Foreword

Special issue on effective methods in algebraic computation

The international conference MEGA (Effective Methods in Algebraic Geometry) is a biennial conference, devoted to computational aspects and applications of Algebraic Geometry. With a tradition dating back to 1990, it has become an important event for the community, showing the strong research activity developed on effective methods and theoretical and practical complexity issues in commutative algebra, geometry, real geometry, algebraic number theory, algebraic geometry, arithmetic geometry, and related fields.

The twelfth MEGA conference, held at Goethe-Universität in Frankfurt am Main, June 3–7, 2013, confirmed this trend. Organized under the supervision of Thorsten Theobald and Christian Haase, it was particularly successful, offering an impressive panorama of investigated subjects and high quality presentations, while fostering vibrant exchanges and attracting young researchers.

The invited speakers were Lucia Caporaso (University Roma Tre), Felipe Cucker (City University of Hong Kong), Bas Edixhoven (University of Leiden), Benjamin Nill (Case Western Reserve University), Giorgio Ottaviani (University of Firenze), Frank-Olaf Schreyer (University of Saarbrücken), Markus Schweighofer (University of Konstanz), Seth Sullivant (North Carolina State University), Rekha Thomas (University of Washington).

The executive committee consisted of Alin Bostan, Wolfram Decker, Alicia Dickenstein, Jan Draisma, Christian Haase, Bernard Mourrain (chair), Tomas Recio, Thorsten Theobald.

The current issue of the Journal of Symbolic Computation is devoted to selected contributions related to the topics of MEGA. A call for contributions, also open to non-participants of the conference, was sent out right after the conference. The manuscripts were received by the middle of October 2013, reviewed by the end of March 2014 and revised by the beginning of May 2014. The present special issue collects 17 selected contributions. Many other interesting results were presented at MEGA 2013, both theoretical and in the form of software packages or posters.

The diversity of contributions reflect various aspects of the ongoing theoretical and algorithmic advances in Effective Methods in Algebraic Geometry. We hope that the reader will find an interesting perspective of this rich and active area.

The paper by Albert, Fetzer, Sáenz-de-Cabezón and Seiler gives new explicit descriptions of free resolutions of graded polynomial modules from the computation of a Pommaret basis. It also shows that they have a mapping cone structure for quasi-stable ideals.

The paper by Baldoni, Boyal and Vergne studies the computation of multiple Bernoulli series in several complex variables, which generalize the classical Bernoulli series and occur in different geometric contexts.

The paper by Bihan classifies systems of circuits of any dimension which give rise to sparse polynomial systems with the extremal property that all complex solutions are positive real.

The paper by Bruns and Söger describes with elementary means an algorithm for the computation of generalized (or weighted) Ehrhart series based on Stanley decompositions.
The paper by Ceria, Mora and Roggero addresses the problem of describing the ideals which have a given type of monomial basis of the quotient ring, using techniques from the theory of involutive bases. A targeted application of these results is the explicit description of the Hilbert scheme.

The paper by Elsenhans takes up a topic in classical invariant theory: With state-of-the-art algorithmic techniques a complete set of invariants of ternary quartics is found, which confirms a conjecture by Shioda.

The paper by Esterov and Gusev studies a natural and significant problem: The classification of sparse systems which generically have a single solution. They show with involved combinatorial arguments that these systems have to be reducible, as expected, to the linear case.

The paper by Fortuna, Gianni and Trager describes an effective method to compute the topology and invariants of a real surface in a 3-dimensional projective space under the hypothesis that the real singularities of the surface are isolated.

The paper by Hegedüs, Li, Schicho, and Schröcker develops new algebraic methods for the analysis of robotic problems. The closed linkages with six rotational joints that allow a one-dimensional set of motions are studied and a complete classification of the linkage configuration curves is provided.

A well-known result of Hilbert describes in which degree and number of variables, there exists non-negative polynomials, which are not sum of squares. The work by Iliman and Wolff describes an effective method to compute separating elements that can certify that a non-negative polynomial is not a sum of squares.

The paper by Koiran, Portier and Tavenas provides bounds on the number of real roots of univariate polynomials presented by circuits of depth four. The motivation for studying these polynomials comes from the reduction of the long-standing conjecture that the permanent cannot be computed by a circuit of a polynomial size, to a polynomial bound on the number of real roots of sums of products of sparse polynomials.

The paper by Koseleff and Pecker gives necessary conditions for a polynomial to be the Conway polynomial of a two-bridge knot (or link), and using these, several old and new results on algebraic knot invariants are proved.

The paper by Lebreton develops a new lifting algorithm for triangular sets over general p-adic rings. This yields efficient methods to recover an exact description of all roots of a polynomial system from modular computations.

The paper by Morrison and Ren develops the theory and the implementation of numerical algorithms for Mumford curves over the field of p-adic numbers, from a tropical approach.

In the paper by Nóren, using combinatorial means, a Markov basis is constructed for the relations among path probabilities in a three-state Markov chain model, uniformly for all time lengths.

The paper by Rodriguez studies formulas and develops algorithms for computing the excess numbers of an ideal. This notion is inspired by Fulton’s definition of the notion of excess theory in enumerative theory.

The paper by van der Put and Top deals with nonlinear first-order o.d.e.’s in positive characteristic; in particular, the notion of stratification and the Grothendieck–Katz conjecture are extended from the linear setting to this nonlinear setting.

The preparation of this special issue has only been possible with the help of many colleagues. Our warmest thanks go to the authors of the papers submitted to this special issue and to the anonymous reviewers who accepted to evaluate these submissions thoroughly. We also thank the people of the committees and the volunteers who where involved in the organization of MEGA 2013, and Hoon Hong as the Editor-in-Chief of the Journal of Symbolic Computation, who hosted this volume.

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