## **CIM Series in Mathematical Sciences**

### Volume 4

#### Series Editors:

Irene Fonseca Department of Mathematical Sciences Center for Nonlinear Analysis Carnegie Mellon University Pittsburgh, PA, USA

Alberto Adrego Pinto Department of Mathematics University of Porto, Faculty of Sciences Porto, Portugal The CIM Series in Mathematical Sciences is published on behalf of and in collaboration with the Centro Internacional de Matemática (CIM) in Coimbra, Portugal. Proceedings, lecture course material from summer schools and research monographs will be included in the new series.

More information about this series at http://www.springer.com/series/11745

João Paulo Almeida • José Fernando Oliveira • Alberto Adrego Pinto Editors

# **Operational Research**

IO 2013 - XVI Congress of APDIO, Bragança, Portugal, June 3–5, 2013







*Editors* João Paulo Almeida Department of Mathematics and LIAAD-INESC TEC Polytechnic Institute of Bragança School of Technology and Management Bragança, Portugal

Alberto Adrego Pinto Department of Mathematics and LIAAD-INESC TEC University of Porto Porto, Portugal José Fernando Oliveira Faculty of Engineering CEGI - INESC TEC University of Porto Porto, Portugal

ISSN 2364-950X CIM Series in Mathematical Sciences ISBN 978-3-319-20327-0 DOI 10.1007/978-3-319-20328-7 ISSN 2364-9518 (electronic)

ISBN 978-3-319-20328-7 (eBook)

Library of Congress Control Number: 2015950648

Mathematics Subject Classification (2010): 90Bxx

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)

### Foreword

The main objectives of the APDIO – the Portuguese OR Society (in Portuguese: Associação Portuguesa de Investigação Operacional) are to disseminate the latest advances in Operational Research, its best practices, and, furthermore, to foster the bonds within the OR Community, helping it to pursue its research interests and meet future challenges. Accordingly, the APDIO promotes Operational Research through courses, seminars, workshops, and conferences, while also providing editorial support for scientific publications (e.g., scientific journals, newsletters, and books). The APDIO is a scientific society that brings together Portugal's Operational Research Community. It was created in 1978 by 140 founding members, including university researchers, industrial practitioners, and several Portuguese institutes and companies as institutional associates. The APDIO has been a member of the International Federation of Operational Research Societies (IFORS) and International Federation of Automatic Control (IFAC) since its inception. It has gone on to become a member of the Association of European Operational Research Societies (EURO) and was involved in the creation of the Association of Latin-Iberoamerican Operational Research Societies (ALIO) in 1982. Over the years, the APDIO has organized a total of 16 National Conferences: Lisbon, 1982; Porto, 1984; Coimbra, 1987; Lisbon, 1989; Évora, 1992; Braga, 1994; Aveiro, 1996; Faro, 1998; Setúbal, 2000; Guimarães, 2002; Porto, 2004; Lisbon, 2006; Vila Real, 2008; Caparica, 2009; Coimbra, 2011; and Bragança, 2013. The next National Conference will be held in Portalegre in September 2015.

The publication of this volume, with a selection of papers from IO2013 – the 16th National Conference of the APDIO, held in Bragança, Portugal, June 3–5, 2013 – is in keeping with the society's main purposes. We hope that it will be the first volume in a Springer Edition Series devoted to the main findings presented at our National Conferences.

We are very much indebted to the Editors of this volume, Professors João Paulo Almeida, José Fernando Oliveira, and Alberto Adrego Pinto, to whom I express my gratitude for having embraced this project and brought it to fruition. I am also grateful to the authors who contributed to this volume; their papers are excellent examples of the current research activities of the Portuguese OR Community members. Lastly, I would also like to thank the reviewers, whose anonymous work was essential to guaranteeing the publication's high quality.

Aveiro, PortugalDomingos Moreira CardosoMay 25, 2015(President of the Directive Committee of the APDIO)

### Acknowledgments

We thank all the authors for their contributed chapters and all the anonymous referees.

We thank the president of APDIO – Associação Portuguesa de Investigação Operacional – Professor Domingos Moreira Cardoso.

We thank the Executive Editor for Mathematics, Computational Science, and Engineering at Springer-Verlag, Martin Peters, for invaluable suggestions and advice and Ruth Allewelt at Springer-Verlag for assistance throughout this project.

