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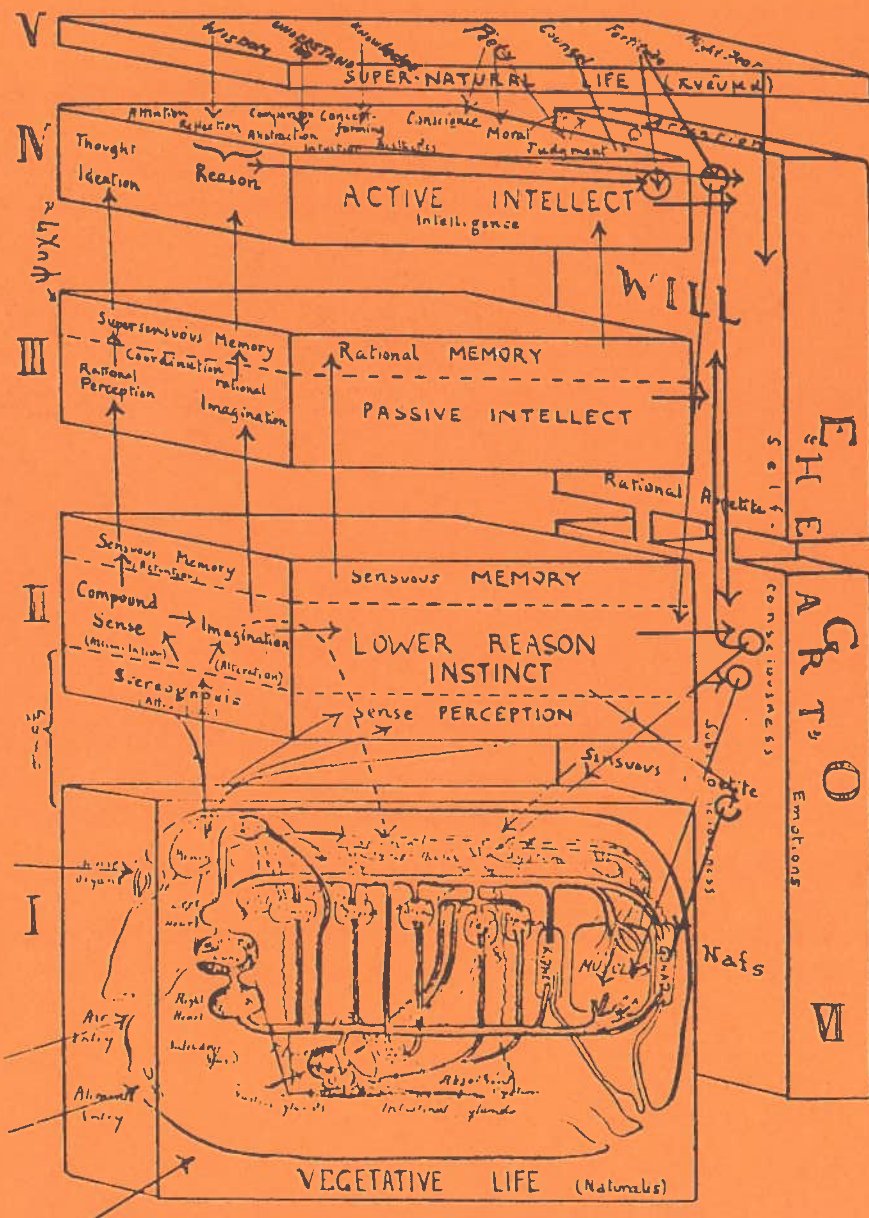
an occasional publication of the Canadian Society for Computational Studies of Intelligence // Société Canadienne des Etudes d'Intelligence par Ordinateur



The cover shows an early intellectual model (including support systems) which is, unmistakably, a partitioned semantic is-a hierarchy procedural frame schema network. It is taken from the Canon of Medicine of Avicenna, and represents a confluence of Arabic, Indian, Chinese and European thought. Avicenna's dates are 980-1037.

CONTENTS

Letter regarding CSCSI/SCEIO future	2
Review of CSCSI/SCEIO 2nd National Conference	4
Review of TINLAP-2	7
GO-MOKU Championship	9
Research Abstracts	12
Course Outlines	32
Science Fiction Review	35

Editor's comments:

This slim volume documents a fraction of the state of the art in Canadian AI research, as of mid-December 1978, when the last contributions were received. It should be pointed out, though, that many researchers have not submitted any report on their work; this probably means they are making feverish progress.

The results of the balloting regarding the legal future of CSCSI/SCEIO (see following pages) were:

Proposal 1	6 votes
Proposal 2	1 vote
Proposal 3	30 votes
Proposal 4	1 vote

Doug Skuce

Dept. of Computer Science
University of Ottawa

UNIVERSITY OF TORONTO Toronto, Canada M5S 1A7

DEPARTMENT OF COMPUTER SCIENCE

November 14, 1978

Dear CSCSI/SCEIO Member:

During the last general meeting of CSCSI/SCEIO (hereafter C/S), its Executive Committee was instructed to search for alternative proposals regarding the formal status of our Society and to make these available to the membership so that a ballot can be held before the end of '78.

The proposals considered by the Executive are as follows:

1. <u>Establish an affiliation with CIPS</u>

   This proposal means that C/S need not obtain its own Letter Patent but simply becomes a Special Interest Group of CIPS, the Canadian Information Processing Society along the lines of the affiliations of SIGS to ACM in the States. According to a written proposal I now have from Wayne Davis, CIPS President(and C/S Treasurer), such an affiliation means that CIPS provides for administrative services (mailing address list, dues collection, bookkeeping, etc.) and C/S can elect a representative to the CIPS National Board. In return, CIPS expects C/S to submit approved by-laws as well as annual financial and activity reports.

2. <u>Obtain a Letter Patent</u>

   This would make C/S a non-profit scientific organization with its own constitution, income and expenses. As far as its administration is concerned this can be handled by one of the Universities with a member on the Executive. According to my information, it is easy to obtain a Letter Patent and to arrange with a University (that is willing to cooperate) for C/S administration in return for a nominal fee.

3. <u>Obtain a Letter Patent and establish an affiliation with CIPS.</u>

This alternative makes C/S an independent Society with ultimate control over its constitution, by-laws, activities and finances. At the same time, it calls for a working relationship with CIPS along the lines of Wayne's proposal, for as long as both organizations find such a relationship beneficial.

During the last general meeting the formal status of C/S was discussed in terms of alternatives (1) and (2) and it was suggested that (1) has two advantages:

(a) C/S can make itself and its activities better known to a large audience of Canadian computer scientists.

