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Preface

An *International Conference on Mathematics Mechanization* was held from May 11 to May 13, 2009, in Beijing, China, to celebrate Professor Wen-Tsun Wu's ninetieth birthday. Around a hundred and fifty people from all over the world participated. There were 70 oral and poster presentations on recent advances in symbolic computation, automated reasoning, computational topology, and the history of mathematics, among which the following twenty four plenary and invited presentations were delivered.

- Bruno Buchberger. A New Symbolic Method for Linear Boundary Value Problems Using Gröbner Bases.
- Francois Boulier. On Applications of Differential Elimination to Modeling Problems in Biology.
- Falai Chen. Recent Developments on the μ-Basis for Rational Curves and Surfaces.
- Yongchuan Chen. The Extended Zeilberger Algorithm with Parameters.
- Shang-Ching Chou. JGEX — the System Java Geometry Expert.
- Haibao Duan. Homology Rigidity of Exceptional Grassmannians.
- Vladimir P. Gerdt. Involutive Gröbner Bases in Boolean Rings.
- Komatsu Hikosaburo. Geometry of Seki Takakazu (1642–1708) and the Takebe Brothers with the Use of Resultants.
- Hoon Hong. Deciding Feasibility of Polynomial Inequalities by Numerical Filtering.
- Evelyne Hubert. Algebra of Differential Invariants.
- Erich Kaltofen. Supersparse Interpolation: Mathematics + Algorithmic and Computational Thinking = Mathematics Mechanization.
- Deepak Kapur. On Wu's Perspective on Theorem Proving with a Recent Application to Program Analysis.
- George Labahn. Solving Structured Linear Problems in Exact and Approximate Arithmetic.
- Daniel Lazard. Theorem Proving in Geometry and Tools for Polynomial System Solving.
- Bang-He Li. A Method for Solving Algebraic Equations up to Multiplicities via the Ritt–Wu Characteristic Sets.
- Hongbo Li. Symbolic Computational Geometry with Advanced Invariant Algebras.
- Ziming Li. Submersive Rational Difference Systems and their Accessibility.
- Marc Moreno Maza. Triangular Decomposition of Polynomial Systems: Algorithmic Advances and Remaining Challenges.
- Dongming Wang. On the Mechanization of Geometry: From Theorem Proving to Knowledge Management.
- Stephen Watt. The Mathematics of Calligraphy.
- Lu Yang. A Dynamical Decision about the Nonnegativity of Multivariate Polynomials.
- Kazuhiro Yokoyama. Computation of the Splitting Field of a Polynomial Using its Galois Group.
- Jingzhong Zhang. Mathematics Mechanization and Education Technology.

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- Lihong Zhi. Determining Singular Solutions of Polynomial Systems via Symbolic–Numeric Reduction to Geometric Involutive Form.

This special issue is a collection of some of the work presented at the conference, which includes results on symbolic solution of the linear boundary problem, a new method for tackling the expression size swell problem in the characteristic set method, automated theorem proving, equation solving in finite fields using the characteristic set method, application of symbolic integration to computer graphics, implicitization and parameterization of a subclass of algebraic surfaces, analyzing singular solutions of a polynomial system, and computing the standard form of a linear functional system. Below, we will give a brief introduction to the papers included in this issue, which have passed through the refereeing procedure of the journal.

The paper by Bruno Buchberger and Markus Rosenkranz presents a general and powerful idea that transforms part of mathematics into algebra by the technique of finitary representation of infinite and abstract mathematical objects via symbolic expressions. The authors then survey the first symbolic solution to the linear boundary problems. The integro-differential algebra is introduced to incorporate differentiation and integration together, and to set up a data structure for solving the linear boundary problem. Abstract boundary problems are introduced and their properties, such as factorization, are studied. Then, noncommutative Gröbner bases are used to give algorithms for computing the symbolic solution to the linear boundary problem.

The paper by Changbo Chen and Marc Moreno Maza first reviews past algorithmic advances on triangular decompositions and then presents new techniques for solving the expression size swell problem which is a bottleneck problem for the computation of the characteristic set. The authors present a method for identifying the "useful part" of the recursive resultant of a polynomial with respect to a triangular set and a modular method for computing the resultant. These methods represent a significant step forward in solving the expression size swell problem.

