

# Advances in Intelligent Systems and Computing

Volume 947

## Series Editor

Janusz Kacprzyk, Systems Research Institute, Polish Academy of Sciences,  
Warsaw, Poland

## Advisory Editors

Nikhil R. Pal, Indian Statistical Institute, Kolkata, India

Rafael Bello Perez, Faculty of Mathematics, Physics and Computing,  
Universidad Central de Las Villas, Santa Clara, Cuba

Emilio S. Corchado, University of Salamanca, Salamanca, Spain

Hani Hagras, School of Computer Science and Electronic Engineering,  
University of Essex, Colchester, UK

László T. Kóczy, Department of Automation, Széchenyi István University,  
Gyor, Hungary


Vladik Kreinovich, Department of Computer Science, University of Texas  
at El Paso, El Paso, TX, USA

Chin-Teng Lin, Department of Electrical Engineering, National Chiao  
Tung University, Hsinchu, Taiwan

Jie Lu, Faculty of Engineering and Information Technology,  
University of Technology Sydney, Sydney, NSW, Australia

Patricia Melin, Graduate Program of Computer Science, Tijuana Institute  
of Technology, Tijuana, Mexico

Nadia Nedjah, Department of Electronics Engineering, University of Rio de Janeiro,  
Rio de Janeiro, Brazil

Ngoc Thanh Nguyen , Faculty of Computer Science and Management,  
Wrocław University of Technology, Wrocław, Poland

Jun Wang, Department of Mechanical and Automation Engineering,  
The Chinese University of Hong Kong, Shatin, Hong Kong

The series “Advances in Intelligent Systems and Computing” contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing such as: computational intelligence, soft computing including neural networks, fuzzy systems, evolutionary computing and the fusion of these paradigms, social intelligence, ambient intelligence, computational neuroscience, artificial life, virtual worlds and society, cognitive science and systems, Perception and Vision, DNA and immune based systems, self-organizing and adaptive systems, e-Learning and teaching, human-centered and human-centric computing, recommender systems, intelligent control, robotics and mechatronics including human-machine teaming, knowledge-based paradigms, learning paradigms, machine ethics, intelligent data analysis, knowledge management, intelligent agents, intelligent decision making and support, intelligent network security, trust management, interactive entertainment, Web intelligence and multimedia.

The publications within “Advances in Intelligent Systems and Computing” are primarily proceedings of important conferences, symposia and congresses. They cover significant recent developments in the field, both of a foundational and applicable character. An important characteristic feature of the series is the short publication time and world-wide distribution. This permits a rapid and broad dissemination of research results.

**\*\* Indexing: The books of this series are submitted to ISI Proceedings, EI-Compendex, DBLP, SCOPUS, Google Scholar and Springerlink \*\***

More information about this series at <http://www.springer.com/series/11156>

Mohammad S. Obaidat · Tuncer Ören ·  
Floriano De Rango  
Editors

# Simulation and Modeling Methodologies, Technologies and Applications

8th International Conference, SIMULTECH 2018,  
Porto, Portugal, July 29–31, 2018,  
Revised Selected Papers

 Springer

*Editors*

Mohammad S. Obaidat  
King Abdullah II School of Information  
Technology  
University of Jordan  
Amman, Jordan

Nazarbayev University  
Astana, Kazakhstan

Floriano De Rango  
University of Calabria  
Rende, Cosenza, Italy

Tuncer Ören  
School of Electrical Engineering  
and Computer Science  
University of Ottawa  
Ottawa, ON, Canada

ISSN 2194-5357                      ISSN 2194-5365 (electronic)  
Advances in Intelligent Systems and Computing  
ISBN 978-3-030-35943-0              ISBN 978-3-030-35944-7 (eBook)  
<https://doi.org/10.1007/978-3-030-35944-7>

© Springer Nature Switzerland AG 2020

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, 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

The present book includes extended and revised versions of a set of selected papers from the 8th International Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH 2018), held in Porto, Portugal, in the period July 29–31, 2018.