(b) C/S Administration will have a permanent home rather than travel from University to University, in return for a nominal fee (e.g. $5.00 per member).

The main advantage of alternative (2) was thought to be C/S maintenance of its independence which eliminates conflict of interest situations between itself and any parent organization such as those experienced by the SIGs and ACM a few years ago.

It seems to me that alternative (3) has the advantages of both (1) and (2) without any of their disadvantages and I therefore recommend it.

You are expected to vote in favor of one of the three alternatives or offer a fourth one which you must describe separately.* If you have not paid your '78-'79 membership dues ($3.00), please include payment along with your ballot.

To help us ensure that each member votes at most once, please make sure that your ballot or its envelope state clearly your name and address. Ballots must be mailed on or before December 15, 1978.

If you have any questions regarding these proposals please contact me ((416) 978-5180) or one of the members of the Executive, Alan Mackworth ((604) 228-4893), Steve Zucker((514) 392-5412) or Wayne Davis ((403) 432-3976).

Sincerely,

John Mylopoulos

John Mylopoulos,
President, CSCSI/SCEIO

JM:y

*If you wish to advertise your proposal to C/S members, I can send you a copy of the membership list on request.

CANADIAN SOCIETY FOR COMPUTATIONAL STUDIES OF INTELLIGENCE

SOCIETE CANADIENNE DES ETUDES D'INTELLIGENCE PAR ORDINATEUR

2nd CSCSI/SCEIO National Conference

Nick Cercone
Simon Fraser University
Burnaby, British Columbia V5A 1S6

The Canadian Society for Computational Studies of Intelligence/ Societe Canadienne des Etudes d'Intelligence par Ordinateur held its second national conference in Toronto at the University of Toronto on July 19-21, 1978.

The conference attracted 125 registrants from across North America; 37 refereed papers and several informal talks covering a wide range of AI topics were presented.

Alan Mackworth presented the keynote address entitled "Understanding Image Understanding". This thoroughly enjoyable overview ended with Alan's cautioning against recommending 'the right way to proceed in image understanding now that we know the pitfalls of earlier approaches' syndrome.

The contents of the 314 page proceedings are listed below. Copies are available for $12.00 (including postage; U.S. funds accepted at par) by prepaid order to:

CSCSI/SCEIO Proceedings
c/o Professor C. Raymond Perrault
Department of Computer Science
University of Toronto
Toronto, Ontario CANADA M5S 1A7

At the annual business meeting, elections were held and the new officers for the two year term commencing in 1978 were as follows:

President
Professor John Mylopoulos
Department of Computer Science
University of Toronto
Toronto, Ontario

Vice President
Professor Alan Mackworth
Department of Computer Science
University of British Columbia
Vancouver, British Columbia

Treasurer
Professor Wayne Davis
Department of Computing Science
University of Alberta
Edmonton, Alberta

Secretary
Professor Steve Zucker
Dept of Electrical Engineering
McGill University
Montreal, Quebec

Officers of Second National Conference of the CSCSI/SCEIO

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Professor C. Raymond Perrault
Department of Computer Science
University of Toronto
Toronto, Ontario

Editor of Proceedings
Professor G.I. McCalla
Department of Computer Science
University of Toronto
Toronto, Ontario

Programme Chairman
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Department of Computer Science
University of Western Ontario
London, Ontario

Programme Committee
Ted Elcock (Western)
John Seely Brown (Xerox PARC)
Jerry Hobbs (SRI)
Gord McCalla (Toronto)
Ray Reiter (UBC)
Steve Zucker (McGill)

CONTENTS

Problem Solving I (Wed. 9:00)

Sleuth: An Intelligent Noticer
--S. Rosenberg

A Test-bed for Developing Support Systems for Information Analysis
--J. Stansfield

Locating the Source of Unification Failure
--P.T. Cox

An Analysis of Theorem Proving by Covering Expressions
--L.J. Henschen, W.M. Evangelist

Natural Language I (Wed., 10:40)

A Simultaneously Procedural and Declrative Data Structure and Its Use in Natural Language Generation
--D.D. McDonald

Knowledge Identification and Metaphor
--R. Browse

Representing and Organising Factual Knowledge in Proposition Networks
--R. Goebel, N. Cercone

Capturing Linguistic Generalizations in a Parser for English
--M. Marcus

Representation I (Wed., 4:40)

Semantic Networks and the Design of Interactive Information Systems
--J. Mylopoulos, H.K.T. Wong, P. Bernstein

Organization of Knowledge for a Procedural Semantic Network Formalism
--P.F. Schneider

On Structuring a First Order Data Base
--R. Reiter

The Genetic Graph: A Representation for the Evolution of Procedural Knowledge
--I.P. Goldstein

Vision I (Thurs., 9:00)

Low-Level Vision, Consistency, and Continuous Relaxation
--S.W. Zucker

Photometric Stereo: A Reflectance Map Technique for Determining Object Relief from Image Intensity
--R.J. Woodham

Image Segmentation and Interpretation Using a Knowledge Data Base
--S.I. Shaheen, M.D. Levine

The Extraction of Pictorial Features
--A.H. Dixon

Representation II (Thurs., 10:40)

Aspects of a Theory of Simplification, Debugging, and Coaching
--G. Fischer, J. Brown, R. Burton

Knowledge Structuring: An Overview
--M.S. Fox

Re-Representing Textbook Physics Problems
--J. McDermott, J.H. Larkin

Representing Mathematical Knowledge
--E.R. Michener

Learning (Thurs., 3:00)

BACON.1: A General Discovery System
--P. Langley

Learning Strategies by Computer
--Y. Anzai

A Computer Program that Learns Algebraic Procedures by Examining Examples and by Working Test Problems in a Textbook
--D.M. Neves

Natural Language II (Fri., 9:00)

Co-operative Responses: An Application of Discourse Inference to Data Base Query Systems
--S.J. Kaplan, A.K. Joshi

A Progress Report on the Discourse and Reference Components of PAL
--C. Sidner

Participating in Dialogues: Understanding via Plan Deduction
--J.F. Allen, C.R. Perrault

Analyzing Conversation
--G.I. McCalla

Vision II (Fri., 10:40)

Hypothesis Guided Induction: Jumping to Conclusions
--E.C. Freuder

Explorations in Visual-Motor Spaces
--Z. Pylyshyn, E.W. Elcock, M. Marmor, P. Sander

Using Multi-Level Semantics to Understand Sketches of Houses and Other Polyhedral Objects
--J.A. Mulder, A.K. Mackworth

A Procedural Model of Recognition for Machine Perception
--W.S. Havens

Problem Solving II (Fri., 3:00)

