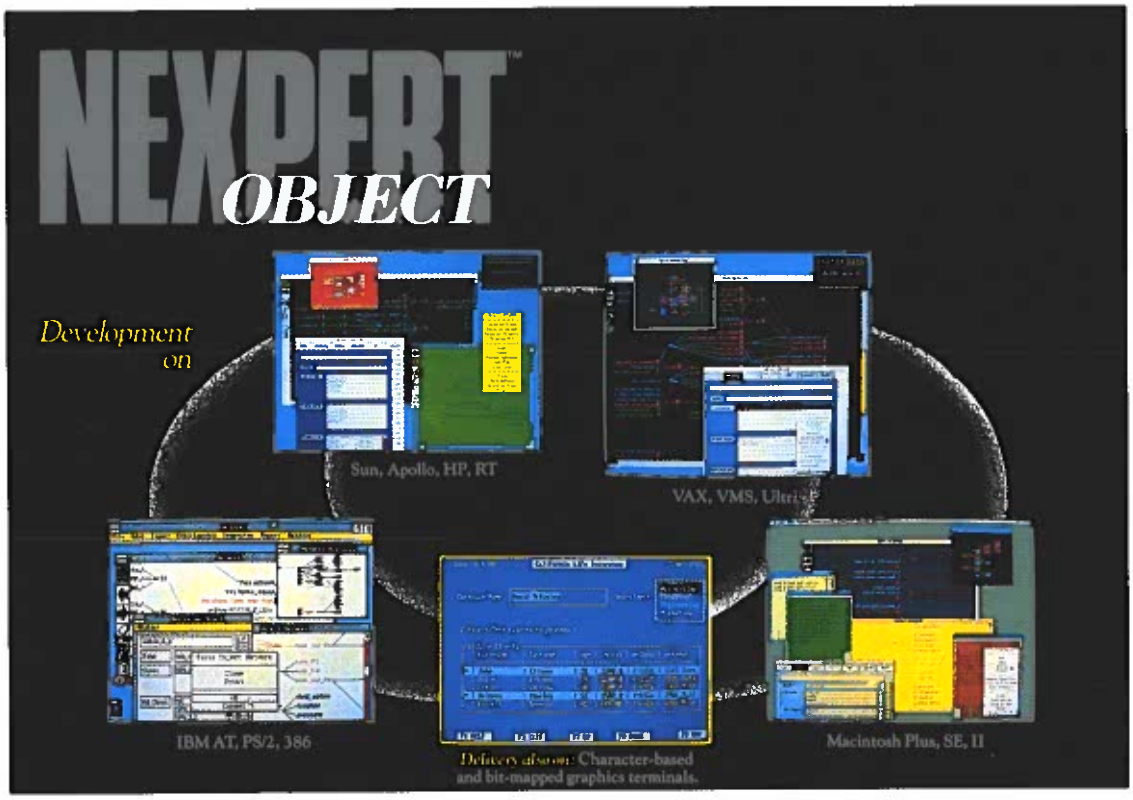
Canadian Artificial Intelligence
Intelligence au Canada

April/avril 1989 No. 19

An official publication of CSCSI, the Canadian Society for Computational Studies of Intelligence
Une publication officielle de la SCEIO, la Société canadienne pour l'étude de l'intelligence par ordinateur



REASONS FOR NEXPERT'S SUCCESS

Links to popular conventional languages

- C
- COBOL
- FORTRAN
- Pascal
- Ada
- Assembly

Effective linkage with other databases

– provides direct system in and out calls through the Library

- Oracle
- Informix
- dBase
- Guide
- Sybase
- RdB
- Lotus 1-2-3
- Hypercard (Q1/89)
- Ingres
- SQL/DS
- Excel

NEXTRA – first truly useful Knowledge Acquisition aid

- graphically induced acquisition process with automated repertory grids
- hierarchical clustering with spatial representations
- inductive engine for example-based analysis
- graphical feedback of elicited knowledge

Linkage to other graphics packages

Ability to graphically represent macrostructure of the knowledge base

- DataViews
- Ease+
- AiVision
- PCPaint/Brush
- MACPAINT

Cross-compatibility across a wide range of platforms

– Quick and efficient adaptation to new platforms due to advanced Software Engineering techniques.

- development on VAXSTATION II, III & 2000 (VAX/VMS, ULTRIX) with delivery on all VAX computers
- Sun, HP, Apollo, and MicroVax workstations
- Hewlett-Packard 9000 series 300 and 800
- 80386 Unix workstations running X-windows
- IBM PC AT, PS/2 and compatible 80386-based PCs running Microsoft Windows
- Macintosh family (Plus, SE, II, IIx)
- IBM mainframe under VM (the 30xx, 43xx, and 9370 machines)
- Several foreign platforms (European, Japanese)

Runtime Package

- serious consideration given to runtime/delivery issues
- dual user interface concept: *end-user interface* not identical to *developer interface*
- highly automated end-user interface design tool

Phone or write for more information

Applied AI Systems, Inc.
Gateway Business Park
300 March Road, Suite 602
Kanata (Ottawa), Ontario, Canada K2K 2E2
Tel. (613) 592-3030 • Fax. (613) 592-2333

Canadian Artificial Intelligence

Intelligence Artificielle au Canada

No. 19 April/avril 1989

Contents

Canadian Society for Computational Studies of Intelligence

Founded 1973

CSCSI is the Canadian society for the promotion of interest and activity in artificial intelligence. It conducts workshops and fully refereed national conferences, publishes this magazine, sponsors the journal *Computational Intelligence*, and coordinates activities with related societies, government, and industry. To join CSCSI, use the membership form in this issue. Non-Canadian members are welcomed. CSCSI is affiliated with the Canadian Information Processing Society and International Joint Conferences on Artificial Intelligence, Inc.

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Membership form is on the last page. Please send subscriptions, memberships, and changes of address to:
CSCSI, c/o CIPS, 243 College Street, 5th floor
Toronto, Ontario, CANADA M5T 2Y1

Société canadienne pour l'étude de l'intelligence par ordinateur

Fondée 1973

SCEIO est la Société canadienne encourageant l'intérêt et la recherche en Intelligence Artificielle. Elle organise des ateliers ainsi que des conférences nationales avec évaluation des articles soumis. Elle publie ce magazine, subventionne le journal *Intelligence Informatique*, et coordonne toute interaction avec des sociétés parallèles, le gouvernement, et l'industrie. Pour devenir membre de la SCEIO, veuillez utiliser le formulaire d'inscription de ce numéro. Les non-canadiens sont bienvenus. La SCEIO est affiliée à l'Association canadienne informatique, et aux International Joint Conferences on Artificial Intelligence, Inc.

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Canadian Artificial Intelligence

Intelligence Artificielle au Canada

Founded in 1974 as / Fondée en 1974 en tant que *CSCSI/SCEIO Newsletter*

Submissions:
Canadian Artificial Intelligence is published quarterly by CSCSI/SCEIO and is a benefit of membership in the society. *Canadian AI* solicits contributions in English or French on any matter related to artificial intelligence, including: articles of general interest; descriptions of current research and courses; reports of recent conferences and workshops; announcements of forthcoming activities; calls for papers; book reviews and books for review; announcements of new AI companies and products; opinions, counterpoints, polemic, controversy; abstracts of recent publications, theses, and technical reports; humour, cartoons, artwork; advertisements (rates upon request); anything else concerned with AI. Paper or electronic submissions are welcome. Electronic submissions are preferred and should be unformatted. *Canadian AI* is published in January, April, July, and October. Material for publication is due six weeks before the start of the month of publication.

Advertising:
Advertising rates and press kits are available upon request from the address below, or by phoning 403-297-2600.

Please send submissions to / Prière d'envoyer contributions à:
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ou à / or to: Marlene Jones
Canadian Artificial Intelligence
Alberta Research Council
6815 8th Street NE, 3rd floor
Calgary, Alberta, CANADA T2E 7H7

Contributions:
L'*Intelligence artificielle au Canada* est publiée trimestriellement par la CSCSI/SCEIO, et est offerte gratuitement aux membres. L'*IA au Canada* encourage les contributions, en français ou en anglais, portant sur l'intelligence artificielle. Ceci comprend: des articles d'intérêt général; des descriptions de recherche courante et de cours; des rapports de conférences récentes et d'ateliers; l'annonce d'activités à venir, et des requêtes d'articles; des critiques de livres ainsi que des livres à critiquer; l'annonce de nouvelles compagnies en IA et de leurs produits; des opinions, des répliques, tout ce qui est polémique; des résumés de publication récentes, de thèses et de rapports; des trucs humoristiques ou artistiques, de bandes dessinées; des annonces (s'enquérir des frais); tout autre matériel touchant à l'IA. Contributions, sur papier ou par courrier électronique, sont bienvenues. Nous préférons le courrier électronique mais les submissions ne devraient pas avoir un format. L'*IA au Canada* apparait en janvier, en avril, en juillet, et en octobre. Toute communication à publier doit nous parvenir au moins six semaines avant le début du mois de parution.

Réclame:
Les prix pour les annonces et les trousses pour la presse sont disponibles sur demande. Écrivez à Marlene Jones à l'addresse à la gauche ou téléphonez 403-297-2600.

Book reviews and candidate books for review should be sent to:
Envoyez des critiques de livres ainsi que des livres à critiquer à:
CDNnet: gh@ai.toronto.cdn
CSNET: gh@ai.toronto.edu
UUCP: gh@utai.uucp
ou à / or to: Graeme Hirst, *Canadian Artificial Intelligence*
Department of Computer Science, University of Toronto
Toronto, Ontario, CANADA M5S 1A4

Canadian Artificial Intelligence is published quarterly by the Canadian Society for Computational Studies of Intelligence (CSCSI).
Intelligence Artificielle au Canada est publiée trimestriellement par la Société canadienne pour l'étude de l'intelligence par ordinateur (SCEIO).
Second Class Mail Registration No. 7373

ISSN 0823-9339

Executive Notes

Is there anybody ... out there?
Pink Floyd, 1979

Canadian Artificial Intelligence Magazine has come a long way from its inception. In issue #1 (Sept. 1984), Graeme Hirst set out the new mandate of the newsletter, which, I believe, still holds:

The newsletter will no longer just be a report on the [CSCSI] activities. Rather, as the *Canadian Artificial Intelligence Newsletter*, it will report on all aspects of AI in Canada, or of special interest in Canada. It will provide a forum for reporting Canadian AI to the world, and I believe that just as people in North America and elsewhere subscribe to the *AISB Quarterly*, the European AI newsletter, to find out what's happening in AI in Europe, so people outside Canada will want to subscribe to the *Canadian AI Newsletter* to find out what's happening in Canada.

The newsletter has since become a magazine and has moved to the Alberta Research Council. In his parting editorial, Graeme comments on the growth of AI as a field and the appropriateness of having the magazine published at the Research Council with its strong academic and industrial ties.

Now, a year and a half later, we would like to ask you, our readers, to provide us with some feedback. What do you think of the magazine? We have designed a simple questionnaire (English: p. 19; français: p. 33) to help us get the feedback we want. Do you think the magazine is fulfilling its mandate? Do you think it is worthwhile to sustain it? Does it reflect the Canadian scene in AI adequately? (Is there a "Canadian AI" scene?)

I know you are all very busy, but the questionnaire is only a page long. We are happy to pay the postage. All you need to do is fold it, staple it, and drop it in the mail (after answering the questions, of course). You could also send the responses by e-mail if you wish. We will publish the results of this survey in the next issue. Thank you all in advance.

Roy Masrani

Notes from Members

New Bindings

Bill Havens, present secretary of CSCSI/SCEIO is the new director of the Expert Systems Laboratory in the Centre for Systems Science at Simon Fraser University.

Jim des Rivieres has moved from the University of Toronto to Xerox PARC.

Letters to the Editors

We take the opportunity to express our belief that it would be advantageous and of interest for the readers to set up a refereed section in your journal, which would cover research results in AI. To our knowledge, there is only one other Canadian review in the field of AI, namely *Computational Intelligence*, the profile of which is strictly theoretical. We believe that there is a lack of a forum for the presentation of application oriented research results. If you find it expedient, we could assist you in identifying researchers that could serve as members of the review board.

Sincerely yours,
Dr. Ilié Popescu
Professor
Department of Computer Science
Université du Québec à Hull

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High Technology Salaries Stabilize

The Canadian Advanced Technology Association (CATA) reports in its annual Compensation and Benefits Survey that 1988 salary increases in the high technology sector were 4-5%, unchanged from the previous two years. This compares with general increases of 4.1% in 1988. CATA also reported, however, that the high technology job market is becoming more competitive, and that some companies are reporting shortages of skilled workers in R&D occupations.

Symbolics Posts Profit

Symbolics, Inc., of Burlington, MA, reported its second consecutive profitable quarter for the quarter ending January 1, 1989, after eight quarters of losses. The profits are attributed to strong demand for the MacIvory hardware and software for Macintosh II computers, and to sales of the XL400 workstation.

Centres of Excellence Program Popular

The federal government has received some 160 applications for the Centres of Excellence (COE) program. The government intends to set up between 10 and 20 centres, which will share $240 million in funding over the next four years. Some researchers suggest that the stiff competition points out the serious funding problem in Canadian research, and they point out that the program fails to address the need to fund basic research.

NRC Signs Agreement with Precarn

The National Research Council (NRC) has signed a five-year agreement with Precarn Associates, Inc., to provide up to $1 million per year to fund projects by Precarn members. The funding will be provided through the Industrial Research Assistance Program (IRAP); Precarn will develop research proposals, which, if they meet IRAP criteria, will be funded by NRC.

Nexa Corporation Falls to Financial Woes

Nexa Corporation, whose subsidiaries include CAIP, Symbolics Canada, IAI, Inference Canada, and Logicware, Inc., has succumbed to financial problems. Nexa was formed in 1982 and served as a funding source for startups in the areas of AI, office automation, and medical information technology. In 1987, largely due to the stock market crash, the company was unable to capitalize its operations; further attempts in 1988 were also unsuccessful. Interestingly, most of Nexa's financial losses occurred in the AI software product business.

CIAR Studies Innovation in Canada

In a task force report entitled "Innovation and Canada's Prosperity", the Canadian Institute for Advanced Research has warned that Canada's prosperity is threatened by our lack of commitment to long-term applied research.

Les salaires du secteur des technologies de pointe se stabilisent

L'Association Canadienne de Technologies de Pointe relate que les résultats de son étude annuelle concernant la rénumération et les avantages sociaux montre que les salaires provenants du secteur des technologies de pointe ont augmentés de 4-5% en 1988. Ce taux est égal aux deux années précédentes. Il peut être comparé à une augmentation générale de 4.1% en 1988. Toutefois, l'Association note aussi que le marché de l'emploi en technologies de pointe devient plus compétitif et que certaines compagnies relatent un manque de personnel qualifié dans le domaine de la recherche et du développement.

Symbolics affiche des profits

Symbolics Inc. de Burlington, MAaine, a annoncé des profits pour le trimestre se terminant le 1er janvier 1989, un deuxième de suite après huit trimestres de pertes. Les profits sont attribuables à la forte demande du matériel et du logiciel MacIvory pour les ordinateurs Macintosh II et aux ventes du poste de travail XL400.

Le programme de centres d'excellence est populaire

Le gouvernement fédéral a reçu quelque cent soixante demandes dans le cadre du programme de centres d'excellence. Le gouvernement a l'intention d'établir entre dix et vingt centres qui se partageront une somme de 240 millions dollars répartie sur quatre ans. Des chercheurs laissent entendre que l'intense compétition met en évidence l'importance du problème de financement de la recherche canadienne et signalent que le programme ne s'attaque pas aux besoins de financement de la recherche fondamentale.

Le CNR signe une entente avec Precarn

Le Conseil national de recherches (CNR) vient de conclure une entente de cinq ans avec Precarn Associates, Inc. selon laquelle il fournira jusqu'à 1 million de dollars par année pour financer les projets des membres du groupe Precarn. Le financement sera effectué dans le cadre du Programme d'aide à la recherche industrielle (PARI); Precarn préparera des propositions de projets de recherches qui, s'ils rencontrent les critères de PARI, seront financés par le CNR.

La Nexa Corporation sombre sous ses troubles financiers

La Nexa Corporation, dont les filiales incluent CAIP, Symbolics Canada, IAI, Inference Canada et Logicware, Inc., a sombré à cause de ses problèmes financiers. Nexa a été formée en 1982 et servait de source de fonds pour le lancement de nouvelles sociétés dans les domaines d'IA, de la bureautique, et des techniques d'information médicale. En 1987, dû en grande partie au krach boursier, la

The report discusses the relationship between basic, long-term applied, and developmental research and stresses that Canadian industry must do more than increase its developmental research — in particular, it must commit to long-term applied research, loosely defined as that research with a three-to ten-year horizon. Basic research, the task force believes, is the proper domain of universities.

While there is a role for government and the universities, the report states that the thrust for any substantive change must come from industry and believes that this is a major structural issue. Because of Canada's large size and small economic resources, it urges the exploitation of consortia, research networks, and other collaborative approaches.

Products and Corporations

• Hecht-Nielsen Neurocomputers Inc. (San Diego, CA) has been awarded a contract for Phase 1 research of DARPA's Computational Map Processor (CMP) project. The CMP is designed to carry out preprocessing for time-series signals and images, a task ideally suited for neural networks. Hecht-Nielsen is also producing co-processor boards for PCs and workstations, as well as providing training services.

• Procyon (Cambridge, England) has developed Procyon Common LISP for the Apple Macintosh. Procyon Common LISP is claimed to be a complete Common LISP implementation, and is being marketed by ExperTelligence (Goleta, CA) for US$620 (US$445 for universities and research centres).

• "Artificial Intelligence on the Macintosh" is a report evaluating the capabilities of the Apple Macintosh as an AI machine, as well as giving AI product reviews and product vendor profiles. The report is available from KE Publishing Corp., PO Box 366, New York, NY 10014-0366, (212) 741-0045, for US$147, plus US$17 postage and handling for foreign orders (foreign orders must be drawn on a U.S. bank).

• IntelliCorp Inc. (Mountain View, CA) has introduced KEEtutor, a training package covering basic aspects of IntelliCorp's Knowledge Engineering Environment system (KEE). KEEtutor uses videotapes, software, and tutorial modules to explain the development of an expert system in KEE. KEEtutor is meant for use with KEE 3.1 and is available for US$5 000.

• Flavors Technology Inc. (Amherst, NH) has announced the Parallel Inference Machine (PIM), a processor capable of 1 000 000 logical inferences per second (LIPS). This makes PIM the first machine to reach DARPA's criteria of 10 000 LIPS in 10 ms. PIM's architecture is based on ideas from the areas of neural networks, cellular automata, and AI. At its heart is a blackboard that allows simultaneous updating capabilities to its 16 000 virtual processors.

PIM is not a stand-alone machine; rather it is designed to work as a co-processor. Flavors has announced the Apple Macintosh II as a front-end for PIM. The user can access PIM's processors via a three-dimensional spreadsheet-like interface. The user can write programs for PIM in a rule-based language called Paracell. Programs are written on the Macintosh and then downloaded into PIM, which then uses the rules to operate on the data.

PIM is expected to ship sometime this year, with the first system already sold to an anonymous factory automation vendor from Japan.

société n'a pas su capitaliser ses opérations; des tentatives similaires en 1988 étaient aussi infructueuses. Il est intéressant que la plupart des troubles financiers de Nexa provenaient de ses affaires dans la production de logiciels d'IA.

L'ICRA étudie l'innovation au Canada

Dans un rapport de détachement spécial intitulé "L'innovation et la prospérité du Canada", l'institut canadien des recherches avancées a averti que la prospérité du Canada est menacée par le manque d'engagement à long terme envers la recherche appliquée. Le rapport examine les relations entre la recherche de base, la recherche appliquée à long terme et le développement et insiste que l'industrie canadienne doit faire plus pour augmenter la recherche qui soutient le développement; en particulier, elle doit s'engager à faire de la recherche appliquée à long terme, librement définie comme de la recherche dont l'horizon est de 3 à 10 ans. La recherche de base, selon le rapport, est le domaine propre des universités.

Bien qu'il existe un rôle à jouer par les gouvernements et les universités, le rapport affirme que l'initiative pour un changement de substance doit venir de l'industrie, et que cela impliquera un changement structurel majeur. À cause de la grandeur du Canada et de ses resources économiques limitées, ce rapport conseille vivement l'utilisation de consortia, de réseaux de recherche et d'autres approches collaboratives.

...(continued from previous column)

• Northern Telecom Inc. has announced the signing of a licensing agreement with Carnegie Group. Carnegie Group is the maker of Knowledge Craft, a tool kit for building knowledge-based systems.

• Teknowledge has teamed up with AICorp to produce knowledge base management systems for mainframes.

• Teknowledge has signed a licensing agreement with Neuron Data in which Teknowledge will provide application development services and training courses for Neuron Data's Nexpert Object expert system shell.

• DEC and Neuron Data have reached an agreement that has DEC supporting Nexpert Object on VMS and Ultrix.

• Gold Hill Computers and Coral Software Corporation are distributing Coral's Allegro Common Lisp with Gold Hill's GoldWorks II software for the Apple Macintosh II.

• Carnegie Group and Texas Instruments have released TestBench, a jointly developed system for troubleshooting machine failures and process problems.

• Integrated Inference Machines has introduced InferStar, a workstation with five times the performance of a Symbolics 3670 and twice the performance as the fastest TI Explorer. Prices range from US$14 950 to US$34 950, depending on the memory configuration.

• Lysia Ltd (London, England) is offering a series of off-the-shelf and customizable expert systems in the domain of business strategy and marketing. The systems run on PCs using either Crystal or Xi Plus, with prices ranging from UK£1 000 to UK£20 000.

• Expert Systems International (Oxford, England) has announced a commercial version of TPM Prolog, a graphics environment for studying the execution of

Prolog programs.

• NeuralWare Inc. (Sewickley, PA) has released Designer Pack, a system that converts networks generated by NeuralWare's NeuralWorks Professional II into C code. Designer Pack is available on PCs and Sun3s.

• Nestor (Providence, RI) has found a UK company, Neurocomputing, to distribute its products. Neurocomputing will also be offering neural network seminars and training, as well as developing its own products.

• Syntek (London, England) has ported its Editor's Assistant to the PC. It can be run on any PC with 640K of memory and be adapted to any word processor format.

• AICorp (Wembley, England) has announced a version of Knowledge Base Management System (KBMS) for OS/2. KBMS is currently available for IBM mainframes.

• Creative Logic (Uxbridge, England) has announced a version of its Leonardo shell for the Apollo.

• Advanced Products and Technologies (Redmond, WA) is releasing VOICE, a hand-held computer that can recognize about 10 000 English phrases and translate them into other languages. It sells for approximately US$2 000, with cartridges costing US$200.

• Anatex (Los Angeles, CA) has released Personal Writer, a graphics tablet that allows the input of text and graphics. It uses character recognition software that learns to recognize the user's handwriting. Personal Writer runs on the Macintosh.

• Calera Recognition Systems (Santa Clara, CA) has signed an agreement with Wang (Lowell, MA) to integrate Calera's recognition system into Wang's Integrated Image Systems. Calera's omnifont character recognition does not need to be trained on particular type styles.

• Honeywell (Minneapolis, MN) has received a three-year US$1.5-million contract from the U.S. Air Force to develop the Learning System Pilot Aiding (LSPA) program. The LSPA program will be able to take past information about combat and apply it to the current situation, presenting the results of its analysis to the pilot for use in tactics selection.

• Voice Control Systems (Dallas, TX) has entered into an agreement with Northern Telecom (NT) to apply its voice technology to NT's Enhanced Operator Position System. The system will use Voice Control System's sixty-word speaker-independent vocabulary to automate many operator-assisted services.

• Inference (Los Angeles, CA) will be selling its ART-IM/MS-DOS for US$8 000 (first copy) and US$800 (run-time).

• After experiencing losses of US$1.1 million on revenues of US$1.7 million in the first fiscal quarter of 1989, Teknowledge (Palo Alto, CA) has announced its merger with American Cimflex.

L'échéance pour le numéro de juillet est le 15 mai

Deadline for the July issue is 15 May

PROFILE: Gordon MacNabb — Managing Research in a Changing Research Environment

by Connie Bryson

PROFILE: Gordon MacNabb — La gestion de la recherche dans un milieu de recherche en évolution

RÉSUMÉ: En tant que président fondateur du conseil en sciences naturelles et en génie, puis en tant que président-directeur général de Precarn Associates Ltd., Gordon MacNabb est un personnage clé de la communauté canadienne de recherche et développement. Comme les recherches à long terme dont il se fait l'avocat, la plupart de ses réalisations n'ont pas d'applications immédiates et ne jouissent pas d'une grande visibilité. Neanmoins, si le futur du Canada est li'e à l'utilisation de son potentiel intellectuel plutôt que de ses ressources naturelles, le travail de MacNabb est vital pour la santé économique et social du pays.

