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SPEECH UNDERSTANDING RESEARCH

STANFORD RESEARCH INSTITUTE
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Staff members: Barbara G. Deutsch, Joyce B. Friedman, Gary G. Hendrix, William H. Paxton, Ann E. Robinson, and Jane J. Robinson

Summaries of the sections of this report will appear in the first 1976 issue of The Finite String.

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Reports

1. Sager, N., Salkoff, M., Morris, J., and Raze, C., Report on the String Analysis Programs, Introductory Volume. String Program Reports (S.P.R.) No. 1, Linguistic String Project, New York University and University of Pennsylvania, March 1966.

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Research and Teaching Materials (available to Universities and government sponsored research projects)

Program Package 1: To use LSP System for writing your own grammar
- Parser Control Data 6000 series/Cyber 70 series--SCOPE or KRONOS operating system--requires $70{,}000_{10}$ words memory
- Restriction Language and Compiler
- Tiny sample grammar (very elementary)
- Tiny sample word dictionary (very elementary)
- Restriction Language Manual, 60 pp.
- Program Manual, 30 pp.

Program Package 2: To use LSP System and LSP English grammar
- All of package 1
- English grammar
- Description of LSP English grammar, ca. 250 pp. (From forthcoming: N. Sager, A Formal Grammar of English and its Computer Applications)
- Short word dictionary, ca. 375 words
- Word class and word subclass definitions, 65 pp (S.P.R. 9)

Research materials:
- About 10,000 lines of machine readable texts from journal literature, mainly in Pharmacology
- Text serialization and concordance program
- 2000 word science dictionary which works with parser
- 10000 word science dictionary which works with parser (needs updating)
- Inverse dictionaries (words listed by subclasses)

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Uniwersytetu Warzawskiego
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Tokarski, Jan. *Fleksja polska, jej opis w swietle mozliwosci mechanizaczi w urzadzeniu przekładowym. Seryjne powiazania fleksyjno-słowotworcze czasownikow z innymi czesciami mowy. [Description of Polish inflexion from the point of view of possibility of mechanization in translation device. Serial inflexional-derivational connections of verbs with other parts of speech. In Polish.] Poradnik Jezykowy, r. 1964, z. 6, pp. 241-??*

Tokarski, Jan. *Fleksja polska. [Polish inflexion. In Polish.] Warszawa: PWN 1973, pp 266.*

Waligorski, Stanisław. *Problemy komunikacji człowiek-komputer w jezyku naturalnym. [Problems of man-machine communication in natural language. In Polish.] In Bolc, L., ed. Zastosowanie maszyn matematycznych do badan nad jezykiem naturalnym, pp. 11-23.*

Wierzbowski, Ludwik. *Podzielnosc morfologiczna wyrazow w automatycznej analizie i syntezie tekstu polskiego. [Morphological segmentation of words in automatic analysis and synthesis of Polish texts.] In Bolc, L., ed. Zastosowanie maszyn matematycznych do badan nad jezykiem naturalnym, pp. 211-219:*

Wierzbowski, Ludwik. *Opis algorytmu poszukiwania słow w maszynowym słowniku tematow na ograniczonym odcinku. [Description of an algorithm of word searching in a computer segmented dictionary*

of stems. In Polish]. Zeszyty Naukowe Wydziału Humanistycznego Uniwersytetu Gdanskiego. Prace Jezykoznawcze nr 1, 1973 [1972]. Str. 7-31.

Wierzbowski, Ludwik. *Recenzja pracy Belskaja I(zabella) K(uzminicna): Jazyk celoveka i masina. [Review of Natural language and computer.] Moskwa 1969. Zeszyty Naukowe Wydziału Humanistycznego Uniwersytetu Gdanskiego. Prace Jezykoznawcze nr 1, 1973 [1972]. Str. 139-148.*

Wierzbowski, Ludwik. *O roznicach systemowych miedzy jezykami naturalnymi a niektorymi jezykami programowania. [On differences between the systems of natural languages and programming languages. In Polish, summary in English.] Biuletyn Polskiego Towarzystwa Jezykoznawczego z. XXXII (1974), pp. 129-136.*

Wojtasiewicz, Olgierd Adrian. *Wstepny opis składniowy i semantyczny czasownikow polskich. [Preliminary syntactic ard semantic description of Polish verbs. In Polish.] In Bolc, L., ed. Zastosowanie maszyn matematycznych do badan nad jezykiem naturalnym, pp. 236-243.*

Zarebina, Maria. *Recenzja pracy Lewicki Andrzej, Masłowski Władysław, Sambor Janina, Woronczak Jerzy: Słownictwo współczesnej publicystyki polskiej. Listy frekwencyjne. [Vocabulary of current Polish journalism, frequency lists.] Warszawa 1972. Jezyk Polski, t. LIII (1973), nr 4, str. 300-302.*

Zarebina, Maria. *Recenzja pracy Walery Pisarek, Frekwencja Wyrazow w prasie (wiadomosci, komentarze, reportaze). Review of Word frequency in journalism. Krakow 1972. Jezyk Polski, LIII (1973), no. 1.*

Zielinski, Gerard. *Modelirovanie igry na vycislitel noj masine. [Computer modelling of a game. In Russian. Summaries in Polish and English.] Algorytmy, vol. X (1973), no 18, pp. 63-78.*

C U R R E N T B I B L I O G R A P H Y

The questionnaire enclosed with this mailing of AJCL includes questions about the scope of the bibliography.

The new format of the entries on the following frames is the work of Martin Kay, who used by permission the computing installation of the XEROX Palo Alto Research Center. AJCL thanks XEROX, Kay, and Iris Kay who contributes her time to the operation of the new system. We expect the system to produce entries, annual indexes, and possibly byproducts.

Many summaries are authors' abstracts, sometimes edited for clarity, brevity, or completeness. Where possible, an informative summary is provided.

Completeness of coverage, especially for reports circulated privately, depends on the cooperation of authors. Summaries or articles to be summarized should be sent to the editorial office, Twin Willows, Wanakah, New York 14075.

The Linguistic Documentation Centre of the University of Ottawa provides valuable help in the development of this bibliography; AJCL thanks Brian Harris for his support.

See the following frame for a list of subject headings with frame numbers.

SUBJECT HEADINGS

Relevance of Computer Science to Linguistics and Vice Versa

J. A. Moyne
Department of Computer Science, Queens College, City University of New York

International Journal of Computer and Information Science 4: 265-279, 1975

The relationship and interpenetration of computer science and linguistics are discussed. The affinity between modern linguistics and computer science is traced back to their beginnings and related developments in the two fields are outlined. Ample references.

