

LNCS 10187

Ivan Dimov
István Faragó
Lubin Vulkov (Eds.)

Numerical Analysis and Its Applications

6th International Conference, NAA 2016
Lozenetz, Bulgaria, June 15–22, 2016
Revised Selected Papers

 Springer

EXTRAS ONLINE

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, Lancaster, 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, Zurich, Switzerland

John C. Mitchell

Stanford University, Stanford, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

TU Dortmund University, Dortmund, Germany

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Gerhard Weikum

Max Planck Institute for Informatics, Saarbrücken, Germany

More information about this series at <http://www.springer.com/series/7407>

Ivan Dimov · István Faragó
Lubin Vulkov (Eds.)

Numerical Analysis and Its Applications

6th International Conference, NAA 2016
Lozenetz, Bulgaria, June 15–22, 2016
Revised Selected Papers

 Springer

faragois@cs.elte.hu

Editors

Ivan Dimov
Institute of Information and Communication
Technologies
Bulgarian Academy of Sciences
Sofia
Bulgaria

Lubin Vulkov
Department of Applied Mathematics
and Statistics
University of Rousse
Ruse
Bulgaria

István Faragó
Department of Applied Analysis
Eötvös Loránd University
Budapest
Hungary

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-319-57098-3 ISBN 978-3-319-57099-0 (eBook)
DOI 10.1007/978-3-319-57099-0

Library of Congress Control Number: 2017937150

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

© Springer International Publishing AG 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This volume of the 6th International Conference on Numerical Analysis and Applications was held at the hotel Sunset Beach, Lozenetz, Bulgaria, June 15–22, 2016. The conference was organized by the Division of Numerical Analysis and Statistics, University of Rouse Angel Kanchev, Bulgaria, in cooperation with the Department of Parallel Algorithms, Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia.

The conference continued the tradition of the five previous meetings (1996, 2000, 2004 in Ruse and 2008, 2012 in Lozenetz) 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 120 scientists from all over the world participated in the conference.

The main tracks comprised: Numerical Modeling; Numerical Stochastics; Numerical Approximation and Computational Geometry; Numerical Linear Algebra and Numerical Solution of Transcendental Equations; Numerical Methods for Differential Equations; High-Performance Scientific Computing;

The special topics covered at the conference were: Novel methods in computational finance based on the FP7 Marie Curie Action, project Multi-ITN STRIKE—Novel Methods in Computational Finance (grant agreement number 304617); and advanced numerical and applied studies of fractional differential equations.

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 to solve real-life problems took place during the conference.

The keynote lectures reviewed some of the advanced achievements in the field of numerical methods and their efficient applications. The conference lectures were presented by university researchers and industry engineers including applied mathematicians as well as numerical analysis and computer experts.

The success of the conference and the present volume are due to the joint efforts of the Scientific Committee, to the local organizers, and to many colleagues from various institutions and organizations. We thank to our colleagues for their help in the organization of this conference. We especially thank to M. Koleva for her help in the preparation of this volume. We are also grateful to the organizers of the minisymposia.

The 7th International Conference on Numerical Analysis and Its Applications will be held in June 2020.

January 2017

Ivan Dimov
István Faragó
Lubin Vulkov

Organization

NAA 2016 was organized by the Division of Numerical Analysis and Statistics, University of Ruse Angel Kanchev, Bulgaria, in cooperation with the Department of Parallel Algorithms, Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia.

Scientific Committee

Ivan Dimov	IICT, Bulgarian Academy of Sciences, Bulgaria
Matthias Ehrhardt	Bergische Universität Wuppertal, Germany
István Faragó	Eötvös Loránd University, Hungary
Martin Gander	Université de Genève, Switzerland
Francisko Gaspar	University of Zaragoza, Spain
Abdul Khaliq	Middle Tennessee State University, USA
Raytcho Lazarov	Texas A&M University, USA
Piotr Matus	Institute of Mathematics, NAS, Belarus
Nikolay Nefedof	Lomonosov Moscow State University, Russia
Vladimir Shaidurov	Institute of Computational Modelling SB RAS, Russia
Martin Stynes	Beijing Computational Science Research Center, China
Petr Vabishchevich	Russian Academy of Sciences, Russia
Song Wang	Curtin University, Australia

