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GENERAL

The Hearsay-I Speech Understanding System: An Example of the Recognition Process**D. Raj Reddy***Department of Computer Science, Carnegie-Mellon University, Pittsburgh, PA 15213***Richard D. Fennell***Federal Judicial Center, Washington, D.C. 20005***Richard B. Neeley***Xerox Palo Alto Research Center, CA 94305**IEEE Transactions on Computers 25: 422-431, April 1976*

In Hearsay-I diverse sources of knowledge can be represented as cooperating independent parallel processes which help in the decoding of the utterances using the hypothesize-and-test paradigm. The system is discussed by considering a specific example of its operation in the realm of voice chess. Topics: feature extraction and segmentation, the recognition process, speaker- and environment-dependent knowledge, syntactic and semantic knowledge.

GENERAL

Preliminary Results on the Performance of a System for the Automatic Recognition of Continuous Speech**L. R. Bahl, J. K. Baker, P. S. Cohen, N. R. Dixon, F. Jelinek, R. L. Mercer, and H. F. Silverman***Speech Processing Group, Computer Sciences Department, IBM T.J. Watson Research Center, Yorktown Heights, NY 10598**Research Report RC 5654, 12p, September 30, 1975*

The recognition system consists of the Acoustic Processor (front end) and the Decoder (back end), which uses statistical models of the various aspects of speech production and recognition. Two types of decoding algorithms have been used; a stack decoder and a Viterbi decoder. In one set of experiments the vocabulary consisted of the 11 digits - *zero, oh, one, two, ... nine*. Sentences consist of 7 digit sequences. After training on a set of 602 utterances, recognition on 100 test sentences yielded 89% and 82% correct for the stack and the Viterbi decoder respectively. Only one speaker was used. The second set of experiments involved the New Raleigh language, with a vocabulary size of 250. In this set the effect of training set size, number of iterations during training, variations in speaker model, and effects of different speakers were tested. Percentages of correct sentences were in the 80-85% range.

Speech Understanding Through Syntactic and Semantic Analysis

Donald E. Walker

Artificial Intelligence Center, Stanford Research Institute, Menlo Park CA 94025

IEEE Transactions on Computers 25: 432-439, April 1976

Summary of an early version (1972) of the SRI speech understanding system. Topics discussed: the nature of the problem of speech understanding (as opposed to speech recognition), syntactic and semantic analysis, acoustic processing, word verification.

Computer Power and Human Reason**Joseph Weizenbaum***Department of Computer Science, Massachusetts Institute of Technology, Cambridge**W.H. Freeman and Company, San Francisco, California, 1976 300 pp.,**HC \$9.95**ISBN 0-7167-0464-1*

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Natural Language Processing (A Bibliography with Abstracts)

David W. Grooms

National Technical Information Service, Springfield, VA

NTIS/PS-75/864/9GA, 204p, December 1975

Computer programming; information storage and retrieval, question-answering, man-computer communications, AI, syntactic analysis, computational linguistics. 199 abstracts.

PHONETICS-PHONOLOGY

Man Converses with Machine

S. A. Barchenko

USSR

*Joint Publications Research Service, Arlington, Va.: NTIS JPRS-66417 Translation of
Chelovek Razgovarivaet s Machinoi, Moscow: 77-83, 105-109, 123-134, 1974
PC \$3.50/MF \$2.25*

Descriptions of electronic devices for speech analysis and conversion and for voice controlled systems and mechanisms.

Speech Research: Jan-Mar 75**Alvin M. Liberman***Haskins Laboratories, Inc., New Haven, Connecticut**Report SR 41 (1975), 235p, June 1975 NTIS AD-A013 325/6GA,
PC \$7.50/MF \$2.25*

Manuscripts cover the following topics: Preliminaries to a theory of action with reference to vision; two questions in dichotic listing; relationship of speech to language; rise time in nonlinguistic sounds and models of speech perception; phonetic coding of words in taxonomic classification task; on the front cavity resonance; synthetic speech comprehension; testing synthesis-by-rule with OVEBORD program Stress and the elastic syllable, VOT or first-formant transition detector; pitch in perception of voicing states in Thai; facial muscle activity in production of Swedish vowels; combined cinefluorographic-EMG study of the tongue during production of /s/; velar movement and its motor command; the stuttering larynx.

PHONETICS-PHONOLOGY

Recent Developments in Speech Research**O. Fujimura***Bell Laboratories, Murray Hill, New Jersey 07974**Manuscript for the Proceedings of the 8th International Congress on the Education of the Deaf, Tokyo, August 1975*

Recent progress in speech research is reviewed with an emphasis on the efforts to relate linguistic units to speech events. Topics discussed: Segmental aspects, Assimilation, Syllables as concatenative segments (instead of phonemes), Suprasegmental aspects. In the discussion of suprasegmentals experiments are reported in which English words were first recorded in a carrier sentence and then constituent syllables were clipped out and used to form new sentences. Various approximations to the target sentence were tested, simple concatenation, a version in which durations of syllables had been adjusted to match natural expansion or compression of syllables, another version in which the natural pitch contour (taken from an utterance of the target sentence) is stretched to match the durations as they were for the source syllables, and another version with natural pitch contour and duration-adjusted syllables.

Implementation of the Digital Phase Vocoder Using the Fast Fourier Transform

Michael R. Portnoff

Department of Electrical Engineering and Computer Science, Research Laboratory of Electronics, M.I.T., Cambridge, MA 02139

IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 243-248 June 1976

A digital formulation of the phase vocoder, an analysis-synthesis system providing a parametric representation of a speech waveform by its short-time Fourier transform, is of interest both for data-rate reduction and for manipulating speech parameters. The system is designed to be an identity system in the absence of any parameter modifications. Computational efficiency is achieved by employing the fast Fourier transform algorithm to perform the bulk of the computation in both the analysis and synthesis procedures, thereby making the formulation attractive for implementation on a minicomputer.

PHONETICS-PHONOLOGY PHONOLOGY

Syllables as Concatenated Demisyllables and Affixes

O. Fujimura

Bell Laboratories, Murray Hill, New Jersey 07974

Paper Presented at the 91st meeting of the Acoustical Society of America, April 1976

By decomposing English syllables into phonetically and phonotactically well-motivated units it should be possible to create a complete inventory for segmental concatenation which will contain about 1,000 entries, and still reproduce natural allophonic variations. A syllable is shown to consist of a syllable core and syllable affix(es), the former being decomposed into the initial and final demisyllables. Consonantal features for each demi-syllable include at most one specification of place of articulation (in terms of a few distinctive features), spirantization (for /sp/, /st/, /sk/, as opposed to /p/, /t/, /k/), tenseness, nasality etc.. The phonetic realization is governed by the vowel affinity principle as described elsewhere in terms of the temporal sequence of pertinent physical events. There is a phonetic constraint that a demisyllable is realized with not more than two phonetic consonantal segments. The final consonantal elements (such as /s/ in /taeks/) that follow a place-specified consonant (/k/ in this case) are treated as syllable affixes. These affixes are all apical, and they observe voicing assimilation with respect to the true consonant in the core.

