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Advances in Computing, Informatics, Networking and Cybersecurity

A Book Honoring Professor Mohammad S. Obaidat's Significant Scientific Contributions

Springer

Editors
Petros Nicopolitidis
Department of Informatics
Aristotle University of Thessaloniki
Thessaloniki, Greece

Laurence T. Yang
Department of Computer Science
St. Francis Xavier University
Antigonish, NS, Canada

Zhaolng Ning
Dalian University of Technology
Dalian, China

Sudip Misra
Department of Computer Science
and Engineering
Indian Institute of Technology
Kharagpur, West Bengal, India

Bernard Zeigler
Department of Electrical and Computer
Engineering
University of Arizona
Tucson, AZ, USA

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Preface

Information and Communication Technologies (ICTs) play an integral role in today's society. Four major driving pillars in the field are computing, which nowadays enables data processing in unprecedented speeds, informatics, which derives information stemming for processed data to feed relevant applications, networking which interconnects the various computing infrastructures and cybersecurity for addressing the growing concern for secure, private and lawful use of the ICT infrastructure and services.

These fields have proven to be essential for any nation to have a place in today's digital and knowledge economy era. COVID-19 has proven that these technologies and systems will be needed for the coming several decades and more. They are the air that other systems and fields breathe.

This book is written to honor Prof. Mohammad Salameh Obaidat's worldwide abundant, lasting and significant recognized technical contributions to the areas of computing, informatics, networking and cybersecurity. He is not only a worldwide researcher, academic, teacher, scholar, engineer and scientist, but also an international technical leader who also has served the international professional community in various aspects such as serving as President and Chair of Board of Directors of the Society for Modeling and Simulation International, SCS, chaired numerous international conferences, founded or Co-founded five international conferences, and given numerous keynote speeches all over the world. He received numerous awards for his worldwide technical contributions and leadership services from IEEE, SCS and other professional entities.

The present book aims to survey as well as introduce recent worldwide research and development efforts in the above-mentioned hot areas, present related case studies together with trends and challenges. These areas—computing, informatics, networking and cybersecurity—have received numerous technical contributions from the renowned worldwide scholar, Prof. Mohammad S. Obaidat, to whom the book is dedicated.

The chapters of the book have been written by worldwide experts in the respective fields. Despite the fact that there are different authors of these chapters, we managed book materials to be coherent so as to be easy to follow by readers.

The content organization is based on the four field categories reflected in the book title. The first part of the book is related to the area of computing. Chapter "Workload Scheduling in Fog and Cloud Environments: Emerging Concepts and Research Directions" addresses fog and cloud environments. It provides the necessary background in this field and presents an overview of the emerging concepts and techniques as well as exploring future research directions.

Chapter "A Comprehensive Survey of Estimator Learning Automata and Their Recent Convergence Results" addresses estimator learning automata algorithms. For almost three decades, the reported proofs of pursuit algorithms possessed a flaw, which is referred to as the claim of the "monotonicity" property. The chapter first records all the reported estimator algorithms and then provides a comprehensive survey of the proofs from a different perspective.

Chapter "Multimodal Data Fusion" studies multimodal data fusion algorithms from the aspects of incomplete modal analysis fusion, incremental modal clustering fusion, heterogeneous modal migration fusion and low-dimensional modal sharing fusion. A series of multimodal data fusion models and algorithms are designed.

Chapter "Efficient Parallel Implementation of Cellular Automata and Stencil Computations in Current Processors" discusses optimization of cellular automata (CA) implementations in current high-performance computational systems, focusing on those especially aimed at current processors, including hardware alternatives like GPUs, BTBs, different forms of parallelism such as instruction-level parallelism, thread-level parallelism, data-level parallelism, as well as software approaches like "if-else" statement elimination, loop unrolling, data pipelining and blocking.

Chapter "Smart Healthcare: Rough Set Theory in Predicting Heart Disease" discusses the use of discrete event system specification (DEVS) as the basic modeling and simulation framework for model-based system engineering methodology that supports the critical stages in top-down design of complex networks. Focusing on design of communication networks for emergency response, it shows how such networks pose challenges to current technologies that current simulators cannot address.

