

1994 Fall Symposium Series Reports

The American Association for Artificial Intelligence (AAAI) held its 1994 Fall Symposium Series on November 4-6 at the Monteleone Hotel in New Orleans, Louisiana. This article contains summaries of the five symposia that were conducted: (1) Control of the Physical World by Intelligent Agents, (2) Improving Instruction of Introductory AI, (3) Knowledge Representation for Natural Language Processing in Implemented Systems, (4) Planning and Learning: On to Real Applications, and (5) Relevance. Proceedings of most of the symposia are available as technical reports from AAAI.

Control of the Physical World by Intelligent Agents: Putting the Pieces Together

Organizing Committee: Piero Bonnisone, General Electric; Jim Hendler, University of Maryland; Michael Jordan, Massachusetts Institute of Technology; Benjamin Kuipers (cochair), University of Texas; Lyle Ungar (cochair), University of Pennsylvania

Control of the physical world, whether by mobile robots or by chemical process controllers, involves many disciplines, including conventional process control, neural networks, fuzzy logic, decision theory, planning, and vision. This workshop brought together researchers from these and other fields with the aim of enumerating the methods available; making a stab at generating a framework for putting them together; and addressing questions such as, How can control help AI? and How can AI help control?

Discussion topics ranged from

ontologies and architectures to the relative merits of individual tools and methods. A recurring theme was the benefits—or lack thereof—of hierarchical systems: A majority of the attendees supported the position that hierarchy was necessary: Low-level subsystems process sensory input and execute control strategies, and higher-level systems select control strategies appropriate for the task at hand, especially by planning and, perhaps, developing and using maps of the environment. The desirability of

The American Association for Artificial Intelligence held its 1994 Fall Symposium Series on November 4-6 at the Monteleone Hotel in New Orleans, Louisiana. This article contains summaries of the five symposia that were conducted: (1) Control of the Physical World by Intelligent Agents, (2) Improving Instruction of Introductory AI, (3) Knowledge Representation for Natural Language Processing in Implemented Systems, (4) Planning and Learning: On to Real Applications, and (4) Relevance.

developing plug-and-play control components was recognized, but a strong minority of participants doubted the feasibility of constructing modular or hierarchical systems.

Many pieces of technology exist that help control the world, ranging from classical feedback control methods, fuzzy logic, and neural networks to situational calculus and active vision. At the lower, control level, methods for lower-level controllers such as fuzzy logic and neural networks are advancing rapidly and converging: Gradient descent methods

(*back propagation*) are used to tune fuzzy logic controllers, and more prior knowledge is built into neural networks. Methods such as fuzzy logic and radial-basis functions provide mappings from the continuous-valued sensor world to discrete state and action spaces such as are typically used in AI reasoning. New tools were also introduced, such as the use of exploration-based learning to develop control strategies and the incorporation of actions into belief networks.

Dave Miller led the campaign for real implementations, with support from others arguing that one cannot address “control of the physical world by intelligent agent” without the agents being situated in the world. Robots can use their interaction with the world in several ways: For example, they can actively seek data to improve their world models and, hence, their performance, and they can use active vision to better perceive the world, for example, improving depth perception by moving cameras. Many implemented systems were presented at the workshop, enriching the discussion.

Much discussion was given to the barriers to building and sharing implemented robots. Building implementations, although desirable, requires an effort disproportional to its career enhancement. Substantial barriers exist to realizing the goal of developing methods for combining control and reasoning techniques and code from different researchers. Some of this difference relates to the lack of incentives for researchers to develop, provide, and support code modules that others can use. Worse, it is not clear to what extent it is possible to plug together different methods without adjusting them to the problem at hand. More positively, the cost of building robots is falling dramatically, and several researchers are working to provide tools and components such as vision systems for general use.

Much of the research presented focused on developing tools on the lower end of the hierarchy to get robots and other agents to really work. Once these tools are in place,

we expect more attention to return to questions about the higher levels in the hierarchy, such as how to build cognitive maps.