Transition Networks for Pattern Recognition**Su Man Chou, and K. S. Fu***School of Electrical Engineering, Purdue University, Lafayette, Indiana**Report TR-EE75-39, 187p, December 1975, NTIS: AD-A020 727/4GA**PC \$7.50/MF \$2.25*

Transition networks and Chomsky's hierarchy; modified Earley's algorithm for transition network grammars. Stochastic and error correcting versions of transition networks are proposed to solve the problem of noise and distortion in syntactic pattern recognition. This approach is illustrated by discussion of an experiment on *voice-chess* language. Inference in transition networks; inference on the probability assignment over the arcs of stochastic transition networks; examples of inference.

PHONETICS-PHONOLOGY: RECOGNITION

An Approach Towards a Synthesis-Based Speech Recognition System**R. B. Thosar***International Computers, Ltd., Poona, India***P. V. S. Rao***Tata Institute of Fundamental Research, Bombay, India**IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 194-196 April 1976*

The scheme uses information about interphoneme contextual effects contained in formant transitions and employs internal trial synthesis and feedback comparison as a means for recognition. The aim is to achieve minimal sensitivity to appreciable variability which occurs in the speech signal, even for utterances of a single speaker. While the approach is quite general, it has initially been tried out on vowel-stop-vowel utterances. Vowels are always identified correctly while recognition scores range from 66% to 78% for the consonants, except for /n/ at 47.9%.

Continuous Speech Recognition via Centisecond Acoustic States**Raimo Bakis***Computer Sciences Department, IBM Thomas J. Watson Research Center,
Yorktown Heights, NY 10598**IBM Research Report: RC 5971, 4p, April 5, 1976*

Continuous speech was treated as if produced by a finite state machine making a transition every centisecond. The observable output from state transitions was considered to be a power spectrum - a probabilistic function of the target state of each transition. Using this model, observed sequences of power spectra from real speech were decoded as sequences of acoustic states by means of the Viterbi trellis algorithm. The finite-state machine used as a representation of the speech source was composed of machines representing words, combined according to a 'language model'. When trained to the voice of a particular speaker, the decoder recognized seven-digit telephone numbers correctly 96% of the time, with a better than 99% per-digit accuracy. Results of syllable and phoneme recognition tests are also given. The approach appears promising, with system training appearing to be the key problem.

PHONETICS-PHONOLOGY: RECOGNITION: SEGMENTATION

A General Language-Operated Decision Implementation System (GLODIS): Its Application to Continuous-Speech Segmentation**N. Rex Dixon, and Harvey F. Silverman***Speech Processing Group, Department of Computer Sciences, IBM Thomas J. Watson Research Center, Yorktown Heights NY 10598**IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 137-162 April 1976*

GLODIS represents a flexible, operating-system approach to the generation and implementation of complex rules for decision making in pattern recognition, such as processing of EEG, EKG, seismic, sonar, radar, and, in this implementation, speech data. The user control of the system, written in GLODISL, is fed to a compiler stage which converts the user-oriented control data for the implementer, which applies the control data to the input data. The system is described in detail sufficient to permit replication. In the segmentation of 8.5 minutes on continuous text, containing 6175 individual phoneme events, the system achieved 6.80% missed events, 10.50% extra events, 4.69% temporarily misplaced events. 88.6% of segments were assigned to the proper phoneme class, with the worst confusion existing between glides and vowels (which is predictable in a system using steady-state classification). GLODIS has been used as the acoustic-to-phonetic translator in a large experiment described in L.R. Bahl *et al.* IBRRB: RC-5654 (abstracted elsewhere on this fiche).

Computer Recognition of Interphonemic Transitions in Continuous Speech**David A. Brown***Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio School of Engineering**Report GSM/BE/75D-45, 90p. December 1975 NTIS: AD-A019 842/4GA
PC \$5.00/MF \$2.25*

The objective of this research was to determine the feasibility of recognizing five distinct speech units (interphonemic transitions) in the speech of one speaker. A computer program performed the recognition task based on formant features in the transition regions of the speech data. A comparison of two sequential recognition models revealed that transitions in continuous speech can be more accurately modelled in terms of independent formant sequences than a simple sequence of sounds.

PHONETICS-PHONOLOGY. RECOGNITION: FORMANTS

Modifications to Formant Tracking Algorithm of April 1974**Stephanie Seneff***Lincoln Laboratory, M.I.T., Cambridge, MA 02173**IEEE Transactions on Acoustics, Speech, and Signal Processing 24:
192-193 April 1976*

An improved version of the algorithm described in McCandless (IETABA 22: 135, *AJCL* abstract on fiche 6: 55). The new algorithm, like the original one, applies continuity constraints and branches out from an anchor point in the middle of each vowel. The changes are that initial estimates for the formant frequencies at the anchor are determined more carefully, and that the option of choosing a new anchor point near the original one is allowed if the original one caused problems.

Prosodic Aids to Speech Recognition: VII. Experiments on Detecting and Locating Phrase Boundaries**Wayne A. Lea***Defense Systems Division, Sperry Univac, St. Paul, Minnesota**Report PX-11534, 52p, 14 November 1975 NTIS: AD-A019 047/0GA
PC \$4.50/MF \$2.25*

Computer programs for detecting syntactic boundaries (BOUND3) and locating stressed syllables (STRESS) have been supplied to ARPA contractors and incorporated into speech recognition facilities. Experiments were conducted on various timing cues that correlate with phonological and syntactic phrase boundaries, showing that 91% of the phonological phrase boundaries that were perceived by listeners who heard spectrally inverted speech could be detected from lengthened vowels and sonorants in phrase-final positions. Also, 95% of these perceived boundaries were evidenced by long time intervals between syllables. The interstress interval also provided a good measure of rate of speech, that correlated with error rates in automatic phonetic classification schemes.

PHONETICS-PHONOLOGY: RECOGNITION: SPEAKER IDENTIFICATION

Evaluation of an Automatic Speaker-Verification System over Telephone Lines**A. E. Rosenberg***Acoustics Research Department, Bell Laboratories**Bell System Technical Journal 55: 723-744, July-August 1976*

The system is based on an acoustic analysis of a fixed, sentence-long utterance resulting in a function of time or contour for each feature analyzed (such as pitch, intensity). In a test of the system 104 male and female speakers called in nominally once each working day, from their own phones, over a period of five months. In the initial call each 'customer' was asked to provide 5 recordings of the test utterance ("We were away a year ago"). Provision is made for updating the reference file. At the early stages the reject-customer rate is about 10%, while it approaches 4% on adapted customers. The accept-imposter rate shows a similar history. The greatest weakness of the system lies in the establishment of adequate initial reference files.