The paper by William Y.C. Chen, Qing-Hu Hou, and Yan-Ping Mu is on automated proving of identities concerning hypergeometric series. The authors proposed an algorithm for computing special linear relations among the sums of similar hypergeometric terms. The coefficients in such a linear relation are not only free of the variable for summation, but also free of certain specified parameters. The algorithm is based on Gosper's and Zeilberger's algorithms for hypergeometric summations. The authors apply their algorithm to determine the linear relations for orthogonal polynomials and to derive recurrence relations for the connection between two sequences of orthogonal polynomials.

The paper by Xiao-Shan Gao and Zhenyu Huang is on equation solving over a finite field, that is, finding solutions of a polynomial equation system in a finite field. The authors develop an efficient variant of the Ritt–Wu characteristic set method which reduces an equation system in a general form to a family of equation systems in triangular forms. In particular, they show that for Boolean equations, the bitwise complexity of the proposed algorithm is single exponential in $n \log(l)$ where n is the number of variables and l is the number of equations. The authors also give a multiplication free algorithm, where the size of the polynomials can be effectively controlled.

The paper by Evelyne Hubert and Marie-Paule Cani concerns an application of symbolic integration to computer graphics. The convolution surface method is a technique used in computer graphics to generate smooth 3D volumes around skeletons which are lower dimensional geometric models of the shape to be created. Convolution surfaces are defined as level sets of a function obtained by integrating a kernel function along this skeleton. The technique has relied on closed form formulae for integration obtained through symbolic computation software. This paper focuses on the convolution surfaces obtained for skeletons given as a finite set of line segments. Uniformly power inverse kernels and Cauchy type kernels are used to generate the convolution surface in a very general way. The convolution functions obtained for higher order kernels are obtained from lower order ones through a recurrence of order 2. Similarly, the recurrence for higher degree polynomial weights in terms of their lower degree and lower order counterparts are also introduced.

The paper by Nan Li and Lihong Zhi studies the multiplicity structure of an isolated singular solution of a polynomial system, which is important for designing stable symbolic–numeric algorithms for finding the singular solutions. The multiplicity structure can be deduced from the local dual space of a polynomial system at its isolated singular solution, and when the corank of the Jacobian matrix of the polynomial system is 1, the traditional deflation method becomes costly. This paper presents an efficient algorithm for computing a basis of the local dual space of a polynomial ideal at its isolated singular solution when the corank of the Jacobian matrix is 1. The size of the linear systems involved in this new algorithm is equal to the number of variables in the polynomial system while the size of the matrices appearing in the classical deflation method increases along with the multiplicity of the singular solution.

The paper by Ziming Li and Min Wu studies how to reduce a partial linear functional system to the standard form. Partial linear functional systems are mixtures of linear partial differential and difference equations. The authors describe an algorithm for transforming a linear functional system into a standard matrix form. The size of the matrices in the standard form is exactly the dimension of the solution space of the given system. Their algorithm may use Gröbner basis in Ore algebras once, but completely avoids using any Gröbner basis computation in Laurent–Ore algebras that involves inverses of difference operators.

The paper by Xuhui Wang and Falai Chen is about implicitization and parametrization of Steiner surfaces. Many algebraic surfaces have representations of two types: the implicit form and the parametric form. Having both representations of a surface is very important for using the surface in geometric modeling. Therefore, discovering efficient algorithms for transforming a surface in one form to one in another form is an important issue. The method of moving surfaces, which Falai Chen is one of the original inventors of, is a nice tool for bridging the implicit form and the parametric form for algebraic curves and surfaces. In this paper, the authors gave efficient implicitization and parameterization algorithms for the class of Steiner surfaces based on the method of moving planes.

We would like to thank the authors who submitted their papers and the referees who provided helpful comments on the submissions. We would also like to thank Hoon Hong for his support. Finally, we wish Professor Wen-Tsun Wu good health and hope that mathematics mechanization, his beloved field, continues to prosper.

Xiao-Shan Gao
Academy of Mathematics and Systems Science,
Chinese Academy of Sciences, China
E-mail address: xgao@mmrc.iss.ac.cn.

Deepak Kapur
Department of Computer Science,
University of New Mexico, United States
E-mail address: kapur@cs.unm.edu.

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