Lecture Notes in Computer Science 3401

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
New York University, NY, 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

Zhilin Li Lubin Vulkov
Jerzy Waśniewski (Eds.)

Numerical Analysis and Its Applications

Third International Conference, NAA 2004
Rousse, Bulgaria, June 29 - July 3, 2004
Revised Selected Papers

Springer

Volume Editors

Zhilin Li
North Carolina State University
Center for Research in Scientific Computation, Department of Mathematics
Raleigh, NC 27695-8205, USA
E-mail: zhilin@math.ncsu.edu

Lubin Vulkov
University of Rousse, Department of Mathematics
Studentska str. 8, 7017 Rousse, Bulgaria
E-mail: vulkov@ami.ru.acad.bg

Jerzy Waśniewski
DTU, Danish IT Centre for Education and Research
2800 Lyngby, Denmark
E-mail: jerzy.wasniewski@uni-c.dk

Library of Congress Control Number: 2005920590

CR Subject Classification (1998): G.1, F.2.1, G.4, I.6, G.2, J.2

ISSN 0302-9743
ISBN 3-540-24937-0 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

springeronline.com

© Springer-Verlag Berlin Heidelberg 2005
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11392989 06/3142 5 4 3 2 1 0

Preface

This volume of the Lecture Notes in Computer Science series contains the proceedings of the 3rd Conference on Numerical Analysis and Its Applications, which was held at the University of Rousse, Bulgaria, June 29–July 3, 2004. The conference was organized by the Department of Numerical Analysis and Statistics at the University of Rousse with the support of the Department of Mathematics of North Carolina State University.

This conference continued the tradition of the two previous meetings (1996, 2000 in Rousse) as a forum where scientists from leading research groups from the "East" and "West" are provided with the opportunity to meet and exchange ideas and establish research cooperations. More than 100 scientists from 28 countries participated in the conference.

A wide range of problems concerning recent achievements in numerical analysis and its applications in physics, chemistry, engineering, and economics were discussed. An extensive exchange of ideas between scientists who develop and study numerical methods and researchers who use them for solving real-life problems took place during the conference.

We thank the plenary lecturers, Profs. R. Lazarov and V. Thome, and the key lecturers and the organizers of the minisymposia, T. Boyadjiev, T. Donchev, E. Farkhi, M. Van Gijzen, S. Nicaise, and M. Todorov, for their contributions. We recognize the effort required to prepare these key lectures and organize the minisymposia. We appreciate your sharing your knowledge of modern high-performance computing numerical methods with the conference participants. We also thank I. Brayanov for the help in putting together the book.

The 4th Conference on Numerical Analysis and Its Applications will take place in 2008.

October 2004

Zhilin Li
Lubin Vulkov
Jerzy Waśniewski

Table of Contents

Invited Papers

Uniform Convergence of a Monotone Iterative Method for a Nonlinear Reaction-Diffusion Problem
Igor Boglaev 1

The Dynamics of Matrix Coupling with an Application to Krylov Methods
Françoise Chaitin-Chatelin 14

High Precision Method for Calculating the Energy Values of the Hydrogen Atom in a Strong Magnetic Field
M.G. Dimova, M.S. Kaschiev 25

Splitting Methods and Their Application to the Abstract Cauchy Problems
I. Faragó 35

Finite Difference Approximation of an Elliptic Interface Problem with Variable Coefficients
Boško S. Jovanović, Lubin G. Vulkov 46

The Finite Element Method for the Navier-Stokes Equations for a Viscous Heat Conducting Gas
E.D. Karepova, A.V. Malyshev, V.V. Shaidurov, G.I. Shchepanovskaya 56

Augmented Strategies for Interface and Irregular Domain Problems
Zhilin Li 66

Accuracy Estimates of Difference Schemes for Quasi-Linear Elliptic Equations with Variable Coefficients Taking into Account Boundary Effect
Volodymyr Makarov, Lyubomyr Demkiv 80

Research Papers

Nodal Two-Dimensional Solitons in Nonlinear Parametric Resonance
N.V. Alexeeva, E.V. Zemlyanaya 91

Supercloseness Between the Elliptic Projection and the Approximate Eigenfunction and Its Application to a Postprocessing of Finite Element Eigenvalue Problems
Andrey B. Andreev 100

One-Dimensional Patch-Recovery Finite Element Method for Fourth-Order Elliptic Problems
Andrey B. Andreev, Todor T. Dimov, Milena R. Racheva 108