Speaker Recognition Using Orthogonal Linear Prediction**Marvin Sambur***Bell Laboratories, Murray Hill, NJ 07974**IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 283-289, August 1976*

Recent experiments in speech synthesis have shown that, by an appropriate eigenvector analysis, a set of orthogonal parameters can be obtained that is essentially independent of all linguistic information across an analyzed utterance, but highly indicative of the identity of the speaker. The orthogonal parameters are formed by a linear transformation of the linear prediction parameters, and can achieve their recognition potential without the need of any time-normalization procedure. The speaker discrimination potential of the linear prediction orthogonal parameters was formally tested in both a speaker identification and a speaker verification experiment. The speech data for these experiments consisted of six repetitions of the same sentence spoken by 21 male speakers on six separate occasions. For both identification and verification, the recognition accuracy of the orthogonal parameters exceeded 99 percent for high-quality speech inputs. For telephone inputs, the accuracy exceeded 96 percent. In a separate text-independent speaker identification experiment, an accuracy of 94 percent was achieved for high-quality speech inputs.

PHONETICS-PHONOLOGY: RECOGNITION: EVALUATION

Speech Recognition Experiments with Linear Prediction, Bandpass Filtering, and Dynamic Programming**George M. White, and Richard B. Neely***Palo Alto Research Center, Xerox Corporation, CA 94304**IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 183-188 April 1976*

Preprocessing by linear predictive analysis and by bandpass filtering are found to produce similar recognition scores. The classifier uses either linear time stretching or dynamic programming to achieve time alignment. Dynamic programming is of major importance for recognition of polysyllabic words. The speech is compressed into a quasi-phoneme character string or preserved uncompressed. Best results are obtained with uncompressed data, using nonlinear time registration for multisyllabic words.

Some Preliminary Experiments in the Recognition of Connected digits

Lawrence R. Rabiner, and Marvin R. Sambur
Bell Laboratories, Murray Hill, NJ 07974

IEEE Transactions of Acoustics, Speech, and Signal Processing 24: 170-182 April 1976

The first part of the recognition system segments the string into individual digits while the second part recognizes the individual segments. Segmentation is based on a voiced-unvoiced analysis of the digit string, as well as information about the location and amplitude of minima in the energy contour of the utterance. The digit recognition strategy is similar to the algorithm used by Sambur and Rabiner (BSTJAN 54: 81) for isolated digits, but with several important modifications due to the impreciseness with which the exact digit boundaries can be located. In evaluating the accuracy of the system high-quality sound recordings obtained from a soundproof booth were segmented with 99% accuracy and the recognition accuracy was about 91% across ten speakers (5 male, 5 female). With recordings made in a noisy computer room the segmentation accuracy remained close to 99% and the recognition accuracy was about 87% across another group of 10 speakers (5 male, 5 female).

PHONETICS-PHONOLOGY RECOGNITION: CLASSIFICATION

Utterance Classification Confidence in Automatic Speech Recognition

Ralph Kimball, and Michael H. Rothkopf
Palo Alto Research Center, Xerox Corporation, CA 94304

IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 188-189 April 1976

A confidence measure for utterance classification using Hamming distance: Given an unknown string U and known strings $T_1 \dots T_k$, we wish to choose the known string T_m most similar to U . The Hamming distance H_m between T_m and U is the total number of character differences between the respective strings. The Hamming ratio, between the two best Hamming distance scores obtained in matching utterance templates with an unknown utterance, is an indication of the degree of competition among alternative classifications. If the Hamming ratio falls below a specific threshold, the classification cannot be taken seriously and it is necessary to invoke a more costly, but more powerful, classifier.

A Comparison of Several Speech Spectra Classification Methods

Harvey F. Silverman, and N. Rex Dixon

Speech Processing Group, Computer Sciences Department, IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598

IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 289-295 August 1975

Four methods of classifying speech-spectra are discussed: 1) maximum direction cosine method, 2) minimum distance with no mean correction, 3) minimum distance with linear mean correction, 4) minimum distance with full correction. These were tested with 80, 40, 20, and 10-point spectral representation. Measures of accuracy and stability were derived through the use of an automatic performance evaluation system. Over 3000 hand-labeled spectra were used. Of those evaluated, a linearly mean-corrected minimum distance measure, on a 40 point spectral representation with a square (or cube) norm was consistently superior to the other methods.

PHONETICS-PHONOLOGY: RECOGNITION CLASSIFICATION

A Pattern Recognition Approach to Voiced-Unvoiced-Silence Classification with Applications to Speech Recognition

Bishus S. Atal, and Lawrence R. Rabiner

Bell Laboratories, Murray Hill, NJ 07974

IEEE Transactions on Acoustics, Speech, and Signal Processing 24: 201-212 June 1976

The linking of voiced-unvoiced decision to pitch analysis not only results in unnecessary complexity, but makes it difficult to classify short speech segments which are less than a few pitch periods in duration. By using measurements of the zero-crossing rate, the speech energy, correlation between adjacent speech samples, the first predictor coefficient from a 12-pole linear predictive coding (LPC) analysis, and the energy in the prediction error it is possible to use a pattern recognition approach to deciding whether a segment is voiced speech unvoiced speech, or silence. The speech segment is assigned to a particular class based on a minimum-distance rule obtained under the assumption that the measured parameters are distributed according to the multidimensional Gaussian probability density function. The means and covariances for the Gaussian distribution are determined from manually classified speech data including a training set. A simple nonlinear smoothing algorithm is described to provide a smooth 3-level contour of an utterance for use in speech recognition applications.

Residual Energy of Linear Prediction Applied to Vowel and Speaker Recognition**Hisashi Wakita***Speech-Communications Research Laboratory, Inc., Santa Barbara, CA 93109**IEEE Transactions of Acoustics, Speech, and Signal Processing 24: 270-271 June 1976*

*Abstract--*Recognition of steady-state vowels based on the residual energy of linear prediction was ascertained to be useful for a recognition system in which the reference data are taken from the intended speaker. Sharp speaker selectivity based on a threshold criterion suggests that the use of the residual signal energy may also be useful for speaker identification, especially for speaker screening in a large population.

PHONETICS-PHONOLOGY: SYNTHESIS

Speech Synthesis by Programmable Digital Filter**Donald B. Warmuth***Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio School of Engineering*

*Report GE/EE/75-41, 78p, December 1975 NTIS: AD-A019 842/4GA
PC \$5.00/MF \$2.25*

Input from teletype, output is recognizable speech. The technique is based on modeling the acoustical consequences of the various configurations of the vocal tract and was tested by listening to output and by use of the Speech Analysis System of the Aerospace Medical Research Laboratory, which consists of an analyzer and associated equipment necessary to produce a real-time hardcopy representation of the frequency characteristics of the speech input. The analyzer is called a COC filter with a design based on the hydro-mechanical operation of the inner ear.

