ASSOCIATION FOR AUTOMATED REASONING
NEWSLETTER

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From the AAR President, Larry Wos...

This issue of the *AAR Newsletter* was completed in 1996 but, because Argonne closes for two weeks in December, did not get printed until January. So, it's a grand way to end the old year—with McCune's solution to the long-standing Robbins problem. And it's a grand way to start the new year—with a new challenge competition for automated reasoning programs and with several new books for eager reviewers.

Since the Robbins problem has now been settled, do any of you or your colleagues have open questions to take its place—questions that appear to be amenable to attack with an automated reasoning program?

Robbins Algebras Are Boolean

William McCune (mccune@mcs.anl.gov)

The Robbins problem—are all Robbins algebras Boolean?—has been solved: Every Robbins algebra is Boolean. This theorem was proved automatically by EQP, a theorem-proving program developed at Argonne National Laboratory.

The Problem

In 1933, E. V. Huntington presented [1,2] the following basis for Boolean algebra:

$$x + y = y + x. \qquad \text{[commutativity]}$$
$$(x + y) + z = x + (y + z). \qquad \text{[associativity]}$$
$$n(n(x) + y) + n(n(x) + n(y)) = x. \qquad \text{[Huntington equation]}$$

At that time, Herbert Robbins conjectured that the Huntington equation can be replaced with a simpler one [5]:

$$n(n(x + y) + n(x + n(y))) = x. \qquad \text{[Robbins equation]}$$

Robbins and Huntington could not find a proof, and the problem was later studied by Tarski and his students [6], but no proof was found.

Algebras satisfying commutativity, associativity, and the Robbins equation became known as Robbins algebras. It is clear that every Boolean algebra is a Robbins algebra, so the interesting problem was whether every Robbins algebra is Boolean. In other words, can the Huntington equation be derived from commutativity, associativity, and the Robbins equation?

In 1979, S. Winker learned of the problem from his advisor, J. Berman. L. Wos suggested attacking the problem by studying Boolean conditions that might make a Robbins algebra Boolean. Many such conditions were found. Several, such as idempotence and existence of a zero, were easily shown by Argonne's theorem provers to make a Robbins algebra Boolean. Winker then showed [3,4] that each of the conditions

$$\exists C \exists D, C + D = C \qquad \text{[first Winker condition]}$$
$$\exists C \exists D, n(C + D) = n(C) \qquad \text{[second Winker condition]}$$

also suffices, with proofs by hand using insight from theorem prover searches. (In 1992 and 1996, respectively, the two Winker conditions were shown automatically to be sufficient [7].)

The Solution

The proof that solves the Robbins problem was found October 10, 1996, by the theorem prover EQP [7]. EQP is similar in many ways to our more well known program Otter. The main differences are that EQP has associative-commutative (AC) unification, is restricted to equational logic, and offers more paramodulation strategies.

EQP proved that every Robbins algebra satisfies the second Winker condition, by refuting (with built in AC unification) the set

$$n(n(n(y) + x) + n(x + y)) = x. \qquad \text{[Robbins equation]}$$
$$n(x + y) \neq n(x). \qquad \text{[denial of second Winker condition]}$$

It follows immediately from this and the Winker lemma that all Robbins algebras are Boolean.

The successful search took about eight days on a UNIX machine and used about 30 megabytes of memory. Subsequent searches have derived the Huntington equation; that is, the automatic proof no longer relies on the Winker lemmas.

See http://www.mcs.anl.gov/home/mccune/ar/robbins/ for more information, including the proofs.

References

1. E. V. Huntington, "New sets of independent postulates for the algebra of logic", *Trans. AMS* 35, 274–304 (1933).

2. E. V. Huntington, "Boolean algebra: A correction", *Trans. AMS* 35, 557–558 (1933).

3. S. Winker, "Robbins algebra: Conditions that make a near-Boolean algebra Boolean", *J. Automated Reasoning* 6(4), 465–489 (1990).

4. S. Winker, "Absorption and idempotency criteria for a problem in near-Boolean algebras", *J. Algebra* 153(2), 414–423 (1992).

5. H. Robbins, Telephone conversation, October 15, 1996.

6. L. Henkin, J. D. Monk, and A. Tarski, *Cylindric Algebras, Part I,* North-Holland, 1971.

7. W. McCune, "33 basic test problems: A practical evaluation of some paramodulation strategies", preprint ANL/MCS-P618-1096, Argonne National Laboratory, 1996.