First as the founding president of the Natural Sciences and Engineering Research Council (NSERC) and now as the president and CEO of Precarn Associates Ltd., Gordon MacNabb is a key player in Canada's R&D community. Like the long-term research he advocates, most of his accomplishments don't have immediate results and aren't high profile. Nonetheless, if Canada's future is tied to the exploitation of its intellectual rather than physical resources, MacNabb's work will be vital to the economic and social welfare of the country.

MacNabb, like only a few others, has been able to bridge the gap separating industry, universities and governments. His success at building up the NSERC programs and developing Canada's first R&D consortium are testaments to his skill at negotiation.

MacNabb is a long-time champion of research in Canada, from NSERC's early days when few people were interested in R&D, to today when business reporters routinely seek out his comments.

Although a consummate diplomat, he has avoided the trap of perpetual wishy-washiness. He is always opinionated, never dull. When the subject is Canadian R&D, he doesn't mince words and usually is able to throw in a colourful analogy or two.

In a 1986 speech where he commented on the shakes and shingles tariff crisis, MacNabb said, "I acknowledge the importance of this commodity [softwood lumber] to the economy and to the individuals involved, but I have to say that our deteriorating competitive position for the long term couldn't be more graphically illustrated than through our screams of protest over impediments to the export of cedar 'chips' to the United States and our counter-attack of imposing added duties on computer chips and literary works from the United States. Wood chips versus computer chips: a sad commentary on our position in a trading environment increasingly driven by innovative and sophisticated products."

Considering his training as a civil engineer and his involvement with science and technology throughout his career, one might expect MacNabb's interests to be focused on research results — the products and processes spawned by R&D. Not true; his focus is people. His first concern is creating the right environment for researchers, in the belief that scientific and technological achievements will follow.

MacNabb says he is fighting "an old Canadian hang-up. We seem to be willing to gamble (collectively through governments) on our physical resources, but are hesitant to gamble on our human intellect. Wildcat drilling versus wildcat research is the comparison I draw and research always come out on the losing end. We remain a nation which proudly proclaims, and usually overestimates, its natural resource wealth, but seldom acclaims, and usually underestimates, its leaders of intellect and innovation."

A Public Service Career

Although MacNabb is probably best known by Canadian researchers for his NSERC presidency, he has had a long career of public service.

After holding a number of positions associated with hydraulic and hydro-electric planning, he joined Energy, Mines and Resources, becoming deputy minister in 1975. In 1978, he was appointed president of NSERC, a job he held for eight years.

MacNabb also has served as chairman of the Energy Supplies Allocation Board and since 1967 has been chairman of the Columbia River Treaty Permanent Engineering Board. From 1975 to 1985, he was president of Uranium Canada Ltd., where he concluded sales and leasing arrangements worldwide for the federal government's stockpile of uranium.

Today, on top of his Precarn and Columbia River board duties, MacNabb is associate to the principal at Queen's University, his alma mater.

Precarn: A Framework for Cooperation

Challenges have been essential to MacNabb's career, and his latest venture is no exception.

With Dr. Fraser Mustard, president of the Canadian Institute for Advanced Research (CIAR), MacNabb co-founded Precarn Associates Ltd. in 1987. Precarn is a consortium of 34 Canadian corporations drawn from a broad cross-section of economic activity — mining, hydroelectric, and aerospace companies to name a few. An interest in robotics and artificial intelligence technologies ties them together. All members recognize the need to be actively aware of, and involved in, the total spectrum of AI research leading from fundamental knowledge to

Connie Bryson is a free-lance technical writer based in Vegreville, Alberta.

product development.

Precarn, a not-for-profit corporation, was born out of the mutual frustration of Mustard and MacNabb — the lack of industry interest in the research effort. CIAR had assembled a team of researchers doing fundamental research on AI and robotics and yet it appeared that industry was not prepared to develop the applications.

"There's a great quote from Fraser [Mustard] to explain this," says MacNabb "He describes himself as a good quarterback with a great play. He falls back but there's no one to throw the ball to. My task was to build up a team of industrial receivers for CIAR."

But MacNabb needed more than a group of companies that would kick in money for AI research, he wanted companies that would become involved in the research. "You can't be a receiver unless you're knowledgeable about the technology. Therefore industries must be involved in the research. This is what makes Precarn fundamentally different from the Centres of Excellence. With us, industries are part of the research."

The kind of research undertaken by Precarn is long-term precompetitive research. It is represented in Precarn's logo — three stylized pyramids, developed from another of Mustard's analogies. He often describes the R&D effort as a series of pyramids overlapping each other about one-third of the way up.

A common slice across the bottom of the pyramids represents the fundamental research foundation that sustains the whole structure. This is primarily the role of the universities and, according to Mustard and MacNabb, should be largely funded by the governments. At the peaks of the pyramids are the products, the results of the entire effort. Just below them is an expensive slice representing the development phase, one that should funded by industry.

In the middle is a kind of no man's land — the area of long-term applied research. It is expensive and high risk, but essential to maintain upward flow through the whole structure. In this band of activity, researchers are working with new fundamental knowledge, but without a full appreciation of its shorter or longer term applications.

"Few industries can afford to be major players in this sector and governments are reluctant to carry the whole burden," says MacNabb. "The challenge in Canada is to turn this no man's land into a meeting ground for industry, for universities and for governments. It is the area where the research effort has to be funded in the same way as President Mitterand proposed for the Esprit Program; the longer the term of the research, the higher the level of government support.

"The best researchers are at our universities, where most of the knowledge lies. They are at the cutting edge. Industry needs their expertise in order to develop AI and robotic systems. But there's a problem. There's only a relatively small number of researchers and they are already heavily loaded with work. If companies came to them individually, I can't see how they could cope with the work. The only reasonable and efficient way is to do this research collectively with industry."

Precarn's policy on technology ownership is guided by the overriding objectives of early exploitation of research results within Canada and stimulation of the flow of commercial benefits to the widest possible base of the Canadian economy.

In general, intellectual property that results from research fully funded by Precarn will be owned by the corporation. Members of Precarn will be granted full licence rights to the intellectual property and will actively pursue commercial applications of the technology, either in-house or in conjunction with others. Rights of publication will be negotiated with university-based participants. In situations where funding or technology contributions come from sources other than Precarn itself, the issue of ownership of intellectual property will be negotiated in each circumstance.

Building the Network

MacNabb estimates that he has approached 150 companies about joining Precarn. The membership fee is $25 000 per year; on top of that, larger companies are expected to contribute more to Precarn's projects.

"I had my doubts about how successful I would be at attracting founding members but it turned out to be not as difficult as I thought. In fact I had some pleasant surprises, especially the interest of the mining industry. Mining companies are known for development but not for research priority. Their support of Precarn is indicative of a significant change in the mining industry.

"But I could also write a book of horror stories. There were big companies who could afford the membership but just didn't see the point.

"The commitment isn't just money, it's time. Senior people in the company have to allocate time to Precarn or membership isn't useful. This is particularly difficult for small companies, where time is money.

"Some of the companies I approached had difficulties with the idea of working in conjunction with other companies and the long time frame of the research. Many companies find it difficult to see beyond the next quarter or the next year. I also ran into the attitude — we can always buy it if we need it.

"Other companies couldn't see the applicability of the technology. One major oil company executive told me AI has no application to the upstream part of the industry, despite the fact that expert systems are already being used to interpret seismic data. It's quite discouraging when you hear people talk this way.

"Of course there have been good things too. I've had a private company join over the telephone. Their attitude was, 'Yes, we have to be involved. We have to make the jump to new technology.' It's heartening to have that kind of reaction. It all depends on the vision of senior people."

So far Precarn has funded 7 feasibility studies, chosen from 28 proposals. Precarn's Technical Advisory Committee, which reviewed the proposals, felt that 4 other proposals had potential but needed refinement. All 4 have now been resubmitted and the committee will review them soon.

"These projects are four- to five-year efforts. As a result we have to be fairly careful about what else we can bite off. I don't see any more competitions in the near future," says MacNabb.

Unlike some other research programs, Precarn's projects are judged on scientific merit alone. There's no combining of socio-economic and technical goals, as is the case with the National Research Council's STEAR program, which supports space-related automation and robotics technology development. Mention of the phrase "regional distribution" is sure to raise MacNabb's ire.

"I don't buy the idea of regional distribution of research. I believe we have to participate with those who can contribute. To allocate regionally is to diminish the

benefit of the work. Everyone loses, the participants and the projects. On the other hand, Precarn is a national organization and members tap into a national effort, no matter what region they are from. Precarn provides a source of knowledge. If membership comes largely from Ontario, then that knowledge is going to go largely to Ontario. If members are from across Canada, the benefits will be spread across Canada.

"It's up to governments to help firms access the technology. For instance the Alberta Research Council is one of our founding members. Alberta companies will get indirect benefits from Precarn through the Research Council's technology transfer mechanisms. But if these companies become members of Precarn, they can sit at the table and listen first-hand to what's going on. They will be better off and able to move faster to exploit the technology."

It's Money that Matters

As it stands now, Precarn operates on the annual financial and other contributions from its member companies. The feasibility studies are funded up to $100 000, but MacNabb estimates that most will cost in the $200 000 range, with the extra input coming from the participating companies. As well, an umbrella agreement with the National Research Council's IRAP program will provide $5 million over five years for specific projects.

The unique nature of Precarn has caused many headaches for MacNabb, especially in battles with the Finance Department over investment tax credits and the rules governing not-for-profit R&D companies.

"We just don't fit the mold, whether it's taxes or funding, and this has created many hassles," says MacNabb. "I enjoy this work but there are some days when it's hell. But if Precarn can sort out at least some of these problems, we're setting the stage for other consortia which I hope will come along."

The coverage of overhead costs has also been a contentious issue. MacNabb reports some progress in persuading the federal government to consider overhead support in its funding equation.

MacNabb expects to have a funding agreement with the federal government concluded soon. It will provide $10 million to Precarn over five years.

"The government said it wanted something like Britain's Alvey project. Well $10 million over five years is a mighty miniscule Alvey. For instance the price tag of the first phase of Europe's Esprit program is somewhere around $1.5 billion.

"But I know we have to start somewhere. We'll definitely need more funding from the government but first we have to establish our credentials and our track record."

Precarn has also approached provincial governments for funding. "We've asked them to help by underwriting one-half of the membership fees of small companies," explains MacNabb. "Alberta has set aside a modest amount. This is a start. We hope to access larger amounts in the future."

IRIS: A New Network

With its core research program under way, Precarn's latest project is the Institute for Robotics and Intelligent Systems (IRIS), a proposal to the federal government's Networks of Centres of Excellence program. Although IRIS is to be established within Precarn, its funding will not be diverted to Precarn's research program but to 20 university-based cooperative projects involving 123 university researchers at 19 Canadian universities. The IRIS price tag is $28.1 million over a four-year period.

Precarn will administer IRIS; IRIS projects have been reviewed and approved by Precarn. The projects will also be subjected to the same scrutiny as are Precarn's own projects.

"Precarn and IRIS will result in two national networks — one industry driven and one university driven. They will be operated in lock-step with each other, a unique example of the growing trust and cooperation between these two sectors of our economy," says MacNabb.

"Coordinated management is the key to making this work and it is what we have in place. This is a significant research effort and we've got the mechanism for moving the knowledge around. This is vital if the work is to benefit the Canadian economy."

The "lock-step" nature of Precarn and IRIS will pose problems for Precarn if IRIS is not one of the 10-15 networks chosen for funding.

"IRIS reinforces Precarn and if IRIS isn't funded it will be difficult to complete many of our projects. Of course, there's always 'Plan B'. If IRIS doesn't go through, you'll be seeing many very interesting Strategic Grant applications."

R&D in a Changing Research Environment

Some basic researchers feel threatened by MacNabb's emphasis on university/industry collaboration. However, MacNabb rejects the notion that his initiatives are turning basic researchers into an endangered species.

"Remember the R&D pyramids — the foundation is fundamental research. If we don't have this base, there's nothing for Precarn to build onto," he says.

"Precarn is providing a vehicle for the economic use of fundamental research. If our economy doesn't grow, less funds will be allocated to fundamental research. So even researchers who aren't involved in Precarn can benefit from its efforts.

"I'll defend the right of any person to do fundamental research, but I have little time for people who believe that even stopping to think about possible applications is a form of prostitution. Individuals who summarily reject any responsibility within the Canadian economy make my task very difficult at times."

Despite his support for personal research freedom, MacNabb says there is another reality to be recognized — a radically changing research environment where multidisciplinary teams, rather than individual researchers, are the norm.

"We're moving into an environment where a collective judgement on research priorities is becoming increasingly essential. This will sorely test the interpersonal strengths of many an academic researcher who is used to having absolute authority on the expenditures from an individual grant. It will test those strengths even more when collaboration with industrial researchers is required, as will frequently be the case.

"A multidisciplinary approach presents all kinds of problems with NSERC grants. From a grant-winning point of view, it's still better to have done the work individually, and published individually, than as part of a group. Research management has to change and NSERC will have to restructure. But I honestly don't know what the solution is."

A Look into the Future

When asked to gaze into his crystal ball and describe the research funding picture in the year 2000, MacNabb hedges his bets.

"I really can't predict it, the outlook changes almost weekly. For example, the federal government is talking about fiscal restraint. That's likely to affect the operational budgets of departments and will likely affect Precarn. If it comes down to putting money into their own departments or giving it to Precarn, guess which option ministers will chose.

"On the bright side, we're now getting the right kind of statements on R&D from the government. But implementation is still very slow.

"The polls show Canadians support an increased effort in R&D, but they think that money will appear from nowhere. The average person is more concerned about who's going to look after his or her children now rather than who's going to employ them ten to fifteen years in the future.

"It's easy to say you support R&D as long as the money doesn't have to come from some other program. I'd like to see this question on a poll: Would you support a one or two cent per litre tax on gasoline to support R&D? Such a tax would be using our finite physical resources to contribute to our intellectual resources. If I thought this would happen, my crystal ball would be very rosy."

Structure of a Knowledge-Based System for Robot Control

by Ilié Popescu and Marek Zaremba

La structure d'un système à base de connaissances pour le contrôle d'un robot

RÉSUMÉ: Dans cet article on présente la structure générale d'un système expert à base de connaissances, capable de contrôler les mouvements d'un système robotique qui opère dans un environnement non-structuré. L'organisation hiérarchique de connaissances couplé avec des techniques de l'intelligence artificielle de contrôle permet un traitement efficace des informations sensorielles fournies au système expert par les capteurs d'un système robotique complexe. La création d'un Meta-Système Expert pour contrôle permet d'analyser à priori les règles, de donner un ordre de priorité à chacune et de déclencher uniquement les règles contenant la solution tout en commençant part les règles les plus promettueses. Nous trouvons que plusieurs applications acutellement sur le marché sont des cas particuliers de la structure générale présenté en cet article.

Introduction

Knowledge-based systems elicit a high degree of interest in various professional disciplines because they enable us to approach automation of certain intellectual functions so far reserved to human beings. Functions such as knowledge acquisition, diagnostic situations, action planning, and adapting a rigorous course of action for a particular environment are difficult to model with a specific algorithm.

The tasks performed by mobile robots, complex robotic systems, multi-arm robots, and, in general, robots operating in not fully structured environments are nondeterministic in nature. This type of operation is rich in sensor requirements: vision systems, proximity detectors, force/torque sensors, etc. The robot control based on extensive processing of sensory data implies hierarchical, multi-level decisions. Levels may vary from simple binary "go no-go" decisions to more complex questions that cannot be answered readily.

On different, particularly higher, levels of control, like the task level, extensive reasoning about tasks, objects, and relations requires heavy employment of the techniques of artificial intelligence.

The problem of efficient backtracking control techniques is dealt with more profoundly in this paper. In depth-first back-track chaining expert systems the rules that at a given moment are the candidates for the solution of problem S are in the situation of equality only modulo an algorithm. That algorithm is exclusively intrinsic to the engine and is independent from the application. It selects as the highest priority rule the one that is the first in the set of applicable rules. However, analysis of all the possibilities leads to the development of a search space practically uncontrollable in real-time.

The creation of a "meta-expert system" based on heuristic search methods and guided by the information supplied by the sensory system is crucial in preventing exponential growth of the search space.

The meta-expert system analyzes a priori the rules, gives an order of priority for each rule, and consequently starts them, beginning with the one most promising for obtaining the solution.

The rules of the system, called meta rules, are knowledge operators described in associative composition and serving in each base cycle of the inference engine.

The meta-expert system presented here is based on the analysis of an industrial multi-sensor robotic system. A critical requirement imposed on the operation of the system is real-time execution of control algorithms. The design of the structure of the proposed meta-expert system aims at solution of the problem.

Robot Control Process

The knowledge representation method presented in this paper is discussed in more detail in an example of a multi-sensory robot control system [9]. The task of the

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robot is to select, acquire, track, grasp, and unload a targeted mechanical part from a carrier, the location of which is only partially known.

Because of the free motion of the part and the presence of obstacles, the work environment should be treated as a dynamic, not fully structured one. Flexible operation of the system in such an environment requires extensive processing of sensory information, as well as hierarchical manipulator control coupled with AI techniques.

The following major phases of the robot operation can be distinguished:

- target/object acquisition,
- object tracking, until acceptable tracking errors are achieved,
- target/object reacquisition, if the target is partly obscured or lost,
- object grasping,
- material handling.

Among different phases of operation one can distinguish deterministic and non-deterministic ones. Sensor requirements for deterministic phases are modest, and the control actions can be programmed in a relatively fixed way. Material handling and normal tracking can be enlisted as deterministic tasks. In the remainder of the paper we will explore non-deterministic phases, requiring intelligent processing of sensory data.

Sensory Information

The information processed by the rule-based control system is provided from a multitude of sensors. Following are the main ones:

- *Object detection sensors*

The set of signals generated by the electro-optical sensors can be expressed as:

$S = \{s1, s2, ..., sn\}$,

where $si \in \{0, 1\}$, $i = 1, 2, ..., n$
n - number of mechanical parts

The conjunction s1, s2, ..., sn gives to the pertinent expert system information about the object's presence in a particular place on the carrier.

- *Vision system*

The position (X, Y, Z) and the orientation (YAW, PITCH, ROLL) of the targeted object with reference to the camera mounted on the robot arm are provided by a vision system based on photogrammetric technology. In addition to those signals, the vision system generates auxiliary information.

$L = \{l1, l2, ..., lp\}$, $li \in \{0, 1\}$

concerning errors of the location of internally generated windows with regard to the elements of the target

- *Force / torque sensor*

Forces and torques detected by the sensor installed at the robot arm wrist are: Fx, Fy, Fz, Mx, My, Mz.

- *Carrier detection sensor*

The carrier detection sensor and the part detection sensors intervene in the initial phase of the robot cycle. Target acquisition, tracking, reacquisition, and (partly) object grasping phases are executed based on the vision system data. The force/torque sensor provides information used mainly in the object grasping phase. Some signals, such as those coming from limit switches, are monitored throughout the robot cycle.

Structure of the Knowledge-Based System

A modular approach to implement different levels of the expert system for robot control was considered. In order to formalize the approach, we organized all the information into several classes. For each class an expert system was created. The communication between higher order and lower level experts is accomplished by using well-defined lines for communication and control, although the horizontal interaction between expert systems is also permitted.

The highest level, the "Meta-Expert System" for control, has knowledge about all the lower experts and can communicate with everyone in the system. Natural language definitions to communicate with the expert — Man-Machine Interface — and different models of real processes are located at this level.

First of all, the Meta-Expert System contains a request for some actions to be taken by the robot. This request, together with all necessary contextual information, is routed to the Expert System Rule Acquisition, containing lists of actions for and from all the inferior level expert systems. The responses from inferior levels are analyzed by the Meta-Expert System for Control, which decides if they are acceptable. In this way, a competition between the rules supplied by the Expert System Rule Acquisition is produced for Control to decide which are the rules that contain the solution. The Meta-Expert System for Control determines the next step, considering the last responses, its own knowledge, and the current agenda. After a repeated procedure like the above, when the request has been satisfied, the solution is then returned to the Expert System Limitations.

The design methodology adopted by us to build each local expert system is based on a prototype approach used in the development of expert systems [4] and on the heuristic research in the state graphs [5].

During the target acquisition phase, the signals from electro-optical sensors are examined. All the information about the presence and location of the mechanical parts to be handled by robot are expressed by rules such as:

part-detection (S, p1, p2, ..., pm)

The parameters p1, p2, ...,pm are used by the Expert System Rule Acquisition to select a subset of rules that is able to guide the robot. The vision system solution can be expressed in the Expert System Tracking as:

target-system (X, Y, Z, YAW, PITCH, ROLL,
L1, T1, T2, ..., T1)

where Tk, k = 1, 2, ..., 1 are actions to change the position and the orientation of the robot.

The auxiliary signals are used basically by the Meta-Expert System for control of target reacquisition. They are represented in the Expert System Target

Reacquisition as facts:

state-base (L, A1, A2, ..., Ak)

where aj, j = 1, 2, ..., k represent actions to be taken by the control system. If each fact has p parameters, then the knowledge base of the Expert System Target Reacquisition contains 2p rules in its factual base to cover all the possibilities.

Generally, in order to determine the actions to be taken, the inference engine of the expert system analyzes all these rules at all times. Systematic tree search techniques are relatively simple to program and guarantee a solution. But, clearly, the search space and execution time may be prohibitively large.

Thus, we organized the inference engine of the Expert System Rule Acquisition in a more intelligent way: the Expert System Tracking Reacquisition rules are indexed and the Expert System Rule Acquisition selects only the pertinent rules, based on the information supplied by the vision system.

Once the tracking error is maintained smaller than a pre-determined value for a certain number of cycles, the Meta-Expert System for Control enters the object grasping phase.

The stand-off is decreased, while the basic tracking algorithms using the vision system are still used. This continues up to the moment when auxiliary signals are detected. This time, however, the target reacquisition phase is not triggered, but the control algorithm is changed to a different one.

All the time, until the grasping commences, the signals are checked for maximum values. If those values are exceeded, then the Meta-Expert System for Control communicates with the Man-Machine Interface System for a decision to be taken.

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IJCAI Policy on Multiple Publication of Papers

by Alan Bundy

La politique d'IJCAI sur les publications multiples d'articles

ABSTRACT: Il ne semble pas y avoir de consensus, dans le monde de l'intelligence artificielle, sur la question des publications multiples d'articles. Dans le but qu'on en arrive éventuellement à un tel consensus, IJCAI, par le biais de cet article, fait connaître sa politique actuelle sur cette question et lance le débat. Les mandataires d'IJCAI ont décrété que les actes d'IJCAI constituaient une publication d'archivage (une publication dans laquelle la recherche scientifique est archivée pour la postérité) et qu'ils ne devraient donc contenir que des articles qui n'ont pas déjà paru dans d'autres publications d'archivage.

Introduction

At their meeting in Milan during IJCAI-87, the IJCAI Inc. trustees were faced with an issue of principle that periodically arises. An IJCAI and an AAAI conference were happening in the same summer. Several authors had submitted the same paper to both conferences. What attitude should we take to this?

Clearly the problem is a wider one than the relationship between IJCAI and AAAI, although it was that coincidence of conference dates that had attracted our attention to it. There are now a number of rival national and international AI conferences. There are also a growing number of international conferences in subfields of AI. Not just IJCAI, but all these conferences, need to evolve mutually compatible policies to cope with multiple publications.

At the moment no such consensus exists. Different publications adopt conflicting policies. Multiple publications are commonplace. A wide variety of incompatible views were reported at our meeting. Few people have thought seriously about the issue[1].

IJCAI's Policy

Any such policy needs to balance two potentially conflicting principles:

- a good piece of work deserves a wide circulation to

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[1] I certainly had not. Now that I have, I am somewhat embarrassed about my own publication list.

maximize the number of people who are aware of it
- archival scientific publications demand originality in the papers they publish.

In resolving this potential conflict, the notion of an *archival* publication seems central. An archival publication is one in which scientific research is archived for posterity. It seems generally accepted in scientific circles that a particular scientific achievement[2] should be described in a single definitive paper and that this should be published in only one archival publication. Presumably, this is both to prevent researchers pretending to a greater scientific output than they have achieved and to save their colleagues from wasting their time reading about the same achievement more than once.

After some discussion, the IJCAI trustees decided that the IJCAI proceedings *was* an archival publication and that it should, therefore, only accept papers that had not already appeared in archival publications. We also implicitly assumed that all AI journals and the proceedings of AAAI conferences and similar national and international AI conferences were also archival. Thus, we would reject from an IJCAI conference any paper that had already appeared, or was about to appear, in another archival publication.

Archival and Non-Archival Publications

The grounds for deciding that IJCAI conference proceedings are archival were as follows:
- the papers in them are refereed and a high standard is demanded of them
- the proceedings are freely available: from the publisher, bookshops and most AI libraries
- the proceedings are widely regarded as a historical record of AI research.

