

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Victor G. Ganzha Ernst W. Mayr
Evgenii V. Vorozhtsov (Eds.)

Computer Algebra in Scientific Computing

9th International Workshop, CASC 2006
Chişinău, Moldova, September 11-15, 2006
Proceedings

Volume Editors

Victor G. Ganzha
Ernst W. Mayr
Technische Universität München
Institut für Informatik
Garching, Germany
E-mail: {ganzha,mayr}@in.tum.de

Evgenii V. Vorozhtsov
Russian Academy of Sciences
Institute of Theoretical and Applied Mechanics
Novosibirsk, Russia
E-mail: vorozh@itam.nsc.ru

Library of Congress Control Number: 2006932483

CR Subject Classification (1998): I.1, F.2.1-2, G.1, I.3.5, I.2

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN 0302-9743
ISBN-10 3-540-45182-X Springer Berlin Heidelberg New York
ISBN-13 978-3-540-45182-2 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2006
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11870814 06/3142 5 4 3 2 1 0

Preface

This 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. The collection of papers included in the proceedings covers not only various expanding applications of computer algebra to scientific computing but also the computer algebra systems themselves and the CA algorithms.

The eight earlier CASC conferences, CASC 1998, CASC 1999, CASC 2000, CASC 2001, CASC 2002, CASC 2003, CASC 2004, and CASC 2005 were held, respectively, in St. Petersburg, Russia, in Munich, Germany, in Samarkand, Uzbekistan, in Konstanz, Germany, in Crimea, Ukraine, in Passau, Germany, in St. Petersburg, Russia, and in Kalamata, Greece, and they proved to be successful.

It was E.A. Grebenikow (Computing Center of the Russian Academy of Sciences, Moscow) who drew our attention to the group of mathematicians and computer scientists at the Academy of Sciences of Moldova conducting research in the field of computer algebra. We were impressed that this group not only is concerned with applications of CA methods to problems of scientific computing but also carries out research on the fundamental principles underlying the current computer algebra systems themselves, see also their papers in the present proceedings volume. It was therefore decided to organize the 9th workshop on Computer Algebra in Scientific Computing, CASC 2006, in Chişinău, the capital of Moldova. We hope that this will foster new and closer interactions between the Moldova CA group and other research groups working in the field of computer algebra.

The papers collected in the present volume are devoted both to the topics that have already become traditional for the CASC workshops, and to several new topics. Among the traditional topics, there are the studies in Gröbner bases, polynomial algebra, homological algebra, quantifier elimination, the applications of computer algebra systems in the field of the solution of differential equations, celestial mechanics, Newton polyhedra, mathematical physics, nuclear physics, and fluid dynamics.

Two papers present the results in a new topic, which was addressed for the first time during the CASC 2005 workshop: the application of computer algebra techniques in the field of nanosciences and nanotechnology. Another novel theme is the application of CA methods to cellular automata with symmetrical local rules.

In addition to the accepted submissions, this volume also includes two invited papers. The paper by T. Sturm (University of Passau) addresses various aspects of the computer-algebra-based computer logic system REDLOG, which focuses on real quantifier elimination algorithms. An immense potential of quantifier elimination techniques for the integers is pointed out. Another new REDLOG domain is queues over arbitrary basic domains. Both have promising applications in practical computer science, viz. automatic loop parallelization and software security.

The invited talk by S.M. Watt (University of Western Ontario) is devoted to algorithms for symbolic polynomials where the exponents are not known in advance, such as $x^{2n} - 1$. The case is considered where multivariate polynomials can have exponents which are themselves integer-valued multivariate polynomials, and algorithms are presented to compute their GCD and factorization. Additionally, the case of symbolic exponents on rational coefficients (e.g., $4^{n^2+n} - 81$) is treated, and it is shown how to avoid integer factorization.

Our particular thanks are due to the members of the CASC 2006 local organizing committee at the Technical University of Moldova: V. Dorogan (Chair), M. Izman, and V. Dragan, who have ably handled local arrangements in Chişinău. We are grateful to W. Meixner for his technical help in the preparation of the camera ready manuscript for this volume.

July 2006

V.G. Ganzha
E.W. Mayr
E.V. Vorozhtsov

Organization

CASC 2006 was organized jointly by the Department of Informatics at the Technische Universität München, Germany, and the Technical University of Moldova, Chişinău, Moldova.

Workshop General Chairs

Vladimir Gerdt (JINR, Dubna)

Ernst W. Mayr (TU München)

Program Committee

Alkis Akritas (Volos)

Gerd Baumann (Cairo)

Hans-Joachim Bungartz (Munich)

Andreas Dolzmann (Passau)

Victor Edneral (Moscow)

M'hammed El Kahoui (Marrakech)

Ioannis Emiris (Athens)

Victor Ganzha (Munich, co-chair)

Evgenii Grebenikov (Moscow)

Jaime Gutierrez (Santander)

Ilias Kotsireas (Waterloo)

Robert Kragler (Weingarten)

Richard Liska (Prague)

Bernard Mourrain (Sophia Antipolis)

Eugenio Roanes-Lozano (Madrid)

Yosuke Sato (Tokyo)