Local Organizers

Luben Vulkov (Chair)	Ruse University “Angel Kanchev”, Bulgaria
Tatiana Chernogorova	Sofia University “St. Kliment Ohridski”, Bulgaria
Jury Dimitrov	Ruse University “Angel Kanchev”, Bulgaria
Miglena Koleva	Ruse University “Angel Kanchev”, Bulgaria
Walter Mudzimbabwe	Ruse University “Angel Kanchev”, Bulgaria
Radoslav Valkov	University of Antwerp, Belgium

Contents

Invited Papers

Behavior of Weak Solutions to the Boundary Value Problems for Second Order Elliptic Quasi-Linear Equation with Constant and Variable Nonlinearity Exponent in a Neighborhood of a Conical Boundary Point.	3
<i>Yury Alkhutov, Mikhail Borsuk, and Sebastian Jankowski</i>	
CVA Computing by PDE Models	15
<i>Iñigo Arregui, Beatriz Salvador, and Carlos Vázquez</i>	
Chaotic Dynamics of Structural Members Under Regular Periodic and White Noise Excitations.	25
<i>J. Awrejcewicz, A.V. Krysko, I.V. Papkova, N.P. Erofeev, and V.A. Krysko</i>	
Convergence Order of a Finite Volume Scheme for the Time-Fractional Diffusion Equation	33
<i>Abdallah Bradji and Jürgen Fuhrmann</i>	
A 2nd-Order FDM for a 2D Fractional Black-Scholes Equation	46
<i>W. Chen and S. Wang</i>	
Convergence of Alternant Theta-Method with Applications	58
<i>István Faragó and Zénó Farkas</i>	
A Numerical Study on the Compressibility of Subblocks of Schur Complement Matrices Obtained from Discretized Helmholtz Equations	70
<i>Martin J. Gander and Sergey Solovyeu</i>	
Convergence Outside the Initial Layer for a Numerical Method for the Time-Fractional Heat Equation	82
<i>José Luis Gracia, Eugene O’Riordan, and Martin Stynes</i>	
Multi-preconditioned Domain Decomposition Methods in the Krylov Subspaces	95
<i>Valery P. Il’in</i>	
Use of Asymptotics for New Dynamic Adapted Mesh Construction for Periodic Solutions with an Interior Layer of Reaction-Diffusion-Advection Equations	107
<i>Dmitry Lukyanenko, Nikolay Nefedov, Egor Nikulin, and Vladimir Volkov</i>	

VIII Contents

A Mathematical Model and a Numerical Algorithm for an Asteroid-Comet Body in the Earth's Atmosphere.	119
<i>V. Shaydurov, G. Shchepanovskaya, and M. Yakubovich</i>	
On Stochastic Representation of Blow-Ups for Distributed Parameter Systems	132
<i>Milan Stehlík and Jozef Kiseľák</i>	
A Singularly Perturbed Boundary Value Problems with Fractional Powers of Elliptic Operators.	141
<i>Petr N. Vabishchevich</i>	
Contributed Papers	
Simulation of Surface Heating Process with Laser.	155
<i>Tatiana Akimenko, Olga Gorbunova, and Valery Dunaev</i>	
A Higher Order Difference Scheme for the Time Fractional Diffusion Equation with the Steklov Nonlocal Boundary Value Problem of the Second Kind.	164
<i>Anatoly A. Alikhanov and Inna Z. Kodzokova</i>	
Local Discontinuous Galerkin Methods for Reaction-Diffusion Systems on Unstructured Triangular Meshes	172
<i>Na An, Xijun Yu, Chaobao Huang, and Maochang Duan</i>	
A Method for Linearization of a Beam Problem	180
<i>A.B. Andreev and M.R. Racheva</i>	
Numerical Modeling of Fluid Flow in Liver Lobule Using Double Porosity Model.	187
<i>M. Yu. Antonov, A.V. Grigorev, and A.E. Kolesov</i>	
Numerical Modelling of Ion Transport in 5-HT3 Serotonin Receptor Using Molecular Dynamics	195
<i>M. Yu. Antonov, A.V. Popinako, G.A. Prokopiev, and A.O. Vasilyev</i>	
Induced Dimension Reduction Method to Solve the Quadratic Eigenvalue Problem.	203
<i>R. Astudillo and M.B. van Gijzen</i>	
Algorithms for Numerical Simulation of Non-stationary Neutron Diffusion Problems	212
<i>A.V. Avvakumov, V.F. Strizhov, P.N. Vabishchevich, and A.O. Vasilev</i>	
Regularization Methods of the Continuation Problem for the Parabolic Equation	220
<i>Andrey Belonosov and Maxim Shishlenin</i>	