A Mathematical Formulation and Comparison of Zero-Crossing Analysis Techniques which have been Applied to Automatic Speech Recognition

Russell J. Niederjohn
Department of Electrical Engineering, Marquette University, Milwaukee, Wisconsin

IEEE Transactions of Acoustics, Speech, and Signal Processing 23: 373-380, 1975

A physical interpretation of each analysis technique is effected. The properties of each method are discussed. Four methods are a description of a short-time waveform in which essentially the same information is preserved. Each turns out to be a particular normalization. A fifth method is shown to be a different type of measure, preserving information concerning the duration of zero-crossing intervals rather than their absolute number. An attempt is made to enumerate general characteristics of each of the techniques so as to make the mathematical analysis generally applicable.

Digital Speech Analysis Using Sequential Estimation Techniques

Jerry D. Gibson
Department of Electrical Engineering, University of Nebraska, Lincoln

Stephen K. Jones
Arthur A. Collins, Inc., Dallas, Texas

James L. Melsa
Department of Electrical Engineering, University of Notre Dame, Notre Dame, Indiana

IEEE Transactions of Acoustics, Speech, and Signal Processing 23: 362-369, 1975

Two new digital speech analysis methods for sequentially identifying the coefficients of the linear prediction model are presented; the methods are based on the stochastic approximation and Kalman filter sequential estimation algorithms. Speech synthesized using the predictor coefficients identified by the Kalman filter algorithm is highly intelligible and comparable in quality to that obtained by the autocorrelation and covariance methods. Speech synthesized using predictor coefficients identified by the stochastic approximation algorithm is also highly intelligible but of lower quality. The analysis and synthesis procedures use handpicked pitch and voiced/unvoiced information, and the predictor coefficients are converted to PARCOR coefficients for checking stability and transmission to the receiver. The sequential techniques are real time feasible and closely related to autocorrelation and covariance methods.

Automatic Language interpretation and the DAWID (In German)

W. H. Vieregge

Informatie 16: 461, 1974

The DAWID system, (Device for Automatic Word Identification by Discrimination) dates from 1964; it can identify 20 Italian words. Word identification has been broken down into elements such as the detection of signals, words. explosive sounds, fricatives, harmonics, vowel sound types and syllable identification. Recent developments include in the IKP project in Bonn using a hybrid computer system with a target of 200 to 300 words. Economic problems and the need for co-operation are noted.

Experiments in the Contextual Recognition of Cursive Script

Roger W. Ehrich, and Kenneth J. Koehler
Department of Electrical and Computer Engineering, University of Massachusetts, Amherst

IEEE Transactions on Computers 24: 182-194, February 1975

A system makes use of letter context (word length, letter segmentation, and character identity) to recognize words. The system consists of a character recognizer that presents a set of best alternatives for each character to a contextual postprocessor whose task it is to determine the correct word. The design of a character recognizer, basically a correlator based on chi-square, is described. The experimental performance of this recognizer is given and is used in conjunction with other experiments to predict the recognition rate of seven-letter words in a hypothesized dictionary of 9000 words of various lengths. One general design principle is the recurring application of Neyman-Pearson like decision criteria.

A Learning Machine with Function of Grasping Its Situation--A Learning System with Recognition Function for Multivocal Patterns

Takashi Nagano
Electrotechnical Laboratory Tanashi-shi, Japan

Systems--Computers--Controls 5, 1:51-58, 1974. Translated from Denshi Tsushin Gakkai Ronbunshi 57-D, 1; 54-61, 1974

The system recognizes by building an internal model of the mutual relationships of the object patterns. Thus the machine knows the surrounding situation. E.g. it recognizes a circular multivocal pattern as the letter *O* or the numeral *0* according to the circumstances. The system consists of a two-dimensional array of computational elements, each an analog threshold element with a threshold value and a saturation value, where mutual coupling in the reverse direction between the fundamental computational elements plays an important role furthermore, an algorithm by which the model for the relationship information is formed internally by self-learning, and also the condition for stable operation of the system, are described. The system has been tested using an input set of English letters, numerals, and Kana letters.

Decomposition of Polygons Into Simpler Components: Feature Generation for Syntactic Pattern Recognition

Hou-Yuan F. Feng, and Theodosios Pavlidis
Department of Electrical Engineering, Princeton University, Princeton, New Jersey

IEEE Transactions on Computers 24: 636-650, June 1975

A technique for decomposition of polygons into simpler components is described and illustrated with applications in the analysis of handwritten Chinese characters and chromosomes. Polygonal approximations of such objects are obtained by methods described in the literature and then parts of their concave angles are examined recursively for separating convex or other simple shape components. Further decomposition of the latter is possible. The final result can be expressed as a labeled graph and processed further through the introduction of either fuzzy predicates or syntactic pattern recognition techniques. The resulting descriptions are invariant under a number of transformations and therefore there is no need for registration and normalization of the input.

Lexicon and morphology as foundation of automatic sentence analysis
(Lexikon und Morphologie als Grundlage einer Automatischen Satzanalyse)

Heinz-Dirk luckhardt, and Heinz-Dieter Maas
Sonderforschungsbereich Elektronische Spraehforschung, Universitaet des Saarlandes, Saarbruecken .

Bericht 5-75:G = LA

LEXICOGRAPHY-LEXICOLOGY: STATISTICS

Quantitative connection between text length and vocabulary

Rolf Henzler
Zentralstelle fuer maschinelle Dokumentation, Frankfurt am Main

ZMD-A-28, Beuth Verlag GMBH, Berlin 30, 1974. ISBN 3-410-44028-3 DM 10

Abstracts, 1970-1971, are studied; the total is 2.5 million tokens. Base forms and stems are considered; both the number of base forms and the number of stems increase linearly with the number of types. Extrapolating, the author estimates that in the first month after 5 years an issue (1000 abstracts) will contain 900 new base forms; after 10 years, 670.

Comparative evaluation of statistical and linguistic methods for suffix analysis

Frank Doerflinger
Institut fuer Informatik, Universitaet Stuttgart, 7000 Stuttgart 1, Germany

Diploma thesis, February 1974. 111 pages.

A continuation of the work of M. Pfeifer (summary: AJCL Microfiche 1:41). Various methods are applied; the authof finds that statistical determination of suffixes in an English vocabulary is about as accurate as any intellectual method.

GRAMMAR: GOVERNMENT: VERBAL FRAMES

On verbal frames in functional generative description II

Jarmila Panevova
Laboratory of Algebraic Linguistics, Charles University, Prague

Prague Bulletin of Mathematical Linguistics 23:17-52, 1975

Verbs of motion, saying, simple working activity; high frequency verbs. Complements: object, addresses, origin, result (effected object). Obligatory and optional complements on semantic and surface-syntactic levels. Distinction between complements and modifiers: interaction with the boundness juncture; separability into an independent clause; possibility of coordinative conjunction. Rules and examples (Czech).

