

Springer Proceedings in Mathematics & Statistics

Abdeljalil Nachaoui
Abdelilah Hakim
Amine Laghrib *Editors*

Mathematical Control and Numerical Applications

JAN013, Khouribga, Morocco, February
22–24, 2021

 Springer

**Springer Proceedings in Mathematics &
Statistics**

Volume 372

This book series features volumes composed of selected contributions from workshops and conferences in all areas of current research in mathematics and statistics, including operation research and optimization. In addition to an overall evaluation of the interest, scientific quality, and timeliness of each proposal at the hands of the publisher, individual contributions are all refereed to the high quality standards of leading journals in the field. Thus, this series provides the research community with well-edited, authoritative reports on developments in the most exciting areas of mathematical and statistical research today.

More information about this series at <http://www.springer.com/series/10533>

Abdeljalil Nachaoui · Abdelilah Hakim ·
Amine Laghrib
Editors

Mathematical Control and Numerical Applications

JANO13, Khouribga, Morocco, February
22–24, 2021

 Springer

Editors

Abdeljalil Nachaoui
Laboratoire de Mathématiques Jean Leray
Université de Nantes
Nantes, France

Abdelilah Hakim
Département Mathématiques
Université Cadi Ayyad
Marrakech, Morocco

Amine Laghrib
FST Béni Mellal
Université Sultan Moulay Slimane
Béni Mellal, Morocco

ISSN 2194-1009 ISSN 2194-1017 (electronic)
Springer Proceedings in Mathematics & Statistics
ISBN 978-3-030-83441-8 ISBN 978-3-030-83442-5 (eBook)
<https://doi.org/10.1007/978-3-030-83442-5>

Mathematics Subject Classification: 49M37, 68Q99, 49-06

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Switzerland AG 2021

This work is subject to copyright. All rights are solely and exclusively licensed 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, expressed 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.

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

Preface

This book contains a collection of selected papers presented at the *Numerical Analysis and Optimization Days* (JANO13), held in Khouribga, Morocco, from 22 to 24 February 2021. The book focuses on topics related to mathematical control and numerical applications. This volume covers new trends and advances in several very important fields of mathematical modelling and recent developments in new numerical approximation methods. The relevance of these topics is particularly related to the study of approximation parameters, sources separation and partial differential equations (PDEs) approximations related to image processing applications. All contributing authors are eminent researchers and scholars in their respective fields, hailing from around the world. The information given in this book will be of value to the work of researchers, scientists and engineers in the fields of both academia and industry.

Nantes, France
Marrakech, Morocco
Béni Mellal, Morocco

Abdeljalil Nachaoui
Abdelilah Hakim
Amine Laghrib

Contents

VRP with Flexible Time Windows Using the ALNS Metaheuristic Algorithm	1
Fatah Labdiad, Mehdi Nasri, Hamza Khalfi, and Imad Hafidi	
VRPTW: From Mathematical Models to Computing Science Tools	13
Nasri Mehdi, Metrane Abdelmoutaib, and Hafidi Imad	
An Anisotropic PDE for Multi-frame Super-Resolution Image Reconstruction	29
Idriss El Mourabit, Abdelilah Hakim, and Amine Laghrib	
Acceleration of the KMF Algorithm Convergence to Solve the Cauchy Problem for Poisson’s Equation	43
Abdeljalil Nachaoui, Fatima Aboud, and Mourad Nachaoui	
Identification of Genuine from Fake Banknotes Using an Enhanced Machine Learning Approach	59
S. Lyaqini and M. Nachaoui	
Identification of Robin Coefficient in Elliptic Problem by a Coupled Complex Boundary Method	71
L. Afraites and A. Oulmelk	
A New Space-Variant Optimization Approach for Image Segmentation	87
M. Nachaoui, A. Laghrib, and M. Hakim	
A Lagrangian Mixed Finite Elements Method for Advection-Diffusion Equations	99
Youness Mezzan and Moulay Hicham Tber	
Adaptation by Nash Games in Gradient-Based Multi-objective/Multi-disciplinary Optimization	107
J.-A. Désidéri	

Blind Noisy Mixture Separation for Dependent Sources	135
A. Ghazdali, A. Metrane, and A. Ourdou	
Blind Separation of Dependent Sources Using Copula	151
A. Ourdou, A. Ghazdali, and A. Metrane	