Benjamin Kuipers
University of Texas at Austin
Lyle H. Ungar
University of Pennsylvania

Improving Instruction of Introductory AI

Organizing Committee: Marti Hearst (chair), Xerox Palo Alto Research Center; Haym Hirsh, Rutgers University; Dan Huttenlocher, Cornell University; Nils Nilsson, Stanford University; Bonnie Webber, University of Pennsylvania; Patrick Winston, Massachusetts Institute of Technology

The symposium on Improving Instruction of Introductory AI was motivated by a desire to address the often-voiced complaint that introductory AI is a notoriously difficult course to teach well. Thus, this AAI symposium was nonstandard in format and content. The symposium was well attended with about 50 participants, and based on the comments written on the exit surveys, it was considered a strong success by most of the participants.

The first and most important goal of the symposium was to provide a forum in which colleagues from various institutions could meet to discuss issues relating to the instruction of introductory AI. The workshop format allocated large blocks of time for discussion and emphasized active participation of the attendees. Another goal was to address issues facing faculty at colleges that focus primarily on teaching and allow new faculty to interact with more experienced instructors.

Beyond this goal, a central part of the call for participation requested that the authors identify an underlying theme that can be used to help structure the material, even if the theme does not precisely reflect all the current viewpoints of the field. An unforeseen consequence was that the working notes reveal not only what the trends are in teaching intro-

ductory AI but also trends in how its members currently perceive the field.

In addition to somewhat standard syllabi, the presentations revealed an emerging pedagogic paradigm centered around an agent-centric viewpoint. In this strategy, agents are entities embedded in an environment in which they perceive input and perform actions that affect the environment. Over the course of the syllabus, both agents and environments increase in complexity, supporting discussions of search, planning, reasoning under uncertainty, learning, and so on. Interestingly (although perhaps not surprisingly), this new trend in instruction reflects trends in research and in attitudes toward the field as a whole. A counterargument to the agent-centric approach was offered: An all-encompassing agent-centric view might distort the subject matter, leading students to believe this framework defines the field or crippling their ability to see how the ideas might be used outside the agent framework.

Another goal of the symposium was to discuss the role of programming: How important is programming to learning the subject matter, to what degree should it be required, what kind of programming assignments are useful, and so on. Several participants emphasized the need for a project-based orientation and an emphasis on having students solve open-ended, nontoy problems. The overall consensus was that programming is an essential part of an introductory course. In a related topic, participants discussed software tools that are available for demonstrating AI concepts in the classroom.

Several participants voiced the need to change the practice of teaching methods and topics only because they are part of AI history and suggested ways to distinguish the old from the important. Another theme was the need to integrate AI with core computer science, to both increase the use of AI methods and enhance interest in computer science. Related points were the importance of showing where computer science and AI overlap, as in compiler theory and NLP (natural language processing) parsing,

and the need to integrate AI methods internally, as in the relationship between truth maintenance systems and theorem proving.

Participants expressed interest in extending the impact of the symposium in the following ways: (1) holding another workshop to focus on how to teach specific topics, such as search, uncertainty, and so on; (2) having tutorials at meetings of AAI and the International Joint Conferences on Artificial Intelligence, Inc. (IJCAI), on how to teach specific subtopics, such as natural language processing, vision, and robotics, that are outside many researchers' specialties; (3) forming an e-mail list to continue relevant discussion; and (4) encouraging the AAI-IJCAI meetings to include a special track on AI education.

In connection with the symposium, an existing repository of instructional material and programs was augmented with papers from the proceedings as well as other information. At the time of writing, this repository can be accessed at <http://yoda.cis.temple.edu:8080/IIIA/ai.html>. Eventually, this information will also be made available through a server maintained by AAI.

Marti Hearst
Xerox PARC

Knowledge Representation for Natural Language Processing in Implemented Systems

Organizing Committee: Syed S. Ali (chair), Southwest Missouri State University; Douglas Appelt, SRI International; Lucja Iwanska, Wayne State University; Lenhart Schubert, University of Rochester; Stuart C. Shapiro, State University of New York at Buffalo

This symposium involved researchers actively working on implemented knowledge representation and reasoning systems for general natural language processing to assess the current state of the field. The format was discussion oriented, with short panel presentations and an overview by the

panel chair. Four panel sessions were followed by a final wrap-up session and demonstrations of various systems.