A Model of Articulatory Dynamics and Control**Cecil H. Coker.***Acoustics Research Department, Bell Laboratories, Murray Hill, NJ 07974**Proceedings of the IEEE 64: 452-460, April 1976*

The system includes: 1) a physical model of the vocal system, with spatial constraints very close to those of natural articulation; 2) a representation of the motional constraints of the articulators which, when moving from one stated shape to another, interpolates realistic intermediate shapes; 3) a similar model for the movements of the excitation system, including subglottal pressure, vocal cord angle and tension; and 4) a controller for this mechanism which produces from input phonetic strings sequences of articulatory commands which cause this dynamic system to execute properly timed articulatory motions.

PHONETICS-PHONOLOGY: SYNTHESIS

Automatic Generation of Voiceless Excitation in a Vocal Cord-Vocal Tract Speech Synthesizer**James L. Flanagan, and Kenzo Ishizaka***Acoustics Research Department, Bell Laboratories, Murray Hill, NJ 07974**IEEE Transactions of Acoustics, Speech, and Signal Processing 24: 163-170, April 1976*

The speech synthesis technique incorporates acoustic models for sound propagation in a tube with yielding walls, turbulent noise generation at locations of constricted volume flow in the vocal tract, and the self-oscillatory properties of the vocal cord source. With the freedom from the traditional assumption of linear separability of sound source and resonant system allowed by this formulation, new opportunities accrue for building realistic physiological characteristics into the synthesizer which represent information that need not be overtly supplied to control the synthesizer. The system is used to synthesize test syllables from controls which are stylized models of articulation and connected speech from controls automatically derived from printed text. The synthesis technique demonstrates the feasibility of generating all speech sounds (voiced unvoiced; nasal) from a common set of physiologically based control parameters (subglottal lung pressure, vocal cord tension, vocal cord neutral area, area of nasal coupling, cross sectional area of the vocal tract along its length).

Digital Analysis of Laryngeal Control in Speech Production

J. L. Flanagan, L. R. Rabiner, D. Christopher, and D. E. Bock
Acoustics Research Department, Bell Laboratories, Murray Hill, NJ 07974

T. Shipp
Veterans Administration Hospital, Speech Research Laboratory, San Francisco, CA 94121

Journal of the Acoustical Society of America 60: 446-455, August 1976

Physiological measurements are made directly on human talkers to determine several dynamic laryngeal functions. The functions are control variables in a speech synthesizer which utilizes acoustic models of the vocal cords and vocal tract. They are the time variation of vocal-cord (glottal) opening (A_g); the electromyographic (EMG) potentials of three laryngeal muscles--posterior crico arytenoid (PCA), interarytenoid (IA), and cricothyroid (CT); the subglottal air pressure (P_s); the speech output sound pressure waveform (P); and timing pulses from a digital clock. Preliminary data for ten utterances by a man are digitized by a multiplexed A/D converter and the results are stored in disk file for analysis. The results show how voice periodicity can be manifested differently at the glottal and sound-output levels. A typical instance is vocal-cord vibration throughout the occluded phase of a voiced stop consonant. The EMG functions are analyzed by computing short-time energy. The results are correlated with voicing onset/offset and with voice pitch. PCA energy is shown to be correlated with voicing offset, and anticipatory to it by about 20-30 msec. IA energy is shown to be correlated with voicing onset, and anticipatory to it by about 40-50 msec. CT energy is found to be nearly directly correlated with the frequency contour for voice pitch. Direct utilization of these physiological parameters for speech synthesis is suggested.

PHONETICS-PHONOLOGY: SYNTHESIS

Speech Resynthesis from Phoneme-Related Parameters

Joseph P. Olive, and N. Spickenagel
Bell Laboratories, Murray Hill, NJ 07974

Journal of the Acoustical Society of America 59: 993-996, April 1976

In work on speech analysis and resynthesis predictor (LPC) derived functions are used to describe the spectrum of the acoustic signal; small changes in the values of these parameters do not affect the speech quality. If the boundaries of the steady-state portion of the phonemes are found, the steady-state portions, as well as the transitions between the phonemes, can be represented by straight lines. This method allows for the description of the acoustic signal with two sets of points per phoneme. Numerous sentences have been encoded by this method, and the resulting sentences do not sound differently from the sentences from which the data were derived. Such a scheme could be used for a rule-synthesis scheme, as well as for segmentation of speech in speech recognition schemes.

WRITING

Computers Learn to Talk

Sergei Ivanov
USSR

Foreign Technology Division, Wright-Patterson AFB, Report: FTD-ID(RS) J-2306-75, Edited translation from Rabochaya Gazeta 208: 4, Sept. 75, by Gale Weisenbarger, NTIS: AD-A017 927/5GA
PC \$3.50/MF \$2.25

Communication with computers in printed form. From the International Conference on Artificial Intelligence held in Tbilisi.

WRITING

Kana to Kanji-and-Kana Conversion System

Y. Matsushita, H. Yamazaki, and F. Sato
Okai Electric Industry Co., Ltd.

Information Processing in Japan 14: 87-92, 1974

Problems in the processing of Japanese language information are indicated and a system is discussed for converting Kana to Kanji-and-Kana.

The Design and Construction of a System to Transliterate Thai by Computer

U. Warotamakikkhadit, and N. Kanchanawan
Ramkhamhaeng University, Thailand

D. Londe
System Development Corporation

6th Australian Computer Conference Proceedings: 833-839, Australian Computer Society, Inc., 1974

The system accepts Thai words as input and produces as output a Romanized transliteration. The components of the system are an IBM 1800 computer, and Thai and Roman character printing Shinko teletype, a string processing language and an interpreter for this language.

WRITING: RECOGNITION

Optical Character Recognition (A Bibliography with Abstracts)

George W. Reimherr
National Technical Information Service, Springfield, VA

NTIS:PS-75/892/0GA, 120p, December 1975
PC \$25.00/MF \$25.00

Design, performance, and applications of optical character recognition devices and techniques for alphanumeric symbols, automatic recognition of handwritten characters. 115 abstracts.

Word Inventory and Frequency Analysis of French Conversations

ERIC: ED100190, 175 p, 1975
MF \$0.75/HC \$9.00

This word frequency list was extracted from a corpus of fifty half-hour conversations recorded in Paris during the academic year 1967-68. The speakers, who did not know that they were being recorded, were all well-educated professionals and all speakers of the most standard dialect of French. The list is made up of all phonetically discrete words recorded, without any attempt to separate homonyms.

LEXICOGRAPHY-LEXICOLOGY: THESAURI

Automated Compiling of Thesauri and Concept Systems for Dictionaries and Technical Glossaries

(Automatisierte Herstellung von Thesauren und Begriffssystemen für Wörterbücher und Fachterminologien)

F. H. Lang

Osterreichische Gesellschaft für Dokumentation und Information

Nachrichten Dokumentation 24: 231-238, 1973

GENTHES supports the construction of a thesaurus and its use and is based on a relational system which corresponds to ISO/DIS 2788 (UNESCO) and DIN 1463, differing, however, in adding generically related and contiguous terms pertaining to a part-whole system. The characteristics that determine narrower terms against their broader terms are introduced as new relations, and many types of associations are made available for experiment. The programmed generation of dependent relations ensures avoidance of formal errors and logical contradictions. The program can operate interactively or in batch. Program functions: input, logical and formal input checking, generations of relations, display, delete, print--on line printer and storage on disk.

