Canadian Artificial Intelligence

Intelligence Artificielle au Canada

Canada's National AI Publication | **La Publication Nationale en IA au Canada**

Autumn 2000 | **No. 47** | **automne 2000**

Contents

Canadian Artificial Intelligence is published by the Canadian Society for Computational Studies of Intelligence (CSCSI). ***Intelligence Artificielle an Canada*** est publiée par la Société canadienne pour l'étude de l'intelligence par ordinateur (SCEIO). Canadian Publications Mail Product Sales Agreement No. 1497200.

ISSN 0823-9339

Copyright © 2000, Canadian Society for Computational Studies of Intelligence. All rights reserved. ***Canadian Artificial Intelligence*** may not be reproduced in any form without the written permission of the editors. Printed in Canada by Benwell Atkins Ltd. *Canadian Artificial Intelligence* is published with the assistance of Simon Fraser University. The opinions expressed herein are those of their respective authors and are not necessarily those of their employers, CSCSI, ***Canadian Artificial Intelligence,*** the editor, CIPS, or Simon Fraser University.

Copyright © 2000, Société canadienne pour l'étude de l'intelligence par ordinateur (SCEIO). Tout droit réservé. *Intelligence artificielle au Canada* ne doit être reproduite par quelque moyen que ce soit sans le consentement écrit de l'éditeur. Imprimée au Canada par Benwell Atkins Ltd. ***Intelligence artificielle au Canada*** est publiée avec l'aide de l'Université de Simon Fraser. Les opinions exprimées dans ce magazine sont celles de leurs auteurs respectifs et non pas nécessairement celles de leurs employeurs, de la SCEIO, de ***l'Intelligence artificielle au Canada,*** de l'éditeur, de l'Association canadienne informatique, de l'Université de Simon Fraser.

Web Version Web

Please **don't throw away** the **envelope** in which CAI/IAC arrived. It contains information about your userID and password, which are needed to access the members-only area of the CSCSI/SCEIO website:

http://cscsi.sfu.ca/cai.html

Sample issues and articles are accessible to non-members. The members-only area contains this issue (#46) and some past issues of *CAI/IAC*. To access the area, type your userID and password at the login window.

Your **userID** is the first letter of your first name plus up to seven letters of your last name. For example, the userID for Anne Murray is amurray.

Your **password** is based on your CSCSI/SCEIO membership number which is **printed on the envelope** in which this issue arrived. Take that number and prepend to it the first letter of your first and last name. (e.g. if Anne Murray's membership number was 876543, then her password would be am876543.)

COMMUNICATIONS

President's Message

Robert Mercer

Looking back at my previous president's message, I realize that I declared that that one was to be my last. Like wishes, such public announcements should never be made, since they may not come true. So, I promise not to make such statements again!

When asked to continue as president, I did so enthusiastically because of the support that I was seeing from the membership for the society. Firstly, the previous executive is continuing either in their former positions or in new ones. (Thanks to all the executive members for their hard work and support in the last two years.) Secondly, many junior colleagues have expressed their interest in the society. Some of these members will likely step forward to serve on future executives.

The New CSCSI/SCEIO Executive

As continuing president of the CSCSI/SCEIO, I would like to present the first executive for the new millennium. As president for the next two years I will be working with our past president Fred Popowich, our vice-president Dekang Lin, our treasurer Howard Hamilton, our secretary Guy Mineau, and our magazine editor Ann Grbavec. In addition to our executive we have three members who have generously offered their time: Ali Ghorbani, Russ Greiner, and Xiang Yang. Because of the many things to be accomplished over the next two years, their help will be greatly appreciated.

Distinguished Service Award

It was my pleasure to present Gordon McCalla with this award during the banquet at the AI 2001 conference. Gord has contributed selflessly to the betterment of AI in Canada. He has served as president and past-president of this society; he has devoted much time promoting Canadian AI in Canada and internationally; and he is a respected teacher and researcher. In addition to his service to Canadian AI, he has also served the broader computer science community.

Conferences

AI 2000 held in Montreal in June 2000 was a success. Together with our sister societies (Canadian Man-Computer Communications Society and Canadian Image Processing and Pattern Recognition Society) we cosponsored AI/GI/VI 2000 and held it in conjunction with ISR 2000 and the IRIS/PRECARN annual conference. Thanks go out to Howard Hamilton and Qiang Yang, program co-chairs, for putting together such a fine program and successful conference.

Some very important conference items were discussed and announced at our Annual General Meeting held during the AI 2000 conference. CSCSI/SCEIO has decided to sponsor an annual rather than biannual conference. Our next conference will be held 7-9 June 2001 in Ottawa. The program chairs are Stan Matwin and Eleni Stroulia. It will, as in the recent past, be held in conjunction with our sister societies as AI/GI/VI 2001.

It was announced that AAAI 2002 will be held in Edmonton. This is the first time that the American AI society sponsored conference will be held outside of the United States.

What Else Lies Ahead

During the next two years the society will have a number of important issues to deal with. The decision to sponsor an annual conference facilitates a more regular conference planning cycle. A steering committee comprised of members from the three societies that sponsor the annual AI/GI/VI conferences needs to be formed. The need for regional representation was seen as a priority item by the last executive. The creation of regional representation will provide the catalyst to bring more information to the membership. Another priority item is to improve our links with the knowledge-based industry in Canada.

Call for Nominations for IJCAI-01 Awards

THE IJCAI AWARD FOR RESEARCH EXCELLENCE

The IJCAI Award for Research Excellence is given at an IJCAI to a scientist who has carried out a program of research of consistently high quality yielding several substantial results. If the research program has been carried out collaboratively, the Award may be made jointly to the research team. Past recipients of this award are John McCarthy (1985), Allen Newell (1989), Marvin Minsky (1991), Ray Reiter (1993), Herbert Simon (1995) Aravind Joshi (1997) and Judea Pearl (1999).

The Award carries with it a certificate and the sum of US$ 2,000 plus travel and living expenses for the IJCAI. The recipient will be invited to deliver an address on the nature and significance of the results achieved and write a paper for the conference proceedings. Primarily, however, the Award carries the honor of having one's work selected by one's peers as an exemplar of sustained research in Artificial Intelligence.

We hereby call for nominations for The IJCAI Award for Research Excellence, which will be presented at IJCAI-01 in Seattle, Washington, USA, 4 August - 10 August 2001.

THE COMPUTERS AND THOUGHT AWARD

The Computers and Thought Lectures are presented at IJCAI conferences by outstanding young scientists in the field of Artificial Intelligence. Past recipients of this honor have been Terry Winograd (1971), Patrick Winston (1973), Chuck Rieger (1975), Douglas Lenat (1977), David Marr (1979), Gerald Sussman (1981), Tom Mitchell (1983), Hector Levesque (1985), Johan de Kleer (1987), Henry Kautz (1989), Rodney Brooks (1991), Martha Pollack (1991), Hiroaki Kitano (1993), Sarit Kraus (1995), Stuart Russell (1995), Leslie Kaelbling (1997), and Nicholas Jennings (1999).

The Award carries with it a certificate and the sum of US$ 2,000 plus travel and living expenses for the IJCAI. The lecture is given one evening during the conference, and the public is invited to attend. The lecturer is encouraged to publish the lecture in the conference proceedings. The lectureship was established with royalties received from the book Computers and Thought, edited by Edward Feigenbaum and Julian Feldman; it is currently supported by income from IJCAII funds.

We hereby call for nominations for the Computers and Thought Award, which will be presented at IJCAI-01 in Seattle, Washington, USA, 4 August - 10 August 2001.

SELECTION PROCEDURES FOR IJCAI AWARDS

Nominations for the IJCAI Research Excellence Award and the Computers and Thought Award are invited from everyone in the international Artificial Intelligence community.

There should be a nominator and a seconder, at least one of whom must not be from the same institution as the nominee. Nominees for the Computers and Thought Award cannot be older than 35 at the start of the conference. There are no other restrictions on nominees, nominators or seconders. Nominating and seconding statements for an award should be submitted on the Nomination and Reference Forms for the award. The forms are (or soon will be) available on the IJCAI-01 web site at http://www.ijcai-01.org An IJCAI Awards Committee has been established to encourage high quality nominations for IJCAI Awards and to propose winners to the Board of Trustees. The IJCAI Awards Committee will be advised by the IJCAI Award Review Committee, which is the union of the former Trustees of IJCAII, the Advisory Committee of IJCAI-01, and the past recipients of the IJCAI Award for Research Excellence and the IJCAI Distinguished Service Award, with nominees excluded.