The first panel topic was concerned with assessing the standard design of morphology-syntax-semantics-pragmatics. Panel chair Appelt descriptively called this design the *pipelined approach*. There was general agreement that the standard design was not a popular approach in implemented systems, which adopt a more interleaved approach. Pipelined implementations lead to separate components, each with its own representation language, creating problems for knowledge sharing. After discussion, it appeared that the standard design is most useful for pedagogy, where it simplifies the presentation of difficult issues.

The session led by Lucja Iwanska was concerned with pragmatic issues (that is, *discourse*) and their connection to the representation language. In the overview, the point was made that there are a large number of such pragmatic issues, and it was not clear that all these issues needed to be dealt with in the representation language. Subsequent discussion revolved around trying to identify what issues should be dealt with by the knowledge representation language rather than the natural language front end. One participant commented that people appeared to be rather large back ends (to which another participant responded that he objected to being called a large back end). There was no consensus; the task of identifying what pragmatics were in the knowledge representation language was extremely difficult and, as a practical matter, depended on the individual researcher's interests.

The session led by Len Schubert discussed what the relationship is (or should be) between the knowledge representation and the language. He commented that expressiveness in the knowledge representation and reasoning language is good; thematic roles were of limited utility; model-theoretic semantics were important (minimally for reasons of "hygiene"); and, in practice, there was no expressiveness-tractability trade-off. Inter-

estingly, with the exception of the point of thematic roles (which provoked some arguments), there was general agreement about these points from researchers in both the natural language and knowledge representation communities.

The following session, led by Stu Shapiro, was concerned with the place of inference methods in the knowledge representation and reasoning language that parallel reasoning in natural language. His overview and subsequent panel presentations suggested that natural language was a productive source of inferential techniques for the knowledge representation language. This suggestion provoked a lengthy discussion about whether it was a good idea to embed such techniques in the knowledge representation and reasoning formalism rather than provide a general-purpose formalism that can model natural language reasoning.

The final session, led by Sy Ali, was a general wrap-up session concerned with summarizing the symposium. It was followed by an unstructured period of demonstrations and discussions. The reaction was positive, with an interesting discussion of the differing goals and demands of researchers working primarily in natural language processing versus those working in knowledge representation. The general assessment was that progress has been made, but much more needs to be done.

Syed S. Ali

Southwest Missouri State University

Planning and Learning: On to Real Applications

Organizing Committee: Steve Chien, Jet Propulsion Laboratory; Yolanda Gil (cochair), USC/Information Sciences Institute; Drew McDermott, Yale University; Dana Nau, University of Maryland; Manuela Veloso (co-chair), Carnegie Mellon University

The goal of the symposium was to discuss and analyze realistic planning applications, identify the sources of complexity in scaling up planning

systems, and better understand how learning techniques can come into play to overcome this complexity.

The symposium brought together learning and planning researchers, as well as planning practitioners to discuss real-world planning problems where the integration of planning and learning techniques shows promise in addressing the complexity of practical situations. Planning practitioners described several applications, including support systems for planning and control of space missions, military mission planning for various tasks, planning for robotic systems, and process planning for manufacturing. While discussing these applications, we detected several overarching research issues, including the need for better representations for domain-specific knowledge, the integration of planning components with other software systems and with end users in operational environments, and the acquisition and maintenance of domain-specific knowledge.

A wide variety of learning techniques for planning were presented. For more than a decade, learning has been used to acquire knowledge to improve search efficiency in planning and problem-solving systems such as PRODIGY, SOAR, and LEX. Beyond this traditional research, known as *speedup learning*, the participants presented approaches to incorporate learning in several new aspects of the planning process that are relevant to planning applications. In particular, explanation-based-learning techniques for speedup learning are now combined with inductive methods to avoid the need for complete specifications of planning domains. Analogical-case-based reasoning is now being tried in a set of interesting applications that point out the need to find faster retrieval mechanisms for large case libraries and representations for similarity metrics that can use application-specific properties. A more novel area is the use of learning methods to acquire and maintain domain knowledge, with techniques such as learning from instruction and from observation. The discussion on learning techniques for acquiring

knowledge to improve the quality of plans was of particular interest; this aspect is of special concern for planning practitioners. The area of learning techniques that incorporate knowledge-acquisition capabilities needs to be explored more.

