Report on the first two Workshops on
AI in Distributed Information Networking (DIN)
IJCAI-95 Workshop on AI in DIN, Montreal, Canada
IJCAI-97 Workshop on AI in DIN, Nagoya, Japan

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Summary of IJCAI-95 Montreal & IJCAI-97 Nagoya Workshops on AI in DIN

Two earlier workshops on AI in DIN were organized and affiliated with the International Joint Conference on AI (IJCAI).

IJCAI-95 AI in DIN Conclusions

The IJCAI-95 workshop was held in Montreal during the joint IJCAI and AAAI conference. Over 40 participants attended the Montreal workshop. Four panels divided the day between a discussion on AI technologies applied to DIN and applications of AI in DIN. The details of the program committee, the objectives, the list of papers and the organization of the day are below in the Montreal AI in DIN workshop section.

The main conclusions from the IJCAI-95 AI in DIN Montreal workshop were divided into two sets. The first set was relevant to the application of agent technology in DIN in response to the workshop objective question of "what are the problems and what AI approach (if any) can be envisioned as part of the solution?". The two applications panels resulted in the presentation of mostly agent architectures as *the* AI solution and highlighted a number of issues:

➤ How can agents be defined? By my experience they remain as difficult to define as intelligence today. My definition of agents these days is "a chunk of software that can be mobile or stationary but can achieve something useful usually in a network".

➤ Are agents the magic AI bullet or a hyped panacea? Four years later, agents remain in wide study and are starting to appear in many commercial applications. As such, they have not been a cure-all but rather useful in distributed applications.

➤ Can the number of agents scale up for network use? In 1995, the scalability of agents was more doubtful than today. Today, the advent of the Internet with its over 148 million users has many static and mobile agent applications on board.

➤ Can communication and negotiation mechanisms for agents be engineered and eventually standardized? Agents are now engineered through software engineering techniques for commercial applications. However, despite the efforts of organizations such as FIPA, there are no standard agent communication or negotiation mechanisms. Perhaps this question is similar to the "can we standardize expert systems" question of the mid-1980s. The answer is no. My belief is that the best we can do is adopt telecom standards communication protocols for handshaking and apply them to agent technology.

The second set of conclusions at the Montreal workshop was relevant to the application of AI in network management. Interestingly it addressed the workshop objective of "why has AI succeeded or failed for various distributed information network problems?". The two panels resulted in discussions around these issues:

➤ Network Management (NM) researchers have not been pragmatic enough in focussing on real-world rather than toy problems. This is an interesting issue for me as I have been an evangelist for real-world approaches to AI R&D for over 11 years. I am happy to see that 4 years later, many NM AI researchers are focussing on practical rather than toy problems in diagnosis, monitoring, configuration management, etc.

➤ NM is a hard, data intensive and laborious problem. It also requires significant human expertise. To me these characteristics make it a perfect AI problem to focus on.

➤ NM requires a human in the loop. Can we build AI programs that more effectively address the human in the loop issue? To me, we are doing this in producing commercial NM applications that have embedded AI on board.

➤ How will NM cope with the convergence? This remains an open issue today as we see the convergence of wired/wireless networks and cable/traditional telephone networks. It is not clear how well or if the converged carriers are coping.

IJCAI-97 AI in DIN Conclusions

The second DIN workshop was held in Nagoya, Japan in affiliation with IJCAI-97. Twenty-six people participated in the workshop. The smaller number of participants was attributed to the venue of the conference being Japan and

the shrinking AI R&D budgets. Despite a smaller crowd, two panels were held which resulted in considerable discussion. The focus of the 1997 workshop was the application of agent technology in DIN be it for network management or for telecom value-added services such as e-commerce and unified messaging in wired and wireless networks. The main conclusions of the IJCAI-97 Nagoya workshop on AI in DIN were:

➢ NM activities that include fraud detection, converged network operation (telephone/cable or wired/wireless, etc.) that bring in AI must adhere to the widely accepted telecommunications standards that include regulations by bodies such as the US FCC. It is not clear how NM AI researchers are addressing these issues if at all.

➢ As AI is built into networks more and more in the form of agents and tracking software, user privacy is being compromised. Many Internet applications today track user habits without the knowledge of the end user. AI researchers have continuously ignored the social implications of advancing the commercial use of AI.

➢ Human in the loop issues with AI-based NM software remains an issue in 1999 as it did in 1995 and in 1997. A delicate balance of human responsibility versus AI program must be maintained. The ideal balance of this will only be perfected through the continued R&D in human factors for the development of NM or any other tools that humans are expected to use with built-in AI technology.

➢ Quality of Service (QOS) issues became a hot topic in NM between 95 and 97. QOS in NM remains a hot topic with the development of automatic tracking and billing software.