Nominations should be sent electronically (mail to: perrault@ai.sri.com), Chair of the Awards Committee for IJCAI-01. The deadline for nominations is **2 October 2000**. To avoid duplication of effort, nominators are requested to submit the name of the person they are nominating by 8 September 2000 so that people who propose to nominate the same individual may be so informed and can coordinate their efforts.

C. Raymond Perrault Awards Chair, IJCAI-01 Artificial Intelligence Center SRI International 333 Ravenswood Avenue Menlo Park, CA 94025 Phone: (650) 859-6470 Fax: (650) 859-3735

Secretary's Report

Guy Mineau

Minutes of the 2000 CSCSI Annual Meeting

Held on May 15th 2000 at AI-2000 in Montreal, the meeting started at 15h45.

The proposed agenda was:

1. Distinguished Service Award
2. Minutes of the 1999 meeting
3. Financial Report
4. CAI Magazine
5. Call for nomination for the next executive
6. Future Conferences
7. State of the Society: membership

The agenda was proposed by Bob Mercer, supported by Guy Mineau, and was adopted unanimously.

1 Distinguished Service Award

This year, the executive of CSCSI, following a proposal made by Prof. Nick Cercone, is pleased to present the Distinguished Service Award of the Society to Prof. Gordon I. McCalla. Since a very small time slot will be allocated for that function at the banquet, Prof. Cercone proceeds to the presentation of the award.

2 Minutes of the 1999 Meeting

Guy Mineau presents the minutes of the 1999 meeting. Fred Popowich moves to adopt them, seconded by Howard Hamilton. The motion to adopt them is carried unanimously. The 1999 meeting was held over the phone on December 22nd, 1999 among the executive.

3 Financial Report

Howard Hamilton presents the annual financial report (available on the web). Howard moves that we adopt it, seconded by Nick Cercone. The motion is carried unanimously. As planned, the Society lost a little money in the past year as the cost of the magazine slightly increased while the membership is slightly down. A copy of the financial report is available through a request sent to: hamilton@cs.uregina.ca.

4 CAI Magazine

As reported by Bob Mercer, it was proposed to recruit regional editors (about 5: BC, Prairies, Ontario, Quebec, Maritimes) who would be in charge of gathering 1 or 2 articles from their region. This is seen as a good initiative by the majority of the attendees. The regional editors would also seek to encourage students to publish in the CAI Magazine. However, no one is appointed to restructure the editorial committee of the CAI Magazine in that way.

5 Call for Nomination for the Next Executive

All members will be notified by email that the nomination period for the next executive will be extended through June 15th, 2000. The secretary will report to the executive on the nomination list. The members will be informed of the nominations through the following issue of the magazine.

6 Future Conferences

AAAI 2002 will be held in Edmonton, Alberta. The majority of the attendees do not seem to think that holding AI 2002 would be recommended. Guy Mineau suggests that some special event collocating with AAAI 2002, with a high Canadian AI content, would be held instead, using it as promotion for the Society. Concrete proposals from the executive are expected concerning AI 2002. This should be done as soon as possible.

Also, the majority of attendees do not seem to think that it would be a good idea to hold a conference in 2001. As a matter of fact, many attendees question the usefulness of the format of the conference in view of this year's attendance. AI 2002 may be seen as an opportunity to change the format of the conference. A more extensive debate on the subject is required. It is expected that the executive will discuss these issues in a near future.

In any case, it will be vital to make sure that the attendees of AAAI 2002 are offered to enroll in CSCSI, on site, for a low rate.

7 State of the Society: Membership

The membership is slightly down this year. Many members were not notified that their membership had expired. It is mentioned that high level talks should be undertaken with CIPS to implement some form of automatic renewal procedure in order to avoid that problem in the future.

Minutes by Guy Mineau, Secretary of CSCSI
Full Professor, Dept. of Computer Science
Université Laval, Quebec City, Quebec, Canada, G1K 7P4
Tel: (418) 656-5189 Fax: (418) 656-2324
Email: mineau@ift.ulaval.ca

Intelligent System Research at TechBC

Tom Calvert, Toby Donaldson, Marek Hatala, Vadym Kyrylov, Fred Popowich, Kay Wiese

Résumé

Au cours de la dernière anné, l'Université Technique de Colombie Britannique (TechBC) a employé plusieurs membres et chercheurs de corps enseignant dont les intérêts incluent les domaines traditionnels de l'intelligence artificielle. En effet, à la conférence de la IA Canadienne de cette année, il y avait deux articles décrivant la recherche associée à TechBC et à ses chercheurs. Nous voudrions saisir cette occasion pour présenter les chercheurs de corps enseignant de TechBC (page 8) et leurs projets de recherche à la communauté canadienne de AI.

Abstract

Over the past year, the Technical University of British Columbia (TechBC) has hired several faculty members and researchers whose interests include traditional areas of Artificial Intelligence. Indeed, at this year's Canadian AI conference (AI 2000), there were two papers describing research associated with TechBC and its researchers. We would like to take this opportunity to introduce the TechBC faculty researchers (see page 8) and their research projects to the Canadian AI community.

1 New Research Facilities

The intelligent system research at TechBC will be conducted within the Interactivity Research Lab, and the Information Networking and Multimedia Centre (Infonet Media Centre). Both of these labs have recently received funding from the Canadian Foundation for Innovation and will provide an interdisciplinary environment for applied research, with a high degree of interaction with industry. A central theme for many of intelligent system research projects is the interaction of humans and computers. The Interactivity Lab will allow researchers in computing science, art, design, performing arts, education and other areas to develop new network interaction design and authoring tools. Within the Infonet Media Centre, research will be done on multiagent systems and learning and knowledge repositories, providing a focus on the development and integration of advanced multimedia technologies to distributed learning, telecommunications, computer games, and film and video production.

2 Multi-agent Systems

Multi-agent systems range from two-person dialogs (e.g. advice-giving systems, intelligent tutoring systems) to teams of thousands of agents. At TechBC, we are interested in designing mixed-initiative and collaborative multi-agent systems that include both humans and programs. A group of people can easily sit together and have a conversation, but conversation is a difficult and resource-intensive activity for computers. Compared to human dialog, computer dialog systems are still toddlers, and a number of fundamental AI problems must be solved before intelligent dialog systems are ever a practical reality. We are currently investigating other, less complex forms of group interaction, such as auctions, voting, and fair division protocols. These sorts of interaction are practical in many situations, and require less of agents than full-blown conversational abilities. Plus, a major practical concern is privacy. Multiagent conversations may force an agent to divulge more information than it deems desirable to other agents, and simpler protocols are easier to trust and make secure.

As an example of the kind of problem we are interested in, suppose a group of agents (consisting of people and robots) have banded together to do the weekly household chores. They agree on what all the chores are, but must divide the chores fairly among themselves. Some researchers have proposed that the agents could solve this problem by holding a combinatorial auction, where the agents bid on doing subsets of the chores; each chore can be assigned a payment proportional to its desirability, and one agent acts as an auctioneer who is responsible for assigning the chores in a way that minimizes the payments. For the bidders, combinatorial auctions are relatively simple and efficient procedures, plus they can be run privately so agents need not share all their preferences with the world. However, the auctioneer is left with a hefty computational chore since determining the winner of a combinatorial auction is NP-complete. Many other approaches to this "fair division" problem have been studied in economics, and we are currently investigating ways of applying them in multiagent systems.

3 Constructive Reasoning about Time and Space

This field of research is closely related to intelligent agents. The way humans perceive temporal and spatial objects has not yet been investigated completely. However, if we could model the notorious ability of humans to infer missing events from an incomplete succession of observed ones, or to imagine obscured parts of objects in a viewed scene, it would be helpful for the improvement of intelligent robotic systems. While traditional reasoning basically deals with inferring relations between given temporal and/or spatial objects, constructive reasoning is about inferring new such objects based on a given set of relations. By far, this kind of reasoning has been studied in depth only for precise time intervals. This research has resulted in an elegant theory of so-called Temporal Networks. (However, its authors gained the constructivism unintentionally, as a by-product.) Still unresolved issues exist when temporal knowledge is imprecise, i.e. it contains either fuzziness or stochastic errors. Building fuzzy and stochastic generalizations of Temporal Networks could pave the way to even more elaborate temporal reasoning techniques and intelligent systems based on them. Even more challenging is constructive reasoning about spatial objects. Little has been done in this direction, and both precise and imprecise versions of constructive spatial reasoning theory are yet to be developed. The expected results of this study could improve robot vision and scene understanding.