The discussions raised two important points: One is how useful particular planning algorithms and learning techniques have proven to be in practice. We concluded that their real effectiveness will emerge as more research techniques are used in real applications. The second point is that it is rather difficult to address every aspect of a particular application. From a few such attempts, we learned that understanding an application requires becoming an expert in the area, mastering the language, the concepts, and the strategies used by humans.

We agreed on a particular way to address these concerns and advance the bidirectional transfer of work between research and applications. This method was also emphasized by the invited speakers as an important step in the direction of clarifying research results and abstracting particular characteristics of applications. We will compile a suite of planning domains motivated by real planning problems that can be shared by different planning and learning systems. Some of the difficulties discussed are that many planning application domains are classified or proprietary, such a task is time consuming and often not appreciated, and comparisons can be hard to do because different performance results can be obtained from the wide variety of representations and approaches used to model the same domain. We generally agreed that these difficulties must be overcome and that they require efforts both from the applications community (to make their domains available in some accessible format) and from the research community (to look for research targets in these domains). The symposium organizers will coordinate the creation of this repository through domains contributed by the participants of this and other planning research forums.

Yolanda Gil

USC/Information Sciences Institute

Manuela Veloso

Carnegie Mellon University

Relevance

Organizing Committee: Russ Greiner (cochair), Siemens Corporate Research; Yann Le Cun, AT&T Bell Laboratories; Nick Littlestone, NEC Research Institute; David McAllester, Massachusetts Institute of Technology; Judea Pearl, University of California at Los Angeles; Bart Selman, AT&T Bell Laboratories; Devika Subramanian (cochair), Cornell University

With too little information, information-processing systems (for example, reasoning or learning programs) cannot work effectively. Surprisingly, too much information can also cause the performance of these systems to degrade in terms of accuracy and efficiency. Therefore, it is important to determine what information must be preserved, that is, what information is *relevant*.

The Relevance Symposium was inspired by the recent flurry of interest in this topic from a range of communities, including (1) *knowledge representation*, reasoning about irrelevance of distinctions to speed up computation, whether in the context of standard logical derivation, a production-system execution, or constraint satisfaction; (2) *machine learning*, removing irrelevant attributes or irrelevant training examples to make induction from very large databases feasible; (3) *uncertainty management*, simplifying Bayesian nets (both topology and values) to permit real-time reasoning in applications; and (4) *neural nets*, identifying good topologies by eliminating irrelevant nodes. The symposium's goal was to obtain a better understanding of the various senses of the term *relevance*, with an eye toward techniques for improving a system's performance by ignoring or deemphasizing irrelevant and superfluous information. These techniques will clearly be of increasing importance as knowledge bases—and learning systems—become more comprehensive to accommodate real-world applications.

We were fortunate to receive a

wealth of excellent submissions from researchers in several fields, including statistics, constraint satisfaction, information retrieval, cognitive science, and philosophy, as well as the fields mentioned earlier. These articles were tremendously diverse in terms of computation models (for example, belief networks, default logics, decision trees) as well as specific applications (for example, text retrieval, game playing, real-time object recognition, plan recognition, speech processing, software agents, data mining). They helped to articulate and refine several important senses of relevance and identify real applications that can benefit from relevance reasoning.

To interrelate the various topics discussed and make the symposium more coherent, recognized experts placed each presented paper in a larger context by connecting it with other computational paradigms represented at the symposium and familiarizing the audience with related work. We found this scheme worked well in facilitating interchanges between the participants; for example, at least two joint projects between members of different communities were initiated at the symposium. The symposium also included two poster sessions as well as a formal panel with experts, from several fields, presenting their thoughts on a research agenda for relevance reasoning. The symposium concluded with a lively discussion on the variety of forms of relevance reasoning and a debate on whether task-independent notions of relevance exist.

The workshop was successful in bringing together researchers from various disciplines and for sharing perspectives, models, and algorithms. The participants collectively felt that they benefited from learning about notions of relevance being pursued in other areas and about task-specific implementations of relevance reasoning. We are currently planning to publish an archival collection of relevant papers.

Devika Subramanian

Cornell University