

# Communications in Computer and Information Science

499

## Editorial Board

Simone Diniz Junqueira Barbosa

*Pontifical Catholic University of  
Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brazil*

Phoebe Chen

*La Trobe University, Melbourne, Australia*

Alfredo Cuzzocrea

*ICAR-CNR and University of Calabria, Cosenza, Italy*

Xiaoyong Du

*Renmin University of China, Beijing, China*

Joaquim Filipe

*Polytechnic Institute of Setúbal, Setúbal, Portugal*

Orhun Kara

*TÜBİTAK BİLGEM and Middle East Technical University, Ankara, Turkey*

Igor Kotenko

*St. Petersburg Institute for Informatics and Automation of the Russian Academy  
of Sciences, St. Petersburg, Russia*

Krishna M. Sivalingam

*Indian Institute of Technology Madras, Chennai, India*

Dominik Ślęzak

*University of Warsaw and Infobright, Warsaw, Poland*

Takashi Washio

*Osaka University, Osaka, Japan*

Xiaokang Yang

*Shanghai Jiao Tong University, Shanghai, China*

More information about this series at <http://www.springer.com/series/7899>

Alexander Plakhov  
Tatiana Tchemisova  
Adelaide Freitas (Eds.)

# Optimization in the Natural Sciences

30th Euro Mini-Conference, EmC-ONS 2014  
Aveiro, Portugal, February 5–9, 2014  
Revised Selected Papers

*Editors*

Alexander Plakhov  
University of Aveiro  
Aveiro  
Portugal

Adelaide Freitas  
University of Aveiro  
Aveiro  
Portugal

Tatiana Tchemisova  
University of Aveiro  
Aveiro  
Portugal

ISSN 1865-0929                      ISSN 1865-0937 (electronic)  
Communications in Computer and Information Science  
ISBN 978-3-319-20351-5              ISBN 978-3-319-20352-2 (eBook)  
DOI 10.1007/978-3-319-20352-2

Library of Congress Control Number: 2015941859

Springer Cham Heidelberg New York Dordrecht London  
© Springer International Publishing Switzerland 2015

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.

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media  
([www.springer.com](http://www.springer.com))

# Preface

This Springer volume of *Communications in Computer and Information Science* is dedicated to the 30th EURO mini-conference on Optimization in the Natural Sciences (EmC-ONS 2014), which was held during February 5–9, 2014, in Aveiro, Portugal.

The conference attracted more than 100 registered participants who represented 21 countries from four continents. More than 70 contributed talks were divided into three streams—Optimization and Applications, Dynamical Systems, and Statistics, Bioinformatics, and Health Sciences—and constituted 22 sessions. The participants discussed recent achievements in optimization theory and related areas, exchanged experiences in solving real-world problems, and reported on the latest developments of appropriate models of optimization and their applications in the natural sciences. The 30th EURO mini-conference provided an excellent forum for researchers and practitioners in optimization to promote their recent advances to the wider scientific community and to identify new research challenges in theory, methods, and applications.

The conference topics reflected the huge diversity of different lines of research in optimization and its application in the natural sciences, including:

- Analysis of microarray data or next-generation sequencing
- Applications of modeling and optimization in physics, biology, chemistry, and medicine
- Billiard theory and applications
- Biomedical engineering
- Design optimization
- Data visualization for optimal decisions
- Image processing
- Infinite and semi-infinite optimization with applications
- Inverse problems
- Linear and nonlinear optimization and applications
- Multi-criteria optimization with applications
- Multi-scale optimization with applications
- Optimal control applied to biological models
- Optimal mass transfer
- Optimization in bioinformatics and computational biology
- Shape optimization
- Solution of optimization problems using statistical methods
- Statistics in high-dimensional data
- Statistical methods and visualization
- Statistical and probabilistic modeling
- Wave scattering

Based on a rigorous reviewing process realized by the members of the Program Committee, 13 papers were selected for publication in this volume. The keywords

of the selected papers reflect the diversity of different lines of research in optimization and their applications in the natural sciences covered in this volume: optimal control, data visualization, spatial data analysis, shape optimization, billiards, multi-objective portfolio optimization, Markov chains, warehousing, multi-criteria optimization, simulation of information processing, principal component analysis in clustering, Herglotz's variational problems, multiple-response surface optimization, unreliable queueing systems, inverse problems, optimization of the hyperbolic type systems, suboptimal optimization, geometric optics, random access and others. The articles are grouped into three sections: Optimization and Applications, Dynamical Systems, and Modeling and Statistical Techniques for Data Analysis.