These grounds also hold for many other AI conference proceedings.

On the other hand there are many publications in AI that are clearly not archival — for example, the many technical report series circulated by individual research laboratories, the newsletters and magazines of AI societies, and the proceedings of workshops and small conferences that are circulated only to the participants. A paper that had appeared only in such publications *would* be regarded as original by IJCAI.

Getting General Agreement on the Policy

It is one thing to make a policy decision, but another to enforce it. How can IJCAI ensure that it does not accept papers that have been published in other archival publications? We certainly do not have the resources to check for overlap with all other such publications. The problem is particularly acute when papers have been accepted by two or more publications, none of which have yet appeared. The referees might pick up some cases of overlap, but some multiple publications are bound to get through. The IJCAI trustees felt that the only effective policing mechanism was social pressure from the research community — i.e., that authors who violated the rules on multiple publication would be noticed as having done so and subjected to peer pressure through references, reviews, gossip, and the like. But for this to work there first has to be consensus on what the rules are. As then-chair of the IJCAI trustees, I was commissioned in Milan to write this article as a way of airing the issue, inviting further discussion and trying to reach a consensus. I was told to try to get the article published in as many places as possible[3].

Tricky Cases

Getting a consensus will not be as simple as it might first appear. As soon as one begins to look at the issue in detail, it becomes clear that there are all sorts of tricky cases where fine lines must be drawn. This reinforces the need for a general airing of the issue. Here are some of these tricky cases.

Should IJCAI allow simultaneous submission of papers to two or more conferences with archival proceedings? Since it is only multiple *publication* that we really object to, then one could argue that multiple *submission* is okay provided the authors withdraw all but one submission in the event that the paper is multiply accepted. However, allowing multiple submission is to invite trouble. Furthermore, if program chairs are trying to fill a quota in accepting papers, then a withdrawn paper upsets their calculations. Papers withdrawn at the last minute also disturb the presentation schedule. For all these reason, the IJCAI trustees decided not to allow submission of papers that had been or were being submitted elsewhere, and to make this clear in the call for papers.

The arguments above apply to unsolicited submissions. Different rules seem to apply to invited papers. Researchers are usually asked to give an invited talk because of the excellence of their research. They are expected to give a talk based on this research. This normally entails describing work that has been published elsewhere. They are often encouraged to write up their talk and include it in the proceedings. This inevitably means that their paper will be unoriginal. Similar arguments apply to winners of IJCAI awards, such as the Computers and Thought and the Research Excellence awards. IJCAI also has plans to invite republication of the best papers from associated international conferences in sub-fields of AI, so as to ensure that the best work in AI continues to appear at IJCAI conferences. Similar arguments would apply to these invited papers. The trustees have taken the attitude that they should relax their policy for invited papers; that their publication is not to be regarded as archival. An alternative, tougher, policy would be to allow invited papers to be presented, but not to publish them. Many people would regret the loss of the written form of invited papers. What do you think?

It has been common practice to encourage republication in the *AI Journal* of the best papers at an IJCAI. This has even been formalized in the case of papers winning the *AI Journal* Best Paper Prize. Since such papers will appear in the IJCAI proceedings first, this is a problem for the *AI Journal* rather than IJCAI, but it is a problem that the research community should also address in the general form of republications of conference papers in journals. The *AI Journal*'s solution is to insist on the papers being revised and/or extended before republication. Is this enough? Some other journals have a more relaxed policy: allowing republication in the original form. Should the research community approve of this?

It is common practice in science generally for collections of papers by a single author or on a common theme

[2] The word "achievement" is meant to be give a broad interpretation, e.g. to include at least experimental results, theoretical results, proposals of theories and hypotheses, analytical studies, syntheses and surveys.

[3] Such multiple publication does not violate the above rules because this article is not intended to be the report of a research achievement.

to be republished together. This seems to be regarded as a legitimate violation of the single archival publication policy in the cause of improving access to a body of work held in high regard. The editor and publisher normally make it clear that the papers are not original, so this practice causes few practical problems. Since this is common practice outside AI, there seems to be no reason to fight it inside AI.

It is useful when attending a workshop to be given a collection of papers or abstracts of the talks to be delivered. Usually these consist of paperback volumes of photocopies. Sometimes when the workshop is over, the organizers get ambitious and start thinking of turning this volume into a book. This has the side-effect of turning a non-archival publication into an archival one. Authors need to be aware of this. By agreeing to their paper being promoted to a book chapter, they may be blocking their chances of subsequent publication in a more prestigious form in a major conference proceedings or a journal. Editors of such books also need to be aware that this is what they are doing to authors, and they should be sure to ask permission of the authors and point out the potential disadvantages.

Conclusion

In this article I have tried to air the problems associated with multiple publication of papers and to publicize the IJCAI policy on it. There does not seem to be an existing consensus on this issue within AI, and this is highlighted by some of the practices mentioned above and by the many different attitudes that I have heard on the topic. For AI to develop into a mature field it must develop a consensus on this issue.

IJCAI has tried to start the consensus developing by announcing its current policy and by airing the issue through this article. We hope that this will encourage a debate from which a consensus emerges. Without such a consensus it will not be possible to have an enforceable policy.

The World Computer Chess Championship: Edmonton, 1989

by Jonathan Schaeffer

Le championnat mondial d'échec par ordinateur: Edmonton, 1989

RÉSUMÉ: Le championnat mondial d'échec par ordinateur aura lieu à Edmonton du 28 au 31 mai 1989 dans le cadre du congrès 1989 de l'ACI. Cet événement, qui se tient à tous les trois ans, réunit les meilleurs programmes d'échec du monde en vue du titre de Champion mondial. Maintenant que les programmes les plus performants sont capables de s'opposer avec succès aux grands maîtres, les résultats de quarante ans de recherches en échec informatique sont peut-être finalement en vue. L'événement met aussi à l'affiche un atelier sur les directions nouvelles dans le domaine de la fouille d'arbres de jeux.

The World Computer Chess Championship is being held in Edmonton on May 28-31, 1989. This triennial event brings the best chess programs in the world together to compete for the title of World Champion. With the top programs now able to successfully compete with human grandmasters, the goals of 40 years of computer chess research may finally be in sight. The event also features a workshop on New Directions in Game-Tree Search. Keynote speakers include John McCarthy (Stanford University) and Donald Michie (The Turing Institute).

For four decades, computer scientists have been striving to create a program capable of defeating the best human players. The field has been marked by unfounded optimism from the artificial intelligence community. Future Nobel Laureate Herbert Simon stated in 1957 that within ten years a program would be capable of defeating the human world champion. The year 1967 came and went with programs playing no better than the average human tournament player. The next year, chess master David Levy made a famous bet with John McCarthy, Donald Michie, and Seymour Papert that within ten years programs would not be capable of defeating him. David easily won the $2 500 bet. It is now 1989 and it is still not clear whether technology is capable of putting David in his place.

In the past decade significant advances in software and hardware have been made in the field. The result is that the best programs are strong masters, verging on grandmaster strength. The day when computers are better than the best humans may not be that far off.

The World Championship has been held every three years since 1974. The inaugural event was held in Stockholm, and *Kaissa* (USSR) took top honours. The subsequent events included: 1977 in Toronto, won by *Chess 4.6* (USA); 1980 in Austria, won by *Belle* (USA); 1983 in New York, won by *Cray Blitz* (USA); and 1986 in Germany, won by *Cray Blitz* on tie-breaker over *Hitech* (USA), *Bebe* (USA), and *Phoenix* (Canada).

Some of the participants in Edmonton will include:

- *Belle* (Thompson, Condon; Bell telephone Labs) — *Belle* was the first chess machine, comprising 1 600 LSI chips. It was the first program to achieve the master title.
- *Deep Thought* (Hsu, Campbell, Anantharaman, Browne, Nowatzyk; Carnegie-Mellon University) — Hsu put *Belle* on a single VLSI chip, allowing processing speeds beyond what is capable on today's supercomputers. With some innovative search algorithms, *Deep Thought* is able to out-search the competition.

Jonathan Schaeffer is an Assistant Professor at the University of Alberta. His B.Sc is from Toronto (1979) and both M.Sc. and Ph.D. from Waterloo (1980, 1986) in computer science. He is best known for his chess program, Phoenix, *which is one of the top programs in the world.*

• *Hitech* (Berliner, Ebeling, Campbell, Goetsch, Palay; Carnegie-Mellon University) — Hans Berliner has been researching computer chess for over 20 years. *Hitech* is another special-purpose VLSI machine. The program is characterized by extensive chess knowledge.
• *Cray Blitz* (Hyatt, Nelson, Gower; University of Alabama) — The program uses an eight-processor Cray YMP.
• *Phoenix* (Schaeffer; University of Alberta) — For the last world championship, *Phoenix* used twenty Sun 3 computers. This time around, Schaeffer intends to use a 128-512 processor Myrias computer.
• *Bebe* (Scherzer; SYS-10) — *Bebe* has been a perennial contender. The program runs on special-purpose bit-slice hardware.
• *Lachex* (Wendroff, Warnock; Los Alamos National Laboratory) — Another program running on a Cray. But probably only two to four processors.
• *Waycool* (Felton, Otto, Morison; Cal Tech) — They will be using a 256-processor Hypercube.
• Commercial entrants — A number of the commercial vendors (e.g., Fidelity, Mephisto) will be coming. Although restricting themselves to microprocessors (MC 68030), these programs seem to do very well against their fast competition.

Computer chess is as much innovative software as it is state-of-the-art hardware technology.

Canadians have played a prominent role in computer chess research. Monroe (Monty) Newborn (McGill University) and Tony Marsland (University of Alberta) have been long-time researchers and competitors in computer chess events. Monty is a past president of the International Computer Chess Association (ICCA), while Tony is currently the ICCA vice-president. Monty's program *Ostrich* has been a perennial competitor in the World Championship. Tony's program *Awit* tied for second place in the 1983 World Championships. Ron Hansen's program *Ribbit* (University of Waterloo) tied for second place in 1974. The University of Toronto program *Chute* (Mike Valenti, Zvonko Vranesic) was a participant in 1977. The 1980 event had Claude Jarry's *L'Excentrique* finish in fourth place. Jonathan Schaeffer's *Phoenix* (University of Alberta) tied for first in 1986.

The workshop being held as part of the conference promises to be an interesting event. Besides the invited speakers, McCarthy and Michie, expected participants include Ken Thompson of *Belle* fame (Ken is best known for his work on the UNIX operating system), Konrad Zuse (the writer of one of the first papers on computer chess over 50 years ago and a computing pioneer), Hans Berliner from the *Hitech* team (Hans is perhaps the world's foremost authority on computer game playing), Georg Adelson-Velsky, Vladimir Arlazarov, and Mikhail Donskoy (the authors of the *Kaissa* program; Adelson-Velsky is best known in the West as the AV in AVL trees), David Levy with his *Cyrus* program (David made the famous bet in 1968; he is also president of the ICCA), and Kevin Spraggett (Canadian Chess Champion and runner-up in the human World Chess Championship).

The tournament involves five games over four days. The first two games are on Sunday, May 28 (1 and 7 p.m.), with one game each on the following three days (at 7 p.m.). The tournament is being run as a Swiss event, meaning no programs are eliminated and all participants will be there for the full four days. The workshop will be held the Monday and Tuesday afternoons beginning at 1:30. The venue is the Edmonton Convention Center. Admission to both the tournament and workshop is free .

The chess event is being held as part of the annual CIPS Congress '89, being held May 31 to June 2. The theme of the conference is "Prospects for the '90s", and there is an outstanding lineup of over 20 invited speakers, including well-known names such as science fiction writer Ray Bradbury and Sun Microsystems co-founder Bill Joy.

For further information on the World Computer Chess Championships or Congress '89 contact: Jonathan Schaeffer, Department of Computing Science, University of Alberta, Edmonton, Alberta, Canada T6G 2H1. Phone: (403) 432-3851.

Bugs in the Church-Turing Thesis

by Harold W. Thimbleby and Ian H. Witten

Erreurs dans la thèse de Church-Turing

RÉSUMÉ: Les moyens efficaces de calcul par ordinateur sont plus nombreux que ceux couramment utilisés. La disponibilité d'ordinateurs d'une part et d'algorithmes distribués d'autre part nous encourage à résoudre les problèmes d'une certaine manière et à raffiner nos solutions en utilisant les mêmes méthodes. Une réevaluation des hypothèses de départ est nécessaire et nous suggèrons qu'il est possible de faire pire que de questionner certains aspects de la thèse de Church-Turing.

It is very difficult to simulate the behaviour of a simple robot in real time. Even a modest four-legged robot presents interesting numerical challenges. Put briefly, the problem is that the best present-day processors using state-of-the-art numerical techniques are hard pressed to obtain real-time performance. More processors running effective distributed algorithms can only offer linear speed-up.

Yet an ant can run in real time. So in some sense the problem cannot really be *that* hard! Note, too, that a spider, with one-third more legs, does not run appreciably slower; and that a millipede, with an order of magnitude more legs, does not run an order of magnitude slower. Furthermore, the "central processor" of these arthropods

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is probably saturated satisfying the basic cognitive necessities of survival. This biological example demonstrates an important fact about locomotion: if the number of legs is increased by an order of magnitude, yet performance does not significantly degrade, the primary location that computation occurs must be in the legs themselves.

A more compelling observation is that spiders can still run if you pull some legs off (and they probably run faster to escape further damage). Thus legs are unlikely to share computational resources. It would be interesting to correlate the sprinting speeds and gait repertoire of such insects with the number and disposition of remaining legs, although such an experiment certainly raises ethical problems.[1]

An issue for the normal mathematical expression of locomotion is whether legs form open or closed chains (via connection with the ground). The systems of differential equations are substantially different, and different numerical techniques are appropriate for their respective solution. If spider legs do perform the locomotion processing, and they can be removed independently (hence drastically affecting the gait and chain sequencing), it is very unlikely that the form of the problem they solve is expressed in a form computationally equivalent to standard mathematical formulations. No mathematical transformations known to us would be robust under such circumstances. It is interesting to note that the most successful research on legged robots finesses this problem by using one-legged hoppers,[2] even modeling the dynamic problems of biped locomotion by treating it as hopping on alternate legs [2]. In contrast, one-legged biological animals are rare, and adding legs after the first one seems to make things easier in nature.

Yet most workers in this field would say that the immediate solution to the problem of locomotion lies in more computational resources, not less. The search is on for algorithms that better exploit the potential of distributed systems, systolic arrays, etc. It seems to us that something is radically wrong with the accepted approach.

It is as if we expect computers to have great potential, and we have only to realize it. Accepting this premise, the research problem is well defined: what algorithms and heuristics can be developed to realize the latent capability of the computer? But the premise is shaky. It is amusing to observe that computers have an IQ commensurate with the common earth worm, yet people do not spend the time conversing with worms that they do with computers [3]. Computers *appear* to be more worthy of our socializing attention. This suggests that, by various social and psychological mechanisms, we project intelligence into computers that may not be there in principle.

We have shown that simple objects can out-perform the most sophisticated electronic computing elements and algorithms, and that there is no theoretical reason to suppose that computers are able to perform as well. If this is so, there is a serious case to reappraise the Church-Turing Thesis. It would appear that not all methods of computation are so easily compared.

It is a well-known fact[3] that a frog recognizes a fly so fast that only two layers of neurons can possibly be involved in the process. Yet conventional vision processing is computationally demanding — it is almost a joke to compare the complexity of computer programs (even those simulating neural networks) with the simple structure of frogs' brains! Not that we want computers to catch flies.

We know that receptors and neurons can respond to quanta, and that simulation of neural networks should therefore take into account quantum-mechanical effects. If quantum mechanics underlies biological processing, then the simulation of biological phenomena (e.g., robot locomotion) almost certainly requires, for instance, grappling with wave functions. Whatever one's model of quantum mechanics (many worlds, causal interpretation, etc.) in any conventional Turing-equivalent computational framework, things would get harder, not easier.

Quite apart from quantum-level arguments, many neurobiologists believe that the operation of the brain is intrinsically chaotic in nature. This means that the computations it performs may be arbitrarily sensitive to small perturbations in initial conditions, perhaps making the brain impossible *in principle* to simulate on discrete systems.

Furthermore, our example of simple animal locomotion is analogous to an observation of Feynman's about the laws of physics as we currently know them. No matter how small a region of space is under consideration, physical laws do not give us the computational leverage to understand in reasonable time what is going on (even in those very special cases where the laws can be expressed in closed form). A computing engine can take an arbitrarily large number of computations to figure out what is going on in no matter how tiny a region of space, in no matter how tiny a region of time [1]. Yet in some deep sense, that region of space — which can be as small, and therefore as computationally limited, as you like — *does* know what it is doing.

In summary, there are certainly more effective ways of computation than are currently exploited in conventional computing. Whether it is possible to exploit such forms of computational model as flexibly as a conventional computer can be exploited is debatable, but it is certainly the case that the availability of electronic computers and the availability of distributed algorithms seduces us to solve the problem in a certain fashion, and to 'improve' our solutions by doing more of the same. A reappraisal of the underlying assumptions is called for, and we suggest that one can do worse than question the status of the Church-Turing Thesis.

We realize that our arguments are empirical and may for this reason appear informal. But this informality is inevitable. For supposing we could express our criticisms of the Church-Turing Thesis in formal language, then that formality would be within the scope of the thesis, and the criticism invalidated. Only informal arguments can escape this snare.

[1] Particularly the variations where n k_i-legged spiders are networked to make n-processor spiders with Σk_i legs, or hierarchical configurations, e.g., the 64 legged, 9 unit.

[2] A one-legged hopping tank was patented in 1942 that was supposed to be hard to hit because of its erratic movements (Wallace, US patent 2 371 368).

[3] Well-known by frogs, at least.

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```
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if ANY tank level is high
and pulp flowrate > = 600
or discharge pressure is_almost critical
then TEXT
You should check your discharge lines
for blockage. #
cf = 100
then ACTIVATE pumpdiag ; cf = 100
then APPLYRULE * * critical ;
cf = 100 #


Rule 71
if high_interest investment is required
and amount to_be_invested < 100000
and term chosen < = medium period
and deposit option is redeemable
then TELL term deposit
recommended ; cf = 90
then interest earned = amount
to_be_invested * term chosen * term
interest
cf = 100
then TELL interest earned # ;
cf = 100
then REPORT invest.doc ;
cf = 100 #
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Artificial Intelligence Research at the University of Ottawa

by Stan Matwin, Doug Skuce, and Stan Szpakowicz

La recherche en intelligence artificielle à l'Université d'Ottawa

RÉSUMÉ: Cet article d'ecrit les activités de trois chercheurs de l'Université d'Ottawa. Chacun d'eux s'intéresse à l'acquisition des connaissances et à la programmation logique. S Matwin s'intéresse aussi à l'apprentissage machine à partir d'exemples. L'approche de D. Skuce conjugue des aspects relevant de la représentation des connaissances, du langage naturel, des systèmes experts, de la programmation à base d'objets et des formalismes logique et algébrique. S Szpakowicz se concentre sur l'aquisition des connaissances à partir de textes techniques.

The Department of Computer Science at the University of Ottawa has been active in AI research since 1978. At present, the authors of this note consider AI their primary area, while several other colleagues have partial interests in some areas of AI, notably those related to software engineering. This report will try to summarize our past, present, and projected interests.

The common link in our research is knowledge acquisition, though each of us tackles a different aspect of this problem, which has many dimensions. Another common thread is that we all use logic programming, either entirely or partially. The differences will be apparent in the individual reports that each of us has prepared below.

This common interest in knowledge acquisition emerged from two projects that we worked on jointly. In 1984, we were supported by NRC in a one-year project in which we developed an expert advisor system that could answer questions about Canadian government travel regulations. To do this, we developed a simple English-like format for rules that compiled into Prolog-like clauses. The inference engine, written in Prolog, allowed forward and backward deduction and partial matching of rules [18]. From 1985 to 1987, we collaborated with Cognos, Inc., Canada's largest software company, to develop another "advisor" type of system. It accepted questions from a typical user in simple English about one of their products, QUIZ, a fourth-generation report writer. The system combined Prolog, Lisp, and the KEE expert system tool [13, 19, 20].

In both these projects, we became even more convinced that the "knowledge acquisition bottleneck" was a major problem for the development of intelligent systems, and that existing software tools contributed very little to solving the problem. In our present research activities, which we now describe, we are all attempting to come closer to a solution of this problem.

Machine Learning for Knowledge Acquisition (S. Matwin)

My research interests belong mainly in the area of machine learning. I am involved in several ongoing projects that draw upon different approaches to learning from examples. All these projects are focused on specific applications. This research is sponsored by Cognos, Inc., NSERC through a CRD grant, and URIF.

In empirical learning, the LEW (Learning by Watching) system has been developed with Franz Oppacher. LEW is an incremental, inductive system that learns conjunctive concept descriptions from positive and negative examples. LEW imposes very few restrictions on the language in which the examples are specified. It has been designed so that it can easily cooperate with a planner as a performance element. In its initial version, LEW was capable of learning simple rules of programming in the fourth-generation programming language QUIZ. It has also been able to learn the recursive rule solving the Towers of Hanoi puzzle for N disks, given the solution for two and three disks.

In the other project in the area of empirical learning, an experimental system that learns *good-quality* two-tiered concept descriptions has been developed with R.S. Michalski, F. Bergadano, and J. Zhang. In a two-tiered representation, the first tier describes typical properties of a concept in an explicit, comprehensible, and efficient format. The second tier contains inference rules and metaknowledge that define allowable transformations of the concept to handle special and context-dependent cases. We have investigated the non-*trivial* problem of quality of two-tiered descriptions. The quality, in our approach, depends on the accuracy of the description (as captured by its extensionally measured completeness and consistency, as well as the typicality of examples covered by each tier), its simplicity, and its cost. Having defined the quality, we use it to drive a heuristic search in the space of different possible descriptions. Generalizations and specializations of descriptions are used as search operators. Our experiments include learning structurally defined concepts (e.g., the concept of a chair), as well as concepts described in an attributive language (e.g., the definition of a good labour-management contract in the service sector of the Canadian economy).

A current project on case-based learning, again with F. Oppacher, involves case-based reasoning to learn domain-dependent rules of operation of an adaptive planner from inter-domain analogies. Results of this project will be applied in the development of a program

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that will generalize descriptions of software design and will have knowledge about re-using them in similar, but different design problems.

Yet another project investigates the applicability of explanation-based generalization to planning. The idea here is that explanations of solutions can be matched, and analogies that are deeper than the ones between matching cases can be obtained.

Finally, in the context of the NEGOPLAN system, we are looking at genetic algorithms as a mechanism that will invent good negotiating rules from known case studies. The project (with T. Szapiro) is in its initial stage.

Conceptually Oriented Design/Description (D. Skuce)

I began work on knowledge acquisition in 1971. My Ph.D. dissertation concerned how to express typical technical knowledge, such as that of an engineer, biologist, or computer scientist, in an "AI-like" language and system. This has remained my main interest to this day, though in the last few years I have been moving more into software engineering applications of knowledge acquisition and representation. My approach, termed *Conceptually Oriented Design/Description* (COD), combines aspects of general knowledge representation issues, natural language, expert systems, object-oriented programming, and logic and algebraic formalisms like abstract data types.

Currently we have running a prototype knowledge acquisition environment called CODE I (Conceptually Oriented Design Environment I). This system, written in Smalltalk 80, is intended to allow a knowledge engineer or trained expert to create definitions or descriptions of concepts in a friendly, graphics-based environment on a SUN or Macintosh. Each concept, usually corresponding to a noun or verb phrase, is entered into a hybrid frame-cum-object structure, which also may include logical statements in a Prolog-like version of first order logic. The system assists a knowledge or software engineer in assembling a correct collection of such descriptions, termed *conceptual descriptors* (cd's), by displaying them graphically. It automatically performs various property inheritance operations, with warnings about potential conflicts, such as reuse of the same variable or property name and syntax errors. The system can accept statements in a simple English format called ClearTalk (formerly: LESK), which maps directly into cd's. A global lexicon of all terminology is maintained. The user can quickly see the effect of adding, moving, changing, etc., new cd's or their properties using a *property browser*. When a collection of cd's has been created, the system can compile them into the associated logic and pass them to a first order logic engine, written in Prolog, for checking for redundancy or inconsistency. Thus a collection of well-defined concepts that define or describe some system can be built up and maintained.

Potential applications of the COD system include:

- software engineering (specification and design of a software system)
- hardware engineering
- description of an existing system, such as for:
  - an intelligent "help" tool (e.g., UNIX)
  - teaching technical concepts to students (e.g., computer science)
- documenting rules and regulations of an organization
- natural language semantics: a linguist is applying COD to lexical and ontological knowledge acquisition.

