Springer Proceedings in Mathematics & Statistics

Mohd Hafiz Mohd
Md Yushalify Misro
Syakila Ahmad
Doanh Nguyen Ngoc *Editors*

Modelling, Simulation and Applications of Complex Systems

CoSMoS 2019, Penang, Malaysia, April 8–11, 2019

Springer

Springer Proceedings in Mathematics & Statistics

Volume 359

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

Mohd Hafiz Mohd · Md Yushalify Misro ·
Syakila Ahmad · Doanh Nguyen Ngoc
Editors

Modelling, Simulation and Applications of Complex Systems

CoSMoS 2019, Penang, Malaysia, April 8–11, 2019

Springer

Editors
Mohd Hafiz Mohd
School of Mathematical Sciences
Universiti Sains Malaysia
Penang, Malaysia

Md Yushalify Misro
School of Mathematical Sciences
Universiti Sains Malaysia
Penang, Malaysia

Syakila Ahmad
School of Mathematical Sciences
Universiti Sains Malaysia
Penang, Malaysia

Doanh Nguyen Ngoc
Department of Science and Technology
Thuyloi University
Hanoi, Vietnam

ISSN 2194-1009 ISSN 2194-1017 (electronic)
Springer Proceedings in Mathematics & Statistics
ISBN 978-981-16-2628-9 ISBN 978-981-16-2629-6 (eBook)
https://doi.org/10.1007/978-981-16-2629-6

Mathematics Subject Classification: 92-10, 76-10, 93A16, 68T09, 90-10

© The Editor(s) (if applicable) and The Author(s), under exclusive license
to Springer Nature Singapore Pte Ltd. 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 Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

This volume collects research papers and survey articles of participants and speakers in the Workshop on Complex Systems Modelling and Simulation 2019 (CoSMoS 2019): IoT and Big Data Integration, which was held in Penang, Malaysia, from 8–11 April 2019. The event was jointly organized by the School of Mathematical Sciences, Universiti Sains Malaysia (USM), Water Resource and Disaster Management (WARM) Vietnam, South East Asia Centre of Unité de Modélisation Mathématique et Informatique des Systèmes Complexes (UMMISCO France-Vietnam), the French Research Institute for Development (IRD) and Thuyloi University, Vietnam. CoSMoS 2019 had also attracted international delegates and participants from across the globe such as Japan, French, Bangladesh, Nigeria, Egypt, China, Indonesia, the Philippines, Myanmar, Vietnam and Malaysia.

The main topics highlighted during this international event were complex systems and agent-based modelling (ABM) incorporating elements of big data analytics and also Internet of things (IoT). Big data methods are often employed to discover potentially interesting patterns in large data sets, while ABM is an approach to investigate complex systems that arise in different real-life situations such as biology, engineering and socio-economic problems. This modelling framework often concentrates on the interactions of heterogeneous agents such as people, animals, vehicles and other entities, and sometimes interesting insights can emerge from the behaviours and also interactions of these agents at an individual scale. During this workshop, the potential of combining big data methods and IoT with those of ABM techniques was discussed in order to make a prediction about complex (biological, physical or engineering) systems and to support the decision-making process. One of the main targets in CoSMoS 2019 was to employ complex systems and ABM techniques together with big data and IoT approaches in order to solve the distinct problems faced by the local community and other parts of the world. Among the issues discussed during this workshop were transportation, agriculture and other real-life problems.

Consistent with the themes of CoSMoS 2019, the Springer PROMS volume entitled “Modelling, Simulation and Applications of Complex Systems - CoSMoS 2019, Penang, Malaysia, 8–11 April 2019” is put together and specially designed to

highlight some significant research results on broad disciplinary areas of complex systems. This edited volume takes into account a multidisciplinary approach in complex systems analysis that will encourage the transfer of ideas and methodology from modelling and simulation fields to the other areas of knowledge (and vice versa). In fact, one of the main highlights of this book is on the practical aspects of complex systems analysis in solving daily life problems faced by the local communities, government policy makers, industries and other relevant parties. Special attention is given to various applications on the techniques of complex systems in examining the transportation and mobility networks, social issues, epidemiology, ecological and conservation management, environmental problems, engineering and industrial applications. Many realistic biological and physical examples from recent research are employed in this book as illustrations. This book will be of interest to a broad readership including those interested in complex systems research and other related areas such as mathematical modelling, big data analytics, numerical simulation and agent-based modelling frameworks.