Comparative Study of the Syntactic Characteristics of Formal-Informal Discussion and Administrative Correspondence

Public Service Commission of Canada, 418p, 1974
ERIC: ED102874,
MF\$0.76/HC\$20.94

The study provides descriptive, comparative, quantitative, and statistical information on the syntactic characteristics of two English registers: 1) formal and informal discussion and 2) administrative correspondence. In chapters 1 and 2 the background and purpose of the study are discussed. The composition of the major spoken and written corpus, the analytical data of which formed the basis of the study, is described in chapter 3. Chapter 4 outlines the multilevel analytical model adopted and its characteristic features.

GRAMMAR

On Relational Constraints on Grammars

David E. Johnson

Mathematical Sciences Department, IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598

IBM Research Report: RC 5868, 50p, February 18, 1976

Within the framework of Relational Grammar the following universal principle of natural language is proposed and defended:

The Continuous Segment Principle: No rule R of a natural language can apply to a non-continuous segment of the Relational Hierarchy (RH) ($S < DO < IO < OO$), i.e., if R applies to noun phrases holding grammatical relations U and W on the RH ($U < W$), then, for all V on the RH such that $U < V < W$, R can apply to noun phrases holding V. [S: subject, DO: direct object, IO: indirect object, OO: oblique object]

Evidence from a wide variety of languages supporting this generalization is discussed.

Size, Index, and Context-Sensitivity of Controlled Partition Grammars**Eva-Maria M. Wotschke***IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598***Detlef Wotschke, and Peter J. Downey***The Pennsylvania State University, University Park, PA 16802**IBM Research Report: RC 5867, 35 p, November 13, 1975*

General Controlled Partition Grammars (CPGs) generate exactly all context-sensitive languages. CPGs have two parameters: *size* and *index*. The partition index of CPGs can be bounded by two, while CPGs with partition index one generate exactly the class of context-free languages. The size (of the partition sets) of CPGs can be bounded by two, while CPGs of size one generate a class of languages properly contained in the class of context-sensitive languages. If one can eliminate recursive productions of the form $A \rightarrow B$ in a CPG then deterministic and nondeterministic CPGs are equivalent.

GRAMMAR: PARSER

Morphological and syntactic analyses of the Portuguese language in an automatic translation project*Analises morfologica e sintatica da lingua portuguesa num projeto de traducao automatica***Paltonio Daun Fraga***Department of Computer Science, Institute of Mathematics,
Statistics, and Computer Science, University of Campinas,
SP 13100, Brazil**Mimeographed, July 1976*

The finite-state system ATEF and the tree transducer CETA developed by Vauquois, Cháuche, et al. at Grenoble have been installed at Campinas. Morphological analysis is in operation. An elementary portion of the syntax has been completed, and work on adjectival and nominal groups is in progress.

Some Frills for Modal Tic-Tac-Toe: Semantics of Predicate Complement Constructions**Aravind K. Joshi***Department of Computer and Information Science, The Moore School of Electrical Engineering, Department of Linguistics, University of Pennsylvania, Philadelphia***Ralph M. Weischedel***Department of Computer and Information Science, University of California, Irvine**IEEE Transactions on Computers 25: 374-389, April 1976*

A system for testing the semantic properties (presuppositions and entailments) of predicate complement constructions. Implementation of these constructions has been explored in some detail in the context of the tic-tac-toe game-playing setting of Isard and Longuet-Higgins (1973) and Davis and Isard (1972) which was devised to explore the semantics of modal verbs (*might, can, will, etc.*) and hypotheticals (*if you had . . .*). The program has two phases. The first phase is merely playing a game of two-dimensional, 3 by 3, tic-tac-toe using a simple numerical approach. In phase two the system processes NL commentary on the game played in phase one. The current parser is top-down, L-R, but in future work the systems will be built around an ATN.

SEMANTICS-DISCOURSE

Case Systems for Natural Language**Bertram C. Bruce***Bolt Beranek and Newman, Inc., Cambridge, MA 02138**Report BBN 3010, 72p,
\$3.50, April 1975*

Because (1) it is difficult to specify semantic-free selection rules for the cases, and (2) related phenomena based on prepositions or word order appear in apparently case-less languages, many have argued that studies of cases should focus on meaning--i.e. "deep cases." Deep cases can be considered to be a special or distinguishing modifier of a concept. Several criteria for recognizing deep cases are considered here in the context of the problem of describing an event. Unfortunately, none of the criteria serves as a completely adequate decision procedure. A notion based on the context-dependent "importance" of a relation appears as useful as any rule for selecting deep cases. A representative sample of proposed case systems is examined.

Belief Systems and Language Understanding**Bertram C. Bruce***Bolt Beranek and Newman, Inc., Cambridge, Mass. 02138**Report BBN 2973, 56p.**\$2.50, January 1975*

In order to recognize intention in behavior (speech or other) one must have a model of the beliefs of others and know how actions fit together into larger units and are determined by intentions and beliefs. A theory of personal causation is developed using primitives of various sorts. These permit accounts of the social dimension of an action. Patterns of behavior, called "social action paradigms" (SAP's), are then defined in terms of social actions. The SAP's provide a structure for episodes analogous to the structure a grammar provides for sentences.

SEMANTICS-DISCOURSE: COMPREHENSION

Partitioned Networks for the Mathematical Modeling of Natural Language Semantics**Gary G. Hendrix***Department of Computer Sciences, University of Texas, Austin**Technical Report NL-28, December 1975*

The models are based on set theory, but are encoded as partitioned semantic networks which facilitate computation by cross-indexing semantically related data. A special network partitioning mechanism is introduced to delimit the scopes of quantified variables, distinguish hypothetical situations from reality encode the multiple alternative worlds considered in planning, share subnetworks among multiple hypotheses during parsing, and focus attention on selected portions of memory. Processes are defined in the network by "process automata," structures capable of encoding discrete, continuous and parallel change at multiple levels of detail.

Conceptual Graphs for a Data Base Interface

John F. Sowa

IBM Systems Research Institute, 219 E. 42nd Street, N. Y. 10017

IBM Journal of Research and Development 20: 336-356, July 1976

A data base system that supports natural language queries is not really natural if it requires the user to know how the data are represented. The formalism of *conceptual graphs* can describe data according to the user's view and access data according to the system's view. The graphs can represent functional dependencies in the data base and support inferences and computations that are not explicit in the initial query. A *conceptual graph* is a finite, connected, undirected, bipartite graph with nodes of one type called *concepts* (tagged with *sort labels*) and nodes of another type called *conceptual relations*, each of which has a certain number of *links*, which may be attached to concepts. Four basic formation rules (copy, detach, restrict, join), derived formation rules, values and quantifiers, conceptual schemas, Boolean connectives.