The Restriction Language for Computer Grammars of Natural Language

Naomi Sager, and Ralph Grishman
Linguistic String Project, New York University

Communications of the ACM 18: 390-400, July 1975

The Restriction Language (RL) is being used in the current implementation of the Linguistic String Parser. Basic statements of RL are declarative in form (ex. THE CORE OF THE SUBJECT IS NOT PLURAL). The subject of the statement locates a node in the parse tree or an attribute of a word definition and the predicate performs some test on that node or attribute. A full range of logical connections, including NOT, AND, OR, NEITHER ... NOR ..., IF ... THEN..., is provided and they can be nested to any depth. Registers are the ariables on RL and are frequently used in the grammar to avoid having to locate the same node several times in one restriction. An imperative format is available for writing routines (tree climbing, testing operators); there are provisions for monitoring the parsing process and for assigning and testing node attributes. Definitions of conjunctional strings are generated dynamically on encounter.

Lexical Analysis Using Context Information

Kenichi Taniguchi, Tadao Kasami, and Toru Kikuno
Faculty of Engineering Science, Osaka University, Toyonska, Japan

Systems - Computers - Controls 5, 2: 97-103, 1974 Translated from Denshi Tsushin Gakkai Ronbunshi 57-D, 4: 228-235, April 1974

The problem of partitioning source programs into tokens for lexical analysis in compilers. Let the order of tokens in the source program be described by an LR(k) grammar and let the characters comprising each token form a regular set in general. When the next token is needed the LR(k) parser finds the set of token strings of length h+1 which can come next and calls the scanner. By scanning until the input coincides with a token string of length h+1, if the partition of the first token is unambiguous, h-partionability is defined. A model of the scanner; construction of a scanner with the minimum number of registers required for temporary storage of partitioning possibility. H-partitionability can be determined if and only if h is given. Relations with deterministic languages, etc.

Tranducers and trees: Studies and realizations of systems, applied to transformational grammars

Jacques Chauche
Groupe d'Etudes pour la Traduction Automatique, Universite Scientifique et Medicale de Grenoble, B.P. 53, 38 041 Grenoble, France

Thesis, December 1974. 350 pages.

Regular and pushdown automata. Substitutive and recursive composition of automata. Trees: subtrees; orientation; labels. Transformations: orientation, labels; transformational grammars. Transformational transducers; linear representation of trees; recognition theorem; transformation theorem; constructibility of transformational transducers. The ATEF system: a regular transducer for preliminary text processing; informatic treatment; syntax of the ATEF language. The CETA system: a network of transducers; components; informatic treatment. Applications.

Presentation of the CETA system

J. Chauche
Groupe d'Etudes pour la Traduction Automatique, Universite Scientifique et Medicale de Grenoble, B.P. 53, 38 041 Grenoble, France

Report No. G - 3 100-A, January 1975. 70 pages.

Node labels; rules of grammar; elementary grammar; linkages between grammars; illustrative application to French noun phrases. The CETA system is described by Chauche, AJCL Microfiche 17, 21-40.

On Certain Aspects o Generative Grammar Computer Testing

Antonin Rina, and Svatava Machova
Center for Numerical Mathematics, Charles University, Prague

Kybernetika 11: 32-38, 1975

The computer testing of a functional generative grammar working with a semantic base (proposed by P. Sgall) is discussed in relation to the work of Joyce Friedman. While a flow chart of the system of programs for testing the entire grammar is given, this article concentrates on the programs for testing the generative component, which is a context-free phrase structure grammar with modifying, substitutional and selectional rules. The rules are not ordered. Some aspects of notation necessitated by the specific requirements of computer testing are pointed out. The grammar has been tested with a base of 275 lexemes.

Bibliography of the Semantics of Human Language

Thomas R. Hofmann
University of Ottawa

Linguistic Bibliography Series/ Collection "Bibliographies de Linguistique," No. 1, University of Ottawa Press, Editions de l'Universite d'Ottawa, 1974.

This bibliography is intended to aid in locating works (articles, books, etc.) on the semantics of human language. As a reference bibliography, it presents as many different places and modes of publication as possible. It is intended to cover all of linguistic semantics, with decreasing contributions from logic, computer science, philosophy, pyscholinguistics, semiotics, cognitive psychology, cognitive anthropology and artificial intelligence. In its present state of completion, this bibliography is weak in European entries, especially in East European items. Items are arranged alphabetically by author with no cross-indexng by title or subject.

Towards an Integrated Theory of Formal and Natural Languages

Petr Jirku
Mathematical Center of Biology, Czechoslovak Academy of Sciences, Prague

Kybernetika 11: 91-100, 1975

A grammar for natural languages must generate sentences with are both syntactically and semantically well-formed. This paper is primarily concerned with the semantic interpretation of declarative sentences, and is based on Montague's work. Semantic interpretations are relational structures. Terms in a language refer to non-linguistic entities called extensions, which provide a base for decisions about the truth values os sentences. From this an intensional semantics is developed. Truth values cannot be assigned to NL sentences without specification of extralinguistic factors (such as time and place of utterance). An index is a sequence of such coordinates necessary for the assignment of a truth value to a statement.

A Preferential, Pattern-Seeking, Semantics for Natural Language Inference

Yorick Wilks
Artificial Intelligence Laboratory, Stanford University

Artificial Intelligence 6: 53-74, 1975

A Preference, Semantics system for natural language analysis and generation is able to handle anaphoric inference problems requiring: (1) analytic knowledge (about relations between concepts) of a complex sort, or (2) weak inductive knowledge of the course of events in the real world. All available knowledge is converted to a canonical template form and then chains of nondeductive inferences from the unknowns to possible referents are constructed. Preference is based on "semantic density"--the principle used to set up the original meaning representation. Thus shorter chains of inference will be preferred over longer chains. Normal usage of concepts will be preferred, but unusual usages will be accepted in the absence of normal usage.

Inference and Paraphrase by Computer

Roger C. Schank
Yale University.

Neil M. Goldman
Information Sciences Institute, Marina del Rey, California

Charles J. Rieger, III
University of Maryland

Christopher K. Riesbeck
Yale University

Journal of the Association for Computing Machinery 22: 309-328, 1975

The MARGIE system attempts to understand natural language and are based. on Conceptual Dependency representation of meaning. The analyzer uses expectations (e.g. the identification of a verb creates expectations about words to fill case roles) in the mapping of sentences into conceptual structures. Using conceptual structure as input, the memory program makes inferences of five types: (1) Normative (what is the normal state of affairs?), (2) Peripheral (what do people automatically assume when hearing something?), (3) Causative, (4) Resultative, and (5) Predictive. The generator codes conceptual structures back into natural language. It uses a set of discrimination nets through which conceptual structures are filtered to discover word sense units. With these units discovered a syntax net can be generated.