João Paulo Almeida and Alberto Adrego Pinto would like to thank LIAAD-INESC TEC and gratefully acknowledge the financial support received by the FCT – Fundação para a Ciência e a Tecnologia (Portuguese Foundation for Science and Technology) – within project UID/EEA/50014/2013 and ERDF (European Regional Development Fund) through the COMPETE Program (operational program for competitiveness) and by National Funds through the FCT within Project "Dynamics, optimization and modelling" with reference PTDC/MAT-NAN/6890/2014. Alberto Adrego Pinto also acknowledges the financial support received through the *Special Visiting Researcher* scholarship program at IMPA, Brazil.

Bragança, Portugal Porto, Portugal João Paulo Almeida José Fernando Oliveira Alberto Adrego Pinto

# Contents

Performance Evaluation of Parfois Retailing Stores Maria Emília Dias Alves and Maria C.A. Silva Portela	1
Optimization Clustering Techniques on Register Unemployment Data Carlos Balsa, Alcina Nunes, and Elisa Barros	19
Web Based Application for Home Care Visits' Optimizationof Health Professionals' Teams of Health CentersBruno Bastos, Tiago Heleno, António Trigo, and Pedro Martins	37
Cell-Free Layer Measurements in a Network with Bifurcating Microchannels Using a Global Approach David Bento, Diana Pinho, Ana I. Pereira, and Rui Lima	53
<b>Computational Comparison of Algorithms for a Generalization</b> <b>of the Node-Weighted Steiner Tree and Forest Problems</b> Raul Brás and J. Orestes Cerdeira	67
<b>Development of a Numerically Efficient Biodiesel Decanter Simulator</b> Ana S.R. Brásio, Andrey Romanenko, and Natércia C.P. Fernandes	85
<b>Determination of (0, 2)-Regular Sets in Graphs and Applications</b> Domingos M. Cardoso, Carlos J. Luz, and Maria F. Pacheco	107
A Multiobjective Electromagnetism-Like Algorithm with Improved Local Search Pedro Carrasqueira, Maria João Alves, and Carlos Henggeler Antunes	123
A Routing/Assignment Problem in Garden Maintenance Services J. Orestes Cerdeira, Manuel Cruz, and Ana Moura	145

A Column Generation Approach to the Discrete Lot Sizing and Scheduling Problem on Parallel Machines António J.S.T. Duarte and J.M.V. Valério de Carvalho	157
<b>A Tool to Manage Tasks of R&amp;D Projects</b> Joana Fialho, Pedro Godinho, and João Paulo Costa	171
An Exact and a Hybrid Approach for a Machine Scheduling Problem with Job Splitting Luís Florêncio, Carina Pimentel, and Filipe Alvelos	191
<b>Testing Regularity on Linear Semidefinite Optimization Problems</b> Eloísa Macedo	213
<b>Decompositions and a Matheuristic for a Forest Harvest</b> <b>Scheduling Problem</b> Isabel Martins, Filipe Alvelos, and Miguel Constantino	237
A Routing and Waste Collection Case-Study Karine Martins, Maria Cândida Mourão, and Leonor Santiago Pinto	261
<b>Exact Solutions to the Short Sea Shipping Distribution Problem</b> Ana Moura and Jorge Oliveira	277
A Consumption-Investment Problem with a Diminishing Basket of Goods Abdelrahim S. Mousa, Diogo Pinheiro, and Alberto A. Pinto	295
Assessing Technical and Economic Efficiency of the Artisanal Dredge Fleet in the Portuguese West Coast M.M. Oliveira, A.S. Camanho, and M.B. Gaspar	311
Production Planning of Perishable Food Products by Mixed-Integer Programming Maria João Pires, Pedro Amorim, Sara Martins, and Bernardo Almada-Lobo	331
Sectors and Routes in Solid Waste Collection Ana M. Rodrigues and J. Soeiro Ferreira	353
Solving Multilocal Optimization Problems with Parallel Stretched Simulated Annealing José Rufino and Ana I. Pereira	377
Efficiency and Productivity Assessment of Wind Farms Clara Bento Vaz and Ângela Paula Ferreira	407

Contents

Multi-period and Multi-product Inventory Management	
Model with Lateral Transshipments	425
Joaquim Jorge Vicente, Susana Relvas,	
and Ana Paula Barbosa Póvoa	
Periodic Versus Non-periodic Multipurpose Batch Plant	
Scheduling: A Paint Industry Case Study	445
Miguel Vieira, Tânia Pinto-Varela, and Ana Paula Barbosa-Póvoa	