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A Generative Decision Support Architecture (GDSA)

Doug Lange
Mike Cowen
Mark St. John

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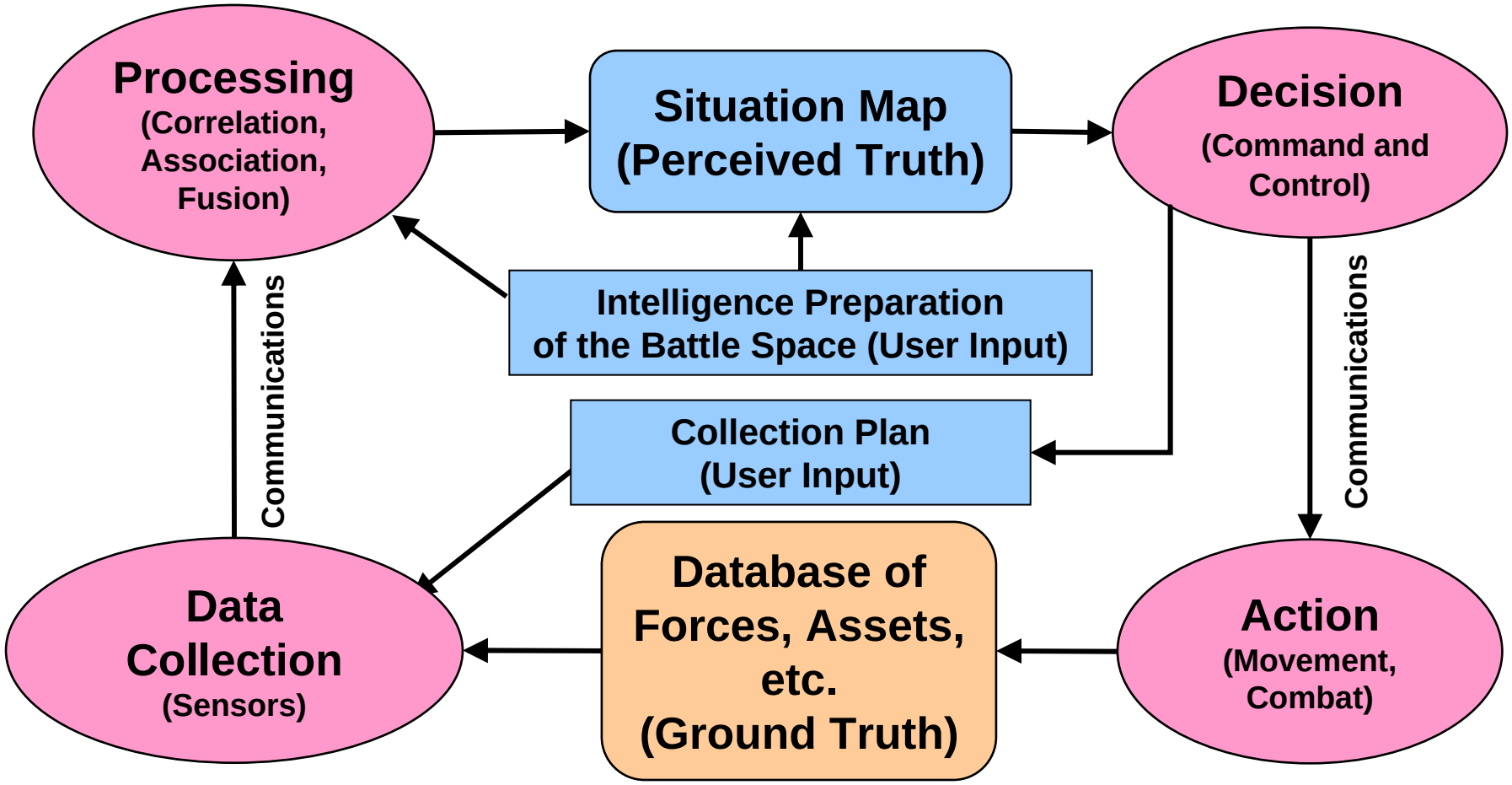
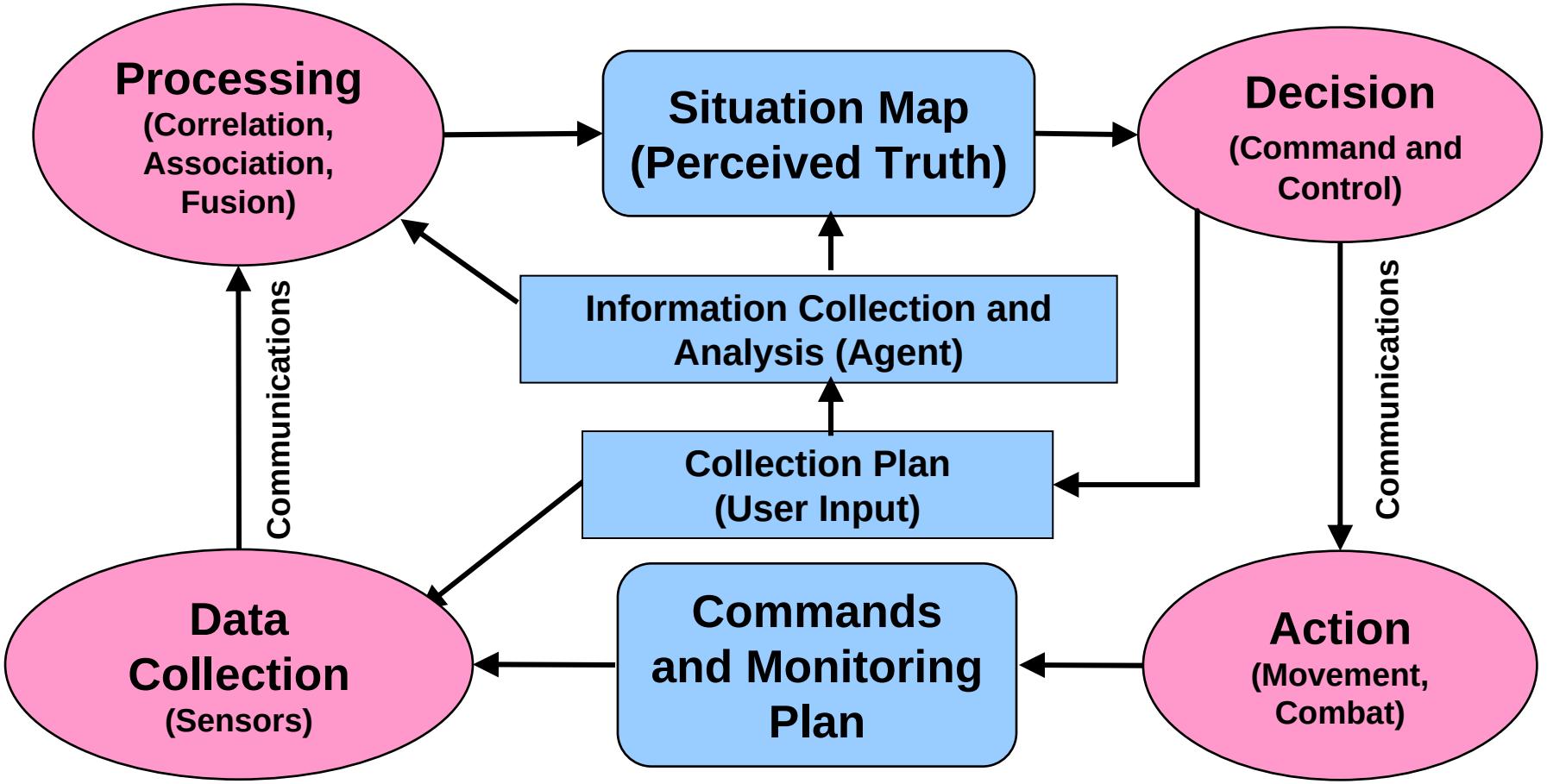
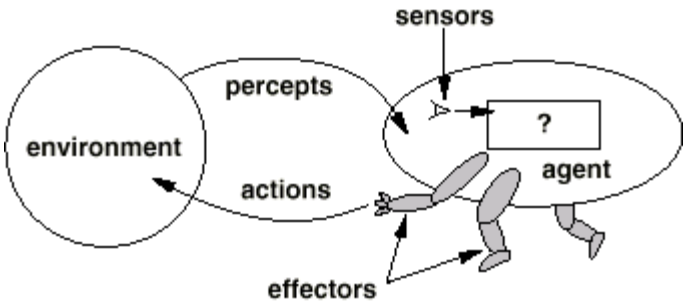
C⁴ISR Model