A new version (II) is currently being developed. Not surprisingly, we are using version I to assist in the design and documentation of version II: every component is thoroughly described as a cd. Thus version II will come with a description of itself, to assist the new user. Some of its main features are:

- the user may custom tailor the appearance of the cd and define classes of properties that are required (e.g., equations for an abstract data type; wffs for some logic; structured entries for a dictionary)
- a number of specialized property classes will be provided for software engineering purposes; a Ph.D. thesis will investigate using the system as a front end to Smalltalk, LOTOS, and Eiffel
- LOTOS, a formal concurrent system specification language, will be incorporated to assist in debugging concurrent and temporal relations (the LOTOS system has been developed by Prof. Luigi Logrippo of our department)
- user-specific property inheritance regimes can be specified
- the ClearTalk and first order logic modules will be enhanced and more closely integrated with the system.

Knowledge Acquisition from Text; Modeling of Decision (S. Szpakowicz)

My research interests cover several more-or-less closely related areas. The project on knowledge acquisition from technical texts, on which I concentrate now, is a continuation of much of my earlier work in natural language processing and knowledge-based systems. For many years I have been involved, together with J. Bien, Z. Saloni, and M. Swidzinski, in long-term work on the computational description of Polish. Two most recent papers, on the syntax of noun phrases and on the syntactically oriented dictionary of Polish, will be published this year. My experience in computational linguistics combined with my participation in the Cognos Advisor project (directed by D. Skuce in 1985-87) grew into a study of the possibility of extracting knowledge from texts. This study is funded by NSERC and, since 1988, by Cognos, NSERC's CRD grant and URIF. Design considerations and some preliminary results have been published in two papers.

The ultimate goal of the project is a semi-automatic system that will provide intelligent assistance to a person who builds a knowledge base. The domains considered will be command-driven software systems similar to PowerHouse Quiz used in the prototype. An initial conceptual network, containing some general computing concepts as well as essential domain concepts added by a domain expert, will be incrementally augmented with information coming from subsequent fragments of the technical text. The system will maintain the growing network and lexicon, and the text will be stored in a hierarchical form. The linguistic processor will analyze a text fragment. Its conceptualization will be analyzed by a matching module that will tentatively propose how to integrate it into the existing network. Most modules of the system have been prototyped in Prolog and an initial network of Quiz concepts has been created. Several issues must be addressed soon: improvements in the existing software, the study of the adequacy of the conceptual notation I use, the design of an integration

algorithm, and the treatment of non-textual elements of technical texts, such as tables, diagrams, examples.

My other major project is the work on logic-based modeling of decision making. This work, together with G. Kersten, Z. Koperczak, S. Matwin, and W. Michalowski, is a continuation of my research in knowledge representation and my long-standing interest in logic programming (which resulted in several papers and two books on Prolog). We have built NEGOPLAN, a prototype knowledge-based system for negotiation modeling and support, in which one uses two kinds of rules to represent the static and dynamic aspects of the negotiation problem. NEGOPLAN, implemented in Prolog, has been tested on several standard cases and the results have been published in several papers. At present, I am working with G. Kersten on a formal logical model of negotiation and with G. Kersten and Z. Koperczak on an extension of NEGOPLAN into decision making in process simulation and control.

The modified NEGOPLAN can model the behaviour of an autonomous agent in a dynamically and quasi-randomly changing environment; the agent and the environment are the two participants of the decision process. The extension requires an increased expressive power beyond that offered by NEGOPLAN's inference engine. We now allow access to pure Prolog in a way similar to that allowed in logic grammars.

My interest in logic grammars and related methods for computational linguistics dates back to the late seventies. Currently, my only project in this area is the editing, together with P. Saint-Dizier, of a book on logic and logic grammars for language processing. The book, with contributions by leading researchers in this field, will be brought out by a large British publishing company.

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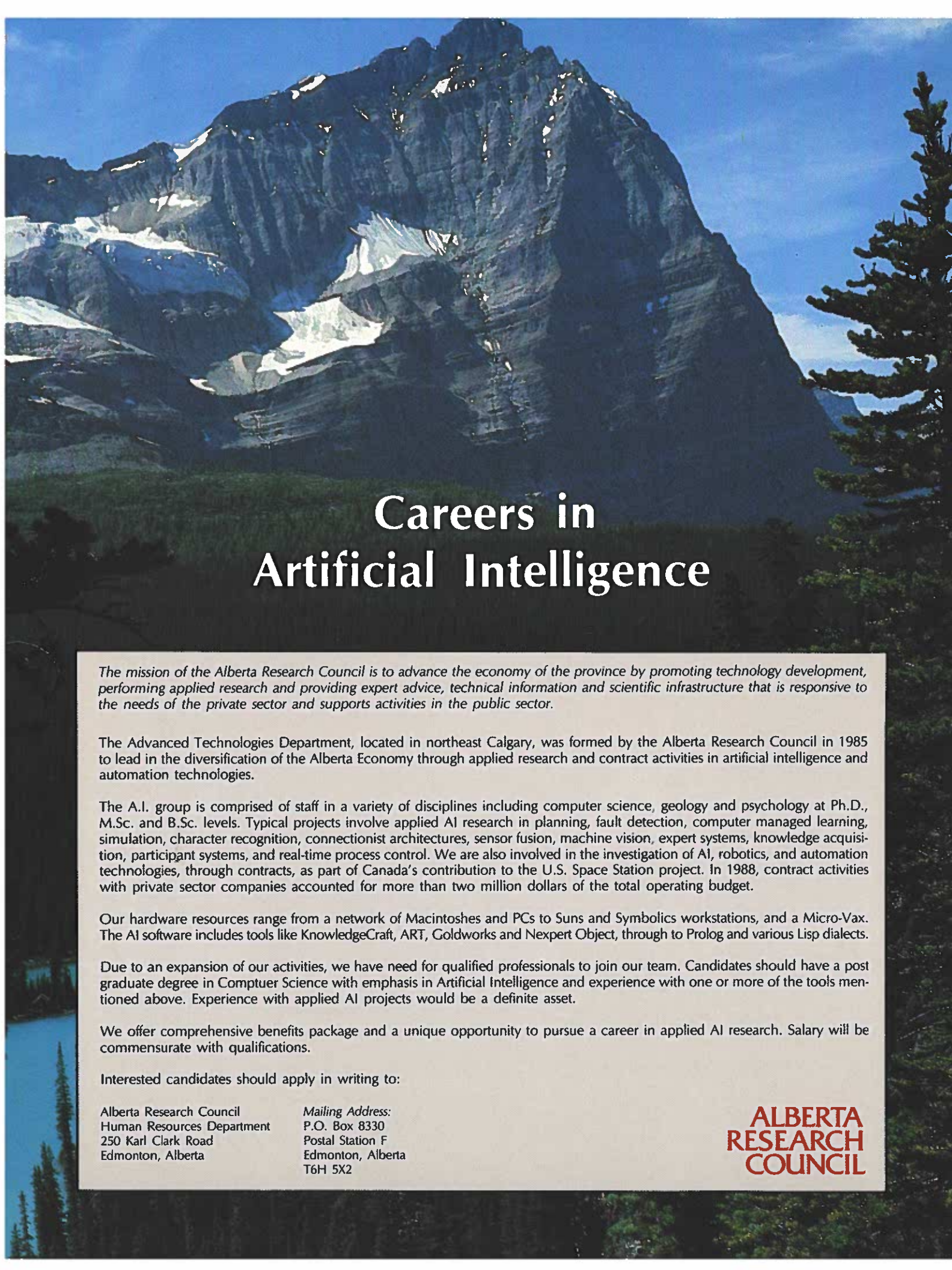

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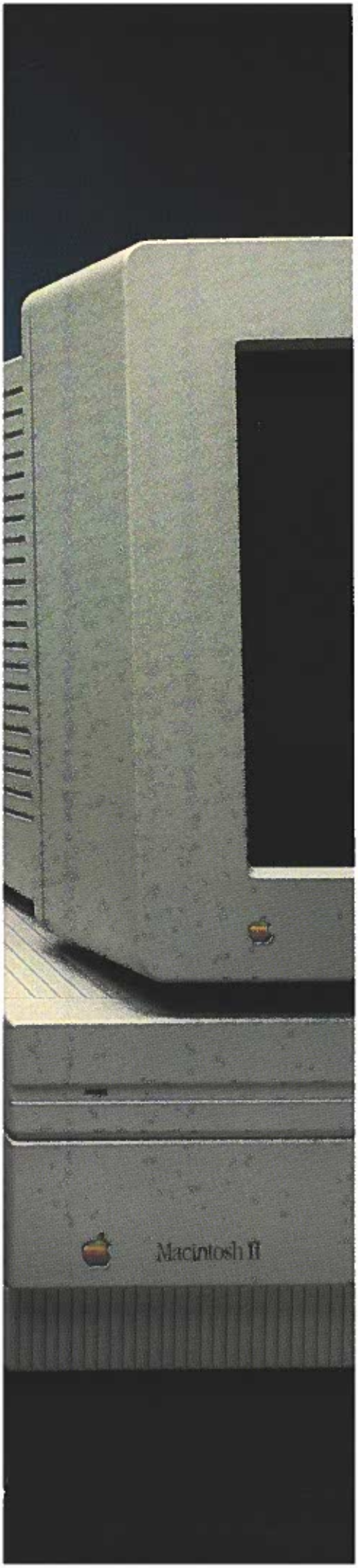

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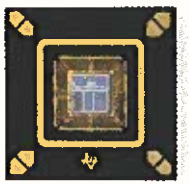

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TEXAS INSTRUMENTS

The 1988 Conference on Computer-Supported Cooperative Work

by Saul Greenberg

La conférence de 1988 sur le travail en collaboration appuyé par ordinateur

RÉSUMÉ: Le travail en collaboration appuyé par ordinateur est un nouveau champ de recherche consacré à l'étude du rôle de l'ordinateur dans le travail de groupe, sur les plans technologique et social. D'une part, sur le plan technologique, cette recherche s'intéresse à des sujets tels que l'informatique répartie, les systèmes de fichiers en réseau, la messagerie électronique et les canaux de communication à large bande. D'autre part, sur le plan social, elle est motivée par l'étude des interactions à l'intérieur des groupes de travail. Les sujets abordés à cette conférence englobaient la communication entre sites éloignés, les installations de travail et leur mise en application, les technologies de communication structurée, le développement de systèmes, les technologies requises et l'environnement, la communication synchrone et le courrier électronique.

26 - 28 September 1988, Portland, Oregon

Computer-supported cooperative work (CSCW) is a new research field focused on the role of the computer in group work. On one hand it is technology driven, motivated by such things as distributed computing, network file systems, electronic messaging, and high-bandwidth communication channels. On the other hand, it is socially driven, motivated by studies of group interaction.

The Second ACM Conference on CSCW was a successful merging of sociology and technology. As a technocrat and computer user, I found myself on the edge of my seat during the descriptions and video presentations of novel systems. With Cruisin', I could wander through a virtual hallway and strike up communications with anyone I happened to bump into, without actually leaving my physical office. I could use the Andrew Messaging System for sending off multi-media mail, such as rasters, complex line drawings, and bits of animation. Through Object Lens, which integrates hypertext, databases and a rule base, I could create intelligent agents to help manage my information-rich world.

In spite of the high creativity component, the conference was not just a show of innovative ideas. As a scientist and designer, I was impressed by both the empirical foundations behind many of the systems and the evaluations of these systems during real use. I was taken by those designers who considered the targeted users to be partners in the design process, by first studying the sociology of the group's interaction in the work setting, discussing with the group how a computer system could provide real support, and then designing the system hand in hand with them.

To my surprise, there was very little hype. Although conference participants believed CSCW important, most seemed to recognize Lucy Suchman's sentiment that:

"...technical development must go hand in hand with the discovery of just what the human enterprises are for which these new technologies might prove useful, and what commitments are involved in designing them to be so."

Dr. Saul Greenberg is a researcher in Human-Computer Interaction in the Concepts group at the Alberta Research Council and an Adjunct Professor at the University of Calgary.

What's in a Name?

What does CSCW mean? Does the general assertion that "it provides computer support for work processes involving more than a single user" give the field any realistic definition? Is it just a buzzword with little meaning? Or is it a generic term that acts as an umbrella for a variety of specializations that already fit well into other recognized domains? A panel discussion on this topic did not come up with any strong conclusion, except that it is too early to pigeon-hole CSCW.

Perhaps the best way to capture the CSCW flavor is to review work performed under its auspices, as exemplified by the papers in this conference. In the remainder of this report, I will try to give the essence of the current interests of CSCW researchers by summarizing each conference session. Of course, I cannot hope to convey the substance and promise of these papers in a few lines, and I do not describe every single paper. My aim is to whet your appetite and to entice you to read the proceedings.

Remote Communication Between Distant Sites

In today's international society, our image of a business meeting is usually a formal gathering held in a conference room, perhaps with participants flown in from distant sites. The much advertised notion of video conferencing (VC) was projected as the closest thing to being there. Dedicated conference rooms linked by high-bandwidth communication lines were envisaged that would allow people located in different cities to meet without the usual time waste and travel costs. Yet there are only about 100 VC sites worldwide, a figure that falls far short of the expected promise. Carmen Egido, of Bellcore, gives two main reasons for this failure. First, vendors gave VC an ill-conceived image as a replacement for face-to-face meetings. Second, VC is based on inade-

quate needs-assessment methodologies. Most formal interactions are not suitable for video conferencing, and travel is not reduced. Rather, Egido notices that VC actually increases the physical face-to-face meetings and argues that it is best viewed as a supplement to, rather than a replacement of, the normal meeting process.

A shift in thinking is required. It is not necessarily planned meetings that are best supported through computer mediation, but informal meetings. Robert Kraut, Carmen Egido, and Joanne Galegher, also of Bellcore, argue that many interactions are required for people to find partners for collaborative work. Since communication between people has an exponential decay with distance, CSCW could bring people into contact through frequent, unplanned, high-quality, and real-time interactions that come at low personal cost. This is where Robert Root's imaginative Cruisin' prototype comes in. Described as a social interface, it is a multi-media desktop communication system. The Cruisin' user can walk around a virtual hallway and, just as in real life, can take a peek into open offices and start conversations if desired. A real-time video link is opened between the visitor and the occupant. For privacy, "doors" can be kept wide open, slightly ajar, or closed.

Work Settings and Applications

When collaborations within everyday work settings are examined, potential applications of CSCW may come to mind.

Anthony Gorry and his colleagues from the Baylor College of Medicine examined how members of a biomedical research group could coordinate efforts and share information. Their aim is to allow a researcher to scan, filter and manage information, to use the information for decision-making, and to disseminate it to the rest of the team and to outsiders through a "web" of interactions. In their implementation, users can structure or filter their information and their collaborations through sets of templates (structured messages), each tailored to fit a task. Templates exist, for example, for searching online medical databases and for sending and selectively receiving mail. Through templates, a uniform interface is created between group members and sources of information. Furthermore, all information can be pasted and presented in a hypertext system that allows its users to share information to the degree appropriate to their activities.

Suchman and Trigg observed that we have to uncover the largely unarticulated detail of what people actually do when they work together if we are to design technology that supports collaborative practices. Charlotte Linde, of the NASA Ames Research Center, embraced this challenge by questioning the common (and perhaps naïve) assumption that the authority status of participants within an organization is fixed. Through extensive videotapes, she observed a flight officer and pilot on board a helicopter engaged in police missions. The pilot is responsible for all on-craft decisions, while the officer is responsible for the actual police mission. She observed a quite complex social structure. In particular, the "authority status" of crew members was subject to moment-to-moment negotiations, invoked as a normal, unremarked background condition of the ongoing daily operations. Linde suggested that negotiating authority is quite common in most collaborative work, and that it would be a mistake to rely only upon the formal organizational hierarchy when deciding upon the authority of participants.

Perspectives on Evaluation

One sure sign of professionalism in a field is the presence of self-criticism. Considering the cost of designing and building a CSCW application and its impact on an organization, realistic criticism is especially important. Jonathan Grudin, of MCC, presented a well-written paper on why CSCW applications fail, a paper that I believe should be read by anyone considering computer-supported collaboration. He notes several telling reasons for failures that seem common to less than successful systems. First, there is a disparity between those who will benefit from a CSCW application and those who must do additional work to support it. For example, an automatic meeting scheduler is of benefit to a meeting organizer, but the burden is placed on all group members to keep their calendars up to date. Second, there is a decision-making failure that leads to ill-fated development efforts, due to the lack of management intuition for these applications. Since groupware is used by many people with different organizational roles and responsibilities, one manager's visions and intuitions about a system would misrepresent its actual use. Third, there is a failure to learn from actual experience because it is extremely difficult to evaluate these applications. Proper evaluation requires methodologies from sociology and anthropology, fields that are largely absent in current research and application environments. Grudin suggests that we must be aware of these problems if we are to overcome them.

Unlike most American approaches that try to package a set of techniques together to do a job, designers in Scandinavia start out with a problem situation defined by workers, and work beside them in order to develop a new system that is "owned" by the workers. Joan Greenbaum, of the Århus University in Denmark, exemplifies this approach by taking a historical perspective of work organization and management strategies. In essence, she argues that the Scandinavian view of user participation in the design process is part of *building democracy in the workplace*. She indicates two central issues in the move to workplace democracy. First, democracy needs to be viewed as active participation in planning and decision-making, thus making worker involvement far more than techniques for improved human-computer interfaces. Second, CSCW means that computer systems need to reinforce forms of cooperation that enhance the chance for a more democratic workplace. For example, information flow in a CSCW application could emphasize lateral movement, as opposed to the top-down flow through authority normally seen in management. Planning functions could then move from current rule-based bureaucratic realms to situations where groups assume the stronger role.

Structured Communication Technologies

Certain types of communication contain a well-defined structure. A mail message, for example, usually has three primitive fields: a sender, an address, and a body. If the structure is well articulated, a CSCW application can take advantage of it, as illustrated by the two systems below.

Kum-Yew Lai and Tom Malone, from MIT, introduced Object Lens, a second-generation version of their fairly well-known Information Lens. Object Lens contains two fundamental ideas. First, passive information can be represented as semi-structured objects, where each object is defined as part of an inheritance hierarchy. For example, consider the added structure as one goes down the following hierarchy branch:

"Thing—Message—Action Request—Meeting Proposal" Whereas a message may be a primitive mail form, a meeting proposal may include time, place, decision requests, and so on. By defining and modifying templates for these objects, users can represent and interact with many different kinds of information. Second, active rules for processing information are represented as semi-autonomous agents. When creating these agents, users specify rules for automatically processing information in different situations. A rule triggered by incoming news from a bulletin board may, for example, sort the interesting and topical news into appropriate folders, discarding the rest. With these two ideas, Object Lens integrates object-oriented databases, hypertext, and electronic messaging with intelligent routing. The seemingly simple user interface of Object Lens belies the work effort of building it.

Jeff Conklin and Michael Begeman, of MCC, presented gIBIS, a hypertext system that captures early design deliberations on large, complex problems. It is based upon the Issue Based Information Design (IBIS) methodology that views design as a rhetorical process, with a set of issues that can be generalized, specialized, responded to, questioned, argued, and so on. As with Object Lens, gIBIS is based to a large part on semi-structured messages. Through its well-designed interface, participants propose and respond to issues in structured ways that eliminate nonconstructive moves such as name calling and argument by repetition. To the authors' credit, they not only presented but also evaluated and criticized their work based upon preliminary observations of its use.

Practical Experiences in System Development

How does one get started in designing systems for collaborative work? The presenters in this session, all from Scandinavia, shared their practical experiences of system development using approaches that are novel to American researchers. The Scandinavian approach, as introduced in a previous section, is best summarized by a quote from Grudin's paper:

> "...start out with a problem situation defined by workers, and work beside them a long time in order to develop a new system that is 'owned' by the workers.... This is very different from traditional systems development.... You can't simply package a set of techniques to do the job."

Berman and Thoreson shared their experience of a cooperative systems development project involving centralization of several previously independent surgical departments in a hospital. A few simple cases illustrate that the conventional development process is wrought with conflicts, contradictions, and challenges. In particular, the design of a cooperative system can neither be pushed by technology, nor by the workers' view of what they require. Rather, the process is collaborative, where both designer and end user forward and evaluate ideas during system development.

From Århus University, Morten Kyng offered one such design methodology in the paper "Design for a dollar a day". He stepped through the Scandinavian experiences with end user participation and reviewed several tools and techniques that will: 1) establish possibilities of alternative forms of work within the workplace; 2) evolve the local work situation through a cycle involving situation analysis, goal discussion, and investigating possible courses of action; 3) create a vision of new and different uses of technology; and 4) view the design through mock-up simulations.

Finally, Bjerknes and Bratteteig described their experiences with the "ultimate test" of a CSCW system built according to the Scandinavian approach by evaluating its use several months after installation. Through a series of flashbacks of diary clips and analysis, they brought us through the design process, giving the reader insight as to what happened and why things were designed a certain way. The result of their ultimate test did more than show a system in active use, for it described several surprising work habits that had developed.

Most participants at CSCW '88 received the Scandinavian approach with both respect and excitement. This is not a surprise, for Scandinavia was following the collaboration theme throughout the design process.

Enabling Technologies and Environment

Another research product from the Bellcore labs is Quilt, a tool for collaborative document production. Unlike other collaborative document systems that support only direct authoring aspects, Quilt emphasizes and supports the communication vital to good collaboration. For example, structured hypermedia links allow people to attach text and voice annotations to the document, specialized as revision suggestions, public comments, and directed messages. The necessary coordination among collaborators is enhanced via activity logging, notification, and triggering mechanisms. Access permissions can be set by the author to reflect the varying roles of collaborators (as writers, commentators, reviewers), while user-customizable definitions for such things as document and annotation types make the system both flexible and extensible.

Randall Trigg, the creator of the Xerox Notecards hypertext system, tackled the "lost in hyperspace" problem — the difficulty of navigating through complex hypertext networks. Unlike sequential documents, the rich interconnections in hypertext may make it difficult for the unguided reader to follow paths preferred by the author (e.g., introductory tours through the document). Trigg introduces two new Notecard techniques to ameliorate this problem: "tabletops" and "guided tours". A tabletop records a specific set of notecards (hypertext fragments) and their layout on a screen. A guided tour is a graphical interface that allows one to navigate between tabletops. Normal notecards can further supplement a tour by pointing to and annotating other cards on the tabletop. In this way, an author can "guide" the reader through the text. Is this the start of meta-hypertext?

Synchronous Communication

Two papers from Xerox PARC concern work surface artifacts produced during meetings, such as notes, drawings, and annotations. The conventional view considers these artifacts as a medium for storing information and conveying ideas and pays little heed to how they are created. In the first paper, Tang and Leifer use detailed transcripts of design sessions to examine the possible purposes behind activities of a small design team who share a drawing surface. They find that artifacts, when combined with a person's gestures, are just as valuable for representing ideas and for engaging attention. A graphic evolves along with ideas into a final artifact, and gesturing is used for pointing and focusing attention during the collaboration. They conclude that too much attention has been paid to the artifacts left behind from

collaborative meetings. In many cases, these are just marks that are inherently meaningless. The process of creating drawings and gesturing to them may be as important to the design process as the drawings themselves.

The same result is furthered in the second paper. Here, Bly observed designers communicating through three different media: face to face; over a video link that included a view of the other person and their drawing surface; and over the telephone. From her observations, she hypothesizes that the actions, uses, and interactions on a drawing artifact are as important to the effectiveness of many design collaborations as viewing the final artifact. Also, allowing designers to share drawing space activities increases their attention and involvement in the design task. When interaction over the drawing surface is reduced, the quality of the collaboration decreases.

In the final paper Marilyn Mantei, from the University of Toronto, described how hard it was to design CoLab. CoLab is a face-to-face meeting room that includes a computer console for every participant and a shared electronic blackboard. She discussed three seemingly trivial but ultimately important design decisions made: seating arrangements, interviewing distances between participants, and access protocols to the shared blackboard. Problems for seating included political ones — issues such as table shape, chair placement, and blackboard location were critical if they were to reflect the existing power structure of the attendees — and physical ones that concerned viewing of the screen and effective lighting. When interviewing distances were too great or computer monitors were obtrusive, Mantei noticed that participants would not speak to each other as much as normal. This problem was solved by recessing monitors into the table and by including an optical illusion on the table surface that made people appear closer together than they really were. Access protocols to the shared blackboard was found to depend on the meeting type. For example, interactive meetings saw all participants writing to the board; "rotating scribes" (the most common) saw people take turns acting as funnels of information; and the designated scribe saw one person responsible for entering all information. Mantei's lesson is that CSCW is much more than software and must also cover political, physical, and social processes. Even a seemingly trivial detail can change the nature of meetings held in a room.

