

ASSOCIATION FOR AUTOMATED REASONING NEWSLETTER

No. 11

January 1989

From the AAR President, Larry Wos...

In this our first issue of 1989, we present a variety of items to interest our members:

- short articles describing current research in automated reasoning;
- a list of our current members; and
- announcements of upcoming conferences, seminars, and classes.

With a membership list of over 300 persons, our hope for the new year is to receive over 300 articles contributed to this newsletter! We encourage you to send us a description of your work, a challenging problem you've encountered, perhaps questions you hope another AAR member might be able to answer.

Conferences

RTA-89

The third biannual conference on rewriting techniques and applications will be held in Chapel Hill, North Carolina, on April 3-5, 1989. Topics will include

term rewriting systems
symbolic and algebraic computation
conditional rewriting
equational programming languages
graph rewriting and grammars
bu unification and matching algorithms

algebraic semantics
equational reasoning
rewrite-based theorem proving
term-based architectures
completion procedures
lambda calculus

For further information, write to N. Dershowitz, RTA-89, University of Illinois, 1304 W. Springfield Ave., Urbana, IL 61801-2987

KR'89

The First International Conference on Principles of Knowledge Representation and Reasoning will be held at Toronto on May 15-18, 1989. Presentations are planned in the following areas:

analogical reasoning
deductive reasoning
temporal reasoning
evidential reasoning

theories of knowledge and belief
diagnostic and abductive reasoning
knowledge representation formalisms
formal task and domain specifications

For further information, write to Ron Brachman, KR'89 Program Co-chairs, c/o AT&T Bell Laboratories, 600 Mountain Avenue, Room 3C-439, Murray Hill, NJ 07974.

Logic at Botik

A one-week seminar entitled Logic at Botik is planned for July 1989 in Pereslavi-Zalessky, USSR. The proposed topics include

complexity aspects of formal systems
lambda calculus and related topics
foundations of logic programming
logics for knowledge representation
verification of programs

Persons interested in attending may write to LAB'89, P.O. Box 11, Program Systems Institute of the USSR Academy of Sciences, 152140 Pereslavl-Zalessky, USSR.

AIENG 89

The Fourth International Conference on AI in Engineering will be held during July 10-14, 1989, in Cambridge, England. The purpose is to provide an international forum for the presentation of applications of AI to engineering problems. Among the topics to be discussed are design, diagnosis, process control and planning, robotics, and sensing and interpretation.

For further information, contact Liz Neuman, conference secretary, Computational Mechanics Institute, Ashurst Lodge, Ashurst, Southampton, SO4 2AA, England.

Austrian Meeting on Artificial Intelligence

The Austrian Society for Artificial Intelligence will hold its fifth meeting on artificial intelligence at Innsbruck on March 28-31, 1989. The scientific program will include papers on

AI tools
impact of AI
knowledge representation
vision
cognitive science

knowledge-based systems
natural language
theorem proving
automatic programming
connectionism

Additionally, workshops will be offered in ontology and conceptual modeling, AI and flexible automation, AI in banking, recognition of pictures, connectionism, philosophical issues of AI, and qualitative reasoning.

For further information, write to Dr. J. Retti, Osterreichische Gesellschaft fur AI, OGAI-Tagung 1989, Postfach 177, A-1014 Wien, Austria, Europe.

Non-Obviousness — Again

(Ralph Wilkerson and Barbara Smith, University of Missouri - Rolla)

Various proofs for a "non-obvious" theorem have appeared in AAR newsletters 6, 7, 9, and 10. Wilkerson and Smith have written a refutation theorem prover based on the work of Hsiang [1] which uses term rewriting and a complete set of reductions for a Boolean ring. Without modifying the basic strategy of this prover, a proof of the "non-obvious" problem was obtained in reasonably few steps.

To use a refutational theorem prover based on rewriting and a complete set of reductions, one must "preprocess" the clauses. The following rules can be used to transform Boolean terms into their EXCLUSIVE-OR and AND equivalents, where AND is indicated by the juxtaposition of literals.

$$x \rightarrow y \rightarrow xy \oplus x \oplus 1$$

$$x \vee y \rightarrow xy \oplus x \oplus y$$

$$\neg x \rightarrow x \oplus 1$$

$$x \leftrightarrow y \rightarrow x \oplus y \oplus 1$$

Here, 1 stands for true and 0 for false. Direct application of the rules is inefficient; however, Hsiang gives a method for effectively carrying out the transformation.

