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Dedicated to

Prof. Ernst W. Mayr

on the occasion of his 60th birthday

Preface

The CASC Workshops are traditionally held in turn in the Commonwealth of Independent States (CIS) and outside CIS (Germany in particular, but, at times, also other countries with lively CA communities). The previous CASC Workshop was held in Japan, and the 12th workshop was held for the first time in Armenia, which is one of the CIS republics. It should be noted that more than 35 institutes and scientific centers function within the National Academy of Sciences of Armenia (further details concerning the structure of the academy can be found `http://www.sci.am`). These institutions are concerned, in particular, with problems in such branches of natural science as mathematics, informatics, physics, astronomy, biochemistry, etc. It follows from the talks presented at the previous CASC workshops that the methods and systems of computer algebra may be applied successfully in all the above-listed branches of natural sciences. Therefore, the organizers of the 12th CASC Workshop hope that the present workshop will help the Armenian scientists to become even more familiar with the capabilities of advanced computer algebra methods and systems and to get in touch with specialists in computer algebra from other countries.

The 11 earlier CASC conferences, CASC 1998, CASC 1999, CASC 2000, CASC 2001, CASC 2002, CASC 2003, CASC 2004, CASC 2005, CASC 2006, CASC 2007, and CASC 2009 were held, respectively, in St. Petersburg (Russia), Munich (Germany), Samarkand (Uzbekistan), Konstanz (Germany), Yalta (Ukraine), Passau (Germany), St. Petersburg (Russia), Kalamata (Greece), Chişinău (Moldova), Bonn (Germany), and Kobe (Japan), and they all proved to be very successful.

The present volume contains revised versions of the papers submitted to the workshop by the participants and accepted by the Program Committee after a thorough reviewing process (each paper was reviewed by at least three referees).

The studies in Gröbner bases and their applications belong to traditional themes of the CASC Workshops. In particular, a new robust method is presented for an accurate floating-point computation of Gröbner bases, which is stable to error accumulation. The application of Gröbner bases to the solution of polynomial equations arising at the solution of the problem of KL-divergence minimization is presented.

The invited talk by E.W. Mayr surveys a number of relationships between computer algebra (in particular, polynomial ideals or, more specifically, binomial ideals) and concepts like Petri nets widely used in computer science for modeling and analyzing concurrent systems, and also presents some new complexity results and algorithms for restricted classes of polynomial ideals.

Another traditional topic of the CASC Workshop, polynomial algebra, is represented by contributions devoted to the construction of irreducible polynomials over finite fields, multivariate homogeneous polynomial decomposition, greatest

common divisor (GCD) computations for finding universal denominators, iterative calculation of the approximate GCD for multiple univariate polynomials, and the REDUCE-based investigation of the convexity of rational functions over a polyhedral domain by reducing convexity questions to real quantifier elimination problems.

Two papers deal with the theory of matrices and its application. In one of them, the algorithms for a fast generalized Bruhat decomposition of the matrix and for the computation of the inverse matrix are presented. In the other paper, the minimal faithful matrix representation of filiform Lie algebras is computed with *Maple*.

Several papers are devoted to the investigation, with the aid of computer algebra, of various topics related to the ordinary differential equations (ODEs): symbolic solution of a third-order ODE, integrability of planar ODE systems near a degenerate stationary point, the use of differential resultants to investigate completely integrable dynamical systems, and derivation of new numerical methods for stiff ODE systems.

Investigating oscillations for parametric ODEs has many applications in science and engineering but is a very hard problem. The invited lecture by A. Weber presents a review of some recently developed criteria which give *sufficient conditions* to exclude oscillations by reducing them to problems on semi-algebraic sets—for polynomial vector fields. Some examples are given, and possible future work in the form of problems to be solved is discussed. Some of these problems might be rather immediate to be solved, some others might pose major challenges.

Two papers handle the topic of partial differential equations (PDEs): disjoint decomposition of nonlinear PDE systems of equations and inequations into so-called simple subsystems, and derivation of semigroup identities for evolution equations using CAS.

Several papers are devoted to software problems in computer algebra. One of them deals with the problem of achieving high performance when both symbolic and numerical computations are required, and it proposes using the Aldor programming language to solve this problem. Two other papers are devoted to the problem of the development of object-oriented computer algebra software and to functional parallelization of rational multiple-residue arithmetic.

A number of papers deal with the application of symbolic or symbolic-numerical computations in applied problems of physics, mechanics, and engineering: computer analysis of spheroidal quantum dot models, the use of symbolic computations in particle accelerator physics, reduction of nonlinear Lagrange systems with cyclic coordinates to the linear Routh systems with the aid of the Legendre transformation, and the use of geometric probabilities to model the self-healing process in concrete with the aid of capsules containing the healing agent.

The survey "Computational Science in Armenia" by H. Marandjian and Yu. Shoukourian is devoted to the development of informatics and computer science in Armenia. The results in theoretical computer science (algebraic models,

solutions to systems of general form recursive equations, the methods of coding theory, pattern recognition, and image processing), constitute the theoretical basis for developing problem-solving-oriented environments. As examples can be mentioned: a synthesizer of optimized distributed recursive programs, software tools for cluster-oriented implementations of two-dimensional cellular automata, and a grid-aware Web interface with advanced service trading for linear algebra calculations. In the direction of solving scientific problems that require high-performance computing resources, examples of completed projects include the field of physics (parallel computing of complex quantum systems), astrophysics (Armenian virtual laboratory), biology (molecular dynamics study of human red blood cell membrane), and meteorology (implementing and evaluating the Weather Research and Forecast Model for the territory of Armenia). The overview also notes that the Institute for Informatics and Automation Problems of the National Academy of Sciences of Armenia has established a scientific and educational infrastructure uniting computing clusters of scientific and educational institutions of the country and provides the scientific community with access to local and international computational resources that is a strong support for computational science in Armenia.

Our particular thanks are due to the members of the CASC 2010 local Organizing Committee in Armenia, V. Sahakyan and M. Haroutunyan (The Institute for Informatics and Automation Problems; National Academy of Sciences of Armenia, Yerevan), who ably handled local arrangements in Yerevan and Tsakhkadzor. Furthermore, we want to thank the PC Committee for their invaluable work. Finally, we are grateful to W. Meixner for his technical help in the preparation of the camera-ready manuscript for this volume.

June 2010

V.P. Gerdt
W. Koepf
E.W. Mayr
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Organization

CASC 2010 was organized jointly by the Department of Informatics at the Technische Universität München, Germany, and the Institute for Informatics and Automation Problems (IIAP) at Yerevan, Armenia.

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