The second part covers research contributions in informatics and emerging applications. Chapter "Healthcare Patient Flow Modeling and Analysis with Timed Petri Nets" discusses rough-set-based methodologies for developing a predictive model for the occurrence of heart disease. Classification accuracy and explanatory power of the rough-set-based methods are compared with these for other machine learning languages and non-rule-based methods.

Chapter "Enabling and Enforcing Social Distancing Measures at Smart Parking Infrastructures Using Blockchain Technology in COVID-19" continues on applications in health care and proposes a method for patient flow modeling and analysis with timed Petri nets. Details of patient flow performance analysis based on stochastic timed Petri nets, such as the average patient waiting time, resource

constraints modeling, task durations modeling and patient flow hierarchical modeling that handles complexity, are discussed.

Chapter "Using DEVS for Full Life Cycle Model-Based System Engineering in Complex Network Design", motivated by the COVID-19 pandemic, proposes a method for enabling and enforcing social distancing measures at smart parking infrastructures using blockchain technology. It provides a practical model where blockchain technology is enforced to find solutions and to deal with the problems in maintaining social distancing at smart parking in pandemic outbreaks situations.

Chapter "Touchless Palmprint and Fingerprint Recognition" presents an overview of the various methods reported in the literature for touchless palmprint and fingerprint recognition; describing the corresponding acquisition methodologies and processing methods.

Chapter "A Survey of IoT Software Platforms" provides an in-depth survey of IoT software platforms. It proposes a broad evaluation scheme for IoT software platforms based on an analysis of the characteristics found in contemporary platforms that are surveyed.

The third part of the book is concerned with networking.

Chapter "FLER: Fuzzy Logic-Based Energy Efficient Routing for Wireless Sensor Networks" presents a fuzzy logic-based energy-efficient routing scheme for wireless sensor networks. The proposed approach chooses the optimal forwarder node, which is predicted with low energy consumption, high stability, low retransmission rate and low average transmission delay.

Chapter "Application of Device-to-Device Communication in Video Streaming for 5G Wireless Networks" presents one of the key-enabling technologies in 5G wireless networks, device-to-device (D2D) communication. It reviews work in the literature on D2D communication and its applications in video streaming and discusses an architecture that provides dynamic adaptive streaming over HTTP-based peer-to-peer (P2P) video streaming in cellular networks.

Chapter "5G Green Network" proposes a multi-user multi-antenna random cellular network model targeted to energy efficiency. A spectrum efficiency model and an energy efficiency model are presented based on the random cellular network model and the maximum achievable energy efficiency of the considered multi-user multi-antenna HCPP random cellular networks.

Chapter "Geocommunity Based Data Forwarding in Social Delay Tolerant Networks" investigates the problem of data forwarding in social-based delay-tolerant networks (DTNs). It also studies the existing location-based routing schemes and highlights the current challenges and future research direction for geocommunity-based routing in social delay-tolerant networks.

Chapter "Resource Allocation Challenges in the Cloud and Edge Continuum" considers bandwidth allocation and suggests modeling and architectural paradigms for integration of satellite communications and networking into the highly virtualized 5G wireless networks and the forthcoming 6G systems.

Chapter "Collaborative Caching Strategy in Content-Centric Networking" studies caching strategies in the content-centric networking (CCN). In order to efficiently and reasonably place contents in routers and reduce the transmission delay, it proposes a caching scheme based on on-path caching and off-path caching. In order to further reduce the energy consumption, it also proposes a caching scheme to minimize energy consumption.

Chapter "Blockchain-Based Software-Defined Vehicular Networks for Intelligent Transportation System Beyond 5G" discusses the integration of software-defined networking (SDN) and cloud computing over 5G mobile communication in vehicular networks. A programmable, efficient and controllable network architecture is introduced to achieve sustainable network development.

Chapter "Application Layer Protocols for Internet of Things" surveys application layer protocols for Internet of Things (IoT) covering also light-way protocols. A performance evaluation of the analyzed IoT application layer protocol is also provided.