The central idea in using rewriting and a complete set of reductions as a refutational theorem prover is to convert Boolean formulas into Boolean rewrite rules and then apply certain superposition techniques (i.e., N -critical pairs) to produce new rules from them. At all times, terms are reduced using the canonical rewriting system for Boolean algebra. This process continues until the contradictory rule $1 \rightarrow 0$ is generated or no more rules can be generated which indicates consistency. This strategy is called the N -strategy. Both the N -strategy and the superposition technique are completely described in [1]. It should also be noted that this strategy requires the use of an extended unification algorithm called BN -unification.

The problem is defined by the clauses

$$\neg Q(c,d)$$

$$\neg P(a,b)$$

$$P(x,y) \vee Q(x,y)$$

$$\neg Q(x,y) \vee Q(y,x)$$

$$Q(x,y) \vee \neg Q(y,z) \vee Q(x,z)$$

$$\neg P(x,y) \vee \neg(y,z) \vee P(x,z)$$

Preprocessing the original six clauses produces the following rules:

$$1. Q(c,d) \rightarrow 0$$

$$2. P(a,b) \rightarrow 0$$

$$3. Q(x,y)P(x,y) \oplus Q(x,y) \oplus P(x,y) \rightarrow 1$$

$$4. Q(x,y)Q(y,x) \oplus Q(x,y) \rightarrow 0$$

$$5. Q(x,z)Q(y,z)Q(x,y) \oplus Q(y,z)Q(z,y) \rightarrow 0$$

$$6. P(x,z)P(y,z)P(x,y) \oplus P(y,z)P(x,y) \rightarrow 0$$

The N -strategy produces 115 new rules. Of these, 9 are simplifications of earlier rules and 54 are deleted. (A rule is deleted when a more general rule is found.) The proof is defined by 28 rules, including the original 6. This represents a fairly high percentage of the rules that are generated. The rules in the proof are shown below, followed by the rule ancestors which were overlapped to form the new rule, together with any additional simplifiers that may have applied.

7. $P(a,x)P(x,b) \rightarrow 0$	2,6	
8. $Q(a,b) \rightarrow 1$	2,3	2
9. $Q(c,x)Q(x,d) \rightarrow 0$	1,5	
16. $P(a,x)Q(x,b) \oplus P(a,x) \rightarrow 0$	7,3	7
17. $P(x,b)Q(a,x) \oplus P(x,b) \rightarrow 0$	7,3	7
19. $Q(c,x)Q(d,x) \rightarrow 0$	9,4	
20. $Q(x,c)Q(x,d) \rightarrow 0$	9,4	
21. $P(a,c)Q(b,d) \rightarrow 0$	9,16	
32. $P(a,d)Q(c,b) \rightarrow 0$	19,16	
38. $P(d,b)Q(a,c) \rightarrow 0$	20,17	
41. $P(x,c)Q(x,d) \oplus Q(x,d) \rightarrow 0$	20,3	20
45. $Q(a,d)Q(b,d) \rightarrow 0$	21,41	
69. $Q(a,d)Q(c,b) \oplus Q(c,b) \rightarrow 0$	32,3	32
83. $Q(a,c)Q(d,b) \oplus Q(a,c) \rightarrow 0$	38,3	38
97. $Q(b,d) \rightarrow 0$	45,5	8
98. $Q(b,x)Q(x,d) \rightarrow 0$	97,5	
99. $Q(d,b) \rightarrow 0$	97,4	
100. $Q(a,c) \rightarrow 0$	83,99	
104. $P(c,b) \rightarrow 0$	100,17	
112. $Q(c,b) \rightarrow 1$	104,3	104
113. $Q(a,d) \rightarrow 1$	69,112	
115. $Q(b,a) \rightarrow 0$	98,113	
$1 \rightarrow 0$	115,4	8

It is well known that a significant problem in automated reasoning is determining the appropriate inference strategy for a given problem. A more specific problem is to characterize when the rewriting approach is more efficient than a resolution-based approach.

