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Volume 79

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Roderick Melnik • Roman Makarov • Jacques Belair
Editors

Recent Progress and Modern Challenges in Applied Mathematics, Modeling and Computational Science



The Fields Institute for Research
in the Mathematical Sciences



Springer

Editors

Roderick Melnik
Department of Mathematics
and MS2Discovery Interdisciplinary
Research Institute
Wilfrid Laurier University
Waterloo, ON, Canada

Roman Makarov
Department of Mathematics
and MS2Discovery Interdisciplinary
Research Institute
Wilfrid Laurier University
Waterloo, ON, Canada

Jacques Belair
Departement de Mathematiques
Universite de Montreal
Montreal, QC, Canada

ISSN 1069-5265

Fields Institute Communications

ISBN 978-1-4939-6968-5

DOI 10.1007/978-1-4939-6969-2

ISSN 2194-1564 (electronic)

ISBN 978-1-4939-6969-2 (eBook)

Library of Congress Control Number: 2017943956

Mathematics Subject Classification (2010): 15-XX, 34-XX, 35-XX, 37-XX, 60-XX, 45-XX, 49-XX, 62-XX, 65-XX, 68-XX, 74-XX, 76-XX, 91-XX, 92-XX

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Cover illustration: Drawing of J.C. Fields by Keith Yeomans

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer Science+Business Media LLC

The registered company address is: 233 Spring Street, New York, NY 10013, U.S.A.

Preface

The application of mathematics and statistics in the age of computational science and engineering has transformed our society and has revolutionized the world we live in. Being some of the oldest cultural achievements of mankind, nowadays these disciplines are intrinsic part of our daily life through our activities and technologies, ranging from our banking and investment systems to new sophisticated electronic devices, and to our civil infrastructure and environment.

These disciplines continuously grow at their frontiers though new areas of applications, new theories, and new tools provided by mathematical and statistical models. As a result, they continue representing the core of human knowledge critical for new discoveries and innovation, our well-being, and our economic prosperity.

There has been a long and rich interplay between mathematics and statistics on the one hand and other disciplines on the other, resulting in their fruitful enrichments. With ever-expanding interdisciplinary horizons of applied mathematics and statistics, we see new progress and modern challenges in their development. This book is about such progress and challenges in applied mathematics, modelling, and computational science.

Today, mathematical and statistical models are applied in natural and social sciences, industry and technology, medicine and finance. They are at the heart of a multitude of human activities, allowing connecting such activities in a modern world, where our communication gets better, faster, and cheaper also due to mathematics-based models. They substantially contribute to our better understanding of complex systems and networks whose components interact in a dynamic manner. Furthermore, mathematics-based computational technologies enable us detailed simulations of complex systems in the areas where the knowledge about such systems has been limited until very recently. Many such systems are functioned in a competitive, and often uncertain, environment. Therefore, the development of mathematical and statistical based methodologies of uncertainty quantification, as well as addressing other associated challenges, is essential.

Along with more traditional applications of mathematics and statistics in physics and engineering, we are witnessing now substantial contributions of these disciplines to new breakthroughs in biology and medicine, finance, and social sciences.

Equally important, mathematical and statistical models allow us to develop new important insight and better understanding of environmental and ecological sustainability in our dynamic and complex world.

This book provides details on recent progress and challenges in selected areas of applied mathematics, modelling, and computational science. It contains 14 chapters which open to the reader details on state-of-the-art achievements in these selected areas. The book provides a balance between fundamental theoretical and applied developments, emphasizing interdisciplinary nature of modern trends in these areas.

Written by 27 experts in their respective fields, the book is aimed at researchers in academia, practitioners, and graduate students. It can serve as a reference in the diverse selected areas of applied mathematics, modelling, and computational science. The book promotes interdisciplinary collaborations in addressing new challenges in these areas.

We are thankful to the referees of this volume for their invaluable help and suggestions. We are also very grateful to the Springer editorial team, and in particular to Dahlia Fisch, for their highly professional support.

Waterloo, ON, Canada
Waterloo, ON, Canada
Montreal, QC, Canada

Roderick Melnik
Roman Makarov
Jacques Belair

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