Computer Simulation of Plasma Dynamics in Open Plasma Trap	227
<i>Evgeny Berendeev, Galina Dudnikova, Anna Efimova, and Vitaly Vshivkov</i>	
Note on a New High Order Piecewise Linear Finite Element Approximation for the Wave Equation in One Dimensional Space	235
<i>Abdallah Bradji</i>	
Short Rate as a Sum of Two CKLS-Type Processes	243
<i>Zuzana Bučková, Jana Halgašová, and Beáta Stehlíková</i>	
Improving the Convergence of Differential Evolution	252
<i>Petr Bujok</i>	
The Service-Oriented Multiagent Approach to High-Performance Scientific Computing	261
<i>Igor Bychkov, Gennady Oparin, Alexander Feoktistov, Vera Bogdanova, and Ivan Sidorov</i>	
Innovative Integrators for Computing the Optimal State in LQR Problems . . .	269
<i>Petra Csomós and Hermann Mena</i>	
Existence and Stability of Contrast Structures in Multidimensional Singularly Perturbed Reaction-Diffusion-Advection Problems	277
<i>M.A. Davydova and N.N. Nefedov</i>	
A Comparison of Numerical Techniques for the FEM for the Stokes Problem for Incompressible Flow	286
<i>Ekaterina Dementyeva and Evgeniya Karepova</i>	
Numerical Modeling of Coupled Problems of External Aerothermodynamics and Internal Heat-and-Mass Transfer in High-Speed Vehicle Composite Constructions.	294
<i>Yury Dimitrienko, Mikhail Koryakov, and Andrey Zakharov</i>	
Latin Hypercube Sampling and Fibonacci Based Lattice Method Comparison for Computation of Multidimensional Integrals	302
<i>Stoyan Dimitrov, Ivan Dimov, and Venelin Todorov</i>	
Non-singular Model for Evaporating Sessile Droplets	311
<i>Stanislav Z. Dunin and Oleg V. Nagornov</i>	
Combinatorial Modeling Approach to Find Rational Ways of Energy Development with Regard to Energy Security Requirements.	317
<i>Alexey Edelev and Ivan Sidorov</i>	
A Conservative Semi-Lagrangian Method for the Advection Problem	325
<i>Alexandr Efremov, Evgeniya Karepova, and Vladimir Shaidurov</i>	

Fast Meshless Techniques Based on the Regularized Method of Fundamental Solutions.	334
<i>Csaba Gáspár</i>	
Parallel Computations for Solving 3D Helmholtz Problem by Using Direct Solver with Low-Rank Approximation and HSS Technique	342
<i>Boris Glinskiy, Nikolay Kuchin, Victor Kostin, and Sergey Solovyev</i>	
ADI Schemes for 2D Subdiffusion Equation.	350
<i>Sandra Živanovic and Boško S. Jovanović</i>	
Evolution of Copulas in Discrete Processes with Application to a Numerical Modeling of Dependence Relation Between Exchange Rates	359
<i>Naoyuki Ishimura and Yasukazu Yoshizawa</i>	
Using ϵ -nets for Solving the Classification Problem.	367
<i>Maria A. Ivanchuk and Igor V. Malyk</i>	
Convergence of a Factorized Finite Difference Scheme for a Parabolic Transmission Problem	375
<i>Zorica Milovanović Jeknić and Boško Jovanović</i>	
Compound Log-Series Distribution with Negative Multinomial Summands. . .	383
<i>Pavlina Jordanova, Monika P. Petkova, and Milan Stehlik</i>	
Inverse Problems of Determination of the Right-Hand Side Term in the Degenerate Higher-Order Parabolic Equation on a Plane.	391
<i>Vitaly L. Kamynin and Tatiana I. Bukharova</i>	
Numerical Methods of Solution of the Dirichlet Boundary Value Problem for the Fractional Allers' Equation	398
<i>Fatimat A. Karova</i>	
Slot Machine Base Game Evolutionary RTP Optimization	406
<i>Delyan Keremedchiev, Petar Tomov, and Maria Barova</i>	
Numerical Analysis of Reinforced Concrete Deep Beams.	414
<i>Aleksandr E. Kolesov, Petr V. Sivtsev, Piotr Smarzewski, and Petr N. Vabishchevich</i>	
Numerical Solution of Thermoporoelasticity Problems	422
<i>Alexandr E. Kolesov and Petr N. Vabishchevich</i>	
Computation of Delta Greek for Non-linear Models in Mathematical Finance	430
<i>Miglena N. Koleva and Lubin G. Vulkov</i>	