Reference

- [1] Hsiang, J. "Refutational theorem proving using term-rewriting systems, *Artificial Intelligence* 25 (1985) 255-300

Availability of Boyer and Moore's Prover (Robert Boyer and J Moore, Computational Logic, Inc.)

A Common Lisp version of our theorem-prover is now available under the usual conditions: no license, no copyright, no fee, no support. The system runs well in three Common Lisps: KCL, Symbolics, and Lucid. There is no operating system or dialect conditionals, so the code may also run in other implementations of Common Lisp.

Included as sample input is the work of Hunt on the FM8501 microprocessor and of Shankar on Gödel's incompleteness theorem and the Church-Rosser theorem.

To get a copy, follow these instructions:

1. ftp to Arpanet/Internet host cli.com. (cli.com currently has Internet numbers 10.8.0.62 and 192.31.85.1)
2. log in as ftp, password guest

3. get the file /pub/nqthm/README
4. read the file README, and follow the directions it gives.

Inquiries concerning tapes may be sent to

Computational Logic, Inc., Suite 290
1717 W. 6th St.
Austin, Texas 78703

A comprehensive manual is available. For information on obtaining a copy, write to the address above.

JAR Special Issue

A special issue of the Journal of Automated Reasoning devoted to automated reasoning and nonclassical logics will be published in 1989. Articles will focus on a wide variety of areas of nonclassical logic, e.g., epistemic, intuitionistic, modal, paraconsistent, relevant, and temporal logics, describing the use of general-purpose or specialized automated reasoning systems and related systems in the investigation or application of such logics. We also expect to have test examples for such systems, open problems, and comparisons of the performance of general-purpose and special-purpose automated reasoning systems in this area.

The editor for this special issue is Dr. Michael McRobbie. Inquiries about the issue should be addressed to him at the Automated Reasoning Project, Institute of Advanced Studies, Australian National University, GPO Box 4, Canberra, ACT 2601, AUSTRALIA.

New Journal

A new journal, entitled *Artificial Intelligence in Medicine*, is scheduled to appear in January 1989. This international journal will be devoted to such topics as medical expert systems, AI in medical practice and research, reasoning and metareasoning in medicine, AI and medical databases, knowledge-based systems in medical education, and ethical issues of AI in medicine. The editor-in-chief K. Sadegh Zadeh, of the University of Munster, Germany, invites scholars to submit papers on these topics.

The journal will be published four times a year at the cost of \$40 for individuals and \$80 for institutions.

Courses Offered

Computational Logic, Inc., is offering several three-day courses for the winter-spring 1988-89 semester that may be of interest to AAR members. The courses include the following:

- Introduction to Logic
- Formal Software Development with Gypsy
- Introduction to Hardware Verification
- Hardware Verification Using Mechanical Theorem Provers

For further information write to Computational Logic Inc., 1717 W. 6th, Suite 290, Austin, TX 78703.

Cray Supercomputer Hobbles OTTER
(*Art Quaife, University of California at Berkeley*)

OTTER is a resolution theorem prover written by William McCune of Argonne National Laboratory and coded in C. I have used the prover extensively on a VAX 8800 running under ULTRIX 2.0. I recently had the opportunity to port the program to a CRAY X-MP/14 running under UNICOS 3.0.

I ran one benchmark several times on both systems, a hard geometry theorem that takes the VAX about 10 minutes to prove. The wallclock time on the CRAY was always *longer* than on the VAX, usually by a factor of about 1.7, and in one case where the CRAY was apparently heavily loaded, by a factor of about 8!

The CRAY C compiler was able to vectorize only one loop within this whole program. Further, there is no numeric processing to speak of in OTTER, and I was told that the CRAY does not handle the type "char" very well. Nonetheless, it was a bit surprising that the raw processing speed of the CRAY was not sufficient to keep up with the VAX.

New AR Workshop Planned at Argonne
(*Larry Wos*)

In place of the usual workshop given at Argonne National Laboratory, focusing on an introduction and applications to automated reasoning, we plan to have a workshop devoted to various research topics. In particular, we shall gather problems from various areas of mathematics and logic with the intention of studying attacks on them with different reasoning programs. We welcome suggestions concerning either the research topics or the specific problems to be studied. Please contact L. Wos at

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