

Editorial

Applied Mathematics for 5th Generation (5G) and beyond Communication Systems

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1. Introduction

Mobile communication systems have a great importance in today's world. Since the introduction of the global system for mobile communications (GSM) in the early 1990s, up to today's more advanced 5th generation (5G) communications system, it has had an enormous impact on people's social lives. Its importance will continue to climb with new fields of application; for example, the Internet of things (IoT), Tactile Internet, ultra-reliable low latency communication (URLLC) with astonishingly high throughput. Such advanced communication systems are continually being introduced to live up to the great variety of applications and desires for new services. This development would have been impossible without the digitalization of communication systems, wherein mathematics played a vital supporting role. In fact, mathematics are the foundation of information and communication theory, the pathbreaker in the development of new transmission procedures, and an essential instrument in the planning and optimization of networks. For example, statistical theories and discrete mathematics are used in information theory; linear algebra, convex optimization and game theory are used in the development of new methods of transmission; and linear, combinatorial, and stochastic optimization are used in planning radio networks. Despite this immense progress, essential foundational issues and challenges for the implementation of machine intelligence in 5G and beyond communication systems are still to be determined. Examples include a network information theory based on machine learning (ML) techniques (such as supervised learning, unsupervised learning, federated learning, and reinforcement learning) for more complex multi-user 5G and beyond systems, a quantum information theory for miniaturized systems, a theory of self-organizing intelligent networks, and the development of new paradigms for the use of the cognitive radio networks. In all these cases, it is the collaboration of applied mathematics and the communications engineering that must deliver the essential contributions to the potential solutions.

In this Special Issue (SI) we focus on those applied mathematical models and methods that reflect the specific features of 5G and beyond communication systems that differ from past and present ones. We deliberate on diverse mathematical approaches for machine intelligence based on stochastic processes, queueing theory, statistics, stochastic geometry, and others.

2. Contributions and Thanking Note

As the Guest Editors (GEs), we are very grateful to all the researchers who have submitted their valuable contributions. We also want to express our gratitude to all reviewers and external editors from the Mathematics Journal for their valuable comments, remarks, suggestions and criticisms toward the improvement of the submitted papers. I hope that these research papers will be found to be of great interest by, and have a major impact on, the international scientific community. In this SI, several research articles



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were contributed, and we feel regret for the paper in which they appeared as rejected for publication. The rejection of their articles never meant that they did not contribute. Their works and contributions were indeed valuable, as most of the reviewers commented on their works. In total, 22 manuscripts were submitted to be considered for publication in this SI, of which 9 papers [1–9] were accepted and published, meaning that the acceptance rate was approximately 41%.

Furthermore, we anticipate, and we are confident, that these works will motivate other researchers to develop similar problems as well as to extend these topics to new research and to find new application fields. We want to thank the MDPI publishing editorial team, who gave us the opportunity of being GEs for the SI “Applied Mathematics for 5th Generation (5G) and beyond Communication Systems”, and especially Miss Ursula Tian for the support she offered us in managing all the manuscripts we received for this volume. She has always been very cooperative and supportive towards us.

Response to our call had the following statistics:

Submissions (22);

Publications (9);

Rejections (13);

Article types: Research Article (9).

Published submissions are related to back-off mechanisms for dense channel resource allocation in future WLANs, routing algorithms techniques and challenges for Internet of Drones, network intrusion detection and classification systems, self-interference cancellation in full-duplex radio transceivers, spectral efficiency in uplink channels, non-orthogonal multiple access in next-generation heterogeneous networks, and multi-carrier waveform design for 5G and beyond communication systems. We found the edition and selections of papers for this book very inspiring and rewarding.

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