Electronic Mail

Perhaps the greatest success story in CSCW is electronic mail (email). A case study of email use offered by Everland and Bikson, from the Rand Corporation, poignantly illustrates this success. Their study considered two slightly different groups in a natural office setting. Both groups comprised two types of people: normal employees who worked in the office and ex-employees (retirees) who were usually at home. While members within each group could communicate between each other in conventional ways, one group also had basic email facilities. They found that retirees using email had a much higher rate of communication with other members of the group than those who did not have email. Also, communication did not cluster as much when email was used — the boundary between cliques was not as sharp. In this case, email was successful in keeping retirees and their expertise involved with the office. The overall interpretation is that email significantly and directly affects the process and outcome of cooperative work.

The Andrew Messaging System is built on the premise that mail is more than just text. Its important points are that it is a combined mail/bulletin board facility and that it is multi-media. One can, for example, transmit line drawings, rasters, animations, and spreadsheets; ask for responses to a message via mail that asks its reader to select from a list of choices; and compile articles into magazines for further distribution on the bulletin board. Through the examples of how Andrew was actually used at Carnegie Mellon University, Borenstein and Thyberg leave a positive impression of what advanced email technology could offer.

Finally, MIT's Wendy Mackay claims that email is more than just a communication system, for it also supports a variety of time and task management activities. She studied email users and rated them in several categories, each with quite different habits and objectives. Prioritizers concentrate on the problem of managing incoming messages. Archivers concentrate on archiving information for subsequent use, and delegators delegate mail by passing it on to others. Mackay's study indicates that mail use is strikingly diverse, and that designers of email should recognize this diversity by designing systems that provide flexibility over a wide range of users.

Perspectives

The final session gave the audience perspective on the area of CSCW. Reder and Schwab reminded us that there are usually many channels of communication available to people within a work group. As a consequence, a CSCW system will assume a variety of socio-functional niches, competing with other electronic or traditional communications systems. Many variables affect how a system fits into an existing communication environment (e.g., functional equivalence between systems, organizational decisions, nature of the task, etc.). When multiple communication channels are available, people should be expected to — and will — switch among them. For example, an email communication may be continued by a face-to-face meeting, perhaps followed by several phone calls and a reminding memo. Reder and Schwab argue that the choice of the communication channel and the switching among them are a natural part of a person's communication strategies and tactics and must be considered when installing a new CSCW system in the workplace.

Don Norman closed the conference by asking several fundamental questions about CSCW. Why use it? Where should it be used? What is its role? He said that there are serious problems in the CSCW area because we have to understand how people work together, an understanding we lack. Unlike standard interface design, we cannot rely on our intuitions, for a CSCW system has to differ for each user. Norman introduces the intriguing term "distributed cognition" as a new area of study. Since knowledge, skills, and people are distributed, we need methods for understanding how all interact with each other.

The conference was exciting, and the proceedings are well worth reading. Copies of the Proceedings may be ordered prepaid from: ACM Order Department, PO Box 64145, Baltimore, Maryland 21264 USA.

Related work can be found in the December 1988 issue of *Byte*; Irene Greif's book *Computer Supported Cooperative Work: A Book of Readings* (Morgan Kaufmann Publishers); and the *ACM Transactions on Office Information Systems* (see Vols. 5/2, 1987, and 6/3, 1988).

The Second International Conference on Computer Vision

by Gregory Dudek

La seconde conférence internationale sur la vision par ordinateur

RÉSUMÉ: La seconde conférence internationale sur la vision par ordinateur s'est acquis une bonne réputation en tant que conférence majeure à caractère académique sur la vision. Les quelque cent communications portaient presqu'exclusivement sur des problèmes théoriques ou scientifiques, accordant peu d'importance aux applications ou à la vision en milieu industriel. Les principaux sujets abordés furent l'analyse du mouvement, l'analyse et la description de la forme et la vision robotique. La représentation canadienne à cette conférence était très forte.

5 - 8 December 1988, Tampa, Florida

The second International Conference on Computer Vision (ICCV) was held at the Innisbrook resort, Tampa, Florida, last December. Despite the fact that this is only the second in this conference series (the first ICCV was held in London, England, in 1987) it has already achieved a good reputation as a major academically oriented vision conference. Of the 309 submitted papers, 100 were accepted, 36 of them as long papers and 54 as short ones (these were allocated 10 pages, with 30 minutes for presentation, and 5 pages, with 20 minutes for presentation, respectively). Both the setting and the weather were exceptional and it was not without a hint of regret that I discovered that the sheer volume and density of good papers was such that it prevented me from escaping to the beach for even a single session.

Unlike other major international conferences with a substantial vision component, such as the conference on Computer Vision and Pattern Recognition or the International Conference of Pattern Recognition, the papers presented here focused almost exclusively on theoretical or scientific problems, with little emphasis on applied or industrial-vision concerns. Although this provided a more uniform theme for the conference both in terms of presentations and audience, it also provoked substantial disagreement. A number of attendees were dismayed by what they perceived as a one-sided approach to the field. In fact, this concern had been brought up in a recent PAMI technical committee bulletin (the IEEE Pattern Analysis and Machine Intelligence technical committee sponsors ICCV) and in conjunction with some other contentious issues provoked a particularly stimulating debate at the PAMI technical committee meeting that took place on the second evening of the conference.

Canadian representation at the conference was very strong. The submission by Brian Funt and Jian Ho of Simon Fraser University entitled "Color from Black and White" won the Marr Prize for the best paper, and David Lowe of the University of British Columbia was one of the three runners-up for the prize with his paper "Organization of Smooth Image Curves at Multiple Scales" (the other runners-up were the papers "Representing Oriented Piecewise C-2 Surfaces" by V. Nalwa and "The Motion Coherence Theory" by Yuille and Grzywacz). In fact, 40 of some 250 attendees were from from Canada and included representatives from UBC, Simon Fraser, Toronto, and McGill. Of the 100 papers accepted, a substantial number were from Canadian institutions, including: "Color from Black and White" (B. Funt and J. Ho, Simon Fraser University), "The Feasibility of Motion and Structure Computations" (J. Barron, A. Jepson, and J. Tsotsos, University of Toronto), "Multi-grid Bayesian Estimation of Image Motion Fields Using Stochastic Relaxation" (J. Konrad and E. Dubois, INRS-Telecommunications, Verdun, Quebec), "Organization of Smooth Image Curves at Multiple Scales" (D. Lowe, University of British Columbia), "Recovering Shape Deformations by an Extended Circular Image Representation" (E. Milios, University of Toronto), "Evolution Properties of Space Curves" (F. Mokhtarian, University of British Columbia), "Singularities of Principal Direction Fields from 3-D Images" (P. Sander and S. Zucker, INRIA and McGill University), "The Organization of Curve Detection: Coarse Tangent Fields and Fine Spline Coverings" (S. Zucker, C. David, A. Dobbins, and L. Iverson, McGill University).

Motion analysis proved to be one of the dominant themes of the conference, with over half the sessions devoted to it. Specific topics included early motion measurement from a variety of sources, shape and structure from motion, and the limitations and stability of motion measurement. Shape analysis and description was also a major theme, although there was less uniformity in the range of approaches and issues discussed than in the motion papers. The extraction of shape information from line drawings continued to be a significant topic, including such issues as the efficient construction of characteristic views and the inference of occluding boundaries. Several interesting approaches for extracting information from photometric information, such as reflectance information, were also presented. A number of papers discussed the use of visual information in robotic systems. Related issues were the use of real-time control strategies for acquiring visual information when and as needed, as well as techniques for making inferences from a series of dynamically acquired images.

In summary, this proved to be a stimulating conference dealing with a broad range of current issues in computational vision. Although no drastically new paradigms for the field were presented, the scope and technical content of the papers confirm the consolidation and maturation going on within the vision field. It appears the ICCV has confirmed its position as one of the major international conferences dealing with this subject.

Gregory Dudek is a Ph.D. student working on computational vision in the department of computer science at the University of Toronto. His research interests include object recognition using 2 1/2-D models and curvature information, segmentation using multiple sources of information, and robotic path planning.

Etude spéciale de nombre de lecteurs

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Book Reviews

edited by Graeme Hirst

Computer Vision: A First Course

Boyle, Roger D.; Thomas, Richard C.
[University of Leeds]

(Artificial intelligence texts)
Oxford: Blackwell Scientific, 1988, ix+220 pp
Paperback, ISBN 0-632-01577-2, US$29.25

Reviewed by
David G. Lowe
University of British Columbia

There is a critical need for a good introductory text to the field of computer vision, so it was with great interest that I examined this latest candidate. The aim of this book is to provide an accessible introduction to upper-level undergraduate or beginning graduate students. It is clearly written and has an attractive format, with many illustrations, so the first impression is favorable. However, I must sadly report that the book fails to achieve its objective and must be considered unsuitable as a serious introductory text.

The most basic problem is that the book attempts to cover the field of computer vision without any significant use of mathematics. While there is always a place for descriptive introductions to various fields for the layperson, it is doing students a great disfavor to pretend that this is the path to serious work in the area. As any study of current research in computational vision will demonstrate, the most successful work in the field is almost all based upon formal mathematical models. The mathematical requirements for the study of vision are somewhat uncomfortable for members of computer science departments, where many students have not been encouraged to obtain much of a background in continuous mathematics. However, this only increases the need for an accessible mathematical introduction to computer vision that builds the necessary tools on an introductory level. In most other respects, computer science students have an ideal background for work in computational vision due to their understanding of computation and ability to connect theory with computational reality. Unfortunately, the appropriate texts to provide the necessary mathematical introduction to computational vision are largely lacking (more on this point later).

The avoidance of mathematical development is no doubt at the root of many of the shortcomings in this book. For example, the only treatment of edge detection is in terms of Roberts and Sobel operators followed by a form of relaxation enhancement. There is no real discussion of the concepts of spatial frequency or scale. The authors seem to have some realization of these shortcomings, as there is a brief appendix at the end summarizing "Fourier theory". Unfortunately, this brief summary could only be understood by someone who has already mastered the material. As we move to higher-level aspects of vision, there are a number of other deficiencies. The only method for stereo correspondence discussed is the early Marr-Poggio algorithm, and there is no mention of the random-dot stereograms for which it was developed. Presumably it was selected due to its mathematical simplicity. One mistake this book shares with a number of other introductory texts is that it describes Roberts' early recognition system under the topic of "line labelling", simply because it shares a blocks-world domain with other work on line labelling. In fact, the methods it uses are entirely different. The description of high-level vision is very abstract, with the emphasis on concepts such as semantic networks rather than matching and recognition.

The authors themselves say that the purpose of the book is to provide only "the vocabulary and a grounding on which advanced study could be built". While some may argue that it provides this form of introduction, my concern is that it would mislead students regarding the type of reasoning and research appropriate for the field.

Let me now move to a more general discussion regarding the choice of textbooks for courses on computer vision, to see what the alternatives might be. I have tried using a number of different texts in the past for the various computer vision courses I have taught, but unfortunately they all have significant shortcomings.

The one book that can fill the role of a basic text, in the sense of containing a clear, comprehensive development of some of the basic principles of the field, is *Robot Vision,* by B.K.P. Horn (MIT Press, 1986). This provides a solid introduction to most of the lower-level aspects of vision, up to the level of image processing, edge finding, and shape from shading. Unfortunately, the coverage of the higher-level aspects of vision is largely based upon the author's particular areas of interest, and there is little coverage of many of the major current directions of research in the field. Here at the University of British Columbia, we have chosen to use Horn's book as the text for our first-semester graduate course in computational vision, but we are still left with a difficult choice to make for our second-semester course on the higher-level aspects of vision.

One book I have used in the past is *Computer Vision,* by D.H. Ballard and C.M. Brown (Prentice-Hall, 1982). This book makes a valiant attempt to survey a large part of the field at the time of writing, but as a result fails to devote enough space to give detailed understanding and insight to many of the selected topics. Unfortunately, there has been no new edition since the original publication and much of the material has begun to seem dated. Another useful survey, which is aimed instead at the connections between biological and machine vision, is *Vision in Man and Machine,* by Martin D. Levine (McGraw-Hill, 1985). This is a very useful reference, but once again it achieves broad coverage at the expense of the detailed development and insight that is so important for an introductory text. *Machine Perception,* by R. Nevatia (Prentice-Hall, 1982) has a good choice of topics but lacks the length and depth needed for a basic text. On occasion, I have used Marr's *Vision* (W.H. Freeman, 1982) as a supplementary text. This book is notable for providing a coherent framework and set of goals for the study of vision, but it attempts to cover only one particular approach and lacks

many of the mathematical and algorithmic details needed for a fundamental understanding of the material.

As a result, the solution I have currently adopted is to teach the higher-level vision course on the basis of a selected set of research papers. This is far from ideal, given that most of these papers are written to address narrow research issues and given the lack of good survey papers. However, it does have the advantage of exposing students immediately to the primary research literature. Unfortunately, the various existing collections of research papers, such as *Readings in Computer Vision,* edited by M.A. Fischler and O. Firschein (Morgan Kaufmann, 1987) or *From Pixels to Predicates,* edited by A.P. Pentland (Ablex, 1986), aim to provide a sampling of current research rather than to provide systematic introductions to various subfields.

One can only hope that further attempts will be made to produce useful textbooks on computer vision, particularly for the higher-level portions of the field. The lack of standard texts is one reason for the explosion of terminologies and variant approaches seen in much of the field and contributes to the ongoing confusion over which problems are central, which are peripheral, and which have been solved. One positive step would be to create a forum for the publication of prestigious survey papers on various subfields within computational vision, in much the way that many other scientific fields attach great significance to substantial review articles. Such review articles could then provide a framework and guidance for the creation of introductory textbooks, such as the one reviewed above.

David Lowe is an assistant professor of computer science at the University of British Columbia and a Scholar of the Canadian Institute for Advanced Research. His research has been on the design of 3-D model-based vision systems and on theories of human visual recognition.

Cognizers: Neural Networks and Machines That Think

Johnson, R. Colin; Brown, Chappell

(Wiley Science Editions)
John Wiley and Sons Canada Ltd, 1988, xi+260 pp
Hardbound, ISBN 0-471-61161-1, Cdn$32.95

Reviewed by
Tony Plate
University of Toronto

Cognizers is a personal view of the history and current state of artificial neural network (ANN) research written by two science journalists. It appears to be intended as an introduction to ANNs for the casually interested layperson. There is little technical content, but the reader new to neural networks will gain some insight into the history and workings of ANNs. A considerable amount of the book is taken up with descriptions of the history of neural and nervous system research and with philosophical discussions on such matters as intelligence, consciousness and the mind-body problem. The philosophical discussions, and for that matter the entire book, are characterized by a lack of rigor. Furthermore, the discussions of the capabilities and future of ANNs are not marked by a high degree of sober and critical analysis.

The scope of the book is broad: it attempts to cover all aspects of ANNs. The chapters concern (more or less) the following topics:

(1) The history of computing and the problems with conventional computing
(2) The history of neural research
(3) Sensory apparatus, its relationship to the mind and brain, and the attempts of Carver Mead at building artificial sensory apparatus
(4) The insights of Hopfield and of Grossberg
(5) Learning algorithms for ANNs
(6) Attempts to build ANN hardware
(7) Example of a successful "cognizer" (NETtalk) and the simulation of ANNs
(8) Philosophical problems to do with the mind and consciousness, and their solution
(9) Applications of "cognizers" and speculation
(10) Epilogue.

Johnson and Brown use the word *cognizer* as a name for ANNs, out of a desire to not call them computers. Doing so would imply that the brain is also a computer, an implication they strongly wish to avoid. A strong distinction is made between computers and cognizers: A computer is a digital machine that follows explicit, programmed rules, and a cognizer is an analog machine that learns from its environment. This distinction is motivated by a not unreasonable desire to have the term *computer* mean something; they argue that if the brain is considered a computer, then so should be a transistor radio. However, although this distinction might initially seem clear and useful, it is difficult to maintain in the face of the universality of computation and the ability to accurately simulate analog systems on digital computers: should a digital radio be considered a computer? Consequently the authors seem to be driven to claim that computers simulating ANNs can do things that computers can't do.

The coverage of ANN schemes is uneven and uncritical. Nearly as much space is devoted to Grossberg's "Adaptive Resonance Theory" (ART) as is devoted to all other ANN schemes combined. Back-propagation and the Boltzmann machine receive very little coverage. There is almost no discussion of the relative merits of the various schemes described or of their similarities and differences. It is mentioned that the work of Grossberg is often either revered or discounted by his colleagues, but no hint is given as to why.

One of the most unfortunate omissions is that of a discussion of distributed representations. A significant proportion of ANN schemes involve the use of distributed representations, and many of the properties of those schemes are a consequence of the use of distributed representations. For example, error tolerance, damage tolerance, soft capacity limits, and representational efficiency are usually all consequences of using distributed representations. The topic of distributed representations is only touched upon very briefly in discussions of particular ANN algorithms. This omission is probably related to the emphasis on Grossberg's ART and the very light coverage of back-propagation and Boltzmann machines; distributed representations are used to a far greater extent in the latter. Given the general importance of distributed representations in ANN research, one might expect to find an entry for them in the index, but there is nothing between "Disembodied existence" and "Double-aspect theory".

The lack of rigor is manifested in a number of errors and half-truths, and controversial claims are made with

little support. Some of the errors appear to be consequences of the authors' misunderstanding a particular neural network scheme, and others are errors that affect their overall conception of ANNs and their relationship with computers. An example of the first is the mischaracterization of John Anderson's "Brain state in a box" model. The interpretation in this book is that the neurons are at the corners of the "box", whereas the correct interpretation is that the corners of the "box" represent the possible states of the system. One example of the second kind of error is their mystical invocation of "the forces of chaos":

> Somehow, the brain is harnessing chaos to solve problems, whereas computers are limited by determinism [p. 16].
>
> and
>
> Rather, cognizers appear to be harnessing the forces of mathematical chaos to arrive at conclusions without computation [p. 231].

These claims are not backed up by discussion or evidence. One can only conclude that Chappell and Brown misunderstand the nature of "chaos"; "chaotic" phenomena are deterministic even though they may be unpredictable in practice. Also annoying are the frequent and unsupported claims about what computers and logic-based systems cannot do. For example:

> Still, the increasingly popular AI symbolic processors create only an artificial intelligence because they merely manipulate symbols according to rules. The problem of how those symbols can contain meaning is a serious barrier to further development of traditional AI techniques. Cognizers, though, have the same notion of meaning that humans do because they model the same processes of acquiring information from the world and recalling it from memory [p. 245].

Overall, *Cognizers* is moderately interesting but suffers from a lack of rigor, its uncritical approach, and its propensity for hyperbole. This reviewer found the histories of neural and artificial neural network research to be the most interesting and best presented material in the book. In attempting to cover all aspects of artificial neural network research, it covers none in any depth. While it might be a good introduction to neural networks for the interested layperson, a person working in AI who wanted to gain an understanding of neural network algorithms would do better to look at the volumes of *Parallel Distributed Processing* by Rumelhart, McClelland, and the PDP research group.

Tony Plate is a Ph.D. candidate in the Connectionist Research Group, Department of Computer Science, University of Toronto. His research concerns sequential pattern recognition in connectionist networks.

Books Received

Books listed below that are marked ‡ will be reviewed in a future issue. Reviewers are still sought for those marked with an asterisk. Readers who wish to review books for the magazine should write, outlining their qualifications, to the book review editor, Graeme Hirst, Department of Computer Science, University of Toronto, Toronto, Ontario, Canada M5S 1A4. Obviously, we cannot promise the availability of books in anyone's exact area of interest.

Authors and publishers who wish their books to be considered for review in *Canadian AI* should send a copy to the book review editor at the address above. All books received will be listed, but not all can be reviewed.

‡ **Artificial Intelligence and Databases**
Mylopoulos, John; Brodie, Michael L. (editors)
[University of Toronto and GTE Laboratories]
San Mateo, CA: Morgan Kaufmann, 1989, vii+688 pp
Paperbound, ISBN 0-934613-53-2, US$34.95

‡ **The Artificial Intelligence Debate: False Starts, Real Foundations**
Graubard, Stephen R. (editor)
Cambridge, MA: The MIT Press, 1988, 311 pp
[Originally published as issue 117(1) of *Daedalus*, Winter 1988]
Paperbound, ISBN 0-262-57074-2, US$9.95

Artificial Intelligence III: Methodology, Systems, Applications
(Proceedings of the third international conference on Artificial Intelligence: Methodology, Systems, Applications [AIMSA '88], Varna, Bulgaria, 20-23 September 1988)
O'Shea, Tim; Sgurev, Vasil (editors)
[The Open University; Bulgarian Academy of Sciences]
Amsterdam: North-Holland, 1988, xii+ 444 pp
Hardbound, ISBN 0-444-70508-2, US$94.75, Dfl 180.00

Applied Natural Language Processing
Shwartz, Stephen C.
Princeton, NJ: Petrocelli Books, 1987, xxvi+292 pp
Paperbound, ISBN 0-89433-260-0, US$35.95

* **Automatic Refinement of Expert System Knowledge Bases**
Ginsberg, Allen
[AT&T Bell Labs]
London: Pitman, 1988, viii+176 pp
(Research notes in artificial intelligence)
Distributed in Canada by John Wiley & Sons Canada
Paperbound, ISBN 0-934613-96-6, Cdn$34.95

* **Formal Methods in Artificial Intelligence**
Ramsay, Allan
[University of Sussex]
(Cambridge tracts in theoretical computer science 6)
Cambridge University Press, 1988, ix+279 pp
Hardbound, ISBN 0-521-35236-3, US$49.50

New Directions in Machine Translation
(Proceedings of the conference, Budapest, August 1988)
Maxwell, Dan; Schubert, Klaus; Witkam, Toon (editors)
[BSO Research, Utrecht]
Foris Publications, 1988, 259 pp
Paperbound, ISBN 90-6765-378-0
Hardbound, ISBN 90-6765-377-2

Philosophy, Language, and Artificial Intelligence: Resources for Processing Natural Language
Kulas, Jack; Fetzer, James H.; Rankin, Terry L. (editors)
[University of Idaho, Moscow; University of Minnesota, Duluth; IBM AI Support Center, Palo Alto]
(Studies in cognitive systems)

Dordrecht: Kluwer Academic, 1988, xii+421 pp
Hardbound, ISBN 1-55608-073-5,
US$90.00, UK£58.00, Dfl 195.00

Proceedings of the 1988 Workshop on Computational Learning Theory
Haussler, David; Pitt, Leonard (editors)
[University of California, Santa Cruz; University of Illinois]
San Mateo, CA: Morgan Kaufmann, 1989, ix+433 pp
Paperbound, ISBN 0-55860-019-1 US$29.95

‡ **Readings from *AI Magazine*, Volumes 1-5, 1980-1985**
Engelmore, Robert (editor)
Menlo Park, CA: AAAI, 1988, x+665 pp
Paperbound, ISBN 0-929280-01-6, US$74.95

* **Readings in Distributed Artificial Intelligence**
Bond, Alan H.; Gasser, Les (editors)
[California Institute of Technology; University of Southern California]
San Mateo, CA: Morgan Kaufmann, 1988, xvii+649 pp
Paperbound, ISBN 0-934613-63-X, US$29.95

Technical Reports

University of Ottawa

NEGOPLAN: An Expert System Shell for Negotiation Support
S. Matwin, S. Szpakowicz, Z. Koperczak, G. Kersten, and W. Michalowski
Technical Report TR-88-05

We present NEGOPLAN, an expert system shell that supports the development of runable formal representations of negotiations. The user of NEGOPLAN can dynamically simulate moves of both parties of the negotiating process. A two-level representation, based on logic, is used to model the negotiation problem. At the first level rules represent the hierarchy of goals, subgoals and facts obtained by decomposing the problem at hand. A goal-to-fact reduction procedure finds satisfying logical substitutions of truth values for facts. At the second level, metarules represent changes in the decomposition and in the set of possible moves of the parties, in particular reactions to the moves of the other side. Metarules control forward chaining, which changes rules into new rules under specified constraints. A large example from the domain of labour-management bargaining illustrates the descriptive power of our notation and the operation of the system. We show how, using background knowledge, NEGOPLAN can infer consequences potentially unexpected to the user. Finally, we present the overall design of a fully operational prototype of NEGOPLAN.

ClearTalk: A Conceptually Oriented Design Language Based on Objects, Logic, and Natural Language
D. Skuce
Technical Report TR-88-07

ClearTalk is a language for knowledge acquisition and representation. It is intended to be used in what we term *Conceptually Oriented Design* (COD), which integrates important concepts from several sources. COD requires the user to think in terms of *concepts* that approximate those designated by the basic natural language constructs, and ClearTalk permits the design and specification of some system using such constructs. The basic conceptual structure is termed a *Logect* (logical object), which can be used for a wide class of knowledge representation requirements, including frames, predicates, and rules.

ClearTalk is intended to be implemented in a language such as Lisp, Prolog, or Smalltalk, though the latter would be the best choice. It combines and unifies ideas from functional programming, logic programming (lp) languages like Prolog, and object-oriented (oo) languages. It also includes features intended for natural language (nl) applications.

