# ASSOCIATION FOR AUTOMATED REASONING NEWSLETTER

No. 16 November 1990

**From the AAR President, Larry Wos ...**

I was simply delighted to read a recent announcement by Kluwer (reproduced in this issue) stating that automated reasoning has "reached a point where it can make significant contributions to computer science, mathematics, and logic." Many of my colleagues know that I have been making a similar claim for several years. Even further, I claim that automated reasoning has *already* made significant contributions to various fields. But if Kluwer's statement somehow gives legitimacy to the claim, marvelous!

Several of the notices in this newsletter show how far automated reasoning has come in the past three decades. In addition to Kluwer's announcement of the new Automated Reasoning Series, we mention two new journals that specifically include manuscripts on automated reasoning and artificial intelligence, a new book on theorem provers, and several international conferences planned for 1991. We also note that new graphics tools are being designed to make experimenting with theorem provers easier.

**Good Deal**

Many of you will soon receive a notice that the subscription cost for the *Journal of Automated Reasoning* will increase from $38 to $50 for 1991. Before you are overcome with panic, take out your slide rule and calculate the **savings.**

The 1991 volume will expand to 160 pages per issue—an increase of 33 percent. A simple calculation shows that you might expect to pay $50.67 for this expanded volume. But Kluwer is offering the 1991 volume for only $50.00—a clear bargain.

And there's more good news: AAR members will continue to enjoy a substantial discount: the new price will be $61 for non-members.

This may be an excellent time, therefore, to remind our members that AAR dues are only $5 for one year, $9 for two years, and $12 for three years. Dues should be sent to William W. McCune, Secretary, Association for Automated Reasoning, MCS-221, Argonne National Laboratory, Argonne, IL 60439-4844, U.S.A. Membership expiration dates are printed on address labels.

## Conferences

### RTA-91

The fourth biennial conference on rewriting techniques and applications will be held in Como, Italy, on April 10-12, 1991. Topics will include

term rewriting systems
completion procedures
algebraic specification
rewrite-based functional and equational programming languages
higher-order systems
Thue systems
combinatorial rewriting in computer science and mathematics
conditional and typed rewriting
unification and matching algorithms
rewrite-based theorem proving
graph rewriting and graph grammars
rewriting techniques in symbolic and algebraic computations
studies of combinatorial structures using rewriting techniques

For further information, write to Ronald V. Book, RTA-91, Theoretische Informatik, Institut fur Informatik, Universitaet Wurzburg, Am Hubland, D-8700 Wurzburg, Germany, or send a mail to book%henri@hub.ucsb.edu or to uniwuebook%geyer@uunet.UU.NET.

### Sixth Annual IEEE Symposium on Logic in Computer Science

The Sixth Annual IEEE Symposium on Logic in Computer Science will take place in Amsterdam on July 15-18, 1991. LICS aims for wide coverage of theoretical and practical issues in computer science that relate to logic in a broad sense, including algebraic, categorical, and topological approaches. Suggested, but not exclusive, topics of interest are the following:

abstract data types
automated deduction
concurrency
constructive mathematics
data base theory
finite model theory
knowledge representation
lambda and combinatory calculi
logics in artificial intelligence
logical aspects of computational complexity
logic programming
modal and temporal logics
program logic and semantics
rewrite rules
software specification
verification

LICS is sponsored by the IEEE Technical Committee on Mathematical Foundations of Computing in cooperation with ACM SIGACT, the Association for Symbolic Logic, and the European Association of Theoretical Computer Science.

Authors should submit twenty copies of a cover page and eight copies of a detailed abstract by January 2, 1991, to Gilles Kahn, INRIA Sophia-Antipolis, 06565 Valbonne Cedex, France (email: kahn@mirsa.inria.fr; FAX: (33) 93 65 77 66).

### TACS Conference

An international conference on the Theoretical Aspects of Computer Software will be held at Tohoku University, Sendai, Japan, on September 24-27, 1991. The TACS conference will focus on theoretical foundations of programming and the theoretical aspects of the design, analysis, and implementation of programming languages and systems. Of especial interest are the following topics: proofs; constructive logic; and theory-based systems for specifying, synthesizing, transforming, testing, and verifying software.

The scientific program will consist of invited lectures, contributed talks, poster and demo sessions, and a panel discussion. The invited speakers include Robert Constable (Cornell Univ.), Takayasu Ito (Tohoku Univ.), Albert R. Meyer (MIT), Gordon D. Plotkin (Edinburgh Univ.), Amir Pnueli (Weizmann Inst.), and Dana S. Scott (Carnegie Mellon Univ.). A Proceedings containing the full papers of the invited and contributed talks published in *Lecture Notes in Computer Science*, Springer-Verlag, will be available at the conference.