Organization and Inference in a Frame-Like System of Common Sense Knowledge

Eugene Charniak
Institute for Semantic and Cognitive Studies, Castagnola, Switzerland

Working Paper No. 14, 1975

A frame approach (Minsky) to the organization of knowledge can be used for understanding texts or for executing actions. A frame is a static data structure about one stereotyped topic. Frames consist of frame statements (FS). A story consists of story statements (SS) which instantiate FS's. The binding of variables in FS's instantiated by SS's is handled by a frame image (FI) which is separate from the FS. Frames must be able to reference subframes and some FS'S will be common to several frames. Many inferences have to be made about information not given in SS's but necessary for comprehension. Given the large number of possible inferences, restrictions must be put on them so that only useful ones are made. A Dual Usage Rule is suggested: If X is an FS in an active frame (one which has an FI) then X will only appear instantiated in the data base (for the particular story) if it has two purposes. Finally, the frame approach is contrasted with a demon approach.

has two purposes.

SEMANTICS-DISCOURSE: COMPREHENSION

A Partial Taxonomy of Knowledge about Actions

Eugene Charniak
Institute for Semantic and Cognitive Studies, Castagnola, Switzerland

Working Paper No. 13, 1975

An incomplete taxonomy is proposed for the knowledge of actions a computer must have if it is to understand stories about people performing these actions. The classification is along two dimensions, *Force*--why a person should follow the rule, and *Form*--what the rule looks like. Four kinds of force are distinguished, Strict, Social, Suggested, and Regulatory, while six forms are distinguished, Subactions, Substates, Side Conditions, Methods, Time Orderings, and Do-Whiles. For the most part it seems that any force type may combine with any form type in producing a rule. One example, how to use an umbrella, is examined in detail although facts about many human activities, from playing bridge to washing one's hair, are used as examples.

SEMANTICS-DISCOURSE: COMPREHENSION

Programs for Natural Language

Lawrence M. Clark

Computers and People 24, 4: 14-23, 1975

Computer programs to understand natural language must deal with grammar and semantics; control of context is crucial. Correspondng to any context (e.g. accounting, geology, music, "common everyday context", etc.) is a vocabulary of "brick-words" for use in that context. Brick-words are joined by cement-words, which may be used in many contexts. Cement-words for ordinary discussion, general science, mathematics and logic are discussed. There is no one-to-one correspondence between cement-words and cement-ideas. The programmer specifies a context and tells the computer the idea labels for the ideas referred to by brick-

Concept theory--a practical contribution to text assimilation and text reception

Wolfgang Samlowski
Instituto per gli studi Semantici e Cognitivi, Castagnola, Switzerland

Working Paper 12, 1974

The theory is similar to Schank's. Four initial categories of concepts are Actions, Objects, Mutations, and Connections. More complex concepts, in particular Circumstances (Sachverhalte), are constructed. Concepts are nodes of a network that represents the knowledge and experience of a person. Understanding a text is a complex of processes relating the text to an individual's (unique) network. Communication is motivated by the need to exchange resources.

An Intelligent Analyzer and Understander of English

Yorick Wilks
Artificial Intelligence Project, Stanford University

Communications of the ACM 18: 264-274, May 1975

A working analysis and generation program for natural language which handles paragraph length input. Its core is a system of preferential choice between deep semantic patterns, based on "semantic density". 70 primitive semantic *elements* of 5 types (entities, actions, type indicators, sorts, and cases). Formulas are binary trees of semantic primitives and express the senses of words, one formula per sense. Formulas are structured into *templates.* The application of *paraplates* to template codings establishes case ties between templates. Common sense inferences are used to resolve anaphora. The system is contrasted: (1) with syntax oriented linguistic approaches, and (2) with theorem proving approaches to the understanding problem. With the addition of generation patterns called *stereotypes* the system is used to translate into French.

An automatic linear analysis of Slavic scientific texts

P. Pognan, and D. Herault

Prague Bulletin of Mathematical Linguistics 23:1-16, 1975

A dependency parser finds the verbs in a sentence and then in a series of phases, deals with various types of dependents. Categories are distinguished by roots; a content analysis program is in operation on an IBM 370 165 at CIRCE.

Sentence Paraphrasing from a Conceptual Base

Neil M. Goldman
Stanford University

Communications of the ACM 18: 96-106, February 1975

A program produces sentence paraphrases which demonstrate understanding with respect to a given context. This generator operates in conjunction with a natural language analyzer and a combined memory and inference model. The model encompasses several classes of linguistic knowledge: (1) executable tests of conceptual properties stored in descrimination nets; (2) information relating conceptual to syntactic roles, stored in a word-sense dictionary, and (3) surface grammatical knowledge, stored in a formal grammar.

An Associative-Categorical Model of Word Meaning

Robert M. Haralick
Department of Electrical Engineering, University of Kansas

Knut Ripken
Mathematisches Institut, Technische Universitat Munchen

Artificial Intelligence 6: 25-99, 1975

Words in a given universe are assigned values from a fixed category set (semantic primitives). A statistical relatedness measure (concomitant variation) is computed for these values on the basis of the specified word universe. An association measure between the words is then defined and the generalization of word clusters is introduced. A comparison with associative (e.g. Quillian) and categorical (e.g. Schank, Winograd) models is made and the application of the associative-categorical model to verbal analogy problems is described. Possible applications in AI and in NL processing, 3 learning generalizations from instances, are discussed.

Memory, Knowledge, and the Answering of Questions

Donald A. Norman
University of California, San Diego

In Robert L. Solso, Editor, Contemporary Issues in Cognitive Psychology: The Loyola Symposium, Washington, D.C.: V. H. Winston & Sons, 1973, 135-165. Distributed by Halstead Press, Division of John Wiley & Sons, Inc., New York. ISBN 0-470-81229-X HC $12.95

In order to answer questions, people must use: (1) simple inference, (2) knowledge of causality, (3) their understanding of physical laws, (4) general knowledge, and (5) their understanding of what the person asking the question already knows. Knowledge of the world can be represented in an active network, with some of the nodes standing for programs that operate upon the network itself *Events, actors, locations, objects, causal factors* and *results* make up *scenarios.* The primitive definitions of actions are sensorimotor instructions. Sensorimotor plans can be examined as data; activated, causing the action; and simulated. *Linear teaching and learning* proceeds by the addition of one new piece of information after another to the developing structure while *web teaching and learning* goes from a general overview, to more detailed overviews, to detailed substructure. The model is being tested by computer simulation.