SEMANTICS-DISCOURSE: MEMORY

On Natural Language Based Computer Systems

S. R. Petrick

IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598

IBM Journal of Research and Development 20: 314-325, July 1976

This article is substantially the same as "On natural Language Based Query Systems" (IBM Research Report 5577) abstracted on *AJCL* Microfiche 50: 66.

The SQAP Data Base for Natural Language Information**Jacob Palme***Research Institute of National Defense, Stockholm, Sweden**National Technical Information Service: PB-243 783/8GA, July 1975**PC \$4.75/MF \$2.25, 79p.*

The Swedish Question Answering Project (SQAP) data base consists of a network of nodes corresponding to objects, properties, and events in the real world. Deduction can be performed. The data base is described, with particularly full treatment being given to the representation of NL noun phrases and to the representation of deduction rules in the data base in the form of data base patterns. Essentially the same contribution was published as AJCL microfiche 24.

SEMANTICS-DISCOURSE: MEMORY

REQUEST: A Natural Language Question-Answering System**W. J. Plath***IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598**IBM Journal of Research and Development 20: 326-335, July 1976*

REQUEST is an experimental Restricted English QUESTION-answering system that can analyze and answer a variety of English questions with respect to a small *Fortune-500*-type data base. To address the somewhat conflicting requirements of understandability for the machine and maximum naturalness for the user, REQUEST uses a language processing approach featuring: 1) the use of restricted English (drawn initially from the world of business statistics); 2) a two-phase organization in which input queries are treated as high-level-language expressions that are to be compiled into executable code; the first phase is parsing and the second is a translation of the resulting structural description into object language code; 3) linguistic analysis based on transformational grammar containing more than 100 transformational rules and which can presently handle *wh-* and *yes-no* questions, relative clauses, genitives, negatives, locatives, and time expressions. An appendix gives examples of current linguistic coverage.

Semantic Modeling for Deductive Question Answering**Robert T. Chien***Coordinated Science Laboratory, University of Illinois at Urbana-Champaign 61801***Fred Stahl***Department of Electrical Engineering, Columbia University, NY 10027***Steven J. Weissman***Coordinated Science Laboratory, University of Illinois at Urbana-Champaign 61801**IEEE Transactions on Computers 25: 358-366, April 1976*

A model for the driver's world is implemented in Micro-Planner. As the input is being accepted, antecedent theorems may be invoked in order to add information to the data base. After the data have been entered any question will be transformed into a goal or a series of goals. In attempting to satisfy these goals, theorems representing traffic laws and facts concerning the driver's are applied. Where information is lacking, specialist routines are invoked to determine the most likely default conditions. If recourse to a specialist fails (the goals are still not satisfied), then the user may be asked to supply additional information and the system again attempts to satisfy its goals. All information is expressed in relation to time frames.

LINGUISTICS: METHODS: MATHEMATICAL

Semantic Directed Translation of Context Free Languages**H. William Buttelmann***Computer and Information Science Research Center,
Ohio State University, Columbus**Report OSU-CISRC-TR-75-6, September 1974**NTIS: PB-242 854/8GA**PC \$3.75/MF \$2.25*

The phrase is the meaning bearing unit. Its meaning is a function of its syntactic structure and the meanings of its constituents. This is the basis of a formal definition for the semantics of a context free language. From a general definition of translation of CFLs the article moves to a form of translation which proceeds by translating on the phrase trees of the languages and is specified by a finite set of tree-replacement rules. Finally a procedure is presented which, given a CFG and phrase-structure semantics for a target language, will (usually) produce the finite set of tree-replacement rules for the translation, if the translation exists. The procedure may be viewed as a computer program which is a translator generator, and which produces another program that is a translator. Essentially the same contribution was published as AJCL microfiche 7.

One Approach to the Problem of Syntactic Analysis**V. V. Shevchenko***Cybernetics 10: 588-596, January 1976*

Recursive-type parametric grammars (RTPG) incorporate an apparatus for controlling descending syntactic analysis in a sentence-generation device. A RTPG depends on 3 parameters, one is the array of generation rules, while the other two are the set of binary relations which are treated as carriers of information regarding history and possible continuation of the sentence and a mapping that links every generation rule with certain binary relations from this set. Constraints can be imposed on the parameters such that the subclasses of RTPGs thus isolated will describe a fairly broad set of formal languages, in particular, programming languages, such that their elements are grammars oriented toward noninspective analysis.

COMPUTATION: INFERENCE

PAS-II: An Interactive Task-Free Version of an Automatic Protocol Analysis System**Donald A. Waterman**
*Rand Corporation, Santa Monica CA 90406***Allen Newell**
*Department of Computer Science, Carnegie-Mellon University, Pittsburgh PA**IEEE Transactions on Computers 25: 402-413, April 1976*

PAS-II is a task-free, interactive modular data analysis system for inferring the information processes used by a human being from his verbal behavior while solving a problem. The input to the system is the transcribed text of verbalization of a subject solving a problem and the output is a problem behavior graph (PBG) which describes the subject's search through a posited problem space. The program is structured on three levels. At the *mode* level there are *run* modes, which hold the data being processed, *rule* modes, which contain task-specific processing rules, and *auxiliary* modes, which contain task-independent rules. A *stage* consists of a run mode plus (a) rule mode(s). The system has six *processors* (consecutive stages in a control cycle): topic processor; Linguistic processor; Semantic processor; Group processor; PBG processor; and a Trace processor which enables the user to write a production system model of the subject and compare the trace obtained by running the production system model with the PBG obtained by the protocol analysis.

Special Issue on Automated Theorem Proving.

IEEE Transactions on Computer 25, August 1976

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COMPUTATION: PROGRAMMING

Automatic Programming Through Natural Language Dialogue, A Survey**G. E. Heidorn***IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598**IBM Journal of Research and Development 20: 302-313, July 1976*

Four projects are reviewed: one at the Information Sciences Institute (ISI) of the University of Southern California, Project MAC at MIT, a project at IBM, and the now discontinued work at the Naval Postgraduate School (NPGS) at Monterey. Each of these systems is intended to be a knowledge-based system that can "understand" a user's statement of a problem or a procedure in his own terms and convert it into a computer program. IBM and MIT are concerned with business applications, while ISI is attempting to develop a domain independent system. The ISI system is intended to *generate* programs "from scratch," whereas the IBM system is intended initially to *customize* parameterized programs. The MIT system is intended to do both. The three current projects are implemented in LISP, but each is developing a higher level language embedded in LISP. All four systems use some form of semantic network representation for the knowledge base and some form of procedural specification for NL processing.