TACS is sponsored by Tohoku University with the pending cooperation of the Information Processing Society of Japan, the IEEE Technical Committee on Mathematical Foundations of Computing, ACM SIGACT, and the Association for Symbolic Logic.

Limited funds for subsidizing contributors from outside Japan are available. To apply for a subsidy, submit—by e-mail if possible—a 500-1000 word abstract of work to be presented at the conference and a brief curriculum vitae to either of the conference Co-Chairs. All interested authors, whether or not applying for a subsidy, should submit for review ten copies of their complete papers (up to 9000 words) by January 15, 1991, to Prof. Albert R. Meyer, MIT Laboratory for Computer Science, 545 Technology Square, NE43-315, Cambridge, MA 02139; e-mail: meyer@theory.lcs.mit.edu; FAX: (617) 253 3480.

## New Journals

### Methods of Logic in Computer Science

*Methods of Logic in Computer Science* is a new quarterly journal of computer science and mathematics devoted to papers that employ the methods of formal logic. Topics include but are not limited to automated reasoning, term rewriting, program semantics, program verification, complexity theory, lambda calculus, logic programming, database theory, knowledge representation, hardware specification, nonmonotonic logic, and the logic of programs. Research contributions ranging from theoretical results to applications of the above-mentioned areas are solicited.

Guidelines for authors can be obtained from Ablex Publishing Corporation, 355 Chestnut St., Norwood, NJ 07648. All papers will be refereed.

### Artificial Intelligence in Medicine

*Artificial Intelligence in Medicine* is an international journal publishing original articles from a wide variety of interdisciplinary perspectives concerning the theory and practice of medical artificial intelligence. Particular attention is focused on AI-based clinical decision-making, knowledge-based systems in medical education and research, intelligent databases, and reasoning and metareasoning in medicine. Guidelines for authors are available from the editor-in-chief, K. S. Zadeh, University of Munster Medical Institutions, Institute of Medical Informatics, Domagk Str. 9, 4400 Munster, Germany. Cost of the new journal is $91.50 for six issues yearly.

## Software

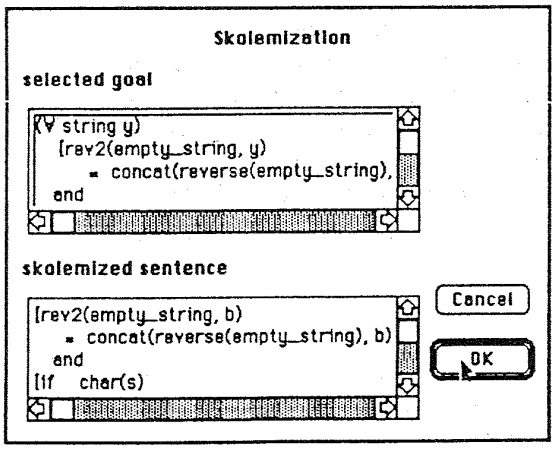
### The Deductive Tableau

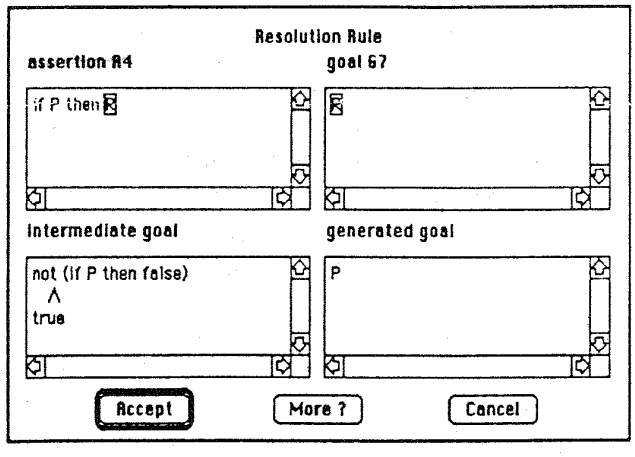
A new program, called The Deductive Tableau, is an interactive, display-oriented theorem prover developed for use by professionals, teachers, and students. Based on the books *The Logical Basis for Computer Programming,* by Z. Manna and R. Waldinger, The Deductive Tableau is designed for university faculty and grad students.

The Deductive Tableau can be used to prove the correctness of algorithms, assist in the synthesis of algorithms, or prove the validity of a theorem. Proofs are displayed on a screen in two-dimensional or tableau format. Each row contains an assertion (facts given or assumed) or goal (to be proved). The user indicates which deduction rule is to be attempted and to which subexpression it is to be applied. The system determines whether the rule application is allowed; if so, it displays the proof step, with explanations as to how the step was created.