Modelling of the Elastic Line for Twist Drill with Straight Shank Fixed in Three-Jaw Chuck
Andrey B. Andreev, Jordan T. Maximov, Milena R. Racheva 116

On the Solvability of the Steady-State Rolling Problem
Todor Angelov Angelov 125

A Quasi-Monte Carlo Method for an Elastic Electron Back-Scattering Problem
Emanouil I. Atanassov, Mariya K. Durchova 133

Numerical Treatment of Fourth Order Singularly Perturbed Boundary Value Problems
Basem S. Attili 141

Selection Strategies for Set-Valued Runge-Kutta Methods
Robert Baier 149

Numerical Methods for the Landau-Lifshitz-Gilbert Equation
L'ubomír Baňas 158

The Continuous Analog of Newton Method for Nonlinear Data Approximation
N.G. Bankow, M.S. Kaschiev 166

Prestressed Modal Analysis Using Finite Element Package ANSYS
R. Bedri, M.O. Al-Nais 171

Computer Realization of the Operator Method for Solving of Differential Equations
Liepa Bikulčienė, Romas Marcinkevičius, Zenonas Navickas 179

The Strong Stability of the Second-Order Operator-Differential Equations
D. Bojović, B.Z. Popović, B.S. Jovanović 187

Semi-Lagrangian Semi-implicit Time Splitting Two Time Level Scheme for Hydrostatic Atmospheric Model
Andrei Bourchtein 195

The Strengthened Cauchy-Bunyakowski-Schwarz Inequality for n-Simplicial Linear Finite Elements
Jan Brandts, Sergey Korotov, Michal Křížek 203

Uniformly Convergent Difference Scheme for a Singularly Perturbed Problem of Mixed Parabolic-Elliptic Type
Iliya A. Brayanov 211

The Numerical Solution for System of Singular Integro-Differential Equations by Faber-Laurent Polynomials
Iurie Caraus 219

An Adaptive-Grid Least Squares Finite Element Solution for Flow in Layered Soils
Tsu-Fen Chen, Christopher Cox, Hasan Merdun, Virgil Quisenberry . . 224

New Perturbation Bounds for the Continuous-Time H_∞-Optimization Problem
N.D. Christov, M.M. Konstantinov, P.Hr. Petkov 232

Progressively Refining Discrete Gradient Projection Method for Semilinear Parabolic Optimal Control Problems
Ion Chryssoverghi 240

Identification of a Nonlinear Damping Function in a Thermoelastic System
Gabriel Dimitriu 249

A Monte Carlo Approach for the Cook-Torrance Model
I.T. Dimov, T.V. Gurov, A.A. Penzov 257

Generic Properties of Differential Inclusions and Control Problems
Tzanko Donchev 266

3D Modelling of Diode Laser Active Cavity
N.N. Elkin, A.P. Napartovich, A.G. Sukharev, D.V. Vysotsky 272

Ant Colony Optimization for Multiple Knapsack Problem and Model Bias
Stefka Fidanova 280

Discretization Methods with Embedded Analytical Solutions for Convection Dominated Transport in Porous Media
Jürgen Geiser 288

Order Reduction of Multi-scale Differential Inclusions
Goetz Grammel 296

Computing Eigenvalues of the Discretized Navier-Stokes Model by the Generalized Jacobi-Davidson Method
G. Hechmé, M. Sadkane 304

Variational Approach for Restoring Random-Valued Impulse Noise
Chen Hu, S.H. Lui 312

Adaptive Filters Viewed as Iterative Linear Equation Solvers
John Håkon Husøy 320

A Rothe-Immersed Interface Method for a Class of Parabolic Interface Problems
Juri D. Kandilarov 328

Volterra Series and Numerical Approximations of ODEs
Nikolay Kirov, Mikhail Krastanov 337

A Property of Farey Tree
Ljubiša Kocić, Liljana Stefanovska 345

Comparison of a Rothe-Two Grig Method and Other Numerical Schemes for Solving Semilinear Parabolic Equations
Miglena N. Koleva 352

An Economic Method for Evaluation of Volume Integrals
Natalia T. Kolkovska 360

Sensitivity Analysis of Generalized Lyapunov Equations
M.M. Konstantinov, P.Hr. Petkov, N.D. Christov 368

An Algorithm to Find Values of Minors of Skew Hadamard and Conference Matrices
C. Kravvaritis, E. Lappas, M. Mitrouli 375