4 Learning Objects Repository

The way in which students learn at TechBC integrates the most effective methods using the latest Internet technology. On-line presentations and other support material form an integral part of the courses delivered. The elementary building blocks, the learning objects, are stored and maintained in the in-house built award winning Course Management System. As TechBC grows, the number of learning objects is increasing and there is a strong need for an effective management of learning objects. Under the direction of Dr. Hatala, the Learning Object Repository project is building a repository that maintains records about learning objects located anywhere on the intranet and extranet. The objects are annotated with ontological concepts (metadata), which enable the user to search for the particular objects using an ontology-based semantic retrieval.

We are building the ontology on the standard IMS metadata to guarantee a minimal level of interoperability between different ontologies that are emerging for the learning objects annotation. The research is oriented in two directions. First, we concentrate on the question how to support the user during the annotation process by predetermining those parts of ontology that are relevant to the annotated learning objects. Secondly, we study and implement techniques for learning object retrieval using semantic information obtained during the annotation process.

5 TeleLearning Exchange

Theme 3 of the TeleLearning Networks of Centres of Excellence examines Systems Models for TeleLearning. The principal investigators of this theme are for the most part drawn from computer science and systems engineering. The TeleLearning Exchange is an applied research project designed initially to help Theme 3 researchers overcome geographic barriers by providing a common web repository for the exchange of ideas and

TECHBC

TECHNICAL UNIVERSITY OF BRITISH COLUMBIA

demonstrations of prototypes software for telelearning. The prototype exchange is modeled after the CEDAR (Contextually Enriched Document ARchive) environment developed by the Enrich Project at the Open University. A second feature of the TeleLearning Exchange will be the recruitment of a network of graduate students to serve as integration agents, actively maintaining the content of the repository and the collaborative conversations between the Theme 3 research sites. The research concentrates on the methods to support publishing and discussions around the research results for the distributed research community with low maintenance effort.

6 The Future

There is currently a renewed interest in the application of artificial intelligence techniques to real world problems, particularly in the area of human computer interaction, education, and knowledge management. At TechBC the faculty researchers will have the advantage of linking graduate students and industry representatives together to provide new insights into how these problems might be solved.

Selected Publications

[1] Calvert, T and Pantel, C.R. (1999). Distributed Multimedia Learning Environments. In S.K. Chang, T.F. Znati and S.T. Vuong (eds), *Distributed Multimedia*, World Scientific Publishers, pp. 55-66.

[2] Calvert, T. and Sonnichsen, A. (1998). Emergent Behaviour in Animated Crowd Scenes, *Life Like Computer Characters Workshop*, Snowbird, Utah, October.

[3] Donaldson, T. and Cohen, R. (1997). Constraint-based Discourse Agents, AAAI-97 *Workshop on Constraints and Agents*.

[4] Donaldson, T. and Cohen, R. (1997). Computer-generated Dialog as a Resource-bounded Activity, *AAAI-97 Workshop on Building Resource-Bounded Reasoning Systems, AAAI Technical Report WS-97-06*, (pp. 101-103), 1997.

[5] Donaldson, T. and Cohen, R. (1997). A Constraint Satisfaction Framework for Managing Mixed-Initiative Discourse, *AAAI-97 Symposium on Mixed-Initiative Interaction,* (pp. 37 - 43)

[6] Donaldson, T and Cohen, R. (1998). Selecting the Next Action in Discourse, *Advances in Artificial Intelligence, AI'98 Proceedings*, (pp. 220-227).

[7] T. Donaldson (1998). A Computational Theory of Turn-taking. Ph.D. Thesis, University of Waterloo, 1998.

[8] Heift, T., Toole, J., McFetridge, P., Popowich, F. and Tsiplakou, S (June 2000). An Interactive Course-Support System for Greek. *Proceedings of Ed-MEDIA 2000, World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Association for the Advancement of Computing in Education. Montreal.

[9] Kubon, P.P., Popowich, F. and Tisher, G. (May 2000). An Extendable Natural Language Interface to a Consumer Service Database. In H. Hamilton and Q. Yang (eds), *Advances in Artificial Intelligence - Proceedings of the 13th Biennial Conference of the Canadian Society for Computational Studies of Intelligence, AI 2000*, Montreal.

[10] Kyrylov, V. (1995). A Mathematical Framework for Fuzzy Constructive Temporal Reasoning About Events. *Proceedings: Florida AI Research Symposium, Melbourne, FL.* (pp.123-129).

[11] Kyrylov V. (1994). Constructive Stochastic Temporal Reasoning in Situation Assessment. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(8), (pp.1099-1113).

[12] Mulholland, P., Zdrahal, Z., Domingue, J. and Hatala, M. (2000). Integrating Working and Learning: a Document Enrichment Approach. *Journal of Behaviour and Information Technology*, 19(3), (pp. 171-180).

[13] Popowich, F., McFetridge, P., Turcato, D. and Toole, J. (2000). Lexicalist Machine Translation of Closed Captions, accepted to *Machine Translation*, 28 pages.

[14] Toole, J., Popowich, F, Nicholson, D. and Turcato, D. (1999). Explanation-based Learning for Machine Translation. *Proceedings of the 8th International Conference on Theoretical and Methodological Issues in Machine Translation*, Chester, (pp. 161-171).

[15] Wiese, K. and Goodwin, S. (1998). "The Effect of Genetic Operator Probabilities and Selection Strategies on the Performance of a Genetic Algorithm", *Advances in Artificial Intelligence, Lecture Notes in Artificial Intelligence*, Springer Verlag, Germany, Vol. 1418, (pp.141-153).

[16] Wiese, K. and Goodwin, S. (1998). "Keep-Best Reproduction: A Selection Strategy for Genetic Algorithms", *Proceedings of the 1998 ACM Symposium on Applied Computing SAC'98, Genetic Algorithms Track*, (pp. 343-348).

[17] Wiese, K. and Goodwin, S. (1999). Convergence Characteristics of Keep-Best Reproduction. *Proceedings of the 1999 ACM Symposium on Applied Computing SAC'99, Genetic Algorithms Track*, San Antonio, Texas, (pp. 312-318).

[18] Wiese, K., Nagarajan, S. and Goodwin, S. (2000). ASERC - A Genetic Sequencing Operator for Asymmetric Permutation Problems. In H. Hamilton and Q. Yang (eds), *Advances in Artificial Intelligence - Proceedings of the 13th Biennial Conference of the Canadian Society for Computational Studies of Intelligence, AI 2000*, Montreal, May 2000.

About the Authors

Dr. Tom Calvert joined TechBC in December 1997 as Professor and VP for Research and External Affairs. Prior to that he spent 25 years at Simon Fraser University in Computing Science, Engineering Science and Kinesiology. At TechBC he continues his interests in computer graphics and telelearning with ongoing projects in the use of autonomous agent techniques for the animation of human figures in crowd scenes and the exploration factors that enhance engagement in virtual learning environments. Contact: calvert@techbc.ca, http://www.techbc.ca

Dr. Toby Donaldson was wooed to TechBC as an Assistant Professor in May 2000. He is involved in the development and delivery of TechBC's introductory computing courses, and has ensured that some AI references were included. His research is in multi-agent systems, especially systems that involve high-level communication between programs and people, such as human-computer dialog. His dreams include applying this work to intelligent educational systems, and coordinating ensembles of wireless devices. Contact: donaldson@techbc.ca, http://www.techbc.ca

Dr. Marek Hatala also joined TechBC this past May as an Assistant Professor. Since 1998 he has worked as a research fellow at the Knowledge Media Institute (KMi) of The Open University in Great Britain. His work at KMi has involved the development of an internet based system for organizational learning within the Esprit international research project. Pilot sites for this system have included companies like British Aerospace (UK) and Siemens (Germany). The CEDAR system he has developed explicitly models knowledge within the organization and makes use of knowledge models for document annotation and intelligent document retrieval. His AI research interests are mainly in knowledge based systems and distributed AI. Since joining TechBC, he has continued his research in the area of conceptual models for repositories, and semantic annotation and retrieval. Contact: hatala@techbc.ca, http://www.techbc.ca

