Association of Automated Reasoning Newsletter No. 5

From the President

AAR Newsletters Available

Current members of the Association for Automated Reasoning who wish back issues of particular newsletters may write to me or to Larry Henschen. We shall attempt to comply with your request. Since our supply of back issues is limited, however, and since membership in AAR is increasing, we expect that we shall soon not be in a position to send new members a complete set of the first few newsletters.

JAR

Journal of Automated Reasoning had 238 members as of May 31, 1985 — 106 institutional and 132 private. As of July 31, 1985, the numbers had grown to 380 — 155 institutional and 225 private. Clearly the Journal is doing well. Two issues have already appeared, and the third issue is in the mail. Articles intended for publication may be sent to the editor-in-chief Dr. L. Wos, MCSD, Argonne National Laboratory, Argonne, IL 60439.

Reports on Research

In keeping with our interest in exchanging information about work in automated reasoning, we shall occasionally include a brief summary of research or applications in the field. We begin in this issue with two such summaries.

Kurt Ammon (from the University of Hamburg, West Germany) is exploring the architecture and growth of cognitive structures. His research is based on two hypotheses:

- The central mechanism of intelligence is concept formation by induction and feedback.

- Induction and feedback are knowledge-based processes that involve the most important activities of intelligence, such as observation, experimentation, and theory formation.

The emphasis is on the automatic acquisition of mathematical theories and on the automatic discovery of cognitive structures for higher mathematics research. Ammon believes that the work has both a theoretical and an experimental basis, with potential applications in mathematics, programming, natural language processing, and cognitive modelling.

Brian Smith (from Argonne National Laboratory) and his colleagues are working on verification of hardware and software, as part of a project related to a nuclear reactor built 25 years ago and still in operation in Idaho. Some of the sensors used to monitor

the reactor performance are now failing as a result of age. Because replacement of those sensors is not feasible, the plan is to use a fault-tolerant computer system and a computer program to monitor the reactor's performance. For the new approach to be accepted by formal committee review, at least some of the software and hardware and the interface between them must be verified. Smith has been using the reasoning program ITP (developed at Argonne and capable of being used in either batch or interactive mode) to devise and then apply techniques to the verification problem. Already, ITP has yielded some surprising results. For example, in studying the original design with ITP, it was discovered that the system —thought to be tolerant of single-component failure —is in fact tolerant of the failure of two components under certain conditions. The verification effort is admittedly difficult, and to date only parts of the hardware system have been verified; but the successful use of an automated reasoning system in such an application is extremely encouraging.

Meetings

AI

A special conference entitled Future and Impacts of Artificial Intelligence will be held in conjunction with the Eighth European Meeting on Cybernetics and Systems Research in Vienna, Austria, on April 1-4, 1986. The aim of this conference is to help determine and assess future developments and impacts of AI in order to avoid potential damage and to encourage socially helpful and economically useful AI research and applications. Colleagues are invited to submit papers by October 1 to the Conference Secretariat:

Österreichische Studiengesellschaft für Kybernetik
A-1010 Wien 1, Schottengasse 3
Austria

Multi-Valued Logic

The Multi-Valued Logic Technical Committee of the IEEE Computer Society will hold its sixteenth annual symposium on May 27-28, 1986, in Blacksburg, Virginia. Among the topics to be discussed are automated reasoning, logic design, and fault detection and diagnosis. Those wishing to submit papers should send four copies, by November 1, to

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Journal News

AAI

A new journal, ***Applied Artificial Intelligence***, will publish its first issue in January 1986. AAI is devoted to practical information such as

- applications of AI, e.g., use of expert systems and robotics for solving tasks in industry, management, administration, and education

- evaluation of existing AI systems and tools

- user experience

- theoretical research with relevance to potential applications

For further information, write to Hemisphere Publishing Corporation, 79 Madison Avenue, New York, NY 10016.

Reports on Mathematical Logic

We are pleased to note that, beginning with issue 21, *Reports on Mathematical Logic* will be including a Problems Section. Each entry should include

- a clear formulation of the problem,

- definitions of fundamental notions, or appropriate literature references,

- basic bibliographical data, and

- an appraisal of the weight of the problem (its relationship to other problems and the role solutions may play in the given field of research).

