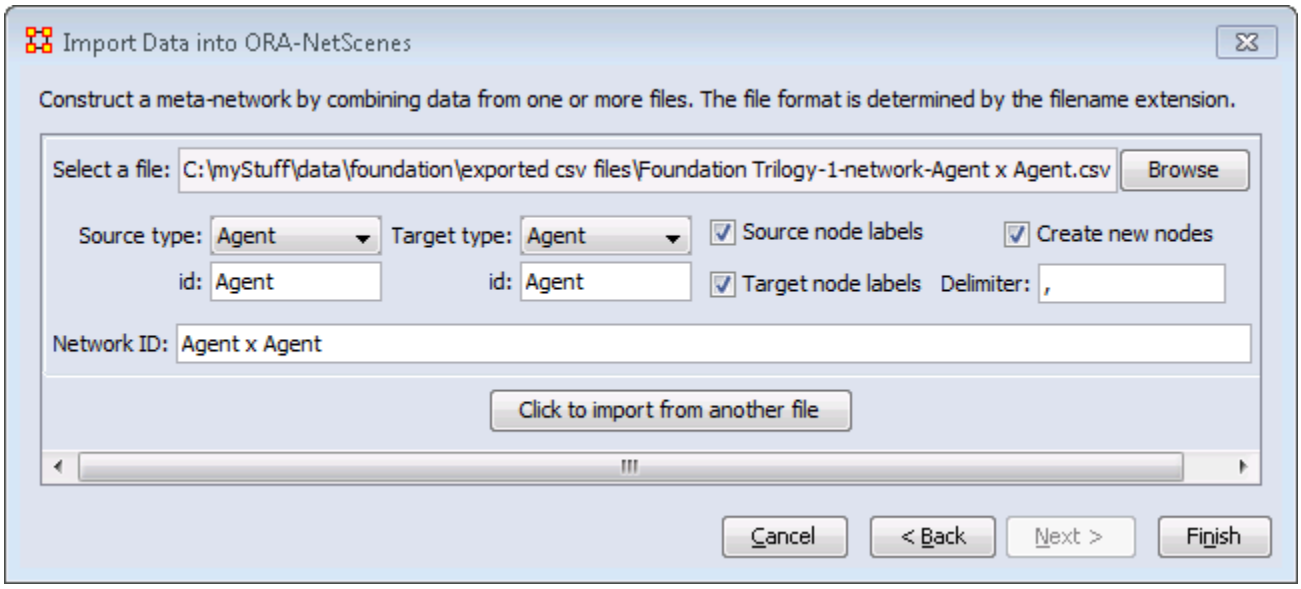


In the next dialog box you will want to select **Create a meta-network with ID:**. This allows you to import a **.csv** file in the form of a **matrix** with labels on the X and Y axis (i.e. an **Agent by Agent** graph or **Resource by Event** and link data in the body). Give your new meta-network a name. I named mine **Foundation Trilogy-1** specifying it is the first of nine parts. When you are done, click **[Next >]**.



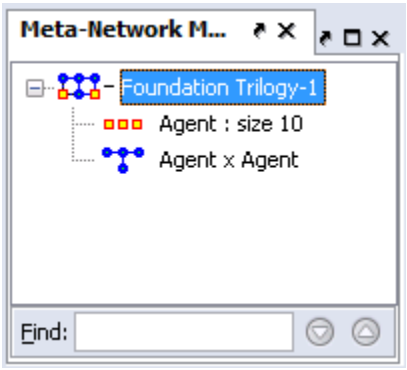
Click the **[Browse]** button and navigate to the directory where the data is located. For this example select the **sg1_agent_x_agent.csv** file. In the Source type and Target type drop down menus select the types of nodes you

are using. In this case both will be **agent**. In the **Network ID:** field, name the network **(typically for this it would be agent x agent)**. When done click **[Finish]**.



Looking in the Meta-Network panel you'll see the Foundation Meta-Network. Clicking the [+] will expand it to reveal the Nodeset and Network created. The Nodeset or Network can be examine by highlighting either to show its information in the Editor and Info tabs.

Adding to the new Meta-Network



You could, if you had multiple networks, import them all in at the same time. For each new Network file to import, click the **[Click to import from another file]** button and repeat the above procedure.

NOTE: If at any time you want to remove a Network from the list select the **[X]** next to the Browse button

Attributes

NOTE : If you are visiting this page from the **Data Import Wizard**, what follows is a lesson on adding **attributes** to the **Foundation sample data set** provided with ORA. To begin the lesson from the very beginning go to **Meta-Networks 101**.

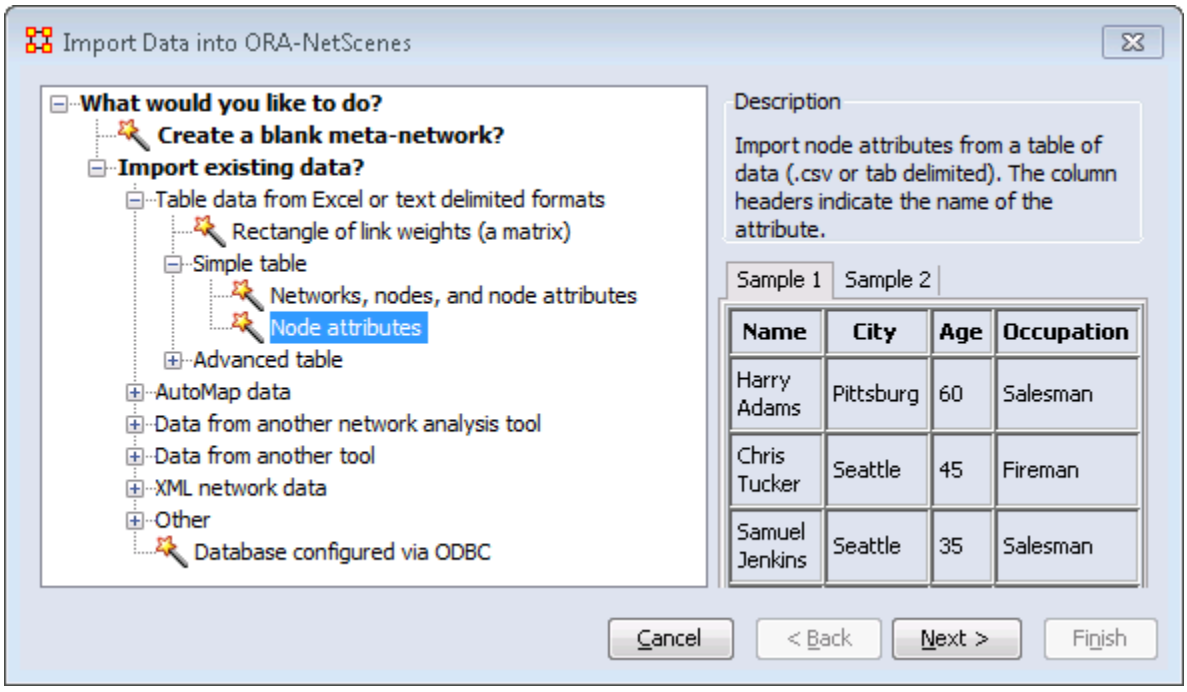
The **Foundation Nodeset** has been created when the network was imported. But even though the nodes have names, there are no attributes. The next step will be to import those from a original file.

The Datasets

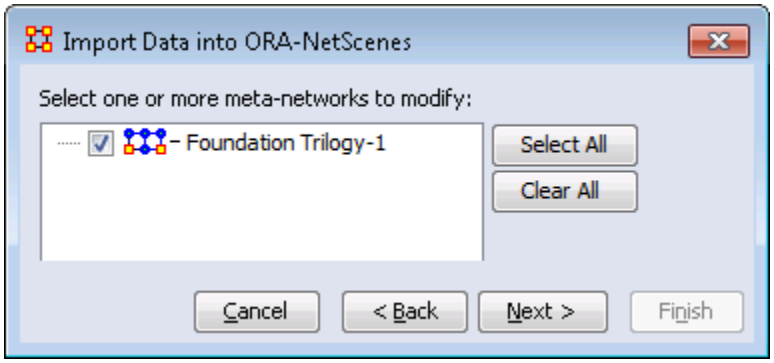
Foundation Trilogy-1-nodeclass-Agent.csv contains the attributes for gender, home world, and job title. As you can see the ID and Title names are the same as in the **Foundation Trilogy-1-network-Agent x Agent.csv** file.

Adding Attributes

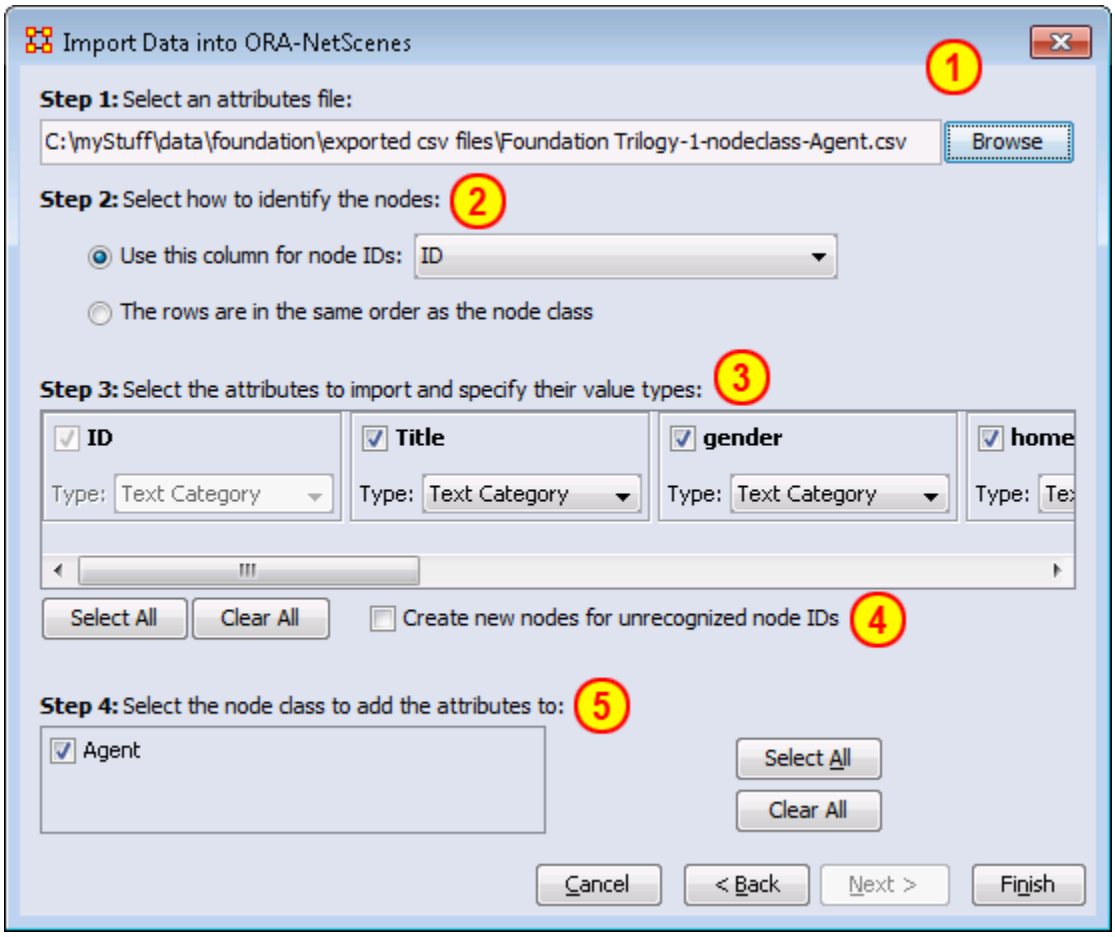
Find the **Foundation Trilogy-1-nodeclass-Agent.csv**. This contains all the attributes for all the nodes. Highlight the **Foundation** Meta-Network. Then click **Import existing data? > Table data from Excel or text delimited formats > Simple Table > Node Attributes**. The click **[Next >]**



With the basic Foundation Nodeset and Network already loaded we will now add attributes to the Nodeset. Place a check mark next to the sg1 dataset. Then click the **[Next]** button.



Below is the main dialog box to inform ORA **what and how to import the new attributes**. After the image is a description of each of the numbered steps.



- **1** With the **[Browse]** button you load the file containing the attributes to add.
- **2** Selects how to identify the nodes. If your file contains a column with node IDs use the top selection. Then select the column from the drop down menu. If your attribute file contains information in the same order as the nodes are already in then you can use the second option.

NOTE : If you select the second option, and your nodes are in a differnt order than your attributes, the ORA will place the attributes in sequential order regardless of whether the IDs match or not.

- **3** For each column a box will appear allowing you to chose which attributes to import. Place a check mark next to each attribute you want and give it a Type: **Text Category, Text, URI, Number Category, Number, or Date**. An attribute without a check mark will not be imported.

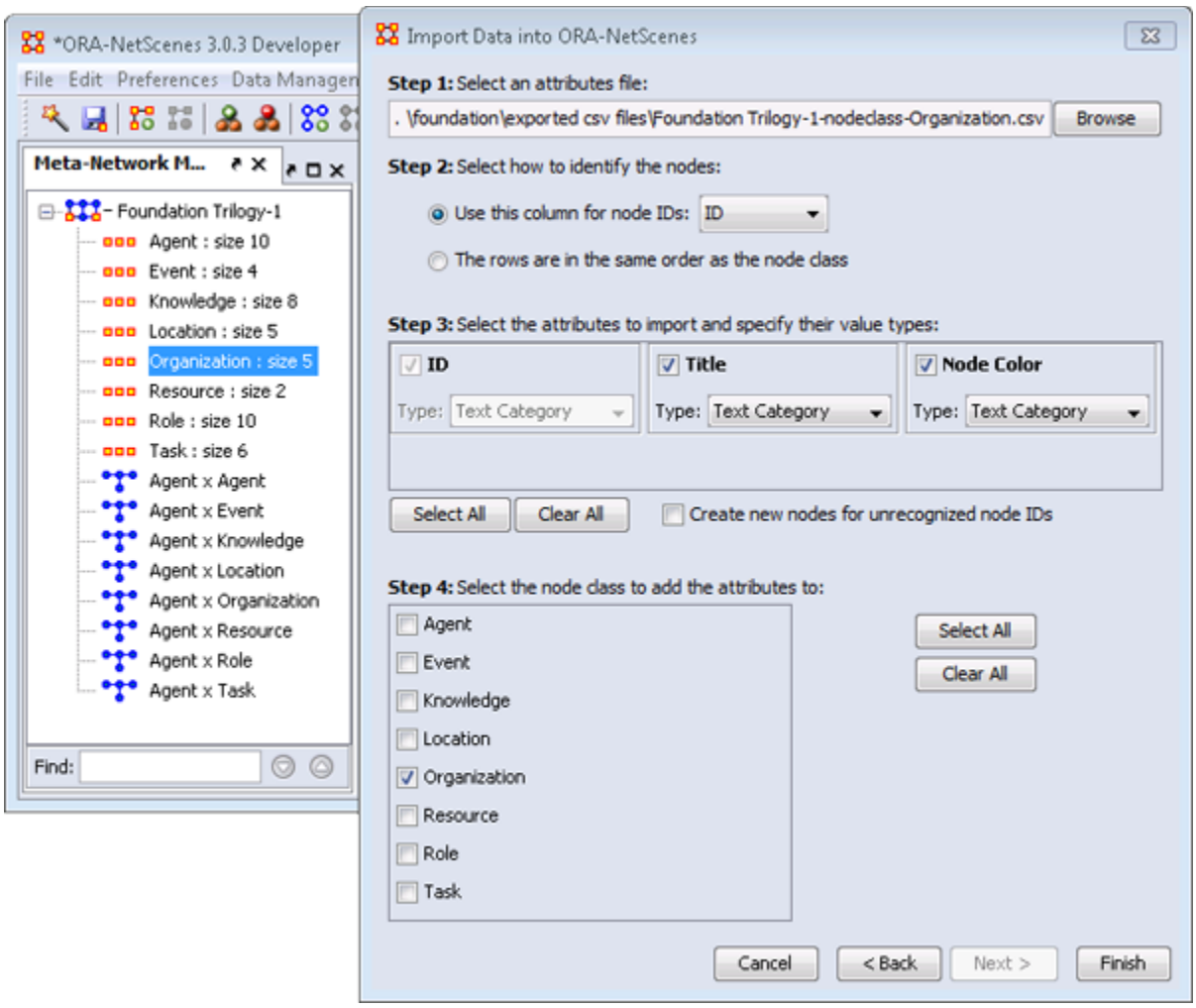
- **4** In this example leave this unchecked as we only want attributes for the first five nodes. This is used if the file contains additional nodes to import which were not in the original Nodeset.
- **5** Select the Nodeset to add the attributes. Place a check mark next to all Nodeset to add attributes to. In this example we have only one.

When finished entering information on this screen, click the **[Finish]** button. The Nodeset now contains names that match up to the IDs from the imported file.

	Node ID	Node Title	gender	home w...	job_title	Node C...	robot
☐	hari_seldon	hari_seldon	male	helicon		-8650752	
☐	gaal_dornick	gaal_dornick	male	synnax		-8650752	
☐	jerril	jerril	male			-8650752	
☐	lors_avakim	lors_avakim	male			-8650752	
☐	linge_chen	linge_chen	male		chief_com...	-8650752	
☐	bor_alurin	bor_alurin	male			-8650752	
☐	agis_xiv	agis_xiv	male		emperor	-8650752	
☐	daneel_olivaw	daneel_olivaw_[chetter_eto]	male			-8650752	yes
☐	boy_emperor	boy_emperor	male		emperor	-8650752	
☐	wanda_seldon	wanda_seldon	female			-8650752	

The remaining Nodesets and Networks

With any remaining Nodesets and Networks for your dataset you can repeat the previous two lessons: first importing a Network of links then importing the attributes for that nodeset that isn't already in the Meta-Network. Below is an example when importing attributes into a single Nodeset with multiple Nodesets in the Meta-Network



Modifying a Meta-Network

At this point the **Meta-Network** has been created and it contains the Nodesets and Networks. And each of the Nodesets contains titles and attributes in which to better define the Nodesets and Networks. But as with any dataset there will always be changes.

Most certainly, as time goes on, Nodesets will require extra attributes or even new nodes. Possibly even new Nodesets will need to be created and worked into the Meta-Network. Or maybe a current set of attributes needs to be changed. What follows are the procedures to accomplish those tasks.

Adding a New Node to a Meta-Network

In this section we'll add a new node to the agent Nodeset using the **Create new nodes from unrecognized IDs** checkbox. It's for the situation that the data being imported contains nodes that are not in the current Nodeset.

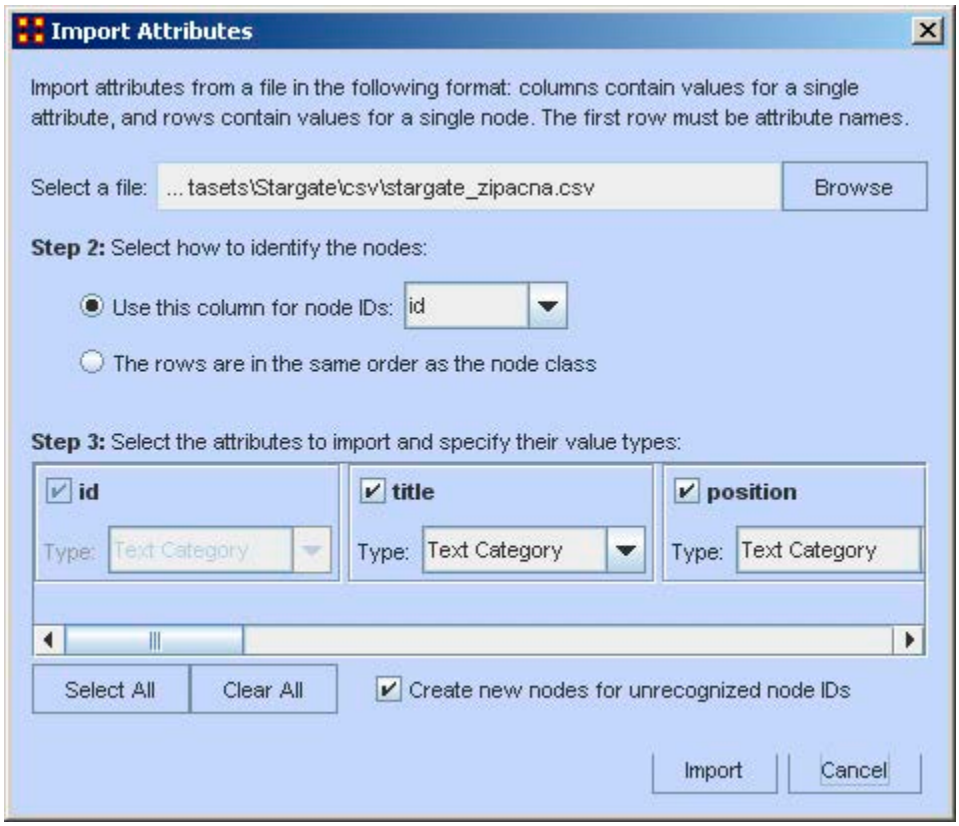
The new .csv file we're using contains one new set of information, the 17th agent to add to the agent Nodeset. Upon importing the new node we will have a 17th node with the **title** attribute.

id,title,position,symbiote,host,dies_when,dies,ally,group,servitude,gender,race,race-2

A17,zipacna,,zipacna,unknown,,,no,anubis,anubis,male,gou'ald,human

It was created in Excel (the same way the other Nodesets and Networks were) and exported out to a new .csv file called **stargate_zipacna.csv**.