Dr. Vadym Kyrylov joined TechBC as a Senior Research Scientist in May 2000. For more than two decades, he was working in Signal Processing, Artificial Intelligence and Software Engineering. While at Air Defense Radio Engineering Graduate College at Kharkov, Ukraine, he started his studies in AI by investigating radar target recognition. In 1977, he joined a research group that was working on applications of knowledge-based methods to military command and control systems. It was one of the first AI research groups that had ever existed in the former USSR. In particular, Dr. Kyrylov developed methods for modeling human reasoning about events in time and space. He was also one of the first scholars who had ever investigated impacts of AI techniques on the software development life cycle, effort and cost. Contact: kyrylov@techbc.ca, http://www.techbc.ca

Dr. Fred Popowich joined TechBC as an Adjunct Professor in July of 1999. He is also an Associate Professor of Computing Science at Simon Fraser University, and is President of gavagai Technology Incorporated, a company active in developing natural language processing technology and products. While at TechBC, he has been active in work involving natural language processing, specifically on natural language interfaces, and in work on computer games, as part of the TechBC Research Cluster on Games. Contact: popowich@techbc.ca, http://www.techbc.ca

Dr. Kay C. Wiese joined TechBC in June 2000 as an Assistant Professor. Prior to that he was teaching in the Department of Computer Science at the University of British Columbia. His research interests include optimization and machine learning. Particularly, Dr. Wiese is interested in the development and application of evolutionary algorithms to problems such as automated design, combinatorial auctions and bioinformatics. His past research contributions to evolutionary algorithms include the design of genetic operators that improve the quality of solutions and the efficiency of the algorithms. Also, Dr. Wiese is interested in the design of mathematical models to predict the behavior of artificial adaptive systems. Contact: wiese@techbc.ca, http://www.techbc.ca

Language and Intelligent Understanding without Semantic Theory

N. Prevost and R. E. Jennings

Résumé

La recherche figurant dans cet article traite du language comme étant un system physique soumis aux même forces que tout autre système descriptible en termes thermodynamiques. Nous démontrons que ces données peuvent être présieuses pour les chercheurs en intelligence artificielle qui ont l'intention d'oppérer au sein du language naturel. Nous comprenons que tout le vocabulaire connectif ou logique de tous languages naturels est hérité des éléments lexicaux de la parole, principalement, le vocabulaire incluant des relations spaciales et autres relations physiques. Contraire aux prémices généralement tenue notre utilization de ce language ne dépand de l'accessibilité d'aucune théory sémantique. En fait, ceci est vrai également pour une grande partie du language hérité de la cognition humaine et des agencements sociaux. Il est possible de découvrir des rôles causals décrivant le language, mais la description de ces rôles doit être exprimée en termes d'une évolution qui trouve sa source au sein des rôles causals de formes de paroles ancestrales.

Abstract

The research reported in this essay treats language as a physical system subject to the same forces as other systems describable in thermodynamic terms. These are, we contend, valuable data for researchers developing artificial intelligence systems intended to operate within natural language. It is well understood that all of the connective or logical vocabulary of any natural language is descended from lexical items of speech — mainly the vocabulary of spatial and other physical relationships. Contrary to commonly-held assumptions, use of this vocabulary is not guided by any accessible semantic theory. In fact this is true also of much of the inherited language of human cognition and social arrangement. Language has perhaps discoverable causal roles, but the explanation of those roles must be an evolutionary explanation that draws upon the causal roles of ancestral forms of speech.

1 The Puzzle: Logic and Understanding

Philosophers and, when they can get them, their computer—scientist clients, often assume that understanding of language consists in having an implicit semantic theory that enables us to compose sentences whose meanings are constructed out of the meanings of their component words. To account for the evident fact that we infer more from one another's utterances than is strictly said, (Consider 'Our lecturer was sober today' or 'The department chair has not yet been sent to prison'.) they invoke a secondary device, also implicitly understood, called *implicatures*, (Grice 1989) based upon rules that are supposed to govern what we say when. In the former cited example, the words *sober* and *today* retain their fixed meanings; the fact that we infer that sobriety is not her usual state is accounted for by maxims of conversational propriety, not by some variability in the meanings of the sentence-elements. In particular, the so-called "logical" words — *and, or, not* and so on — are supposed to have fixed meanings that can be specified in the truth-tables that set out the conditions under which sentences containing them are true or false. In fact the logical vocabulary of natural language has long been supposed to provide a sort of truth-conditional bedrock upon which a full semantic theory can eventually be built.

Now the idea that each of the logical words has a single fixed truth-conditionally specifiable meaning seems to fly in the face of what most introductory logic texts tell us, at least about the word *or*, even those written by eminent logicians, such as Tarski (1941): "The word 'or' in everyday language, possesses at least two different meanings." (21)

This is the famous exclusive/inclusive distinction:

> In the so-called *non-exclusive* sense, the disjunction of two sentences is true if at least one of the sentences is true... When people use 'or' in the *exclusive* sense to combine two sentences, they are asserting that one of the sentences is true and the other false. (Suppes 1957, 5-6)

Almost invariably, the logic texts that make this point (which is to say, most logic texts) go on to claim that one of the meanings of *or* coincides with that of the familiar *xor* function. Now if we are all supposed to be possessed of a semantic theory, this is a very curious fact, for as every undergraduate computing student knows, a string of sentences composed with xor will be true if and only if an odd number of its component sentences are true. So a sentence of the form 'A xor B xor

C' will be true if exactly one of its component sentences is true, but it will be true also if they all are. So it seems that either our semantic theory is inconsistent or even logicians don't know what it is. In fact, assembled in one place, and read carefully in quick succession, the textbook authors, on this subject anyway, are like the chorus of *Pickwick Papers* in which every man took the tune that he knew best and sang it to his own satisfaction.

You can test your own semantic theory on the following sentence, adapted from a common type of example in the textbooks. Consider 'You can have soup or you can have juice.' Is the quoted sentence an inclusive or an exclusive disjunction? Most undergraduate logic students, asked this question, will respond that it is an exclusive disjunction, and most textbook authors will either agree or will argue that since it would not be false if you were allowed to have both, it must be an inclusive disjunction. Which is correct? In fact neither is, since the sentence is not a disjunction at all. To see that it is not consider that if a waiter said this to you, you would be correct in inferring from what he said that you could have soup; you would also be correct in inferring that you could have juice. It cannot, therefore, be a disjunction, since from a disjunction neither disjunct can be correctly inferred. It must in fact be a kind of conjunction. If, as the customer might assume, it is taken to exclude one or the other starters, then it is being taken as the conjunction: 'You can have soup; you can have juice; you cannot have both soup and juice.'

We could add numerous independent uses to the list of uses of the word *or*, none of which is adequately represented by the disjunctive truth-functor. In fact these conflicting prejudices (that *or* has just one meaning, that *or* has two meanings, and so on) and the confidence about our possession of an accessible semantic theory appear to have become prevalent only since the invention of the truth-table in the earlier twentieth century. Earlier logical theorists were nothing like so confident of their understanding. Venn, famous eponym of the diagrams, himself confessed bewilderment at 'the laxity, the combined redundancy and deficiency, of our common vocabulary [*and* and *or*]' (1894, 45) In this admission, Venn showed better sense than his successors. Our use even of so-called "logical language" does not in general rest upon any underlying semantic theory, accessible or inaccessible, and our various uses of the word *or* do not rest upon an implicit understanding of truth-functions. Given that this is so, any explicitly formulated semantic theory must be regarded as suspect. Indeed if we ask ourselves how confident we ought to be about there being such a semantic theory the answer would seem to be this: *we ought to be no more confident that a semantic theory underlies our use of language than we are that such a semantic theory is essential for the transmission of language from one generation to the next.* In fact the transmission of language requires very little such understanding. If it did, languages would not change beyond recognition within so short a span as a thousand years.

But, we may ask, if the transmission of language does not require much understanding, even of the logical vocabulary, how does a language come to have any logical vocabulary at all? It emerges that it is partly *because* so little understanding is necessary for the transmission of language that languages acquire the vocabulary that we think of as logical—likewise the vocabulary that we think of as psychological, or ethical, or come to that, religious. To sum up, for certain kinds of vocabulary, we may say that in using it, we literally do not know what we are talking about. Its use does not require that we do. How is this possible?