Werner Seiler (Heidelberg)

Stanly Steinberg (Albuquerque)

Serguei Tsarev (Krasnoyarsk)

Evgenii Vorozhtsov (Novosibirsk,
co-chair)

Michael N. Vrahatis (Patras)

Andreas Weber (Bonn)

Local Organizing Committee

Valerian Dorogan (Chişinău, chair)

Vladimir Dragan (Chişinău)

Mihai Izman (Chişinău)

General Organizing Committee

Werner Meixner (Munich, chair)

Annelies Schmidt (Munich, secretary)

Electronic Address

WWW site: <http://wwwmayr.in.tum.de/CASC2006>

Table of Contents

Comparison Maps for Relatively Free Resolutions	1
<i>V. Álvarez, J.A. Armario, M.D. Frau, P. Real</i>	
A Symbolic-Numeric Approach for Solving the Eigenvalue Problem for the One-Dimensional Schrödinger Equation	23
<i>I.N. Belyaeva, N.A. Chekanov, A.A. Gusev, V.A. Rostovtsev, S.I. Vinitzky</i>	
Reducing Computational Costs in the Basic Perturbation Lemma	33
<i>Ainhoa Berciano, María José Jiménez, Pedro Real</i>	
Solving Algorithmic Problems on Orders and Lattices by Relation Algebra and RELVIEW	49
<i>Rudolf Berghammer</i>	
Intervals, Syzygies, Numerical Gröbner Bases: A Mixed Study	64
<i>Marco Bodrato, Alberto Zanonì</i>	
Application of Computer Algebra for Construction of Quasi-periodic Solutions for Restricted Circular Planar Three Body Problem	77
<i>V.P. Borunov, Yu.A. Ryabov, O.V. Surkov</i>	
Efficient Preprocessing Methods for Quantifier Elimination	89
<i>Christopher W. Brown, Christian Gross</i>	
Symbolic and Numerical Calculation of Transport Integrals for Some Organic Crystals	101
<i>A. Casian, R. Dusciac, V. Dusciac, V. Patsiuk</i>	
On the Provably Tight Approximation of Optimal Meshing for Non-convex Regions	109
<i>Dmytro Chibisov, Victor Ganzha, Ernst W. Mayr, Eugenii V. Vorozhtsov</i>	
Providing Modern Software Environments to Computer Algebra Systems	129
<i>Svetlana Cojocar, Ludmila Malahova, Alexander Colesnicov</i>	
The Instability of the Rhombus-Like Central Configurations in Newton 9-Body Problem	141
<i>D. Diarova, N.I. Zemtsova</i>	

Algorithmic Invariants for Alexander Modules	149
<i>Jesús Gago-Vargas, Isabel Hartillo-Hermoso, José María Ucha-Enríquez</i>	
Sudokus and Gröbner Bases: Not Only a <i>Divertimento</i>	155
<i>Jesús Gago-Vargas, Isabel Hartillo-Hermoso, Jorge Martín-Morales, José María Ucha-Enríquez</i>	
Simplicial Perturbation Techniques and Effective Homology	166
<i>Rocio Gonzalez-Díaz, Belén Medrano, Javier Sánchez-Peláez, Pedro Real</i>	
Numerical Study of Stability Domains of Hamiltonian Equation Solutions	178
<i>E.A. Grebenicov, D. Kozak-Skoworodkin, D.M. Diarova</i>	
Numeric-Symbolic Computations in the Study of Central Configurations in the Planar Newtonian Four-Body Problem	192
<i>Eugenii A. Grebenikov, Ersain V. Ikhsanov, Alexander N. Prokopenya</i>	
A Symbolic-Numerical Algorithm for Solving the Eigenvalue Problem for a Hydrogen Atom in Magnetic Field	205
<i>Alexander Gusev, Vladimir Gerdt, Michail Kaschiev, Vitaly Rostovtsev, Valentin Samoylov, Tatyana Tupikova, Sergue Vinitzky</i>	
On Decomposition of Tame Polynomials and Rational Functions	219
<i>Jaime Gutierrez, David Sevilla</i>	
Newton Polyhedra and an Oscillation Index of Oscillatory Integrals with Convex Phases	227
<i>Isroil A. Ikromov, Akhmadjon Soleev</i>	
Cellular Automata with Symmetric Local Rules	240
<i>Vladimir V. Korniyak</i>	
Parallel Laplace Method with Assured Accuracy for Solutions of Differential Equations by Symbolic Computations	251
<i>Natasha Malaschonok</i>	
On Connection Between Constructive Involutive Divisions and Monomial Orderings	261
<i>Alexander Semenov</i>	

A Symbolic-Numeric Approach to Tube Modeling in CAD Systems	279
<i>Gerrit Sobottka, Andreas Weber</i>	
Inequalities on Upper Bounds for Real Polynomial Roots	284
<i>Doru Ștefănescu</i>	
New Domains for Applied Quantifier Elimination	295
<i>Thomas Sturm</i>	
Algorithms for Symbolic Polynomials	302
<i>Stephen M. Watt</i>	
Testing Mersenne Primes with Elliptic Curves	303
<i>Song Y. Yan, Glyn James</i>	
Author Index	313