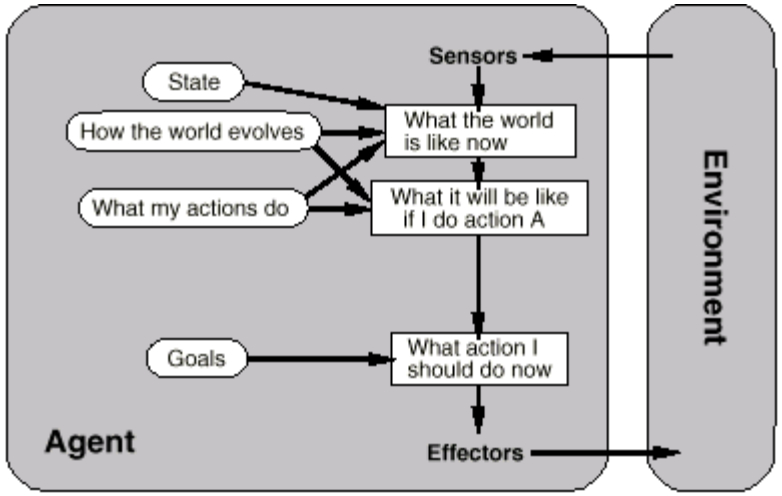
Decision Support Model

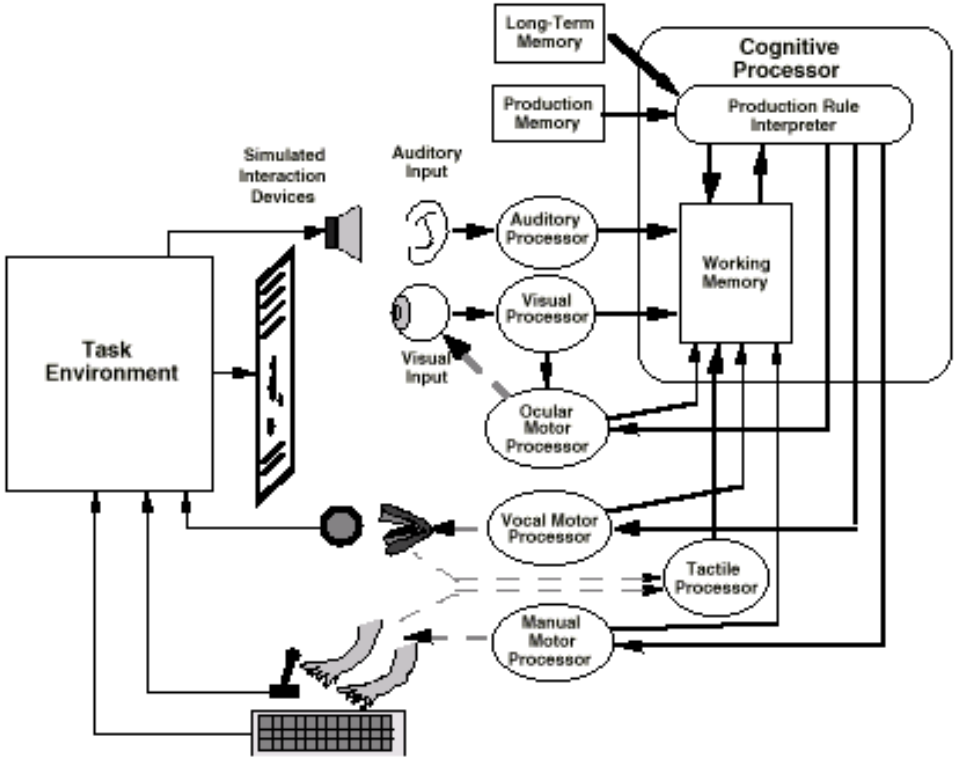


Agents



Russell and Norvig, Artificial Intelligence: A Modern Approach





Kieras and Meyer, "An Overview of the EPIC Architecture for Cognition and Performance with Application to Human-Computer Interaction"

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Objective

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- Develop an agent generation architecture for decision support applications.
  - Improve the tie between cognitive task analysis and software development.
  - Lessen the time necessary for developing decision support software.
  - Improve the quality of decision support software
  - Provide the flexibility necessary to support NCW
- Provide a method to evaluate an agents contribution to decision support.