2 The Solution: Delexicalization

The answer is that all such vocabulary descends from vocabulary that in its more primitive uses would have been capable of relatively straightforward dictionary-style definition or ostensive demonstration. Descendent vocabulary sheds its lexical connections, and sufficiently late descendents may be incapable of being understood at all, except through an historical explanation of their descent. The linguistic uses of a language user of one generation are in part engendered by the linguistic uses of previous generations. But in part, as in biological evolution, vocabulary pre-adapted to one role may be co-opted or exploited in another. (Ultimately all linguistic practices must be traceable to non-linguistic practices through such exploitation of incidental causal features of pre- and proto-linguistic structures.) All except the earliest linguistic practices have combined vocabulary lacking an accessible semantic account with vocabulary denoting simple, sensorily immediate items: objects, physical relationships, actions, that is, vocabulary whose use can be conveyed directly by ostension and simple definition. Such relatively simple items of vocabulary are the ancestors of all of the semantically difficult vocabulary of later stages of a language. All connectives, for example, evolve, by various describable stages of logicalization from the semantically rich but specific vocabulary of physical relationships between individuals to the semantically attenuated but extremely

versatile uses linking whole sentences. For example, the Modern English word *but* is the descendant of Anglo-Saxon *butan* (by outan, i.e., *outside*); *or* is the descendent of the comparative *other* (*second*, as in 'every other day'), and so on. We can now say in some detail how the transformations come about, and corresponding stories can be sought for all of the semantically challenged vocabulary of folk psychology, ethics and religion.

Now at every stage of linguistic history the process of logicalization, and more generally, delexicalization is in progress. The semantic childhood simplicities of today will engender tomorrow's philosophically adult difficulties. Nevertheless, small children continue to acquire language (notice that we don't say 'the language': they don't acquire ours, but their own) and manage linguistic intercourse with their parents and grandparents. But by slow degrees, what was the simple vocabulary of childhood in earlier generations passes into less simple linguistic roles within the adult language of later generations. And at each stage there is a balance, though in each a different balance, between the semantically rich and the semantically attenuated. As applied to the corresponding elements of human language, Immanuel Kant's remark is borne out by the facts: percepts without concepts are blind; concepts without percepts are empty. Language maintains a dynamic balance between what we must directly understand and what we need not understand (perhaps, need not to understand) in order to participate in its practices.

3 Intelligent Understanding

The familiar worry: how are we to understand the *artifice* of artificial intelligence? Is it like artificial vanilla, which is a simulation and not vanilla at all, or is it like artificial insemination, which is genuine insemination, not a simulation? An important consequence of this study of language is that in the case of language understanding, simulation ought to be the goal, since simulation of understanding is a better approximation of what we ourselves have. This point deserves to be made more explicit. We are not denying that, in the ordinary way, any competent speaker of a language understands that language; there is such a thing as conversational understanding. A master of a language, a good novelist, say, has this sort of understanding to a very high degree. But conversational understanding does not confer any other sort, and depends upon something approaching a semantic understanding only for a portion of the material of speech. It is not the sort of understanding that we strive for in mathematics or physics, biology or history. To put the matter bluntly, much of the understanding exhibited in human conversation is (or is remarkably like) a simulation of understanding (a simulation of a simulation). Moreover, it is a sufficiently good simulation to have sent many generations of philosophers harking after semantic theories, even long before truth-tables conjured this late illusion of success.

4 Physics of Language

Language is a physical phenomenon. But it is easy to see why the idea that its understanding requires a semantic rather than a physical explanatory theory. After all there are many languages, and indefinitely many physically unrelated linguistic types can be made to serve the same physical end. Consider the hundreds of linguistic ways there are of getting someone to open a window. In the physiological account, the linguistic contribution is merely that of a low-energy relay that switches on the desired motor responses. But for any particular language, the *physical* explanation of such successes must include an account of how the components of particular linguistic switches have evolved. This is a large and daunting task, but not for that reason alone to be ignored. Moreover, for much of the vocabulary of language, once such an account has been given, the onus of justification must lie upon those who think that there is an essential and additional *semantic* component that the account omits. If there is, then language must be unique in this respect among physical phenomena.

Now any theory must find its language, and its researchers must settle upon where in the hierarchy of theoretic languages their conclusions will find their rightful place. In the life sciences, for example, we would place population biology somewhere far above the biology of the gene, but require that its claims be compatible with experimental outcomes of research at lower levels. The descriptions of flight formation will not necessarily use the language of polypeptide replication. But in some cases mathematical models suitable for describing much lower level phenomena may, in modified form, find a place in the descriptions of higher theories as fundamental patterns of micro-phenomena recur in altered form at macro-phenomenal levels. The theory of language development that grounds the research here described would be placed nearer to the level of population biology rather than that of the cell, but frequently encounters phenomena that seem to dictate a language closer to the level of cell biochemistry for their description. The question of this subsidiary project was this: can the dynamics of that gradual change in state of linguistic items from lexical to non-lexical be described in

the language of the Ising model, a model for which the 2 dimensional solution was suggested by Ernst Ising (1900 -) and now a familiar tool of statistical thermodynamics. In plainer terms, is this central phenomenon of language change mathematically similar to a change in state of a collection of physical molecules from, say, liquid to solid? Think of the developments of language as the product of the millions of individual linguistic transactions that convert the raw physical energy expended in the production of speech or inscription into minute neurophysiological alterations in other members of the linguistic community, alterations that contribute to the shape of future linguistic interactions. If the underlying research is correct, then the eventual outcome of this process is that many items of language pass from a stage in which we typically can explain them by definition or ostension to a stage in which virtually all of us can use them, but none of us can understand them. This is the process that we call *lexical attenuation*.

5 The Ising Model

The Ising model is realized in this research as a computer simulation in which events, *spin vectors*, are positioned on a 2-dimensional grid of *sites*. The spins can be in one of two states, up or down. That state is determined by the sum of 2 values: first, an interaction value for sets of *nearby spins* on the lattice, second interactions of particular events with an external energy grid. This second grid provides a landscape for the actualization of a potential state at a specific site, that is, it represents the energy available for the use of individual spins. The dynamics can be described as follows:

Individual constituents interact with neighboring constituents. The states (spin-up or spin-down) of neighbors determine the amount of energy that a given spin needs to change its state. The energy available to determine this flip defines the notion of temperature. Temperature is roughly defined by the average amount of energy available in the system. That variable is an intensive quantity of the system and increasing or decreasing it modifies the characteristics of the behavior of the system. We implement a standard Maxwellian demon in our model, with one demon per spin site to allow for the concept of local temperature.

6 Ising and Language

The Ising Model can be remade to model the dynamics of what we call *lexical attenuation* in natural language. Four Cartesian grids are required to describe such a dynamic. One grid represents a set of instances or occurrences of one language item. A black pixel for a constituent represents a lexical state of the language item while a grey pixel represents a delexicalized state. A second grid represents the potential for attenuation for each instance of the language item. A gradient from black to white describes the state of attenuation the item can achieve. The potential state of attenuation is equivalent to the degeneracy factor in traditional applications of Ising models. As we have earlier remarked, a degeneracy value is assigned to every spin in the system. This indicates that there are equivalent identical states, in this case the down state. In other words, for the case where degeneracy equals 2, there are 2 identical down states. In our model an attenuation value is assigned to some spins in the system. Some spins may not have an attenuation state: they may only be up or down. Some other spins may have an attenuation that equals 2 or more, indicating 2 or more equivalent identical down states.

The simulation (figures 1 to 5) shows the top of the *attenuation* grid as dark. Depending upon the level of attenuation attainable by the system, the grid will show a gradient from black to dark grey to white. A third grid (corresponding to the energy grid) illustrates a *propagation* rate, since the physical energy driving delexicalization is the physical energy expended in the actual uses of the item in speech. As with the energy function in the traditional Ising model, *propagation* is stimulated by activity. This grid holds the available energy limiting spin activity at a specific location. Usage increases the extension of a lexical item. As the *energy* value is increased or decreased in the traditional Ising model, this *activity* value can increased or decreased. Augmenting the *activity* value represents an increase in the use of an item within a linguistic community. In the real world, this value increases also with increases in a human population; however, as the model has a stable population, it is solely the accumulation of uses of an item more often that promotes the extension of use, and hence the lexical attenuation of the language item. For example, given a system of two organisms, language items can become delexicalized by use. Consider the case of technical language used by a small group of people in the context of developing a new technology. As the use of such an item becomes maximally extended, we lose our capacity to say what it means. We think that *jargon* is a product of similar dynamics.