Approaches to Object Selection for General Problem Solvers
--P. London

Experimental Case Studies of Backtrack vs. Waltz-Type vs. New Algorithms for Satisficing Assignment Problems
--J. Gaschnig

Distributed Problem Solving: The Contract Net Approach
--R.G. Smith, R. Davis

Programming (Fr., 4:20)

Describing Programming Language Concepts in LESK
--D.R. Skuce

TONAL: Towards a New AI Language
--D.J.M. Davies

Examples of Computations as a Means of Program Description
--M.A. Bauer

Review of TINLAP-2

held at the

University of Illinois at Urbana-Champaign

July 25-27, 1978

Gordon McCalla

Department of Computational Science

University of Saskatchewan

Saskatoon, Saskatchewan

Last July, amidst corn fields and shimmering heat, approximately 350 truth seekers met at the University of Illinois at Urbana-Champaign to debate the state of natural language processing in this year of our lord 1978. The time had come for the second workshop on Theoretical Issues in Natural Language Processing (TINLAP-2). Jointly sponsored by the Association for Computational linguistics and SIGART, the main brunt of the conference organization fell onto the shoulders of Dave Waltz.

Waltz divided the conference into six sessions, each with its own theme:

1. language representation and psychology;
2. language representation and reference;
3. discourse: speech acts and dialogue;
4. language and perception;
5. inference mechanisms in natural language;

and 6. computational models as a vehicle for theoretical linguistics.

Each session consisted of two parts: (i) a panel discussion where a panel of "experts" individually presented views on the session's theme; and (ii) discussion by the panelists of comments or questions raised by the general audience. Rather than go into a detailed description of each presentation, I will instead outline several main trends/issues which I perceived as dominating the workshop. Those requiring a more specific viewpoint can read the Proceedings[1], although often the speakers strayed substantially from their printed papers.

Perhaps the main observation that can be made about TINLAP-2 is the large amount of research into the progmatics of natural language which was presented. Among progmatics oriented topics were the representation of knowledge, inferencing, various aspects of the reference problem, context, focussing, imaging, and perception. Discourse and conversation were predominant research vehicles for these pragmatics topics.

Another observation concerned the interdisciplinary nature of the workshop. Viewpoints centered in psychology, linguistics, philosophy, as well as computer science were all represented in just about every session. In fact, four of the six sessions (1, 3, 4, and 6) were explicitly interdisciplinary in their theme.

A third main feature of the conference was the controversy over whether programs constitute theories. There was considerable debate on the issue, the strongest views having been promulgated by the Schank group at Yale who argued in the affirmative. Other than on this issue, Schank and his colleagues kept a fairly low profile (with only two papers), one of the bigger surprises of the conference.

Dave Wa`tz and the other organizers deserve full credit for an outstanding confe ence. I have a few beefs, of course, such as the "closed shop" nature of the conference (most of the papers were by invitation only), the dearth of advance publicity (and much of it available only through the ARPA-NET until much too late), and the "elitism" shown by separating the panelists from the unwashed masses by lodging them in the relative luxury of the Students Union. But, all in all, these beefs are minor compared to the good points. The technical merit was fine, the panel format very suitable for the interchange of ideas, and the weather was superb (with a tornado warning thrown in just to add a little spice).

Since this is the CSCSI/SCEIO Newsletter, a final note on Canadian influence at the workshop. Canadian contest was substantial, although I'm not sure it met CRTC standards. Ray Perrault, Jim Allen and Phil Cohen from U. of Toronto along with David Olson from the Ontario Institute for Studies in Education had papers in the speech acts and dialogue session; Zenon Pylyshyn from Western Ontario spoke in the languge and perception session; and Ray Reiter from UBC sat on the inference mechanisms in natural language panel. Many other Canadian attended the workshop and provided the single biggest piano playing contingent at the student dormitories where many of us stayed.

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1 Proceedings (in microfiche) will be published shortly in the American Journal of Computational Linguistics and are also available (in hardcopy) from ACM (P.O. Box 12105, Church Street Station, New York 10249) at a prepaid cost of $10.50 (U.S.) for ACM or ACL members and $14.00 (U.S.) for non-members.

NORTH AMERICAN, EUROPEAN AND WORLD GO-MOKU CHAMPIONSHIP

Lawrence J. Mazlack
Department of Quantitative Analysis
University of Cincinnati
Cincinnati, Ohio 45221

On November 26 and 27, 1977 Go-Moku tournaments were concurrently held in Europe and in North America. On the following weekend, a play off was held between the winners of the two tournaments.

Go-Moku is an ancient oriental game played on a 19 x 19 matrix. It is similar to Tic-Tac-Toe in that to win, it is necessary to place five "stones" in a row (horizontally, vertically or diagonally). The game is quite rich and there is no known winning algorithms.

The University of Guelph acted as a telephone clearing house for the North American Tournament. The University of Copenhagen did the same for the European Tournament.

The eventual winner of the North American tournament was ARTHUR (Mike Compton, Montreal) on a 370/168. A surprising entry was DAVID (Crouch, Iowa) on an IMSA 8080. DAVID finished 6th out of 13 and beat several good programs, including the second place program PLUNC (from North Carolina).

The European tournament resulted in ZAHLE1 (Zahle, Copenhagen) emerging victorious. ZAHLE1 finished the European tournament tied with DARWIN (Janos, Budapest). Both authors agreed to modify their programs and try again. On the replay, ZAHLE1 won.

When ARTHUR and ZAHLE1 played, they each won once (in the same number of moves!). Both authors again agreed to modify their programs and try again. Once again, on the replay, ZAHLE1 triumphed by winning both games.

The North American results were as follows:

Standing	Program	Author	City	Equipment	Languages	Points 2-win 1-tie 0-loss
1	ARTHUR	Compton	Montreal	IBM 370/168	PL/1	40
2	PLUNC	Johnston Coston	Chapel Hill	PDP 11/45	Assembler	38
3	WINR	Dennis Ouye	Sacramento	Microdate 1600	Assembler	37
4	SHEIN	Wang	Guelph	IBM 370/155	FORTRAN IV	35
5	WOOKIE	Walden	Chicago	Xerox (Sigma 7)	Assembler	25
6	DAVID	Crouch	Iowa City	IMSA 8080	PL/M	23
7	GORGO	Gibson	Toronto	PDP 11/34	C	21
8	SHIFTLESS	Day	Cupertino	PDP 11/70	FORTRAN IV	20
9	D	Ung	Guelph	PDP 11/34	C	20
10	GMK10	Yang	New York	PDP 11/50	BASIC Plus	16
11	FIVE	Baird	Princeton	PDP 8	BASIC	10
12	DOT	Coon	Wheeling	PDP 11/34	BASIC	6
13	GEORGE	Murray	Toronto	IBM 370/168	PL/1	0