Two ClearTalk Examples
D. Skuce
Technical Report TR-88-09

Two examples of ClearTalk, an English-like language for knowledge acquisition, are presented. One is an example of knowledge for a database conceptual schema. The other is an abstract specification of the notion of a "hardware resource" for use in describing operating systems.

A Language and System for Making Definitions of Technical Concepts
D. Skuce
Technical Report TR-88-17

A simple English-like language is described in which one can make clear definitions of certain types of technical concepts needed in computer systems design. The semantics are based on *conceptual graphs*, as introduced by Sowa, which we briefly review. An example using real concepts from commercial fourth-generation software is discussed. In addition, a Smalltalk-based tool is described that permits the rapid acquisition, editing, and graphical display of definitions to aid in conceptual design and the choice of terminology. A major point of the paper is that such a process of clarifying terminology should become an essential component of software design. This should become recognized as influences from artificial intelligence become more common in software design.

Rule-based Formalism and Preference Representation: An Extension of NEGOPLAN
G.E. Kersten and S. Szpakowicz
Technical Report TR-88-19

NEGOPLAN is a prototype expert system shell for negotiation support and strategic decision support. It uses rule-based formalism for problem representation and modification and a three-valued valuation function that gives the user strong control over the solution procedure. In this paper, extensions and modification of NEGOPLAN are discussed. Satisfying solutions can be obtained by applying a procedure using bounds and conditional bounds. The flexibility of a decision alternative reflects its ability to remain feasible when the environment changes. Two fact-ranking methods are proposed to enable the choice of alternatives with a required flexibility. Prefer-

ences not accounted for by flexibility may be described by weighed ranks.

Conceptually Oriented Design: A Synthesis of Objects, Logic, and Natural Language for Software Production
D. Skuce
Technical Report TR-88-34

A unified approach to formally specifying the essential concepts required in software design, production, and user packaging is proposed, termed *Conceptually Oriented Design/Description* (COD). COD permits precise yet practically useful descriptions and definitions of the components of a software or other system. It incorporates natural language constructs, logical constructs, and ideas from object-oriented programming and is based on a precise mathematical semantics. A simple English-like language, ClearTalk, intended to be used uniformly for COD by designers, implementers, documenters, and eventually users, is described. ClearTalk is intended to replace or augment the kinds of prose descriptions, both at the specification/design end and at the user end, that cause confusion and error in software design and implementation. An example, taken from database conceptual design literature, is used.

A Frame-like Knowledge Representation Integrating Abstract Data Types and Logic
D. Skuce
Technical Report TR-89-05

This paper describes a very general formal knowledge representation based on algebraic ideas from abstract data types — i.e., on ideas originating outside the AI literature in research on foundations for programming and specification languages. Nevertheless, the representation incorporates practically necessary features found in inheritance systems, such as AI frame systems used for natural language understanding, while offering a precise algebraic semantics. We term the approach *Conceptually Oriented Description*.

The contribution of this paper is 1) to reformulate and simplify these ideas for AI applications, incorporating the useful features found in many practical AI inheritance systems, while retaining the theoretical foundation; and 2) to show how the approach is valuable in natural language semantics applications. This paper will use some difficult examples motivated by natural language applications, but the formalism is very general and could be used for other applications, such as software requirements specification.

The approach is based mainly on ideas from the language LOTOS, intended for the formal specification of concurrent systems, and also on similar work by Goguen and Meseguer on algebraically based functional specification. LOTOS adds to basic ADT concepts additional concepts for defining the notions like *state*, *event*, and temporal relationships, including *causality* and *synchronization*.

The main components of a software system for creating and debugging conceptual definitions using the formalism have been implemented and are briefly mentioned.

University of Waterloo

Construction of a Sound Nonnumeric Probabilistic Reasoner
Eric Neufeld
doctoral dissertation

The AI community has long sought a nonnumeric formalism for reasoning in the presence of uncertainty. Probability was abandoned in the beginning for several reasons: the distributions were difficult to obtain, computation was exponential in most cases, and results were considered to be counter-intuitive.

Alternatives to probability included ad hoc "reasoners", novel numeric and symbolic uncertainty formalisms and extensions of mathematical logic. The first two alternatives had semantic difficulties. "Nonmonotonic" extensions of mathematical logic kept running into variations of the lottery paradox as a consequence of rules that accepted not quite certain conclusions as certain.

We present a framework for representation and reasoning under uncertainty that does not demand numeric probability distributions and which is not a victim of the lottery paradox. The formalism is called an inference graph. Nodes encode events and arcs encode both probabilistic inequalities and information about statistical independence. We have implemented an efficient inference graph interpreter. If one accepts this formalism as a partial account of defaults, then this interpreter produces the expected answer for nearly every problem we have encountered in the nonmonotonic literature. Where it disagrees, one can show that the expected "answer" is wrong in a statistical sense.

Its greatest advantage is that beliefs encoded in the graph can (in principle) be verified by performing an experiment in the real world; they possess a rigorous semantics that none of the nonmonotonic formalisms can claim.

Eric Neufeld is currently an assistant professor at UNB. His Ph.D. will be conferred in May 1989 from the University of Waterloo.

World Watch

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1.0 THEORETICAL ASPECTS

2022 Effects of Reinforcement on Knowledge Retrieval and Evaluation
S.J. Leven, D.S.Levine
U. of Texas, Arlington, Texas, USA
Proceedings of the IEEE First International Conference on Neural Networks, San Diego, CA, USA, 21-24 June 1987 (San Diego, CA, USA: SOS Printing 1987), vol. 2, pp 269-77

The effects of strengthening or weakening reinforcement signals on neural networks designed for certain cognitive tasks are studied. A network has been designed to shift category boundaries in response to an external signal. The behaviour of the network with strong reinforcement signals suggests that of normal monkeys or humans. The behaviour of the same network with weak reinforcement signals suggests that of monkeys or humans with lesions of the frontal cortex, which lead to various forms of non-error-correcting perservative behaviour and also, paradoxically, to hyperreaction to novel stimuli. A numerical simulation of a particular example of preservative behaviour is presented. (20 refs.)

2026 Automated Reasoning on Neural Networks: A Probabilistic Approach
S.-s Chen
Dept. of Comp. Sci., North Carolina U., Charlotte, North Carolina, USA
Proceedings of the IEEE First International Conference on Neural Networks, San Diego, CA, USA, 21-24 June 1987 (San Diego, CA, USA: SOS Printing 1987), vol. 2, pp 373-8

The author proposes a model of human reasoning that is implementable on neural networks. This model also provides an approach to human knowledge formation. He presents an automated reasoning system in which new evidence will update the certainty or belief measures of a collection of propositions, and then constraint satisfaction among these propositions in the relational network will revise these measures. This mechanism is similar to human reasoning. (18 refs.)

2038 Expert Systems: Knowledge Acquisition and Systems Epistemology
F.A. Stowell, D. West
Sch. of Inf. Sci., Portsmouth Polytech., UK
Cybernetics and Systems '88. *Proceedings of the Ninth European Meeting on Cybernetics and Systems Research*, Vienna, Austria, 5-8 Apr 1988 (Dordrecht, Netherlands: Kluwer 1988), pp 941-7

An area of increasing importance to expert system design is that of knowledge acquisition. Recognized as fundamental to the successful design of expert systems, it often proves to be the stumbling block, since the selected expert may be reluctant to divulge his expertise, he may be unable to verbalize his knowledge, or he may be unaware of what he knows. Current knowledge elicitation methods are generally used on an "ad hoc" basis, dependent upon the preference of the individual knowledge engineer. Evidence suggests that the application of expert systems is more suited to some domains of expertise than to others and that those domains dealing with less well-defined areas of knowledge remain outside the present range of expert systems. This paper explores the methodological implications of the process of knowledge acquisition within the context of the systems epistemology. (16 refs.)

2286 Neural Networks with a Hopf Bifurcation: Slowly Modulated Waves
M.S. Cohen, W.H. Julian
New Mexico State U., Las Cruces, New Mexico, USA
Proceedings of the IEEE First International Conference on Neural Networks, San Diego, CA, USA, 21-24 June 1987 (San Diego, CA, USA: SOS Printing 1987), vol. 2, pp 161-8

The authors seek a neurodynamical model that can implement search and decision trees that branch and cycle. To implement chains of associations and deductions leading to a conclusion, they propose a model that will tumble through a sequence of metastable states and may branch or cycle before reaching a fixed point. They model the neuron as an excitable oscillator biased just below its threshold for oscillation. In this model, the cells are connected laterally by synaptic junctions, most simply to nearest neighbours, but more generally to others nearby via activation and inhibition kernels. The effect is that the phases of the oscillators in neighbouring cells couple through synaptic triggering. This model is used as a basis for examining associative and content-addressable memory, as well as time-sequence memory. (9 refs.)

2537 An Alternative Semantics for Linguistic Variables
D.G. Schwartz
Dept. of Comp. Sci., Florida State U., Tallahassee, Florida, USA
Uncertainty and Intelligent Systems. *Proceedings of the 2nd International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems: IPMU '88*, Urbino, Italy, 4-7 July 1988 (Berlin, W. Germany: Springer-Verlag 1988), pp 87-92

The concept of a linguistic variable, first introduced by Zadeh (1975) is modified and reinterpreted with the aim of producing a computationally more manageable model of natural human reasoning with linguistic imprecision. An important characteristic of the new interpretation is that it establishes the meaning of linguistic terms relative to a context composed of the available atomic linguistic terms. This in turn leads to a formal distinction between the precision of linguistic terms and their specificity. A future work is planned wherein the new formulation will be explored as the possible basis for an intuitively plausible semantics for Horn clauses. It is hoped that this will yield a viable approach to approximate reasoning in various kinds of automated deduction systems. (5 refs.)

2556 A Method for Determination of Evidential Weighting Factors in a Medical Expert System
D.L. Hudson
California U., Fresno, California, USA
M.E. Cohen
Uncertainty and Intelligent Systems. *Proceedings of the 2nd International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems: IPMU '88*, Urbino, Italy, 4-7 July 1988 (Berlin, W. Germany: Springer-Verlag 1988), pp 330-7

The necessity of dealing with uncertainty in expert systems has been recognized since the time of the first development of these systems. Initially, ad hoc techniques were incorporated to deal with these problems. At the same time, approximate reasoning technology was developing as a separate field. It is only recently that techniques from these two fields have been combined. EMERGE, a medical expert system developed by the authors, has been modified by replacing the original ad hoc approach to reasoning with uncertainty with techniques from approximate reasoning based on work by Yager (1984). A method is presented for obtaining values for evidential weighting factors. (20 refs.)

2292 Uncertainty as a Foundation of Computational Power in Neural Networks
B.R. Gaines
Dept. of Comp. Sci., U. of Calgary, Alberta
Proceedings of the IEEE First International Conference on Neural Networks, San Diego, CA, USA, 21-24 June 1987 (San Diego, CA, USA: SOS Printing 1987), vol. 3, pp 51-7

The author reviews stochastic computers, their applications, and theoretical results. He suggests that the stochastic computing perspective of viewing the networks as performing analog computations on probabilities may be valuable in the analysis of a variety of parallel distributed processing systems. He analyzes uncertainty in information representation and processing. He shows that uncertainty is a source of computational power in neural networks and that stochastic phenomena are of fundamental importance, and are not noise, as in conventional information processing. (30 refs.)

2.0 SYSTEMS AND TECHNIQUES

2047 Expert Systems in Crisis Management: Ambulance Dispatch
A.N. Hawke, C.D. Marlin
Dept. of Comp. Sci., Adelaide U., S. Australia, Australia
Aust. Comput. J. (Australia), vol. 20, no. 1, pp 1-9, Feb 1988

Crisis management concerns situations where a human operator must make rapid decisions in an environment in which incorrect decisions have severe consequences. This paper describes an experiment in the application of expert system techniques to a particular form of crisis management: the allocation of ambulances to requests in a metropolitan area. The ambulance coordinator's task is described and the implementation of an expert system to advise coordinators is outlined. OPS5 is used to code the coordinator's expertise and Pascal is used to perform calculations, to interact with the operating system and to handle databases of information about suburbs and ambulances. Testing the expert system is also described. (14 refs.)

2054 Adding Probabilistic Decision Making to EXPERT2
L.G. Watson
Dept. of Mech. Eng., U. of Sask., Saskatoon, Saskatchewan
J. Forth Appl. Res. (USA), vol. 5, no. 1, pp 229-32, 1987. [received: 10 May 1988] (1987 Rochester Fourth Conference on Comparative Computer Architectures, Rochester, NY, USA, 1987)

Discusses a method of extending EXPERT2, the well-known FORTH expert system shell, by incorporating a structure to assign Bayesian probabilities to the hypothesis in the knowledge base and then by using RUNWORDS to manipulate the probabilities after proving any THEN. After the accemptance of a hypothesis, the probabilities of each of the hypothesis being true are listed. The manipulation of the probabilities is carried out as suggested by Charniak and McDermott (1984), who argued that even though the probabilities of occurrence of various symptoms are not independent of each other, useful information can be gained by assuming they are and manipulating the conditional probabilities accordingly. This method of handling the probabilities in EXPERT2 should be of interest. The method used for adding the probability handling to EXPERT2 can also be used for assigning fuzzy confidence numbers to the EXPERT2 decisions. (4 refs.)

2057 Simplifying Decision Trees
J.R. Quinian
AI Lab., MIT, Cambridge, Massachusetts, USA
Int. J. Man-Mach. Stud. (UK), vol. 27, no. 3, pp 221-34, Sep 1987. [received: 10 May 1988]

Many systems have been developed for constructing decision trees from collections of examples. Although the decision trees generated by these methods are accurate and efficient, they often suffer the disadvantage of excessive complexity and are therefore incomprehensible to experts. It is questionable whether opaque structures of this kind can be described as knowledge, no matter how well they function. This paper discusses techniques for simplifying decision trees while retaining their accuracy. Four methods are described, illustrated, and compared on a test-bed of decision trees from a variety of domains. (14 refs.)

2085 A Friendly Merger of Conceptual Expectations and Linguistic Analysis in a Text Processing System
P.S. Jacobs, L.F.Rau
G.E. Corp. R&D, Schenectady, New York, USA
Proceedings of the Fourth Conference on Artificial Intelligence Applications (Cat. No. 88CH2552-8), San Diego, CA, USA, 14-18 Mar 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), pp 351-6

The SCISOR system is a computer program designed to scan naturally occurring texts in constrained domains, extract information, and answer questions about that information. The system currently reads newspaper stories in the domain of corporate mergers and acquisitions. The language analysis strategy used by SCISOR combines full syntactic (bottom-up) parsing and conceptual expectation-driven (top-down) parsing. Four knowledge sources, including syntactic and semantic information and domain knowledge, interact in a flexible manner. This integration produces a more robust semantic analyzer designed to deal gracefully with gaps in lexical and syntactic knowledge, transports easily to domains, and facilitates the extraction of information from texts. (17 refs.)

2318 Six Steps to Successful Expert Systems
S.L. Shafer, R.E. Westney
Cost Eng. (USA), vol. 30, no. 6, pp 17-20, June 1988

Expert systems are programs that respond very much like a human expert in a well-defined area. The usual impression is that artificial intelligence systems are complex, massive programs that require major effort and expenditures to develop. This is not always true, and small systems can be constructed at reasonable costs. A six-step process for developing an expert system includes: defining the needs and the domain of the "expert"; knowledge engineering approach in defining the "rules"; determining the structure — forward-chaining or backward-chaining; selecting the AI program; prototyping, testing and debugging; and implementation and training.

2333 Legal Aspects of Knowledge-Based Technology
R. Clarke
Dept. of Commerce, Australian Nat. U., Canberra, Australian Capital Terr., Australia
J. Inf. Technol. (UK), vol. 3, no. 1, pp 9-16, Mar 1988

A definition of knowledge-based technology (KBT) is provided that is more operational than conventional definitions of the term "expert system". Ownership rights in products developed using KBT are considered and difficulties discussed. Legal liabilities that may arise from such products are considered and issues identified. It is concluded that commercial exploitation of KBT may be hindered by these legal difficulties. Some policy implications are identified. (36 refs.)

2355 Interactive Graphical Representation of Knowledge
S. Brooke
Dept. of Syst., Lancaster U., UK
Alvey KBS Club, Explanation SIG: third Workshop, Guildford, UK, 29 Sept -1 Oct 1987 (London, UK: Alvey Directorate 1987), pp 10-20

The author seeks to explain the reasons for representing knowledge as graphs, arguing that for many knowledge

representation schemes, graphs are the most natural and most easily understood presentations. He argues that, consequently the most natural way of interacting with, exploring, and modifying a knowledge base will in many cases be through the graphical representation. He then describes an example system, where such a means of interaction is explored. (5 refs.)

2343 Knowledge Base Machine Based on Parallel Kernel Language
H. Itoh
ICOT Res. Center, Inst. for
New Generation Comp. Technol., Tokyo, Japan
T. Takewaki, H. Yokota
Database Machines and Knowledge Base Machines,
Karuizawa, Nagano, Japan 5-8 Oct 1987
(Norwell, MA, USA: Kluwer Acad. 1988), pp 17-30

Describes a knowledge base machine (KBM) that is being researched and developed from the viewpoint of parallel logic programming. From the idea of parallel logic programming, a parallel kernel language (PKL) has been developed for the Fifth Generation Computer System (FGCS) project. The KBM is based on the PKL. It has a parallel inference mechanism and a parallel retrieval mechanism, which are controlled by an operating system. (15 refs.)

2367 Advice, Discourse and Explanations
G.N. Gilbert
Surrey U., Guildford, UK
Alvey KBS Club, Explanation SIG: third Workshop,
Guildford, UK, 29 Sept - 1 Oct 1987 (London, UK:
Alvey Directorate 1987), pp 94-109

An advice system is being designed and implemented to demonstrate how IKBS could be used to provide information about the UK social security system. The advice system would be used by members of the public to help them find answers to a variety of questions about claiming welfare benefits. The fact that the majority of the user population will not previously have used a computer for a "serious" purpose, will have no notion of what an expert system is, and will probably have only the haziest idea of the structure of the social security system, means that considerable attention has to be paid to the form and content of the interaction with the user. The author describes the natural design of this interaction and the whole advice system. (18 refs.)

2377 Benchmarks for Knowledge-Based Systems
G.F. Butler, M.J. Corbin
Royal Aircraft Establ., Farnborough, UK
UK IT 88 Conference Publications, Swansea, UK, 4-7 July
1988 (London, UK: Inf. Eng. Directorate 1988), pp 61-4

No generally agreed set of benchmark tests exists for KBS. The authors describe work that was motivated by several different factors: a requirement to compare the performance overheads involved in development via AI toolkits such as ART or KEE rather than direct programming; there was a perceived lack of speed in prototype KBS implementations, which needed to be quantified; and a small library of well-defined test cases to aid in the evaluation of new and existing products was needed. The major elements of the activity have been concerned with: problem selection and definition collation of performance figures; and identification of reasons for performance differences. (5 refs.)

2372 Explanation and Expectation: Why Ask Why?
C. O'Malley
Inst. of Educ. Technol., Open U., Milton Keynes, UK
Alkey KBS Club, Explanation SIG: Third Workshop,
Guildford, UK, 29 Sept - 1 Oct 1987 (London, UK:
Alvey Directorate 1987), pp 157-67

The circumstances under which people seek explanations are discussed. The author examines the theory that people feel puzzled and therefore driven to seek an explanation when their current understanding contains a paradox in the sense of matching two conflicting schemas. She takes issue with the strong version, at least, of the "expectation-failure" theory — i.e., that people feel puzzled when a schema is violated or a plan fails. The author argues, drawing upon work in psychology and AI, that there are cases where one can be puzzled by something without having any precomputed expectations. She also discusses the implications of this for attempts to design explanation facilities on the basis of user modeling and plan recognition. (28 refs.)

2577 Beyond the Keyword Barrier: Knowledge-Based Information Retrieval
M. Mauldin, J. Carbonell, R. Thomason
Dept. of Comp. Sci., Carnegie-Mellon U.,
Pittsburgh, Pennsylvania, USA
Inf. Serv. Use (Netherlands), vol. 7, no. 4-5,
pp 103-17, 1987. [received: 27 July 1988] (29th NFAIS
Annual Conference, Arlington, VA, USA, 1-4 Mar 1987)

Most present-day information retrieval systems use the presence or absence of keywords to determine whether a document is relevant to a user's query. Although some systems do sophisticated statistical weighting and word-stem extraction, or exploit a hierarchical controlled vocabulary, all suffer from the same basic limitation: their inability to represent relational information among primitive concepts. Research in artificial intelligence and natural-language processing has produced richer representations of texts and techniques for reasoning about these representations. At the heart of these developments is the use of frames to provide a relational semantic representation of documents and user queries. This paper describes these frame-based knowledge representation methods as they apply to information retrieval, including research in user interfaces and automatic document classification, most notably the FERRET project at CMU, which classifies texts using a text skimming parser. (27 refs.)

2584 GATES: an Airline Gate Assignment and Tracking Expert System
R.P. Brazile, K.M. Swigger
N. Texas State U., Denton, Texas, USA
IEEE Expert (USA), vol. 3, no. 2, pp 33-9, Summer 1988

A description is given of GATES, an expert system that assigns gates to arriving and departing flights at New York's John F. Kennedy International Airport (JFK). GATES uses flight information and knowledge about current constraints to produce possible gate assignment schedules. GATES is a constraint-satisfaction expert system. To make its decisions, it uses two types of production rule: permissive rules and conflict rules. Permissive rules determine when it is appropriate to consider a particular gate for a particular flight and permit the system to search the next level of rules to obtain an assignment. Conflict rules determine when particular flights cannot be assigned to particular gates. System operators can modify schedules by retracting rules, adjusting tolerances, and deleting information. The system was developed for a PC, thereby providing an efficient and flexible user environment. The approach is extensible to various engineering and industrial problems where limited resources and weakly defined constraints exist and in which scheduling must occur. (10 refs.)

2581 Knowledge Gateways: the Building Blocks
D.T. Hawkins, L.R. Levy
AT&T Bell Labs., Murray Hill, New Jersey, USA
K.L. Montgomery
Inf. Process.Manage, (UK), vol. 24, no.4, pp 569-68, 1988

Technological advances over the past two decades have made data retrieval faster and easier. Some progress has been made towards increasing the relevance of the data obtained by the

information user. Despite these activities, information sources remain scattered, hard to find, and difficult to access. Using technology, visionary individuals will build knowledge gateways capable of leading knowledge-seekers to the needed information, wherever it may be stored. Some basic building blocks, or components, of a knowledge gateway include multiple system interfaces, access to private and public databases, invisible logon protocols, assistance with database selection, postprocessing, assistance with query formulation, and limited natural language input. The authors discuss some of the technologies useful in building knowledge gateways: artificial intelligence and expert systems, networking, online retrieval systems, optical storage, and natural language processing. They can be linked together to provide a powerful connection between the user and the stores of electronic information throughout the world. Four fledgling gateways are discussed: EasyNet, the Department of Defense Gateway Information System (DGIS), a library access station under development by the Library Network operated by AT&T Bell Laboratories, and the National Materials Property Data Network. (20 refs.)

2587 INVEST: an Expert System for Financial Investments
S. Heuer, U. Koch, C. Cryer
Inst. fuer Numerische und Instrum. Math.,
Westfaelische Wilhelms U., Muenster, W. Germany
IEEE Expert (USA), vol. 3, no. 2, pp 60-8, Summer 1988

A description is given of INVEST, an expert system developed to help make financial decisions. In dialogues with bank officials, INVEST obtains information about a customer's wishes and attempts to make useful and well-founded investment proposals. INVEST is being written as an application of an expert system shell, DONALD, specially developed for this purpose. DONALD is a frame-based system using frame matching as its principal inference mechanism. The inference method and representation of objects as frames are examined in detail, and a brief description of DONALD is given. (7 refs.)

2592 MicroExplorer Computer System
PC Bus. Softw. (UK), vol. 13, no. 3, pp 2-5, 1988

The MicroExplorer computer system combines Texas Instruments' Explorer AI microprocessor and software environment with the Apple Macintosh II personal computer. It is a system that provides the symbolic processing power of an optimized AI microprocessor within a personal computer. AI and symbolic processing technologies apply computer-based tools and techniques to represent and manipulate knowledge and concepts, in contrast to traditional numeric computing, which uses numbers and structured data. Texas Instruments' equipment and expertise has been put to practical use in a range of applications: medical, environment, shipping, food, defense, airlines, chemicals, computing, manufacturing, banking, space, electronics, and catalogue.