Problem/Deficiency Being Addressed

- Decision support requirements change rapidly in the operational war-fighting environment.

- Our current process for developing decision support software cannot meet the needs of the move towards NCW. Even current demands are stressing our capabilities.

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Technical Approach

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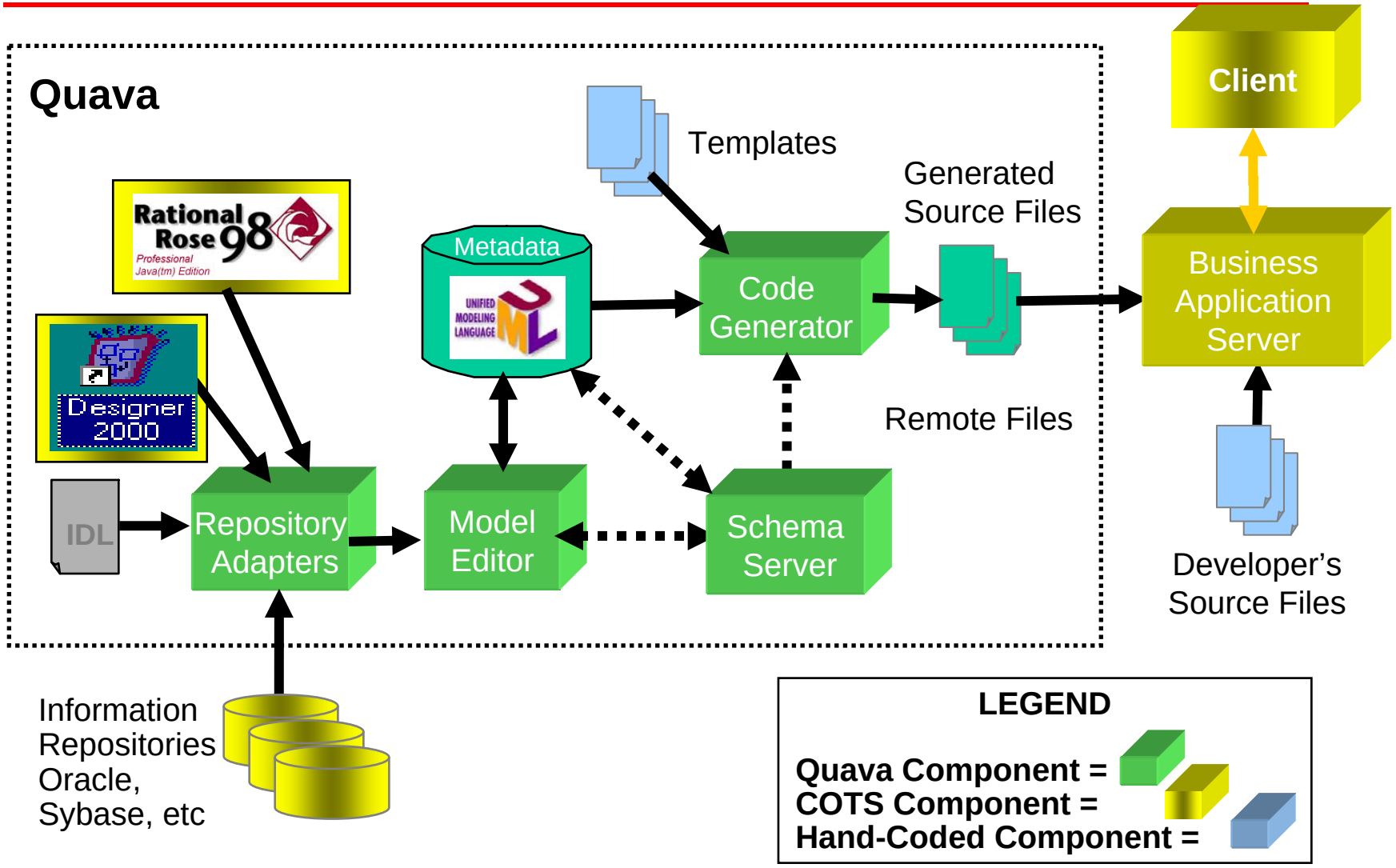
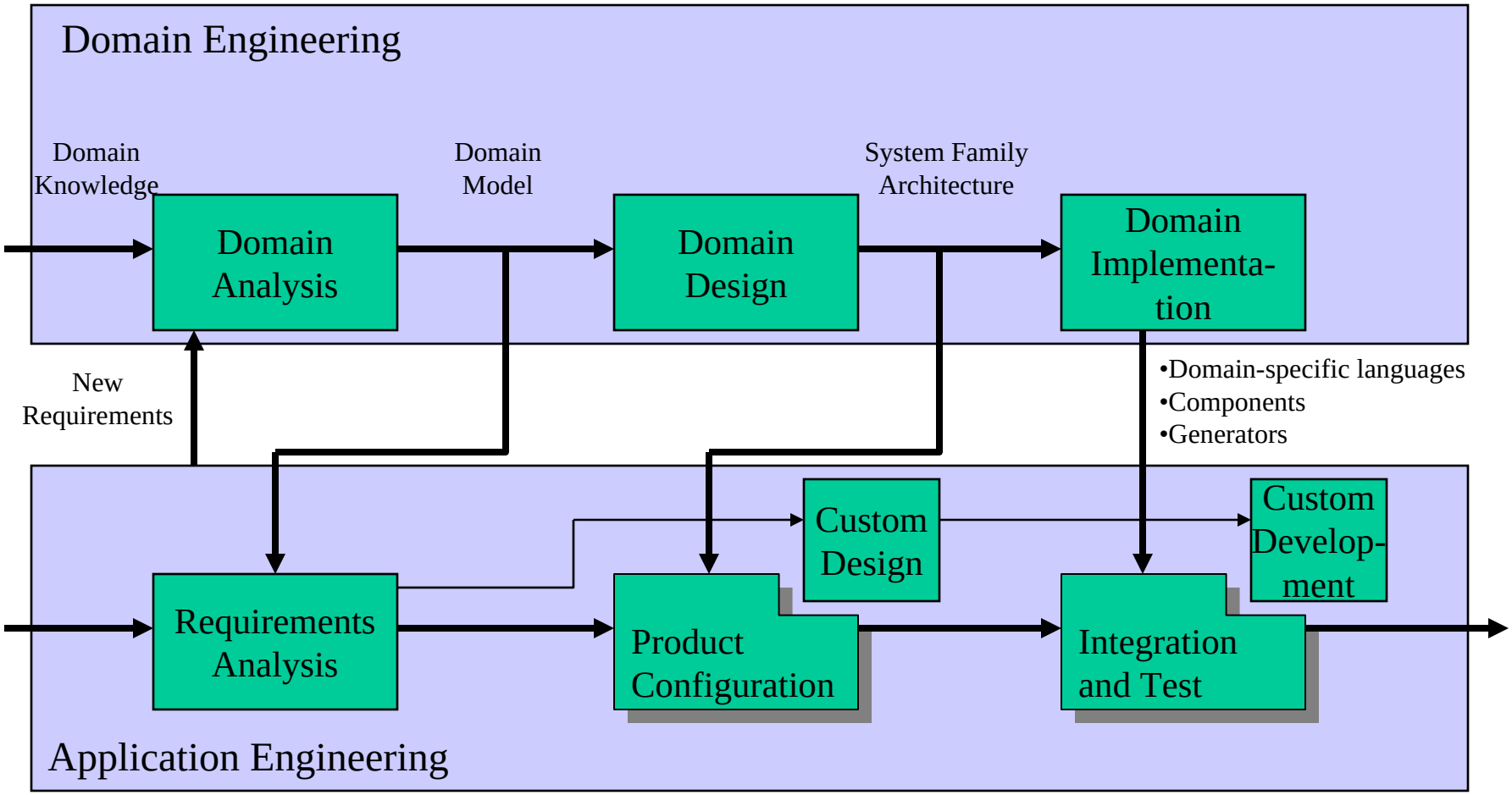
- Identification of cognitive task domain.
- Evaluate models of cognitive decision-making.
- Define a cognitive model that describes the environment.
- Translate the cognitive task model into a formal software model within a generative software architecture.
- Create a domain specific language (DSL).
- Domain design.
- Domain implementation.