The European competitors were as follows:

Standing	Program	Author	City	Equipment	Language
1	ZAHLE1	Zahle	Copehagen	RC4000	ALGOL 6
2	DARWIN	Janos	Budapest	TPA-70	Assemble
3	CAESAR	Pederson	Copenhagen	RC4000	ALGOL 6
4	LUFF	Bjornsson	Lund, Sweden	UNIVAC 1100	Simula, FORTRAN, Assemble

Abstract

A Procedural Model of Recognition for Machine Perception

Technical Report 78-3

William S. Havens

Computer Science Department
University of British Columbia
Vancouver, Canada V6T 1W5

This report is concerned with aspects of a theory of machine perception. It is shown that a comprehensive theory is emerging from current research in computer vision, natural language understanding, cognitive psychology, and Artificial Intelligence programming language technology. In this report, a number of aspects of such a theory are presented. Perception is characterized as a recognition process which composes new descriptions of sensory experience in terms of stored stereotypical knowledge of the world. Perception requires both a schema-based formalism for the representation of knowledge and a model of the processes necessary for performing search and deduction on that representation. As an approach towards the development of a theory of machine perception, a computational model of recognition is presented. The simularity of the model to formal mechanisms in parsing theory is discussed. The recognition model integrates top-down, hypothesis-driven search with bottom-up, data-driven search in hierarchical schemata representations. Domain-specific procedural methods are associated with particular schemata as models to guide their recognition. Multiple methods may be applied concurrently in both top-down and bottom-up search modes. The implementation of the recognition model as an Artificial Intelligence programming language called MAYA is described. MAYA is a multiprocessing dialect of LISP that provides data structures for representing schemata networks and control structures for integrating top-down and bottom-up processing. A characteristic example from scene analysis, written in MAYA, is presented to illustrate the operation of the model and the utility of the programming language. A programming reference manual for MAYA is included. Finally, applications for both the recognition model and MAYA are discussed and some promising directions for future research proposed.

Graeme Hirst. **ANAPHORA IN NATURAL LANGUAGE UNDERSTANDING: THE DEFINITIVE SURVEY.** To appear as a technical report, Department of Computer Science, University of British Columbia, Vancouver BC, Canada V6T 1W5. [Expected publication: December 1978.]

This large document is a complete survey and review of the problems that reference and anaphora pose for natural language understanding by computer (NLU), and how they have been approached from Bobrow's 1964 program STUDENT, through to the contemporary focus-oriented theories of Grosz, Sidner and Webber. Each approach is discussed in detail and evaluated. A summary of the contents follows:

1. Introduction.
2. Anaphora and the problems they cause. Anyone who believes their NLU system is good with anaphora should read this chapter and think again. This chapter includes a large number of difficult anaphor problems which should provide a useful benchmark for NLU systems. It also presents an integrated theory of what an anaphor actually is, and a list of the different types of anaphor, many of which have been ignored by NLU workers.
3. Traditional approaches to anaphora from Bobrow (1964) through to Schank (1977). This chapter examines the traditional approaches and shows why they were inadequate.
4. Modern approaches. This chapter develops the focus- and discourse-oriented approach to anaphora, based on the recent work of Kantor, Grosz, Webber and others, and explains why it seems to be the path to the future. The chapter also provides an affirmative action program by integrating the long-ignored minority anaphora (locative, temporal and proactional anaphors, among others) into focus theory.
5. Factors in anaphor resolution. A review of the different matters that enter into anaphor resolution.
6. Conclusion. Prospects for the future, including anaphor generation. A list of unsolved anaphor problems which would make interesting research projects is also given.

This survey is carefully written so as to be easily read and comprehensible to both AI workers who know no linguistics, and linguists who have not studied AI.

COMPUTER VISION AND
GRAPHICS LABORATORY
Department of Electrical Engineering
McGill University
Montreal, Canada

Howard C. Lee, Martin D. Levine
Alfred S. Malowany, Steven W. Zucker

ACKNOWLEDGEMENTS

The contributions of the National Research Council of Canada, the Medical Research Council of Canada, the Department of Education of the Province of Quebec, and McGill University to the support of this research are gratefully acknowledged.

RESEARCH PROJECTS

Monocular Depth Perception

Computer vision systems are concerned with the interpretation of two dimensional pictures obtained through the projective transformation of three dimensional scenes. These projections result in the mapping of object surfaces into pictorial regions, and in order to recognize and interpret these regions, the vision system must compute the appropriate depth relationships. We have developed a program called CYCLOPS that uses certain heuristic evidence of occlusion to compute the depth relationships IN-FRONT-OF, BEHIND, and EQUIDISTANT. While these heuristics may be wrong some of the time, the requisite consistency between them, deriving from the underlying physical reality, will usually be sufficient for discarding the incorrect inferences. CYCLOPS uses a relaxation labelling process to produce a depth map which is then employed to verify the consistency of a depth graph representing the heuristic occlusion cues. Traversal of this graph yields the desired relative depth relationships for the regions in the picture.

Image Segmentation and Interpretation Using a Knowledge Data Base

This research is concerned with a model representation and control structure for a high level component of a computer vision system. The high level stage is characterized by the necessity to solve subproblems containing large search spaces, diverse and large sources of knowledge, and requiring non-deterministic (possibly in error) decisions made at various levels in the analysis. The high level stage adopts the concept of competition and cooperation as a basic paradigm for the system vision strategy. The system uses a relational database together with a relational algebraic sublanguage as an accessing mechanism to both the long and short term memories. Current knowledge about the particular picture under study is stored in the Short Term Memory which is designed as a communication channel between the different sources of knowledge of the system. The Long Term Memory contains all the relevant information (syntactic, semantic and pragmatic) about the class of scenes under analysis. Experiments with coloured outdoor pictures are presently being carried out.

Cooperative and Competitive Computation in Vision Systems

This research in low level vision has primarily been centered around the study of networks of cooperating and competing computational processes. These processes, called relaxation labelling processes, are particularly useful in reducing local ambiguities which arise during the processing of visual information. For example, when an original intensity array (i.e., picture) is interpreted into a low-level, symbolic vocabulary, local feature detectors do not respond only to the selected pattern feature; they also respond to various noise configurations. The relaxation labelling processes reduce these kinds of local ambiguities by making use of constraint or compatibility relationships between pairs of neighbouring response interpretations (or labels). They work in a parallel and interactive manner, thus allowing local certainties to exert a global influence.