The easiest way to bring in a new node is to use the **Attribute Import button**.



1. Use the **Browse** button to navigate to the directory containing the new .csv file. It will show up in the textbox to the left.
2. Check the proper column to use for the node ID and from the drop down menu select the type of node.
3. Select the **Attribute(s)** you want to import.
4. And most importantly, make sure the box **Create new nodes for unrecognized IDs** contains a checkmark in order to allow ORA to create new nodes. Without this checkmark ORA will ignore any nodeIDs that aren't already in the Nodeset.

When you review your agent Nodeset in the editor you will see a new entry at the bottom, the 17th node with **zipacna** in the **Entity Title** attribute.

	Node ID	Node Title	ally	dies
	<set filte...	<set filte...	<set filte...	<set filte...
☐	A01	col_jack_o'...	yes	
☐	A02	maj_samant...	yes	
☐	A03	daniel_jack...	yes	
☐	A04	teal'c	yes	
☐	A05	gen_hammo...	yes	
☐	A06	lt_elliott	yes	dies
☐	A07	ren'al	yes	dies
☐	A08	aldwin	yes	dies
☐	A09	janet_frazier	yes	
☐	A10	maj_mansfi...	yes	dies
☐	A11	jacob_carte...	yes	
☐	A12	lantash	yes	dies
☑	A13	narim	yes	dead
☐	A14	travell	yes	dead
☐	A15	osiris	no	
☐	A16	yu	no	
☐	A17	zipacna	no	

The new node, and all their attributes, have been imported into the Meta-Network.

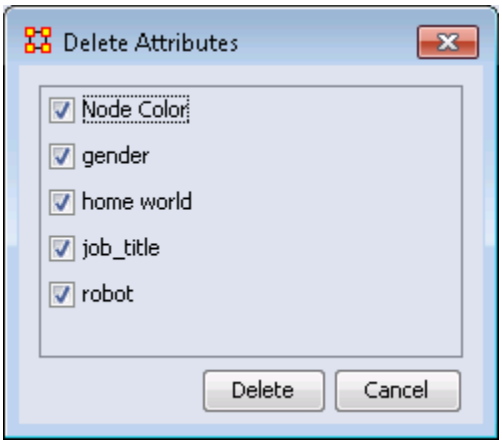
Working with SubSets

There will be times when you have a SubSet of a larger Meta-Network and you'll want to import data from a larger, main dataset. And you want to do this **without** creating new nodes. What follows are the procedures for accomplishing those goals.

We start off with the SubSet of **Foundation**, a Meta-Network of three agents. Highlight the Foundation Meta-Network. Select the **Agent** Nodeset. Place a check mark in all nodes except **hari_seldon, gaal_dornick, and wanda_seldon**. Click the **Delete** button.

	Node ID	Node Title
☐	hari_seldon	hari_seldon
☐	gaal_dornick	gaal_dornick
☐	wanda_seldon	wanda_seldon

Next, under Attributes, click the [**Delete**] button on the right side of the Editor. This brings up a dialog box with the attributes in the Nodeset. A check mark indicates to ORA to delete that attribute. For our purposes we need to delete them all. CLick the [**Delete**] button.



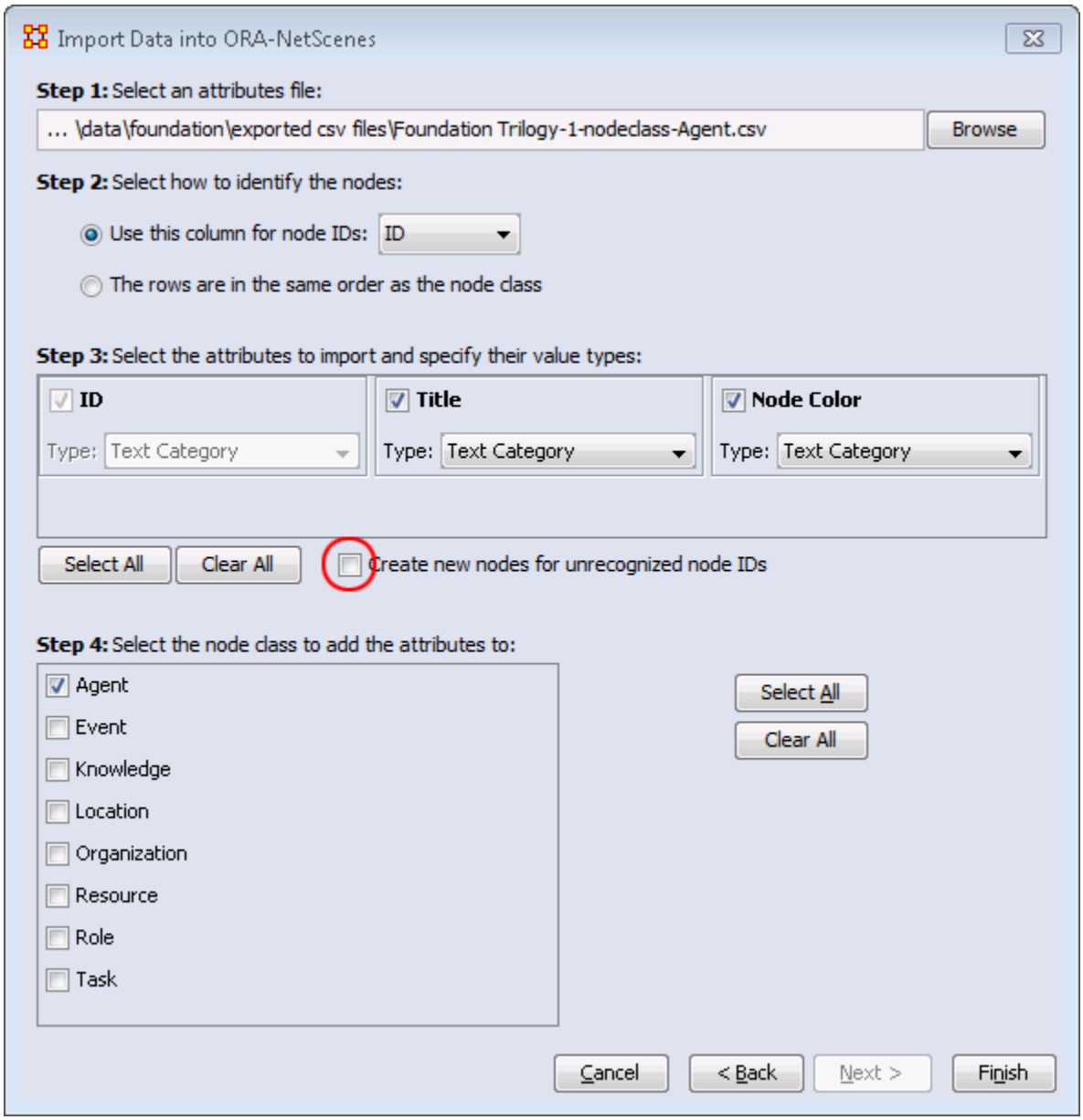
You now have a Meta-Network with a SubSet of the original Foundation Dataset with no attributes.

For importing we will use the original file **Foundation Trilogy-1-nodeclass-Agent.csv** for the attributes

Now, as before, open the **Data Import Wizard**. Navigate to **Node Attributes** and click [**Next >**]. Select the newly created Meta-Network by

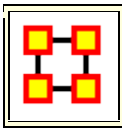
placing a check mark next to the name then click [**Next >**]. Make sure Step 1 contains your Nodeset file. If not, click [**Browse**] and navigate to the correct directory. Next make sure Step 4 only has the **Agent** Nodeset selected. When read click [**Finish**]

The most important item for this to work is to make sure that the **Create new nodes for unrecognized nod IDs** remains **UNCHECKED**. This will prevent ORA from creating new nodes for the other data it finds in the file.



The result is maintaining a Nodeset with three nodes but attribute data from the Agent Nodeset file imported only for the attributes for the three nodes. No new nodes will be created in this process.

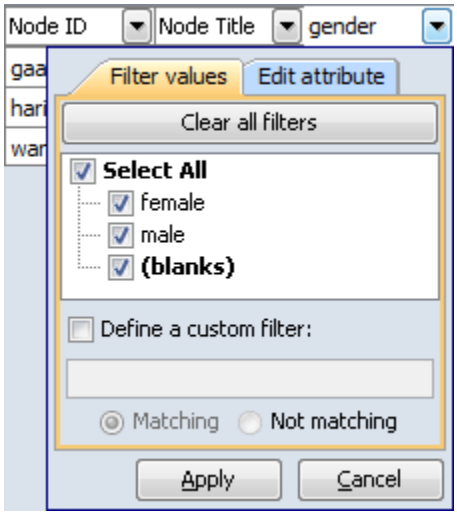
	Node ID	Node Title	gender	home w...	job title	robot
☐	hari_seldon	hari_seldon	male	helicon		
☐	gaal_dornick	gaal_dornick	male	synnax		
☐	wanda_sel...	wanda_sel...	female			



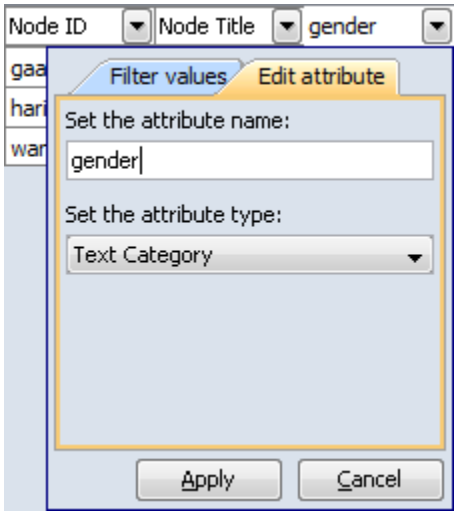
Attribute Columns

There are four functions that can done with Attributes. All four are accomplished by **Right-Clicking** on the downward arrown next to the Attribute Name. This prings up a dialog box with two tabs.

Filter Values



Edit Attribute



Filter Values

Clear all filters : Clears an previous filter parameters you have set.

Value check boxes : Select or Deselect values to display.

Define a custom filter : Type in specifics to use as a filter and whether or not they match the values.

Edit Attribute

Set the Attribute Name : Used for renaming an existing Attribute column.

Set the Attribute Type : Attributes can be tagged with two types: **Categorical** or **Continuous**.

Replacing an Attribute Column

NOTE: This method is suggested as ORA has the capability of retaining multiple values. If you want to completely replace the values then **deletion and replacement** of the column is suggested.

For most **small** changes you can type in a new attribute value or two directly into the Editor. But say your Nodeset contained quite a few nodes, and the majority of the values needed changed. If might be easier to create a new .csv file and import the values in just as in the previous lesson. In the example below it was decided to completely replace all the **skill_needed** with a new set of values.

Go to the ORA main interface and under select the Nodeset. Under the Attributes section click **Delete**. Remove all the check marks from any attributes you want to keep. All attributes with check marks will be removed.

After deleting a column then use the procedure for importing Attributes from **Lesson-203** to import a new attribute information. Remember, you'll want to import into an **Existing** Meta-Network as in the example above.

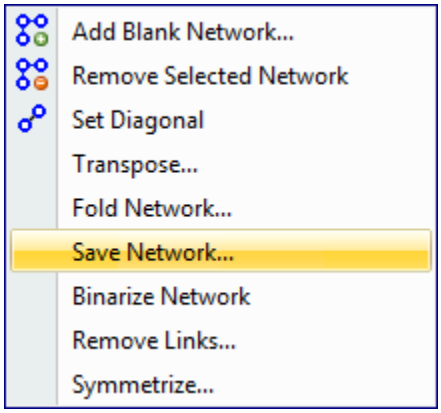
The **skill_needed** attribute has been imported into the Nodeset with the revised values.



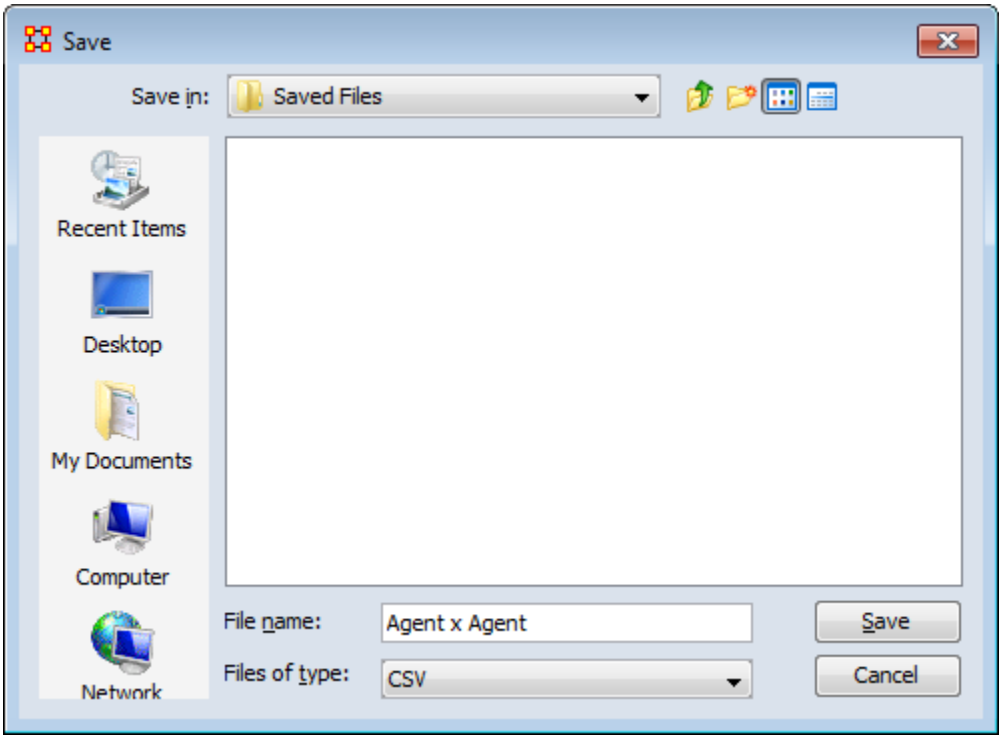
Updating Your Data Files

After importing data from the .csv files into ORA and then altering the data in ORA this somewhat makes your original data files out-of-date. What follows are the procedures to update your original .csv and Excel files with any changes that have been made recently.

Saving Your Network Data



From the main interface highlight the Network you want to save and **Right-Click**. This will bring up a contextual menu. Select **Save Network**. This will bring up a **Save** dialog box. First, navigate to the directory you want to save your new Network file. Next, select the format **(DyNetML, UCINET, DL, or CSV)** to save the file. Give it a filename and select **[Save]**.



Usually files are saved to the csv format and can be opening in a Excel or a text editor.

REMEMBER: The UCINET uses both .##d and .##h extensions and both are needed to build a Meta-Network.

NOTE: Since this **Save** box does not display the files present in the directory it is **Highly Suggested** that you save to a new directory and verify which previous file you want to replace. More information on these file formats can be found **HERE**

Saving A Meta-Network

You can an entire Meta-Network to individual files using **File > Data Export**. This will write out one file for each Nodeset and Network. Type in a prefix name which will be ayyaced to each file, select the **Files of type**, and then click [**Save**]

Saving Your Attribute Data

The above mentioned procedure works well for saving Networks but there are also the attributes in the Nodesets to think about. All the data is can be saved from **File ⇒ Save Meta-Network** and the **File ⇒ Save Meta-Network...**. But this saves the data into **one xml file**. What if you what to save the data into individual files, the same as when you imported it.

The quickest way is using the **Copy / Paste** method. Values copied directly from the **Main Interface Editor** can be pasted into a **Excel spreadsheet**.

In the ORA editor, highlight the cells you need to copy. Use either **Ctrl-C** or **Edit > Copy**.

	Node ID	Node Title	gender	home w...	job_title	Node C...	robot
☐	hari_seldon	hari_seldon	male	helicon		-8650752	
☐	gaal_dornick	gaal_dornick	male	synnax		-8650752	
☐	jerril	jerril	male			-8650752	
☐	lors_avakim	lors_avakim	male			-8650752	
☐	linge_chen	linge_chen	male		chief_com...	-8650752	
☐	bor_alurin	bor_alurin	male			-8650752	
☐	agis_xiv	agis_xiv	male		emperor	-8650752	
☐	daneel_olivaw	daneel_olivaw_[chetter_eto]	male			-8650752	yes
☐	boy_emperor	boy_emperor	male		emperor	-8650752	
☐	wanda_seldon	wanda_seldon	female			-8650752	

Then switch to your **Excel** spreadsheet. Highlight the cell that corresponds to the **top/left** cell you started with in ORA and use either **Ctrl-V** or **Edit > Paste**. Entire Nodesets can be done in this fashion.

IMPORTANT NOTE: Before you **Copy/Paste** in this manner make sure your columns are in the same order. This operation will **NOT** match up data as it's a **blind copy/paste** operation.

You can then backup all of your Nodesets in the procedure and then re-save it to your .csv files.

Key Entity Report

The Reports

A **Key Entity Report** creates the following reports: central actors, organizations, central knowledge, resources, central events, tasks, central locations, and performance indicators.

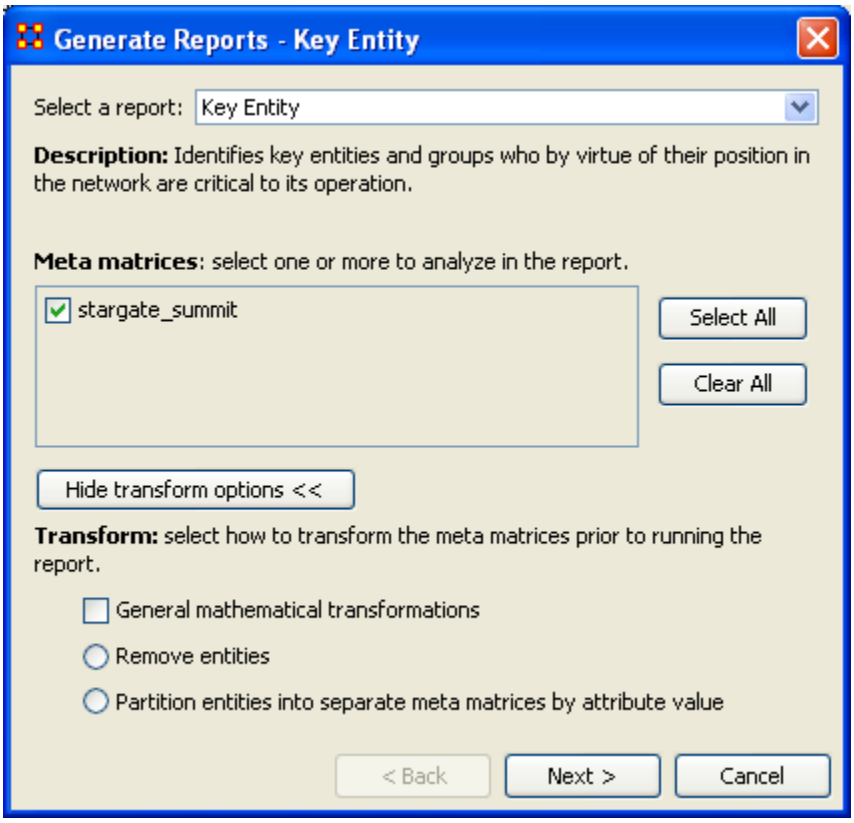
The Key Entity Report can either run its measures over the entire network or be refined or filtered to run them over only a select portion of the network.

More detailed information regarding the basic workings of the Key Entity Report screens can be found **Reports Section**.

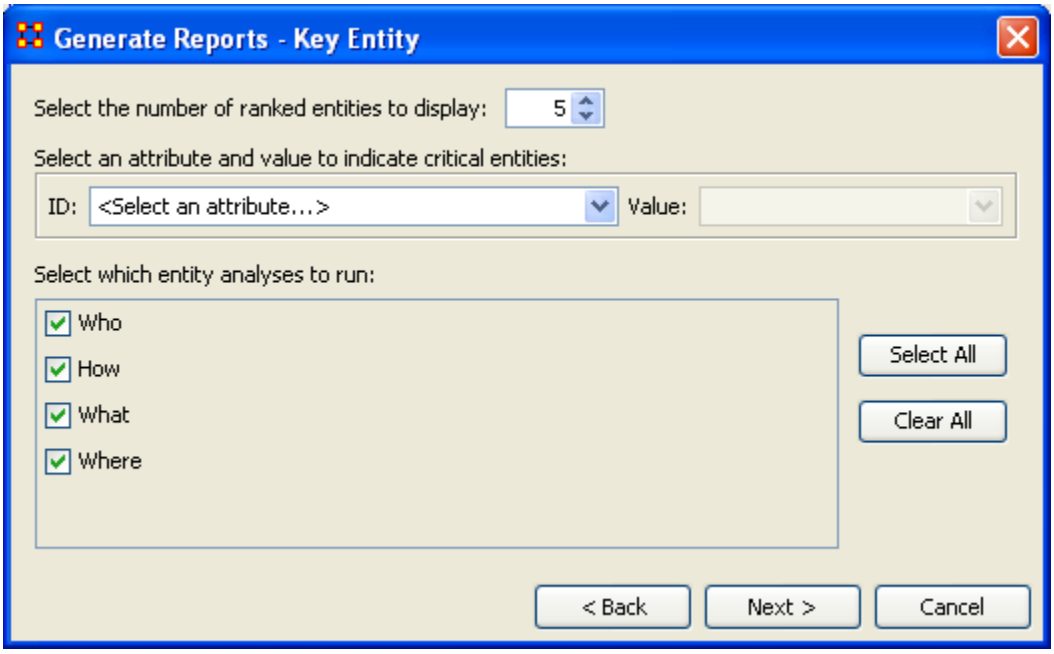
Running a Key Entity Report:

We'll be using the network **Stargate: Summit** contains all the agents involved in the scenario, friend and foe. The first report run will contain all the agents, friend and foe.