Template Based Techniques



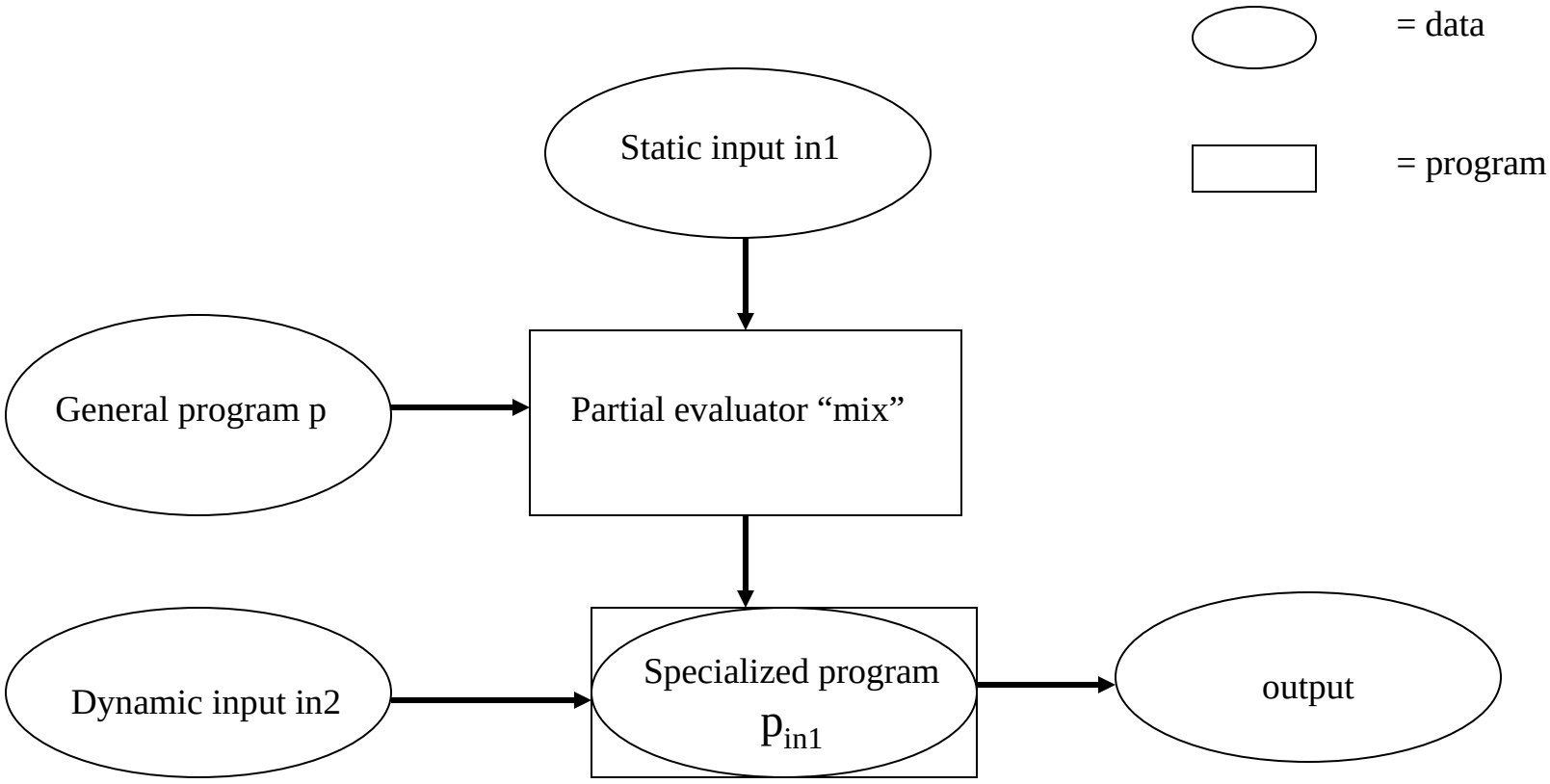
Ray and Farrar, "Object Model Code Generation for the Enterprise"

Generative Software Development



SEI, *Model-Based Software Engineering*

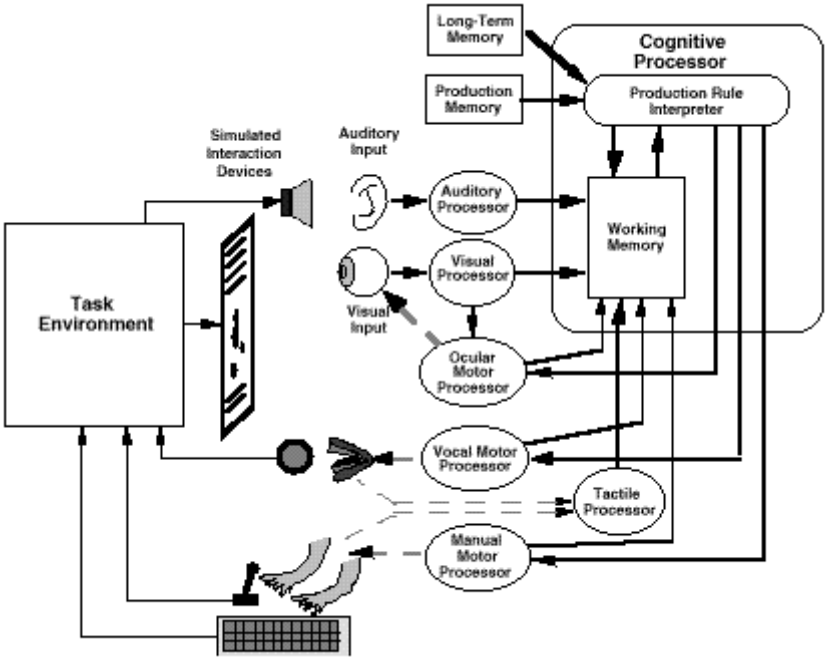
Partial Evaluation

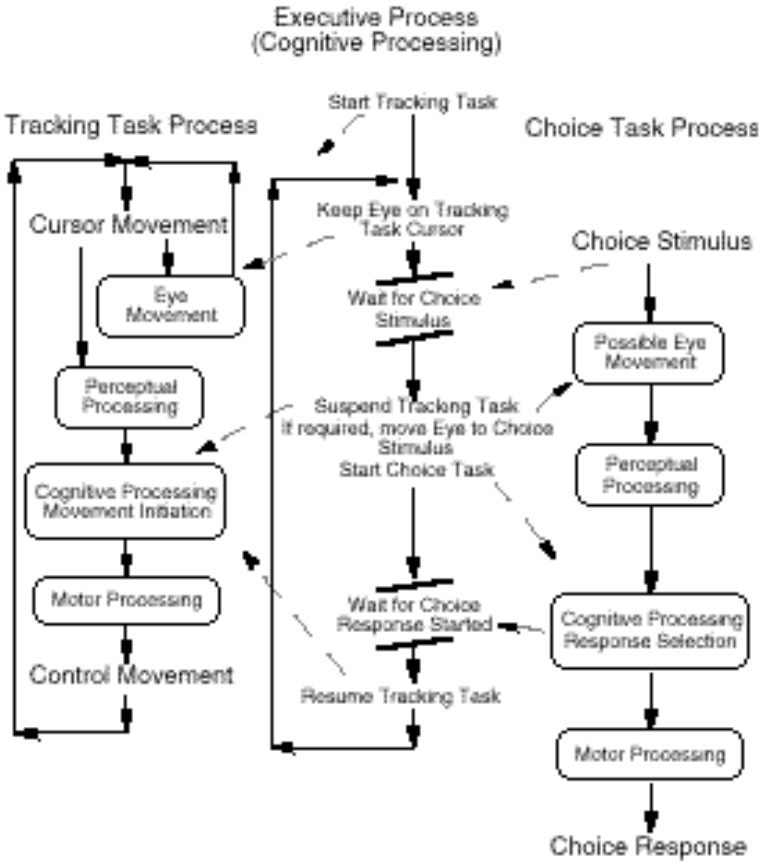


$$[\mathbf{p}]\ [in1, in2] = [p_{in1}]\ \ in2$$

Jones, “An Introduction to Partial Evaluation”