Contributions should be sent to the Department of Logic, Jagiellonian University, Ul, Grodzka 52, 31-044 Cracow, Poland.

An Interesting Source of Problems

(Ross Overbeek)

In response to our request for open problems, or simply challenging puzzles, Ross Overbeek sent us the following.

"I recently started working on problems from a remarkable new book by Raymond Smullyan. The book, *To Mock a Mockingbird*, published by Alfred A. Knopf, contains problems that can reasonably be attacked with automated theorem-proving systems. Although I have only encoded about twenty of these problems, I have found that they range from fairly trivial to fairly complex.

The most interesting part of the book involves a "sugar-coated" development of combinatory logic. To illustrate, let me describe the first problem in this section:

1. The reader is asked to imagine a forest inhabited with birds. These birds all have names. Furthermore, given any bird x, if you say the name of some bird y to x, it will respond with the name of some bird. If the response is y, x is said to be 'fond' of y.
2. A mockingbird is a bird such that, if you say x to the mockingbird, it will respond with exactly what x would respond.
3. Some forests fulfill what Smullyan calls the 'composition condition.' In such a forest, for any two birds x and y, there exists a bird z such that z will respond to a query with exactly what x would repond to what y would say in response to the query. That is, z behaves as a pipelined version of x and y.

The problem is to prove that, in a forest that fulfills the composition condition and contains a mockingbird, every bird is fond of at least one other bird.

I found this problem interesting. First, I have seen the proof of this fixed-point theorem elsewhere. Hence, I supposed that I could solve it in a few minutes. I worked on the problem while attending a conference and found that I could not solve it. I like to think that this reflects my general condition after several long evenings with friends, but I am inclined to think that it would be challenging even with a clear head. After several hours of effort, I gave up and decided to run it on the Argonne theorem prover ITP when I got home. The axioms that I used were simply as follows:

$x = x$

$S(x,S(y,z)) = S(f(x,y),z)$ composition condition

$S(m,x) = S(x,x)$ m is a mockingbird

not $(S(a,x) = x)$ claims that a is not fond of any bird

The program derived a short, elegant proof of contradiction in just a few seconds on the first run. I then proceeded to run a number of other problems from the section and got similarly pleasing results.

Smullyan has a marvelous way of making fairly deep problems sound quite amusing. Here is a representative set of problems (I'll let you go to the book to actually get the required definitions):

1. Prove that any bird that is fond of at least one bird must be a happy bird.
2. Prove that if a kestrel is egocentric, then it must be hopelessly egocentric.
3. Prove that if the forest contains a lark L and an identity bird I, then it must also contain a mockingbird M.

The book contains almost 100 such problems, all of them simply stated. Solutions for most of the problems are provided.

On the first evening, I ran only 5 or 6 of the early problems. They all seemed quite easy (for the program — I didn't have the courage to attempt them). However, in later chapters, I found problems that Smullyan believes are actually open problems. I did answer one question that Smullyan posed as a challenge, but have not yet attacked any of the problems he lists as open (he states that he has not done a complete literature search, so they may not actually be open). All in all, the book is a beautiful presentation of combinatory logic, a source of good problems for playing with theorem provers, and a potential source of great pleasure."

Automated Reasoning on the CRAY

(from W. McCune)

The automated reasoning system ITP was recently ported to the CRAY X-MP-22 at the National Magnetic Fusion Energy Computer Center in Livermore, California. NMFECC has its own operating system (CTSS), but the standard CRAY Research Pascal compiler was used. On a set of five benchmark problems, speedups from a VAX 11/780 running Berkeley UNIX 4.2 to the CRAY ranged from 5.8 to 9.4. This performance is especially disappointing, considering that the Berkeley UNIX Pascal compiler does not generate fast code.

The following factors may explain the poor performance; all are related to the fact that CRAYs are designed for numeric computation. First, the non-numeric sequential computation of ITP cannot make use of the vectorization or multitasking capabilities of the CRAY. Second, the stack-based execution required by the use of Pascal is rumored to cause a slowdown of 2. Finally, it seems likely that the CTSS operating system does not use sophisticated techniques for managing dynamically allocated memory.

This experience supports the argument that there is a need for ultra-high-performance hardware and software tailored specifically for symbolic computation.