Volume I: Technical Papers

Proceedings
The Seventh Conference on Artificial Intelligence Applications

Sponsored by the IEEE Computer Society
Miami Beach, Florida February 24–28, 1991

IEEE Computer Society Press
The Institute of Electrical and Electronics Engineers, Inc.

SEVENTH IEEE CONFERENCE ON ARTIFICIAL INTELLIGENCE APPLICATIONS

Miami Beach, Florida
February 24 - 28, 1991

IEEE Computer Society Press
Los Alamitos, California

Washington • Brussels • Tokyo

The papers in this book comprise the proceedings of the meeting mentioned on the cover and title page. They reflect the authors' opinions and are published as presented and without change, in the interests of timely dissemination. Their inclusion in this publication does not necessarily constitute endorsement by the editors, the IEEE Computer Society Press, or The Institute of Electrical and Electronics Engineers, Inc.

Published by

IEEE Computer Society Press
10662 Los Vaqueros Circle
P.O. Box 3014
Los Alamitos, CA 90720-1264

Robert Werner, Production Editor

Cover design by Jack I. Ballestero

Printed by Technical Communication Services, North Kansas City, MO

IEEE Computer Society Press Order Number 2135
Library of Congress Number 90-85778
IEEE Catalog Number CH2967-8
ISBN 0-8186-2135-4 (paper)
ISBN 0-8186-6135-6 (microfiche)
ISBN 0-8186-9135-2 (case)
SAN 264-620X

Additional copies can be ordered from:

IEEE Computer Society Press
Customer Service Center
10662 Los Vaqueros Circle
P.O. Box 3014
Los Alamitos, CA 90720-1264

IEEE Computer Society
13, Avenue de l'Aquilon
B-1200 Brussels
BELGIUM

IEEE Computer Society
Ooshima Building
2-19-1 Minami-Aoyama,
Minato-Ku
Tokyo 107, JAPAN

IEEE Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331

The Institute of Electrical and Electronics Engineers, Inc.

SEVENTH IEEE CONFERENCE ON ARTIFICIAL INTELLIGENCE APPLICATIONS

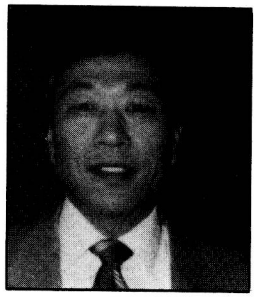
1951 - 1991
40 YEARS OF SERVICE
IEEE COMPUTER SOCIETY

Proceedings
The Seventh Conference on Artificial Intelligence Applications

Sponsored by the IEEE Computer Society
Miami Beach, Florida February 24–28, 1991

IEEE Computer Society
The Institute of Electrical and Electronics Engineers, Inc.

GENERAL CHAIR'S MESSAGE



Welcome to the Seventh IEEE Conference on Artificial Intelligence Applications. This last week of February is packed with significant technical presentations and debates in sunny Miami Beach. As the area is maturing into an everyday technology, this conference takes on an increasing importance. This is the forum where those developing applications and those advancing the technology learn from each other so that together we may make it more effective and relevant.

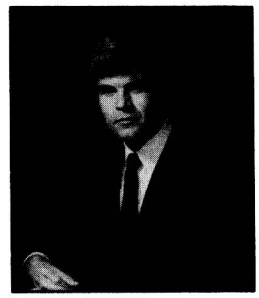
During this decade, we are faced with the prospect of a dramatic increase in computing power, due to advances in hardware, communications bandwidth, and multi-media technology. It is inevitable that a very high level and realistic user interface will be the technology of tomorrow. The field of artificial intelligence (AI) never had such a demanding challenge and opportunity, for the mission seems to be tailor-made for AI. Higher level processing for complex applications and intelligent user interface have always been at the core of the field.

This conference can uniquely contribute to this endeavor by playing the role of catalyst in accomplishing three main characterizations during the coming years: First, so as to not waste the increasing computing power, we need to characterize the AI algorithms. Algorithms for searching, planning, maintaining truth, and matching need to be understood in terms of their effective ranges and appropriate usage. Second, we need advances in characterizing the tasks of applications, in order to apply the most effective problem solving technique for the given task. Third, with the emergence of very large knowledge bases (knowledge substrates), there is a critical need for a more studied ontology for knowledge representation. Knowledge bases today contain concepts and role attributes that are characterized in an ad hoc hierarchy with ad hoc attribute names, which limits their applicability.