2589 Development of a Prototype Expert System for Identification and Control of Insect Pests
G.M. Pasqual
Div. of Plant Ind., W. Austr. Dept. of Agric.,
S. Perth, W. Australia, Australia
J. Mansfield
Comput. Electron. Agric. (Netherlands),
vol. 2, no. 4, pp 263-76, June 1988

A prototype, rule-based expert system (PEST — pest expert system) was developed to evaluate how knowledge engineering techniques may be used to provide insect identification and control advice to farmers. PEST uses expert system techniques to ask questions and gives recommendations and advice. This paper describes the types of decisions made and the knowledge engineering tasks undertaken during development of PEST. The methods used to acquire and represent entomological knowledge in the form of facts, rules and relationships are explained. The reasoning mechanisms employed by the system to interpret and apply rules are also discussed and an example of a session with the PEST program is presented. It is concluded that the problem of identifying insect pests and recommending control strategies is suitable for resolution by a rule-based expert system because the knowledge is of a shallow or empirical nature, the problem domain is of a manageable size, the solutions are well defined and solving the problem requires heuristic solution and the application of expertise that few people possess. PEST was implemented in LPA MacProlog using the University of Edinburgh standard on the Macintosh Plus microcomputer. (11 refs.)

2612 CESTL: an Expert System Function Library and Workbench for UNIX System/C Language
W.B. Frakes
AT & Bell Labs., Holmdel, New Jersey, USA
C.J. Fox
AT&T Tech. J. (USA), vol. 67, no.2, pp 95-106, Mar-Apr 1988

Integrating expert system components into production software can be difficult, because environments for developing expert systems typically are not compatible with traditional software-engineering technology. To deal with this problem, the authors are developing CEST, a C-language expert system toolset. It is a library of inference engines implemented as C functions that can be called from C programs — and a workbench of knowledge-engineering support tools. CEST allows easy integration of expert system components into C-based software systems and provides knowledge-engineering support tools analogous to traditional software-engineering support tools. The first tool written for CEST is AVIEN, a backward-chaining attribute-value inference engine. It has been widely distributed within AT&T and has been used to build both stand-alone expert systems and C-based hybrid systems. In particular, the Quality Assurance Center at AT&T Bell Laboratories is using AVIEN in software tools being developed for quality and reliability analysis. (39 refs.)

3.0 APPLICATIONS

2135 Detecting and Modeling Users' Beliefs about Unix
J.M. Lewis, P.M. Ross
Dept. of AI, Edinburgh U., UK
IEE Colloquium on "Intelligent Tutorial Systems" (Digest No. 73), London, UK, 12 May 1988
(London, UK; IEE 1988), pp 61-3

Users of the Unix operating system have misconceptions about Unix commands, make errors in specifying commands, and have incomplete knowledge of the domain. The authors' approach is to infer users' intentions from the commands that they issue and use this information to detect their problems. An active chart parser generates all possible parses according to a grammar of typical plans that users follow. The points when the user might need advice are detected from a heuristic analysis of the chart, and the goal that he is attempting to achieve is inferred. This goal is verified against a STRIPS-like model of the user's beliefs about Unix commands, which determines the misconceptions and errors that the user could possess. This model of the user's command beliefs is specific to an individual and is dynamically altered as the session progresses to account for the user commands. (3 refs.)

2147 DIDIMA — an Expert System for Supporting Diagnosis in the Early Stages of Breast Cancer
W. Schuler
Wiss Z. Tech. Hochsch. Ilmenau (E. Germany),
vol. 34, no. 1, pp 107-20, 1988, in German

The results of a survey regarding the difficulties of detecting cancer in the early stages are given. The use of logical

statements, discriminating analyses and BAYES theorem for computerized diagnoses is backed up by the experiences and success rates of these approaches. The structure of the DIDIMA database is described. Aggregation rules, parameters, and equations are provided in the explanation. (14 refs.)

2161 EXPERTISE: an Expert System for Infrared Spectrum Evaluation
T. Blaffert
Philips GmbH Forschungsiab., Hamburg, W. Germany
Philips Tech. Rev. (Netherlands), vol.44, no. 2, pp 44-50, Apr 1988

Infrared spectra are exceptionally useful for providing information about chemical structure. Analytical chemists who use these spectra to identify the chemical structure of unknown or newly synthesized compounds will find the EXPERTISE expert system a great help. Besides identifying complete spectra by comparing them with the spectra in an extensive library, this system can to some extent "reason" as the chemist does. This is achieved by subdividing the structures in the library into substructures, establishing the spectral features related to these substructures, recognizing these features in spectra of unidentified compounds and combining the substructures to form a complete structure. The procedure for identifying the substructures from the spectral features includes a safety factor to prevent substructures from being excluded in error because of statistical variations in the spectra. This is done with the aid of fuzzy-set theory. The system may provide more than one result, in which case the chemist has to make the final decision. The great advantage of such systems is that all the possible results are found relatively quickly. (3 refs.)

2169 INCA: an Expert System for Process Planning in PCB Assembly Line
P. Cavalloro, E. Cividati
ITALTEL, Milan, Italy
Proceedings of the Fourth Conference on Artificial Intelligence Applications (Cat. No. 88CH2552-8), San Diego, Ca, USA, 14-18 Mar 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), pp 170-4

A description is given of INCA, an expert system that tackles the problem of optimization of the automatic insertion of components on printed circuit board (PCB) in the production assembly line. The authors describe the present situation in the PCB assembly line for component insertion, why an expert system has been chosen and the benefits expected from its introduction, how it is integrated into the manufacturing environment, its architecture, the development environment, the development phases, and future issues. (4 refs.)

2189 A Concurrent Architecture for Real-Time Intelligent Process Control
J. Park, S.R. Le Clair
J. Forth Appl. Res. (USA), vol. 5, no. 1, pp 199-204, 1987 [received: 10 May 1988] (1987 Rochester Forth Conference on Comparative Computer Architectures, Rochester, NY, USA, 1987)

Describes an architecture comprising of three microprocessor-based expert systems, each operating concurrently in a real-time process control environment. This architecture has been applied to the control of an autoclave. Early results are encouraging: successful curing of 256-ply carbon-fiber laminates traditionally requires up to twelve hours of cure time, while the knowledge base created for the concurrent architecture has successfully cured the same laminates repeatably in three hours. Two of the expert systems are implemented on M68000-based coprocessors on an IBM PC-class computer, and the third expert system is implemented in the PC itself. Each expert system is a version of the FORTH-based EXPERT-5, running a qualitative process shell language (QPA) and a knowledge based suited to the process control task. The PC-based expert system serves as a blackboard monitor, controlling communications between the expert systems themselves and between process sensors, autoclave controls, and the expert systems. (17 refs.)

2171 The HICLASS Software System: a Manufacturing Expert System Shell
D. Liu
Hughes Aircraft Co., San Diego, California, USA
Proceedings of the Fourth Conference on Artificial Intelligence Applications (Cat. No. 88CH2552-8), San Diego, CA, USA, 14-18 Mar 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), pp 256-61

Several expert system applications are being used at the Hughes Aircraft Company's Electro-Optical and Data Systems Group to aid in the engineering-to-manufacturing cycle of circuit board design and production. The author focuses on the evolution of the Hughes Integrated Classification Software System and its applications. He describes the various versions of the system and the auxiliary support modules; these are a rule-driven graphics generator, a rule-driven file generator, and a route sheet generator.

2198 A Coupled Expert System for Optimum Design of Bridges
H. Adeli, K.V. Balasubramanyam
Dept. of Civil Eng., Ohio State U., Columbus, Ohio, USA
Proceedings of the Fourth Conference on Artificial Intelligence Applications (Cat. No. 88CH2552-8), San Diego, CA, USA, 14-18 Mar 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), pp 114-19

A prototype coupled expert system has been developed for optimum design of truss bridges, called BTEXPERT. The scope of BTEXPERT is limited to the optimum design of four types of truss bridges — i.e., Pratt, Parker, parallel-chord K truss and curved-chord K truss for a span range of 100-500 feet. The approach to the expert systems used in BTEXPERT is novel in at least two respects. First, mathematical optimization is introduced in the expert system. Second, the knowledge base of BTEXPERT contains not only heuristic rules and experiential knowledge but also knowledge obtained by machine experimentation. (10 refs.)

2205 Intelligent Alarming and Diagnostics for PLC-Controlled Systems
J. Sue-Tang, G.J. Savage
Syst. Design Eng., Waterloo U., Ontario
R.P. Picard, K. Prichard
Proceedings of the Third Annual Canadian Programmable Control Conference and Exhibition: "Programmable Controls — The Expanding Role" (Cat. No. 87TH0201-4), Hamilton, Ont., 10-11 Nov 1987 (New York, NY, USA: IEEE 1987), pp 10A2.3/1-4

Multiple alarms caused by a single condition create a background of alarm "clutter" against which a new critical event must be recognized, interpreted and acted on. The development of an intelligent alarming system that would decrease the cognitive overload of the operator is considered. The authors propose expert-system techniques as a simple, logical approach to the alarm-management problem. They discuss what expert systems are and what the requirements of such a system are for PLC-controlled systems, show that all the hardware needed for intelligent alarming is available, and report on some early work being investigated to provide expert system tools for this application. (8 refs.)

2390 Rule-Based Mission Planning
C.R. Ovenden
Smiths Ind. Aerosp. & Defence Syst. Ltd., Cheltenham, UK
UK IT 88 Conference Publication, Swansea, UK, 4-7 July 1988 (London, UK: Inf. Eng. Directorate 1988), pp 24-7

It is envisaged that future military aircraft will be under the control of a single operator executing all functions currently handled by two or more operators. An attempt to relieve the operator of this extra workload is embodied in the tactical decision aid (TDA), which consists of a mission planner and a situation assessment module with the mission planner. The missions considered are ground attack or mid-air rendezvous in areas of high threat density. The task of the mission planner is to create an executable plan that will achieve the mission goals while being constrained in the use of resources, such as fuel and expendable countermeasures. Various planning techniques are considered, with a rule-based system chosen and implemented as the best method. (5 refs.)

2212 Real-Time Aspects of Expert Systems in Process Control
M.J. Chantler
Dept. of Electr. & Electron. Eng.,
Heriot-Watt U., Edinburgh, UK
IEE Colloquium on "Expert Systems in Process Control" (Digest No. 48), London, UK, 28 Mar 1988
(London, UK; IEE 1988), pp 4/1-8

Over the last few years, expert systems have been applied to process control in increasing numbers. These systems differ from the more traditional type of expert systems in that they receive their data primarily from plant sensors, operate continuously, and operate under time constraints imposed by their plant. This paper surveys the real-time aspects of a number of such systems. Firstly, the requirements that are particular to or prominent in the operation of these systems are discussed. Then a number of real-time expert systems are briefly reviewed, with the emphasis placed on their real-time architectural features. The paper concludes by summarizing the architectural features discussed and relating them to the requirements described in the first section. (20 refs.)

2221 Interpretation of an Expert System in a Design System of Framework Drawings
J.-M Andre, J.-M. Chazot
Lab. de Marcoussis, CGE, France
P. Collange, D. Denier, J.-L. Ravalet
MICAD '88. Proceedings of the 7th European Conference on CADCAM and Computer Graphics, Paris, France, 21-25 Mar 1988 (Paris, France: Editions Hermes 1988), vol. 1, pp 297-310, in French

The paper describes FEREX, an expert system for designing frameworks, integrated with a CAD software package. The particular problem covered is flat frame or reinforced concrete. The system architecture and expert system are also described. Many design problems have been resolved with the integration of artificial intelligence techniques and CAD. The automation of designing the reinforcement in reinforced concrete is described and sections cover data, software packages, the expert system, and the representation of known facts. The expert system operates on a SUN 3 workstation, under Unix. (6 refs.)

2234 A Review of Automated Debugging Systems: Knowledge, Strategies and Techniques
M. Decasse, A.-M Emde
ECRC, Munich, W. Germany
Proceedings of the 10th International Conference on Software Engineering (Cat. No. 88CH2554-4), Singapore, 11-15 Apr 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), pp 162-71

The authors propose a classification of global debugging strategies used in the systems and a description of the corresponding techniques. They assess the identified strategies from a real-world program development point of view. The knowledge types identified are: knowledge of the intended program; knowledge of the actual program; understanding of the programming language; general programming expertise; knowledge of the application domain; knowledge of bugs; and knowledge of debugging methods. The strategies identified are: filtering; checking computational equivalence of intended program and actual one; checking the well-formedness of actual program; and recognizing stereotyped errors. (49 refs.)

2401 A Framework for Expert System Development in Statistical Quality Control
J.R. Evans
Dept. of Quantitative Anal. & Inf. Syst.,
Cincinnati U., Ohio, USA
W.M. Lindsay
Comput. Ind. Eng. (UK), vol. 14, no. 3, pp 335-43, 1988

The authors propose a framework for developing expert systems for statistical process control applications. The knowledge base is partitioned into three sets: domain-independent analysis rules, which determine whether or not the sample observations indicate a lack of control; interpretive rules, which analyze the patterns in the chart in terms of process changes; and domain-dependent diagnostic rules, which assist in determining assignable causes and corrective action. This structure allows some portability between applications and customizing to specific applications. (5 refs.)

2407 ESPNET: Expert-System-Based Simulator of Petri Nets
J. Duggan, J. Browne
Comp. Integrated Manuf. Res. Unit.,
U. Coll., Galway, Ireland
IEE Proc. D, Control Theory Appl. (UK), vol. 135, no. 4, pp 239-47, July 1988

A Petri net is a modeling tool used in the design and analysis of systems. The expert system language OPS5 has a similar execution strategy to a Petri net model, and hence Petri nets may be simulated using the OPS5 language. ESPNET has been designed to be used in a rapid prototyping mode to allow users to quickly develop simulation models of the work flow through manufacturing systems. The system described takes a Petri net for its input and then generates an OPS5 simulator as output. The simulation model developed may then be used to size flexible assembly and manufacturing systems based on the system performance and resource utilization data generated by the model. (11 refs.)

2410 KBSES: a Knowledge-Based System for Equipment Selection
A. Kusiak, S.S. Heragu
Dept. of Mech. & Ind. Eng., Manitoba U.,
Winnipeg, Manitoba
Int. J. Adv. Manuf. Technol. (UK),
vol. 3, no.3, pp 97-109, July 1988

A knowledge-based system KBSES for the selection of production equipment — i.e., machine tools and material handling carriers in an automated manufacturing system — is presented. Existing expert systems that have been applied to the selection of material handling carriers are briefly reviewed. A new model for the selection of production equipment is presented. The knowledge-based system developed has a tandem architecture and closely interacts with a set of models and algorithms. The components of the system are discussed. (13 refs.)

2412 Expert System Tools for Construction Planning and Control
O. Moselhi, M.J. Nicholas
Concordia U., Montreal, Quebec
Microcomput. Civ. Eng. (USA),
vol. 3, no. 1, pp 75-80, Mar 1988

The potential utilization of expert systems in construction management has drawn considerable attention in recent

years. Many prototype systems were developed and have been described in previous studies. None of these studies, however, has addressed the basis for the selection of an expert system building tool (ESBT), the most important component in developing such systems. The paper presents a set of criteria for such selection. The criteria are then applied to investigate nine commercially available ESBTs, including four microcomputer-based tools, for building a knowledge-based expert system for construction planning and control. The criteria, although developed for specific application, could be readily extended to cover other problem domains. (14 refs.)

2433 Use of an Expert System to Optimize Electricity Demand in a Groundwood Mill
P. Beijderwellen, R.W. Schlunk, E. Zijlstra
Foxboro Nederland NV, Soest, Netherlands
M.J. Neeteson
J. A. (Belgium), vol. 29, no. 1, pp 27-32, March 1988

To investigate the applicability of expert system technology for real-time operator decision support, an expert system has been built for an application in the area of energy management. Electrical load shedding is the selective shutdown of electrical equipment in order to reduce electricity cost. The expert system shell KES has been used to build a prototype system for a groundwood paper mill. The embedding of the KES rulebase and inference engine in a C-program makes it possible to adapt the process and operator interface for a real-time environment. The results of this project support the authors' belief that an expert system can add to the authority of a human operator. (6 refs.)

2450 IT and Road Safety
A. Fraser
Inf. Technol. Public Policy (UK),
vol. 6, no. 3, pp 196-9, Summer 1988

Car manufacturers from the UK, France, Italy, Germany and Sweden were led by Daimler Benz to collaborate in the production of vehicle systems that would dramatically reduce accidents and congestion on Europe's roads. Under the banner of Prometheus — the program for European Traffic with Highest Efficiency and Unprecedented Safety — researchers started a project to lay the groundwork for a new generation of "intelligent cars". Road accidents are largely due to the limitations of drivers and the fact that road users do not form a coherent traffic system. The answer lies in creating and using the latest electronic developments, particularly microelectronics, sensors, information technology and artificial intelligence, to give drivers information and to help them cope with both normal and critical driving conditions. Particular ways these methods will be used and the organization of parameters are discussed.

2452 Expert Systems and the Use of Information in Building Design and Construction
C.H. Davidson
Sch. of Archit., Montreal U., Quebec
P.L. Davidson, K. Ruberg
J. Doc. (UK), vol. 44, no.2, pp 91-118, June 1988

The building industry, through its structure and its mandate, faces endemic information problems; expert systems are expected to impact positively. Expert systems are suited to situations of uncertainty; knowledge and reasoning are separated, allowing easier updating. Knowledge acquisition from human experts is difficult and problems of information reliability arise, suggesting the scope for cooperation between knowledge engineers and documentalists familiar with the domain. In building, prevailing conditions seem to indicate the appropriateness of expert systems, particularly during the design phase; however, written documentation and general research results are rarely consulted. The paper highlights the need for an information "refining" stage between production and use. It is easier to set up expert systems for specialized sub-domains; however, on-going research is attempting to develop a comprehensive approach to project-specific information that would be operational from initial design through to completed construction. Criteria for a comprehensive design information system are listed. (49 refs.)

2455 Knowledge-based System for Wire-EDM
R. Snoeys, W. Dekeyser
Dept. of Mech. Eng., Leuven U., Belgium
Int. J. Adv. Manuf. Technol. (UK),
vol. 3, no. 3, pp 83-96, July 1988

Wire-EDM (electric discharge machining) is a nontraditional machining technique in which the workpiece material is removed by the erosive impact of electric discharges. The EDM-process in its entirety is quite complex and requires skilled and experienced operators. Eliciting their expertise and making it available for new operators is, therefore, a necessary task. This makes the wire-EDM problem appropriate for knowledge-based implementation since experts are available to deal with the problem routinely. The author presents the development of a knowledge-based system that enables process monitoring and control to be carried out for wire-EDM. An expert system module for operator assistance, training and diagnostics is included. Machine settings are determined automatically by means of a work preparation module. These settings are available both for process control and operator assistance. (14 refs.)

2627 An Expert System Advisor for Missile Logistics (LOGADVISOR)
C.C. Barclay, W.C. Kelly
Proceedings of the 1988 IEEE SOUTHEASTCON
(Cat. No. 88CH2571-8), Knoxville, TN, USA, 11-13 Apr 1988 (New York, NY, USA: IEEE 1988), pp 546-50

The effectiveness of an expert system for alleviating work loads of air defense command-post personnel in stressed tactical and near-tactical situations is demonstrated. When the expert system can make routine decisions, summarize information, and give options for making complex decisions, it allows air defense personnel to deal with immediate threat issues without ignoring the more routine issues, such as supply. This type of expert system can prevent critical shortages from occurring by predicting these shortages and giving options for dealing with the problem while there is still time to react. (1 ref.)

2632 A Knowledge-Based Expert System for Synthetic Aperture Radar Target Recognition
S.K. Rogers, M. Kabrisky, S. Anderson
Air Force Inst. of Technol.,
Wright-Patterson AFB, Ohio, USA
J.P. Mills
SPIE — Int. Soc. Opt. Eng. (USA), vol. 937, pp 56-8, 1988
(Applications of Artificial Intelligence VI,
Orlando, FL, USA, 4-6 Apr 1988)

This paper describes a knowledge-based expert system that uses return features, provided by image analysts, to identify an object as a specific instance or class of object, such as a tank or truck. Partial feature sets allow the expert system to classify occluded and unfamiliar or falsified object data returns to the most likely class with a specified reasoning path. The rule-based system was developed using the Prolog version of M1.

2629 Kalman Filter Residual Expert System
J. Grimshaw, P. Amburn
AFIT/ENG, Wright-Patterson AFB, Ohio, USA
Proceedings of the IEEE 1988 National Aerospace and Electronics Conference: NAECON 1988 (Cat No. 88CH2596-5), Dayton, OH, USA, 23-27 May 1988
(New York, NY, USA: IEEE 1988), vol. 1, pp 360-6

The Pilot's Associate (PA) program has been initiated to help mitigate the extensive workload of the fighter pilot. The PA must continually monitor and evaluate important aircraft, weapon, and threat systems as well as terrain and weather conditions by means of sensor systems. The data from these systems must be fused together to present the PA with a coherent picture of the environment. One common technique for fusing sensor data uses Kalman filters in a multiple model adaptive filter (MMAF). An improved filter selection technique is presented as part of an advanced MMAF. A knowledge-based system is used to augment the usual selection technique. Preliminary results indicate that this approach helps in situations known to cause problems for Kalman filter-based MMAF systems. (14 refs.)

2655 A Clinical Tool for Nursing [Software]
S. Evans
Creighton U., Des Moines, Iowa, USA
Comput. Healthc. (USA), vol. 9, no. 8, pp 41-2, 44, Aug 1988

COMMES (Creighton Online Multiple Modular Expert System) is an artificial intelligence system that uses rule-based medical diagnostics to help nurses develop high-quality patient care plans. The cognitive associations of many nursing professionals have been gathered and stored in a huge neuron-like network of connections — the semantic network. Decision-support-derived quality care can lead to fewer patient complications and reduced length of stay. When care-plan development takes less time, nurses have more time to provide care, rather than spend it reconstructing and retrieving structured knowledge.

2657 Time in Clinical Decision Support Systems: Temporal Reasoning in ONCOCIN and ONYX
M.G. Kahn, L.M. Fagan, E.H. Shortliffe
California U., San Francisco, California, USA
SIGBIO Newsl. (USA), vol. 8, no. 1, pp 13-16, Mar 1986
[received: 28 July 1988]

The development of two decision support programs for cancer chemotherapy management of Stanford University has provided an opportunity to investigate the representation and utilization of temporal relationships and reasoning techniques in medical computer-based advice systems. ONCOCIN provides treatment advice to physicians administering experimental chemotherapy to cancer patients. ONCOCIN's recommendations are based on the therapy guidelines specified in a research protocol document. This document details the order of treatment events, the contents of each treatment episode, and possible adjustments that may occur if specific patient conditions are present. ONYX is a chemotherapy advising system being developed to provide treatment recommendations in clinical situations where the protocol does not provide therapy guidelines. ONYX will develop therapy plans in unusual clinical situations that are not specified in the ONCOCIN protocols. These two systems provide markedly different settings in which to explore approaches to temporal representation and reasoning.

2676 An Expert System for Matrix Analysis (ExMat)
I.N. Imam, A.S. Elmaghraby
Dept. of Eng. Math. & Comput. Sci.,
Louisville U., Kentucky, USA
Proceedings of the 1988 IEEE SOUTHEASTCON (Cat. No. 88CH2571-8), Knoxville, TN, USA, 11-13 Apr 1988 (New York, NY, USA: IEEE 1988), pp 533-6

A rule-based expert system (ExMat) for analyzing matrices and systems of linear equation is presented. ExMat allows the user to enter a coefficient matrix and the right-hand side vector of the system. Based on rules derived from the subject area of matrix theory and matrix numerical analysis, ExMat provides an expert analysis of the system. The analysis includes solvability of the systems and the calculations of the proper inverse and solution of the system. The procedural knowledge of ExMat consists of a list of action rules determining the needed numerical procedure. The inference engine will consult the rule-based knowledge and the procedural knowledge and then take the specified action. ExMat provides a significant improvement over standard numerical libraries in the sense that it uses its built-in analysis to select the appropriate numerical method. (7 refs.)

2683 AI for ASICs Pinpoints Potential Problems
S. Richardson, R. Steele, D. Ellsworth
NCR Microelectron., Fort Collins, Colorado, USA
ESD, Electron, Syst. Des. Mag. (USA),
vol. 18, no. 6, pp 45-51, June 1988

The authors describe NCR's Design Advisor system. Available on a Mentor Graphics/Apollo DN4000 workstation, and coupled with the NetEd Schematic Capture tool, the system analyzes partial or complete designs. It points out critical problems that may either cause the device to fail or create difficulties in manufacturing or testing. The system also provides information for improving performance. The Design Advisor system's knowledge base is built on Proteus, a hybrid artificial intelligence developed language that combines many techniques for utilizing the power of knowledge.