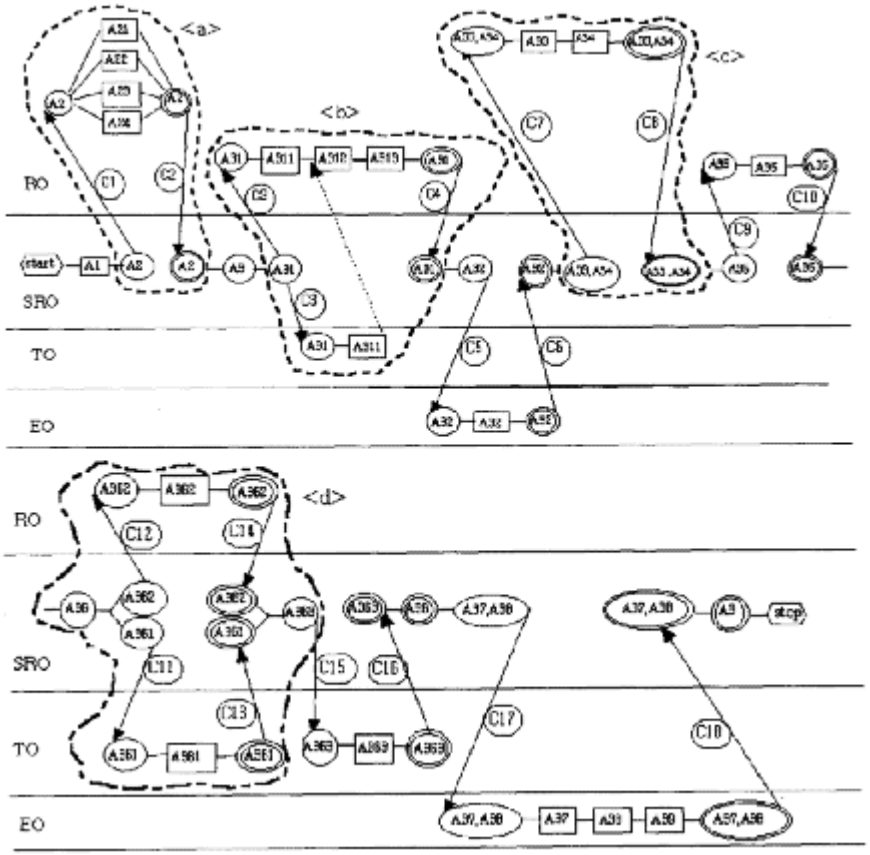
EPIC Model





Kieras and Meyer, "An Overview of the EPIC Architecture for Cognition and Performance with Application to Human-Computer Interaction"

GOMS Models




```
Method for goal: edit the document
   Step 1. Get next unit task information from marked-up manuscript.
   Step 2. Decide: If no more unit tasks, then return with goal accomplished.
   Step 3. Accomplish goal: move to the unit task location.
   Step 4. Accomplish goal: perform the unit task.
   Step 5. Goto 1.

Selection rule set for goal: perform the unit task
   If the task is moving text, then
          accomplish goal: move text.
   If the task is deletion, then
          accomplish goal: delete text.
   If the task is copying, then
          accomplish goal: copy text.
   ... etc. ...
   Return with goal accomplished.

Method for goal: move to the unit task location
   Step 1. Get location of unit task from manuscript.
   Step 2. Decide: If unit task location on screen, return with goal
          accomplished.
   Step 3. Use scroll bar to advance text.
   Step 4. Goto 2.

Method for goal: move text
   Step 1. Cut text
   Step 2. Paste text
   Step 3. Verify correct text moved.
   Step 4. Return with goal accomplished.
```

Min, et. al., "Distributed GOMS: An extension of GOMS to Group Task"

Kieras, "A Guide to GOMS Model Usability Evaluation using NGOMSL"