➢ A number of open agent issues remain in 1999 as well as in 1997. These issues include:
  - The development of mobile or stationary agents that incorporate AI while others that do not. I chaired a Mobile Agents panel in Ottawa in 1997 that included Jim White of General Magic and Danny Lang of IBM Japan (Lang is also now at General Magic) who argued vehemently with Katia Sycara or CMU that agents *do not* need AI to be useful.
  - Differing agent architectures can be used for centralized versus decentralized architectures. What is common and what is not?

➢ Finally, the issue of what has changed in NM over the last 25 years was discussed. We concluded at the 1997 workshop that we moved towards centralized NM with the NM control center to reduce costs. However, we are now seeing web-based NM decentralize the approach to NM trading off communication costs versus on demand NM. We also concluded that AI has acted as both a consumer and a producer of AI technology.

The remainder of the paper is divided into Part I and Part II. They respectively provide the details on the IJCAI-95 and the IJCAI-97 workshops on AI in DIN respectively.

Part I: Report on IJCAI-95 AI in DIN Workshop, Montreal, Quebec, Canada August 19, 1995

Workshop on AI in Distributed Information Networks, Where are the successes and where are the challenges for the future?

Organization

The workshop had a chair and an 11 member program committee gathered from Industry and Academia. Specifically:

Chair: Sue Abu-Hakima
Seamless Personal Information Networking Group
Institute for Information Technology
National Research Council of Canada

Review Committee:
1. Stephen Corley, Intelligent Systems Unit, BT Labs, Suffolk, UK
2. Michel Feret, Sony Corporation, Research Center, Tokyo, Japan
3. Andreas Girgensohn, NYNEX Science & Technology, White Plains, NY, USA
4. Nancy Griffeth, Bellcore, Morristown, NJ, USA
5. Jacob Groote, PTT Research, Groningen, Netherlands
6. Yezdi Lashkari, MIT Media Laboratory, MIT, Cambridge, MA, USA
7. Steve Laufmann, US West Technologies, Boulder, Colorado, USA
8. Beat Liver, R&D, Swiss Telecom PTT, Berne, Switzerland
9. Peter Selfridge, R&D, AT&T Bell Laboratories, Murray Hill, NJ, USA
10. Dominique Sidou, Institut Eurecom, Sophia Antipolis, France
11. Jon Wright, AT&T Bell Laboratories, Murray Hill, NJ, USA

Objectives of the Montreal Workshop

Distributed Information Networks deliver information over a variety of networks, which include telecom, cable, wireless and satellite networks. The workshop objectives were to address the past and the future of AI in information networks. Two classes of problems were ate the time traditionally addressed by AI for these networks. The first class of problems has been in network management, which addresses diagnosis, monitoring, alarm filtering, routing and traffic analysis. The second class of problems has been in applying AI to manage and present the information

flowing along networks. The network providers commonly refer to information network applications as services. Current services for end users vary from information filtering and financial services available through personal computers with modems to talking yellow pages available through telephone switching centers and distributed databases.

Both classes of problems have had successes and failures with the use of AI. One objective of the workshop was to discuss and categorize the results of using AI in both network management and information network applications. A key question was to address "why has AI succeeded or failed for various distributed information network problems?"

High speed heterogeneous networks formed by integrating telephone, cable, wireless, and satellite networks pose a variety of new problems in network management. They also present new opportunities in information network applications such as personalized electronic newspapers, video-on-demand, personalized home shopping, and nomadic computing with personalized digital assistants to name a few. The second objective of the workshop was to discuss and enumerate the challenges for AI in managing the new integrated networks and the opportunities in making use of them. A key question to address here was "what are the problems and what AI approach (if any) can be envisioned as part of the solution?"

Specifically, well-written papers were sought that described previously unpublished successes or failures in applying AI in a novel manner to:
a) network management problems such as, but not limited to: fault and/or alarm management, performance monitoring, configuration, adaptive routing, diagnosis, distributed intelligent agents, scheduling and provisioning.

b) Information network applications such as, but not limited to: information filtering (including off the world wide web), digital libraries, personal digital assistant applications, video-on-demand, Tele-medicine, distance learning and talking yellow pages

Day of the Montreal Workshop Organization

The goal of the workshop was to maximize discussion and avoid having a mini-conference. To meet this goal, the workshop was organized as four panels, 2 morning and 2 afternoon:

➤ *Panel 1: Successes/failures in network management*

➤ *Panel 2: Vision for AI in network management*

➤ *Panel 3: Successes/failures in information network applications*

➤ *Panel 4: Vision for AI in information network applications*

The conclusions from the panel discussions are highlighted in the first section or summary section of this paper.