COMPUTATION: PROGRAMMING: LANGUAGES

Clisp: Conversational Lisp**Warren Teitelman***Xerox Palo Alto Research Center, CA 94304**IEEE Transactions on Computers 25: 354-357, April 1976*

Clisp is an attempt to make Lisp programs easier to read and write by extending the syntax of Lisp to include infix operators, IF-THEN statements, FOR-DO-WHILE statements, and similar Algol-like constructs, without changing the structure or representation of the language. Clisp is implemented through Lisp's error handling machinery, rather than by modifying the interpreter. When an expression is encountered whose evaluation causes an error, the expression is scanned for possible Clisp constructs, which are then converted to the equivalent Lisp expressions. Thus, users can freely intermix Lisp and Clisp without having to distinguish which is which. Emphasis in the design and development of Clisp has been on the system aspects of such a facility, with the goal of producing a useful tool, not just another language. To this end, Clisp includes interactive error correction and many "do-what-I-mean" features.

D-Script: A Computational Theory of Descriptions**Robert C. Moore***Artificial Intelligence Laboratory, MIT, Cambridge, MA 02139**IEEE Transactions on Computers 25: 366-373, April 1976*

D-Script is a language for representing knowledge in AI programs and contains the following types of expressions 1) constants 2) variables 3) forms, and 4) lists. All functions, predicates and operators evaluate their arguments with evaluation rules largely adapted from LISP. Types of D-Script statements: simple predication, logical connectives (OR, AND, NOT IMPLIES), descriptions of three types, existential (SOME) universal (EVERY), and definite (THE). A description is a form whose first element is SOME, EVERY or THE, whose second element is a list containing a variable, and whose third element is an expression whose value is a statement. D-Script is capable of handling statements involving opaque contexts, time contexts, and knowledge about knowledge; it contains the lambda calculus and is Turing universal.

COMPUTATION: INFORMATION STRUCTURES

The Architecture of Coherent Information System: A General Problem Solving System**Chitoor V. Srinivasan***Department of Computer Science, Rutgers University, New Brunswick, NJ 08903**IEEE Transactions of Computers 25: 390-402, April 1976*

The meta-descriptive system (MDS) is used to generate intelligent information systems in different domains of discourse. MDS is specialized to a specific domain by accepting definitions of description schemas and descriptions of knowledge concerning *facts, objects, processes* and *problem solving* in the domain. The contributions of the proposed (and partially implemented) architecture are: 1) the capacity to use large data bases, 2) a highly flexible descriptive mechanism to model a domain, 3) definition of the descriptive language itself in terms of the models the system can build in a domain.

Unified Theory of Image Processing

Azriel Rosenfeld

Computer Science Center, University of Maryland, College Park

NTIS: AD-A018 154/5GA, 27p 31 October 1975

PC\$4.00/MF\$2.25

The 10 year project had two purposes: 1) formulation of a general approach to image processing, 2) investigation of the formal theory of computation on pictures. 39 technical reports came from the project; they are listed, along with abstracts.

COMPUTATION: PICTORIAL SYSTEMS.

Scene Analysis: A Survey

Carl Weiman

Courant Institute of Mathematical Sciences, New York University

Report NSO-9, 67 p, December 1975

NTIS: AD-A020 700/1GA,

PC \$4.50/MF \$2.25

This survey traces the development of scene analysis by computer from its origins in digitized picture processing and pattern recognition. Discussion of diverse approaches is unified by geometric concepts related to projection. A concluding overview contains suggestions for new approaches based on projective geometry and neurophysiological models. The bibliography, available as a deck of Hollerith cards, is organized according to topic and document accessibility.

DOCUMENTATION

90

Collective Index to the Journal of the American Society for Information Science, Volumes 1-25

Prepared by Aspen Systems Corporation

*American Society for Information Science, 282 pages, 1976
\$42.00 ASIS members, \$51.00 ASIS affiliates, \$60.00 list price*

DOCUMENTATION

Cumulative Index to the Annual Review of Information Science and Technology, Volume 1-10

*American Society for Information Science, 244 pages, 1976
\$22.00 ASIS members, \$24.75 ASIS affiliates, \$27.50 list price*

Complete index to the *Annual Review of Information Science and Technology* for the years 1966-1975.

Computer-Readable Bibliographic Data Bases - A Directory and Data Sourcebook

*American Society for Information Science, 814 pages, 1976
\$54.40 ASIS members, \$61.20 ASIS affiliates, \$69.00 list price*

Volume contains information and data on 301 bibliographic and bibliographic-related data bases produced in U.S. and Europe.

TRANSLATION

On Machine Translation from Japanese into English for a Technical Field

K. Shudo
Fukuoka University

Information Processing Japan 14: 44-50, 1974

Japanese to English translation for the field of transistor circuits.

Feasibility Study for Design of a Biocybernetic Communication System

Lawrence R. Pinneo, Patricia Johnson, Jennine Herron, and Charles S. Rebert
Stanford Research Institute, Menlo Park, California

NTIS: AD-A017 405/2GA, 158p, August 1975
PC \$6.75/MF \$2.25

The purpose of this three-year research program was to test the feasibility of designing a close-coupled, two-way communication link between man and computer using biological information from muscles of the vocal apparatus and the electrical activity of the brain during overt and covert (verbal thinking) speech. The research plan was predicated on existing evidence that verbal ideas or thoughts are subvocally represented in the muscles of the vocal apparatus. If the patterns of this muscle activity are at all similar to those involved in normal overt speech, a reasonable assumption is that the electrical activity of the brain during verbal thinking may be similar to that during overt speech. The results are reported in two parts. Part I concerns the off-line and on-line analysis of the EEG coincident with overt and covert speech as it might be used in biocybernetic communication, and Part-II concerns the hemispheric laterality difference.

SOCIAL-BEHAVIORAL SCIENCE: PSYCHOLOGY

Information Processing in Humans. Volume 1: 1964-1973, Volume 2: 1974-November 1975

Elizabeth A. Harrison
National Technical Information Service, Springfield, VA

Vol 1: NTIS/PS-75/857/3GA, Vol. 2: NTIS/PS-75/858/1GA, December 1975
PC\$25.00 per volume

Selected abstracts on reports which cover psychophysiology, memory, visual evoked responses, psychoacoustics, neuroses, decision making and learning as related to information processing in humans. Vol. 1: 209 abstracts, Vol. 2: 89 abstracts.

Studies in Interactive Communication: Limited Vocabulary Natural Language Dialogue**Michael J. Kelly***Department of Psychology, The Johns Hopkins University, Baltimore, MD 21218**Doctoral Thesis, 82p NTIS: AD-A019 198/1GA, August 1975
PC \$5.00/MF \$2.25*

Two-person teams communicated through a computer-controlled teletypewriter system to cooperatively solve real-world problems. They were permitted to use only words on predetermined lists of 300 words, or 500 words, or as a control condition with no vocabulary restrictions. Dependent measures were taken on four classes of variables: 1) time to solve the problem, 2) several measures of overt behavior, 3) several measures of verbal output, 4) measures of errors made by subjects using two restricted vocabularies. The main effect of vocabulary size was significant for only 3 of the 21 dependent measures and only 4 of the 105 interactions involving vocabulary size were statistically significant. These results suggest that NL dialogues with computers can proceed well under fairly strict vocabulary restrictions.