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Colored Petri Nets

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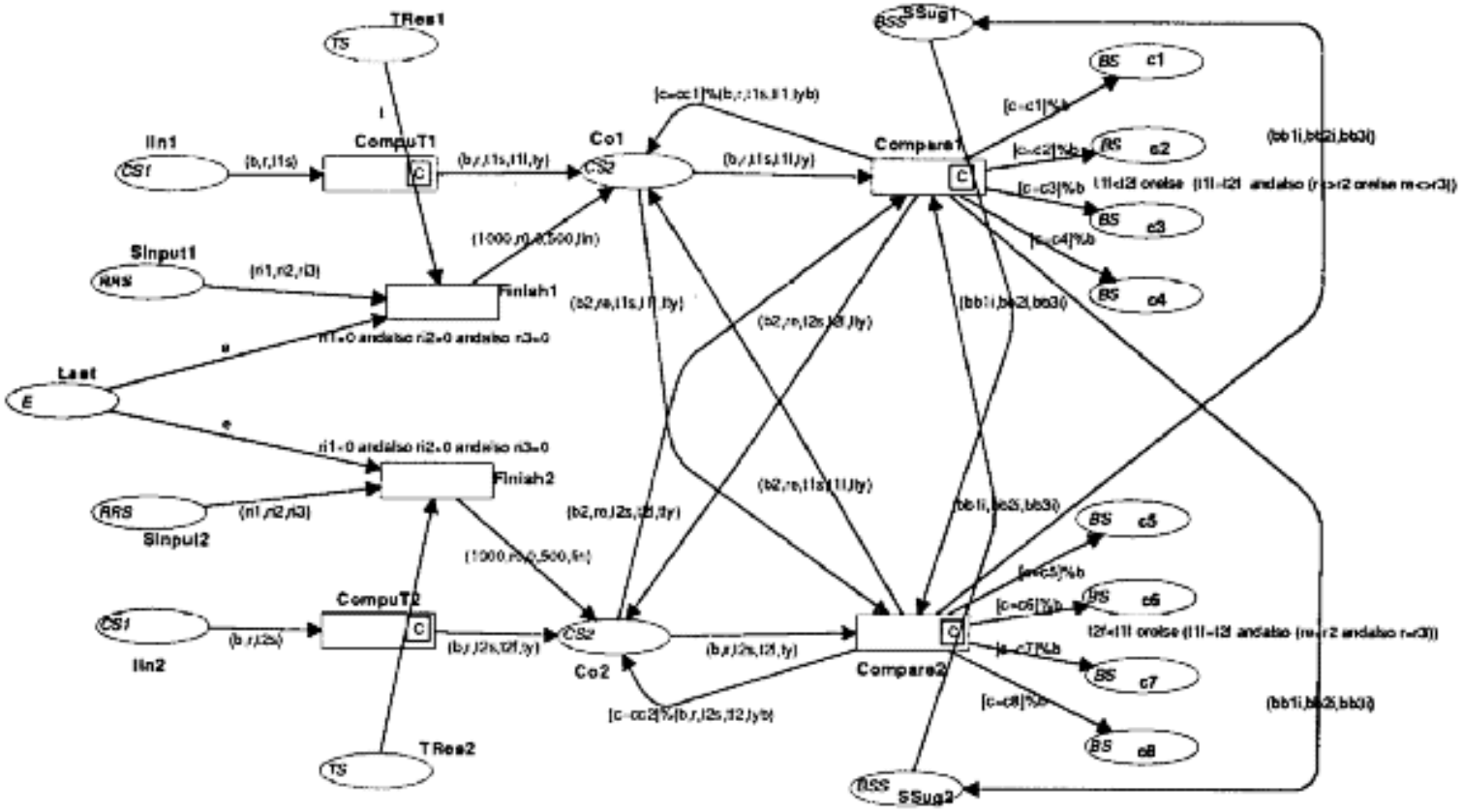
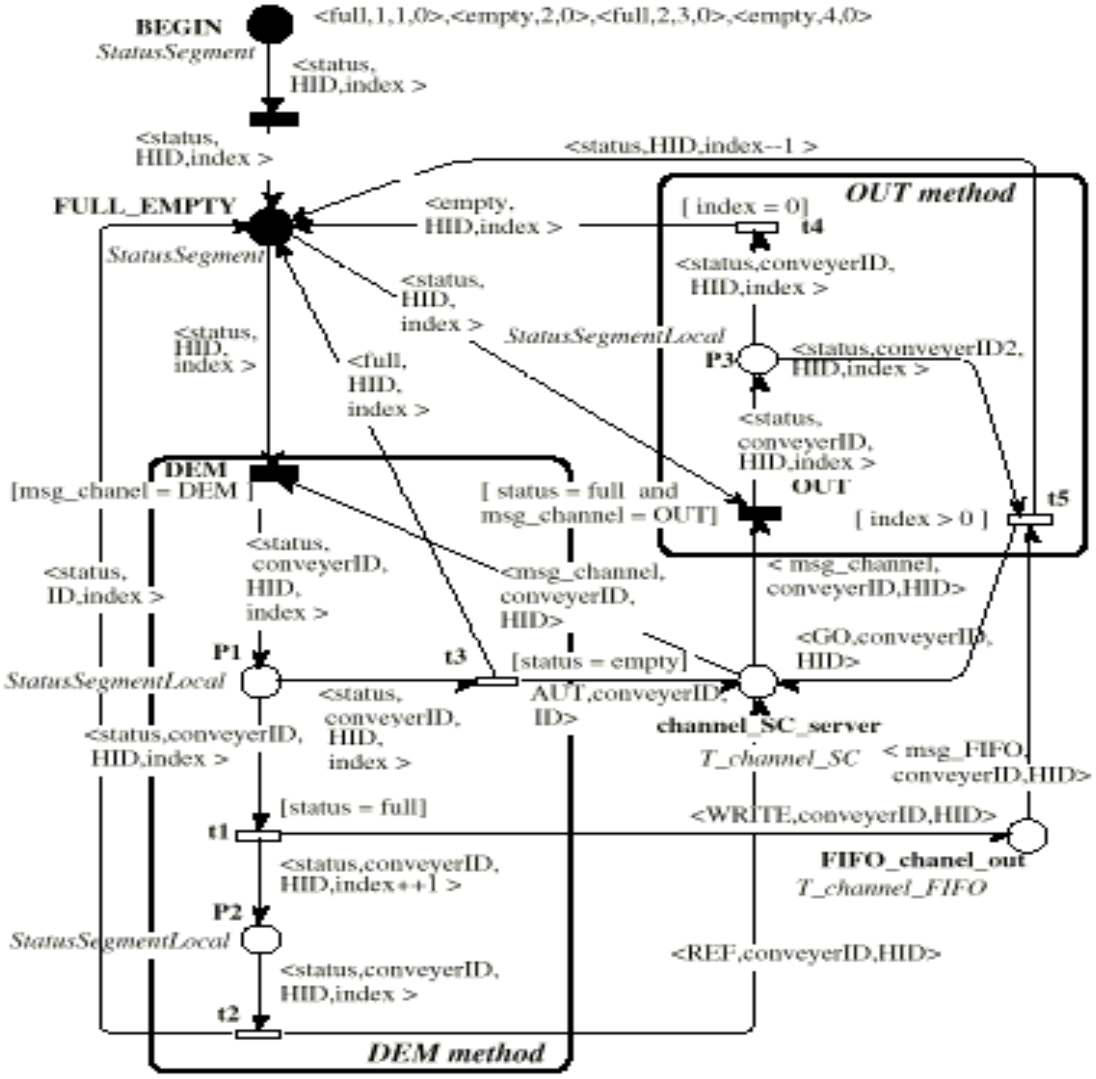