- From the main menu select **Analysis ⇒ Generate Reports** which brings up the **Generate Reports** dialog box.
- At the top of the window is a dropdown menu titled **Select a Report**. Pull down the menu by clicking the small inverted arrow icon to its right, and select **Key Entity**.
- In the box titled **Select one or more meta matrices:** select the network to run the report on.
- At the bottom of the box is the **Transform options**.
    - **General Mathematical Transformation :** Contains various formulas for manipulating a network.
    - **Remove Entities :** Remove node(s) from a network before running the measures.
    - **Partition entities into separate meta matrices by attribute value :** Create new networks based on your choice of nodes and attributes.



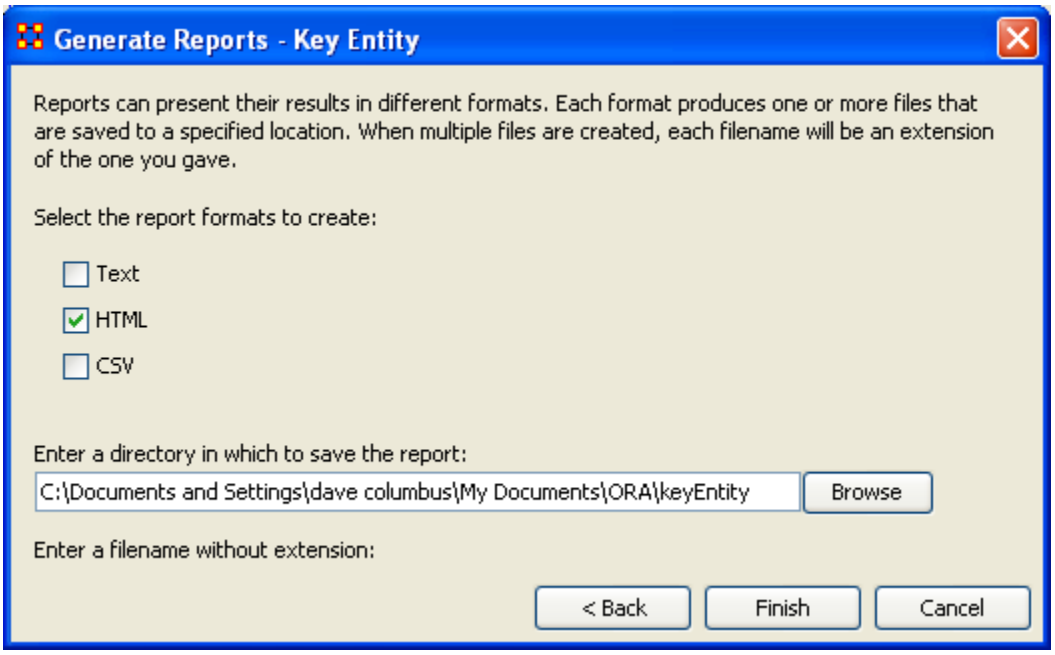
Select the **[Next >]** button at the bottom of the dialog box.



The next dialog box is for selecting **the number of ranked nodes**, **critical attribute and values** and also for selecting **which reports** you want to view. I am only interested in the top five nodes in the network and place a **5**

in the top box. I don't want to point out any particular nodes, only the friends, so I'll leave the textbox blank. I want all the reports run so I place a checkmark in all four boxes.

Click the **[Next >]** button.

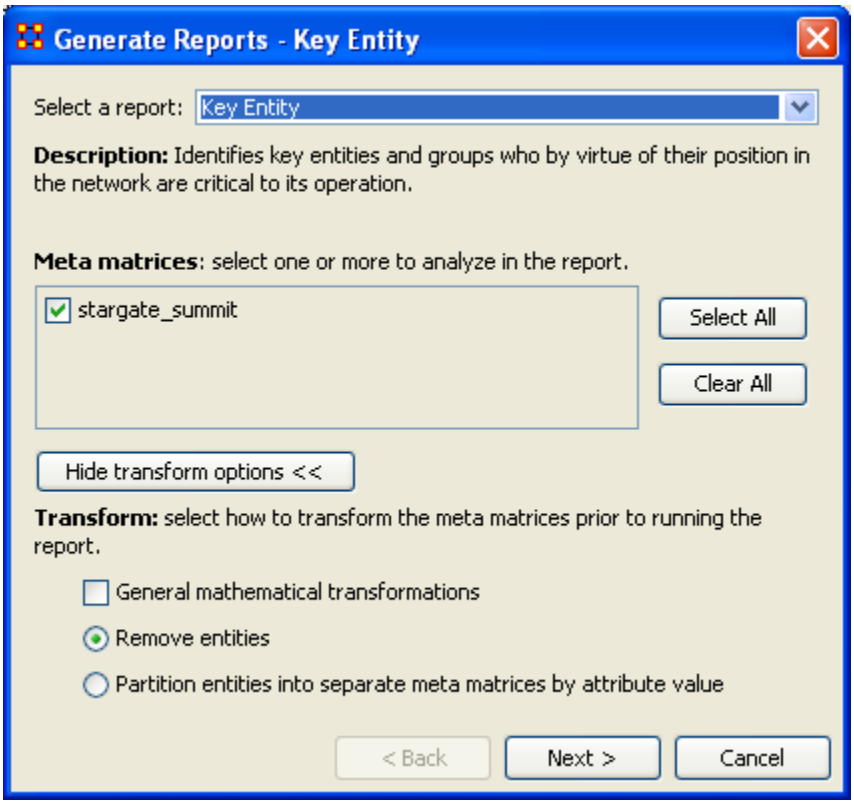


The last dialog box is for selecting what type of format for the final reports and the directory to place them. **Text** will create reports that will appear in **Panel 3** of the interface, **HTML*** creates reports that will open up your browser, and **CSV*** creates files that are usable in ORA. The bottom section allows you to navigate to a directory where you want to save your files.

Remove Nodes from a Key Entity Report:

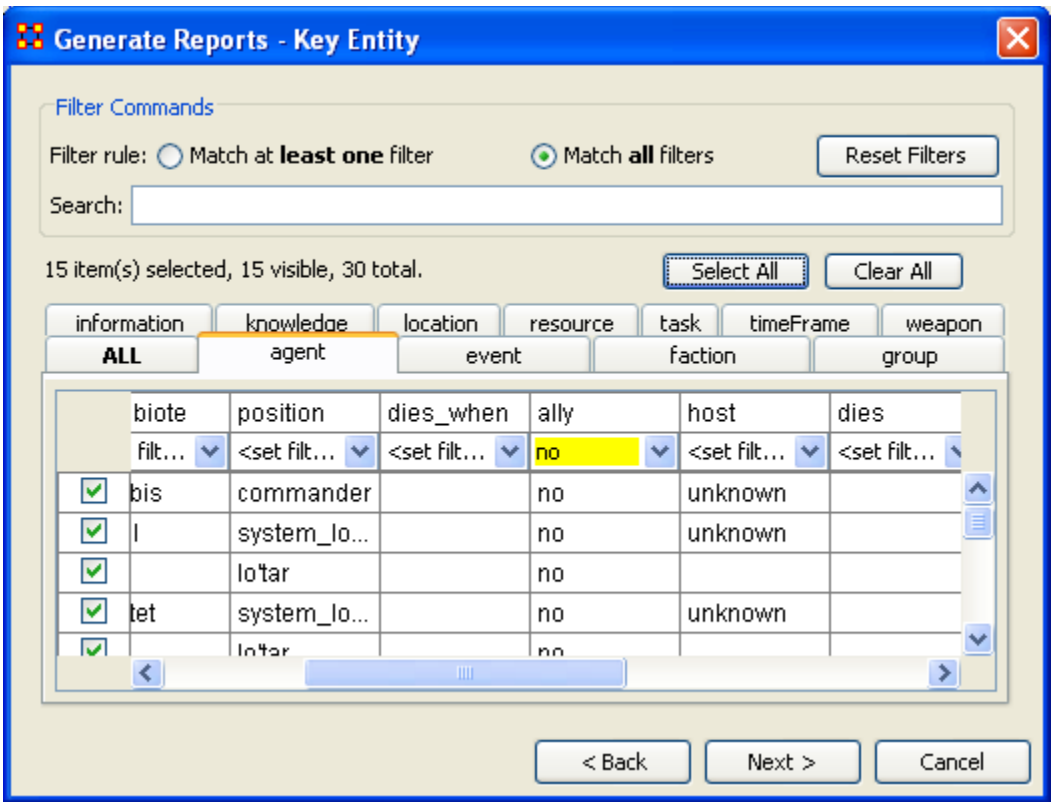
Next we'll look at removing nodes from the report. The network **Stargate: Summit** contains both the friends and foes in the scenario. But say you only want to see only how the **friendly agents** interacted. Being that there's an **ally** attribute this will make it simple to eliminate the **foe agents**.

Follow the same procedure as above except click in the **Remove entities** radio button.



In this example we're going to eliminate a portion of the network before we run the measures. Select the **Remove entities** button. Then select the **[Next >]** button at the bottom of the dialog box.

In this dialog box you can select exactly which nodes to remove.

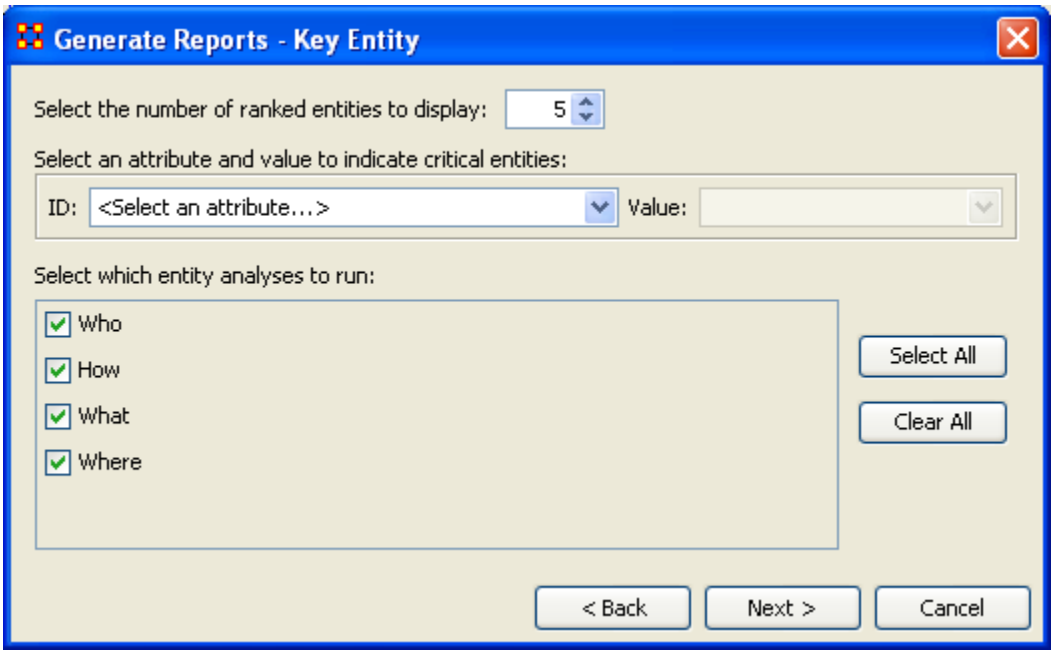


The top section, **Filter Commands**, allows you to create a **single filter** or compound them and force it to **Match all filters**.

The bottom sections contains tabs which further allow you to refine your filter. There is a tab for each Nodeset in your network.

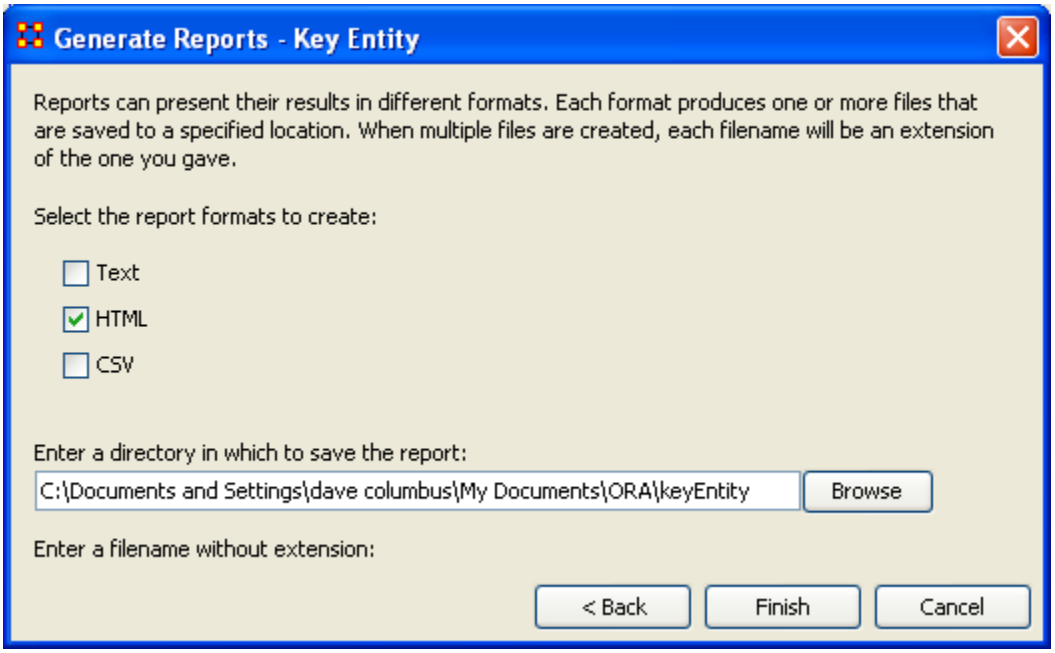
I only want to run the measures on the **Allies** so I select the **agent** tab, scroll over to the **ally** tab, and in the dropdown menu I select **no**. This will call up all the **non-ally** agents. I then click the **[Select All]** button which places a checkmark in each box effectively removing them from the network.

Click the **[Next >]** button.



The next dialog box is for selecting **the number of ranked nodes**, **critical attribute and values** and also for selecting **which reports** you want to view. I am only interested in the top five nodes in the network and place a **5** in the top box. I don't want to point out any particular attributes so I'll leave the textbox blank.

Click the **[Next >]** button.



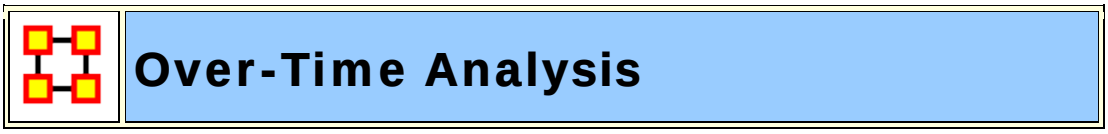
The last dialog box is for selecting what type of format for the final reports and the directory to place them. **Text** will create reports that will appear in **Panel 3** of the interface, **HTML*** creates reports that will open up your browser, and **CSV*** creates files that are usable in ORA. The bottom section allows you to navigate to a directory where you want to save all your files.

Comparison of the two reports

As the reports are rather large, let's compare a small portion of cognitive effort from the reports.

All agents			Allies-only		
Rank	Value	Agent	Rank	Value	Agent
1	**0.340911**	**jacob_carter_selmak**	**1**	**0.354626**	**jacob_carter_selmak**
2	**0.257479**	**ren'al**	**2**	**0.284762**	**daniel_jackson**
3	**0.248333**	**daniel_jackson**	**3**	**0.284218**	**ren'al**
4	**0.205698**	**olokun**	**4**	**0.166667**	**maj_samantha_carter**
5	**0.205698**	**morrigan**	**5**	**0.164218**	**teal'c**

The left-hand column shows all nodes, including the non-allies **olokun and morrigan**. But after eliminating the non-allies two friendly agents take their place. You'll also notice that **daniel_jackson and ren'al** swapped places. With various links removed, after eliminating the non-allies, the order of the remaining nodes can shift. It should also be noticed that the rating for jacob_carter_selmak has increased elevating his position as Emergent Leader.



Performing a View Network Over-Time Analysis

What follows are procedures to perform a **View Network Over Time** and **View Measures Over Time** Analysis.

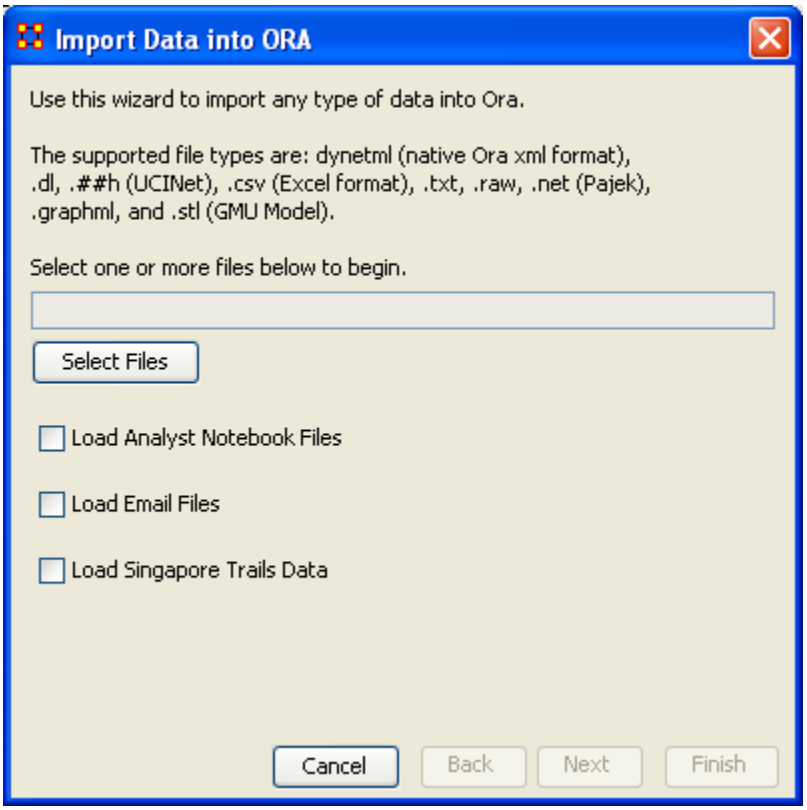
To either requires multiple network datasets representative of your network over different time periods. The goal is to analyze how a network changes across multiple time periods. The time period is determined by the intervals of collected network data and presented as multiple Meta-Networks, which are loaded into ORA in sequential order. The steps below provide detailed instruction on how type of analysis.

To perform a **View Network Over-Time Analysis**, you must load Meta-Networks that relate to different time captures of your network data, which need to be in the form of multiple Meta-Networks.

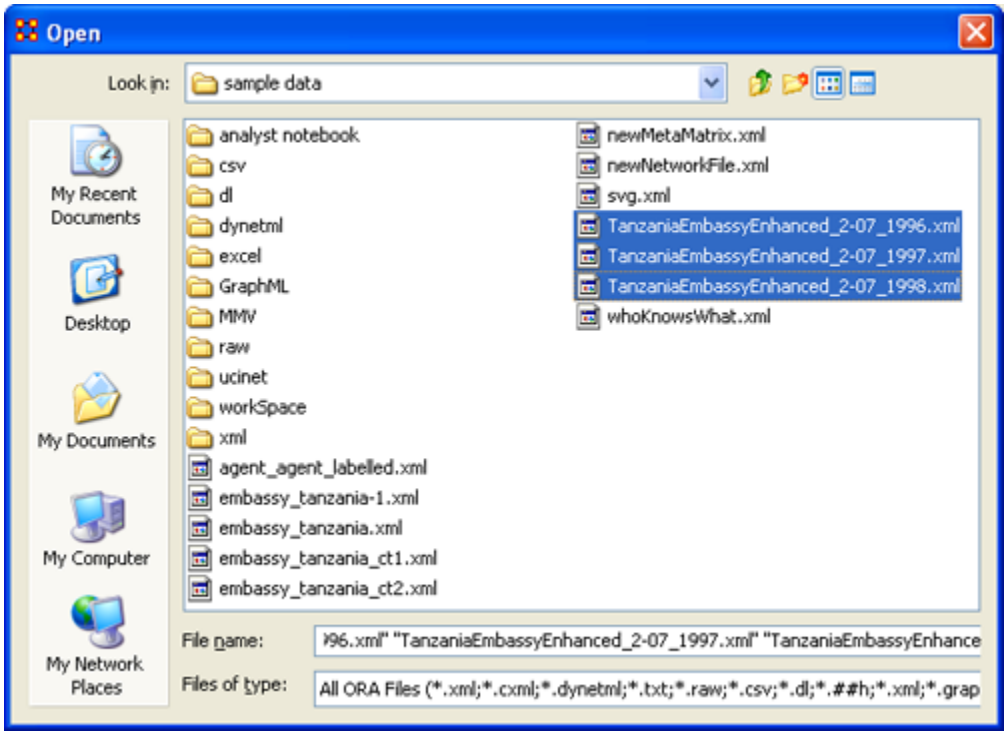
In the following example, we will use network time captures of the **1998 Embassy Bombing in Tanzania** Meta-Network data set and compare the same data set as we knew it in 1997 and 1996 and 1998. We will then compare all the Meta-Networks in the Network Over-Time Viewer to gain a visual representation of how this network changed between 1996 and 1998.

Note : For our purposes, we have changed data in this example and have renamed the Meta-Network for three different years. This will denote different network variables that have changed over time.