Research of Optimum Strategy for Semi-Markov Queueing Models at Control of CBSMAP-Flow. Algorithmization	439
<i>Elizaveta V. Kondrashova and Victor A. Kashtanov</i>	
On Some Piecewise Quadratic Spline Functions	448
<i>Oleg Kosogorov and Anton Makarov</i>	
Moving Limit Cycles Model of an Economic System	456
<i>Vladimir Kryuchkov, Mark Solomonovich, and Cristina Anton</i>	
The Use of Contrast Structures Theory for the Mathematical Modelling of the Wind Field in Spatially Heterogeneous Vegetation Cover	464
<i>Natalia Levashova, Julia Muhartova, and Marina Davydova</i>	
An Approximate Solution of Optimization Problems for Elliptic Interface Problems with Variable Coefficients and Imperfect Contact.	473
<i>Aigul Manapova</i>	
An Antithetic Approach of Multilevel Richardson-Romberg Extrapolation Estimator for Multidimensional SDES	482
<i>Cheikh Mbaye, Gilles Pagès, and Frédéric Vrins</i>	
Front Dynamics in an Activator-Inhibitor System of Equations	492
<i>Alina Melnikova, Natalia Levashova, and Dmitry Lukyanenko</i>	
American Options in an Illiquid Market: Nonlinear Complementary Method.	500
<i>Walter Mudzimbabwe and Lubin Vulkov</i>	
Inverse Problem for Paleo-Temperature Reconstruction Based on the Tree-Ring Width and Glacier-Borehole Data.	508
<i>Oleg V. Nagornov and Sergey A. Tyufilin</i>	
Collision of Solitons for a Non-homogenous Version of the KdV Equation: Asymptotics and Numerical Simulation	517
<i>G. Omel'yanov</i>	
On Construction of Combined Shock-Capturing Finite-Difference Schemes of High Accuracy	525
<i>Vladimir Ostapenko and Olyana Kovyorkina</i>	
Numerical Methods for a Class of Fractional Advection-Diffusion Models with Functional Delay	533
<i>Vladimir Pimenov and Ahmed Hendy</i>	
Calculation of Kinetic Coefficients for Real Gases on Example of Nitrogen . . .	542
<i>Viktoriia O. Podryga</i>	

New Grid Approach for Solution of Boundary Problems for Convection-Diffusion Equations.	550
<i>Sergey V. Polyakov, Yuri N. Karamzin, Tatiana A. Kudryashova, and Viktoriia O. Podryga</i>	
Finite-Difference Method for Solution of Advection Equation by Unstable Schemes.	559
<i>Igor V. Popov</i>	
Algorithm of Competing Processes for the Richardson Iteration Method with the Chebyshev Parameters.	568
<i>Mikhail V. Popov, Yuriy A. Poveschenko, Igor V. Popov, Vladimir A. Gasilov, and Alexander V. Koldoba</i>	
Unstable Flow Modes of the Non-isothermal Liquid Film	576
<i>Ludmila A. Prokudina</i>	
Discrete Modeling of Oscillatory Processes in a Blocky Medium	583
<i>Vladimir M. Sadovskii and Evgenii P. Chentsov</i>	
An Overlapping Domain Decomposition Method for the Helmholtz Exterior Problem.	591
<i>Alexander Savchenko and Artem Petukhov</i>	
A Semi-Lagrangian Numerical Method for the Three-Dimensional Advection Problem with an Isoparametric Transformation of Subdomains . . .	599
<i>Vladimir Shaydurov, Alexander Vyatkin, and Elena Kuchunova</i>	
Some Quadrature-Based Versions of the Generalized Newton Method for Solving Unconstrained Optimization Problems.	608
<i>Marek J. Śmiateński</i>	
One Parallel Method for Solving the Multidimensional Transfer Equation with Aftereffect.	617
<i>Svyatoslav I. Solodushkin, Arsen A. Sagoyan, and Irina F. Yumanova</i>	
Numerical Simulation of Heat Transfer of the Pile Foundations with Permafrost	625
<i>Sergei P. Stepanov, Ivan K. Sirditov, Petr N. Vabishchevich, Maria V. Vasilyeva, Vasiliy I. Vasilyev, and Anastasiya N. Tceeva</i>	
The Inverse Problem of the Simultaneous Determination of the Right-Hand Side and the Lowest Coefficients in Parabolic Equations	633
<i>LingDe Su, P.N. Vabishchevish, and V.I. Vasil'ev</i>	
The GPU Solvers for High-Frequency Induction Logging	640
<i>Irina Surodina</i>	