A distribution grid for the *activity* value permits us to observe local fluctuations. Each spin site has an *activity* value assigned to it. In the application to language, a high *activity* value at a spin site can be thought of as

representing extensive use of an item by a single organism. The underlying theory suggests that higher usage also entails a higher rate of attenuation. So a low *activity* value at a spin site can be taken to represent comparative lexical richness. A bias is also calculated into the mix: lexical items tend to stay lexical for reasons energetically like the reasons why ice tends to stay ice until a certain amount of energy is fed to the system. This phenomenon is typical of systems that exhibit a first order phase transition. Why? Because a system is in its most stable macro-state when all of its constituents share a similar micro-state. Because all natural systems tend to their lowest possible energy state and a homogeneous state is the lowest energy state, systems tend toward homogeneity. The *energy* that is *fed* to lexical items is the physical energy expended in increasing its *use*. Water molecules behave similarly, as the liquid state allows molecules more movement than a solid state. However the interaction between molecules is more complex and it is these local fluctuations that ultimately influence the state of the whole system. The key lies in nearest-neighbour interactions in which energy is transferred. In the simplification of the model, each individual constituent is in contact with the four constituents surrounding it and is influenced by them. Items further away have progressively less bearing on any given constituent. When most immediate neighbours are in a given state, it is favorable for a given spin site to be in the same state.

Ultimately, of course it is physical *energy* that promotes the use of a particular language item in an organism. But it is enlightening to think about the dynamics of linguistic transaction in a more coarse-grained fashion. The *attenuation* phenomenon will occur as the nearest-neighbour interaction provides a certain level of *consistency*. Consistency is the local state in which the *use* value for neighbour sites is either all *functional* or all

figure 1

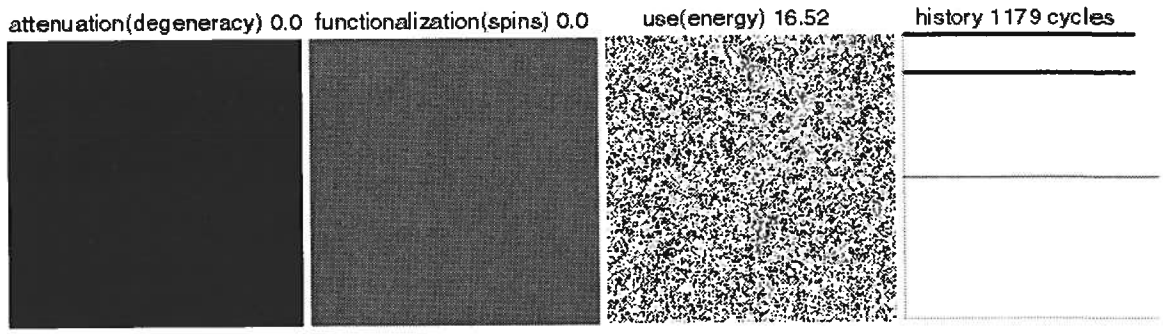

Figure 1: *Spins* are in a lexical state. The *attenuation grid* does not show any attenuation value so the potential for items to attenuate is not possible. The use grid shows a high value indicating that the language item is highly in use yet the item does not develop any functional use.

figure 2

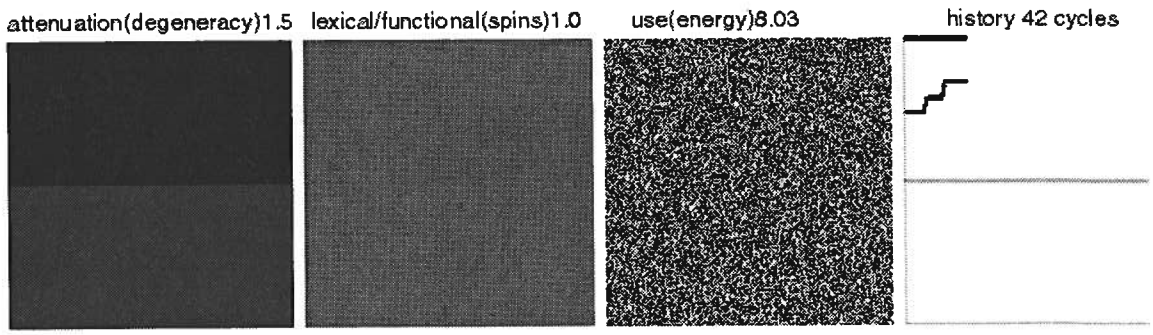

Figure 2: *Spins* are in a lexical state. The *attenuation grid* shows an average 1.5 value where the upper part of the grid shows no attenuation and the bottom part shows an attenuation of 2. The *use grid* shows an 8.03 value that demonstrates the state of the system just before functional states appear in the *lexical/functional* grid.

lexical. The case where one site is functional and the neighbouring sites are lexical is, by contrast, *inconsistent*. The *high use* value of a functional state is inconsistent with the *low use* value of lexically rich sites. Imagine someone's using *table* meaning *table of contents* at a stage of the history of the language in which interlocutors use *table* only as in *dining table*. *Table of content* uses in such a case cannot generate the neurophysiological effects appropriate to that more functionalized use. In real cases, less dramatic innovations, even if they cannot be fully understood, nevertheless increase the extension for the neighbours' still lexically rich use, even if they are not yet in a position to use the item in that role. In the model when the *high use* value is lowered as it *gives up* some of its *extension* so that *consistency* is restored.

As this dynamic prevails in all neighbourhoods of the system we see a *relaxation* for all states. *Relaxation* occurs when the arbitrarily assigned starting values are modified by the dynamics of the simulation. In our simulation we *relax* the system to show how an attenuation level is reached given an average *use value* for a particular linguistic item. We follow the history of the dynamics using a fourth grid showing the changes over time of the ratio of black to grey pixels of the spin grid and the average use value for the use grid. An additional record of spin state is the imposition of a white line that calculates the ratio of black to gray for each row on the spin grid.

The model describes the possible history of the dynamics a particular language item. However our theory suggests that what is true for one linguistic item is also true for all linguistic items and that the dynamics between linguistic items is the consequences of similar dynamics occurring at a more fundamental level. Obviously there is no *solid* state for language but there is a state where language cannot propagate further. Like a crystal, the structure of world associations is semantically circumscribed and as such easy to *understand* but difficult to use. Semantically attenuated language is much like a liquid state, in which items are in a structurally loose state: easy to use but difficult to understand. The structure of liquid water is correspondingly difficult to describe at a molecular level. Semantically attenuated language is syntactically circumscribed and has lost most of the semantic connections present at its birth. This phenomenon is a direct consequence of its propagation. The mere fact of use produces a degree of semantic attenuation, howsoever minute. And the loss of *semantic circumscription* that would be required for stability in a language, itself promotes new uses, and therefore greater instability.

Now changes in the rate of attenuation can be occasioned in a number of ways, certainly through an increase in the biological population of its users; certainly by changes in the rate of environmental changes such as average age of the users and their longevity, by immigration, by technological developments and so on. The model is not dependent upon the specifics of propagation; it gives only a mathematical model of behavior at and near equilibrium.

The Experiment

Preliminary results show that the model is consistent with observational data. Initial values are set in such a way that all spins are up, that is, with the language item in a uniformly lexical state. The attenuation grid is set at zero. This state might be appropriate to certain (though not every) proper noun, since such an item is unlikely to attenuate even with dramatic increases in use. The model respects that fact (figure 1). As the use value is increased, none of the uses represented the spin grid become functionalized. The use grid does however show an increase in usage for individual spins so we may assume that even proper nouns become somewhat attenuated. This is reflected in language with say, given names. Given names usually refer to a particular person, say Albert, but the set of Alberts may be restricted to some distinguishable social group, so that the name gradually acquires characteristics of a common noun. (Contrast the class-associations of the name "Tracy" with those of "Pennelope".)