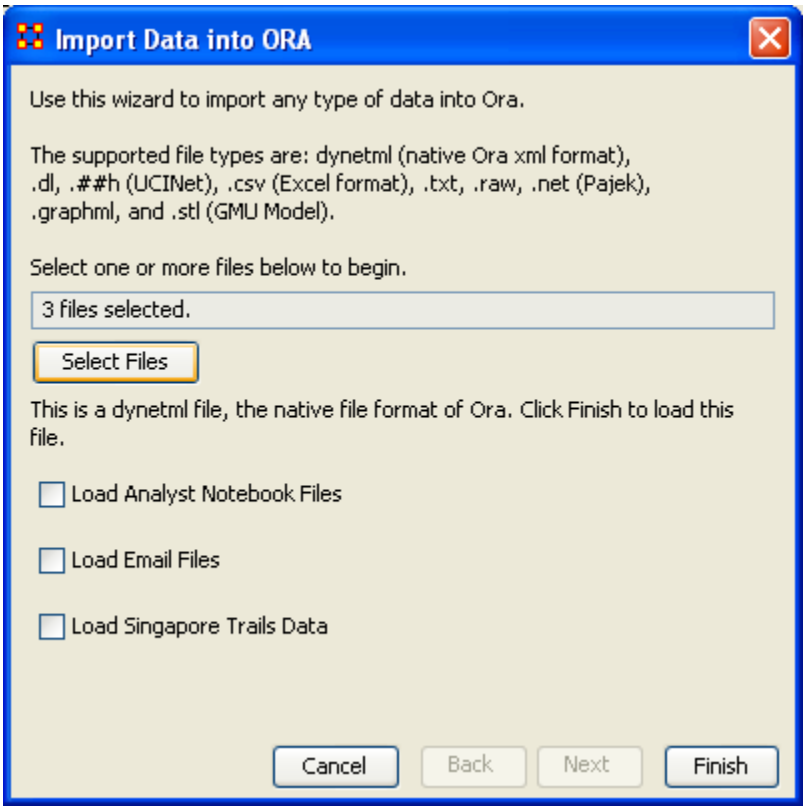
You will see in the left window pane under input dataset three Meta-Networks, 1998, 1997, and 1996, have been loaded. From the menu bar select **File > Open Meta Network**



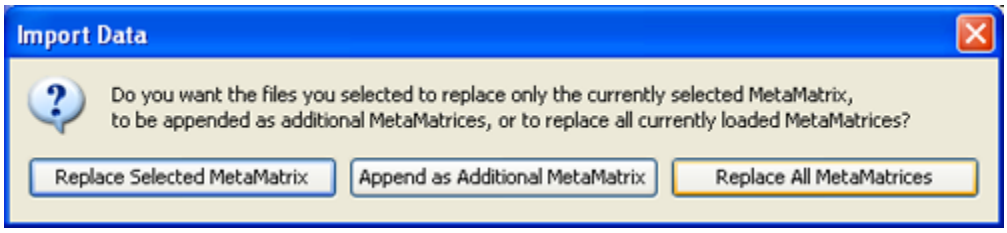
Click the [**Select Files**] button



You will see all of our example data sets, which will load simultaneously into ORA, buy highlighting and selected all the files. Next highlight all files you analyze in Over-Time Viewer and click [**Enter**].

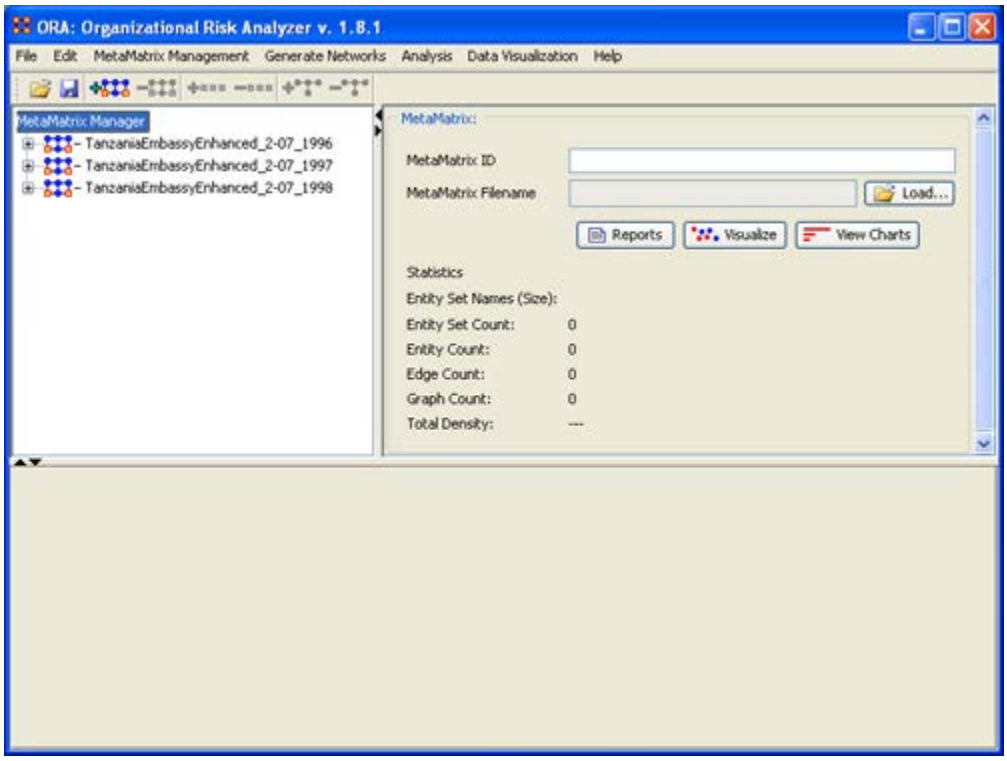


The import data window will appear (below). This will confirm the files you wish to analyze.



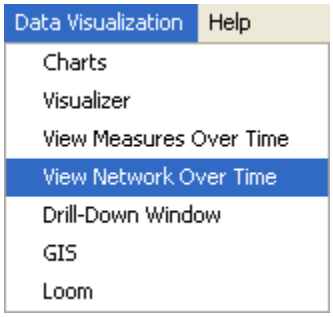
Click [**Finish**].

All three Meta-Networks should display in Panel 1.



Performing the Over-Time Analysis

Now that we have time captures of our network data represented and loaded into ORA in the form of three Meta-Networks relating to **1996, 1997 and 1998**, we can perform the Over-Time Analysis. From the Menu Bar select **Data Visualization > View Network Over-Time**



The ORA Visualizer will render all of the loaded Meta-Networks.

Please take special note of the Time Viewer pop-up Window. This window displays a slider, which will allow you to quickly change from the first Meta-Network time capture of **1996, to 1997 and 1998** respectively.

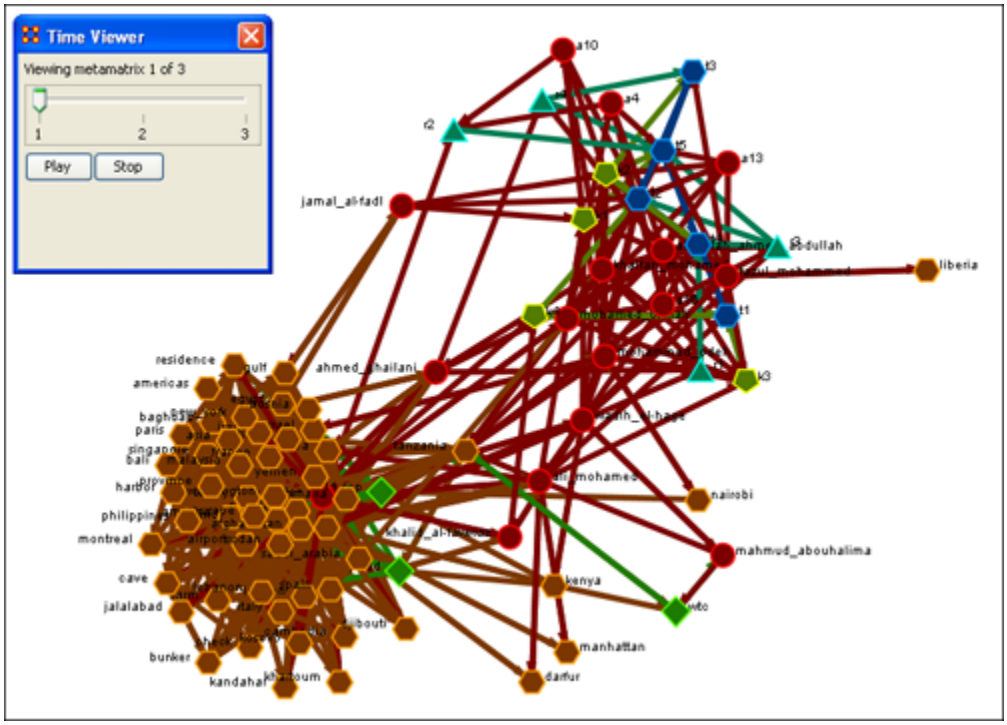
By moving the slider from one Meta-Network to the next, you will gain a visual perspective on how the network has changed over Time.

The series of screen shots below display how the visualized data changes from one slider to position to the next. This allows you a picture of how the network changes Over-Time.

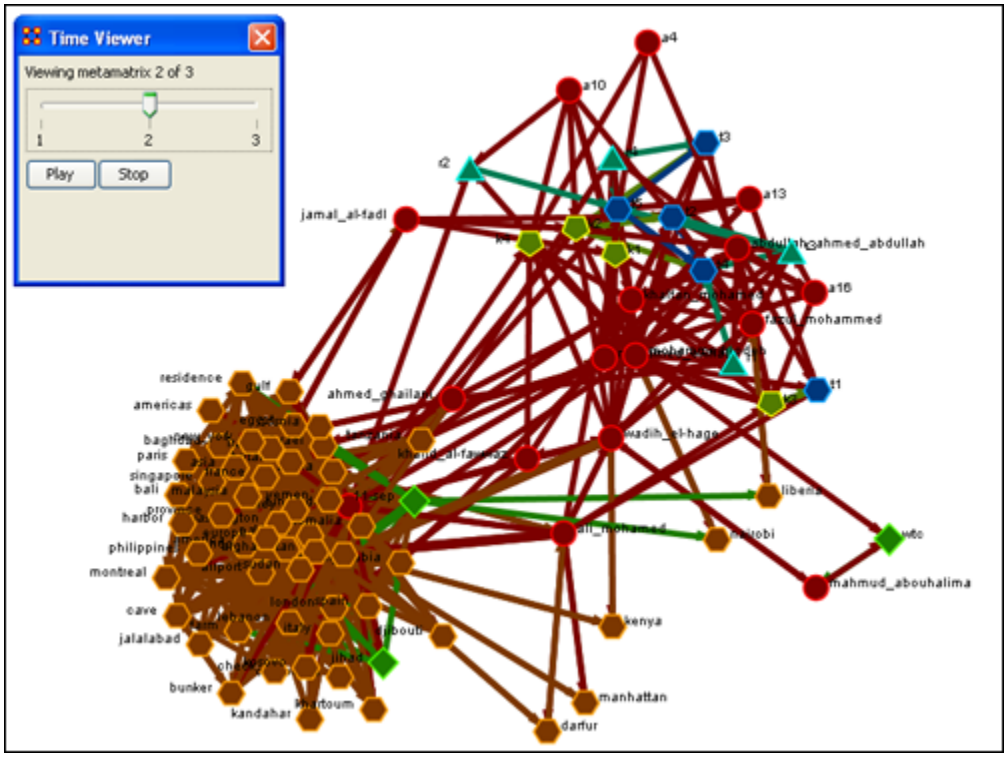
Note : Depending on the complexity of the network and the extent to which relationships (ties) have changed, the visualization of those changes may be subtle.

The screen shots below, however, will emphasize the extent to which the role of the **WTC Event** entity has changed from **1996 to 1998** in relation to the network of which it is part of namely the Tanzania data set. Below these screen captures, are a series of detail screen captures focusing on the WTC Event node.

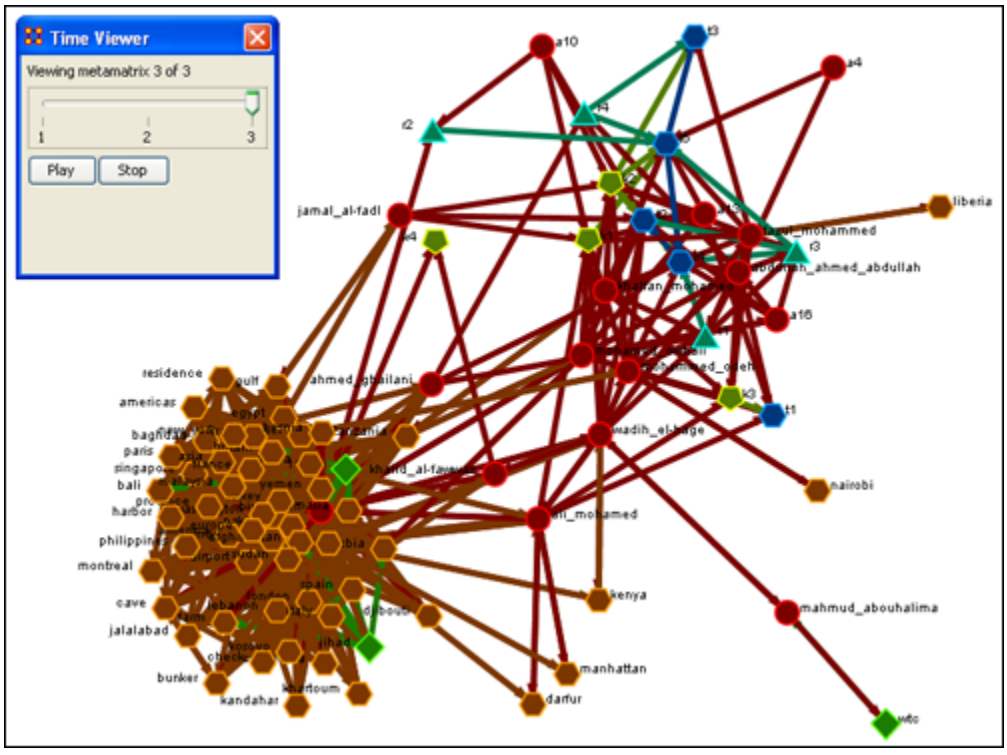
Example Slider Position 1



Example Slider Position 2

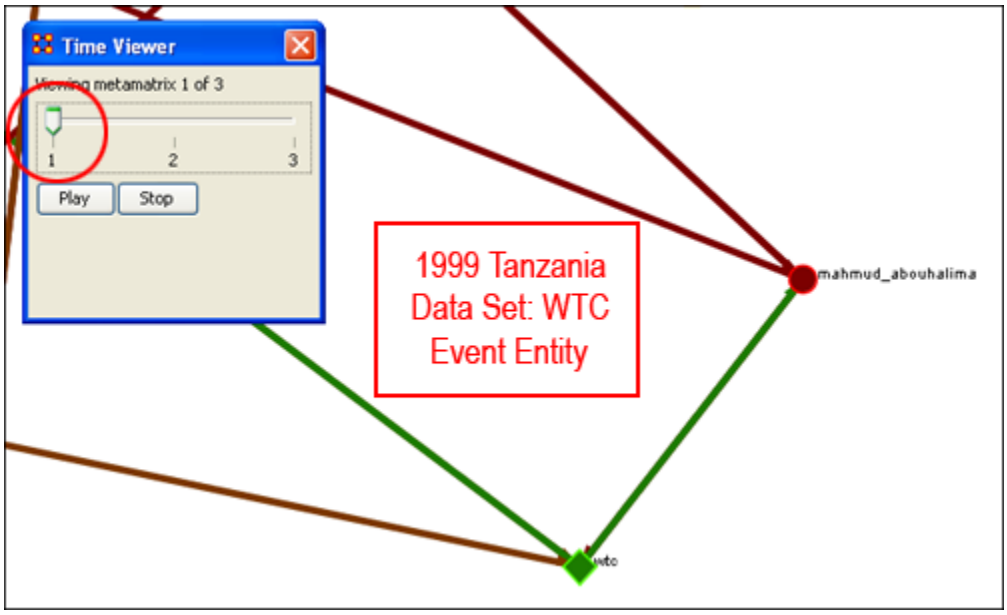


Example Slider Position 3



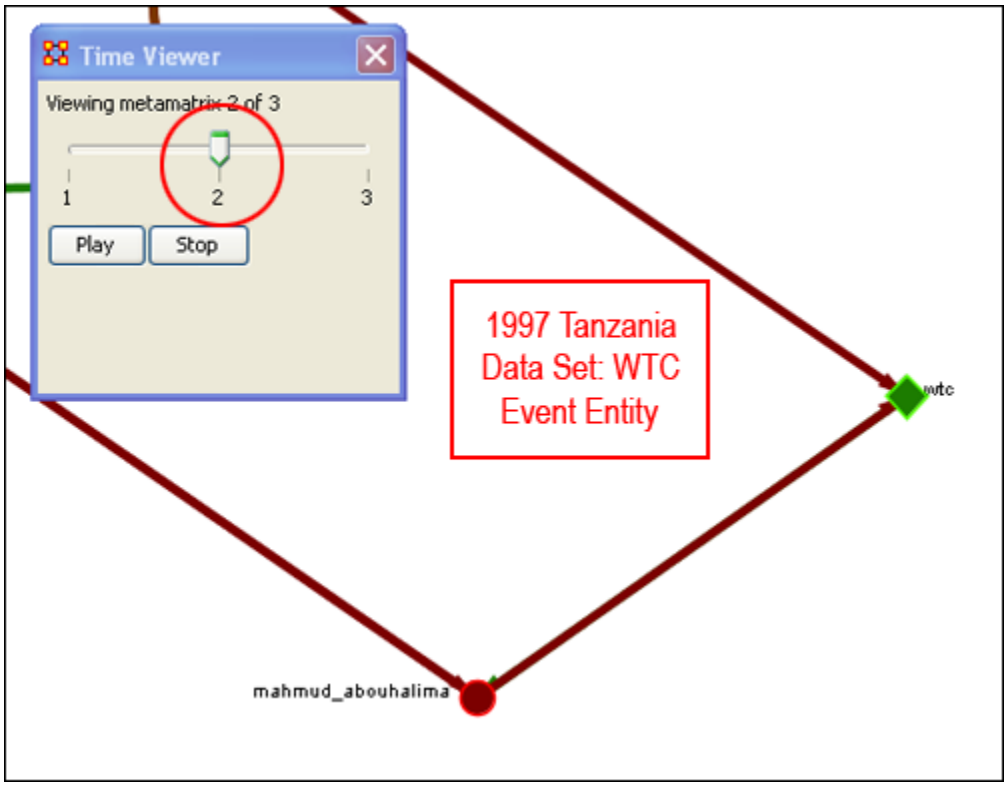
Detail of WTC Event Node when visualized in the Over-Time Viewer as part of the 1996, 1997 and 1998 Tanzania Data Sets.

WTC Event Node: Detail 1 - 1996

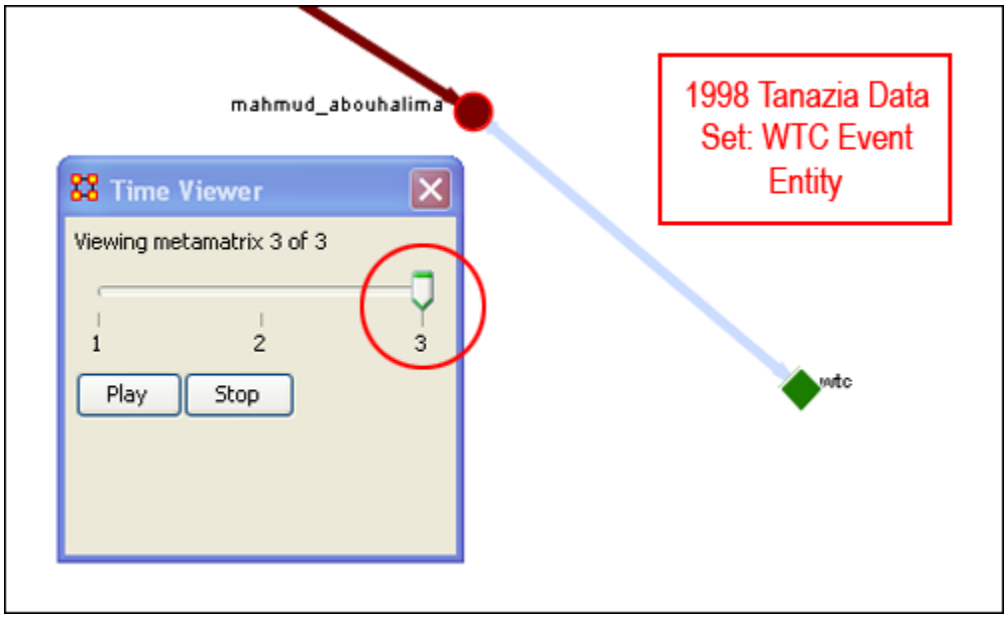


WTC Event Node: Detail 2 - 1997

Notice who how the relationships of this node to the rest of the network has changed from 1996 to 1997.



Notice that the connections (links) have changed from 1996 to 1997.



As you can see, as we progress through the data sets pertaining to **1996, 1997 and 1998**, the event node WTC lost direct **ties** to other parts of the network. In the 1996 data set, **WTC had 3 ties to other entities in the Tanzania Embassy network; In 1997, only 2; Finally, in 1998, the**

WTC event node had only 1 link to Tanzania Network. This may indicate that the WTC node may have lost importance from one year to the next.