List of Papers Presented in Montreal

Full Papers

1) A Help Desk Application for sharing resources across high speed networks using a multi-agent architecture. Sue Abu-Hakima, Innes Ferguson, Nancy Stonelake, Ed Bijman and Richard Deadman. National Research Council of Canada and Mitel Corporation, Canada
   - Paper topics - multimedia agent application for sharing resources over ATM

2) Scenario generation for telecommunication network supervision. Serge Bibas, Philippe Dague, Francois Levy, Marie-Odile Cordier and Laurence Roze. Universite Paris Nord and IRISA, France
   - Paper topics - alarm management & network modelling

3) TENNIS: a computer network ease of service evaluation system. David Brown, Craig Wills, Bertram Dunskus and Jonathan Kemble. Worcester Polytechnic Institute, Mass., USA
   - Paper topics - cooperating agents & the design of new networks based on previously designed nets

4) An AI Approach to Network Fault Management. Denise W. Gurer, Irfan Khan, Richard Ogier and Renee Keffer. SRI International, Menlo Park, California and Sprint, USA
   - Paper topics - neural nets and case-based reasoning for network fault management

5) Facilitators: a networked computing infrastructure for distributed software interoperation. Taha Khedro and Michael Genesereth. Stanford University, Calif, USA
   - Paper topics - heterogeneous agents, organizational modelling

6) Knowledge and Location. Isabel Novoa and Mark Wilby. BT Research Labs, Ipswitch, UK
   - Paper topics - addressing space in distributed computing using a classification tree approach

7) Dual role agents for communications network management. B. Pagurek, J. Bryant and N. Dawes. Carleton University, Ottawa, Canada

- Paper topics - agents and network management

8) A constraint-based approach to diagnosing configuration problems. Daniel Sabin, Mihaiela Sabin, Robert Russell and Eugene Freuder. University of New Hamshire, USA
   - Paper topics - use of constraints in model-based diagnosis of network software

9) A Service Environment for Distributed Multimedia Applications. Michael Weiss, Tom Gray and Aurora Diaz, Mitel Corporation and National Research Council of Canada,
   - Paper topics - agent architecture and organizational modeling

10) Intelligent agents for service management in integrated fixed and mobile networks. C.S. Winter, M. Busuioc and R. Titmuss. BT Laboratories, Martlesham Heath, UK
   - Paper topics - agents, modelling services over mixed networks

11) Conceptual Modeling using knowledge representation: configurator applications. Jon Wright, Deborah McGuinness, Charles Foster and Gregg Vesonder. AT&T Bells Labs, Murray Hill, New Jersey, USA
   - Paper topics - modelling for software applications in organizations

Short Papers

1) Modelling Knowledge and Access in Corporate Distributed Information Systems. Alfred Attipoe and Guy Boy. European Inst. Cognitive Science and Engineering (EURISCO), France

2) Abstraction Methods for Resource Management in a Distributed Information Network. Berthe Choueiry and Dean Allemang. Swiss Federal Inst. Technologly and Swiss PTT.

3) On Establishing Multi-Sensory Multi-channel Communications Among Networked Users. Innes Ferguson and James Davlouros. National Research Council of Canada, Ottawa, Canada

4) Distributed Coordination: A Rational Approach. Hamada Ghenniwa , Jose Reinaldo Silva and Mohamed Kamel. University of Waterloo, Canada

5) Experience and Trends in AI for Network Monitoring and Diagnosis. Christopher Leckie. Telstra Research Labs, Clayton, Australia

6) Contents-based Information Gathering in the WWW by Integration of Textual and Cooperative Tools. Christian Martel and Serge Stinckwich. Universite de Savoie, Bourget, France

Part II: Report on IJCAI-97 AI in DIN Workshop, Nagoya, Japan August 24, 1997

Workshop on AI in Distributed Information Networks, What have we learned and how will we deal with the convergence?

Organization

The workshop had a chair and a 9 member program committee again gathered from Industry and Academia. The details of the program committee were:

Chair: Sue Abu-Hakima
Seamless Personal Information Networking Group
Institute for Information Technology
National Research Council of Canada

Program Committee:

1. Stephen Corley, Intelligent Systems Unit, BT Labs, Suffolk, UK
2. Michel Feret, Sony Corporation, Research Center, Tokyo, Japan
3. Innes Ferguson, Agents System Group, UK
4. Andreas Girgensohn, FX Palo Alto Laboratory, California, USA
5. Nancy Griffeth, Bellcore, Morristown, NJ, USA
6. Steve Laufmann, US West Technologies, Boulder, Colorado, USA
7. Beat Liver, R&D, Swiss Telecom PTT, Berne, Switzerland
8. Hugo Velthuijsen, KPN Research, The Netherlands
9. Jon Wright, AT&T Bell Laboratories, Murray Hill, NJ, USA

Objectives of the Nagoya Workshop

This workshop addressed the convergence and the future of AI in seamless information networking for Distributed Information Networks that deliver information over a variety of media which include telecommunication, cable, wireless and satellite networks. Seamless networking is the ability to create and deliver information in personal communication workspaces. These workspaces include multimedia multi-modal devices such as desktop video conferencing tools, telephones, pagers, and cellular phones, which can be used for voice, text or video communication. To achieve the transparent capability of moving seamlessly from one device to another and from one application to another there exists a need to develop intelligent personal

assistants. These personal communication assistants are being developed as intelligent agents. They range from talking yellow page agents, financial assistants to information filtering softbots.