Formally, relaxation labelling is a class of computational processes which manipulate labels on graphs. The underlying graph structure denotes both the picture parts or abstract objects to be labelled and the neighbour relations over these objects. If the relaxation process operates discretely, then it discards labels which are inconsistent with the label sets attached to neighbouring nodes. If it operates continuously, then it updates a measure of certainty attached to each label. The initial certainties are obtained, e.g., on the basis of the feature detector responses.

Our research into cooperative computation is proceeding both theoretically and empirically.

Relaxation Labelling and Dynamic Programing

An Alternate approach to studying the relaxation computation is to determine equivalences (or conditions for equivalence) between it and other well-known algorithms. Since the numerical relaxation computation can be viewed as one that is attempting to satisfy a system of nonlinear constraints, this relationship to mathematical programming techniques becomes important. An important side-effect of establishing any such relationships would then be the explicit statement of minimization criteria, thus revealing optimality conditions implicit in the relaxation computation.

As a first step toward obtaining these equivalences, the one-dimensional analog between relaxation and dynamic programming is being considered. Relaxation systems have been written that simulate dynamic programming, and more theoretical studies are now underway.

After local assertions have been attached to positions in an image, they must be grouped into more global and abstract ones. Since this grouping process is as inherently ambiguous and uncertain as the original labelling process, relaxation techniques can once again be used. However, now they are organized into multiple-level systems in which consistency (compatibility) requirements must hold both at each level and between levels. Thus the local neighbourhood for the relaxation updating rule has grown from a circle, for single-level systems, to a sphere for multiple-level ones.

The labelling and grouping of unit line segments in noisy, gray-level images was chosen as a problem domain in which these complex relation systems could be studied. The first level of this system labels the image with oriented unit line assertions. This is a complete relaxation process in which the compatibility relations are derived from a model for the good continuation of line orientation. A second relaxation process, operating concurrently with this one, attempts to disambiguate labels indicating whether pairs of neighbouring line segments should be connected. This grouping process uses intensity-based compatibility functions. Thus the two processes use modularly-independent knowledge sources in a richly cooperative manner. Finally, two relaxation processes run between the levels so that information is transferred properly between them. One of these processes updates line labels on the basis of grouping labels, and the other updates grouping labels on the basis of line labels.

An Automatic Picture Processing Method for Tracking and Quantifying the Dynamics of Blood Cell Movement

Many of the lives which are lost yearly due to cancer could have been saved if early diagnosis and treatment had taken place. A study of the movement of defensive blood cells and the factors which affect their motion aims at defining those parameters which might be of importance to the understanding of cell interaction leading to the elimination of tumour cells. Based on this biomedical research, this work deals with an automatic picture processing method for tracking and quantifying the dynamics of cell movement.

The input data to the system is a 16 mm movie film of the cell motion taken using time-lapse photography. Initialization takes place when the image is digitized, the cells are detected, and then interactively selected for further analysis. In the succeeding processing steps, the selected cells are tracked from frame to frame by locating each cell in terms of its centroid coordinates. The analysis of this data then yields the desired direction of movement. The direction of the cells, the average time in each direction, and the transition probabilities from one direction to another are all quantities which are estimated by the measurements made on the observed cell trajectories. These data are then used to compute the steady-state probabilities which yield the probability that the cells will ultimately move in a specific direction.

DEDICATED COMPUTATIONAL FACILITY FOR COMPUTER VISION AND GRAPHICS RESEARCH

The computational facility dedicated to computer vision and graphics research consists of several interconnected processors and an assortment of peripheral devices. The main processor, a DEC PDP 15/40, will be replaced in August 1978, with a VAX 11/780 system. This is the powerful new DEC virtual memory machine that allows users up to 2 million bytes of address space. In speed, the VAX has produced performance benchmarks approximately equivalent to those for an IBM 370/158.

Our second processor, a PDP 11/20, primarily acts as an I/O channel and peripheral device controller. When it is transferred to the VAX via a UNIBUS interface, it will continue to control the peripheral devices and share in their associated local computations. The peripheral devices for image acquisition include an Optronics drum scanner and a Cohu Camera with a column digitizer. The display devices include a 24 plane Grinnell color display and frame grabber, as well as an assortment of Tektronix and other graphic displays. Standard interactive devices such as light pens and joysticks, are also provided.

The software interface to this facility, the McGill Image Processing System (or MIPS), is an interactive set of program modules, each of which is totally independent. The modules are linked through a monitor that permits both user interactive invocation, through a displayed menu of options, and program-directed invocation. MIPS is now running under a real-time multi-tasking operating system written at McGill for the PDP-15, and is currently being revised and extended to run under the VAX/VMS operating system for the VAX 11/780. The revisions will include a substantial transformation of the monitor into a background communications handler so that the individual modules can communicate through a more general message-passing protocol. This will advance the module concept to the point where it can begin to become processor or language independent.

STAFF

Research Staff

V.K. Agarwal
H.C. Lee
M.D. Levine
A.S. Malowany
S.W. Zucker

Technical Staff

J. Daly (Computer Technician)
K. Fraser (Laboratory Administrator)
D. Kashtan (Software Engineer)
J. Leemet (Systems Engineer)
R. Quik (Computer Technician)
R. Rosa (Computer Technician)
Y. Youssef (Archivist)
P. Sander (System Manager)

Graduate Students

R. Bridgeman, M. Eng.
G. Brighten, M. Eng.
F. Ferrie, M. Eng.
S. Haboucha, M. Eng.
H. Hubschman, M. Eng.
D. Kashtan, M. Eng.
M. Kobernick, M. Eng.
B. Kuo, M. Eng.
Y. Leclerc, M. Eng.
V. Moshtagh, M. Eng.
J. Mohammed, M. Eng.
A. Nazif, Ph.D.
G. Perluzzo, M. Eng.
S. Ramji, M. Eng.
D. Rosenberg, M. Eng.
L. Sha, M. Eng.
S. Shaheen, Ph.D.
A. Tabrizi, M. Eng.
D. Ting, M. Eng.
R. To, M. Eng.
Y. Youssef, Ph.D.

A Procedural Approach to Semantic Networks

Hector Levesque, John Mylopoulos, Peter Schneider

This project is concerned with the development of a formalism for the creation, maintenance and search of knowledge bases. The proposed formalism starts with semantic networks and augments them so that the semantics of each one of their components is defined in terms of a small set of procedures.

The semantic network knowledge bases have three dimensions with respect to which their components are organized:

(i) A PART-OF dimension based on the whole/part relationship that may hold between two entities;

(ii) An INSTANCE-OF dimension based on the type/token relationship;

(iii) An IS-A dimension based on the generalization relationship.