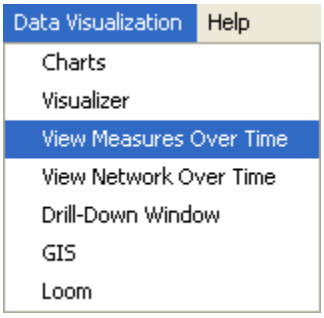
Performing the View Measures Over-Time Analysis

ORA provides an alternative method to analyzing your network data **(in the form of Meta-Networks captured over time)** than the only in the Visualizer.

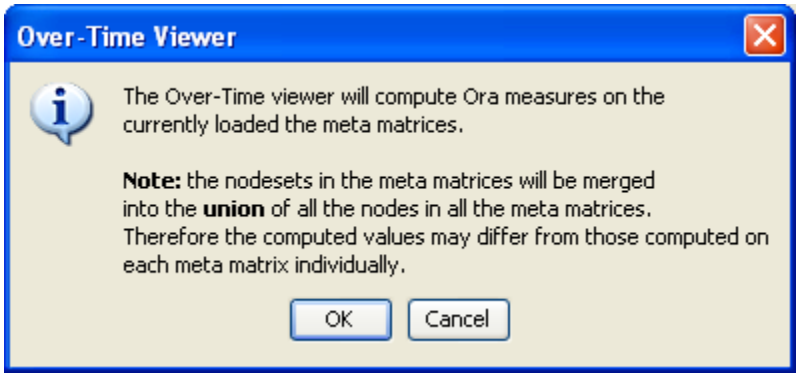
By running a **View Measures Over Time analysis** you can visualize how your network changes in relation to any given measure in the form of charts, which take you from one time point to the next.

Below is a series of screen captures and instruction on how to access the View Measures Over Time feature:

From the main menu bar select **Data Visualization > View Measures Over Time**



Select **View Measures Over Time**.



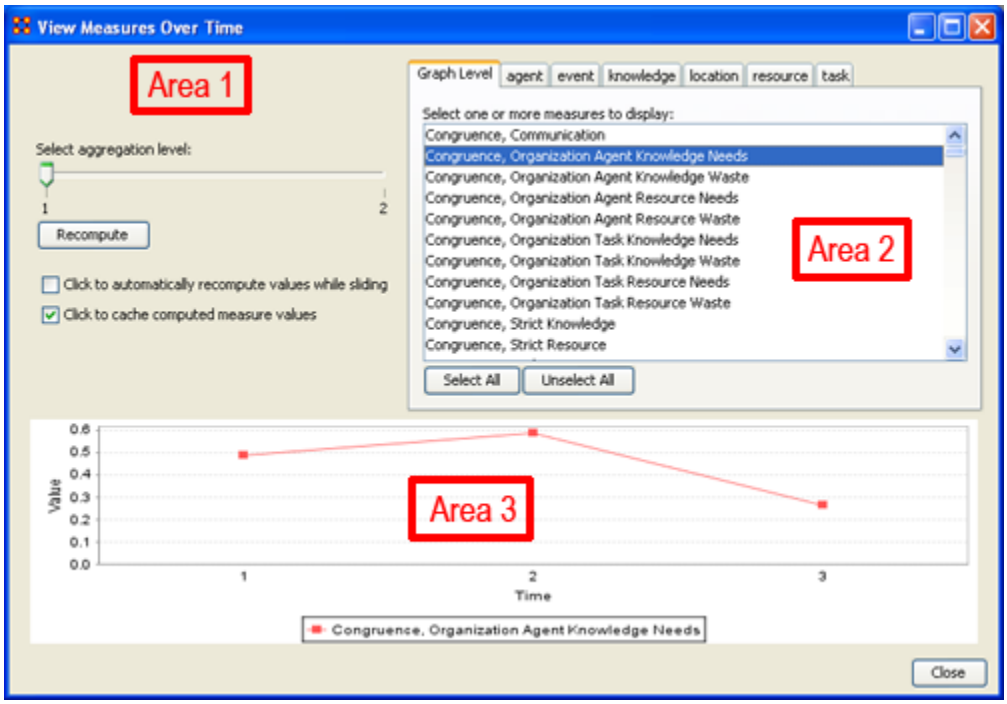
Click [**OK**]

The **View Measure Over Time** Window will appear. You will see that this window is primarily organized into three sections.

Area 1: is a slider where you can control various inputs that affect the aggregation level of your Meta-Networks.

Area 2: is a tabbed index allowing you to select the graph level you desire and the individual entity sets you are interested in analyzing.

Area 3: displays the actual chart based on the measures you selected in the tabbed index and the position of the aggregation slider.

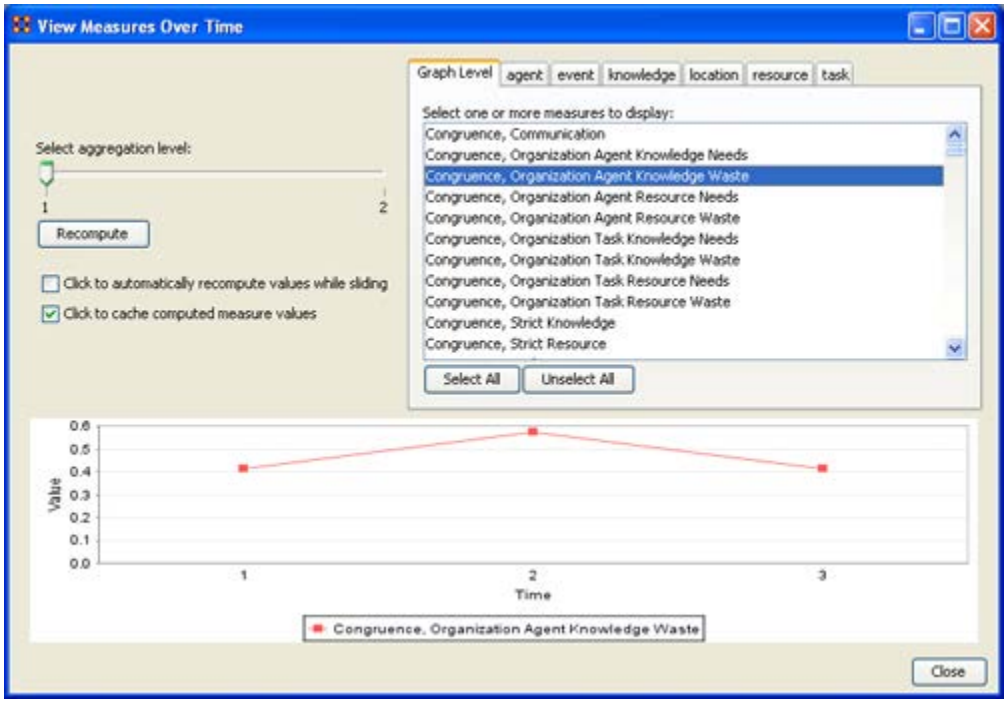


Interpreting The Results After Performing View Measures Over-Time Analysis

In the example above, we have loaded all three of our network time captures into the View Measures Over Time Analysis tool. The result of our analysis, as we have indicated before, will be displayed as a chart in the bottom section of the ORA interface in Panel 3. But, what does this tell us? To find out, we will examine the Graph Level measure **Knowledge Waste.** From the tabbed measures window:

Graph tab > Congruence, Organization Measure, Knowledge Waste.

The result is displayed below.



We can see the chart displays an axis scale correlating to our networks over time. The graph level measure of **Knowledge Waste** was selected using the **View Measures Over Time** tool and the result is displayed in the chart area of the window.

We can see that the graph level measure of Knowledge Waste held a value slightly above **40** in the first Meta-Network, 1996, displayed with **1** on the Time axis. We can deduce from the chart that in 1997 something affected our measure of Knowledge Waste to increase the value to nearly **60**. This corresponds to the time scale axis of **2**, which represents 1997, our second year of network data. In the final year, 1998, our measure of Knowledge Waste declined to the value in 1996. This should be visually evident with its relative line graph position.

It is clear that the value for the Knowledge Waste Measure increased from the first Meta-Network (**1996)** to the second **(1997)** and then retreated back to its original **(1996)** level. It would be up to you to determine what may have affected that measure for it to undergo this progression and regression.

Summary of Lesson

At this point, you should be able to complete the following tasks to perform a View Measures Over-Time Analysis:

- Load multiple data files into ORA **(in the form of Meta-Networks)** representative of your network across certain periods of time.
- Select an aggregation level and choose a graph level or entity entity set to analyze.
- Analyze the data output in the charting tool located in the bottom section of the View Measures Over Time window.
- See how your network may have changed from one time capture to the next for any given graph level or entity node measure.
- Use this visual comprehension to draw conclusions about how your network changed across multiple time periods.

Working with Attributes

What is an attribute?

An **attribute** is a quality, an added description, a differentiation of some sort, of a Who, What, Where, How and When and Whatever. It also indicates the presences, absence or strength of a particular connection. As an example, you might create a network of people (Whos) who work at certain buildings (Locations). The **attributes** of those people could range anywhere from their first and last name, their employee identification number, their job grade in the corporation, their salary, their home phone number, education, political affiliation and the list goes on. Moreover, we might say that you have a connection to both your friend and father. However, we might give the connection to your father the attribute of **family** whereas your friend might be attributed **personal**. The key is to know that attributes can be both differentiate nodes or ties or both.

It follows that it would be helpful to view a network of Whos (and or any of the other Nodesets) and see how those Whos are grouped according to any particular attribute you are interested in analyzing. ORA has the capability to do just that and provides several ways of doing so. We will explore several methods of locating groups namely by using ORA's report tool and in the Visualizer.

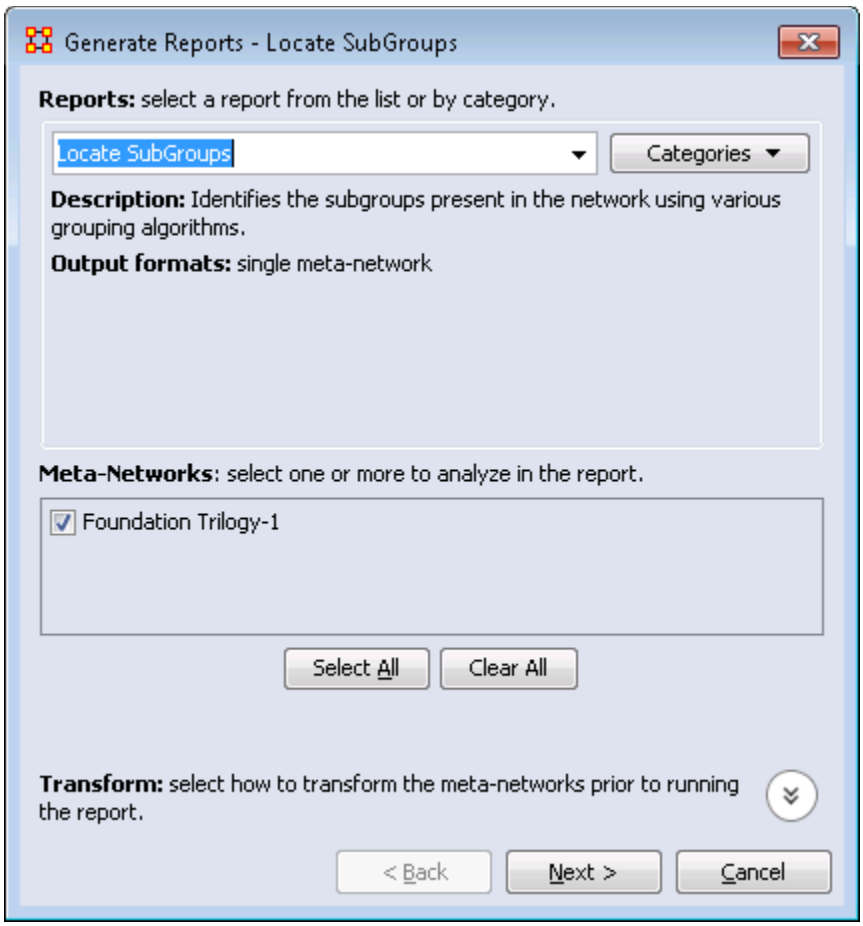
> > Go to Using attributes to find groups in ORA Reports

> > Go to using attributes to find groups in the ORA Visualizer

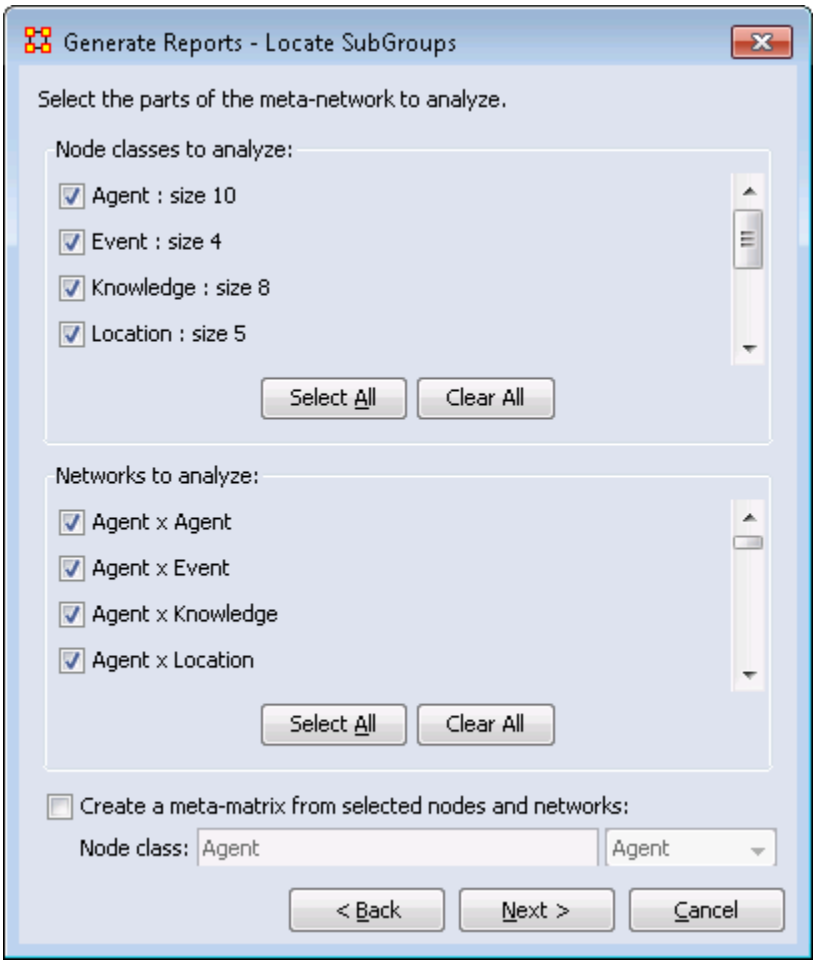
Using Attributes to find groups in ORA Reports

To **create and assess groups by attribute** use the **Locate Subgroups report** accessible in ORA Reports at the following path:

From the Main Menu select **Analysis > Generate Reports > Characterize Groups and Networks > Locate SubGroups**. In the dialog box place a check mark next to the Meta-Network to analyze and click [**Next >**].



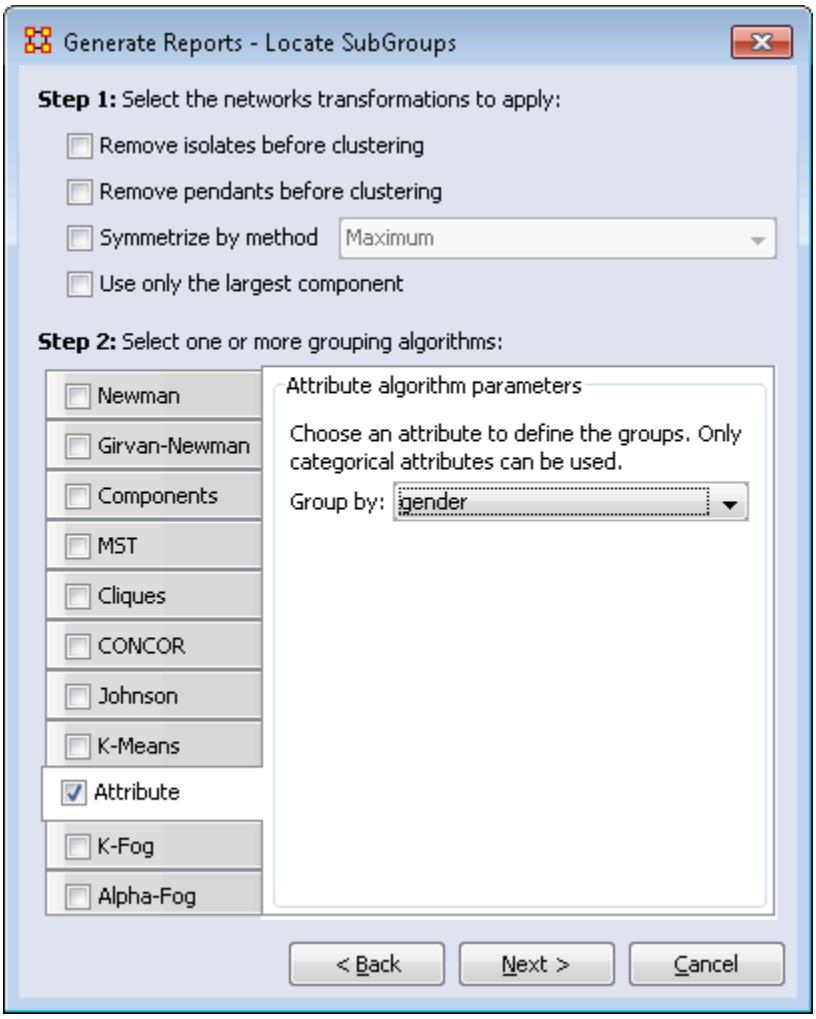
By default all Nodesets and Networks are check marked. Remove the check mark for any you do not wanted included in the analysis. Then click [**Next >**].



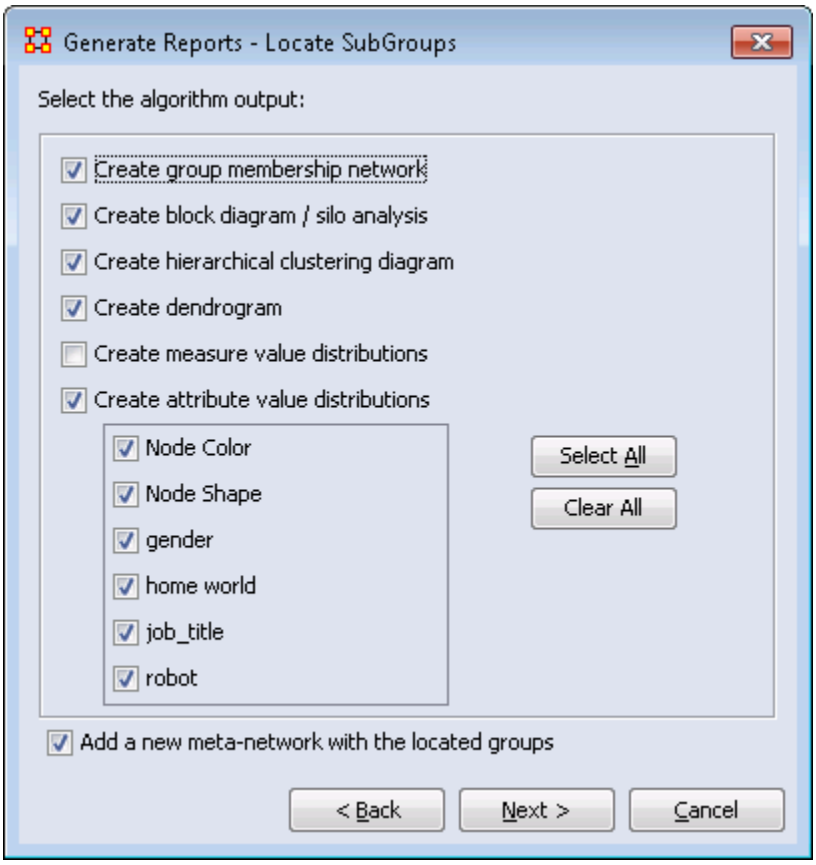
Click the side tab **Attribute**. Be sure to place a check mark next to the algorithm's name. From the dropdown menu select an attribute to use. Then click [**Next >**].

In **Select the networks transformation to apply:**you can specify removal of isolates and pendants, symmetirize method, and selecting only the largest component.

In **Select one or more grouping algorithms:**you select one or more analytic methods. Place a check mark next to the name and fill in the parameters.



Place a check mark next to any output parameters to need. Then click [**Next >**].



On the final screen click the [**Browse**] button and navigate to a directory to save the results. Give it a unique prefix in the second box. Then click [**Finish**].

A new Meta-Network will be created that contains the networks used in the grouping. This new Meta-Network will contain a new Nodeset, **attribute groups** and new Networks, **Nodeset x attribute groups** is created that contains the group nodes. Also two **block model group x group networks** are created.