Automated Deduction as an International Discipline – An open letter to the president of CADE

Pierre Lescanne (Nancy, France) and Christoph Walther (Darmstadt, Germany)

During this year's Conference on Automated Deduction (July 30 - August 3, Rutgers University, N.J.), new democratic bylaws were adopted that give the membership more rights in the administration of CADE than the bylaws that were established when CADE was incorporated some years ago in the state of Illinois. However, as a result of the former election process, the current board of trustees is U.S. dominated and does not reflect the activities in automated deduction throughout the world: It consists of 1 trustee from the UK, 1 trustee from Australia, and 5 trustees from the U.S. reasoning community. This is surprising, at least if one considers the development of the field in the past decade, which is illustrated by the following table showing the contributions to the last five CADEs in percentage:

Year	U.S.	EU	Other	Site
1988	61 %	35 %	4 %	Argonne, Ill.
1990	51 %	45 %	4 %	Kaiserslautern, Germany
1992	44 %	49 %	7 %	Saratoga Springs, N.Y.
1994	23 %	73 %	4 %	Nancy, France
1996	19 %	79 %	2 %	New Brunswick, N.J.

We doubt that the policy of CADE's trustees, to let the largest reasoning community play only a minor role in the administration of CADE, would be beneficial for CADE's future. We also believe that it seems not wise to dispense with almost all of the experiences, knowledge, and skill of one successful part of the reasoning community for the administration of CADE. Proceeding in such a way risks the danger of splitting the community into two parts such that Europe eventually organizes its own event (which then would weaken the whole reasoning community).

Another issue is the choice of program chairs: 4 PC chairs from the U.S., 1 from Australia, but only 1 from Europe have been selected since CADE-9 in 1988. Remembering the developments of the past decade, it is hard to believe that there is no one in Europe who is ready, willing, and able to do the job. This is not a question of the qualification or the reputation of the selected chairs, but the question of why a successful part of the reasoning community is withheld from

this position. We think that it is time to change this disposition and to choose the future chairs according to the real picture of the community.

The problem resulting from the domination by one community was visible during the business meeting, which required a thorough background in the American culture of standing orders and rules to come to a democratic decision, which made it difficult for many from other parts of the world to follow and to contribute to the procedure. The problem of domination also became obvious at the panel session entitled "Does Automated Deduction Have a Future?" There was only one panelist from Europe, and the other five panelists from the U.S. soon focused on the funding problems of the U.S. community. This caused some trouble and resistance from the floor because many felt that the future of the field also outside the U.S. would be worth discussing. There are communities also in Europe that are successful, and it is pure ignorance to dispense with the experiences gathered in other cultures with other traditions, other systems of education, and other ways of funding research. The attendance of this year's CADE would have allowed to set up a panel for discussing the future of the field in all aspects trying to find answers helpful for the whole community.

For all these reasons we urge for a change in the administration of CADE: Instead of running CADE in a way which was reasonable and beneficial 15 or 20 years ago, the trustees should give the European reasoning community an appropriate voice wrt. the board of trustees, the selection of program chairs, and the composition of panels. This would yield an optimal identification of the members of the community with CADE, it would be beneficial for CADE's future and for further developing automated deduction as a real international discipline.

Response to the Open Letter

Mark Stickel, President of Trustees, CADE, Inc.

Although most CADE trustees and recent program chairs are American, this is a transitory phenomenon (two Americans, Loveland and I, will leave the board of trustees next year; the 1998 program chair, probably European, will become a trustee when appointed; two trustees will be elected at CADE in 1997). Moreover, the nationality of the trustees is only one indicator of the internationalism of CADE. For example, note that CADE will be held outside the United States at least the next three times—in Australia in 1997, in Germany in 1998, in Italy in 1999 (there has been no discussion yet about locations after 1999). The program committee for CADE in 1997 is mostly non-American (22 out of 32). The program chair for CADE in 1998 has not been selected yet, and the current program committee is being consulted before a selection is made, but it is the trustees' wish to select a European program chair for 1998 (there has been no discussion yet about program chairs after 1998).