2717 Symbolic Computation of Robot Manipulator Kinematics
L.G. Herrera-Bendezu, E. Mu, J.T. Cain
Dept. of Electr. Eng., Pittsburgh U., Pennsylvania, USA
Proceedings of the 1988 IEEE International Conference on Robotics and Automation (Cat. No. 88CH2555-1), Philadelphia, PA, USA, 24-29 Apr 1988 (Washington, DC, USA: IEEE Comput. Soc. Press 1988), vol. 2, pp 993-8

A software package has been developed to solve, symbolically, the direct and inverse kinematics of an n-degree-of-freedom manipulator. As an input, SRAST (symbolic robot arm solution tool) expects the corresponding parameters described by Denavit and Hartenberg (1955). As an output it generates (in closed form) the direct- and inverse-kinematics solutions. When solving the inverse kinematics it is capable of excluding solutions with the n, o, and a vectors, dealing with redundant manipulators and documenting how the solutions were found. SRAST implements its own symbolic processor and makes use of AI techniques. To solve the inverse kinematics, eleven trigonometric rules are heuristically applied to identify a mathematical set of solutions. SRAST has successfully solved a number of industrial manipulators. A least it is the only software package capable of generating the inverse kinematics in symbolic form. (29 refs.)

2726 A Hybrid AI/Game Theory Approach to Serial Combat Simulation
R.D. Powell, J.A. Maier
Anal. Sci. Corp., Fairborn, Ohio, USA
Proceedings of the IEEE 1988 National Aerospace and Electronics Conference: NAECON 1988 (Cat. No. 88CH2596-5), Dayton, OH, USA, 23-27 May 1988 (New York, NY, USA: IEEE 1988), vol. 4, pp 1292-9

An architecture is proposed that combines AI and game theory to produce near-optimal aerial combat maneuvers. The architecture consists of a flight-path generator, a series of communicating expert objects (CEOs) representing various maneuvers, and an executive. The executive chooses the CEO with the highest score. The chosen CEO passes the formulation of an optimization problem to the flight-path generator, which calculates open-loop controls for the near-optimal flight path, thus closing the loop. The architecture has been realized in the Air Combat Maneuvering Expert (ACME) model, which gives a good representation of one-on-one basic fighter maneuvers. (18 refs.)

Upcoming Conferences

In Canada

Workshop in Game-tree Search
28 - 31 May 1989, Edmonton, Alberta
This workshop is part of the Canadian Information Processing Society's Annual Congress (CIPS). As well as presentation of papers, the 6th World Computer Chess Championship will be held, and hardware/software from all major manufacturers and research labs will compete in public competition. Topics include: Search algorithms; Search analysis; Parallelism; Planning; Learning; Knowledge representation and acquisition; Program design; Databases; Historical perspectives.
Contact: Dr. T. Marsland, Computing Science Dept., U. of Alberta, Edmonton, AB T6G 2H1. Phone: (403) 432-3971. Email: tony@alberta.cdn or ... .uucp.

2nd International Conference on AI and Law
13 - 16 June 1989, Vancouver, British Columbia
Topics include: Legal expert systems; Conceptual information retrieval; Case-based reasoning; Analogical reasoning; Representation of legal knowledge; Computational models of legal reasoning. Also invited are papers on relevant theoretical issues in AI (e.g., mixed paradigm systems using rules and cases) and in jurisprudence/legal philosophy (e.g., reasoning with precedents and rules).
Contact: Edwina Rissland, Dept. of Comp. and Info. Sci., U. of Massachusetts, Amherst, MA 01003. Phone: (413) 545-0332. Email: rissland@cs.umass.edu.

27th Annual Meeting of the Association for Computational Linguistics
26 - 29 June 1989, Vancouver, British Columbia
Topics include: Pragmatics, discourse, semantics, syntax, and the lexicon; Phonetics, phonology, and morphology; Interpreting and generating spoken and written language; Linguistic, mathematical, and psychological models of language; Machine translation and translation aids; Natural language interfaces; Message understanding systems.
Contact: Julia Hirschberg, ACL89 Program Chair, AT&T Bell Laboratories, 2D-450, 600 Mountain Ave., Murray Hill, NJ 07974. Phone: (201) 582-7496.
Email: julia@btl.att.com.

In the United States

ICGA-89 3rd Conference on Genetic Algorithms
4 - 7 June 1989, Washington, District of Columbia
Topics include all aspects of genetic algorithms, including: Foundations of genetic algorithms; Search, optimization, machine learning using genetic algorithms; Classifier systems, Apportionment of credit algorithms; Relationships to other search and learning paradigms. Papers discussing specific applications (e.g., OR, engineering, science, etc.) are encouraged.
Contact: Dr. J.D. Schaffer, Philips Laboratories, 345 Scarborough Rd, Briarcliff Manor, NY 10510. Phone: (914) 945-6168. Email: ds1@philabs.philips.com.

Computer Vision and Pattern Recognition
4 - 8 June 1989, San Diego, California
Topics include: Image processing; Pattern recognition; 3-D representation and recognition; Motion; Stereo; Visual navigation; Shape from (shading, contour, etc.); Vision systems and architectures; Applications of computer vision; AI in computer vision; Robust statistical methods in computer vision. Contact: Prof. R. Chellappa, Dept. of EE-Systems, U. of Southern California, Los Angeles, CA 90089-0272.

Industrial and Engineering Applications of AI and Expert Systems
6 - 9 June 1989, Tullahoma, Tennessee
Topics include: Knowledge acquisition and representation; Machine learning; Qualitative and temporal reasoning; Uncertainty management; Neural nets; Fault monitoring and diagnosis; Process control; Sunsor fusion; Human-machine interfaces; Vision; Pattern recognition; Natural language and speech processing; Robotics; Intelligent tutoring.
Contact: Dr. M. Ali, U. of Tennessee Space Institute, Tullahoma, TN 37388. Phone: (615) 455-0631 ext. 236.

4th Rocky Mountain Conference on AI
8 - 9 June 1989, Denver, Colorado
Theme: Augmenting Human Intellect by Computer. Topics include: Intelligent support of human communication; Computer-supported cooperative work; Automated reasoning and problem solving; User interfaces and user interface management systems; Tutoring, training and education; Design, manufacturing and control; Planning; Human problem solving.
Contact: James Alexander, RMCAI Program Chair, US WEST Advanced Technologies, 6200 S. Quebec #320, Englewood, CO 80111.

IASTED Conference on Expert Systems
12 - 14 June 1989, Los Angeles, California
For topics, see similar conference in Zurich, 26-28 June 1989. Submission deadline: Sept 15, 1989.
Contact: Expert Systems LA, IASTED Secretariat, PO Box 25, Stn. G, Calgary, AB, Canada T3A 2G1. Phone: (403) 270-3616. Fax: (403) 270-8855. Telex: 03-826670.

Joint Conference on Neural Networks
18 - 22 June 1989, Washington, District of Columbia
IJCNN-89 is the first conference in a new series devoted to the technology and science of neurocomputing and neural networks in all of their aspects. The series replaces the previous IEEE ICNN and INNS Annual Meeting series and is jointly sponsored by the IEEE Technical Activities Board Neural Network Committee and the International Neural Network Society (INNS). (IEEE ICNN-89 and the 1989 INNS Annual Meeting have both been cancelled). Topics include: Neural network architectures and theory; Supervised learning theory; Reinforcement learning theory; Robotics and control; Optical neurocomputers; Optimization; Associative memory; Image analysis; Self-organization; Neurobiological

models; Vision; Electronic neurocomputers.
Contact: Nomi Feldman, IJCNN-89 Conference Coordinator, 3770 Tansy Street, San Diego, CA 92121. Phone: (619) 453-6222.

6th Workshop on Machine Learning

29 June - 1 July 1989, Ithaca, New York

The workshop will be divided into approximately 5 disjoint sessions, each focusing on a different theme and consisting of 50 participants invited on the basis of abstracts submitted to the session chair.
Contact: Alberto Segre, Dept. of Comp. Science, Cornell U., Upson Hall, Ithaca, NY 14853-7501.
Phone: (607) 255-9196.
Email: ml89@cs.cornell.edu or segre@gvax.cs.cornell.edu.

Summer Computer Simulation Conference

24 - 27 July 1989, Austin, Texas

Topics include: Knowledge-based simulation theory; Intelligent simulation systems; Knowledge-based simulation tools; Knowledge-based systems (KBS) using simulation; Knowledge representation for simulation; Intelligent simulation control architectures; Applications of simulation techniques to KBS; Interactions between conventional simulations and KBS.
Contact: Society for Computer Simulation, ATTN: Group XIII, PO Box 17900, 4838 Ronson Court, Suite 'L', San Diego, CA 92117-7900.

CIE: Computers in Engineering Conference

30 July - 2 August 1989, Anaheim, California

Technical papers are invited in all areas relevant to the utilization of computers in the engineering profession; from research and development to applications, education, business and management issues and challenges.
Contact: (for AI, ES, KBS, Design Theory) Dr. G. Gabriele, Rensselaer Polytechnic Institute, Dept. of Mechanical Engineering, 110 Eight St., Troy, NY 12180-3590. Phone: (518) 276-2601.
(for Computers/Robotics in Education, Teaching CAD, Computer Aided Learning Systems) Dr. K. Tamma, Mechanical Engineering Dept., U. of Minnesota, 111 Church St., Minneapolis, MN 55455. Phone: (612) 625-1821.

3rd Workshop on Qualitative Physics

9 - 11 August 1989, Palo Alto, California

The workshop will emphasize both theoretical and practical aspects of qualitative and naive physics. Topics include: New qualitative reasoning methods; Complexity analyses of fundamental algorithms; Implementation techniques and performance studies; Applications of qualitative physics; Temporal reasoning and representation; Automated modeling.
Contact: Dr. Patrick Hayes, Xerox PARC, 3333 Coyote Hill Rd., Palo Alto, CA 94304. Phone: (415) 494-4749.
Email: hayes.pa@xerox.com

4th Conference on Computers and Philosophy

10 - 12 August 1989, Pittsburgh, Pennsylvania

The conference will focus on intellectual, ethical and practical problems in all aspects of the relationships between philosophy and computers. Papers on AI are especially invited. There will be a showcase of instructional software for use in philosophy classes.
Contact: Leslie Burkholder, Center for the Design of Educational Computing, Carnegie Mellon U., Pittsburth, PA 15213. Email: lb0q@andrew.bitnet.

IJCAI 11th Joint Conference on AI

20 - 26 August 1989, Detroit, Michigan

The technical program consists of a "paper track" and a "videotape track". The paper track focuses on empirical, analytical, theoretical, conceptual, foundational aspects and applied research. The videotape track focuses on applications in all subfields best suited for this type of presentation.
Topics include: AI tools and technologies; Machine architectures, languages, shells; Search methods; Knowledge acquisition, learning, analogy; Real-time performance; Parallel and distributed processing; Cognitive modeling; Planning, scheduling, and reasoning about actions; Natural language, speech understanding and generation; Perception, vision, robotics; ITS; Design, manufacturing, control; Philosophical foundations, perspectives and attitudes, social implications.
Contact: IJCAI 89, c/o AAAI, 445 Burgess Drive, Menlo Park, CA 94025-3496. Call for workshop proposals are due Feb 1, 1989. Contact: J. Katz, MITRE Corp., MS L203, Burlington Rd., Bedford, MA 01730. Phone: (617) 271-5200. Fax: (617) 271-5161.
Email: katz@b.mitre.org.arpa

AAAI 9th Distributed AI Workshop

12 - 14 September 1989, Orcas Island, Washington

Topics include: Intelligent agents; Coordination; Negotiation; Distributed reasoning; Distributed interfaces; Technology platform. There will be a travel-and-expense award of $600 for best grad student contribution. Submission material: 3 copies of a draft proposal. Submission deadline: May 15, 1989.
Contact: Miroslav Benda, Knowledge Systems Lab, Boeing, M/S 7L-64, P.O.Box 24346, Seattle, WA 98124. Phone: (206) 865-3244.

4th IEEE Symposium on Intelligent Control

24 - 26 September 1989, Albany, New York

Topics include: Machine learning; Adaptive and self-organizing control; Hierarchical/fuzzy/linguistic control; Knowledge-based control systems; Qualitative reasoning in intelligent control; Models of approximate reasoning; Evidential reasoning and control; Cooperative and antagonistic multiple agent systems; Neural networks as a control tool; Expert databases for intelligent control; Robot vision; Space and underwater exploration.
Submission deadline: April 1, 1989. Submission material: Extended summary, but authors are encouraged to submit full papers.
Contact: Prof. K P. Valavanis, Robotics Lab, Northeastern U., Department of ECE, Boston, MA 02115. Phone: (617) 437-2164. Proposals for tutorials and invited sessions should be mailed by May 1, 1989 to: Prof. A.A. Desrochers, Dept. of ECSE, Rensselaer Polytechnic Institute, Troy, NY 12180-3590. Phone: (518) 276-6718.

North American Conference on Logic Programming

16 - 19 October 1989, Cleveland, Ohio

Topics include: Applications of logic programming; Logic programming and databases; Theory of logic and functional programming; Parallel execution of logic programs; Implementation of logic programming systems; Inference machines.

Contact: Ewing Lusk, Mathematics and Computer Science Division, Argonne National Lab, Argonne, IL 60439.

Neural Information Processing Systems — Natural and Synthetic

27 - 30 November 1989, Denver, Colorado

Topics include: Neurobiological models of development, cellular information processing, synaptic function, learning, and memory; Design and evaluation of net architectures to perform cognitive or behavioral functions and to implement conventional algorithms; Training paradigms for static and dynamic networks; analysis of capability, generalization, complexity, and scaling; Applications to signal processing, vision, speech, motor control, robotics, knowledge representation, cognitive modeling and adaptive systems; Implementation and Simulation: VLSI or optical implementations of hardware neural nets.
Submission material: 4 copies of summary (1000 words max) plus 4 copies of abstract (100 words max).
Submission deadline: May 30, 1989.
Contact: Kathy Hibbard, NIPS89 Local Committee, Engineering Center, Campus Box 425, Boulder, CO 80309-0425.

Outside North America

4th Conference on AI and Education

24 - 26 May 1989, Amsterdam, The Netherlands

Topics include: Intelligent tutoring systems (ITS); Development methods of ITS; Relevant cognitive and educational research; Advanced ITS architectures; Domain representation; Student modeling and diagnosis of student problems; Interaction/teaching strategies; Evaluation of ITS; AI-based learning environments; Modeling/simulating worlds.
Contact: AIED '89 Secretary, SWI, U. of Amsterdam, Herengracht 196, 1016 BS Amsterdam, The Netherlands.
Email: aied@mcvax!swivax.uucp.

International Symposium on Multiple-Valued Logic

29 - 31 May 1989, Guangzhou, China

Topics include: Automated reasoning; Algebraic and formal aspects; Circuit/device implementation; Fault detection and diagnosis; Logic design and switching theory; High-speed computation; Probabilistic and variable-valued systems; Optical computing; Fuzzy logic; Philosophical aspects.
Contact: Prof. J. Muzio, Comp. Sci. Dept., U. of Victoria, PO Box 1700, Victoria, B.C., Canada V8W 2Y2.

Second-Generation Expert Systems

29 May - 2 June 1989, Avignon, France

Second-Generation ES are able to combine heuristic reasoning with deeper reasoning, based on a model of the problem domain. Topics include: Integration of different reasoning techniques; Architecture for combining heuristic reasoning and model-based reasoning; Cooperation of multiple expertise; Application of cooperative reasoning to real-world problems; Use of qualitative, causal or temporal reasoning techniques to augment heuristic reasoning; Integration of qualitative and quantitative reasoning.
Contact: Jean-Marc David, Laboratoires de Marcoussis, route de Nozay, 91460 Marcoussis, France.
Phone: 33-1-64.49.14.89. Fax: 33 - 1 - 64.49.06.94.

SCAI '89: 2nd Scandinavian Conference on AI

13 - 15 June 1989, Tampere, Finland

Topics include: Logic and AI theory; Knowledge representation and inference methods; Knowledge-based systems; Natural language and speech; AI tools and environments. An exhibition of AI tools and literature will be presented.
Contact: SCAI '89, Tampere U. of Technology, Ms. Raili Siekkinen, PO Box 527, SF-33101 Tampere, Finland.
Phone: Int +358 31 162441. Telex: 22313.
Email: scai89@tut.fi.

Foundations of Artificial Intelligence

19 - 21 June 1989, Ramat Gan, Israel

The Bar-Ilan Symposium on the Foundations of AI is intended to become a bi-annual event focusing on a range of topics applying quantitative, combinatorial, logical, algebraic and algorithmic methods to AI areas as diverse as decision support, automatic reasoning, knowledge-based systems, machine learning, computer vision, and robotics.
Contact: Dr. Ariel Frank, BISFAI-89, Dept. of Mathematics and Computer Science, Bar-Ilan University, Ramat Gan, ISRAEL. Email: ariel@bimacs.bitnet

IASTED Conference on Expert Systems

26 - 28 June 1989, Zurich, Switzerland

IASTED is the International Association of Science and Technology for Development. Topics include: Knowledge acquisition and representation; ES design procedures and tools; Logic programming; Reasoning; Advisory systems; User interface; Testing and maintenance; Neural networks; and all areas of application. Special one-day conferences on: ES in banking; ES in medicine, bioengineering and health care.
Contact: Expert Systems, A. Kopp, IASTED, PO Box 354, CH-8053 Zurich, Switzerland. Telex: 817491.
(also see December conference in Los Angeles)

EKAW89: 3rd European Knowledge Acquisition for Knowledge-Based Systems Workshop

3 - 7 July 1989, Paris, France

Topics include: Elicitation/modeling of expertise (automatic, manual); Apprenticeship, explanation-based, other learning systems and integration of such systems with other knowledge acquisition techniques and systems (hypermedia, DBM systems, spreadsheets, simulators); Issues in cognition and expertise that affect the knowledge acquisition process; Extracting and modeling of knowledge from text; Knowledge acquisition methodology and training; Validation of knowledge acquisition techniques.
Contact: B. Gaines, Dept. of Comp. Science, U. of Calgary, 2500 University Dr. NW, Calgary, AB, Canada T2N 1N4.
Phone: (403) 220-5901. Email: gaines@calgary.cdn.

4th Conference on AI in Engineering

10 - 13 July 1989, Cambridge, England

One major theme will be AI in design.
Contact: AIENG89, Computational Mechanics Institute, Ashurst Lodge, Ashurst Southampton SO4 2AA, England.
Email: (John Gero, Australia) john@archsci.su.oz.

Modeling Autonomous Agents in a Multi-Agent World

16 - 18 August 1989, London, England

The purpose of the workshop is to stimulate exchange and discussions on the AI models of an autonomous agent having to interact with other autonomous entities. Distributed Artificial Intelligence (DAI) occurs as a special case of the problem, but the main concern deals with complementary aspects of DAI by allowing the agents to have unrelated goals.

Submission material: 3 copies of papers (max 5000 words). Submission deadline: May 1, 1989.

Contact: Prof. Jean-Pierre Meuller, Université de Neuchatel, Institut de Mathèmatiques et Informatique, Chantemerle, 20, CH-2000 NEUCHATEL.

IEEE ICIP '89
Image Processing Conference

5 - 8 September 1989, Singapore

Topics include: AI vision techniques; VLSI implementation; Image restoration/enhancement; Machine vision; Video communications; Office image processing; Image pattern recognition; Biomedical imaging; Remote sensing; System architecture.

Contact: Technical Program Chairman, ICIP '89, c/o Meeting Planners, 100 Beach Road, #33-01, Shaw Towers, Singapore 0718, Republic of Singapore.

Email: (Dr. Cho-Huak TEH) eletehch@nusvm.bitnet, or chteh@nuseev.bitnet.

AI and Cognitive Science

14 - 15 September 1989, Dublin, Ireland

Topics include: AI tools and technologies; Natural language, machine translation, speech understanding and generation; Perception, vision, robotics; Intelligent tutoring systems; Design, manufacturing and control; Cognitive modeling; Commonsense reasoning; Knowledge representation; Planning, scheduling, reasoning about actions; Knowledge acquisition, learning, analogy; Automated deduction; Philosophical foundations, social implications.

Submission material: 3 copies of paper, max 10 pages. Submission deadline: July 1, 1989.

Contact: Alan Smeaton, Chairman, AI/CS — '89, School of Computer Applications, N.I.H.E., Dublin 9, Ireland.

TENCON 1989 — AI and Neural Networks

22 - 24 November 1989, Bombay, India

TENCON is the premier IEEE International Conference sponsored by Region 10 (Australia, China, Hong Kong, Indian subcontinent, Japan, Korea, New Zealand, Singapore, and so on). Topics include: Expert systems technology and its application to information processing; Knowledge representation; Learning; Languages; Logic; Search techniques; Neural networks; Robotics and its introduction into the workplace.

Contact: V. Seshadri, AT&T Bell Laboratories, MT3G122, 200 Laurel Ave., Middletown, NJ 07748. Phone: (201) 957-6516. Fax: (201) 957-7545. Email: ...!att!mtfmi!sesh.

AI in Industry and Government

23 - 25 November 1989, Hyderabad, India

Topics include: Recent trends and impact of AI technology; Application of AI techniques in areas such as banking systems, design and manufacturing, health management, law, marketing, planning and control, project management, sensing and interpretation, training.

Contact: The Director, National Centre for Expert Systems, Institute of Public Enterprise, Osmania U. Campus, Hyderabad 500 007, India. Phone: 868145. Telex: 0425-7064 IPE IN.

Knowledge Based Computer Systems

11 - 13 December 1989, Bombay, India

Topics include: Advances in expert systems; Learning; Logic programming; AI and engineering; Natural language understanding; AI systems and software; Pattern recognition; Intelligent tutoring systems; Reasoning; Knowledge representation; Speech; Vision.

Submission deadline: June 1, 1989.

Contact: Dr. S. Ramani, Chairman, Program Committee, National Centre for Software Technology, Gulmohar Cross Road No. 9, Bombay 400 049, India. Phone: (91-22) 620-1606, (91-22) 620-1574. Telex: 11-78260 NCST IN.

6th Israeli Conference on AI and Computer Vision

26 - 27 December 1989, Tel-Aviv, Israel

Topics include: AI and education; AI languages, logic programming; Automated reasoning; Cognitive modeling; Expert systems; Inductive inference, learning and knowledge acquisition; Knowledge theory, logics of knowledge; Natural language processing; Planning and search; Image processing and pattern recognition; Image analysis and computer vision; Visual perception; Applications; Robotics.

Submission material: 4 copies of full paper or extended abstract. Submission deadline: June 1, 1989.

Contact: *Vision*: Dr. Y. Yeshurun, 6th IAICV, Dept. of Computer Science, Tel Aviv U., 69978 Tel Aviv, Israel.

AI: Dr. J. Rosenschein, Dept. of Computer Science, The Hebrew University, 91904 Jerusalem, Israel.

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( ) Montréal, 1986 (Cdn$30. Postage within Canada: Cdn$5. Outside Canada: Cdn$7. Mail to **CIPS**.)

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Computational Intelligence Intelligence informatique

Editors Directeurs scientifiques
N. Cercone / G. McCalla

Computational Intelligence, the official journal of the Canadian Society for Computational Studies of Intelligence, is a quarterly journal first published in 1985 by the National Research Council of Canada. It contains high-quality theoretical and experimental research papers in computational (artificial) intelligence, by encouraging contributions from the following fields: knowledge representation; natural language understanding; computational vision; applications of artificial intelligence; logic programming; theorem proving; learning; cognitive science; problem solving and planning; languages and tools for artificial intelligence; speech understanding; game playing; philosophical implications; and foundations of artificial intelligence. Three special issues were published in 1988: "Taking Issue: an inquiry into Computer Understanding"(February), "AI in France"(May), and "Planning"(November). The Journal is international in content and distribution and is quickly becoming one of the leading AI journals in the world.

La revue Intelligence informatique, organe officiel de la Société canadienne pour l'étude de l'intelligence par ordinateur, est publiée quatre fois par an par le Conseil national de recherches du Canada depuis 1985. Elle renferme des articles de qualité dans le domaine de l'intelligence artificielle, tant au niveau théorique qu'expérimental, et encourage la publication de communications dans les domaines suivants: la représentation des connaissances, la compréhension des langages naturels, la vision computationnelle, les applications de l'intelligence artificielle, la programmation logique, la démonstration de théorèmes, l'apprentissage, la science cognitive, la résolution et la planification de problèmes, les langages et les outils de l'intelligence artificielle, la compréhension de la parole, les jeux, la portée philosophique et les fondements de l'intelligence artificielle. Trois numéros spéciaux ont été publiés en 1988: Forum : "An Inquiry into Computer Understanding" (février), "AI in France" (mai) et "Planning" (novembre). La revue est internationale tant par l'origine des auteurs qui y contribuent que par sa distribution et est rapidement en voie de devenir une publication de pointe dans le domaine de l'IA.

Computational Intelligence is published quarterly. Subscription rates for 1989 are $46.00 for Individuals and $114.00 for Institutions

La revue Intelligence informatique est publiée 4 fois par an. En 1989, l'abonnement individuel coûte 46$ et l'abonnement collectif 114$.

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