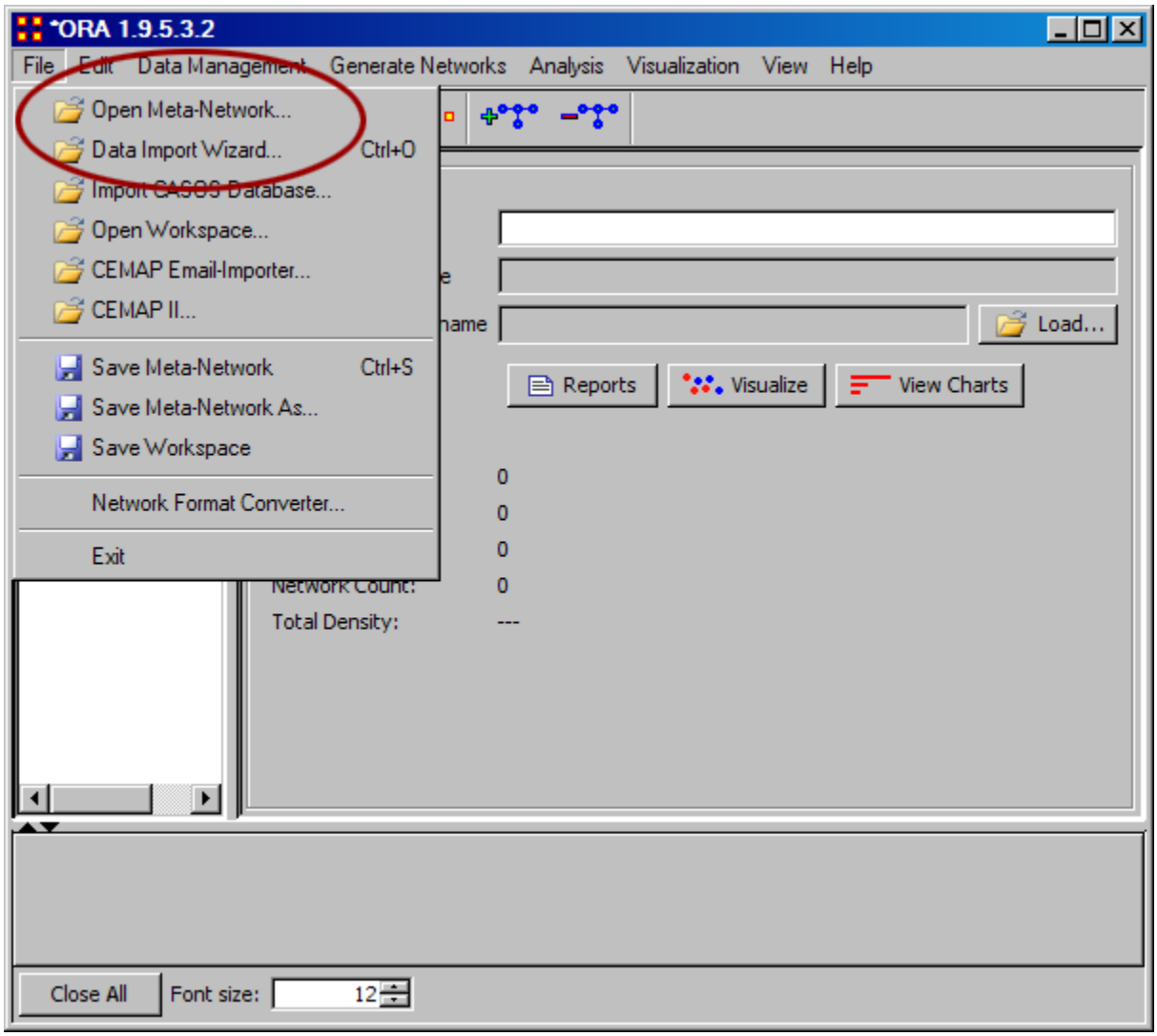
==========

In **Select the algorithm outout:** you can select the specific grouping algorithm parameters. Each of these parameters will give additional output in the report.

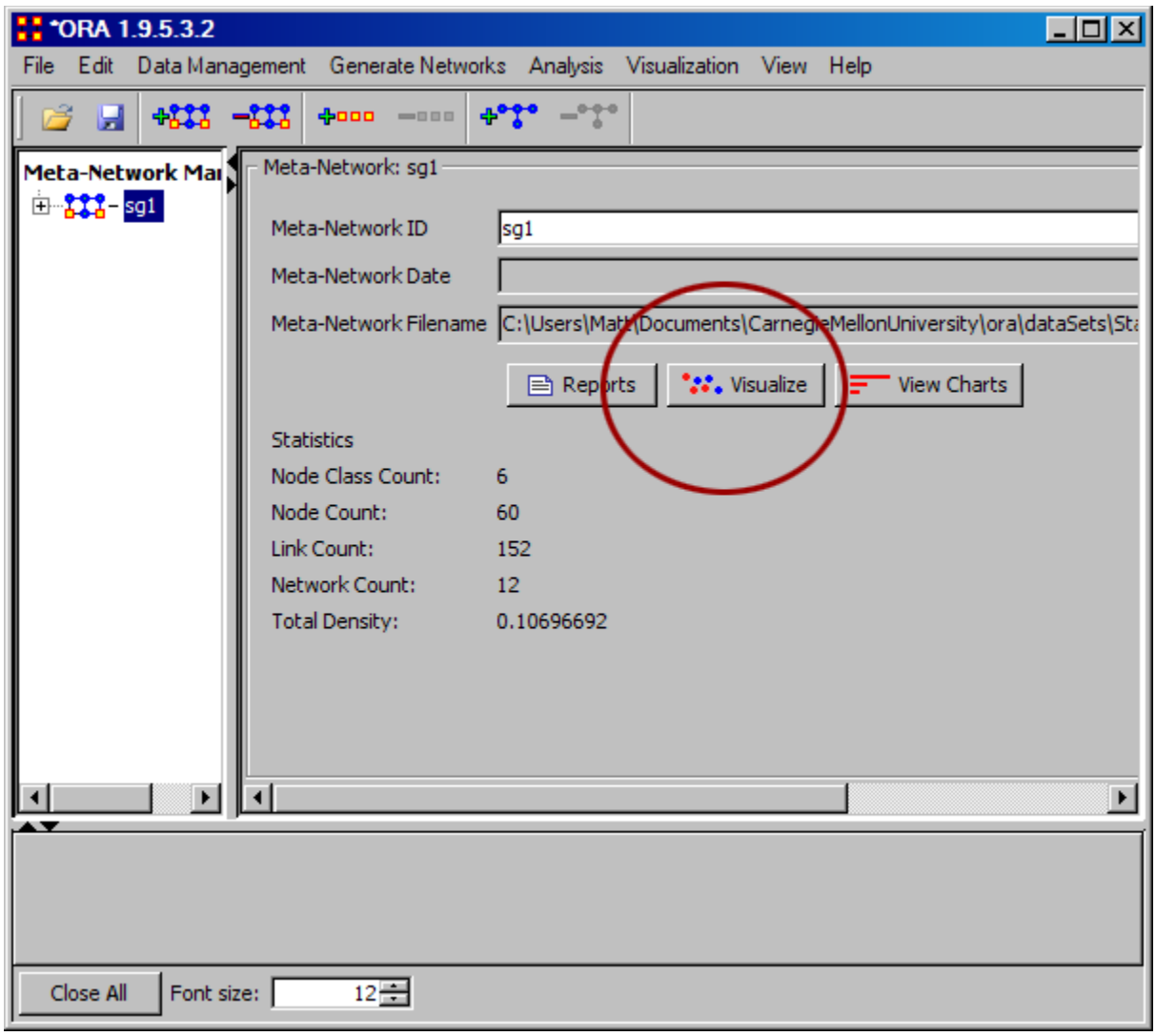
Using Attributes to find groups in the Visualizer

What follows are instructions for finding various groups that may exist in your Meta-Network by using attributes and the ORA Visualizer too. To follow along with this lesson, please load the SG1 data set included with your installation.

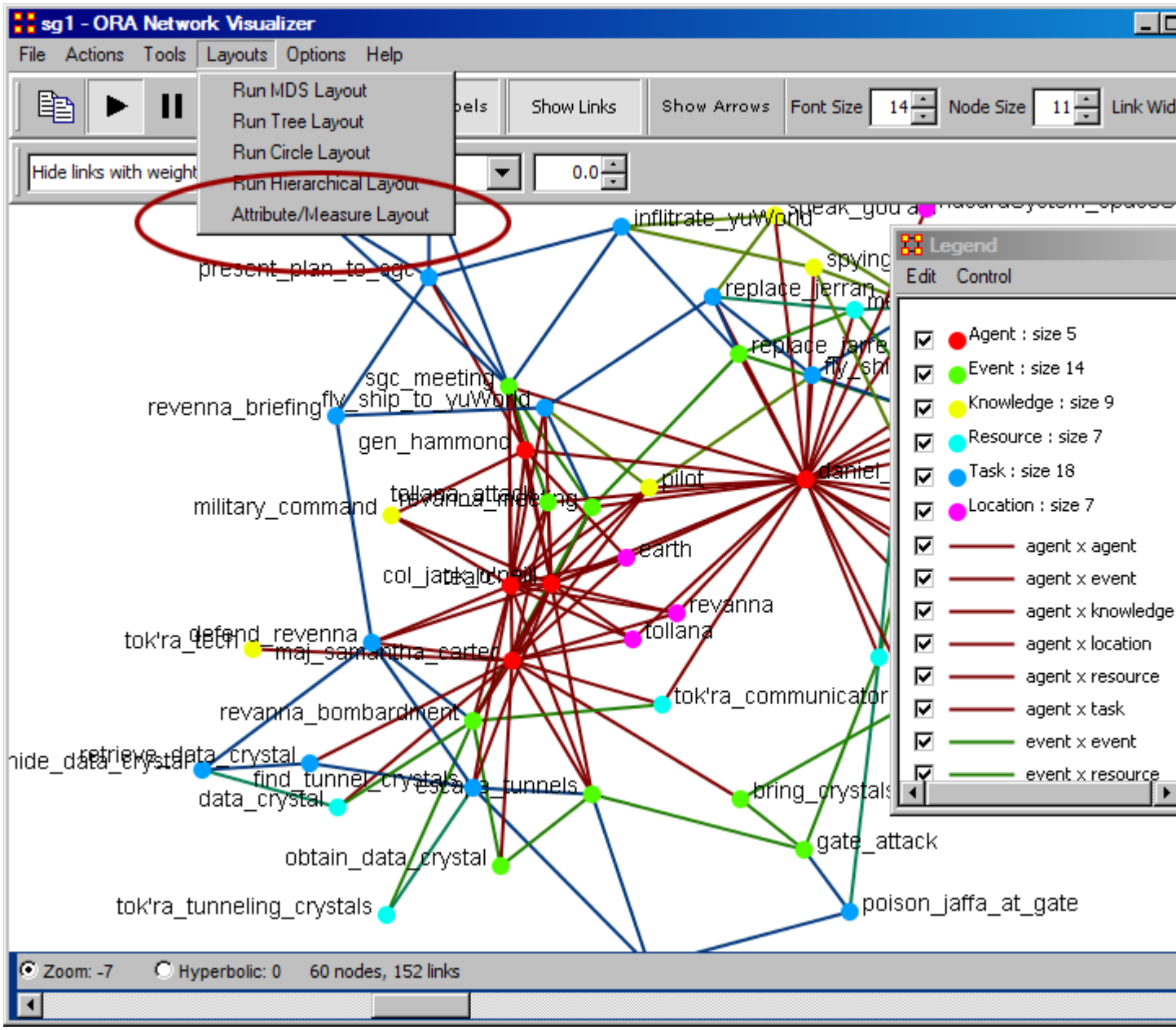
Step 1: Open the Stargate Meta-Network.



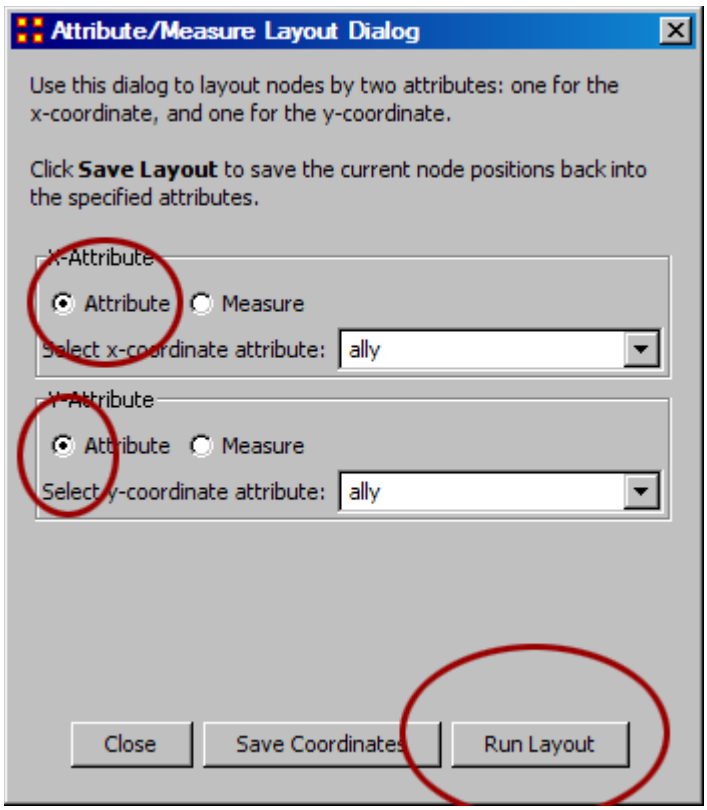
Step 2: Select [Visualizer] button.



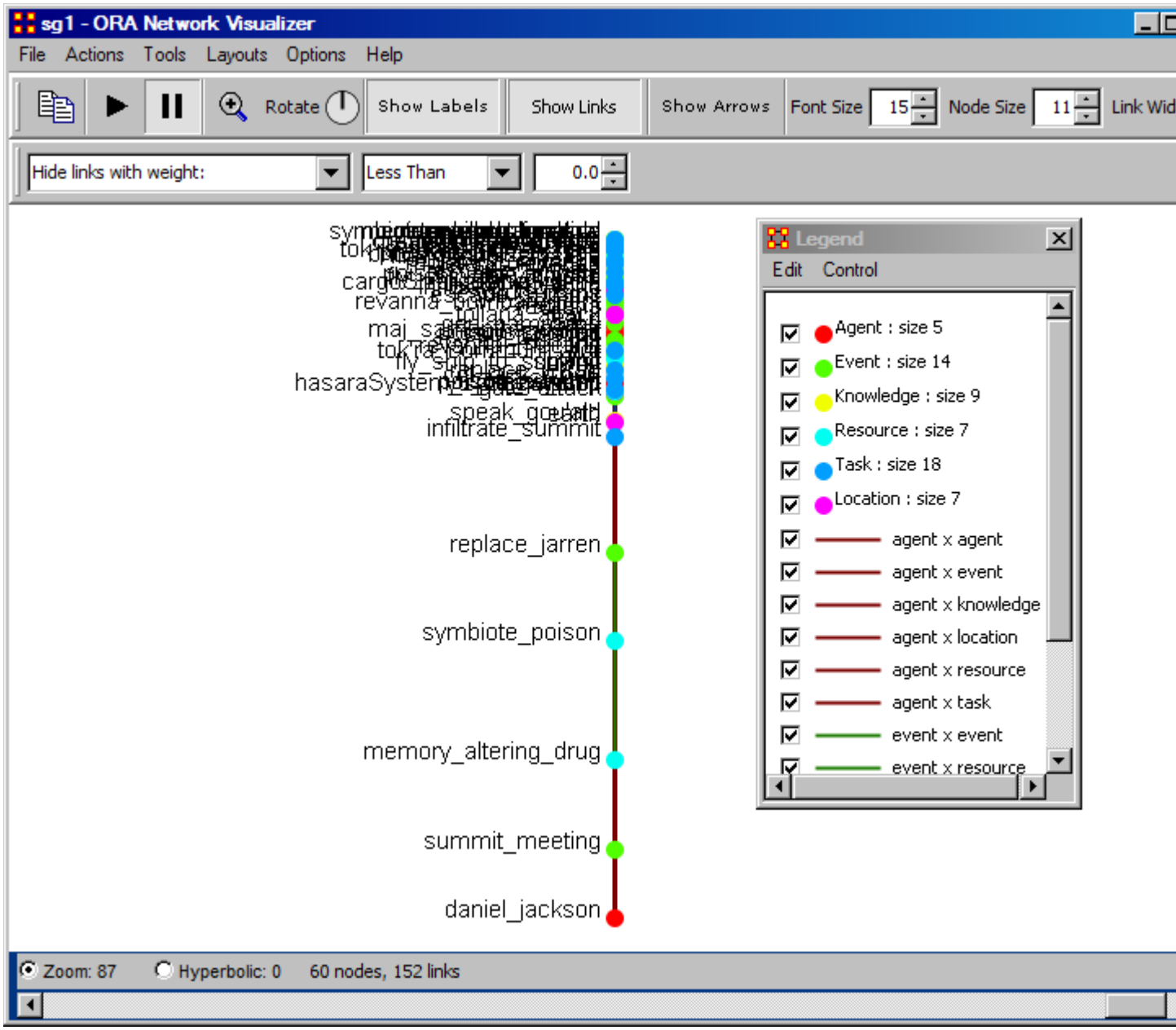
Step 3: In The Visualization, select "Attribute / Measure" Layout.



Step 4: Next (screen shot below) you will see the "Attribute / Measure" Layout Dialog box appear. In this box, select the attribute for an X and Y coordinate. You can use the save button to come back to these settings later. After choosing your attributes, click "Run Layout."



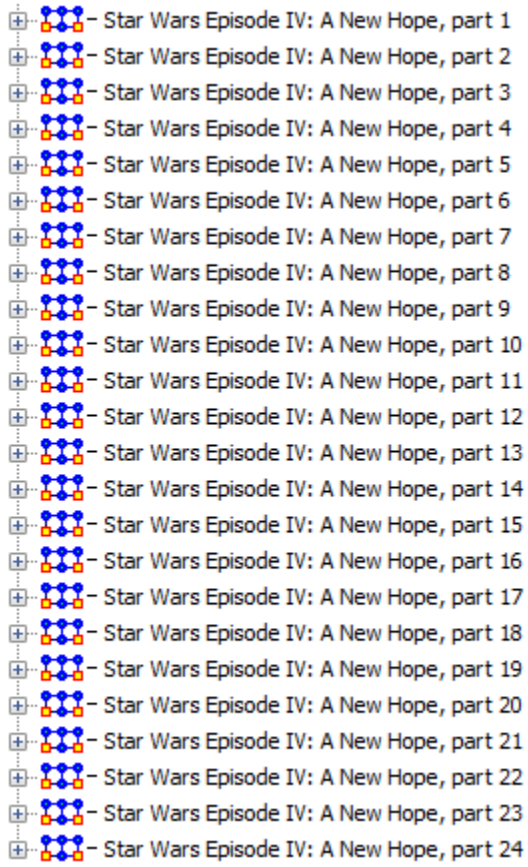
Step 5: You can experiment with the X and Y values by using either attributes or measures. In the final result shown below, we choose to use the X value as an attribute and the Y values as a measure.


sg1 - ORA Network Visualizer
File Actions Tools Layouts Options Help
Rotate
Show Labels
Show Links
Show Arrows
Font Size 15
Node Size 11
Link Wid
Hide links with weight:
Less Than
0.0
revanna_
maj_
hasaraSystem
speak_
infiltrate_summit
replace_jarren
symbiote_poison
memory_altering_drug
summit_meeting
daniel_jackson
Legend
Edit Control
Agent : size 5
Event : size 14
Knowledge : size 9
Resource : size 7
Task : size 18
Location : size 7
agent x agent
agent x event
agent x knowledge
agent x location
agent x resource
agent x task
event x event
event x resource
Zoom: 87
Hyperbolic: 0
60 nodes, 152 links

Working with Loom Clustering

Loom allows you to view nodes over time and which locations these nodes visited.

NOTE : This does require a dataset with a time attribute.



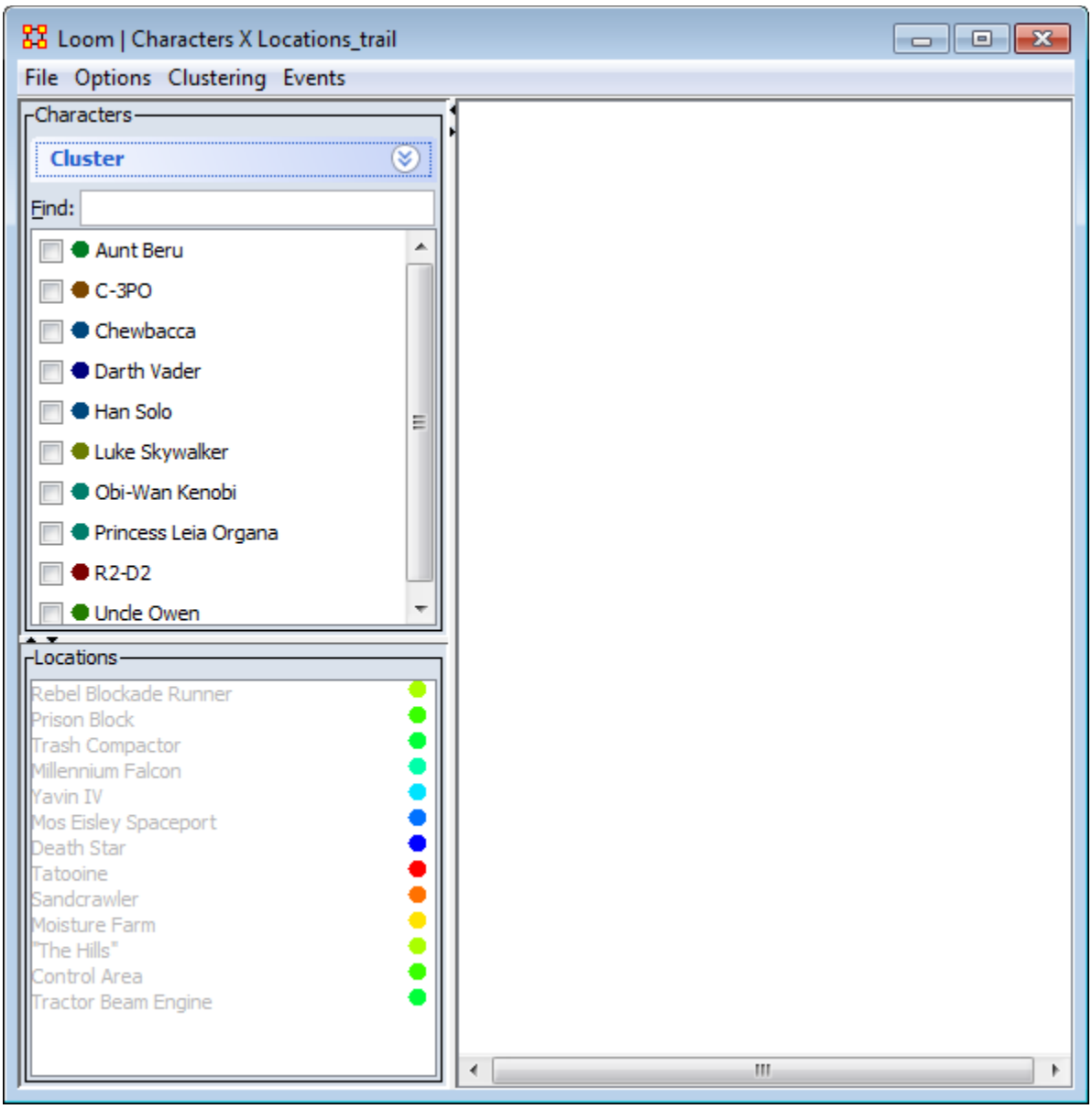
Loading the Star Wars dataset

For this example we will be using the Star Wars dataset included in the sample folder. You can find it in the following folder: **ORA > sample data > Loom data > Star Wars**. There will be 24 xml files. From the main menu select **File > Open Meta-Network...**. Navigate to the folder specified above. Select the first file then Shift-Click the last file to select them all. Then select [**Open**]. This will display them in the Meta-Network panel.