Chapter "Resource Allocation in Satellite Networks—From Physical to Virtualized Network Functions" discusses resource allocation challenges in the cloud and edge continuum. It presents key computing technologies of the past and the present, along with related networking technologies. It continues by describing the important resource allocation challenges and concludes by formulating and evaluating a basic resource allocation problem for assigning application's workload in an edge–fog–cloud hierarchical infrastructure.

The fourth part of the book contains research contributions in cybersecurity.

Chapter "Secure D2D in 5G Cellular Networks: Architecture, Requirements and Solutions" reviews the security architecture, security requirements and existing solutions for the 5G D2D networks. It classifies various security challenges and requirements of a secure 5G D2D network and major research works according to their application scenarios. Finally, it discusses open related research issues.

Chapter "New Waves of Cyber Attacks in the Time of COVID19" surveys cyberattacks in relation to the COVID-19 pandemic crisis. The analysis covers different technical and socioeconomical aspects, and the needed countermeasures in response to such attacks are also evaluated.

Chapter "A Comparison of Performance of Rough Set Theory with Machine Learning Techniques in Detecting Phishing Attack" applies classical rough set analysis (CRSA) for detecting phishing attacks. It focuses primarily on comparing the classification performance of CRSA with the traditional machine learning (ML) tools.

Chapter "Towards Owner-Controlled Data Sharing" discusses some of the main problems related to allowing data owners to share their data with interested consumers in a controlled way in the context of digital data market. It illustrates some recent proposals for the specification and enforcement of the owners' requirements. It also reviews proposals addressing the issue of ensuring that data owners remain in control of their data.

Chapter "Emerging Role of Block Chain Technology in Maintaining the Privacy of Covid-19 Public Health Record is also influenced by the COVID-19 pandemic and in the context of blockchain technology. It introduces a related distributed protocol for handling the amount of potential data and the usage of distributed data provisions for maintaining the privacy of COVID-19 public health records in an effort to guarantee secure decentralized data record protection.

Chapter "Malware Forensics: Legacy Solutions, Recent Advances, and Future Challenges" covers the background of malware across different platforms, existing solutions and malware analysis techniques for malware prevention and detection, as well as recent advances in the malware domain using cutting-edge technologies and future directions.

Chapter "Security of Cyber-Physical-Social Systems: Impact of Simulation-Based Systems Engineering, Artificial Intelligence, Human Involvement, and Ethics" deals with cyber-physical-social systems. Sources of failures in cyber-physical-social systems and the fact that with increased connectedness, the systems become more vulnerable. Some possibilities to get prepared for unexpected conditions are discussed. The impact of human involvement is explained as sources of additional and severe problems.

Chapter "Machine Learning Methods for Enhanced Cyber Security Intrusion Detection System" discusses the origin and evolution of an intrusion detection system (IDS), followed by the classification of IDSs and the contribution of machine learning (ML) in the field. It briefs the prominent current works. An outline of the datasets frequently used for evaluation purposes is presented. Moreover, it describes the collaborative IDS that enhances the Big Data security and presents IDS research issues and challenges.

Chapter "5G Network Slicing Security" is concerned of 5G network slicing security. It introduces the technical background and architecture of 5G and explains the architecture of SDN/NFV and the threats to information security and privacy in 5G systems. It discusses network slicing security, including inter-slice and intra-slice security threats and also reviews security risks related to 5G network slicing and corresponding solutions identified by 3GP.

Chapter "A Security-Driven Scheduling Model for Delay-Sensitive Tasks in Fog Networks" proposes a security-driven scheduling model for delay-sensitive tasks in fog networks. The contribution of the proposed method is twofold: First is to provide the robust security service to the delay-sensitive tasks, and second is to enhance the performance of the system without violating the scheduling constraints of delay-sensitive tasks.

We are very thankful to all the authors of the chapters of this book, who have worked very hard to bring forward excellent-quality chapters to the aid of students, instructors, researchers and community practitioners. As the individual chapters of this book were written by different authors, the responsibility for the contents of each chapter lies with the respective authors.

We would also like to thank solicited chapter reviewers for their constructive suggestions. Many thanks to Springer Nature editors and editorial assistants for their outstanding work. We hope that this book will be a token of appreciation to the

abundant, lasting and original numerous contributions of our distinguished worldwide colleague, Prof. Mohammad S. Obaidat, who has been a first-class dedicated scholar, academic, researcher and teacher. Finally, we hope that the book will be a valuable reference for students, instructors, researchers, scientists, engineers and developers.