The project has studied the interactions between these dimensions. Moreover, it has dealt with the problem of representing the programs associated with the components of a semantic network in terms of semantic networks; also with the problem of organizing such programs in terms of the three dimensions mentioned earlier. Completed work on these issues is described in (Levesque 77), (Schneider 78a), Levesque and Mylopoulos 78), (Schneider 78b).

Some of the problems currently under consideration are:

(i) The representation of partial knowledge on such knowledge bases;

(ii) The use of exceptions (e.g. "every bird flies; penguins are birds but don't fly") in the knowledge base;

(iii) The organization of expressions into an IS-A hierarchy and the relationship of such a hierarchy to IS-A hierarchies for other objects.

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page 2

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TAXIS: A Language for the Design of Interactive Information Systems

Jo n Mylopoulos, Harry K. T. Wong

This project is concerned with the design of Interactive Information Systems (IISs) such as credit card verification, airline or hotel reservations etc. The problem facing the designer of such a system is the amount of detail that has to be integrated into a program. Few solutions have been suggested for the problem either by Programming Languages or Database Management researchers, who generally view the task of designing such systems as inherently tedious.

The project is based on the premise that the task is not inherently tedious or boring, but rather the languages used for such designs (FORTRAN, PL/I, COBOL) make it so by not offering appropriate abstraction mechanisms through which one can capture the structure of an IIS. Accordingly, the project's main goal has been the design of a programming language which offers new abstraction mechanisms and other constructs helpful to the designer of an IIS. The language has been called TAXIS.

The framework of TAXIS is based on semantic networks, and in particular the procedural semantic network approach advocated in (Levesque 77), (Levesque and Mylopoulos 78). Namely, an IIS is treated as a semantic network consisting of classes and tokens which have properties through which they are related to other classes and tokens. All classes are organized into an ISA hierarchy which defines similarities between them.

This framework is applied to all contructs offered by TAXIS, which include relations and relational operations for modifying and searching a relation, procedures that operate on the database and exceptions that signal abnormal situations that may arise during the operation of the IIS. The ISA relationship is offered as the new abstraction mechanism that allows the organization of details, be they about the data structures or procedures of the IIS, through classification.

The project is concerned at this stage with the formalization of TAXIS which includes unusual constructs such as ISA hierarchies for procedures, expressions and exceptions. The formalization is carried out axiomatically as well as denotationally. An expected result of the project is the development of a new design methodology for IIS based on stepwise refinement through specialization rather than decomposition (Wirth 71). Also, the development of verification techniques for IISs which can be carried out stepwise in parallel with the design of an IIS.

Preliminary descriptions of TAXIS appear in (Mylopoulos, Bernstein and Wong 78a), (Mylopoulos, Bernstein and Wong 78b), (Mylopoulos, Bernstein and Wong 78c). More recent results on TAXIS will appear in the Ph.D thesis of Harry K. T. Wong.

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ALVEN : A Left Ventricular Wall Motion Analysis Computer Consultant

Participants : John Mylopoulos   Dept. of Computer Science
John Tsotsos
Steve Hume
Stuart Norman

Dominic Covvey   Cardiovascular Unit, Toronto
E.D. Wigle   General Hospital

In the recent past, there have been a great many attempts by medical researchers to build computer systems which can analyze cineangiograms of the left ventricle. Cineangiograms are X-ray films of the human left ventricle in action. The problems they encountered include recognition of the left ventricular border, determination of some method of establishing followable real points on a relatively featureless outline, rather than arbitrarily set ones, following these points from image to image in the sequence, classification of motion types which these points exhibit, and abstraction of the relevant data from masses of numerical results. The systems which have been built thus far are not very successful. In particular, they are very poor in solving the last four of the five problems mentioned above. The reason is a lack of interaction between the medical and computer science communities. There is a definite need for interaction between the two. In addition, medical reseachers have exhausted the old "engineering type" techniques without success - new ones are needed.

ALVEN is a system designed to attack the problems mentioned above using techniques from artificial intelligence [1,2,3]. A representation scheme for knowledge about objects and their motions has been developed based on past work on motion understanding in our department [4,5]. The concepts included are the "isa" and "partof" relationships, frames and similarity links [6], motion verbs and their associated semantic components such as velocity, direction, duration, etc., [5,7], and shape transformation predicates. Changes in left ventricular pressure or electrocardiogram are considered as events similar to the motion verbs and thus are represented using the same methodology. Frames are organized along the isa hierarchy, each frame containing knowlegde about a particular motion class or verb. Similarity links, relating values of instantiated concepts to the expected ones are used to provide a set of alternate frames for either failure of match or traversal down the isa hierarchy. The objects which are followed are the segments of the left ventricle, determined by regions of concavity and convexity on the outline.

Recognition of motion classes proceeds as outlined in [5] and is similar to the VISIONS [8] and HEARSAY-II [9] systems in that cooperation and competition of knowledge sources and a central communication facility are used. For each motion detected, frames are activated from the top of the frame hieracrhy, and isa and similarity links aid in traversal down this hierarchy in order to determine the most specific verb for this motion type.

Predictions of next location of the left ventricular border are made using the current location of the outline and the expected motions from the active frames for each segment of the ventricle. These predictions are then used to guide a low level system which uses relaxation labelling [10]. The set of points considered is determined by the prediction and much stronger constraints can be placed on the edge labels found than possible for general edge finding in arbitrary images. There is interaction between low and high level processes for verfication of the edge found and determination of alternate actions in cases of failure .

A system for verification and correction of system output is also being implemented. This system will take in a portion of the knowledge base which either describes a film which the system analyzed or the generic knowledge about specific motion types. It can generate the film or class of films for the cardiologist, who can alter the shapes produced using interactive graphics tools. His changes are then re-incorporated into the knowledge base. A natural language explanation system is also being planned.

Most of the low level of the system has been implemented, as well as a compilier for the knowledge base formalism and portions of the verification and correction system. Early testing has yielded encouraging results. In addition, another member of the group, Taro Shibahara, is now beginning application of a very similar methodology for an arrythmia consultation system.