SIMULTECH 2018 received 83 paper submissions from 29 countries, of which 11% were included in this book. The papers were selected by the event chairs, and their selection is based on a number of criteria that includes the reviews and suggested comments provided by the program committee members, the session chairs' assessments and also the program chairs' global view of all papers included in the technical program. The authors of selected papers were then invited to submit a revised and extended version of their papers having at least 30% new material.

The purpose of the 8th International Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH 2018) was to bring together researchers, engineers, applied mathematicians and practitioners interested in the advances and applications in the field of system simulation. Four simultaneous tracks were held, covering on one side domain-independent methodologies and technologies and on the other side practical work developed in specific application areas. The specific topics listed under each of these tracks highlight the interest of this conference in aspects related to computing, including conceptual modeling, agent-based modeling and simulation, interoperability, ontologies, knowledge-based decision support, Petri nets, business process modeling and simulation, among others.

The papers selected to be included in this book contribute to the understanding of relevant trends of current research on simulation tools and platforms, formal methods, as well as complex system modeling and simulation. The readers can find contributions of simulation in business process analysis and risk management, Internet of things, advanced material science and fuel cell design. Formal method contributions include visual password systems, co-simulation of complex subsystems, heating system application of feedback linearization for MTI systems in a tensor framework and iterative construction of complete Lyapunov functions.

We would like to thank all the authors for their contributions as well as to the reviewers who have helped ensuring the quality of this publication. We also thank the staff of INTICCC and Springer for their good efforts and cooperation.

July 2018

Mohammad S. Obaidat  
Tuncer Ören  
Floriano De Rango

# Organization

## Conference Chair

Mohammad S. Obaidat

University of Jordan, Jordan, and Nazarbayev  
University, Kazakhstan

## Program Chairs

Tuncer Ören (Honorary)  
Floriano De Rango

University of Ottawa, Canada  
University of Calabria, Italy

## Program Committee

Nael Abu-Ghazaleh  
Lyuba Alboul  
Mikulas Alexik  
Carlos Argáez  
Gianfranco Balbo  
Isaac Barjis  
Martin Benedikt  
Mohamed Bettaz  
Louis Birta  
Wolfgang Borutzky

University of California, Riverside, USA  
Sheffield Hallam University, UK  
University of Zilina, Slovak Republic  
University of Iceland, Iceland  
University of Torino, Italy  
City University of New York, USA  
Technische Universität Graz, Austria  
Philadelphia University, Jordan  
University of Ottawa, Canada  
Bonn-Rhein-Sieg University of Applied  
Sciences, Germany  
University of Patras and CTI&P Diophantus,  
Greece  
INESC TEC, Faculdade de Engenharia,  
Universidade do Porto, Portugal  
Computer Architecture Group, University  
Carlos III of Madrid, Spain  
Politecnico di Milano, Italy  
University of Buenos Aires, Argentina