Trail pattern depth determines which clusters will be shown.

To open this data in Loom make sure all Meta-Networks are selected. From the drop down menu select **Visualizations > View Trails**. You will be asked to chose a network. For this dataset chose **Characters x Location**. On the left will be two panes. On top is a list of Characters and below that is a list of locations.

After opening the dataset in Loom all the characters will appear in the left/top pane and will start with no nodes checked. Below are the locations and the colors which will signify them on the Loom.

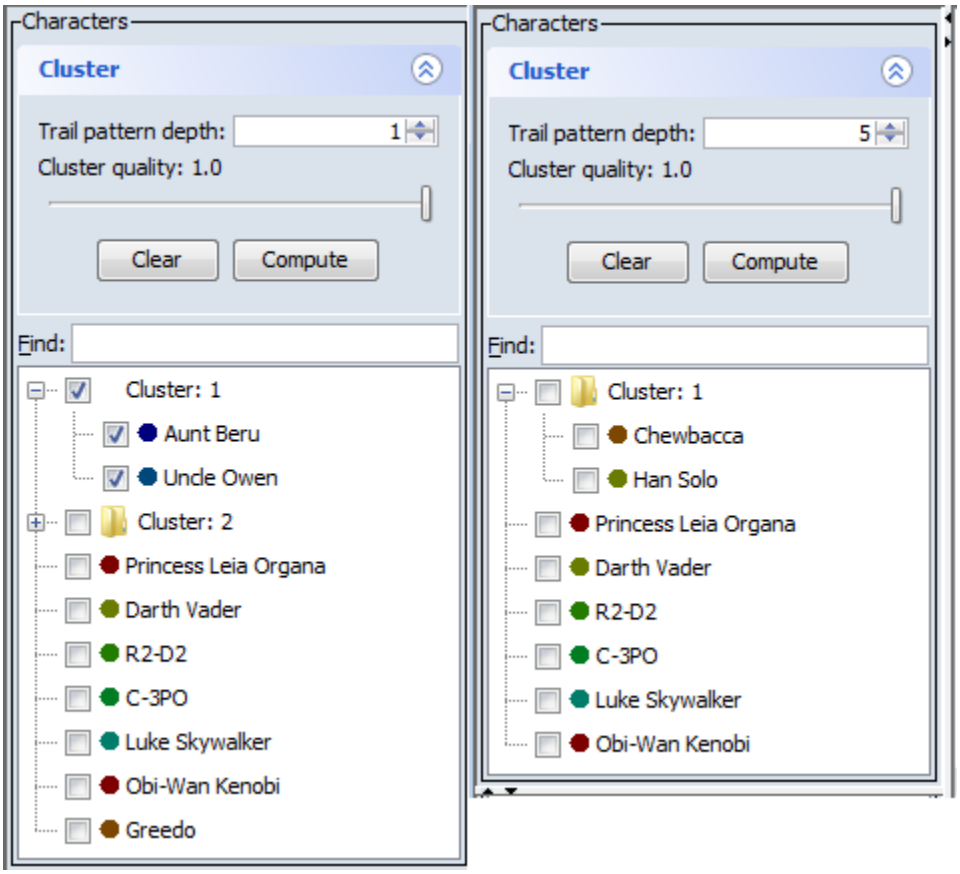


Trail pattern depth

Trail pattern depth displays clusters of nodes which have the same general trail. The number is the minimum number of points they all need to have in common.

Example

Uncle Owen and Aunt Beru are in [4] timeslices. They will continue to be clustered until the **Trail pattern depth** reaches [5]. At that point they no longer meet the conditions and are no longer clustered.



Cluster Quality

Running ORA in Batch Mode

January, 2010
ORA Batch Mode XML
Version 2.0.0

I. Command Line Arguments

The program ora.exe (henceforth called ORA) takes one or more of the following command line arguments as input: (1) Measures File to be used, (2) the Script File to use, and (3) the Log File to use.

If you installed the front-end of ORA, then the executable can be found as:
[ORA installation directory] \include\OraFiles\bin\ora.exe

Likewise, the Measures file can be found as:
[ORA installation directory] \include\OraFiles\xml\ora_xml_measures.xml

Measures File

The Measures File is distributed with ORA and contains an XML encoded description of all the measures available to ORA. This is distributed with ORA and is usually called ora_xml_measures.xml. The following command line parameter specifies the filename:

-measures <filename>

Script File

The Script File is an XML file created by the user and tells ORA where to load the input network data and which reports to generate. Section II - ORA Script XML Specification - describes in detail the format of this XML script. The following command line argument specifies the filename:

-script <filename>

Log File

The Log File is generated by ORA to record the progress and problems of ORA in processing the Script File. The log file is a text file, and the following command line argument specifies its filename:

-log <filename>

Help

A listing of the above parameters is available by using the following command line parameter:

-help

Version

The ORA version can be obtained by the following command line parameter:

-version

II. XML Script

The batch mode script is a user supplied XML document that is input to ORA (see the -script command line parameter above). It tells ORA what network data to load and what reports to generate.

Please note the following general guidelines for the script:

1. camel case capitalization is used for element names: therefore element names begin lower case and the first letter of each word is capitalized. For example, Meta-Network is metaNetwork.

2. default values are used: therefore a short, simple script can initially be used to run ORA. Advanced users can change the default values.

The root n is <ora>, which has two child elements <input> and <output>. The input element describes the network data to load, and the output section describes the reports to generate.

Example: an empty script
<ora>
<input/>
<output/>
</ora>

A. Input Section

The main unit of input to ORA is the Meta-Network, and therefore the input section of the XML script tells ORA how to load one or more Meta-Networks.

A Meta-Network is simply an organization modeled as a collection of matrices. The entire Meta-Network can be loaded from a single data file, or each matrix can be loaded from separate data files with possibly different data formats.

1. Meta-Network Specification

A Meta-Network is specified by the <Meta-Network> element. It accepts a single attribute called id which must be unique across all the Meta-Network elements.

The child elements describe the location and format of its matrix data. There are two cases: (1) all data for the Meta-Network is stored in a single file, (2) the data for matrices of the Meta-Network are located in separate files.

1.1 Meta-Network data in a single file

The first case is only possible for a data file in the DyNetML format. In this case, the <filename> and <format> children are required, and the <properties> child is optional. The child elements are described below:

filename : location of the data
format : must by dynetml
properties : [optional] Describes how ORA should interpret the data read from the file, but does not cause ORA to modify the input data in any way. Each graph in the Meta-Network is given the property.

Properties are specified with the attributes below, each of which takes values: yes or no

1. sparse: indicates whether the data is sparse
2. binary: indicates whether the data should be treated as binary (i.e. ignore edge weights)
3. symmetric: indicates whether the unimodal graphs should be considered symmetric
4. diagonal: indicates whether the diagonal values of unimodal graphs should be used

Example:
<Meta-Network id="Organization">
<filename>data/organization.xml</filename>
<format>dynetml</format>

<properties binary="yes"/>
</Meta-Network>

1.2 Meta-Network data in multiple matrix files

The second case has the Meta-Network data located in multiple files. In this case, the script must describe how to assemble the Meta-Network from different data files.

Matrix data describes a relationship between two sets of nodes, called the source and target Nodesets. Therefore, in specifying a matrix, these nodesets must be specified. A unique id for the matrix is also specified. This id must be unique across all matrices in the Meta-Network.

The <matrix> element defines a matrix and has the following case-insensitive attributes:

sourceType : type of the source Nodeset
source : [optional] unique identifier of the source Nodeset
targetType : type of the target Nodeset
target : [optional] unique identifier of the target Nodeset
id : [optional] id of the matrix

The above attributes can be any string.

The sourceType and targetType attributes specify the class or general category of the Nodesets. By convention, these are taken from Agent, Knowledge, Resource, Task, Location, or Organization, but any string can be used.

The source and target attributes uniquely identify the source and target Nodesets, and if they are not specified the sourceType and targetType are used. To have more than one Nodeset of a given type (e.g. "blue" agents and "red" agents), the source attribute must be used.

The id uniquely identifies the matrix within the collection of matrices that is the Meta-Network. By default, the id is constructed from the source and target types.

Examples:
<matrix sourceType="agent" targetType="agent" id="reports to"/>
<matrix sourceType="agent" source="employee" targetType="agent" target="employee" id="works with"/>

As in the first case, the <matrix> element must have the child elements <filename> and <format> that describe the location and format of the matrix data. The <properties> element is optional, and pertains only to the matrix.

The <format> element takes one of the following values:

dynetml : DyNetML specified data
ucinet : UCINET binary format (refer to UCINET documentation)
dl : UCINET text format (refer to UCINET DL documentation)
csv : CSV (Comma Separated Values) allows row and/or column labels
raw : space, comma, or semi-colon separated data (no labels allowed)

Example:
<Meta-Network id="SampleOrganization">
<matrix sourceType="agent" targetType="agent" id="communication">
<filename>data/organization_agent_agent.dl</filename>
<format>dl</format>
</matrix>
</Meta-Network>

Multiple <matrix> elements are used to define the constituent matrices of the Meta-Network. Note that <Meta-Network> has no immediate <filename> and <format> children since the data is described under the <matrix> child elements.

Example:
<ora>
<input>
<Meta-Network id="SampleOrganization">
<matrix sourceType="agent" targetType="agent" id="social">
<filename>data/organization_agent_agent.dl</filename>
<format>dl</format>
</matrix>
<matrix sourceType="agent" targetType="knowledge">
<filename>data/organization_agent_knowledge.dl</filename>
<format>dl</format>
</matrix>
</Meta-Network>
</input>
</ora>

In the example, the Meta-Network contains two matrices: the first of type Agent x Agent and named social, and it is populated with data from the

specified file of the specified format. The second has type Agent x Knowledge, and no name is specified.

1.3 Multiple Meta-Networks

Multiple Meta-Networks can be specified in the <input> section using unique id attributes.

Example: multiple Meta-Networks differentiated by id attribute
<ora>
<input>
<Meta-Network id="SampleOrganization1">
<matrix sourceType="agent" targetType="agent" id="social">
<filename>data/organization_agent_agent.dl</filename>
<format>dl</format>
</matrix>
<matrix sourceType="agent" targetType="agent" id="friendship">
<filename>data/organization_agent_agent_friend.csv</filename>
<format>csv</format>
</matrix>
<matrix sourceType="agent" targetType="knowledge">
<filename>data/organization_agent_knowledge</filename>
<format>ucinet</format>
</matrix>
</Meta-Network>
<Meta-Network id="SampleOrganization2">
<filename>data/organization2.xml</filename>
<format>dynetml</format>
</Meta-Network>
</input>
</ora>

1.3 Meta-Network Directories

If there are multiple DyNetML files in a single directory, then one can specify the directory and ORA will create a Meta-Network from each file. The <Meta-NetworkDirectory> element is used, whose only attribute is name that specifies the path of the directory. Each file must have .xml extension. A <transform> element can be used within the element to apply to each Meta-Network. The id for each Meta-Network is its filename.

Example: load all Meta-Networks from a directory
<ora>

```
<input>
<Meta-NetworkDirectory name="data/sample/">
<transform>
<conform method="union"/>
</transform>
</Meta-NetworkDirectory>
</input>
</ora>
```

B. Output Section

The second section of the script file is the <output> element, and it describes which reports to generate. The reports available in ORA and how to specify them in the ora-script is documented in the file ORA-batch-mode-parameters.xml, which is an XML specification in Relax-NG.

Ora-Script Report Generation
To tell ORA to create a report, the <reports> child element is used in the ora-script. The <reports> child element contains a collection of <report> elements. Each report element specifies any input parameters, the output filename, and the output file type/format. Each <report> is uniquely identified by its id attribute.

The <filename> child specifies the name of the output file to create. The filename should NOT have an extension. The <formats> child contains one or more <format> children which specify the format of the report output.

For each report, the possible formats are: text, html, csv, dynetml

Example: generating a report in multiple output formats

```
<report id="intelligence">
<filename>reports/intelligence</filename>
<formats>
<format>text</format>
<format>csv</csv>
</formats>
</report>
```

Any report specific parameters are designated within the <parameters> child. The parameters for each report are documented in the file: ora_xml_measures.xml

Example: specifying report parameters

```
<report id="intelligence">
```

```
<parameters>
<numberOfKeyEntities>10</numberOfKeyEntities >
</parameters>
<filename>reports/intelligence</filename>
<formats>
<format>html</format>
<format>csv</format>
</formats>
</report>
```

Example: shorter script if only one output format is specified

```
<report id="intelligence" filename="reports/intelligence" format="text">
<parameters>
<numberOfKeyEntities>10</numberOfKeyEntities >
</parameters>
</report>
```

3. Saving Meta-Networks

The input Meta-Networks can themselves be saved to files. This allows for converting between matrix formats and for saving transformed or conformed input data.

Example: saving a specific Meta-Network

```
<ora>
<output>
<Meta-Networks>
<Meta-Network id="sample">
<filename>data/output/sample.xml</filename>
<format>dynetml</format>
</Meta-Network>
</Meta-Networks>
</output>
</ora>
```

Only the specified Meta-Networks will be saved. Individual matrices can be saved using the syntax identical to that of the <matrix> element in the input section. The following, for example, saves the agent x agent matrix:

Example: saving a specific matrix from a Meta-Network

```
<ora>
<output>
<Meta-Networks>
<Meta-Network id="sample">
```

```
<matrix sourceType="agent" targetType="agent">
<filename>data/output/sample_agent_agent.dl</filename>
<format>dl</format>
</matrix>
</Meta-Network>
</Meta-Networks>
</output>
</ora>
```

In addition, network set operations (union, intersection, difference) can be performed on the input networks and then saved. The sample below assumes that there were two Meta-Networks specified in the <input> section, namely, A and B, and the set operations all pertain to them. Union and Intersect operate on one or more input Meta-Networks, and the parameter method indicates how to handle common edges. The method attribute takes on one of the following values: binary, sum, maximum, or minimum. The difference between two Meta-Networks is taken with respect to edges only, and thus no nodes are removed.

Example: saving union of multiple input Meta-Networks

```
<output>
<Meta-Networks>
<!--Union-->
<Meta-Network id="A Union B">
<filename>data/output/A-union-B.xml</filename>
<format>dynetml</format>
<union method="sum">
<Meta-Network id="A"/>
<Meta-Network id="B"/>
</union>
</Meta-Network>
<!--Intersect-->
<Meta-Network id="A Intersect B">
<filename>data/output/A-intersect-B.xml</filename>
<format>dynetml</format>
<intersect method="minimum">
<Meta-Network id="A"/>
<Meta-Network id="B"/>
</intersect>
</Meta-Network>
<!--Difference (edges only)-->
<Meta-Network id="A Minus B">
<filename>data/output/A-minus-B.xml</filename>
<format>dynetml</format>
```

<difference>
<Meta-Network id="A"/>
<Meta-Network id="B"/>
</difference>
</Meta-Network>
</Meta-Networks>
</output>
</ora>

4. Transform Element

The transform element is used to pre-process a Meta-Network or an individual matrix of a Meta-Network before generating reports. It transforms its parent element. For example, if the <transform> element is a child of a <matrix> then it applies to that matrix. If it is a child of <Meta-Network>, then it transforms the entire Meta-Network: for Nodeset modifications (removeNodes, subsetNodes, conform), these apply to the Meta-Network as a whole, but transformations of edges (symmetrizing, dichotomizing) are applied to each matrix independently.

The <transform> element has the following child elements that define the transformation:

<transpose> : transpose the graph

<removeIsolates> : remove isolate nodes

<removePendants> : remove pendant nodes

<symmetrize method=””> : symmetrize using one of two methods
“union” : symmetrize using the union/maximum method
“intersect” : symmetrize using the intersect/minimum method
Default is “union”.

<subsetNodes> : defines a subset of nodes to create a subgraph
contains one or more of the following child elements:
<nodeSet type=””/> : adds all nodes in the specified Nodeset to the subset.

The type attribute can have values: agent, knowledge, resource, task, organization

<node type=”” id=”” radius=””/> : adds the specified node to the subset
The type attribute is identical to that of the <nodeSet> element.

The id attribute is the node's unique id within the Nodeset.

The radius attribute is optional (by default it is zero), and includes all nodes within a distance <= radius of the node. This is useful for defining ego Nodesets.

<removeNodes> : defines a subset of nodes to remove
contains the same <nodeSet> and <node> child elements as subsetNodes

<conform method=""/> : creates an identical set of nodes across Meta-Networks. This is useful for time-series data to give each Meta-Network the same Nodesets. The union method adds isolates to achieve identical sets, and the intersect method removes nodes.

The method attribute can have one of two values:
union: create union of Nodesets
intersect: create intersection of Nodesets
Default is "union".

By default the agent, knowledge, resource, task, and organization Nodesets are conformed. This can be customized by adding <nodeSet> child elements to specify specific Nodesets, as in subsetNodes above.

<dichotomize criteria="" cutoff=""/> : creates a binary graph according to the criteria and cutoff. Any edges whose value does not satisfy the criteria and cutoff are given a value of 0, otherwise a value of 1.

The criteria attribute takes one of the following values:
lessThan, lessThanEquals, equals, greaterThanEquals, greaterThan

The cutoff attribute can be any numerical value.

Precedence
The order (i.e. precedence) in which the transformations occur is as follows: (1) individual matrices, (2) Meta-Networks, (3) across Meta-Networks. Each of these usages is in the examples below.

The precedence of operations within a transform (for example, is the graph symmetrized before dichotomizing, etc.) is defined to be the same as they are specified in the <transform> element. Thus, if the <symmetrize> child is before the <dichotomize> child, then the transformation first symmetrizes and then dichotomizes.

Example: remove all agent nodes and the specified knowledge nodes from the Meta-Network

```
<Meta-Network id="test">
<transform>
<removeNodes>
<nodeset id="agent"/>
<node nodesetId="knowledge" id="physics"/>
<node nodesetId="knowledge" id="mathematics "/>
</removeNodes>
</transform>
<filename>data/sample.xml</filename>
<format>dynetml</format>
</Meta-Network>
```

Example: symmetrize a single matrix of the Meta-Network

```
<Meta-Network id="test">
<matrix sourceType="agent" targetType="agent">
<filename>data/aa.csv</filename>
<format>csv</format>
<transform>
<symmetrize method="union"/>
</transform>
</matrix>
<matrix sourceType="agent" targetType="knowledge">
<filename>data/ak.csv</filename>
<format>csv</format>
</matrix>
</Meta-Network>
```

This example creates a sub-Meta-Network as follows: a set of nodes is defined, and then the Meta-Network induced by the nodes (that is, all the edges incident upon those nodes). The set of nodes consists of all nodes within distance 2 of agent Andy and within distance one of Sam. Because the transform is part of the Meta-Network, knowledge, task, or organization nodes can be connected to these agents, and would therefore be part of the set.

Example: define a subset of nodes

```
<Meta-Network id="test">
<transform>
<subsetNodes>
<node nodesetId="agent" id="Andy" radius="2"/>
<node nodesetId="agent" id="Sam" radius="1"/>
</subsetNodes>
```

```
</transform>
<filename>/data/myorg.xml</filename>
<format>dynetml</format>
</Meta-Network>
```

This example makes the agent nodes in the Meta-Networks conformable by creating the union of all the agent Nodesets across the Meta-Networks. Currently, only agent nodes can be made conformable.