Parallel Performance of a 3D Elliptic Solver
Ivan Lirkov 383

Generalized Rayleigh Quotient Shift Strategy in QR Algorithm for Eigenvalue Problems
Yifan Liu, Zheng Su 391

Parameter Estimation of Si Diffusion in Fe Substrates After Hot Dipping and Diffusion Annealing
B. Malengier 399

Numerical Design of Optimal Active Control for Seismically-Excited Building Structures
Daniela Marinova, Vasil Marinov 408

Computing Transitive Closure Problem on Linear Systolic Array
I.Ž. Milovanović, E.I. Milovanović, B.M. Randjelović 416

A Method Which Finds the Maxima and Minima of a Multivariable Function Applying Affine Arithmetic
Shinya Miyajima, Masahide Kashiwagi 424

On Analytic Iterative Functions for Solving Nonlinear Equations and Systems of Equations
G. Nedzhibov, M. Petkov 432

Parallel Implementation and One Year Experiments with the Danish Eulerian Model
Tzvetan Ostromsky, Ivan Dimov, Zahari Zlatev 440

Conditioning and Error Estimation in the Numerical Solution of Matrix Riccati Equations
P.Hr. Petkov, M.M. Konstantinov, N.D. Christov 448

Numerical Modelling of the One-Phase Stefan Problem by Finite Volume Method
Nickolay Popov, Sonia Tabakova, François Feuillebois 456

Adaptive Conjugate Smoothing of Discontinuous Fields
Minvydas Ragulskis, Violeta Kravcenkiene 463

Finite Differences Scheme for the Euler System of Equations in a Class of Discontinuous Functions
Mahir Rasulov, Turhan Karaguler 471

The λ-Error Order in Multivariate Interpolation
Dana Simian 478

Computational Aspects in Spaces of Bivariate Polynomial of w-Degree n
Dana Simian, Corina Simian, Andrei Moiceanu 486

Restarted GMRES with Inexact Matrix–Vector Products
Gerard L.G. Sleijpen, Jasper van den Eshof, Martin B. van Gijzen ... 494

Applications of Price Functions and Haar Type Functions to the Numerical Integration
S.S. Stoilova 503

Numerical Modelling of the Free Film Dynamics and Heat Transfer Under the van der Waals Forces Action
Sonia Tabakova, Galina Gromyko 511

Two Resultant Based Methods Computing the Greatest Common Divisor of Two Polynomials
D. Triantafyllou, M. Mitrouli 519

Conservative Difference Scheme for Summary Frequency Generation of Femtosecond Pulse
Vyacheslav A. Trofimov, Abdolla Borhanifar, Alexey G. Volkov 527

Compariosn of Some Difference Schemes for Problem of Femtosecond Pulse Interaction with Semiconductor in the Case of Nonlinear Mobility Coefficient
Vyacheslav A. Trofimov, Maria M. Loginova 535

Soliton-Like Regime of Femtosecond Laser Pulse Propogation in Bulk Media Under the Conditions of SHG
Vyacheslav A. Trofimov, Tatiana M. Lysak 543

Computational Method for Finding of Soliton Solutions of Nonlinear Shrödinger Equation
Vyacheslav A. Trofimov, Svetlana A. Varentsova 551

Convergence Analysis for Eigenvalue Approximations on Triangular Finite Element Meshes
Todor D. Todorov 558

Performance Optimization and Evaluation for Linear Codes
Pavel Tvrdík, Ivan Šimeček 566

Modeling and Simulating Waves in Anisotropic Elastic Solids
Valery G. Yakhno, Hakan K. Akmaz 574

Numerical Method for a Chemical Nonlinear Reaction Boundary Value Problem
A.I. Zadorin, O.V. Kharina 583

Parametrically Driven Dark Solitons: A Numerical Study
E.V. Zemlyanaya, I.V. Barashenkov, S.R. Woodford 590

Numerical Investigation of the Viscous Flow in a Bioreactor with a Mixer
Ivanka Zheleva, Anna Lecheva 598

Stability Analysis of a Nonlinear Model of Wastewater Treatment Processes
Plamena Zlateva, Neli Dimitrova 606

Numerical Search for the States with Minimal Dispersion in Quantum Mechanics with Non–negative Quantum Distribution Function
Alexander V. Zorin, Leonid A. Sevastianov, Gregory A. Belomestny . . 613

About the Iteration Method for Solving Difference Equations
Valentin G. Zverev 621

Author Index 629