All authors contributing to the chapters in this book are in fact active researchers in the fields. The papers in this volume have also been through a rigorous refereeing process to ensure high scientific quality and standards. Through the publication of this edited volume, it will provide a platform for researchers from various scientific backgrounds the opportunity of disseminating recent research and knowledge in complex systems modelling and analysis. While other existing books in the fields often give more attention to a particular topic, this edited volume concentrates on the state-of-the-art research on complex systems in a broader sense. This is crucial to ensure that readers can grasp different concepts and ideas in complex systems research and also can demonstrate how the techniques from modelling and simulation and computational methods being employed to investigate the complexity of real-life systems. The development of new computational tools can improve our understanding of complex systems under consideration and highlight the emergent observations of complex biological and physical phenomena of interest.

We would like to thank all participants, course lecturers and invited speakers of the workshop for making the event a great success. Thanks to the organizing committee as well for their great efforts in conducting a well-run event. We are grateful to all the authors for their contributions to this volume and to all the reviewers for their timely and detailed feedbacks on the manuscripts. Additionally, we would like to extend our deepest gratitude to the School of Mathematical Sciences USM, WARM, UMMISCO, IRD France, Thuyloi University, Divison of Academic and International USM, Divison of Research and Innovation USM, Malaysian Mathematical Sciences Society (PERSAMA), Penang Convention and Exhibition Bureau (PCEB), Uni Paper Products Sdn. Bhd., Penang State Museum and Universiti Sains Malaysia Press for their valuable support and sponsorship to make the event successful.

April 2019

Organization

Workshop on Complex Systems Modelling and Simulation 2019 (CoSMoS 2019): IoT and Big Data Integration was jointly organized by the School of Mathematical Sciences, Universiti Sains Malaysia (USM), Water Resource and Disaster Management (WARM) Vietnam, South East Asia Centre of Unité de Modélisation Mathématique et Informatique des Systèmes Complexes (UMMISCO France-Vietnam), the French Research Institute for Development (IRD) and Thuyloi University, Vietnam.

USM Organizing Committee

Advisors

Hailiza Kamarulhaili
Ahmad Izani Md. Ismail

Chairperson

Mohd Hafiz Mohd

Deputy Chairperson

Majid Khan Majahar Ali

Secretary

Noor Saifurina Nana Khurizan

Assistant Secretary

Norshafira Ramli

Treasurer

Md Yushalify Misro

Assistant Treasurer

Yusnita Yusop

Programme Committee

Yazariah Mohd Yatim
Syakila Ahmad
Mohd Nadhir Ab Wahab
Ahmad Sufril Azlan Mohamed

Food and Accommodation Committee

Fam Pei Shan
Siti Zulaikha Mohd Jamaludin

Technical, Logistic and Transportation Committee

Norazrizal Aswad Abdul Rahman
Syed Mohamed Hussain Syed Osman

Publicity and Promotion Committee

Ong Wen Eng
Hartini Ahmad

Secretariat

Siti Amirah Abd Rahman
Ahmad Wafi Sahedan
Shamani Supramaniam
Ng Zhen Chuan
Nur Atiqah Jamaluddin

International Scientific Committee

Advisor

Alexis Drogoul

Chairperson

Nguyen Ngoc Doanh

Secretary

Le Huu Ton

Scientific Programme Committee (Course Speakers)

Benoit Gaudou
Kevin Chapuis
Tran Giang Son
Le Huu Ton

Contents

Editorial Notes 1
Mohd Hafiz Mohd, Md Yushalify Misro, Syakila Ahmad, and Doanh Nguyen-Ngoc

Agent-Based Modelling (ABM) in Complex Systems

Simulation of Japanese National Diet Members Election System Using Agent-Based Modeling 9
Satoshi Takatani and Hirohide Haga

Modelling the Dilution and Amplification Effects on Sin Nombre Virus (SNV) in Deer Mouse in GAMA 1.8 27
Lloyd W. F. Lee and Mohd Hafiz Mohd

Experimenting the Impact of Pedestrianisation on Urban Pollution Using Tangible Agent-Based Simulations: Application to Hoan Kiem District, Hanoi, Vietnam 43
Arthur Brugière, Minh Duc Pham, Kevin Chapuis, Alexis Drogoul, Benoit Gaudou, Arnaud Grignard, Nicolas Marilleau, and Nguyen-Huu Tri