The new software supports proofs of theorems in propositional and first-order predicate logic and in various special theories, including theories with mathematical inductions such as tuples and trees. Major categories of deduction include rules for rewriting, splitting, resolution, equivalence, Skolemization, equality, and induction. The user simply specifies the logical language and the special theory desired; a different set of deduction rules are associated with each logic system.

The Deductive Tableau is available from Chariot Software, 3659 India Street, Suite 100C, San Diego, California 92103; 619-298-0202. Cost is $59.00 for the disk and documentation. The system requires at least a Mac Plus with 1 megabyte of memory; an SE is recommended.

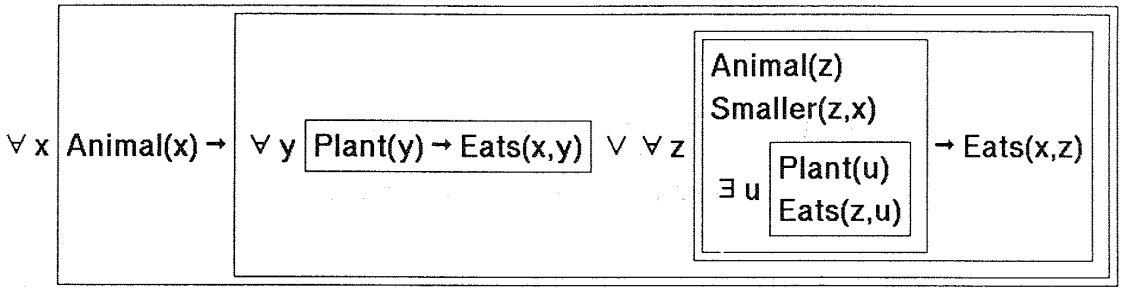


**FormEd: A Program for Managing First-Order Formulas**

*Tamara L. Henry and William W. McCune (mccune@mcs.anl.gov)*

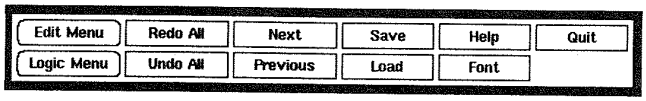
FormEd [1] is a window-based program for constructing, displaying, and managing first-order logic formulas. The main motivation for constructing FormEd was the desire to have formulas displayed in a readable, two-dimensional format. For example, one of the axioms in the famous puzzle Schubert's Steamroller is displayed as



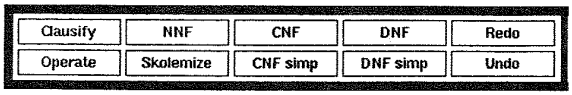

Users of FormEd can make two kinds of transformation on formulas: (1) logic transformations, such as negation normal form (NNF) translation, which preserve the meaning of a formula, and (2) edit transformations, which can be used to make arbitrary changes, such as adding a hypothesis to a subformula. Most transformations can be made to the entire displayed formula or to a selected subformula. The sequence of transformations leading to the current formula is saved so that any or all of them can be "undone" and "redone."

FormEd reads a list of formulas (in OTTER [2] language) from a file. One formula is displayed at a time. Conjunctions are displayed vertically, and disjunctions and other types of formula are displayed horizontally. Rectangles rather than parentheses or brackets are used to group subformulas.

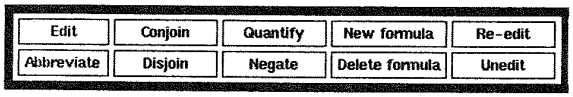
The user can make transformations on the formulas and save the transformed formulas to a file. The main menu is



(The button ''Help'' is very helpful.) The menu for logic transformations is




The menu for editing transformations is




The most general editing operation is ''Edit'' which allows the user to edit the formula or a subformula as a text string.

FormEd is not yet connected to a theorem prover, but we intend for it to become the interface to an interactive theorem prover and/or proof checker (which does not yet exist). However, it is useful now as a stand-alone program to

1. help students learn formal logic;
2. study properties of normal-form conversion (the buttons ''CNF simp'' and "DNF simp" are decision procedures for validity and unsatisfiability, respectively, of propositional logic formulas); and
3. help prepare input for a resolution/paramodulation theorem prover.

FormEd was written using the X Window System, Version 11, and code from the theorem prover OTTER. For information on obtaining a copy of FormEd, send e-mail to mccune@mcs.anl.gov.

**References**

1. Henry, T., and McCune, W., *FormEd: An X Window System Application for Managing First-Order Formulas*, Technical Memorandum ANL/MCS-TM-141, Argonne National Laboratory, Argonne, Illinois (October 1990).

2. McCune, W., *OTTER 2.0 Users Guide*, Technical Report ANL-90/9, Argonne National Laboratory, Argonne, Illinois (March 1990).