Thessaloniki, Greece — Petros Nicopolitidis
Kharagpur, India — Sudip Misra
Antigonish, Canada — Laurence T. Yang
Tucson, USA — Bernard Zeigler
Dalian, China — Zhaolng Ning

About Professor Mohammad S. Obaidat

Prof. Mohammad S. Obaidat (Fellow of IEEE 2005, Life Fellow of IEEE 2018) is an internationally known academic/researcher/scientist/ scholar. He received his Ph.D. degree in computer engineering with a minor in computer science from The Ohio State University, Columbus, USA. He has received extensive research funding and published to date (2019) about one thousand (1000) refereed technical articles. About half of them are journal articles, over 95 books and over 70 book chapters. He is Editor-in-Chief of three scholarly journals and an editor of many other international journals. He is the founding Editor-in-Chief of *Wiley Security and Privacy Journal*. Moreover, he is founder or co-founder of five international conferences.

Among his previous positions are Advisor to the President of Philadelphia University for Research, Development and Information Technology; President and Chair of Board of Directors of the Society for Molding and Simulation International, SCS; Senior Vice President of SCS; Dean of the College of Engineering at Prince Sultan University; Chair and tenured Professor at the Department of Computer and Information Science and Director of the MS Graduate Program in Data Analytics at Fordham university; Chair and tenured Professor of the Department of Computer Science and Director of the Graduate Program at Monmouth University; Tenured Full Professor at King Abdullah II School of Information Technology, University of Jordan; The PR

of China Ministry of Education Distinguished Overseas Professor at the University of Science and Technology Beijing, China; and an Honorary Distinguished Professor at the Amity University-A Global University. He is now the Founding Dean and Professor, College of Computing and Informatics at The University of Sharjah, UAE.

He has chaired numerous (over 175) international conferences and has given numerous (over 175) keynote speeches worldwide. He has served as ABET/CSAB evaluator and on IEEE CS Fellow Evaluation Committee. He has served as IEEE CS Distinguished Speaker/Lecturer and an ACM Distinguished Lecturer. Since 2004, he has been serving as an SCS Distinguished Lecturer. He received many best paper awards for his papers including ones from IEEE ICC, IEEE Globecom, AICSA, CITS, SPECTS and DCNET International conferences. He also received best paper awards from IEEE Systems Journal in 2018 and in 2019 (two best paper awards). In 2020, he received four best paper awards from IEEE Systems Journal. In 2021, he also received the IEEE Systems best paper award.

He also received many other worldwide awards for his technical contributions including: The 2018 IEEE ComSoc-Technical Committee on Communications Software Technical Achievement Award for contribution to Cybersecurity, Wireless Networks Computer Networks and Modeling and Simulation, SCS prestigious McLeod Founder's Award, Presidential Service Award, SCS Hall of Fame—Lifetime Achievement Award for his technical contribution to modeling and simulation and for his outstanding visionary leadership and dedication to increasing the effectiveness and broadening the applications of modeling and simulation worldwide. He also received the SCS Outstanding Service Award. He was awarded the IEEE CITS Hall of Fame Distinguished and Eminent Award.

He is a Life Fellow of IEEE and a Fellow of SCS.

Contents

Computing

Workload Scheduling in Fog and Cloud Environments: Emerging Concepts and Research Directions 3
Georgios L. Stavrinides and Helen D. Karatza

A Comprehensive Survey of Estimator Learning Automata and Their Recent Convergence Results 33
B. John Oommen, Xuan Zhang, and Lei Jiao

Multimodal Data Fusion 53
Zhikui Chen, Liang Zhao, Qiucen Li, Xin Song, and Jianing Zhang

Efficient Parallel Implementation of Cellular Automata and Stencil Computations in Current Processors 93
Fernando Diaz-del-Rio, Daniel Cagigas-Muñiz, Jose Luis Guisado-Lizar, and Jose Luis Sevillano-Ramos