SEMANTICS-DISCOURSE: MEMORY

The Representation of Meaning in Memory

Walter Kintsch

Lawrence Erlbaum Associates, Publishers, Hillsdale, New Jersey. Distributed by the Halstead Press Division of John Wiley & Sons. ISBN 0-470-48074-2 HC $14.95.

Contents

Document Analysis Algorithms and MT Research

Jacques Noel
Vrije Universiteit Brussel and Universitaire Instelling Antwerpen

Revue des Langues Vivantes Tijdschrift voor Levende Talen 41:237-260,1975

MT requires the use of a natural language (NL)/metalanguage (ML) distinction in which the ML for representation of a particular domain of knowledge is independent of any NL. The ML is conceived of as representing the culture of a scientific community. MT would proceed by using the appropriate ML as a *tertium quid* between the two NL's. A system for text analysis, applicable to any NL or ML, is described in which each text is treated as a tree and analyzed from bottom to top using 9 grammars requiring 4 programs.

Grammatical Inference: Introduction and Survey - Part II

King-Sun Fu
School of Electrical Engineering, Purdue University

Taylor L. Booth
Department of Electrical Engineering and Computer Science, University of Connecticut

IEEE Transactions on Systems, Man, and Cybernetics 5: 409-423, July 1975

Inference of high-dimensional grammars is discussed. Specifically, techniques for inferring tree grammars are briefly presented. The problem of inferring a stochastic grammar to model the behavior of an information source is also introduced and techniques for carrying out the inference process are presented for a class of stochastic finite-state and context-free grammars. The possible application of these methods is illustrated by examples.

Position and problems of algebraic linguistics (introduction) II

Petr Sgall
Laboratory of Algebraic Linguistics, Charles University, Prague

Prague Bulletin of Mathematical Linguistics 23:53-74, 1975.

Constituent-structure theory; generative power, transformational and stratificational theories; semantics in linguistics and logic; the program of text linguistics.

The Concept of a Linguistic Variable and its Application to Approximate Reasoning - I

L. A Zadeh
Computer Sciences Division, Department of Electrical Engineering and Computer Sciences and Electronics Research Laboratory, University of California, Berkeley

Information Sciences 8: 199-249, 1975

A variable is characterized by a triple $(X, U, R(X; u))$, in which X is the name of the variable; U is the universe of discourse (finite or infinite set); u is a generic name for the elements of U; and $R(X; u)$ is a subset of U which represents a *restriction* on the values of u imposed by X. Variables may or may not interact (a concept analogous to the dependence of random variables). The *extension principle* is in essence a basic identity which allows the domain of the definition of a mapping or a relation to be extended from points in U to fuzzy subsets of U. If the membership function of a fuzzy set of *type 1* ranges over the interval [0, 1], then the membership function of *type 2* fuzzy set has fuzzy subsets of the interval [0, 1] for its values.

The Concept of a Linguistic Variable and its Application to Approximate Reasoning - II

L. A. Zadeh
Computer Sciences Division, Department of Electrical Engineering and Computer Science and Electronics Research Laboratory, University of California, Berkeley

Information Sciences 8: 301-357, 1975

A fuzzy variable is characterized by a triple in which $R(X, u)$ represents a fuzzy *restriction* on the values of u imposed by X. A linguistic variable takes fuzzy variables as its values and is characterized by a quintuple $(X, T(X), U, G, M)$ in which X is the name of the variable (e.g. *Age*); $T(X)$ denotes the *term-set* of X, that is, the set of names of its *linguistic values* (e.g. *old, young, very old*, etc.); U is the universe of discourse; G is a *syntactic rule* which generates the terms in $T(X)$, and M is a *semantic rule* which associates with each linguistic value X its *meaning* $M(X)$, where $M(X)$ denotes a fuzzy subset of U. Since linguistic values can be composite (*not very old and not very young*) the syntactic rule and the semantic rule are needed to associate composite terms with their meanings. Treating *Truth* as a linguisitc variable with values such as *true, very true, completely true*, etc., leads to *fuzzy logic* which provides a basis for *approximate reasoning.*

Networks of Automata: Some Applications

Azriel Rosenfeld
Computer Science Center, University of Maryland, College Park

IEEE Transactions on Systems, Man, and Cybernetics 5: 380-383, May 1975

Parallel web automata (PWA)--a generalization of cellular arrays to arbitrary graph structures--are defined. It is shown that such automata make poor acceptors (i.e., they are not good recognizers of their own graph structures). However, they can be used to perform parallel local pattern matching (with respect to patterns of bounded size) on themselves, so that they have potential usefulness as models for "semantic memory." They can also be used to find greatest compatible sets of graph labelings subject to given local constraints; this problem arises, for example, in the analysis of scenes containing three-dimensional objects.

Fuzzy-PLANNER: Reasoning with Inexact Concepts in a Procedural Problem-Solving Language

Rob Kling
Department of Information and Computer Science, University of California, Irvine

Journal of Cybernetics 4,2: 105-122, 1974

A precise computationally specific method for coupling two different many-valued logics with a procedural problem-solving system (micro-PLANNER). Solutions to deductive problems can be found which meet specific criteria of validity. This scheme enables the system to dynamically compute the truth-value of a subgoal during the search process. Thus, the validity of a subgoal may be used to direct the heuristic search procedure. The notions elaborated here are relevant to any procedural problem-solving language.

State-Space, Problem-Reduction and Theorem Proving - Some Relationships

Gordon J. VanderBrug, and Jack Minker
Department of Computer Science, University of Maryland, College Park

Communications of the ACM 18: 107-115, February 1975

A bidirectional relationship between state-space and problem-reduction representation uses a formalism based on multiple-input and multiple-output operators. A representation of the language recognition problem which is based on the Cocke parsing algorithm is used as an illustration. A method for representing problems in first-order logic in such a way that the inference system employed by a resolution-based theorem prover determines whether the set of elauses is interpreted in the state-space mode or in the problem-reduction mode is presented. The analogous concepts in problem-reduction and theorem proving, and the terminology used to refer to them, are noted. The relationship between problem-reduction, input resolution, and linear resolution is discussed.

COMPUTATION: PROGRAMMING

Interactive Consulting via Natural Language

Stuart C. Shapiro, and Stanley C. Kwasny
Computer Science Department, Indiana University, Bloomington 47401

Technical Report No. 12, June 1974

Interactive programming systems often contain help commands to give the programmer on-line instruction regarding the use of the various systems commands. It would be relatively easy to make these help commands significantly more helpful by having them accept requests in natural language. As a demonstration Weizenbaum's ELIZA program has been provided with a script that turns it into a natural language system consultant. Appendices contain script and list of key words for ELIZA helper.