Tim Finin and his program committee have put together an exciting program with quality presentations in 18 paper sessions, six panel sessions, and six invited talks on relevant topics. Dan O'Leary arranged 12 tutorial sessions by accomplished lecturers on important subjects. We are particularly honored by the keynote address by Dr. Eric Bloch, former director of the National Science Foundation. Jeff Pepper did a wonderful job as publicity chair for the second year in a row. Alex Pelin and Mansur Kabuka are providing local help for the conference. I thank all the members of the conference committee for their hard work in bringing about this program and the guidance of the steering committee chaired by Mark Fox. I would also like to thank IBM for their sponsorship of the best student paper award again this year. Finally, the IEEE Computer Society staff, especially Nancy Wise, provided expert coordination and management services crucial to the success of this conference.

Se June Hong
General Chair, CAIA-91

TUTORIAL CHAIR'S MESSAGE



Experience has shown that successful AI applications in business and industry depend as much on knowledge of techniques and methodologies as on use of appropriate tools. The purpose of the tutorial sessions at this conference on Artificial Intelligence Applications is to provide opportunities for attendees to broaden their knowledge of the "real world" state-of-the-art and to learn about exciting new approaches that are likely to affect future practice. Accordingly, we have selected tutorial speakers who are actively engaged in the industrial side of AI and/or are leaders in their research speciality. In addition, I believe that the Program Committee has selected good teachers who are prepared to present their topics in an effective manner.

Each tutorial is designed to convey the depth, detail, and conceptual foundation needed to understand the issues and options in a particular area. The tutorials fall into roughly four different groups. Three of the tutorials are aimed at a specific domain-based set of applications (Expert Systems for Project Managers, AI in Engineering Design, and AI Approaches to Scheduling). Three of the tutorials focus on reasoning and pattern recognition (Case-Based Reasoning, Constraint-Based Reasoning, and Pattern Recognition). Three of the presentations examine the use of different programming architectures and concepts in AI (Integrating Hypermedia, Blackboard Applications, and Object-Oriented Programming Applications). Finally, three other tutorials discuss probably the most frequently developed type of expert systems (Verification and Validation) and model user dialogs to render systems more cooperative (User Modeling).

The field of applied AI began with a flurry of new concepts and methods. It continues to evolve as we better learn to use the old techniques and also discover new ones. I would like to thank the tutorial speakers for the time and effort that they have spent preparing and leading their sessions so that the rest of us can stay abreast of the field. I also would like to thank the Program Committee for helping to select this outstanding group.

Daniel E. O'Leary
Tutorial Chair, CAIA-91

PROGRAM COMMITTEE CHAIR'S MESSAGE

"Once a new technology rolls over you, if you are not part of the steamroller, you're part of the road." – Stewart Brand, *The Medial Lab*

On behalf of the Program Committee I welcome you to the Seventh IEEE Conference on Artificial Intelligence Applications. I believe that this conference serves as a bellwether for our interest and success in applying AI technology. I am very happy to report that all indicators are very positive. The number of papers submitted to the conference was up more than 30 percent over CAIA-90's total, which was itself almost 30 percent over the number submitted to CAIA-89. I am also very happy to note three additional trends: a continued general increase in the overall quality of the submitted papers, a significant increase in the number of papers submitted from outside North America, and an increase in papers that were submitted by industrial or commercial groups whose main function is not research and development.

The conclusions that I draw from these data are:

- Interest in applying AI technology is again on the upswing, after a decline in the last part of the 80's due to excessive hype and the resulting disappointment.

- This renewed interest is a "grass roots" one – AI technology is indeed being experimented with and applied because it is useful to a wide range of industries, businesses, and government agencies.

- The increased activity is also world-wide in scope – the large fraction of papers received from Asia and Europe testifies to this.

As in previous years, the Program Committee for CAIA-91 sought two kinds of papers: case studies of knowledge-based applications that solve significant problems and stimulate the development of useful techniques and papers on techniques and principles that underlie knowledge-based systems, and in turn, enable ever more ambitious real-world applications. The papers were organized into three tracks:

- A *Scientific/Engineering Applications Track* for contributions stemming from the general area of industrial and scientific applications.