The genesis and purpose of the inaptly named "Does Automated Deduction Have a Future?" panel at CADE were explained at that time. Automated deduction research is at risk in the United States, and the U.S. National Science Foundation convened a meeting of U.S. researchers to discuss the future of the field. This panel was invited (not by the trustees, but by the program chairs who have complete control over the conference they chair) to report on what happened at

that meeting and to seek input from the whole CADE community to deal with the threat. The opening statements of panel members were limited to two minutes each so that most of the time would be open discussion period for everyone attending. Successes in Europe and problems in America should both be seen as relevant to both groups. Government research funding policies often spread from one nation to another.

The business meeting at CADE was conducted as fairly and orderly as we could. Not being a native speaker of English was clearly a disadvantage for participation. I don't see any easy solution to this problem. What do you think would have helped? I wonder whether the procedures at the meeting acted to exclude non-American participation. None of us were experts on parliamentary rules, so there was no rigid adherence to such. Are rules for proposing laws, amending them, and voting on them substantially different in Germany and France than America?

The CADE-14 ATP System Competition Call for Participation

The CADE conferences are the major forum for the presentation of new research in all aspects of automated deduction. In order to stimulate ATP system development, and to expose ATP systems to interested researchers, a competition for first-order ATP systems will be held at CADE-14, on Wednesday, July 16, 1997.

CASC-14 will evaluate the performance of sound fully automatic ATP systems. The evaluation will be in terms of the number of problems solved, and the average time taken for each successful solution; in the context of a specified CPU time limit for each solution attempt, and a bounded number of eligible problems, chosen from the TPTP Problem Library. Information regarding the competition divisions, problem selection and preparation, time limits and timing, system execution, performance evaluation, special hardware demonstration divisions, and the conditions for participation can be found in the CASC-14 WWW pages:

`http://wwwjessen.informatik.tu-muenchen.de/~tptp/CASC-14/`

The competition is being organized by Christian Suttner and Geoff Sutcliffe. The competition will be overseen by a panel of knowledgeable researchers who are not participating in the event. It is planned to publish the competition results in a form that includes contributions written by entrants.

Registration for participation closes on May 15, 1997. Please fill in the registration form on the WWW page (or e-mail one of the organizers). Please register as early as possible (e.g., right away), so that the organizers can ensure that sufficient resources are available.

CASC-14 Organizers:

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Workshop on the Future Directions of Automated Deduction

Donald Loveland

A workshop on the Future Directions of Automated Deduction was held in Chicago the weekend of April 20–21, 1996. Participants were Peter Andrews, Wolfgang Bibel, Robert Boyer, Shang-Ching Chou, Edmund Clarke, Robert Constable, Nachum Dershowitz, Xiao-Shan Gao, Larry Henschen, Deepak Kapur, Ken Kunen, Donald Loveland, Michael Lowry, Rusty Lusk, Bill McCune, Ross Overbeek, Natarajan Shankar, Mark Stickel, Richard Waldinger, Larry Wos, Hantao Zhang, and Xudong Zhao. The meeting was organized by Donald Loveland, assisted by a Steering Committee of Peter Andrews, Robert Boyer, Deepak Kapur, Mark Stickel, and Larry Wos.

The workshop was funded by the (U.S.) National Science Foundation, which has considerable interest on the assessment of opportunities and future directions of our field. The NSF has sponsored similar workshops in computer science recently as part of an evaluation of allocation of research funds. The funds provided for the workshop permitted only a small number of attendees and only from North America. (We were happy to be able to stretch the funds to include Wolfgang Bibel to present the European view of the status of automated deduction. As coordinator for the major Schwerpunkt Deduktion program, Wolfgang was well suited to inform us of the European research in this area.) We were eager to have users of automated deduction technology included in the participants, but their inclusion limited us even more in invitations to the active researchers in the field. In spite of this consideration and that not all invitees could attend, we feel that we obtained good coverage of the major areas of automated deduction.