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Investigations into Planning and Executing in an Independent and Continuously Changing Microwned

G. McCalla, P. Scheider, R. Cohen, and H. Levesque

Department of Computer Science

University of Toronto

Toronto, Ontario M5S 1A7

Abstract

This report describes the initial phases of our research into planning and executing in an independent and continuously changing micro-world. We have designed a simulated taxi driver, ELMER, who takes a "fare" from one place to another in a simulated city, where the city and ELMER are implemented as asynchronous processes. The city contains the usual range of permanent features (e.g. streets, road signs) as well as numerous transient hazards (e.g. traffic lights, pedestrians, other cars). ELMER is divided into four components: an Executor which carries out a plan of action, a Planner which produces this plan, a Map which provides geographic information to aid the planning process, and a Controller to allocate resources among the other components. Among the interesting features of ELMER are the ability to execute several things at once; an interesting approach to planning that involves splicing together previously successful routes; the development of the early parts of a plan first so that they can be executed without delay while further development proceeds on the rest of the plan; the construction of hierarchical plans which are useful both in execution and in error recovery; and a uniformity in structure of plans and routes which promises to facilitate the acquisition of new routes built out of "instantiated" older plans.

AN IMAGE INTERPRETATION SYSTEM

J.L. Paul
D.Phil. dissertation, University of Sussex

present address: Dept. of Pathology, University of Manitoba, 770 Bannantyne Ave., Winninpeg, R3E 0W3

order from: University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106 USA
publication no. 78-11,757
$16.50 for Xerox copy, $8.25 for 35mm or microfiche copy

This thesis describes a program which interprets, in 3-dimensional terms, pictures of a puppet in various poses. The program handles a variety of puppet constructions (as long as the body parts have parallel edges), and images produced from a variety of sources (e.g. produced from grey-level images, by hand, by a computer puppet-drawing program). The program expects the images to be noisy, so does not rely much on such traditional considerations as line junctions or line configurations, but on 'higher' concepts such as clusters of parallel lines. Several levels and kinds of intermediate structures are used, such as 'limb' regions, combinations of 'head'-'trunk' regions, 'arm' pairs, and 2.5-dimensional (i.e. overlapping laminae) puppet models. The final interpretation of the image is basically non-quantitative, and is in terms of the direction the trunk is turned (e.g. 'right', 'left'), and the degree of turn (e.g. 'slight', 'moderate', 'extreme'), the viewing angle ('down' or 'straight'), the angle of the limbs with respect to the trunk, etc. This interpretation (called a 3-D specification) is based on the 2.5-D puppet, and may be used to help specify the 3-D parameters of a 3-D puppet model which the computer can then draw.

The control of the system is non-hierarchic. The overall control structure is that of a tree search, the nodes of the tree being either processes or 2.5-D puppets. Expanding a node is equivalent to running a process -- running a process may result in the creation of new node processes. Local control is via demons -- in this case, the demons are planted onto functions, and are activated when the functions are called.

The thesis uses one ongoing example to illustrate the different stages of interpretation. One example is considered in detail in Chapter 12, and Appendix C goes through 10 examples in less detail.

The thesis contains two chapters not directly related to the program. Chapter 2 contains a discussion of a number of aspects of computer vision systems, and superficially compares many of these systems via a table. Chapter 3 discusses an optimization problem (how to find the 'best' instance in the image of a multi-part object), which commonly occurs in vision systems, in terms of several representations of the problem, and several computational solution techniques (mainly quantitative).

Progress Report on Plans and Natural Language Understanding

C. Raymond Perrault
Dept. of Computer Science
University of Toronto

Work continues at the University of Toronto on the use of plans in natural language understanding. Phil Cohen's thesis (Cohen 1978) describes OSCAR, a problem-solving system that generates plans to achieve goals, and these plans may include speech acts (i.e. operators whose execution produces linguistic utterances to inform, request, and ask questions). The system maintains a model of the beliefs and goals of its user, which in turn includes a model of the beliefs and goals of the system, etc.

We are currently working on two extensions of Cohen's work: to recognize speech acts, and to understand referring expressions. James Allen's forthcoming thesis focuses on recognizing the intentions of the speaker of an utterance. He shows how the hearer can use his model of the speaker and certain syntactic and semantic features of an utterance, such as mood and performative verbs, to determine what speech act(s) the speaker intended to perform. One of the crucial components of the system is a model of what inferences speakers and hearers expect each other to perform. In concert, plan deduction and expected inferences based on shared knowledge allow the hearer to recognize the intentions behind the so-called "indirect speech acts" such as "Do you know when the Montreal train leaves?", which, although literally a yes/no question, is usually intended as a request for the time.

The plan deduction process is also very useful in determining the intention underlying some utterances consisting only of a noun phrase (e.g. "The Montreal train?"). These can often be recognized without the hearer having to "reconstruct" a syntactically well formed sentence of which they might be a part. These utterances are frequently used in task-oriented dialogues with relatively constricted contexts. In particular, they appear in sub-dialogues whose purpose is to clarify the intentions of the participants and to dispel speech act ambiguities.

The second extension of Cohen's work, currently being pursued by Cohen, Corot Reason, and myself, aims to answer the question "Under what circumstances can a speaker S utter a definite description D to a hearer H, intending to refer to some entity E?"

Some facts to be considered are:

1. Some descriptions which are true of E, and even believed

by S to be true cannot be used to refer to E.
2. Some descriptions which are not true of E, and even not believed to be true, can be used to refer to E.
The object of this line of investigation is to provide a definition of the act of reference, and to integrate reference in the general planning framework.

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Research Progress Report

by
Peter F. Rowat
University of British Columbia.

We take the view that simulating an artificial organism and working out a satisfactory structure for the organism controlling program is a worthwhile approach to AI. To this end, we implemented a simulated tabletop world on which two dimensional shapes (objects) can be moved around by a simulated robot, subject to the laws of physics. The robot maintains a world model of his/her surroundings. She/he gathers information by means of an eye which has progressively coarser resolution towards the periphery, and uses this information to correct (accomodate) the world model.

The robot is given path-finding and object-moving tasks. The top-level robot-controlling program, PPA, executes a continual loop of perceiving, planning, acting. Major parts of this have been implemented.

The world model is stored in point/line format, but paths and plans are found by projecting the world model onto a digital array and carrying out the search on this array. The search space for paths is greatly reduced by first finding the connected "skeleton" of the "empty" space on the array and then carrying out the search on the skeleton. The skeleton of a shape is most simply described by imagining the shape as a grass prairie and setting a fire simultaneously at all points of the prairie's boundary. The quench points where advancing lines of fire extinguish each other form the skeleton. An algorithm has been developed and implemented for finding the skeleton of fairly clean shapes - i.e. the edges do not have many small perturbations. It remains to be seen whether this skeleton approach can handle messier shapes.

Describing the Semantics of a Database in LESK

D. Skuce
Dept. of Computer Science
University of Ottawa

One of many possible applications of LESK (Language for Exactly Stating Knowledge) is in describing precisely the semantics of a database in terms comprehensible to the users of the data, who are not computer experts. LESK does this by requiring the user to define and use consistently noun, adjective and verb phrases which best describe the concepts modelled by the database. Thus the basic motivation of LESK is that ultimately, all semantic problems hinge on the precise use of words.