SOCIAL-BEHAVIORAL SCIENCE: PSYCHOLOGY

Experimental Determination of Design Requirements for a Program Explanation System**Ashok Malhotra, and Peter B. Sheridan***IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598**IBM Research Reports: RC 5831, 56 p, January 29, 1976*

The development of design requirements for interactive, computer-based systems to support human task performance was investigated by interconnecting two consoles logged into a time-sharing system. A subject is seated at one of the consoles and is asked to use the system, making believe it existed, to solve a set of representative problems. The subject's commands or requests for information appear on the other console where they are examined by the experimenter who creates responses to them that are analogous to those that would be given by the system, albeit with a slower response time. The experiments were conducted to determine the requirements for a system that would contain knowledge about programs and would be capable of explaining their intentions and behavior to a user who wished to use them modify them and interface them with other software. The system would be capable of answering questions and responding to commands phrased in English. It is essential that a practical system be able to respond intelligently to questions it cannot analyze syntactically. Experimental protocols are given and analyzed. An outline of the response generation strategy that would be required for such a system is given.

The Structure and Recall of Narrative Prose

Donald R. Gentner

Center for Human Information Processing, University of California at San Diego

NTIS: AD-A017 093/6GA, 21p, October 1975

PC\$3.50/MF\$2.25

Subjects listened to repeated presentations of a tape recording of two pages from a history book, with verbal recalls collected after each presentation. The elements of the passage were organized according to a serial structure based on order in the passage and a story grammar structure based on causal relations. While the serial structure at first influenced which elements of the passage were remembered, as the subjects remembered more of the passage, the story grammar structure became the dominant influence over the elements remembered on subsequent recalls.

SOCIAL-BEHAVIORAL SCIENCE: PSYCHOLOGY: PSYCHOLINGUISTICS

A Method for Studying Natural Language Dialogue

John C. Thomas

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IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598*

IBM Research Report: RC 5882, 59p, February 27, 1976

To study application-specific dialogues a 'user' (subject) interacts via typed messages with a second person who is simulating a computerized NL interface. The dialogues are all concerned with order-handling and invoicing; however, they are collected in three different situations. The user is variously attempting to describe, understand, or diagnose an order-handling and invoicing system. It seems clear that a NL interface must be able to deal with at least some metacomments about the interaction. Second, the way in which various expressions (e.g. conditionals) are used is heavily dependent upon pragmatics of the dialogue, not just the semantics. Third, users of different backgrounds will interact quite differently with a NL interface - so differently that the interface should probably be able to discriminate professionals from nonprofessionals and take appropriate action.

Writing and Following Procedural, Descriptive, and Restricted Syntax Language Instructions**John D. Gould***IBM Thomas J. Watson Research Center, Yorktown Heights, New York 10598***Clayton Lewis***Psychology Department, University of Michigan, Ann Arbor***Curtis A. Becker***Psychology Department, University of Oregon, Eugene**IBM Research Report: RC 5943, 22p, April 9, 1976*

Two exploratory experiments compared the way people (with no experience in the use of computing systems) write and carry out natural language procedures, NL descriptions, and instructions expressed in an artificial restricted syntax language. The results suggest that there is no single "natural" way that people write simple plans and instructions. Speed and accuracy of writing were about the same for all three approaches, although the linguistic characteristics differed greatly from approach to approach. While subjects were tolerant of ambiguity both in writing and in carrying out instructions, they often voluntarily employed restricted-syntax notation in their writing after being exposed to the notation. Subject's accuracy in following detailed instructions was no greater than that in writing those instructions.

Cybernetic Theory of Cognition and Learning

Gordon Pask

*Systems Research Ltd., 2 Richmond Hill, Richmond, Surrey, U.K.;
Brunel University and the Open University (I.E.T.)*

Journal of Cybernetics 5: 1-90, January-March 1975

A theory of conversational interaction and one embodiment of that theory--CASTE (Course Assembly System and Tutorial Environment)--is presented. A conversation involves individuals who participate in process of problem solving, learning, and understanding with respect to a set of topics. All psychological observations are observations

of conversations, albeit with very restricted domains. The stable organization of conversations is characterized as a set of procedures (program-like entities) that are executed in particular processors such as brains or computing machines. Thus a conversation involving 2 human beings is conceived as a set of procedures executed in parallel in physically distinct processors. One characterization of the

individual is the M Individual, or mechanically characterized individual--a physically distinct individual. The P Individual is defined as follows: 1) a concept is a procedure for reproducing a relation, 2) a memory is a procedure for reproducing a concept, 3) a P Individual is a procedure for reproducing a class of memories. A P Individual, as a procedure, is run or executed in some M Individual, but there is not necessarily a 1-to-1 correspondence between P Individuals and M Individuals. Thus a conversation is a P Individual distributively run in 2 (or more) M Individuals.

HUMANITIES: ANALYSIS

Cognitive Networks and Literary Semantics

William Benzon

Department of English, State University of New York, Buffalo, 14226

Modern Language Notes 91: 952-981, 1976

Drawing on the servomechanism theory of William T. Powers (*Behavior: The Control of Perception*) and the cognitive network theory of David Hays (*Cognitive Structures*, New Haven: HRAF Press, forthcoming) a fragment of the Elizabethan worldview is modeled as a network and paths are described in the network which serves as the semantic base for Shakespeare's sonnet *Th'Expense of Spirit*. The opening line and a half of the poem is an extended pun--"Th' expense of spirit in a waste of shame/ Is lust in action." The lexical nodes for *spirit*, *expense*, *shame*, and *lust* are each linked to two different nodes in the semantic network. One set of nodes is defined in relation to the sensorimotor system (which is external to the network) and the other is recursively defined over episodes in the network. This pun extends through the rest of the poem. Further analysis shows that the single string of lexemes which is at the base of the poem's language is in fact being simultaneously mapped into four isomorphic episodic fragments. The highest level pattern into which the lexemes are mapped is the *Fortunate Fall*--one of the central themes of medieval and Renaissance Christian thought.

Processes in Acquiring Knowledge**Allan Collins***Bolt Beranek and Newman, Inc. Cambridge, Mass.**Semi-annual technical report no. 1, 15 September 1975-30 March 76: BBN-3231 NTIS AD-A020 270/5GA
PC \$4.50/MF \$2.25*

The objective of this paper is to develop a theory of Socratic tutoring in the form of pattern-action (or production) rules for a computer program. These pattern action rules are being programmed on a computer system for tutoring causal knowledge and reasoning. The production rules were derived from analysis of a variety of tutorial dialogues. The analysis accounts for the specific teaching strategies used by the tutors in the dialogues within a content-independent formalism. The paper includes twenty-three production rules derived from the data analyzed.