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Applicable algebra and artificial intelligence

Julio Rubio · Werner Seiler

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In February 2008, a workshop *Applicable Algebra and Computer Science* was organised by us in Logroño (Spain) in order to honour Jacques Calmet on the occasion of his retirement at Karlsruhe University in the winter term 2007.[1] In the wake of the workshop, the idea of this special issue on the slightly more specialised topic *Applicable Algebra and Artificial Intelligence* was born (kindly suggested by Martin Golumbic, Editor-in-chief of the journal *Annals of Mathematics and Artificial Intelligence*). Some authors were specifically invited to submit an article; others answered an open call for papers. All submissions were refereed according to the usual standards of AMAI by at least two independent referees (leading to the rejection of several manuscripts). However, before we briefly discuss the contents of this special issue, we must say a few words about Jacques Calmet and his work.

Jacques started his career as a theoretical physicist obtaining his Ph.D. at the University of Marseille in 1970. Already at that time he was interested in what is nowadays called computer algebra and developed LISP programs for calculations with Feynman diagrams.[2] Around 1979, Jacques decided to leave physics and to move to computer science. At the same time, he also moved to the University of

[1] Everybody knowing Jacques will of course understand that to "retire" means here only that Jacques is now free of teaching and administrative duties.

[2] In order to put this work in a historical perspective, let us mention that a similar endeavour by Tony Hearn at about the same time lead to the development of REDUCE, the probably first general purpose computer algebra system.

J. Rubio (✉)
Universidad de La Rioja, Edificio Vives.
Calle Luis de Ulloa s/n, 26004 Logroño, Spain
e-mail: julio.rubio@unirioja.es

W. Seiler
Universität Kassel, Heinrich-Plett-Str. 40,
34132 Kassel, Germany
e-mail: seiler@mathematik.uni-kassel.de

Grenoble where he stayed until 1988, when he finally moved to Karlsruhe University. Between these major stations of his career, Jacques held visiting positions at a number of institutions in the United States, Israel, Germany and Switzerland. During his career, Jacques supervised around 20 Ph.D. students. Five of these proceeded to become themselves professors—three in computer science and two in mathematics—in four different countries (Brazil, France, Germany and Canada); several others started highly successful careers in industry.

A central theme of Jacques' research interests has been for many decades the interaction between mathematics and artificial intelligence. For him, this interaction represents a two-way street. On one side, he strongly believes that a purely mathematical approach to computer algebra will fail for complex application fields like partial differential equations and has often tried to convince mathematicians that artificial intelligence goes beyond heuristics. On the other side, he considers mathematical modelling as invaluable for artificial intelligence (and consequently a strong theoretical background in mathematics as fundamental for any work in this field). As a by-product, he became much interest in philosophical questions like the structure of mathematics.

Without particular order, we list some topics on which Jacques has successfully worked together with colleagues or students: disunification, differential Galois theory, a formal approach to knowledge representation, theorem proving and computer algebra (within the Calculemus project), knowledge management via mediator systems, decision making under uncertain knowledge, defence against (D)DoS attacks via logical fibering and virtual knowledge communities.

Finally, we should mention that Jacques co-initiated two successful series of conferences: the *Rhine Workshops on Computer Algebra* (RWCA) have been specifically targeted at junior researchers and newcomers in the field of computer algebra; the conference series *Artificial Intelligence and Symbolic Computing* (AISC) has been a natural result of his research interests. In addition, Jacques was the founding editor of the journal *Applicable Algebra in Engineering, Computing and Communication* (AAECC) and served as its Managing Editor until his recent retirement.

This special issue contains seven articles, reflecting some of Jacques' research interests. There are three papers with a Calculemus flavour, meaning that they are related to the integration of computer algebra systems and mechanised reasoning tools. Another paper deals with probabilistic theorem proving. And the last block of three papers is devoted to mathematical structures for reasoning and learning.

Starting the first block, the paper *Flyspeck II: The Basic Linear Programs* by Nipkow and Obua presents the state of a part of the large Flyspeck project aimed to give a mechanised certification for Hale's proof of the Kepler conjecture on the packing of spheres. The paper *Invariants for the FoCaL language* by Rioboo explains how to include quotient structures in the FoCaL system which integrates a programming environment (designed for computer algebra) with a theorem proving tool for reasoning on program properties. Roanes-Lozano, Hernando, Laita and Roanes-Macías go in their paper *A Gröbner Bases-based Approach to Backward Reasoning in Rule Based Expert Systems* the other way around: they show how computer algebra can be used in the analysis of software systems, specifically expert systems.

The paper by Mie, entitled *Short PCPPs Verifiable in Polylogarithmic Time with O(1) Queries*, makes a transition from theorem proving aspects to mathematical structures, studying efficient probabilistically checkable proof systems.

Coquand, Lombardi and Schuster continue in their paper *Spectral Schemes as Ringed Lattices* their long-term project for giving a constructive basis to abstract algebra as a first step towards mechanised reasoning in the context of constructive type theory. The paper *Congruence Relations on some Hyperstructures* by Cordero, Cabrera, Gutiérrez, Martínez and Ojeda-Aciego explores structures with hyperoperations, instrumental for generalising fuzzy reasoning. Montaña and Pardo study in *On the Vapnik-Chervonenkis Dimension of Computer Programs which use Transcendental Elementary Operations* the complexity of algorithms for concept learning models.

Finally, we would like to thank all authors and referees for their great work and Jacques Calmet for the pleasure of cooperating with us over many years in many different roles. We hope that he will continue to motivate good and exciting research.