Christos Bouras

António Brito

Jesus Carretero

Francesco Casella  
Rodrigo Castro

|                        |  |
|------------------------|--|
| Srinivas Chakravarthy  | Kettering University, USA  |
| Franco Cicirelli       | Università della Calabria, Italy   |
| Tanja Clees            | Fraunhofer Institute for Algorithms and Scientific Computing (SCAI), Germany           |
| Flavio Correa da Silva | University of Sao Paulo, Brazil  |
| Andrea D'Ambrogio      | Università di Roma "Tor Vergata", Italy  |
| Guyh Dituba Ngoma      | Université du Québec en Abitibi-Témiscamingue, Canada                                  |
| Karim Djemame          | University of Leeds, UK  |
| Atakan Dogan           | Anadolu University, Turkey   |
| Julie Dugdale          | Laboratoire d'Informatique de Grenoble, France   |
| Dirk Eisenbiegler      | University of Furtwangen, Germany  |
| Sabeur Elkosantini     | University of Monastir, Tunisia  |
| Georg Engel            | AEE - Institute for Sustainable Technologies, Austria                                  |
| Zuhal Erden            | Atılım University, Turkey  |
| Denis Filatov          | Institute of Physics of the Earth, Russian Academy of Sciences, Russian Federation     |
| Jason Friedman         | Tel Aviv University, Israel  |
| Marco Furini           | Università di Modena e Reggio Emilia, Italy  |
| José Manuel Galán      | Universidad de Burgos, Spain   |
| Petia Georgieva        | University of Aveiro, Portugal   |
| Charlotte Gerritsen    | Vrije Universiteit Amsterdam, the Netherlands  |
| John Goulermas         | University of Liverpool, UK  |
| Alexandra Grancharova  | University of Chemical Technology and Metallurgy, Bulgaria                             |
| Francisco Grimaldo     | Universitat de València, Spain   |
| Mykola Gusti           | International Institute for Applied Systems Analysis, Austria                          |
| Maamar Hamri           | Laboratoire d'Informatique et Systèmes, France   |
| Cathal Heavey          | University of Limerick, Ireland  |
| Monika Heiner          | Brandenburg University of Technology Cottbus, Germany                                  |
| Tsan-Sheng Hsu         | Institute of Information Science, Academia Sinica, Taiwan                              |
| Xiaolin Hu             | Georgia State University, USA  |
| Eric Innocenti         | IUT DE CORSE - University of Corsica, France   |
| Nobuaki Ishii          | Kanagawa University, Japan   |
| Mhamed Itmi            | INSA Rouen, France   |
| Syed Waqar ul Qounain  | University of the Punjab, Pakistan   |
| Jaffry                 |  |
| Emilio Jiménez Macías  | Universidad de La Rioja, Spain   |
| Nina Kargapolova       | Institute of Computational Mathematics and Mathematical Geophysics, Russian Federation |
| Peter Kemper           | College of William and Mary, USA   |



|                           |  |
|---------------------------|--|
| Juš Kocijan               | Jozef Stefan Institute, Slovenia   |
| Petia Koprinkova-Hristova | IICT - Bulgarian Academy of Sciences, Bulgaria   |
| Vladik Kreinovich         | University of Texas at El Paso, USA  |
| Claudia Krull             | Otto von Guericke University Magdeburg,<br>Germany   |
| Jean Le Fur               | IRD (Inst. Res. Development), France   |
| Willem le Roux            | CSIR, South Africa   |
| Pierre L'Ecuyer           | Universite de Montreal, Canada   |
| Mike Lees                 | University of Amsterdam, the Netherlands   |
| Alberto Leva              | Politecnico di Milano, Italy   |
| Richard Lipka             | University of West Bohemia, Czech Republic   |
| Antonio Lopes             | University of Porto, Portugal  |
| Maria Celia Lopes         | COPPE-UFRJ, Brazil   |
| José Machado              | Institute of Engineering, Polytechnic of Porto,<br>Portugal                                  |
| Maciej Malawski           | AGH University of Science and Technology,<br>Poland  |
| Andrea Marin              | University of Venice, Italy  |
| Carla Martin-Villalba     | UNED, Spain  |
| Moreno Marzolla           | University of Bologna, Italy   |
| Radek Matušu              | Tomas Bata University in Zlin, Czech Republic  |
| Roger McHaney             | Kansas State University, USA   |
| Nuno Melão                | Instituto Politécnico de Viseu, Escola Superior de<br>Tecnologia e Gestão de Viseu, Portugal |
| Adel Mhamdi               | RWTH Aachen University, Germany  |
| Bozena Mielczarek         | Wroclaw University of Science Technology,<br>Poland  |
| Vikram Mittal             | United States Military Academy, USA  |
| Cristina Montaña Sales    | Universitat Politècnica de Catalunya, Spain  |
| Roberto Montemanni        | IDSIA - Dalle Molle Institute for Artificial<br>Intelligence (USI-SUPSI), Switzerland        |
| Jairo Montoya-Torres      | Universidad de La Sabana, Colombia   |
| Bertie Müller             | Swansea University, UK   |
| Ivan Mura                 | Universidad de los Andes, Colombia   |
| Navonil Mustafee          | University of Exeter, UK   |
| Nazmun Nahar              | University of Jyvaskyla, Finland, and University<br>of Tartu, Estonia                        |
| Angela Nebot              | Universitat Politècnica de Catalunya, Spain  |
| Bao Nguyen                | Defence R&D Canada and University of Ottawa,<br>Canada                                       |
| Lialia Nikitina           | Fraunhofer Institute for Algorithms and Scientific<br>Computing (SCAI), Germany              |
| James Nutaro              | Oak Ridge National Laboratory, USA   |
| Mohammad Obaidat          | University of Jordan, Jordan, and Nazarbayev<br>University, Kazakhstan                       |