Example: conform nodesets across Meta-Networks

```
<input>
<transform>
<conform method="union"/>
</transform>
<Meta-Network id="org1">
<filename>data/org1.xml</filename>
<format>dynetml</format>
</Meta-Network>
<Meta-Network id="org2">
<filename>data/org2.xml</filename>
<format>dynetml</format>
</Meta-Network>
<Meta-Network id="org3">
<filename>data/org3.xml</filename>
<format>dynetml</format>
</Meta-Network>
</input>
```



Java Licenses

Library	Name / Website / License
activation	JavaBeans Activation Framework http://java.sun.com/products/archive/javabeans/jaf102.ht Sun Microsystems, Inc. Binary Code License Agreement
ant-launcher	Ant Laucher http://ant.apache.org The Apache Software License, Version 2.0
ant-optional-1.5.1	Ant Optional http://ant.apache.org The Apache Software License, Version 1.1
batik-awt-util-1.6	Batik AWT Utilities http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-bridge-1.6	Batik Bridge http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-css-1.6	Batik CSS http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-dom-1.6	Batik DOM Implementation http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-ext-1.6	Batik Extension http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-gvt-1.6	Batik Graphics Vector Tree http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-parser-1.6	Batik Parser http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-script-1.6	Batik Script http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0

batik-svg-dom-1.6	Batik SVG DOM http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-svggen-1.6	Batik SVG Generator http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-transcoder-1.6	Batik Transcoder http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
batik-util-1.6	Batik Utilities http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
>batik-xml-1.6	Batik XML http://xmlgraphics.apache.org/batik/ The Apache Software License, Version 2.0
casosparser	CASOS Parser http://www.casos.cs.cmu.edu/projects/ora/
colt	Colt http://acs.lbl.gov/software/colt/ CERN, 1999
common-2.1.0	Commons http://commons.apache.org/ The Apache Software License, Version 2.0
commons-beanutils-1.4	Commons BeanUtils http://commons.apache.org/ The Apache Software License, Version 2.0
commons-cli-1.2	Commons CLI - Command Line Interface http://commons.apache.org/ The Apache Software License, Version 2.0
commons-cli-2.0-gt2-pre1	Commons CLI - Command Line Interface http://commons.apache.org/ The Apache Software License, Version 2.0
commons-codec-1.4	Commons Codec http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-	Commons Collections

collections-3.1	http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-httpclient-3.1	Commons HttpClient http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-io-1.2	Commons I/O Utilities http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-jxpath-1.2	Commons JXPath http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-lang-2.1	Commons Lang http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-logging-1.1.1	Commons Logging http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-logging-api-1.1.1	Commons Logging API http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-math-1.2	Commons Math http://commons.apache.org/ The Apache Software License, Version 2.0"
commons-pool-1.3	Commons Pool http://commons.apache.org/ The Apache Software License, Version 2.0"
concurrent-1.3.4	Java Concurrency http://download.oracle.com/javase/1.5.0/docs/api/java/util/concurrent/package-summary.html Java 2 Platform SE 5.0
db2jcc_dummy-8.2.1	DB2 Spatial Data http://geotools.org/ Lesser General Public License (LGPL)
dnsjava-2.0.8	DNS in Java http://www.xbill.org/dnsjava/ BSD license
dom4j-1.6.1	

ecore-2.1.0	Ecore http://java2ecore.blogspot.com/ Lesser General Public License (LGPL)
facebook-java-api-1.8-final	Facebook Java API http://mrepo.happyfern.com/sites/facebook-java-api/ MIT License
facebook-util-1.8-final	Facebook Companion Utility http://mrepo.happyfern.com/sites/facebook-java-api/ MIT License
freehep-graphics2d-2.0	FreeHEP 2D Graphics http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-graphicsio-2.0	FreeHEP GraphicsIO http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-graphicsio-pdf-2.0	FreeHEP GraphicsIO PDF http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-graphicsio-svg-2.0	FreeHEP GraphicsIO SVG http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-io-2.0.1	FreeHEP IO http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-util-2.0.1	FreeHEP Utilities http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
freehep-xml-2.0.1	FreeHEP XML http://java.freehep.org/ GNU LESSER GENERAL PUBLIC LICENSE, Version 2.1
geoapi-nogenerics-2.1-M2	GeoAPI http://www.geoapi.org/ GNU Lesser General Public License (LGPL)
geowidgets-1.0-M1	GeoWidgets http://geowidgets.sourceforge.net/ GNU Lesser General Public License (LGPL)

geronimo-stax-api_1.0_spec-1.0	
gluegen-rt	GlueGen http://jogamp.org/gluegen/www/ BSD license
gt2-api-2.3.3	GeoTools API http://geotools.org/ Lesser General Public License (LGPL)
gt2-arcgrid-2.3.3	GeoTools ArcGrid http://geotools.org/ Lesser General Public License (LGPL)
gt2-arcsde-2.3.3	GeoTools ArcSDE http://geotools.org/ Lesser General Public License (LGPL)
gt2-brewer-2.3.3	GeoTools Brewer http://geotools.org/ Lesser General Public License (LGPL)
gt2-coverage-2.3.3	GeoTools Coverage http://geotools.org/ Lesser General Public License (LGPL)
gt2-coveragetools-2.3.3	GeoTools Coverage Tools http://geotools.org/ Lesser General Public License (LGPL)
gt2-cql-2.3.3	GeoTools CQL http://geotools.org/ Lesser General Public License (LGPL)
gt2-db2-2.3.3	GeoTools DB2 http://geotools.org/ Lesser General Public License (LGPL)
gt2-demo-data-2.3.3	GeoTools Data Demo http://geotools.org/ Lesser General Public License (LGPL)
gt2-demo-mappane-2.3.3	GeoTools MapPane http://geotools.org/ Lesser General Public License (LGPL)
gt2-demo-property-2.3.3	GeoTools Property Demo http://geotools.org/

	Lesser General Public License (LGPL)
gt2-directory-2.3.3	GeoTools Directory http://geotools.org/ Lesser General Public License (LGPL)
gt2-epsg-access-2.3.3	GeoTools EPSG Access http://geotools.org/ Lesser General Public License (LGPL)
gt2-epsg-hsql-2.3.3	GeoTools EPSG-HSQL http://geotools.org/ Lesser General Public License (LGPL)
gt2-epsg-postgresql-2.3.3	GeoTools ESPG PostreSQL http://geotools.org/ Lesser General Public License (LGPL)
gt2-epsg-wkt-2.3.3	GeoTools ESPF-WKT http://geotools.org/ Lesser General Public License (LGPL)
gt2-geomedia-2.3.3	GeoTools Geomedia http://geotools.org/ Lesser General Public License (LGPL)
gt2-geotiff-2.3.3	GeoTools GeoTIFF http://geotools.org/ Lesser General Public License (LGPL)
gt2-gml-2.3.3	GeoTools GML http://geotools.org/ Lesser General Public License (LGPL)
gt2-go-2.3.3	GeoTools Geospatial Object http://geotools.org/ Lesser General Public License (LGPL)
gt2-graph-2.3.3	GeoTools Graph http://geotools.org/ Lesser General Public License (LGPL)
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rssutils	RSS Utilities http://java.sun.com/developer/technicalArticles/javaserverpages/rss_utilities/ Java 2 Platform SE 5.0
signpost-core-1.2.1.1	Signpost http://code.google.com/p/oauth-signpost/ The Apache Software License, Version 2.0"
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xml-writer	XML Writer http://download.oracle.com/javase/1.5.0/docs/api/javax/sql/rowset/spi/XmlWriter.html Java 2 Platform SE 5.0
xsd-2.1.1	XML Schema Definition http://vmgump.apache.org/gump/public/msv/xsdlib/index.html JAVA WEB SERVICES DEVELOPER PACK, VERSION 1.5
xsdlib-20050614	XML Schema Definition Library http://vmgump.apache.org/gump/public/msv/xsdlib/index.html JAVA WEB SERVICES DEVELOPER PACK, VERSION 1.5"

Bibliography

Ashworth, M. and Carley, K. M. (2003). *Critical human capital.* Unpublished Document: Carnegie Mellon University.

Ashworth, M. and Carley, K. (2006). *Who you know vs. what you know: The impact of social position and knowledge on team performance. Journal of Mathematical* Sociology, 30(1):43{75.

Ashworth, Michael J., & Carley, Kathleen M. (2003). *Critical Human Capital.* Working Paper. Carnegie Mellon University, School of Computer Science, Institute of Software Research, Center for Computational Analysis of Social and Organizational Systems (CASOS).

Behrman, R., *Network analysis of the structure and capacity of brigade level military organizations.* Unpublished Document: Carnegie Mellon University.

Bonaich, Philip. (1987). Power and Centrality: A Family of Measures. *American Journal of Sociology, 92*(5), 1170-1182.

Borgatti, S. and Everett, M. (1997). *Network analysis of 2-mode data.* Social Networks, 19(3):243{269.

Borgatti, Steve P. (2003). The Key Player Problem. In Ronald Breiger, Kathleen M. Carley & P. Pattison (Eds.), *Dynamic Social Network Modeling and Analysis: 2002 Workshop Summary and Papers* (pp. 241-252). Washington, D.C.: National Academies Press.

Burt, Ronald S. (1992). *Structural Holes: The Social Structure of Competition.* Cambridge, MA: Harvard University Press.

Carley, Kathleen M. (2002). *Summary of Key Network Measures for Characterizing Organizational Architectures.* Unpublished document. Carnegie Mellon University, School of Computer Science, Institute for Software Research.

Carley, K. (2002). *Summary of key network measures for characterizing organizational architectures.* Unpublished Document: Carnegie Mellon University.

Carley, K., Dekker, D., and Krackhardt, D. (2000). *How do social networks affect organizational knowledge utilitization?* Unpublished Document: Carnegie Mellon University.

Cataldo, Marcelo, Wagstrom, Patrick, Herbsleb, James, & Carley, Kathleen M. (2006). *Identification of Coordination Requirements: Implications for the design of collaboration and awareness tools.* Paper presented at the Conference on Computer Supported Cooperative Work, Banff, Alberta, Canada. Awarded Best Papers of CSCW 2006.

Clauset, A., M.E. Newman, et al. (2004). "Finding community structure in very large networks." Physical Review 70 SP - EP

Cormen, Thomas H., Leiserson, Charles E., Rivest, Ronald L., & Stein, Clifford. (2001). *Introduction to Algorithms.* Cambridge, MA: The MIT Press.

Dekker, David, Kathleen M. Carley, and David Krackhardt. (2002, June 23). *How Do Social Networks Affect Organizational Knowledge Utilization?* Paper presented at the CASOS Conference 2002, Pittsburgh, PA.

Fienberg, Stephen E., Meyer, Michael M., & Wasserman, Stanley S. (1985). Statistical Analysis of Multiple Sociometric Relations. *Journal of the American Statistical Association, 80*, 51-67.

Freeman, Linton C. (1979). Centrality in social networks I: Conceptual clarification. *Social Networks(1)*, 215-239.

Friedkin, Noah E. (1998). *A Structural Theory of Social Influence.* New York: Cambridge University Press.

Graham, J. M., Schneider, M., and Gonzalez, C. (2004). *Report social network analysis of unit of action battle laboratory simulations.* Technical Report CMU-SDS-DDML-04-01, Carnegie Mellon University, Social and Decision Sciences.

Gullapalli A, Carley Kathleen M. (2011) Extracting temporal trail clusters in networks using symbolic time series analysis, submitted to Social Network Analysis and Mining.

Hirschman, A. O. (1945). *National Power and the Structure of Foreign Trade.* University of California Press, Berkeley.

Krackhardt, David. (1994). Graph Theoretical Dimensions of Informal Organizations. In Kathleen M. Carley & Michael J. Prietula (Eds.), *Computational Organization Theory* (pp. 89-112). Hillsdale, NJ: Lawrence Earlbaum Associates.

Krackhardt, David. (1996). Simmelian Ties: Super Strong and Sticky. In Roderick Kramer and Margaret Neale (Ed.), *Power and Influence in Organizations* (pp. 21-38). Thousand Oaks, CA: Sage.

Latora, Vito, & Marchiori, Massimo. (2001). Efficient behavior of small-world networks. *Physical Review Letters, 87*(19).

Lee, J.-S. and Carley, K. M. (2004). *Orgahead: A computational model of organizational learning and decision making.* Technical Report CMU-ISRI-04-117, Carnegie Mellon University, Social and Decision Sciences.

Newman, Mark. E. J., Moore, C., & Watts, D. J. (2000). Mean-field solution of the small-world network model. *Physical Review Letters, 84*(14), 3201-3204.

Newman, Mark E. J., & Watts, D. J. (1999). Renormalization group analysis of the small-world network model. *Physics Letters A, 263*(4-6), 341-346.

Newman, M. E. J., & Watts, D.J. (1999). Scaling and percolation in the small-world network model. *Physical Review E, 60*(6), 7332-7342.

Newman, M. E. J., *The Structure and Function of Complex Networks*, SIAM Review, Vol. 45, No. 2 (Jun., 2003), pp. 167-256.

Pearson, K. (1895). *Mathematical contribution to the theory of evolution. II. Skew variation in homogeneous material.* Philosophical Transactions of the Royal Society of London, A, 186, 343-414.

Ray A (2004) Symbolic dynamic analysis of complex systems for anomaly detection. Signal Processing 84(7):1115 - 1130.

G. Robins, P. Pattison, Y. Kalish, D. Lusher, *An introduction to exponential random graph (p*) models for social networks*, Social Networks, Volume 29, Issue 2, May 2007, Pages 173-191.

Wasserman, S. and Faust, K. (1994). *Social Network Analysis: Methods and Applications.* Cambridge University Press, Cambridge.

Wasserman, Stanley, & Faust, Katherine. (1994). *Social Network Analysis: Methods and Applications.* Cambridge: University of Cambridge Press.

Watts, Duncan J. (1999). Networks, Dynamics, and the Small-World Phenomenon. *The American Journal of Sociology, 105*(2), 493-527.

Watts, Duncan J., & Strogatz, S. H. (1998). Collective dynamics of'small-world' networks. *Nature, 393*(6684), 440-442.

Mixture of Topological Forms

Amblard, Frédeacute;ric. (2002). *Which ties to choose? A survey of social network models for agent-based social simulations.* Paper presented at the International Conference on Artificial Intelligence: Simulation and Planning in High Autonomy Systems, Lisbon, Portugal.

Ayers, W.L. (1938). Some elementary aspects of topology. *The American Mathematical Monthly, 45*(2), 88-92.

Borgatti, Steve P. (1997). Communication Structure and its Effects on Task Performance, from www.analytictech.com/networks/commstruc.htm

Burt, Ronald S. (1980). Models of network structure. *Annual Review of Sociology, 6*, 79-141.

Kephart, J.O. (1994). How topology affects population dynamics. In C. G. Langton (Ed.), *Artificial Life III* (pp. 447-463). New York: Harper & Brothers.

Meyer, John W., & Rowan, Brian. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *The American Journal of Sociology, 83*, 340-363.

Miles, Raymond E., & Snow, Charles C. (1992). Causes of failure in network organizations. *California Management Review, 34*(4), 53-72.

Moreno, J. L., & Jennings, H. H. (1938). Statistics of Social Configurations. *Sociometry, 1*(3/4), 342-374.

Newman, Mark E. J. (2002). The structure and function of networks. *Computer Physics Communications, 147*, 40-45.

Strogatz, Steven H. (2001). Exploring complex networks. *Nature, 410*, 268-276.

Circle / Wheel

Gilchrist, Jack C., Shaw, Marvin E., & Walker, L. C. (1954). Some effects of unequal distribution of information in a wheel group structure. *Journal of Abnormal Psychology, 49*, 554-556.

Guetzkow, Harold, & Simon, Herbert A. (1955). The impact of certain communication nets upon organization and performance in task-oriented groups. *Organization Science, 1*, 233-250.

Matrix

Burns, Lawton R., & Wholey, Douglas R. (1993). Adoption and abandonment of matrix management programs: Effects of organizational characteristics and interorganizational networks. *Academy of Management Journal, 36*, 106-138.

Kuprenas, John A. (2003). Implementation and performance of a matrix organization structure. *International Journal of Project Management, 21*, 51-62.

Mee, John F. (1964). Matrix Organization. *Business Horizons, 7*, 70-72.

Hierarchy

Miles, Raymond E., & Snow, Charles C. (1995). The new network firm: A spherical structure built on human investment philosophy. *Organizational Dynamics, 23*(4), 5-18.

Ravasz, Erzsebet, & Barabasi, Albert-Laszlo. (2003). Hierarchical organization in complex networks. *Physical Review E, 67*, 026112-1 - 026112-7.

Thorelli, H. B. (1986). Networks: Between markets and hierarchies. *Strategic Management Journal, 7*, 37-51.

Core-Periphery

Borgatti, Stephen P. , & Everett, Martin G. . (1999). Models of core/periphery structures. *Social Networks, 21*, 375-395.

Bourgeois, Michael, & Friedkin, Noah E. (2001). The distant core: Social solidarity, social distance and interpersonal ties in core-periphery structures. *Social Networks, 23*, 245-260.

Random

Newman, Mark E. J. (2003). Random graphs as models of networks. In S. Bornholdt and H. G. Schuster (Ed.), *Handbook of Graphs and Networks* (pp. 35-46). Berlin: Wiley-VCH.

Newman, Mark E. J., Watts, Duncan, & Strogatz, S. H. (2002). Random graph models of social networks *National Academy of Science* (Vol. 99, pp. 2566-2572).

Small-World

Kleinberg, Jon. (2000). The Small-World Phenomenon: An Algorithmic Perspective. *In Annual Proceedings of the Thirty-second Annual ACM Symposium on Theory of Computing* (pp. 163-170). New York: ACM Press.

Milgrim, Stanley. (1967). The Small World Problem. *Psychology Today, 1*, 61-67.

Newman, Mark. (2000). Models of the small world. Journal of *Statistical Physics, 101*, 819-841.

Travers, Jeffrey, and Stanley Milgram. (1969). An experimental study of the small world problem. *Sociometry, 32*, 425-443.

Watts, Duncan J. (1999). Networks, Dynamics, and the Small-World Phenomenon. *The American Journal of Sociology, 105*(2), 493-527.

Watts, Duncan J., & Strogatz, S. H. (1998). Collective Dynamics of "Small-World" Networks. *Nature, 393*, 440-442.

Bow-Tie

Broder, Andrei, Kumar, Ravi, Maghoul, Farzin, Raghavan, Prabhakar, Rajagopalan, Sridhar, Stata, Raymie, . . . Wiener, Janet. (2000). Graph structure in the web. [IBM Research Paper]. *Nature, 405*, 113.

Cellular

Carley, Kathleen M. (2003). Dynamic Network Analysis. In Ronald Breiger, Kathleen Carley & Philippa Pattison (Eds.), *Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers, Committee on Human Factors* (pp. 133-145). Washington, DC: National Research Council.

Carley, Kathleen M., Matthew Dombroski, Maksim Tsvetovat, Jeffrey Reminga, and Natasha Kamneva. (2003). *Destabilizing Dynamic Covert Networks.* Paper presented at the 8th International Command and Control Research and Technology Symposium, National Defense War College, Washington DC.

Scale-Free

Albert, Reka, & Barabasi, Albert-Laszlo. (2000). Topology of evolving Networks: Local events and universality. *Physical Review Letters, 85*(24), 5234-5237.

Barabasi, Albert-Laszlo, & Bonabeau, Eric. (2003). Scale-Free Networks. *Scientific American, 288*(50-59).

Boss, Michael, Elsinger, Helmut, Summer, Martin, & Thurner, Stefan. (2003). *The Network Topology of the Interbank Market.* Working paper. Santa Fe Institute. Santa Fe.

Cohen, Reuven, Havlin, Shlomo, & Ben-Avraham, Daniel. (2002). Structural Properties of Scale-Free Networks. In S. Bornholdt & H. G. Schuster (Eds.), *Handbook of graphs and networks* (pp. 85-110). Wernheim, Germany: Wiley-VCH.

Dorogovtsev, S. N., Mendes, J. F. F., & A. N. Samukhin, A. N. (2000). Structure of Growing Networks with Preferential Linking. *Physical Review Letters, 85*, 4633-4636.

Simon, Herbert A. (1955). On a Class of Skew Distribution Functions. *Biometrika, 42*(3/4), 425-440.

Complex Networks (Statistical Mechanics)

Albert, Reka, & Barabasi, Albert-Laszlo. (2002). Statistical mechanics of complex networks. *Reviews of Modern Physics, 74*, 47-97.

Dorogovtsev, Sergey, & Mendes, J. F. F. (2002). Evolution of networks. *Advances in Physics, 51*, 1079-1187.

Newman, Mark E. J. (2003). The Structure and Function of Complex Networks. *SIAM Review, 45*(2), 167-256.

Pastor-Satorras, Romualdo; Rubi, Miguel; Diaz-Guilera, Albert (Ed.). (2003). *Statistical mechanics of complex networks.* Berlin: Springer.

Network Processes

Jeong, H, Neda, Z, & Barabasi, A. L. (2003). Measuring preferential attachment in evolving networks. *Europhysics Letters, 61*(4), 567-572.

Motter, Adilson E., & Lai, Yin-Cheng. (2002). Cascade-based attacks on complex networks. *Physical Review E, 66*, 065102-1 - 065102-4.

Newman, Mark. J., Jensen, I., & Ziff, R. M. (2001). *Percolation and Epidemics in a two-dimensional small world.* Working Paper 01-09-046. Santa Fe Institute. Santa Fe, NM.

Pastor-Satorras, Romualdo, & Vespignani, Alessandro. (2002). Immunization of Complex Networks. *Physical Review E, 65*(036104), 1-4.

Vragovic, I., E. Louis, and A. Diaz-Guilera. (2005). Efficiency of informational transfer in regular and complex networks. *Physical Review E, 71*, 036122-1 - 036122-9.