Fundamenta Informaticae 39 (1999)
IOS Press

Preface

The topic of this special issue of Fundamenta Informaticae should be understood as "Symbolic Computation and Related Topics in Artificial Intelligence." It contains full versions of papers describing some of the results announced at the Fourth International Conference on Artificial Intelligence and Symbolic Computation – AISC'98. The conference was hosted by the Plattsburgh State University of New York in September 1998.

The domain of symbolic computation includes automated theorem proving, computer algebra and computational logic. It has applications in many areas of engineering, operations research and artificial intelligence, besides pure and applied mathematics.

We would like to comment on trends visible in the research and also cannot avoid the temptation to formulate some predictions or wishes concerning future directions.

Experiments on computer algebra (CA) systems started in mid-60s and the work considerably intensified in early 80s. Now, they integrate symbolic (algebraic) manipulations, numeric computations, computer graphics and interfaces for effective interaction with the user. Current research looks at a possibility of adding a theorem proving component.

Only in recent years have CA software packages such as Mathematica, Maple, Macsyma, etc. been taken up very widely in academia and industry, after a long period of promise when they were not in such wide circulation. This expansion is due mainly to the growth in cheapness and availability of the right kind of desktop computing power. The potential of CA has been there for a long time; it has now been set free by economics.

CA packages are in common use for instruction (mainly in calculus-related courses), as well as in research where they act as tools that make it possible to automate the testing of conjectures with a combinatorial character and even to conduct mathematical experiments leading to the formulation of conjectures. Underlying all these applications is the fact that CA can relieve the researcher or engineer from the need to perform tedious calculations with symbolic expressions.

Automated theorem proving (ATP) has reached a stage where it is capable of solving open problems concerning axiomatizations of finite groups, Boolean algebras, formal logics and similar formal systems. A significant development has occurred in a related area: ATP techniques have been extended to support automated reasoning in various non-classical logics, and these extensions are now being verified in many experimental implementations.

One of the reasons for the remarkable recent increase in visibility of CA systems is the ease of their use – a researcher working on differential equations must have good understanding of the problem to be solved but does not need to be a computer-algebra expert to exploit a computer-algebra software package. On the other hand, in the case of automated theorem proving, the user must make choices about how to represent the problem, what ATP rules to use and what search strategy to employ. These are difficult choices at present – even ATP experts must rely on intuition here, because there are few clear procedures that are guaranteed to work.

This sounds like a story that has been repeated in several areas of artificial intelligence in the past. The state of the art in a topic has been heuristic, which has attracted researchers to the question of how and to what extent the heuristics can be replaced by fixed procedures or algorithms. Successes have had their own considerable mathematical or technical interest, and have produced obvious immediate benefits for the end-users of software in the relevant area. (Indefinite integration, in calculus, is a very good example of this process.) Automated theorem proving is now ripe for the same treatment. While success is not guaranteed, we can identify the following lines of research, arising from recent progress indicated in places like papers in this issue, which deserve to be pursued in order to expand the capabilities of symbolic computation:

1. Development of heuristics for choosing appropriate ATP methods, clarification of a taxonomy of such heuristics, and the construction of expert systems embodying them, to help ATP users;
2. Incorporation of (non-classical) ATP subsystems into knowledge-based or AI systems, particularly those for the representation and use of mathematical knowledge;
3. Integration of computer algebra and automated theorem proving as well as development of interfaces and presentation tools for all of these systems, taking account of the special cognitive characteristics that go together with mathematical knowledge - to facilitate painless interaction with the user.

Some aspects of integration of CA and ATP are already being addressed in this collection of papers. We hope that the remaining aspects will receive attention in future research, and that results will begin to appear at (and even before) the next AISC conference, which is scheduled for the early fall of 2000 in Madrid.

We are grateful to the editors and staff of Fundamenta Informaticae for making this special issue possible, and to the referees and members of steering and program committees of AISC'98 for the efficient reviewing of the papers that were submitted.

Special Issue Editors

Jan A. Plaza and
Computer Science Department
Plattsburgh State University of New York
101 Broad Street
Plattsburgh, NY 12901
U.S.A.
jan.plaza@plattsburgh.edu

John A. Campbell
Department of Computer Science
University College London
Gower Street
London WC1E 6BT
England
jac@cs.ucl.ac.uk

March 1999