Now suppose that we increase the attenuation value to include different levels of attenuation potential (figures 2, 3, 4, 5). We think of the attenuation grid as coexisting neighbourhoods, the black level displaying a population for which the linguistic item has only its minimally extended uses, and the other extreme, the white level, showing a population for which the full extent of its potential attenuation is available. Now the use value is increased. At a certain level (around 8.00 on average), functional uses appear. Notice that the use value at which spins start flipping is similar despite the attenuation level. This indicates that the level of use of the item is fully independent from its semantic content. As the underlying theory implies, it is the extensive use that produces the attenuation of items and not the reverse. Notice also that the use value drops after functionalized items appear: the emergence of functional language may interfere with the use of the item, since now there is

figure 3

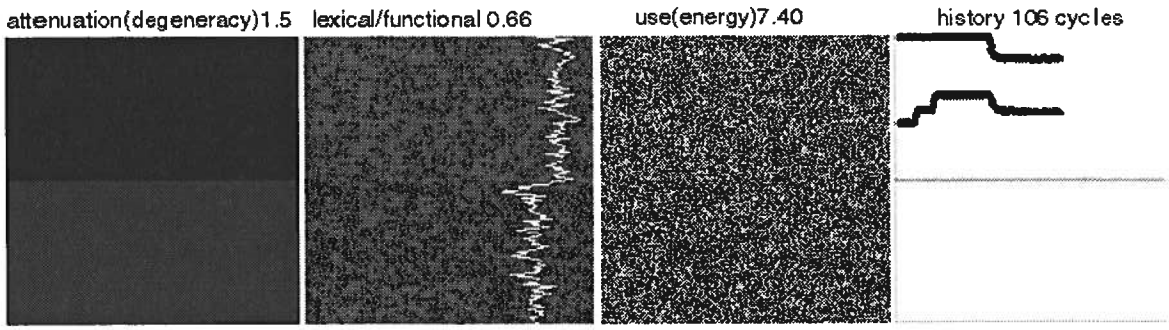

Figure 3: *Spins* are mostly in a lexical state while showing some functional states throughout the grid. The *attenuation grid* show an average 1.5 value where the upper part of the grid show no attenuation and the bottom part show an attenuation of 2. The *use grid* show an 7.03 value that demonstrate the state of the system just after functional states appear in the *lexical/functional* grid.

figure 4

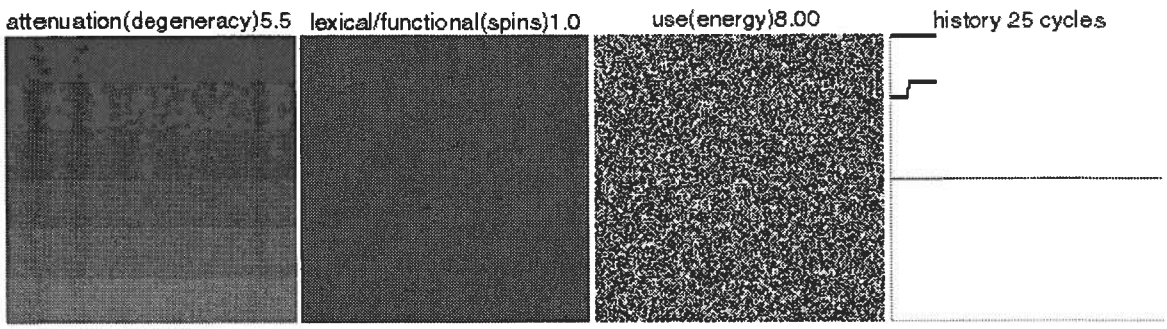

Figure 4: *Spins* are in a lexical state. The attenuation grid shows a gradiant of six levels of attenuation throughout the grid. The use grid shows an 8.00 value that demonstrates the state of the system just before functional states appear in the lexical/functional grid.

figure 5

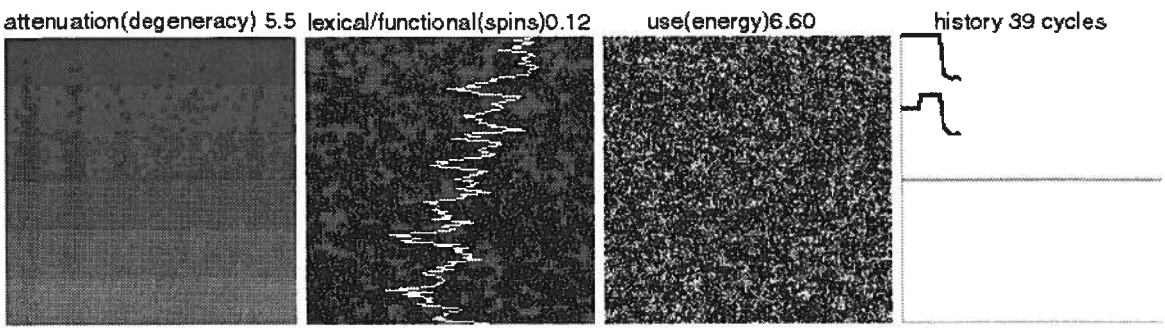

Figure 5: *Spins* are in lexical and functional states throughout the grid. The *attenuation grid* shows a gradiant of six levels of attenuation throughout the grid. The *use grid* shows a 6.00 value that demonstrates the state of the system just after functional states appear in the *lexical/functional* grid.

a discrepancy between lexical and functional use. However, again as the underlying theory suggests, an increase of use will favor flips from lexical to functional uses. Another interesting, and theoretically predictable feature is the scatter pattern of functional language in the upper portion of the spin grid, corresponding to the strictly lexical *neighbourhoods*. This would indicate that the proximity of neighbourhoods of extended uses will forces extensions of lexical uses.

8 Lessons for AI

If we are to produce intelligence by artifice, it is important to have an adequate theory of the sort of intelligence that is produced by nature. Theories of natural intelligence that assume that well-trained intelligent agents must know what they are intelligently talking about are theories that have not sufficiently attended to the facts of human language. The research that underlies this study suggests strongly that in general our use of language, far from requiring us to have an implicit but accessible semantic theory, depends upon our using vocabulary for which no semantic theory can be given. It also suggests that when we consciously try to develop a semantic theory, even for what is generally supposed to be the easy part of the language, we still manage to use the language correctly no matter how wildly wrong the semantic theory is that we concoct. The more particular project reported in this essay reminds us that language is a physical phenomenon, predictably similar, mathematically, to other well-studied physical phenomena, and shows us, through an application of the familiar language of statistical thermodynamics, why these facts ought not to surprise us.

References

Gould, harvey and Tobochnick, Jan [1988] *An Introduction to Computer Simulation Methods; Applications to Physical Systems Part 2*. Addison-Wesley.

Grice, Paul [1989] *Studies in the Way of Words*. Cambridge.

Suppes, Patrick [1957] *Introduction to Logic*. Princeton.

Tarski, Alfred [1941] *Introduction to Logic and to the Methodology of the Deductive Sciences*. New York. (Revised 1946 edition.)

Venn, John [1894] *Symbolic Logic*. 2nd ed. New York. First published 1881.

About the Authors

R.E. Jennings is Professor of Philosophy and director of the Laboratory for Logic and Experimental Philosophy (LLEP) at Simon Fraser University. Through his involvement with formal logical research and the evolution of language, he participates in the cognitive science group of the Centre for Systems Science. Email: jennings@sfu.ca

Nathalie Prevost is a doctoral student (under special arrangements) whose research interests intersect those of the LLEP and Computing Science. She also acts as the research director of the LLEP. Her previous publications include visual models for hypergraph-theoretic constructions. Email: thalie@cecm.sfu.ca

AI 2001

Ottawa, June 7 - 9 2001

The Fourteenth Canadian Conference on Artificial Intelligence

Call For Papers

The purpose of this conference is to provide a forum where Canadian and international researchers and practitioners in Artificial Intelligence can present their work, exchange scientific ideas and results and explore possibilities for collaboration. As always, papers may represent significant contributions to any aspect of AI, including

*** Theory**
- o Knowledge Representation
- o Reasoning and Problem Solving
- o Machine Learning
- o Natural Language Processing
- o Evolutionary Algorithms
- o Intelligent Agents
- o Knowledge Discovery - Data mining
- o Expert Systems

*** Applications**
- o Intelligent Information Systems
- o Integration of AI with other disciplines (biology, software engineering)
- o Emerging AI Applications on the Internet

Conference Format

This year, the format of the AI conference will emphasize interaction among the participants. Following each group of papers on a given topic, there will be in-depth discussion of the topic area, the work described in the presentations, and the implications for future research. We expect the AI 2001 attendees to actively participate in the discussion, so that they can explore the potential relevance of the presented work in their own research and give constructive feedback to the presenters.