The Representation of Fuzzy Knowledge

R. A. LeFaivre
Computer Science Department, Hill Center, Busch Campus, Rutgers University, New Brunswick, New Jersey

Journal of Cybernetics 4,2: 57-66, 1974

A new AI programming language (called FUZZY) is introduced which provides a number of facilities for efficiently representing and manipulating fuzzy processes. General techniques for representing fuzzy knowledge in FUZZY are examined: the use of the associative net for explicit representation of fuzzy sets and fuzzy relations, the use of deduce procedures" to implicitly define fuzzy sets, logical combinations of fuzzy sets, linguistic hedges, and fuzzy algorithms. The role of inference in a fuzzy environment is also discussed, and a technique for computing fuzzy inferences in FUZZY is examined. The programming language FUZZY is implemented in LISP, and is currently running on a UNIVAC 1110 computer.

New Programming Languages for Artificial Intelligence Research

Daniel G. Bobrow
Xerox Palo Alto Research Center, California

Bertram Raphael
Stanford Research Institute, Menlo Park, California

Computing Surveys 6: 153-174, September 1974

New directions in artificial intelligence research have led to the need for certain novel features to be embedded in programming languages. This paper gives an overview of the nature of these features, and their implementation in four principal families of AI languages: SAIL; PLANNER/CONNIVER; QLISP/INTERLISP; and POPLER/POP-2. The features include: new data types and accessing mechanisms for stored expressions; more flexible control structures, 3 multiple processes and backtracking; pattern matching to allow comparison of data item with a template, and extraction of labeled subexpressions; and deductive mechanisms which allow the programming system to carry out certain activities includng modifying the data base and deciding which subroutines to run next using only constraints and guidelines set up by the programmer.

Interactive Command Language Design Based on Required Mental Work

Siegfried Treu
Department of Computer Science, University of Pittsburgh, Pennsylvania

International Journal of Man-Machine Studies 7: 135-149, January 1975

Although the definition of "mental work" remains elusive, systematic means/ methods should be considered for gaining evidence about interactive language features requiring more/less effort of the human mind. The suggested approach employs a structuring of the user's conceptual reference spaces into sets of "action primitives", peculiar to the type of computer-aided task involved. An interactive command language can then be regarded as the range of some transformation on the user's set of action primitives. The nature and efficiency of that transformation, in conjunction with the inherent number of mental association links, are hypothesized to have direct relationships to the level of required mental work. The user's delay or "think time", expended immediately preceding command utilization, is one measurable quantity that should be useful as a work level indicator.

BRIDGE: An Interactive Dialogue-Generation Facility

William Stallings
Honeywell Information Systems, Waltham, Mass.

IEEE Transactions on Systems, Man, and Cybernetics 5: 402-406, May 1975

An interactive programming system for the generation of man-computer dialogues is introduced. The system consists of an integrated set of tools that are used to define and generate the software for a variety of dialogues. The system is capable of generating dialogues for computer-assisted instruction (CAI), data processing, and the programming of special-purpose applications.

An Introduction to SNePS

Stuart C. Shapiro
Computer Science Department, Indiana University, Bloomington 47401

Technical Report No. 31, June 1975

SNePS (Semantic Network Processing System) is a system for building directed graphs with labelled nodes and edges and locating nodes in such graphs according to graph patterns. Rather than being a general system for processing labelled digraphs, SNePS is restricted in certain ways, appropriate for its intended use--to model "semantic" or "cognitive" structures. SNePS may be used interactively by a human to explore various approaches to semantic representation, or it may be used as a collection of functions by a more complete natural language understanding program. This paper gives a user-oriented introduction to SNePS, which is written in LISP 1.6 and runs on a DECsystem-10.

Survey: Picture Processing: 1974

Azriel Rosenfeld
University of Maryland, College Park

Computer Graphics and Image Processing 4: 133-155, 1975

Picture compression; image enhancement and reconstruction; picture matching, edge and curve detection; picture processing implementations; pictoral pattern recognition; picture properties; picture parts and picture description: picture automata and grammars. Bibliography of nearly 350 references.

Computers & Graphics: A New Journal

Robert L. Schiffman, Editor
Computing Center, University of Colorado Boulder, Colorado 80302

Volume 1, No. 1 May 1975

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COMPUTATION: PICTORIAL SYSTEMS

Learning to Identify Toy Block Structures

Patrick Winston
Massachusetts Institute of Technology

In Robert L. Solso, Editor, Contemporary Issues in Cognitive Psychology: The Loyola Symposium, Washington, D. C.: V. H. Winston & Sons, 1973, 135-165. Distributed by the Halsted Press Division of John Wiley & Sons, Inc., New York ISBN 0-470-81229-X HC $12.95

Scene analysis routines analyze block structures and produce hierarchical symbolic descriptions which can be represented as a network of nodes, for objects, and arcs, for relations between objects. In teaching the machine to identify block structures one presents it with examples of a particular type of structure (such as a pedestal or an arch) and with near misses. The machine is able to note the difference between the description of an example and the description of a near miss and from that to learn what is essential to the concept. In this way a *model* of the concept is constructed. The program can compare some scene with a list of models and report one as an acceptable match, identify some particular object in a scene, and find instances of some particular model in a scene.

Metainformational approach to the Theory of Integrated Information Retrieval Systems

Marek Ciganik
Computing Research Center, UNDP, Bratislava, Czechoslovakia.

Information Processing and Management 11, 1-10, 1975

Primary documents contain the retrieval information in an implicit form. The metainformational approach attempts to transform this implicit information structure to an explicit one. A successful solution of the problem is based on a metasyntactic analysis of texts, a creation of the semantic language in an oriented graph metastructure, and a pragmatic interpretation of metastructures based on relational contextual indexes. The metasyntactic analysis starts with a small set of inclusion metarelators, faceted relators as governing words, self-acting delimiters, and some excluding modifying phrases. A transition from the metasyntactic analysis to additional common syntactic analysis is assumed.

A Text Organizing System

Kemal Koymen
Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia

Information Processing & Management 11: 23-38, 1975

The system consists of the following processes: (1) Analyzing the text items and assigning candidate index terms to the items; (2) Generating and assigning index phrases to the items; (3) Discriminating and rejecting candidate index terms determined to be ineffective in forming a classification automatically; and (4) Generating a classification system and repositing the text items in accordance with this system. Some degree of interactive user involvement is incorporated, particularly for (3). The system informs the user of the impact of his decisions to delete terms on a mass basis. An affinity dictionary allows the user to locate synonymous or near synonymous index terms. The system has been adequately documented (indcluding a user guide) and tested for its reliability and dependability.

A file organization and maintenance procedure for dynamic document collections

Donald B. Crouch
University of Alabama

Information Processing Management 11: 11-21, 1975

Several techniques have been proposed for clustering document collections. However, these algorithms ignore file maintenance problems which occur whenever the collection is dynamic. This paper describes a clustering algorithm designed for dynamic data bases and presents an update procedure which maintains an effective document classification without reclustering. The effectiveness of the algorithm is demonstrated for a subset of the Cranfield collection.