- A *Business/Decision Support Applications Track* for contributions stemming from the general area of decision support applications in business, government, law, etc.

- An *Enabling Technology Track* for contributions focusing on techniques and principles that facilitate the development of practical knowledge-based systems that can be scaled to handle increasing problem complexity.

Papers in the two application tracks were asked to: (1) justify the use of the AI technique, based on the problem definition and an analysis of the application's requirements; (2) explain how AI technology was used to solve a significant problem; (3) describe the status of the implementation; and (4) evaluate both the effectiveness of the implementation and the techniques used.

describe the status of the implementation; and (4) evaluate both the effectiveness of the implementation and the techniques used.
A total of 250 papers were submitted, up substantially over the 192 submitted to CAIA-90. These were assigned to the three tracks as follows:

SUBMITTED PAPERS BY TRACK

Track	Number	Percentage
Science/Engineering	81	32%
Business/Decision Support	65	26%
Enabling Technology	104	42%

Of these, 73 papers (about 30 percent) were accepted for presentation and publication in the proceedings. The final two tables give a breakdown of accepted papers in terms of their country of origin and type of organization.

ACCEPTED PAPERS BY REGION

Number	Region/Country
11	**Asia**
6	Japan
3	India
1	Korea
1	Australia
12	**Europe**
4	Germany
3	Austria
2	France
1	Italy
1	Sweden
1	United Kingdom
50	**North America**
48	United States
2	Canada

ACCEPTED PAPERS BY TYPE OF ORGANIZATION

Number	Percentage	Type
38	52%	Commercial or Institute
28	38%	University
5	7%	Joint Commercial/ University
2	3%	Government

The program commitee has selected a paper to receive the *Best Student Paper* certificate along with a cash award of $1500 generously provided by IBM. The 1991 CAIA best student paper award goes to Mr. Chen-Chau Chu of the Computer and Vision Research Center of the University of Texas at Austin for his paper entitled "Multi-Sensor Image Interpretation Using Laser Radar and Thermal Images" co-authored with J.K. Aggarwal. We have also selected two excellent papers by promising graduate students to receive honorable mention awards. The first goes to Michel Benaroch of the Information Systems Department at New York University for his paper "An Intelligent Assistant for Financial Hedging" co-authored with Vasant Dhar. The second honorable mention award is for Michal Prussuk of the Computer Science Department of the State University of New York at Buffalo for his paper entitled "A Multi-Level Pattern Matching Method for Text Image Parsing" written with Jonathan J. Hull.

In addition to the excellent program of submitted technical papers, CAIA-91 has a very strong program of invited addresses and talks, panel sessions, and tutorials.

I would personally like to thank the authors for submitting their paper to this conference. It was a difficult job to select only a portion of them for inclusion – many very good and relevant papers could not be included due to the limited time available for the conference. I would also like to thank the General Chair, Dr. Se June Hong, the members of the Program Committee, the many guest reviewers, and the conference staff of the IEEE Computer Society. All of them worked very hard to make this an informative, high-quality program.