Mathematical Modeling of Fan-Structure Shear Ruptures Generated in Hard Rocks	648
<i>Boris G. Tarasov and Vladimir M. Sadovskii</i>	
On the Numerical Analysis of Fan-Shaped Waves.	657
<i>Boris G. Tarasov, Vladimir M. Sadovskii, and Oxana V. Sadovskaya</i>	
High Performance Computations for Study the Stability of a Numerical Procedure for Crossbar Switch Node	665
<i>Tasho D. Tashev, Vladimir V. Monov, and Radostina P. Tasheva</i>	
Solving a Singularly Perturbed Elliptic Problem by a Multigrid Algorithm with Richardson Extrapolation	674
<i>Svetlana Tikhovskaya</i>	
Conservative Finite-Difference Scheme for Computer Simulation of Field Optical Bistability	682
<i>Vyacheslav A. Trofimov, Maria M. Loginova, and Vladimir A. Egorenkov</i>	
Numerical Modeling of Micropolar Thin Elastic Plates	690
<i>Maria Varygina</i>	
Iterative Solution of the Retrospective Inverse Problem for a Parabolic Equation Using the Conjugate Gradient Method	698
<i>V.I. Vasil'ev and A.M. Kardashevsky</i>	
Discrete Approximations for Multidimensional Singular Integral Operators. . .	706
<i>Alexander Vasilyev and Vladimir Vasilyev</i>	
A Generalized Multiscale Finite Element Method for Thermoelasticity Problems	713
<i>Maria Vasilyeva and Denis Stalnov</i>	
Asymptotic-Numerical Method for the Location and Dynamics of Internal Layers in Singular Perturbed Parabolic Problems.	721
<i>Vladimir Volkov, Dmitry Lukyanenko, and Nikolay Nefedov</i>	
Influence of Snow Cover on the Seismic Waves Propagation	730
<i>Gyulnara Voskoboynikova, Kholmatzhon Imomnazarov, Aleksander Mikhailov, and Jian-Gang Tang</i>	
Hybrid Model of Particle Acceleration on a Shock Wave Front	737
<i>Lyudmila Vshivkova and Galina Dudnikova</i>	

Solution of the Stochastic Differential Equations Equivalent to the Non-stationary Parker Transport Equation by the Strong Order Numerical Methods	744
<i>Anna Wawrzynczak and Renata Modzelewska</i>	
Numerical Method for Solving an Inverse Boundary Problem with Unknown Initial Conditions for Parabolic PDE Using Discrete Regularization	752
<i>Natalia M. Yaparova</i>	
Two-Dimensional Interpolation of Functions with Large Gradients in Boundary Layers.	760
<i>Alexander Zadorin</i>	
A Volunteer-Computing-Based Grid Architecture Incorporating Idle Resources of Computational Clusters.	769
<i>Oleg Zaikin, Maxim Manzyuk, Stepan Kochemazov, Igor Bychkov, and Alexander Semenov</i>	
Effects of the Neuron Permutation Problem on Training Artificial Neural Networks with Genetic Algorithms	777
<i>Iliyan Zankinski</i>	
Author Index	783