To get input from other centers of deduction research around the world, we issued a Call for Contributions that would permit people to provide electronic input to the topics we would address. These documents were made available to all workshop participants prior to the workshop. We received a good number of high-quality contributions; they can be seen at the Web site

`http://www.cs.duke.edu/NSFwkshopAD/`

The meeting covered a day and a half, starting at 9 a.m. Saturday and adjourning at noon Sunday. We wished discussion of the issues at hand to be the primary agenda, so only two formal talks were scheduled: "Opening Remarks: A Perspective for the Workshop" by Dr. Kamal

Abdali of the National Science Foundation and "European Efforts in Automated Deduction and Its Applications" by Wolfgang Bibel. The remainder of the morning was dedicated to discussion of the contributions received in response to our call. In the afternoon we split into working groups to provide more detailed discussion by general area. The working groups were in the areas of mathematics, verification/specification, symbolic computation, and AI/program synthesis/logic programming. Later, small groups in education and in nonconventional applications (such as formal methods in social science) also convened. Late Saturday afternoon and Sunday morning were devoted to discussions by the the full committee on the reports of the working subgroups. Very informal discussions also occurred Saturday evening.

Clearly, it is important that the appropriate people in the hierarchy at NSF have a good understanding of our achievements and the opportunities that now exist. We are taking care to present a report to NSF that best accomplishes these goals. The report will reflect the pragmatic attitude toward research now prevailing in the United States but will still address the major basic research areas. Research opportunities will be discussed within the framework of the application areas of verification/specification, program synthesis, mathematical proof discovery, mathematics education, and other applications. Topics as diverse as reasoning in inductive domains and the integration of computer algebra systems (and the need for soundness of such systems) occur within this setting. We hope that those weighing the worth of various research areas will see both the specific utility of success in automated deduction and the tremendous intellectual accomplishment this would mean.

We intend to publish a version of the report in the near future.

Call for Book Reviewers

We are seeking reviewers for the following books related to automated reasoning and automated deduction. Those reviews approved by the book review editor, Rick Stevens, will appear in the *Journal of Automated Reasoning.*

Currently, we have the following books available for review:

1. *Automated Deduction in Equational Logic and Cubic Curves,* by W. McCune and R. Padmanabhan, Springer-Verlag, 1996
2. *An Experimenter's Notebook with OTTER Tutorial,* by Larry Wos, Academic Press, 1996
3. *Extensions of First Order Logic,* by Maria Manzano, Cambridge University Press, 1996
4. *For the Sake of the Argument: Ramsey Test Conditionals, Inductive Inference, and Nonmonotonic Reasoning,* by Isaac Levi, Cambridge University Press, 1996
5. *ML for the Working Programmer,* 2nd ed., by L. C. Paulson, Cambridge University Press, 1996

Interested reviewers are asked to contact Gail W. Pieper, pieper@mcs.anl.gov, for information on the type of review we are seeking.

Call for Papers

HOA '97

The 1997 workshop on Higher-Order Algebra, Logic and Term Rewriting will take place September 4–5, 1997, in Southampton, UK, immediately following ALP '97 and PLILP '97. The scope of the workshop includes higher-order aspects of algebra, logic, and model theory; term rewriting; specification and verification languages; computational logic and theorem proving; system implementations and case studies. Extended abstracts (up to 4 pages) should be sent to the program committee chairman: Jan Heering, CWI, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands. E-mail: jan@cwi.nl. Fax +31 20 592 4199. URL http://www.cwi.nl/~jan/. E-mail submissions are preferred. The deadline for submissions is April 1, 1997.

WoLLIC'97

The Fourth Workshop on Logic, Language, Information, and Computation will take place in Fortaleza (Ceara'), Brazil, on August 20–22, 1997. Contributions are invited in the form of two-page (600 words) abstracts in all areas related to logic, language, information and computation, including pure logical systems, proof theory, model theory, algebraic logic, type theory, category theory, constructive mathematics, lambda and combinatorial calculi, program logic and program semantics, nonclassical logics, nonmonotonic logic, logic and language, discourse representation, logic and artificial intelligence, automated deduction, foundations of logic programming, logic and computation, and logic engineering. Interested authors should submit an abstract, preferably by e-mail to wollic97@di.ufpe.br by June 1, 1997. For further information, see http://www.lia.ufc.br/wollic97.

Erratum: Challenge Problems in First-Order Theories

Benjamin Price Shults, The University of Texas at Austin

In the October 1996 *AAR Newsletter,* I presented a number of challenge problems in first-order theories. In the first example (about locally compact spaces) the following corrections should be made:

1. All occurrences of continuous-from-to **should be changed to** continuous-from-onto.
2. All occurrences of open-from-to **should be replaced with** open-from-onto.

These corrections do not change any of the reasoning. They do, however, make the knowledge base make more sense to people.