Tim Finin
Program Committee Chair, CAIA-91

Guest Reviewers

Elisabeth Andre
Jim Aragones
Daisaku Asao
B. Badrinath
P. Balasubramaniam
Bruce Ballard
Vijay Bandekar
John Bares
Can Baykan
Michel Benaroch
Don Berndt
Timothy Bickmore
William Birmingham
Gautam Biswas
Lauren Blau
Harold Boley
David Bourne
Wes Braudaway
Richard Brooks
Stephan Busemann
Jonathan Cherneff
James Comly
Linda Cook
Mark Cutkosky
Debbie Dahl
Fred Damerau
Francois Daube
Andreas Dengel
Bob Dionne
David E. Smith
Tom Ellman
Brigitte Endres-Niggemeyer
David Etherington
Steven Feiner
Eric Finch
Susan Finger
Robert Frederking
Rich Fritzson
Bruno Fromont
John Gabbe
Rajit Gadh
Richard Gammons
Jim Garrett Jr.
Ashok Goel
Winfried Graf
Greg Hagerty
Hans Haller
Taku Harada
Karin Harbusch
Hans Haugeneder
Barbara Hayes-Roth
Jochen Heinsohn
Daniel Hennessy
Haym Hirsh
Basit Hussain
Roman Jansen-Winkeln
Hardeep Johar
David Johnson
John Kaminski
Youzou Kashima
Henry Kautz
Charles Kellogg
Christel Kemke
Steven Kim
Alfred Kobsa
Mark Kolb
Mahito Konno
Don Kosy
Glenn Kramer
Rachna Kumar
R.T. Soundara Kumara
Francois Lang
Noshir Langrana
Rick Lathrop
Soklei Leong
Chun Liew
Ringo Ling
Ralph Linsker
Raghav Madhavan
Heinz Marburger
Steve Masticola
Paula Matuszek
Roy Maxion
James McGuire
Sunil Mohan
Jack Mostow
Janet Mostow
Peter Mullarkey
M. Nagendra Prasad
Dundee Navinchandra
Mick Noordewier
Lew Norton
Hayato Ohwada
Chris Overton
Armagan Ozdinc
Jahir Pabon
Jon Pastor
Peter Patel-Schneider
Rita Peak
Alex Pentland
Jim Peters
Lori Pratt
B. Ramesh
Nicky Ranganathan
Lisa Rau
Norbert Reithinger
Andres Rios
Thomas Rist
Stan Rosenschein
Jon Scholssberg
Kurt Schreiner
Peter Selfridge
David Serrano
Reid Simmons
John Smith
Steve Smith
Jim Solderitsch
R. Srikanth
Jonathan Stillman
Takeshi Sugai
Suzanne Taylor
Allan Terry
Arun Thakore
Jennifer Tripp
Harald Trost
Sherman Tyler
Kerstin Voigt
Tony Weida
Carl Weir
Arthur Westerberg
Bob Young
Akmal Younis
Uri Zernik

Conference Committees

General Chair

Se June Hong, IBM Research

Program Chair

Tim Finin, Unisys

Publicity Chair

Jeff Pepper, Carnegie Group, Inc.

Tutorial Chair

Daniel O'Leary, University of Southern California

Local Arrangements Chairs

Alex Pelin, Florida International University
Mansur Kabuka, University of Miami

Program Committee
At Large

Tim Finin, Unisys (chair)
Jan Aikins, AION Corp.
Robert E. Filman, IntelliCorp
Ron Brachman, AT&T Bell Labs
Wolfgang Wahlster, German Research Center for AI & Universitat des Saarlandes
Mark Fox, CMU

Scientific/Engineering Track

Chris Tong, Rutgers (chair)
Sanjaya Addanki, IBM Research
Bill Mark, Lockheed AI Center
Sanjay Mittal, Metaphor Computer Systems
Ramesh Patil, USC/ISI
David Searls, Unisys
Duvvuru Sriram, MIT

Enabling Technology Track

Howard Shrobe, Symbolics (chair)
Lee Erman, Cimflex Teknowledge
Eric Mays, IBM Research
Norm Sondheimer, GE Research
Fumio Mizoguchi, Tokyo Science University
Dave Waltz, Brandeis & Thinking Machines

Business/Decision Support Track

Peter Hart, Syntelligence (chair)
Chidanand Apte, IBM Research
Vasant Dhar, New York University
Steve Kimbrough, University of Pennsylvania
Don McKay, Unisys

Invited Addresses and Talks

Keynote Address

Technology and People
Erich Bloch, former director, National Science Foundation
Chair: Tim Finin, Unisys

Plenary Talk

AI in Biology and Challenges of the Human Genome Project
Bruce Buchanan, University of Pittsburgh
Chair: Se June Hong, IBM

Plenary Talk

Toward Intelligent Systems in the DoD
Lt. Col. Stephen Cross, DARPA
Chair: David Waltz, Thinking Machines Corporation

Invited Talk

Application Projects at ICOT
K.C. Furukawa, ICOT
Chair: Sanjay Mittal, Metaphor Computer Systems

Invited Talk

The ESPRIT Program
D.E. Talbot, Commission of the European Communities
Chair: Tim Finin, Unisys

Invited Talk

Applying Common Sense – Necessity or Oxymoron?
Doug Lenat, MCC
Chair: Eric Mays, IBM