Grammatically-Based Automatic Word Class Formation

Lynette Hirschman, Ralph Grishman, and Naomi Sager
Linguistic String Project, New York University

Information Processing and Management 11: 39-57, 1975

Most previous attempts at producing word classes (thesauri) by statistical analysis have used very limited distributional information such as word co-occurrence in a document or a sentence. The present procedure uses syntactic relations. It forms classes by grouping together nouns that occur as subject (or object) of the same verbs, and similarly by grouping together verbs occurring with the same subject or object. The program was applied to a small corpus of sentences in a subfield of pharmacology. This procedure yielded the word classes for the subfield, in good agreement with the word classes recognized by pharmacologists. The word classes can be used to describe the informational patterns that occur in texts of the subfield, to disambiguate parses of a sentence, and perhaps to improve the performance of current information retrieval systems.

Semantics and automatic translation

Ch. Boitet
Groupe d'Etudes pour la Traduction Automatique, Universite Scientifique et Medicale de Grenoble, B.P. 53, 38 041 Grenoble, France

Report No. G. - 3 000-A, December 1974. 66 pages.

Semantics is useful in MT to the limited extent that it is needed in resolving ambiguities; levels of sense, situation, and knowledge can be distinguished. Review of systems or models: Titus II (Institut Textile de France), the CETA and GETA pivot languages, Meaning-Sense (Mel'chuk), preferential semantics (Wilks), TLC (Quillian), Conceptual Dependency (Schank), microworld (Winograd). A method using definitions written in GETA pivot language is proposed. Heuristic and combinatoric methods are contrasted: Simmons and Quillian treat semantic problems combinatorically; Wilks uses heuristic methods for syntax, GETA for morphology.

Explorations in Mathematical Anthropology

Paul Kay, editor

The MIT Press, Cambridge, Massachusetts, and London, England, 1971. HC/ISBN 0-262-11034-2, $12.00. PC/ISBN 0-262-61019-1, $3.95

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HUMANITIES: ANALYSIS

The Semantic Structure of *the Wanderer*

Ellen Spolsky
University of New Mexico

Journal of Literary Semantics 3: 101-119, 1974

Word meaning is a function of a finite number of semantic components. Of the available components, the applicable ones are determined by context. Poetic texts reinforce the themes/components of the poem by repetition of words bearing the proper components. Definitions of all the words in *the Wanderer* were loaded into a computer and a concordance made of all words in the definitions. The print-out listed the components (words used to define poem words) alphabetically and indicated each poem word in whose definition the component occurred. The poem is broken into half-lines and each half-line is marked for the occurrence or absence of each component Some components have been combined by hand in the data presented. Using frequency of occurrence in half-lines as a criterion, themes/components central to the poem are identified. Themes not previously discussed in the critical literature on the poem have been identified.

On Marcus Method for the Analysis of the Strategy of a Play

Barron Brainerd, and Victoria Neufeldt
Department of Mathematics, University of Toronto

Poetics: International Review of the Theory of Literature 10: 31-74, 1974

A matrix in which each character in a play heads a column and each scene (as defined in Marcus' theory) a row is constructed. For each character p there is a set A(p) composed of the natural numbers corresponding to the scene in which p appears. Characters p and q can be *concomitant*, *independent*, *alternative*, *complementary*, or one can *dominate* the other depending on the relationship between A(p) and A(q). It is also possible to calculate character density up to the kth scene, the scenic difference between two characters, the scenic diameter of the play, the encounter number of two characters, and the character-scene frequency. Other properties are defined on the incidence graph of the characters. These methods are testec and refined in the investigation of seven plays of widely different character and it is shown that these methods do differentiate among the types of play studied, though the model cannot be relied upon by itself to yield an explication of play-structure.

INSTRUCTION

The Representation of Knowables

G. Pask, D. Kallikourdis, and B. C. E. Scott
System Research Ltd., 2 Richmond Hill, Richmond, Surrey, U.K.

International Journal of Man-Machine Studies 7: 15-134, January 1975

A formal account of the structure of conversational domains and a procedure for buildng representations of knowledge structures; examples from "diseases of the thyroid" and "educational testing" Computer programs have been implemented; one permits the student to assume the role of "expert" and modify the conversation domain by adding new topics if he can show how the new topic can be derived from existing topics so that the total structure remains cyclic and consistent The programs are described and interpreted for a theory of comprehension lea ning, operation learning, and versatile learning--an optimum mix of comprehension and operation. The interpretation is related to empirical studies of learning style.

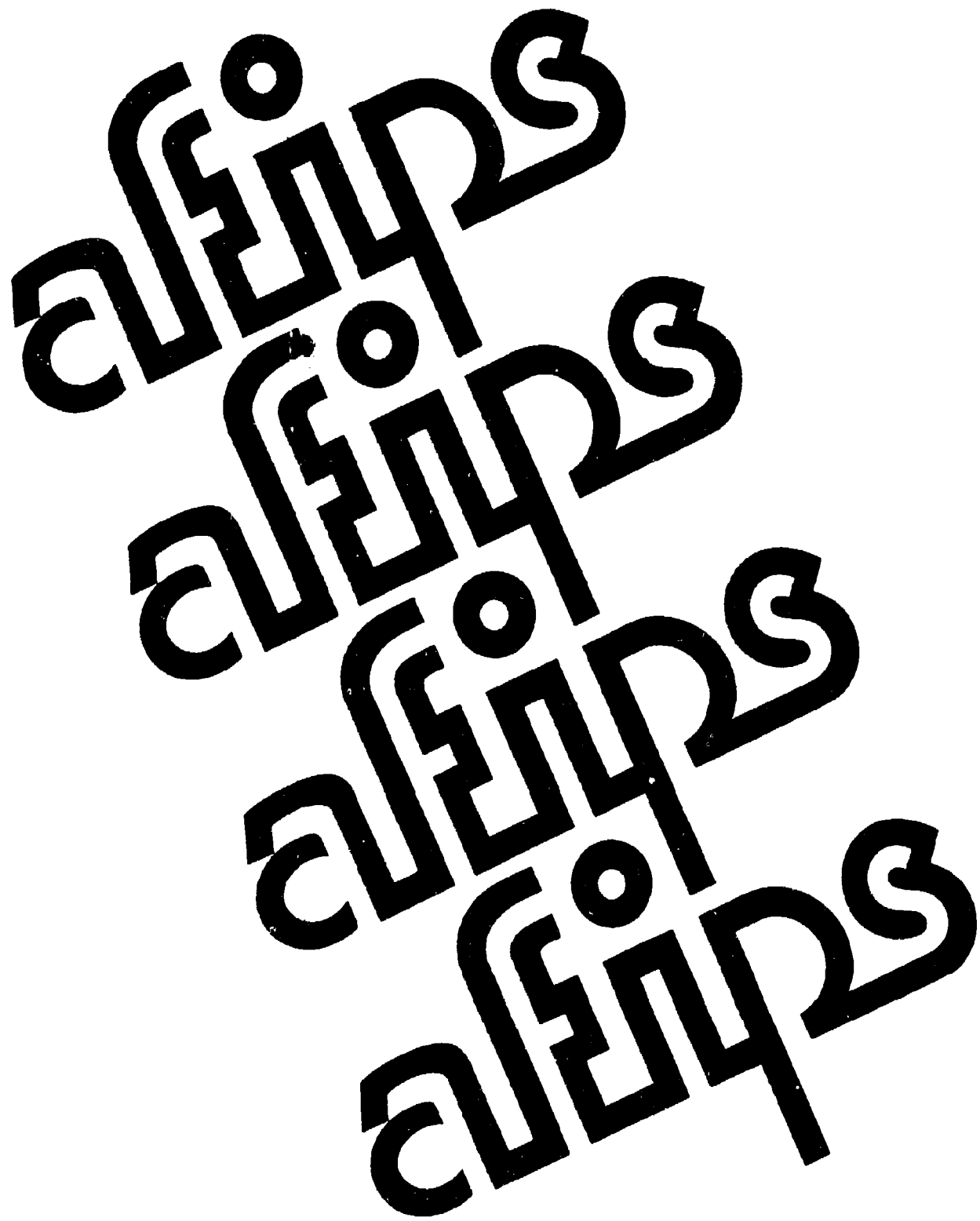
An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller

