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Final Report
Office of Naval Research
Contract N00014-75-C-0612

During this contract, papers were produced, published in
journals, books, and conference proceedings, and issued as
University of Illinois reports or working papers. These papers
constitute the most appropriate description of the work done on
this contract. The rest of this report is an annotated
bibliography of these publications; copies of many of the
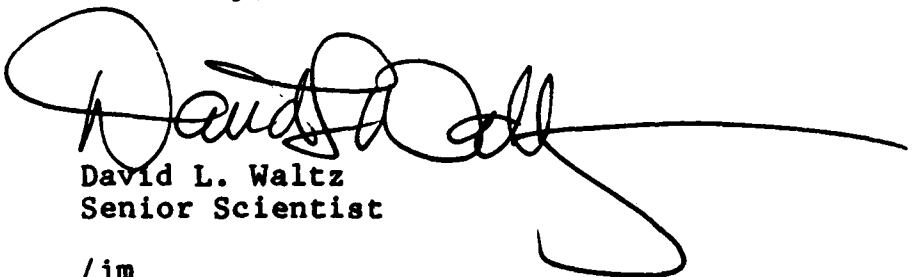publications are attached as appendices.

July 11, 1985

Mr. John W. Michalski
Administrative Contracting Officer
Department of the Navy
Office of Naval Research
Resident Representative
Federal Building, Room 286
536 South Clark Street
Chicago, IL 60605-1588

Dear Dr. Michalski:

Enclosed is the Final Report for my ONR contract
N00014-75-C-0612. I apologize for the lateness of the report,
and hope that this has not caused you any serious problems. I
very much appreciate ONR's support of my research over the years.

Sincerely,

David L. Waltz
Senior Scientist

/jm

enclosure

Artificial Intelligence
David L. Waltz

Scientific American 247, 4, October 1982, 118-133.

This article is intended to be a brief introduction to AI. It
surveys the kinds of results AI can achieve by explaining the
operation of a number of AI programs for natural language
understanding, game playing, reasoning, vision, and learning.
Most of the programs discussed have been widely referenced and
are well-known to AI researchers.

Event Shape Diagrams
David L. Waltz

Proc. National Conference on Artificial Intelligence, August
1982.

"Event shape diagrams" are proposed as a representation for
capturing the nuances of meaning of verbs that describe similar
events. These diagrams represent timing, causal relationships
between case roles, and typical value ranges for role fillers.
Event shape diagrams are expressed in terms of primitive
predicates and timing information that we believe could be
computed by perceptual systems, and are intended to be a step
toward the eventual connection of language systems to perceptual
(vision, hearing and touch) sensing systems. The diagrams are
capable of representing modification of verbs by adverbs, can
support judgments of the degree of plausibility of various
interpretations of a sentence's meaning, and may be useful in
figuring out the meaning of certain kinds of metaphors.

Natural Language Processing Using Spreading Activation and
Lateral Inhibition
Jordan Pollack and David L. Waltz

Proc. of the 1982 Cognitive Science Society Conference, August,
1982

The knowledge needed to process natural language comes from many
sources. While the knowledge itself may be broken up modularly,
into knowledge of syntax, semantics, etc., the actual processing
should be completely integrated. This form of processing is not
easily amenable to the type of processing done by serial "von
Neumann" computers. This work in progress is an investigation of
the use of a highly parallel, spreading activation and lateral
inhibition network as a mechanism for integrated natural language
processing.

Understanding Novel Language
Gerald F. DeJong and David L. Waltz

In this article we treat in some detail the problem of designing mechanisms that will allow us to deal with two types of novel language; (1) text requiring schema learning and (2) the understanding of novel metaphorical use of verbs. Schema learning is addressed by four types of processes: schema composition, secondary effect elevation, schema alteration, and volitionalization. The processing of novel metaphors depends on a decompositional analysis of verbs into "event shape diagrams," along with a matching process that uses semantic marker-like information, to construct novel meaning structures. The examples we describe have been chosen to be types that occur commonly, so that rules that we need to understand them can also be used to understand a much wider range of novel language.

Encoding the Natural Language Meaning of Time - Toward a Conceptual Model for Temporal Meaning
L. R. Maran, D. T. Spoor, D. L. Waltz; November 1982 (revised May 1983)

WP-37

This paper proposes a method for representing the time information contained in natural language. We suggest that time may be represented by using language universal and cognitive universal concepts obtained by analyzing data from a variety of natural languages. Preliminary efforts to formulate representations for natural language time content in conceptual terms is reported; specifically, we try to show how the temporal aspects of particular natural language descriptions of events may be dealt with. The focus of the report is the presentation of a facet of a universal framework for time for natural language.

This is an intial report of ongoing research on natural language temporal mechanisms. Subsequent reports will show results of attempts to implement the model.

Toward a Reader-Based Model of Narrative Understanding
Marcy Dorfman; June 1983

WP-38

This paper presents a critical review of story understanding
literature in cognitive psychology and artificial intelligence,
and outlines an approach to story understanding based on the
literary notion "point of view." Point of view is used to
distinguish "character-based systems," or story understanding
systems that model events from the point of view of the
characters in the story, from "reader-based systems," or systems
that model events from reader's perspective. While both systems
are capable of representing what story characters do and say, I
will argue that only reader-based systems can provide a complete
account of stories that require readers to maintain multiple
points of view. A comparison between reader- and character-based
analyses of an Aesop fable is provided as a case in point.