A Comprehensive Review on Edge Computing: Focusing on Mobile Users 121
A. Dimou, C. Iliopoulos, E. Polytidou, S. K. Dhurandher, G. Papadimitriou, and P. Nicopolitidis

Informatics

Smart Healthcare: Rough Set Theory in Predicting Heart Disease 155
Arpit Singh, Subhas Chandra Misra, and Sameer Kumar

Healthcare Patient Flow Modeling and Analysis with Timed Petri Nets 181
Jiacun Wang

Enabling and Enforcing Social Distancing Measures at Smart Parking Infrastructures Using Blockchain Technology in COVID-19 205
Amtul Waheed, Jana Shafi, and P. Venkata Krishna

Using DEVS for Full Life Cycle Model-Based System Engineering in Complex Network Design 215
Abdurrahman Alshareef, Maria Julia Blas, Matias Bonaventura, Thomas Paris, Aznam Yacoub, and Bernard P. Zeigler

Touchless Palmprint and Fingerprint Recognition 267
Ruggero Donida Labati, Angelo Genovese, Vincenzo Piuri, and Fabio Scotti

A Survey of IoT Software Platforms 299
Konstantinos Astropekakis, Emmanouil Drakakis, Konstantinos Grammatikakis, and Christos Goumopoulos

Networking

FLER: Fuzzy Logic-Based Energy Efficient Routing for Wireless Sensor Networks 329
Thompson Stephan, S. Punitha, Achyut Shankar, and Naveen Chilamkurti

Application of Device-to-Device Communication in Video Streaming for 5G Wireless Networks 345
Ala'a Al-Habashna and Gabriel A. Wainer

5G Green Network 373
X. Ge, J. Yang, and J. Ye

Geocommunity Based Data Forwarding in Social Delay Tolerant Networks 421
Jagdeep Singh, Sanjay Kumar Dhurandher, and Isaac Woungang

Resource Allocation Challenges in the Cloud and Edge Continuum 443
Polyzois Soumplis, Panagiotis Kokkinos, Aristotelis Kretsis, Petros Nicopolitidis, Georgios Papadimitriou, and Emmanouel Varvarigos

Collaborative Caching Strategy in Content-Centric Networking 465
Shupeng Wang and Zhaolong Ning

Blockchain-Based Software-Defined Vehicular Networks for Intelligent Transportation System Beyond 5G 513
Yash Modi, Mihir Panchal, Jitendra Bhatia, and Sudeep Tanwar

Application Layer Protocols for Internet of Things 535
Abdon Serianni and Floriano De Rango

Resource Allocation in Satellite Networks—From Physical to Virtualized Network Functions 559
Franco Davoli and Mario Marchese

Cybersecurity

Secure D2D in 5G Cellular Networks: Architecture, Requirements and Solutions 583
Man Chun Chow and Maode Ma

New Waves of Cyber Attacks in the Time of COVID19 617
Izzat Alsmadi and Lo'ai Tawalbeh

A Comparison of Performance of Rough Set Theory with Machine Learning Techniques in Detecting Phishing Attack 631
Arpit Singh and Subhas C. Misra

Towards Owner-Controlled Data Sharing 651
Sabrina De Capitani di Vimercati, Sara Foresti, Giovanni Livraga, and Pierangela Samarati

Emerging Role of Block Chain Technology in Maintaining the Privacy of Covid-19 Public Health Record 673
Jana Shafi, Amtul Waheed, and P. Venkata Krishna

Malware Forensics: Legacy Solutions, Recent Advances, and Future Challenges 685
Farid Naït-Abdesselam, Asim Darwaish, and Chafiq Titouna

Security of Cyber-Physical-Social Systems: Impact of Simulation-Based Systems Engineering, Artificial Intelligence, Human Involvement, and Ethics 711
Tuncer Ören

Machine Learning Methods for Enhanced Cyber Security Intrusion Detection System 733
M Satheesh Kumar, Jalel Ben-Othman, K G Srinivasagan, and P Umarani

5G Network Slicing Security 755
Tin-Yu Wu and Tey Fu Jie

A Security-Driven Scheduling Model for Delay-Sensitive Tasks in Fog Networks 781
Surendra Singh and Sachin Tripathi