An Agent-Based Co-modeling Approach to Simulate the Evacuation of a Population in the Context of a Realistic Flooding Event: A Case Study in Hanoi (Vietnam) 79
Kevin Chapuis, Taha Amine Elwaqoudi, Arthur Brugière, Eric Daudé, Alexis Drogoul, Benoit Gaudou, Doanh Nguyen-Ngoc, Huynh Quang Nghi, and Jean-Daniel Zucker

Agent Based Modelling Using GAMA 1.8 with Applications to Biological System in Epidemiology 109
Lloyd W. F. Lee and Mohd Hafiz Mohd

Deterministic Modelling and Simulation of Complex Systems

Mathematical Analysis of Fasciola Epidemic Model with Treatment and Quarantine 133
Mouhamadou Diaby, Oumar Diop, Estelle Nassouri, Abdou Sène, and Mariama Sène

Control, Sensitivity and Identification of a Cardiovascular-Respiratory System Model 151
Pio Gabrielle B. Calderon, Lean V. Palma, Franz Kappel, and Aurelio A. de los Reyes V

Cytotoxic Activity of *Raphanus sativus* Linn. on Selected Cancer Cell Lines and Mechanistic Pathways Predicted Through Mathematical Modeling 175
Angelyn Lao, Jan Marie Claire Edra, Kathleen Dane Talag, Daisylyn Senna Tan, Glenn Oyong, Marissa Noel, Ma. Luisa Enriquez, and Maria Carmen Tan

Bifurcation Analysis of a Tuberculosis Model with the Risk of Re-infection 197
Fatima Sulayman, Mohd Hafiz Mohd, and Farah Aini Abdullah

Managing Regime Shift in Lake Systems by Modelling and Simulation 215
Chai Jian Tay, Su Yean Teh, Hock Lye Koh, Mohd Hafiz Mohd, and Zhiming Zhang

Stability Analysis of Magnetohydrodynamic Mixed Convection Flow and Heat Transfer over a Moving Flat Plate in Ferrofluids with Suction and Slip Effects 233
Norshafira Ramli and Syakila Ahmad

Data Science and Optimization of Complex Systems

Modeling and Analysis of the Dengue Activity in Baguio City Using Two-Mode and One-Mode Networks 253
Rosel R. Oryan, Joel M. Addawe, and Donnabel Tubera-Panes

Spatio-Temporal Distribution of Dengue Infections in Baguio City, Philippines 273
Louie Ville A. Balino, Kenneth S. Caasi, and Rizavel C. Addawe

Spatio-Temporal Analysis of Measles Cases in Baguio City, Philippines from 2010–2018 283
Rizavel Addawe, Gervy Marie Angeles, and Maricar Balolong

Spatiotemporal Analysis of Typhoid Cases in Baguio City, Philippines 293
Nheil Ignacio, Roberto Liwag, and Rizavel Addawe

Chaotic Time Series Prediction Using Random Fourier Feature Kernel Least Mean Square Algorithm with Adaptive Kernel Size 309
Noor A. Ahmad and Shazia Javed

A Robust DEA Model to Handle the Uncertainty in Production Trade-Offs 331
Rokhsaneh Yousef Zehi and Noor Saifurina Nana Khurizan

An EPQ Model for Delayed Deteriorating Items with Two-Phase Production Period, Variable Demand Rate and Linear Holding Cost 351
Mustapha Lawal Malumfashi, Mohd Tahir Ismail, Babangida Bature, Dari Sani, and Majid Khan Majahar Ali

An EPQ Model for Delayed Deteriorating Items with Variable Production Rate, Two-Phase Demand Rates and Shortages 381
Mustapha Lawal Malumfashi, Mohd Tahir Ismail, Amirah Rahman, Dari Sani, and Majid Khan Majahar Ali

Binary Decision for Discretionary Lane Changing by Time-Effects Factors 405
Md. Mijanoor Rahman, Mohd. Tahir Ismail, Ahmad Farhan Mohd Sadullah, Noor Saifurina Nana Khurizan, and Majid Khan Majahar Ali

Lane Changing Effects on Surrounding Vehicles by Incorporating the Risk Factors 425
Md. Mijanoor Rahman, Mohd. Tahir Ismail, and Majid Khan Majahar Ali