## New Challenge Problem in Sentential Calculus

*Larry Wos (wos@mcs.anl.gov)*

One approach to stimulate research and to experience the excitement of the chase is to attempt to obtain a proof a difficult theorem. Until roughly one year ago, our best offerings focused on equivalential calculus. Now we have a new target: sentential calculus.

We suggest the following theorem—from among the theorems whose proof is known—to take the place of the problems previously considered tough for an automated reasoning program to solve, the following theorem from many-valued sentential calculus provides an excellent target. (We use notation consistent with that acceptable to McCune's program OTTER [3], where - means **not** and | means **or**.)

The theorem, sometimes known as the fifth conjecture of Lukasiewicz [2], asserts that, from the first four of the following five clauses, the fifth can be deduced by using condensed detachment.

```
P(i(x,i(y,x))).
P(i(i(x,y),i(i(y,z),i(x,z)))).
P(i(i(i(x,y),y),i(i(y,x),x))).
P(i(i(n(x),n(y)),i(y,x))).
P(i(i(i(x,y),i(y,x)),i(y,x))).
```

To use condensed detachment, you can use hyperresolution with the following clause.

```
-P(i(x,y)) | -P(x) | P(y).
```

The problem asks for an approach that enables an automated reasoning program to prove the Lukasiewicz conjecture, using condensed detachment. Two points to keep in mind: (1) a proof of a related conjecture has been obtained with OTTER where the problem was rephrased as one for equality, and (2) McCune and I have a 63-step proof of the conjecture using condensed detachment, a proof obtained using OTTER in a mode that is in part proof-checking and in part proof-finding. Our solution—obtained in a style somewhat reminiscent of that in which you have an outline and OTTER fills in the holes—does *not* count, for we relied heavily on the equality-oriented proof that was obtained with OTTER. This problem in its equality form was brought to our attention by Maria Paola Bonacina [1], who succeeded in getting a proof prior to our success.

Since the fifth conjecture is indeed challenging to the point that it may be beyond the limits of the current programs—we once generated 983,000,000 clauses with OTTER in an attempt to obtain a proof—we offer four problems that are in range, but that merit study. Again, condensed detachment is present as well as the four axioms for sentential calculus. The four problems focus, respectively, on proving each of the following theorems expressed in clause notation; the comment beginning with "%" merely gives a name to the theorem.

```
P(i(n(n(x)),x)).              % (step_24).
P(i(i(x,y),i(i(z,x),i(z,y)))). % (step_25).
P(i(x,n(n(x)))).              % (step_29).
P(i(i(x,y),i(n(y),n(x)))).    % (step_36).
```

The first and third are ordinarily easier to prove than the second and fourth.

If you prefer to study the fifth conjecture of Lukasiewicz in an equality form [2], the following clauses are appropriate, where *T* can be thought of as *true*.

i(T,x) = x.
i(i(x,y),i(i(y,z),i(x,z))) = T.
i(i(x,y),y) = i(i(y,x),x).
i(i(n(x),n(y)),i(y,x)) = T.

The theorem to prove asserts the following.

i(i(i(x,y),i(y,x)),i(y,x)) = T.

Good hunting!

### References

1. Bonacina, M. P., "Automated proofs in Lukasiewicz logic," preprint, Department of Computer Science, SUNY at Stony Brook, 1989.

2. Font, J. M., Rodriguez, A. J., and Torrens, A., Wajsberg algebras, *Stochastica,* **8**, no. 1, pp. 5-31 (1984).

3. McCune, W., *OTTER 2.0 Users Guide,* Technical Report ANL-90/9, Argonne National Laboratory, Argonne, Illinois (1990).

## New Books

### Logic and Computer Science

*Logic and Computer Science,* a new book edited by P. Odifreddi and published by Academic Press, may be of interest to our readers. The book presents current developments in generic theorem provers and examines the applications of one of the best-known theorem provers, Nuprl. Also included is a chapter by D. Miller entitled "Isabelle: The Next 700 Theorem Provers."

### Automated Reasoning Series

Kluwer Academic Publishers has announced a new book series in automated reasoning. The series is devoted to recording significant technical work on fundamental research issues in automated reasoning and areas where automated reasoning can be beneficial to problem solving. Manuscripts are solicited that range from theoretical results to applications and techniques. Each book will focus on one aspect of automated reasoning, e.g.:

| | |
|---|---|
| theorem proving | computational logic |
| unification | deductive databases |
| term rewriting | logic programming |
| decision procedures | inference systems |

Prospective authors for the Automated Reasoning Series should contact William Pase, Odyssey Research Associates, 265 Carling Ave., Suite 506, Ottawa, Ontario K1S 2E1; (613) 238-7900.