Massively Parallel Parsing
Jordan Pollack; May 1983

WP-39

This is a summary of research in progress on a developing natural
language processing system with modular knowledge sources but
highly integrated processing. The processing takes place in a
massively parallel, analog network which is dynamically created
from both language input and long-term knowledge, and then
allowed to "settle," through a relaxation process, on the best
interpretation.

Artificial Intelligence Research Projects at the University of
Illinois Coordinated Science Laboratory
AI Research Group; September 1983

WP-42

Brief summaries are presented for each of the current AI research
projects at the University of Illinois Coordinated Science
Laboratory. Research covers: (1) Understanding and Representing
Natural Language Meaning, (2) An Expert System that Integrates
Language, Perception and Learning, (3) Cognitive and Linguistic
Universals, (4) Explanatory Schema Acquisition, (5) Computer
Vision, (6) Acquisition, Representation, and Manipulation of
Three-Dimensional Time Varying Information, (7) Hierarchical
Control and Monitoring with Conceptual Levels, (8) Mechanism
Modeling and Automatic Diagnosis, and (9) Air Traffic Control,
Problem-Solving, and Learning. Also included is a list of recent
publications.

A Two Dimensional Activation Cell
Christian Debrunner; December 1982

WP-46

This paper presents a hardware implementation of a spreading
activation/lateral inhibition network. It describes a
2-dimensional network communication cell based on Pollack's [1,3]
1-dimensional network cell. A memory structure, the Multiple
Linked List Sorting Memory (MLLSM), is introduced to deal with
some of the new complexities which arise from using a
2-dimensional rather than a 1-dimensional network.

Parallel Interpretation of Natural Language
Jordan B. Pollack and David L. Waltz

Proc. International Conference on Fifth Generation Computer
Systems, Tokyo, Japan, November 6-9, 1984.

This is a description of research in developing a natural
language processing system with modular knowledge sources but
strongly interactive processing. The system offers insights
into a variety of linguistic phenomena and allows easy testing of
a variety of hypotheses. Language interpretation takes place on
an activation network which is dynamically created from input,
recent context, and long-term knowledge. Initially ambiguous and
unstable, the network settles on a single interpretation, using a
parallel, analog relaxation process. We also describe a parallel
model for the representation of context and of the priming of
concepts. Examples illustrating contextual influence on meaning
interpretation and "semantic garden path" sentence processing are
included. Furthermore, our model has been designed with the
constraints of New Generation Computing in mind, and we will
describe our first pass at the architectural design of a
message-merging communications network which implements the
relaxation process.

Massively Parallel Parsing: A Strongly Interactive Model of
Natural Language Interpretation
David L. Waltz and Jordan B. Pollack

Cognitive Science, 9, 1, (pp. 51-74), 1985.

This is a description of research in developing a natural
language processing system with modular knowledge sources but
strongly interactive processing. The system offers insights into
a variety of linguistic phenomena and allows easy testing of a
variety of hypotheses. Language interpretation takes place on an
activation network which is dynamically created from input,
recent context, and long-term knowledge. Initially ambiguous and
unstable, the network settles on a single interpretation, using a
parallel, analog relaxation process. We also describe a parallel
model for the representation of context and of the priming of
concepts. Examples illustrating contextual influence on meaning
interpretation and "semantic garden path" sentence processing,
among other issues, are included.

Phenomenologically Plausible Parsing
David L. Waltz and Jordan B. Pollack; May 1984

Proc. of the 1984 National Conference on Artificial Intelligence
(AAAI-84), Austin, Texas (August 1984).

This is a description of research in developing a natural
language processing system with modular knowledge sources but
strongly interactive processing. The system offers insights into
a variety of linguistic phenomena and allows easy testing of a
variety of hypotheses. Language interpretation takes place on an
activation network which is dynamically created from input,
recent context, and long-term knowledge. Initially ambiguous and
unstable, the network settles on a single interpretation, using a
parallel, analog relaxation process. We also describe a parallel
model for the representation of context and of the priming of
concepts. Examples illustrating contextual inflence on meaning
interpretation and "semantic garden path" sentence processing are
included.

Understanding and Representing Natural Language Meaning
David L. Waltz, La Raw Maran, Marcy H. Dorfman, Rick Dinitz,
David Farwell, Anthony B. Maddox, Jordan Pollack and David Spoor;
December 1982.

T-119

Annual Progress Report to Office of Naval Research for period
8/1/81 - 7/31/82.

During this contract period we have: (a) continued investigation
of events and actions by means of representation schemes called
"event shape diagrams"; (b) written a parsing program which
selects appropriate word and sentence meaning by a parallel
process known as activation and inhibition; (c) begun
investigation of the point of a story or event by modeling the
motivations and emotional behaviors of story characters; (d)
started work on combining and translating two machine-readable
dictionaries into a lexicon and knowledge base which will form an
integral part of our natural lanaguage understanding program; (e)
made substantial progress toward a general model for the
representation of cognitive relations by comparing English scene
and event descriptions with similar descriptions in other
languages; (f) constructed a general model for the representation
of tense and aspect of verbs; (g) made progress toward the design
of an integrated robotics system which accepts English requests,
and uses visual and tactile inputs in making decisions and
learning new tasks.

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