PANEL SESSIONS

AI IN ENGINEERING DESIGN: THE USER PERSPECTIVE

Chair: D. Sriram, Intelligent Engineering Systems Laboratory, Department of Civil Engineering, MIT

Most of the AI applications in the engineering industry have been geared toward classification-type problems. There are several reasons for this trend: (1) design problems are more ill-structured than classification-type problems; and (2) the inference mechanisms of most commerical tools facilitate classification-type problem solving. To regain our competiveness in the global market place there is a need to produce high quality products. AI-based tools can play a significant role in this process. In the recent past several AI-based tools for product development have emerged. This panel will address the issues involved in implementing design systems using commercially available AI-based tools. The panelists will discuss their experience in using these tools for engineering design.

THE ROLE OF STANDARDS IN KNOWLEDGE-BASED SYSTEMS

Chair: Ronald B. Ohlander, Information Sciences Institute, University of Southern California

The panel will discuss standards in the knowledge-based systems area. The issues will be considered from the standpoint of need for standardization in particular areas of technology, as well as the impact that such standards might have on research and development. Focus will be on languages, development environment features, interfaces, and knowledge representation standards. Perspectives will be given from academia, industry, and the government.

MULTI-MEDIA IN AI: CHALLENGES AND OPPORTUNITIES

Chair: Wolfgang Wahlster, German Research Center for AI, Saarbruecken, Germany

Intelligent presentation systems like COMET, SAGE, and WIP are important blocks of the next generation of user interfaces, as they translate from the narrow output channels provided by most of the current application systems into high-bandwidth communications tailored to the user. Since in many situations information is only presented efficiently through a particular combination of communication modes, the automatic generation of multi-media presentations combining natural language, graphics, gestures, and video is one of the tasks of such intelligent presentation systems. This leads to the central question of how to divide a given communicative goal into subgoals to be realized by the various mode-specific generators, so that they complement each other. This means that we have to explore computational models of the cognitive decision processes coping with questions such as: what should go into text, what should go into graphics, and which kinds of links between the verbal and non-verbal fragments are necessary?

Sharing Knowledge and the Role of Common Ontology

Chair: Thomas Gruber, Stanford University

The next generation of knowledge-based systems will need to move from isolated, one-off programs toward sytems that are integrated with other systems, sharing institutional knowledge bases and databases. The technical question is, how to share and reuse knowledge resources? This panel will explore the idea of using a common ontology – a standard vocabulary of representational primitives – as a vehicle for knowledge sharing. An ontology embodies a way of representing relevant aspects of the world in a computationally useful way: specific knowledge bases instantiate the ontology for particular domain objects and processes.

Cyc is well-known example of a system that integrates large amounts of knowledge with a common ontology. Other efforts include the Uniform Medical Language System, which integrates the major medical databases with common vocabulary; the Human Genome project, with data exchange standards based on a set of domain-specific features; natural language systems such as Penman, which specify the coupling to knowledge bases with a common ontology; and the DARPA/NSF Knowledge Representation Standards effort, which is developing mechanisms for knowledge interchange and shared ontologies. Panel members representing these efforts will offer their differing perspectives.

When Does Truth Maintenance Pay Off

Chair: Vasant Dhar, New York University

Over the last few years, truth maintenance systems have been used in a number of applications for supporting non-monotonic reasoning, caching problem-solver data, maintaining consistency in this data, resolving data inconsistencies, and so forth. There is now some accumulated experience from these applications, relating to the functionality that truth maintenance systems provide a reasoning system, and the costs involved in achieving this functionality. This panel examines these tradeoffs. Perspectives are provided by the research, vendor, and user communities.

Is Qualitative Physics Practical?

Chair: Fumio Mizoguchi, Tokyo Science University

Is qualitative physics a theoretical tool or a practical technology? The panel will address this issue as well as discuss future directions in the development of qualitative physics.

TABLE OF CONTENTS

RULE-BASED SYSTEMS THEORY
Chair: H.S. Lee

VISUALIZATION AND COOPERATIVE SYSTEMS
Chair: D. Navichandra

HYBRID KNOWLEDGE REPRESENTATION LANGUAGES
Chair: J. Pepper

BUSINESS/MANAGEMENT DECISION SUPPORT
Chair: C. Apté