E. H. Mandani, and S. Assilian
Queen Mary College, London University

International Journal of Man-Machine Studies 7: 1-13, January 1975

An experiment on the "linguistic" synthesis of a controller for a model industrial plant (a steam engine). Fuzzy logic is used to convert heuristic control rules stated by a human operator into an automatic control strategy. The experiment was initiated to investigate the possibility of human interaction with a learning controller. However, the control strategy set up linguistically proved to be far better than expected in its own right, and the basic experiment of linguistic control in a non-learning controller is reported here.

American Journal of Computational Linguistics Microfiche 30 : 73



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462 pages, hardcover, $23.50

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edited by Charles Freiman

Proceedings of the IFIP Congress held in Ljubljana, Yugoslavia, August 23-28, 1971.

1650 pages, two volumes, hardcover, $171.00

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Proceedings of the IFIP Congress held in Stockholm, August 5-10, 1974.

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350 pages, hardcover. In preparation. March 1975

COMMAND LANGUAGES

edited by C. Unger

This IFIP working conference brought together users and designers of operating systems with the purpose of establishing a common base for further research into command languages and their design considerations. Topics discussed include functions and facilities analysis, the relationship of command languages to general purpose programming languages; formal descriptions of operating systems from the users point of view; portability and machine independence; and network command languages.

410 pages, hardcover, $27.75

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edited by Donald A. Jardine

Proceedings of the SHARE Working Conference on Data Base Management Systems held in Montreal, Canada, July 23-27, 1973. All papers were invited and discussed topics such as user experience, the presentation of user requirements, discussion on problems of migration, growth and data independence.

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MEDINFO 74

edited by J. Anderson and J. M. Forsythe

This book gives a broad view of the problems, hopes and difficulties raised by the application of data processing techniques to the various fields of medical practice, medical education and medical research. Eighteen themes of direct importance to present and future developments in health computing are viewed from human, psychological, political and technical standpoints.

1140 pages, hardcover. January 1975

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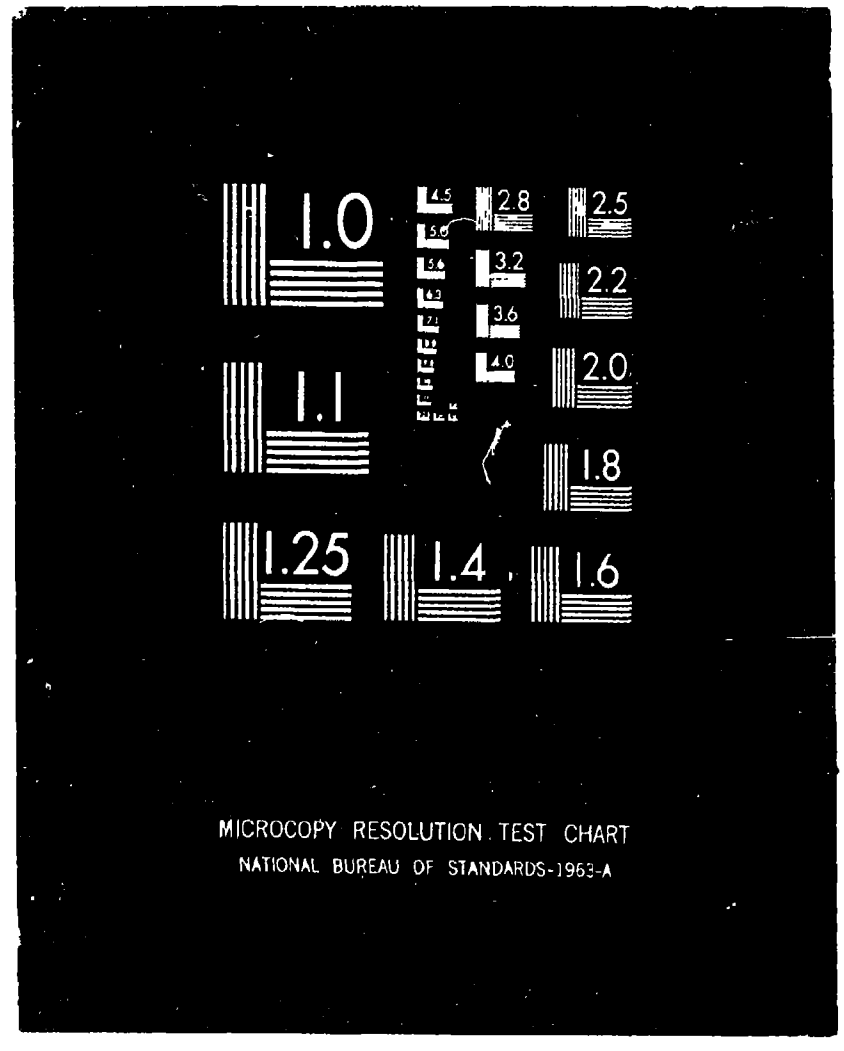
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