We are also exploring other ideas for encouraging lively interaction during the conference. If you would be interested in proposing a workshop, or a panel discussion, or a birds-of-a-feather session, please contact the chairs. This page will be regularly updated to reflect elaborations on the conference format.

Important Dates
- * **November 15,2000 :** paper submission (electronic preferred) deadline
- * **January 25, 2001 :** notification of acceptance or rejection
- * **March 1, 2001 :** camera-ready copy due

Details: http://www.cs.ualberta.ca/~stroulia/AI2001/

Program Chairs:

Dr. Stan Matwin
E-mail: stan@site.uottawa.ca

Dr. Eleni Stroulia
E-mail: stroulia@cs.ualberta.ca

IJCAI 2001

17th International Joint Conference on Artificial Intelligence

August 4 - 10, 2001

Seattle, Washington, USA

Washington State
Convention & Trade Center

Sponsored by the International Joint Conferences on Artificial Intelligence
Co-sponsored by the American Association
for Artificial Intelligence

Information: http://www.ijcai-01.org

International ICSC Congress on

COMPUTATIONAL INTELLIGENCE: METHODS & APPLICATIONS

CIMA 2001

June 19-22 2001

Bangor, Wales, U.K.

http://www.icsc.ab.ca/cima2001.htm

International ICSC Congress on

INTELLIGENT SYSTEMS AND APPLICATIONS

ISA 2000

December 11-15, 2000

at the University of Wollongong
(near Sydney), Australia

http://www.icsc.ab.ca/isa2000.htm

KBCS 2000

CALL FOR PAPERS

INTERNATIONAL CONFERENCE ON KNOWLEDGE BASED COMPUTER SYSTEMS

Mumbai, India
December 17-19, 2000

The conference is intended to act as a forum for promoting interaction among researchers in the field of Artificial Intelligence. There will be a two-day conference during December 18-19, 2000, preceded by a day of pre-conference tutorials on December 17, 2000.

Papers are invited on substantial, original and unpublished research on all aspects of Artificial Intelligence.

Submission Deadlines for Papers:

o Due: July 31, 2000

o Acceptance Notification: September 30, 2000

o Camera Ready Copy Due: October 30, 2000

Details: www.ncst.ernet.in/kbcs2000/ or send an email to kbcs@ncst.ernet.in

---

32nd International Symposium on Robotics

ISR 2001

April 19-21, 2001

Seoul, Korea

Schedule: (extended)
Submission of abstract (300 to 1000 words): October 31, 2000
Notification of paper acceptance: November 15, 2000
Final submission of paper: February 15, 2001

http://isr2001.kist.re.kr/Teams/isr2001/

The Fourteenth International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems

(IEA/AIE-2001)

June 4-7, 2001 Budapest, Hungary

Submission Deadline: November 17, 2000

Authors can obtain details of the call for papers announcement either from the conference web page, http://www.sztaki.hu/conferences/ieaaie2001/

or from

Dr. Laszlo Monostori,
Program Chair IEA/AIE-2001,
Computer and Automation Research Inst.,
Hungarian Academy of Sciences,
Kende u. 13-17, H-1111
Budapest, Hungary.
FAX (+36 1) 466 7503;
E-mail ieaaie2001@sztaki.hu,
kindl@sztaki.hu

Dr. Moonis Ali, General Chair,
IEA/AIE-2001,
Southwest Texas State University,
Department of Computer Science,
601 University Drive,
San Marcos, TX 78666-4616, USA.
Telephone (512) 245-3409;
FAX (512) 245-8750;
E-mail ma04@swt.edu;

Sponsored by the International Society of Applied Intelligence and cooperated with major international organizations, including ACM/SIGART, AAAI, INNS, IEE, CSCSI, JSAI, SWT, ERCIM, and SZTAKI.

ISI 2001

International Congress on Information Science Innovations

March 17-21, 2001

to be held at the American University in Dubai, U.A.E.

http://www.icsc.ab.ca/isi2001.htm

The Eleventh Annual
PRECARN • IRIS Conference

June 4-5, 2001
Ottawa Congress Centre

For conference information updates:

PRECARN•IRIS **www.precarn.ca/Events**

For conference information, contact:

PRECARN Associates Inc.
300-30 Colonnade Rd.
Nepean Ontario,
Canada K2E-7J6
Telephone: (613) 727-9576,
Fax (613) 727-5672

E-Mail: info@PRECARN.ca

CSCSI/SCEIO Membership Application

I wish to join CSCSI/SCEIO and receive *Canadian Artificial Intelligence /Intelligence Artificielle au Canada*

Yes ___ / No ___ Web Access Only ($30.00* Cdn./yr.)

Yes ___ / No ___ Printed Copy and Web Access ($40.00* Cdn./yr.)

I am a student

Yes ___ / No ___ Web Access Only ($15.00* Cdn./yr.)

Yes ___ / No ___ Printed Copy and Web Access ($15.00* Cdn./yr.)

I am a member of CIPS

Yes ___ / No ___ Web Access Only ($25.00* Cdn./yr.)

Yes ___ / No ___ Printed Copy and Web Access ($30.00* Cdn./yr.)

*Includes applicable G.S.T.

Name .....

Job Title .....

Company .....

Address .....

.....

.....

.....

E-mail .....

Phone .....

Fax .....

Visa or Amex Number .....

Expiry Date .....

Signature .....

Please send your membership application to:

Mail: CIPS National Office, One Yonge St., Suite 2401, Toronto, Ontario M5E 1E5

Phone: (416) 861-2477

Fax: (416) 368-9972

E-mail: aff@cips.ca

For more information, contact CIPS or a member of the CSCSI/SCEIO executive.

Canadian Artificial Intelligence
Intelligence Artificielle au Canada

CAI Personnel • Personnel d'IAC

Editor • Rédacteur en chef
Ann Grbavec

Editor Emeritus • Rédacteur Emeritus
Dan Fass, School of Computing Science, Simon Fraser University, Burnaby, BC V5A 1S6; fass@cs.sfu.ca

Translation • Traduction
Thalie Prevost

Advertising • Publicité
Ann Grbavec

The editor welcomes contributions from members and non-members. Possible formats include, but are not limited to:

- commentary, in the form of letters or short articles, on any AI issue of concern to you (e.g. research priorities, funding, educational trends, cultural, political, or ethical aspects of AI)
- interdisciplinary work
- survey papers
- reports on new work by students
- abstracts
- web site reviews
- news
- humour
- employment opportunities
- conference announcements or reviews.

CSCSI Executive • Éxecutif de SCEIO (1998–2000)

President • Président:
Robert Mercer, Department of Computer Science, University of Western Ontario, London, ON N6A 5B7; mercer@csd.uwo.ca

Past-President • Président précédent:
Fred Popowich, School of Computing Science, Simon Fraser University, Burnaby, BC V5A 1S6; popowich@cs.sfu.ca

Vice-President • Vice-président:
Russ Greiner, Department of Computing Science, University of Alberta, Edmonton, AB T6G 2H1; greiner@cs.ualberta.ca

Secretary • Secrétaire:
Guy Mineau, Département d'informatique, Université Laval, Sainte-Foy, QC G1K 7P4; Guy.Mineau@IFT.ulaval.ca

Treasurer • Trésorier:
Howard Hamilton, Department of Computer Science, University of Regina, Regina, SK S4S 0A2; hamilton@cs.uregina.ca

Editor • Rédacteur en chef:
Ann Grbavec, School of Computing Science, Simon Fraser University, Burnaby, BC V5A 1S6; agrbavec@cs.sfu.ca

Submission information • Guide de soumission

Canadian Artificial Intelligence / Intelligence Artificielle au Canada welcomes submissions on any matter related to artificial intelligence. Please send your contribution, preferably in electronic form, with an abstract and biography to:

Ann Grbavec
Editor, *Canadian AI / IA au Canada*
School of Computing Science
Simon Fraser University
Burnaby, British Columbia, Canada
V5A 1S6 or — agrbavec@cs.sfu.ca
Phone (604) 291-3208
Fax (604) 291-3045

Please contact the editor as early as possible to obtain complete submission guidelines.
Submission deadline: November, 21, 2000.

Sample issues and articles can be viewed at: http://cscsi.sfu.ca/cai.html

Advertising rates are available upon request from the editor.

Recycled / Recyclable