|                        |   |
|------------------------|---|
| Sorin Olaru            | CentraleSupélec, France   |
| Paulo Oliveira         | Universidade de Tras-os-Montes e Alto Douro,<br>Portugal  |
| Feng Pan               | Liaoning Normal University, China   |
| Victor Parque          | Waseda University and Egypt-Japan University<br>of Science and Technology (E-JUST), Japan               |
| George Pavlidis        | “Athena” Research Centre, Greece  |
| Alessandro Pellegrini  | Sapienza University of Rome, Italy  |
| L. Felipe Perrone      | Bucknell University, USA  |
| Alexandre Petrenko     | Centre de Recherche Informatique de Montreal,<br>Canada   |
| Alexandr Petukhov      | Lobachevsky State University of Nizhni<br>Novgorod, Russian Federation                                  |
| Régis Plateaux         | SUPMECA, France   |
| Tomas Potuzak          | University of West Bohemia, Czech Republic  |
| Jacinto Quintero       | Universidad de Los Andes, Venezuela   |
| Mpho Raborife          | University of Johannesburg, South Africa  |
| Urvashi Rathod         | Symbiosis Centre for Information Technology<br>(SCIT), India  |
| Manuel Resinas         | Universidad de Sevilla, Spain   |
| Jerzy Respondek        | Silesian University of Technology, Poland   |
| M. Riazi               | Kuwait University, Kuwait   |
| José Risco-Martín      | Universidad Complutense de Madrid, Spain  |
| Oliver Rose            | Universität der Bundeswehr München<br>(University of the Federal Armed Forces<br>Munich), Germany       |
| Rosaldo Rossetti       | Laboratório de Inteligência Artificial e Ciência de<br>Computadores, LIACC/FEUP, Portugal               |
| Jaroslav Rozman        | Brno University of Technology, Czech Republic   |
| Katarzyna Rycerz       | Institute of Computer Science, AGH, Krakow,<br>Poland   |
| Jordi Sabater-Mir      | IIIA-CSIC, Spain  |
| Paulo Salvador         | Instituto de Telecomunicações, DETI, University<br>of Aveiro, Portugal                                  |
| Antonella Santone      | University of Molise, Italy   |
| Jean-François Santucci | SPE UMR CNRS 6134 - University of Corsica,<br>France  |
| Jefrey Smith           | Auburn University, USA  |
| Xiao Song              | Beihang University, China   |
| Yuri Sotskov           | United Institute of Informatics Problems of the<br>National Academy of Belarus, UIIP, Minsk,<br>Belarus |
| James Spall            | Johns Hopkins University, USA   |
| Giovanni Stea          | University of Pisa, Italy   |
| Mu-Chun Su             | National Central University, Taiwan   |

|                                  |   |
|----------------------------------|---|
| Nary Subramanian                 | The University of Texas at Tyler, USA   |
| Peter Summons                    | University of Newcastle, Australia  |
| Antuela Tako                     | Loughborough University, UK   |
| Halina Tarasiuk                  | Warsaw University of Technology, Poland   |
| Constantinos Theodoropoulos      | The University of Manchester, UK  |
| Mamadou Traoré                   | University of Bordeaux, France  |
| Klaus Troitzsch                  | University of Koblenz-Landau, Koblenz Campus,<br>Germany                            |
| Zhiying Tu                       | Harbin Institute of Technology, China   |
| Kay Tucci                        | Universidad de los Andes, Venezuela   |
| Adeline Uhrmacher                | University of Rostock, Germany  |
| Alfonso Urquia                   | Universidad Nacional de Educación a Distancia,<br>Spain                             |
| Durk-Jouke van der Zee           | University of Groningen, the Netherlands  |
| Svetlana<br>Vasileva-Boyadzhieva | Bulgarian Modeling and Simulation Association<br>(BULSIM), Bulgaria                 |
| Vladimír Veselý                  | Faculty of Information Technology, Brno<br>University of Technology, Czech Republic |
| Maria Viamonte                   | Instituto Superior de Engenharia do Porto,<br>Portugal                              |
| Manuel Villen-Altamirano         | Universidad de Malaga, Spain  |
| Friederike Wall                  | Alpen-Adria-Universität Klagenfurt, Austria   |
| Frank Werner                     | Otto-von-Guericke-Universität Magdeburg,<br>Germany                                 |
| Philip Wilsey                    | Univ. of Cincinnati, USA  |
| Kuan Yew Wong                    | Universiti Teknologi Malaysia, Malaysia   |
| Hui Xiao                         | Southwestern University of Finance<br>and Economics, China                          |
| Yiping Yao                       | National University of Defense Technology,<br>China                                 |
| Gregory Zacharewicz              | IMT Mines Ales, France  |
| František Zboril                 | Faculty of Information Technology,<br>Czech Republic                                |

