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Preface

One of the directions of research at the Center of Applied Mathematics and Theoretical Physics, University of Maribor (CAMTP), is the application of methods and algorithms of computer algebra to studying some long-standing problems of the theory of differential equations, such as the Poincaré center problem and Hilbert's 16th problem. In the work of the group, led by Valery Romanovski, efficient computational approaches to studying the center problem and the closely related isochronicity problem have been developed. It allowed the group to completely solve the problems for many classes of polynomial systems of ODEs. In recent work (with V. Levandovskyy, D.S. Shafer, and others), they also developed a powerful algorithmic method to obtain some bounds on the number of small limit cycles bifurcating from elementary singular points of polynomial systems of ODEs, i.e., to evaluate algorithmically the cyclicity of the elementary center and focus. Research on applications of computer algebra to differential equations and dynamical systems at CAMTP is carried out in collaboration with colleagues worldwide working in similar directions; among them we can mention X. Chen, M. Han, W. Huang, Y.-R. Liu and W. Zhang (China), V. Edneral (Russia), J. Giné (Spain), and A. Mahdi and D.S. Shafer (USA). Some goals and features of the approaches mentioned above are described in a recent book [V.G. Romanovski, D.S. Shafer. The center and cyclicity problems: a computational algebra approach. Boston, Basel–Berlin: Birkhäuser, 2009; ISBN 978-0-8176-4726-1].

In 2010, CAMTP, in collaboration with the Institute of Mathematics, Physics, and Mechanics (IMFM), the Faculty of Natural Science and Mathematics of the University of Maribor, and with the support of the Slovenian Research Agency, organized the conference "Symbolic Computation and Its Applications" (SCA). The concept of this meeting was to bring together researchers from various areas of natural sciences, who employ and/or develop symbolic techniques, and to provide a platform for discussions and exchange of ideas. Following the success of the meeting, a second conference was organized in May 2012 at RWTH Aachen University, thus turning SCA into a series of conferences.

In connection with the above, it was decided to hold the 14th CASC Workshop in Maribor. The 13 earlier CASC conferences, CASC 1998, CASC 1999, CASC 2000, CASC 2001, CASC 2002, CASC 2003, CASC 2004, CASC 2005, CASC 2006, CASC 2007, CASC 2009, CASC 2010, and CASC 2011 were held, respectively, in St. Petersburg (Russia), in Munich (Germany), in Samarkand (Uzbekistan), in Konstanz (Germany), in Yalta (Ukraine), in Passau (Germany), in St. Petersburg (Russia), in Kalamata (Greece), in Chişinău (Moldova), in Bonn (Germany), in Kobe (Japan), in Tsakhkadzor (Armenia), and in Kassel (Germany), and they all proved to be very successful.

This volume contains 28 full papers submitted to the workshop by the participants and accepted by the Program Committee after a thorough reviewing process. Additionally, the volume includes two abstracts of invited talks.

One of the main themes of the CASC workshop series, namely, polynomial algebra, is represented by contributions devoted to new algorithms for computing comprehensive Gröbner and involutive systems, parallelization of the Gröbner bases computation, the study of quasi-stable polynomial ideals, new algorithms to compute the Jacobson form of a matrix of Ore polynomials, a recursive Leverrier algorithm for inversion of dense matrices whose entries are monic polynomials, root isolation of zero-dimensional triangular polynomial systems, optimal computation of the third power of a long integer, investigation of the complexity of solving systems with few independent monomials, the study of ill-conditioned polynomial systems, a method for polynomial root-finding via eigen-solving and randomization, an algorithm for fast dense polynomial multiplication with Java using the new opaque typed method, and sparse polynomial powering using heaps.

The invited talk by K. Yokoyama deals with the usage of modular techniques for efficient computation of ideal operations. The following applications of modular techniques are considered: Gröbner bases computation and computation of minimal polynomials. The methods for recovering the true result from the results of modular computations are also discussed.

Several papers are devoted to using computer algebra for the investigation of various mathematical and applied topics related to ordinary differential equations (ODEs): algebraic methods for investigating the qualitative behavior of bio-chemical reaction networks, algorithms for detecting the Hopf bifurcation in high-dimensional chemical reaction networks, the solution of linear ODEs with rational coefficients, also known as D-finite (or holonomic) series, the calculation of normal forms and the first integrals of the Euler–Poisson equations, conditions for the first integral of the cubic Lotka–Volterra system in a neighborhood of the origin, and the analysis of the asymptotic stabilizability of planar switched linear ODE systems.

Two papers deal with applications of symbolic computation in mechanics: the investigation of stability of equilibrium positions in the spatial circular restricted four-body problem of celestial mechanics, and the investigation of stability of a gyroscopic system with four degrees of freedom and with three parameters.

New symbolic-numeric algorithms presented in this volume deal with the solution of the boundary-value problem for the Schrödinger equation in cylindrical coordinates and the solution of the Navier–Stokes equations for the three-dimensional viscous incompressible fluid flows.

Other applications of computer algebra systems presented in this volume include the investigation of the questions of existence of polynomial solutions for linear partial differential equations and (q-)difference equations, new algorithms for rational reparameterization of any plane curve, Maple-based algorithms for determining the intersection multiplicity of two plane curves, and the reduction

of the solution of the combinatorial problem of rainbow connectivity to the solution of a certain system of polynomial equations.

The invariant theory, which is at the crossroads of several mathematical disciplines, is surveyed in the invited talk by G. Kemper. Some examples are given, in which invariant theory is applied to graph theory, computer vision, and coding theory. The talk also gives an overview of the state of the art of algorithmic invariant theory.

The CASC 2012 workshop was supported financially by the Slovenian Research Agency and CAMTP. Our particular thanks are due to the members of the CASC 2012 local Organizing Committee in Slovenia: M. Robnik and V. Romanovski (CAMTP, Maribor) and M. Petkovšek (University of Ljubljana), who ably handled local arrangements in Maribor. Furthermore, we want to thank the Program Committee for their thorough work. Finally, we are grateful to W. Meixner for his technical help in the preparation of the camera-ready manuscript for this volume.

July 2012

V.P. Gerdt
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Organization

CASC 2012 has been organized jointly by the Department of Informatics at the Technische Universität München, Germany, and the Center for Applied Mathematics and Theoretical Physics at the University of Maribor, Slovenia.

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Table of Contents