A project is currently underway in collaboration with Statistics Canada to define the semantics of the data for the 1981 census using LESK. No such description is available now. These data are stored in a relational database system, RAPID, developed by Statcan. When such a description is available, it will enable the user to clarify his/her concept of the data, and permit much improved human-human communication when discussing them, particularly between user and RAPID personnel.

The next step is to consider an interface between LESK and RAPID. A user could directly create RAPID file structures by entering LESK definitions, and access them by entering LESK queries, which would be translated into RAPID. Proposals for such a system will be developed in cooperation with Statcan.

THE UNIVERSITY OF BRITISH COLUMBIA
Computer Science Department

CPSC 503

Computational Linguistics I

INSTRUCTOR: R.S. Rosenberg — Spring 1979

One of the major research efforts in Artificial Intelligence is the development of programs able to communicate in natural language. The applications of such research are obvious; namely, to provide a convenient access for non-experts to useful data bases such as governmental, educational and scientific. There is of course a direct scientific aim which is to explore the question of natural language understanding from the perspective of what has come to be called, the computational paradigm.

The first part of the course will deal with contemporary linguistic theories, emphasizing the contributions of Noam Chomsky. We will be concerned with such issues as:

- The nature of linguistic research
- Descriptive linguistics
- Formal models of grammar
- Transformational grammar (Chomsky)
- Case grammar (Fillmore)
- Systemic grammar (Halliday)
- Semantics

We will then turn to a brief history of developments in computational linguistics over the last 25 years, emphasizing the major achievements. This will include

Earlywork:
- BASEBALL
- SAD SAM

More recent:
- ATN's and Procedural Semantics - Woods
- SHRDLU - Winograd
- Conceptual Dependency - Schank

Recent:
- Scripts - Schank, Abelson
- Frames - Minsky, Winograd et al

Application Areas:
- LUNAR - Woods et al
- Data base interfaces - Waltz, Sacerdoti, etc.

Students will be required to carry out a project, the specifications of which will be outlined later. It will involve the development of a natural language front end to an existing data base.

THE UNIVERSITY OF BRITISH COLUMBIA
Computer Science Department

CPSC 422

Introduction to Artificial Intelligence

INSTRUCTORS: R.S. Rosenberg
A.K. Mackworth

1978/79

1st Term Outline:

The first term of the course is an introduction to some of the major themes of research in A.I. After briefly tracing the historical development of the field, we will turn to one of the dominant concerns in AI - the representation of knowledge. The first term's lectures will parallel the textbook fairly closely as can be seen by the following.

CHAPTER	TOPIC
1	Introduction
2	Representing Knowledge - Evans' ANALOGY - Winston's learning program
4	Searching Problem Spaces - trees, games, etc. - some basic results in heuristic search
5	Controlling Attention - Newell and Simon General Problem Solver - Production Systems
3	Exploiting Natural Constraints - Case grammars in natural language understanding
6	The Meaning of Meaning - The Blocks miniworld
7	Representing Knowledge in Frames
8	Knowledge Engineering

It will be necessary, in order to make the course relatively self-contained, to introduce a variety of topics such as introductory logic, cognitive psychology, and linguistics as a background to some of the issues dealt with in A.I.

OTHER INFORMATION

Problem Assignments - There will be at least four problem sets and possibly six for the year.

Projects - Two large programming projects, one in each term, involving two or three people, are required. The first term's project will be a game playing program.

> <u>NOTE</u>: The project for the first term is due on the last day of classes in December. 10% will be deducted for each day late.

Examinations - None. Final grade will be based on the problem sets (about 1/3) and the projects (about 2/3).

<u>TEXT</u>: Winston, Patrick H., <u>Artificial Intelligence</u>, Addison Wesley, Reading, Mass. 1977.

<u>OTHER REFERENCES</u>: See pages 13, 14 in Winston.

2nd Term Outline

The second term of the course concentrates mainly on the application of AI techniques to a particular area: the design and implementation of a natural language (English) understanding program that acts as a "friendly" interface between the user and the database system. The database varies each year. We usually use the system implemented in the current version of CPSC 312. The lectures are oriented mainly towards the project; however, we cover a wide range of almost state-of-the-art AI techniques in the course of designing the project.

1. Languages and Machines
   The Chomsky Hierarchy and the corresponding machines
   Phrase Structure Grammars
   Basic, Recursive and Augmented Transition Network Parsers
2. Grammars for ATN parsers
3. Advanced LISP - extending LISP's control structure
4. Morphographemics: Write a morpher that understands word prefixes and suffixes
5. A sample grammar of English: Write your own
6. AI prog. languages: PLANNER from a user's point of view.
7. Semantics of English: SHRDLU and Woods
8. Designing the semantics of the project you implement our design in PML, a special purpose pattern matching language.
9. AI prog. languages: pattern matching, ATNs, PLANNER, ... from an implementation point of view.
10. Image understanding - the cycle of perception
    - applications in remote sensing etc.
11. Uses and Abuses of AI. Social, political, moral, and technical implications of AI and its applications.

Science Fiction Review

"The Experiment", by Stanislaw Lem.
New Yorker, July 24 1975, pp.26-42.

The story starts out as a discussion of personetics: the study of personoids, which are simulated beings who inhabit simulated worlds within a computer. The simulated world may not only be 2 or 3 dimensional but also 5,6.... 10.... dimensional. This is all mildly interesting, at least for those who, like myself, work with a simulated robot world. In the second part the store grows more compelling, at least for mind/consciousness philosophizers and for theologians. Lem goes into a definition of consciousness, then describes communities of personoids who are able to converse with each other and who, after many generations of "cultural development" begin to discuss their origins and to construct explanations of why and how they exist. This leads to discussions about the existence of a God or Creator. Starting from Pascal's argument for belief in God, many other arguments pro and con the existence of God, and arguments for serving or not serving Him if He exists, are presented. Even faith and love get definitions. The conclusion of the leading personoid? - that it is reasonable to postulate the existence of a Creator, but that "we serve ourselves and no one else".

Note - the whole story is presented as a critic's review of a book on personetics written by the leading personeticist of the time. Lem appears to be aware of current trends in AI. He has explored the idea that we and our world are just playing out a simulation in some giant computer, just as Borges in his short story "The Circular Ruin" explored the idea that we are the actors in a dream; but then, if you take seriously the AI credo and believe that mind equals computer, the ideas are the same, since a simulation in a hardware computer is equivalent to a dream in a wetware brain. In summary, an enjoyable and thought-provoking story.

Peter Rowat.