As guest editors, we would like to thank all the authors who contributed to this volume and all the reviewers who accepted the invitation to provide their expertise and give constructive comments. Our special thanks to the computer science editorial team at Springer, in particular to Aliaksandr Birukou, Frank Holzwarth, and Leonie Kunz for the opportunity to organize this volume, their expertise and coordination of the editorial process, and the continuous support and assistance.

March 2015

Alexander Plakhov  
Tatiana Tchemisova  
Adelaide Freitas

# Organization

## Program Chairs

Alexander Plakhov      University of Aveiro, Portugal  
Tatiana Tchemisova    University of Aveiro, Portugal  
Adelaide Freitas        University of Aveiro, Portugal

## Program Committee

Adil Bagirov              University of Ballarat, Australia  
Adilson Elias Xavier    Federal University of Rio de Janeiro, Brazil  
Boris T. Polyak          Institute of Control Problems, Moscow, Russia  
Domingos M. Cardoso    University of Aveiro, Portugal  
Gerhard-Wilhelm Weber   Middle East Technical University, Turkey  
Guiseppe Buttazzo      University of Pisa, Italy  
János D. Pintér          Pintér Consulting Services, Inc., Canada  
Joaquim Júdice          University of Coimbra, Portugal  
Julius Žilinskas         Vilnius University, Lithuania  
Leonidas Sakalauskas   Vilnius University, Lithuania  
Lisete de Sousa          University of Lisbon, Portugal  
Mourad Elloumi          University of Tunis-El Manar, Tunisia  
Oliver Stein              Karlsruhe Institute of Technology, Germany  
Purificación Galindo    University of Salamanca, Spain  
Vladimir Bushenkov    University of Évora, Portugal  
Miguel Pinheiro          University of St. Andrews, UK  
Vadim Strijov             Moscow Institute of Physics and Technology, Russia

# Contents

## Dynamical Systems

Motion of a Rough Disc in Newtonian Aerodynamics . . . . .	3
<i>Sergey Kryzhevich</i>	

Comparative Study on Efficiency of Mirror Retroreflectors . . . . .	20
<i>João Pedro Cruz and Alexander Plakhov</i>	

## Optimization and Applications

Multicriteria Optimization in a Typical Multi-Isle Warehouse with Multiple Racks . . . . .	35
<i>Diana G. Ramirez-Rios, Laura P. Manotas Romero, and Jairo R. Montoya-Torres</i>	

Reconstruction of the Surface Heat Flux for a Quasi-linear System of the Hyperbolic Type Heat-Conduction Equations . . . . .	49
<i>Valentin Borukhov and Olga Kostyukova</i>	

Multi-Objective and Financial Portfolio Optimization of $p$ -Persistent Carrier Sense Multiple Access Protocols with Multi-Packet Reception . . . . .	68
<i>Ramiro Sámano-Robles and Atilio Gameiro</i>	

Robust Optimal Control of Dynamically Decoupled Systems via Distributed Feedbacks . . . . .	95
<i>Natalia Dmitruk</i>	

An Optimal Control Approach to Herglotz Variational Problems. . . . .	107
<i>Simão P.S. Santos, Natália Martins, and Delfim F.M. Torres</i>	

Lowering Toxic Concentrations in the Diesel Exhaust Gases . . . . .	118
<i>Elena Pervukhina, Kostiantyn Osipov, and Victoria Golikova</i>	

Desirability Functions in Multiresponse Optimization . . . . .	129
<i>Başak Akteke-Öztürk, Gerhard-Wilhelm Weber, and Gülser Köksal</i>	

## Modeling and Statistical Techniques for Data Analysis

Analysis of Unreliable Single Server Queueing System with Hot Back-Up Server. . . . .	149
<i>Alexander Dudin, Valentina Klimenok, and Vladimir Vishnevsky</i>	



Identification of DNA CpG Islands Using Inter-dinucleotide Distances . . . . . 162  
*Vera Afreixo, Carlos A.C. Bastos, João M.O.S. Rodrigues,  
and Raquel M. Silva*

The Alternating Least-Squares Algorithm for CDPCA . . . . . 173  
*Eloísa Macedo and Adelaide Freitas*

Rapid Spatial Aggregation . . . . . 192  
*Markus Loecher and Madhav Kumar*

**Author Index** . . . . . 207