### **Additional Reviewers**

|                          |   |
|--------------------------|---|
| Gökhan Cinar             | Eskisehir Osmangazi University, Turkey          |
| Tansu Filik              | Anadolu University, Turkey                      |
| Celal Kandemir           | Eskisehir Osmangazi Üniversitesi, Turkey        |
| Francesco Mercaldo       | National Research Council of Italy (CNR), Italy |
| Ezequiel Pecker-Marcosig | FIUBA, ICC, CONICET, Argentina                  |
| Lucio Santi              | Universidad de Buenos Aires, Argentina          |
| Long Wang                | Johns Hopkins University, USA                   |

## **Invited Speakers**

Juan M. Durán  
Janusz Kacprzyk

University of Stuttgart, Germany  
Systems Research Institute, Polish Academy  
of Sciences, Poland

Gabriel Wainer

Carleton University, Canada

# Contents

|   |            |
|---|------------|
| <b>Atomistic Modelling and Simulation of Transmission Electron Microscopy Images: Application to Intrinsic Defects of Graphene . . . . .</b>      | <b>1</b>   |
| Cyril Guedj, Léonard Jaillet, François Rousse, and Stéphane Redon   |            |
| <b>Using Simulation in Business Process Analysis and Risk Management: The Blood Bank Case Study . . . . .</b>                                     | <b>20</b>  |
| Ilaria Angela Amantea, Antonio Di Leva, and Emilio Sulis  |            |
| <b>An SDN/NFV Based Approach for Mobility Management in 5G Networks . . . . .</b>   | <b>39</b>  |
| N. Omheni, F. Zarai, B. Sadoun, and M. S. Obaidat   |            |
| <b>Dockemu: An IoT Simulation Framework Based on Linux Containers and the ns-3 Network Simulator — Application to CoAP IoT Scenarios. . . . .</b> | <b>54</b>  |
| Antón Román Portabales and Martín López Nores   |            |
| <b>Iterative Construction of Complete Lyapunov Functions: Analysis of Algorithm Efficiency. . . . .</b>   | <b>83</b>  |
| Carlos Argáez, Peter Giesl, and Sigurdur Hafstein   |            |
| <b>A Pre-step Stabilization Method for Non-iterative Co-Simulation and Effects of Interface-Jacobians Identification . . . . .</b>                | <b>101</b> |
| Simon Genser and Martin Benedikt  |            |
| <b>A Heating Systems Application of Feedback Linearization for MTI Systems in a Tensor Framework . . . . .</b>                                    | <b>126</b> |
| Kai Kruppa and Gerwald Lichtenberg  |            |
| <b>Syntactic Generation of Similar Pictures . . . . .</b>   | <b>153</b> |
| Nuru Jingili, Sigrid Ewert, and Ian Sanders   |            |

|  |     |
|--|-----|
| <b>Mathematical Modeling of Alkaline Methanol Oxidation for Design of Efficient Fuel Cells</b> ..... | 181 |
| Tanja Clees, Igor Nikitin, Lialia Nikitina, Sabine Pott, Ulrike Krewer, and Theresa Haisch           |     |
| <b>Author Index</b> .....  | 197 |