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Numerical Computations: Theory and Algorithms

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Revised Selected Papers, Part II

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Preface

This volume, edited by Yaroslav D. Sergeyev and Dmitri E. Kvasov, contains selected peer-reviewed papers from the Third Triennial International Conference and Summer School on Numerical Computations: Theory and Algorithms (NUMTA 2019) held in Le Castella – Isola Capo Rizzuto (Crotone), Italy, during June 15–21, 2019. The NUMTA 2019 conference has continued the previous successful editions of NUMTA that took place in 2013 and 2016 in Italy in the beautiful Calabria region.

NUMTA 2019 was organized by the University of Calabria, Department of Computer Engineering, Modeling, Electronics and Systems Science, Italy, in cooperation with the Society for Industrial and Applied Mathematics (SIAM), USA. This edition had the high patronage of the municipality of Crotone – the city of Pythagoras and his followers, the Pythagoreans. In fact, Pythagoras established the first Pythagorean community in this city in the 6th century B.C. It was a very special feeling for the participants of NUMTA 2019 to visit these holy, for any mathematician, places with a conference dedicated to numerical mathematics.

The goal of the NUMTA series of conferences is to create a multidisciplinary round table for an open discussion on numerical modeling nature by using traditional and emerging computational paradigms. Participants of the NUMTA 2019 conference discussed multiple aspects of numerical computations and modeling starting from foundations and philosophy of mathematics and computer science to advanced numerical techniques. New technological challenges and fundamental ideas from theoretical computer science, machine learning, linguistic, logic, set theory, and philosophy met the requirements, as well as fresh, new applications from physics, chemistry, biology, and economy.

Researchers from both theoretical and applied sciences were invited to use this excellent opportunity to exchange ideas with leading scientists from different research fields. Papers discussing new computational paradigms, relations with foundations of mathematics, and their impact on natural sciences were particularly solicited. Special attention during the conference was dedicated to numerical optimization techniques and a variety of issues related to the theory and practice of the usage of infinities and infinitesimals in numerical computations. In particular, there were a substantial number of talks dedicated to a new promising methodology allowing one to execute numerical computations with finite, infinite, and infinitesimal numbers on a new type of a computational device – the Infinity Computer patented in the EU, Russia, and the USA.

This edition of the NUMTA conference was dedicated to the 80th birthday of Professor Roman Strongin. For the past 50 years Roman Strongin has been a leader and an innovator in Global Optimization, an important field of Numerical Analysis having numerous real-life applications. His book on Global Optimization, published in 1978, was one of the first in the world on this subject. Now it is a classic and has been used by many as their first introduction and continued inspiration for Global Optimization. Since that time, Roman has published numerous books and more than 400 papers in

several scientific fields and has been rewarded with many national and international honors including the President of the Russian Federation Prize. For decades Roman served as Dean, First Vice-Rector, and Rector of the famous Lobachevsky State University of Nizhny Novgorod. Since 2008 he has been President of this university. He is also Chairman of the Council of Presidents of Russian Universities, Vice-President of the Union of the Rectors of Russian Universities, and Chairman of the Public Chamber of the Nizhny Novgorod Region.

We are proud to inform you that 200 researchers from the following 30 countries participated at the NUMTA 2019 conference: Argentina, Bulgaria, Canada, China, Czech Republic, Estonia, Finland, France, Germany, Greece, India, Iran, Italy, Japan, Kazakhstan, Latvia, Lithuania, the Netherlands, Philippines, Portugal, Romania, Russia, Saudi Arabia, South Korea, Spain, Switzerland, Thailand, Ukraine, the UK, and the USA.

The following plenary lecturers shared their achievements with the NUMTA 2019 participants:

- Louis D’Alotto, USA: “Infinite games on finite graphs using Grossone”
- Renato De Leone, Italy: “Recent advances on the use of Grossone in optimization and regularization problems”
- Kalyanmoy Deb, USA: “Karush-Kuhn-Tucker proximity measure for convergence of real-parameter single and multi-criterion optimization”
- Luca Formaggia, Italy: “Numerical modeling of flow in fractured porous media and fault reactivation”
- Jan Hesthaven, Switzerland: “Precision algorithms”
- Francesca Mazzia, Italy: “Numerical differentiation on the Infinity Computer and applications for solving ODEs and approximating functions”
- Michael Vrahatis, Greece: “Generalizations of the intermediate value theorem for approximations of fixed points and zeroes of continuous functions”
- Anatoly Zhigljavsky, UK: “Uniformly distributed sequences and space-filling”

Moreover, the following tutorials were presented during the conference:

- Roberto Natalini, Italy: “Vector kinetic approximations to fluid-dynamics equations”
- Yaroslav Sergeyev, Italy and Russia: “Grossone-based Infinity Computing with numerical infinities and infinitesimals”
- Vassili Toropov, UK: “Design optimization techniques for industrial applications: Challenges and progress”

These proceedings of NUMTA 2019 consist of two volumes: Part I and Part II. The book you have in your hands is the second part containing peer-reviewed papers chosen from the general stream, plenary lectures, and small special sessions of NUMTA 2019. Papers carefully selected from big special streams and sessions held during the conference have been collected in the Part I of the NUMTA 2019 proceedings.

This volume contains 19 long papers and 32 short papers that were accepted for publication after a thorough peer review process (required up to three review rounds for some manuscripts) by the members of the NUMTA 2019 Program Committee and independent reviewers. This volume also contains the paper of the winner (Lorenzo Fiaschi, Pisa, Italy) of the Springer Young Researcher Prize for the best NUMTA 2019 presentation made by a young scientist. The support of the Springer LNCS editorial staff and the sponsorship of the Young Researcher Prize by Springer are greatly appreciated.

The editors express their gratitude to institutions that have offered their generous support to the international conference NUMTA 2019. This support was essential for the success of this event:

- University of Calabria (Italy)
- Department of Computer Engineering, Modeling, Electronics and Systems Science of the University of Calabria (Italy)
- Italian National Group for Scientific Computation of the National Institute for Advanced Mathematics F. Severi (Italy)
- Institute of High Performance Computing and Networking of the National Research Council (Italy)
- International Association for Mathematics and Computers in Simulation
- International Society of Global Optimization

The editors thank all the participants for their dedication to the success of NUMTA 2019 and are grateful to the reviewers for their valuable work. Many thanks go to Maria Chiara Nasso from the University of Calabria, Italy, for her kind support in the technical editing of this volume.

The next Triennial International Conference and Summer School NUMTA “Numerical Computations: Theory and Algorithms” will take place in 2022 in Italy. The editors of this volume, who are chairs of the NUMTA Scientific and Organizing Committees, respectively, invite all the participants of NUMTA 2019, and readers of this book, to submit their high-quality results to the next edition of this wonderful event.

October 2019

Yaroslav D. Sergeyev
Dmitri E. Kvasov

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