Coupled with personal agents is a need for infrastructure agents and AI technologies to manage the converging wired and wireless networks. This is the field of network management and it addresses fault management, diagnosis, monitoring, alarm filtering, routing and traffic analysis.

The workshop followed the highly successful IJCAI-95 workshop on AI in Distributed Information Networks. That workshop examined the successes and failures of AI applications and of applying AI in network management. It was clear that AI has been successful in constrained well-defined domains. However, AI technology has often been applied to toy problems that do not adequately scale up to network problems or represent the real world. For example, 7 different agent architectures for network applications were presented for agents at the IJCAI-95 workshop. The IJCAI-97 workshop addressed the common features of the agent architectures and AI technology in network applications and network management. It is clear that network applications require persistent, predictable agents whose behaviours are bounded and will not consume infinite resources. Questions that needed addressing included: how can network agents realize predictable behaviors while maintaining some form of autonomy?; what are the ideal communication mechanisms for distributed and sometimes mobile agents?; how can agents exist in secure and non-secure environments?; how can agents recognize friendly versus rogue agents?; etc.

High-speed heterogeneous networks formed by converging networks pose a variety of new problems in network management. They also present new opportunities in information network applications such as personalized electronic newspapers, video-on-demand, personalized home shopping, and nomadic computing with personalized digital assistants to name a few. The IJCAI-95 workshop identified agents as a key AI technology for managing the new integrated networks. The IJCAI-97 workshop also addressed the question of how to use agents to manage the networks.

Well-written papers were sought that described previously unpublished application of AI and agent technology in a novel manner to:

a) Network management problems including: adaptive routing, diagnosis, monitoring, and scheduling provisioning.

b) Personal information network assistants or agents for applications that include: seamless messaging over wired and wireless networks, information filtering (including off the world wide web), personal digital assistant applications computer supported collaborative work (groupware) applications, distance learning and tele-medicine.

Papers that present a well-supported vision as to where the challenges lie for AI and agents in the new converging networks were also sought.

Well-written reviews were also requested that addressed: personal assistants or agents for information networking application problems and AI technology or agents for network management problems.

Day of the Nagoya Workshop Organization

The goal of the workshop was again to maximize discussion and avoid having a mini-conference. To meet this goal, the workshop was organized as two panels, one morning and another afternoon with an introductory and concluding session:

➢ Introduction: Summary of IJCAI-95 Workshop and Goals for IJCAI-97 Workshop.

➢ Panel 1: Agents for personal networking applications in the converging networks

➢ Panel 2: AI Technologies and Agents in Network Management

➢ Conclusion and summary of issues

The conclusions of the Nagoya workshop are included in the first summary section of this paper.

List of Papers Presented in Nagoya

Full Papers

1) A multi-agent system approach for fraud detection in personal communication systems. Suhayya Abu-Hakima, Mansour Toloo and Tony White. NRC and Nortel Inc., Canada.
   - Paper topics - wireless networks, security, MAS

2) A multi-agent system for seamless messaging by email, fax or voice mail. Suhayya Abu-Hakima, Ramiro Liscano, Roger Impey and Elaine Sin. NRC and University of Calgary, Canada.
   - Paper topics - seamless hybrid messaging, MAS

3) Interoperability of systems: from distributed information to cooperation. Michel Bares and Laurent Chaudron. French Ministry of Defence & ONERA-CERT, France.

- Paper topics – network interoperability, formal analysis, constraint methods

4) A rule-based approach for monitoring the performance of data networks. Michael Dale, Chris Leckie, Herman Ferra and Alan Christiansen. Telstra Research Laboratories, Australia.
   - Paper topics - real-time net event monitoring and correlation, rule-based systems

5) Web economics: a case for agent-based digital libraries. Innes Ferguson, Jorg Muller, Markus Pischel and Michael Wooldridge. Agent Systems Group, Zuno Ltd., UK.
   - Paper topics - digital libraries, multi-agent systems

6) A dynamic hierarchy of intelligent agents for network management. Christian Frei and Boi Faltings. Artificial Intelligence Laboratory, Swiss Federal Institute of Technology (EPFL), Switzerland.
   - Paper topics - network management, MAS

7) Social carrier recommendation: the final step towards electronic telecoms markets.
   Beat Liver and Jorn Altmann, Swiss PTT.
   - Paper topics - quality of service, multi-agent systems