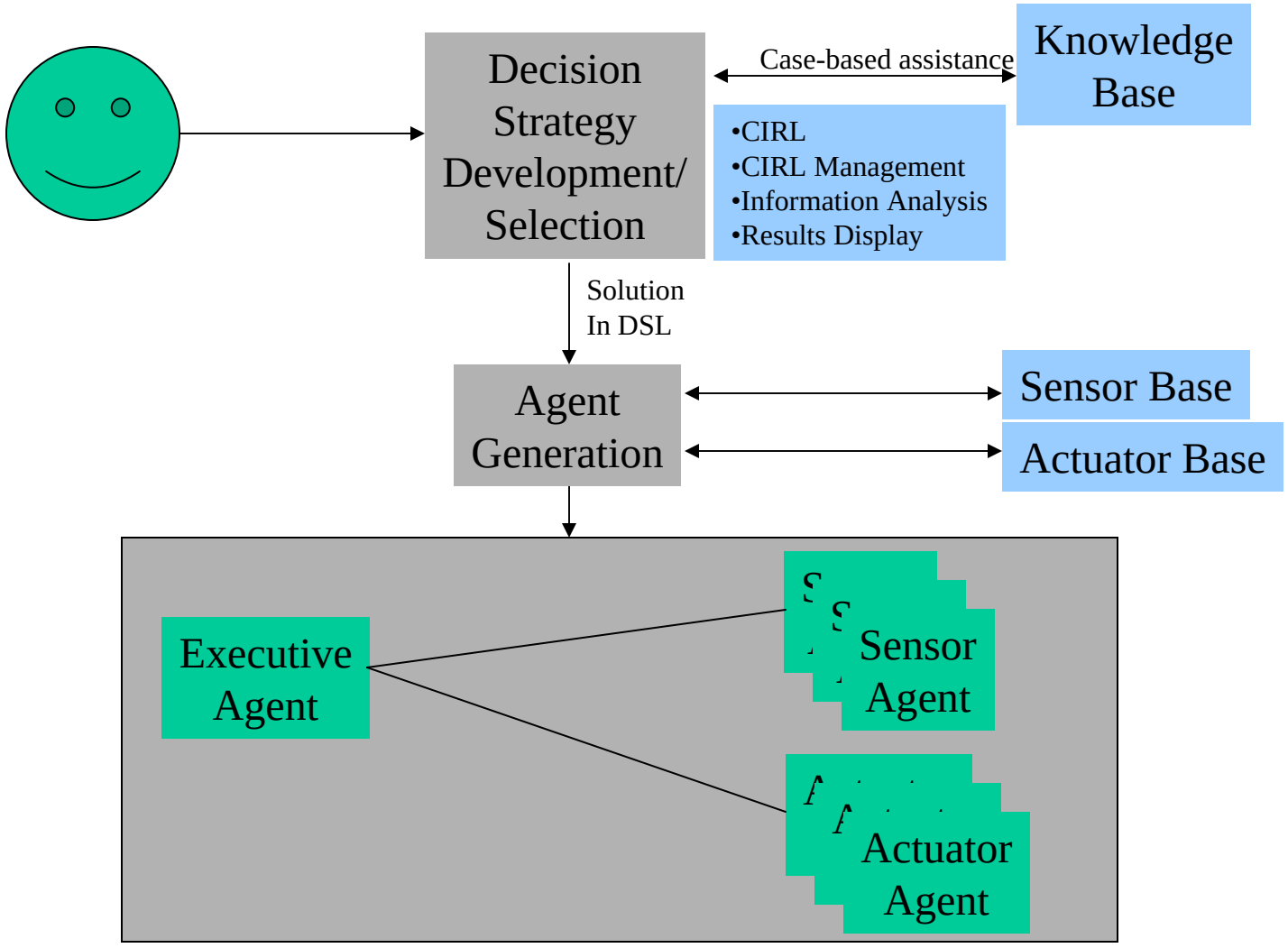
Lu, *A Colored Petri Net Model of Tactical Decision Making*

Petri Nets for Code Generation



F. Kordon, I. Mounier, E. Paviot-Adet, D. Regep, “Formal verification of embedded distributed systems in a prototyping approach”

GDSA


Decision Strategy Development/ Selection
Case-based assistance
Knowledge Base
•CIRL
•CIRL Management
•Information Analysis
•Results Display
Solution In DSL
Agent Generation
Sensor Base
Actuator Base
Executive Agent
Sensor Agent
Actuator Agent

Domain Specific Language

- Based on Deterministic Timed Hierarchical Colored Petri Nets. Adds semantic content to the places, transitions, and edges relative to decision support agents.
  - Interactions with infrastructure
  - Use of sensors and actuators
  - Information item and list management strategies
  - Analysis steps
  - Result display
- Initial level is based on the level of reusable sensor and actuator modules and the level of abstraction of associated information objects.

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Research Areas

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- Cognitive model adaptation for decision strategy description for agent use and generation
  - Critical Information Requirements List
  - CIRL management criteria
  - Information analysis method
  - Result display
- Domain specific language for decision strategies
- Agent generation engine
- Sensor and Actuator reuse bases and semantic descriptions for selection
- User interface language for decision strategies
- Case-based reasoning support for decision strategy selection