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# Mathematics and Computing

## 4th International Conference, ICMC 2018
## Varanasi, India, January 9–11, 2018
## Revised Selected Papers

Springer

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# Message from the General Chairs

It is our privilege and great pleasure to welcome you to the proceedings of the 4th International Conference on Mathematics and Computing 2018 (ICMC 2018). The scope of the conference is to provide an international forum for the exchange of ideas among interested researchers.

ICMC 2018 was supported by invited speakers giving talks on mathematical analysis, cryptology, approximation theory, graph theory, operations research, numerical methods, etc. Technical sessions on a variety of fields covering almost all aspects of mathematics were arranged. The conference addressed key topics and issues related to all aspects of computing.

The conference was held at the Indian Institute of Technology (Banaras Hindu University), which is situated in the oldest city of the world – Varanasi. Varanasi is well known for its heritage and culture, and the participants enjoyed the city by visiting many places of interests.

We hope the interactions and discussions during the conference provided the participants with new ideas and recommendations, useful to the research world as well as to society.

P. K. Saxena
P. D. Srivastava
U. C. Gupta
L. P. Singh
Debjani Chakraborty

# Message from the Program Chairs

It was a great pleasure for us to organize the 4th International Conference on Mathematics and Computing 2018 held during January 9–11, 2018, at the Indian Institute of Technology, BHU, Varanasi, Uttar Pradesh, India. Our main goal in this conference is to provide an opportunity for participants to learn about contemporary research in cryptography, security, modeling, and different areas of mathematics and computing. In addition, we aim to promote the exchange of ideas among attendees and experts participating in the conference, both the plenary as well as the invited speakers. With this aim in mind, we carefully selected the invited speakers. It is our sincere hope that the conference helped participants in their research and training and opened new avenues for work for those who are either starting their research or are looking to extend their area of research to a new field of current research in mathematics and computing.

The inauguration ceremony of the conference was held on January 9, 2018, starting with the one-hour keynote talk of Prof. T. S. Ho, University of Surrey, UK, followed by 11 forty-five-minute invited talks by Prof. R. N. Mahapatra, University of Central Florida, Orlando, USA, Prof. Matti Vuorinen, University of Turku, Finland, Prof. Srinivas R. Chakravarthy, Kettering University, USA, Dr. Srinivas Pyda, Oracle's System's Technology, USA, Dr. Parisa Hariri, University of Turku, Finland, Prof. S. Ponnusamy, Indian Institute of Technology Madras, Prof. Debasis Giri, Haldia Institute of Technology, India, Prof. Kouichi Sakurai, Kyushu University, Fukuoka, Prof. Chris Rodger, Auburn University, Alabama, USA, Prof. S. K. Mishra, Banaras Hindu University, India, Prof. T. Som, IIT (BHU), and Dr. Arvind, SCUBE India. The speakers/contributors came from India, Japan, UK, and the USA.

After an initial call for papers, 116 papers were submitted for presentation at the conference. All the submitted papers were sent to external reviewers. After a thorough review process, 29 papers were recommended for publication for the conference proceedings published by Springer in its *Communications in Computer and Information Science* (CCIS) series.

We are truly thankful to the speakers, participants, reviewers, organizers, sponsors, and funding agencies for their support and help without which it would have been impossible to organize the conference. We owe our gratitude to the research scholars of the Department of Mathematical Sciences, IIT (BHU), who volunteered the conference and worked behind the scene tirelessly in taking care of the details to make the conference a success.

Debdas Ghosh
Debasis Giri
Ram N. Mohapatra
Ekrem Savas
Kouichi Sakurai
L. P. Singh

# Preface

The 4th International Conference on Mathematics and Computing (ICMC 2018) was held at the Indian Institute of Technology (Banaras Hindu University) Varanasi, during January 9–11, 2018. Varanasi, located in the Indian state of Uttar Pradesh, is one of the oldest cities in the world and is well-known for its culture and heritage. The Indian Institute of Technology (BHU) Varanasi is an institution of national importance.

In response to the call for papers for ICMC 2018, 116 papers were submitted for presentation and publication through the proceedings of the conference. The papers were evaluated and ranked on the basis of their significance, novelty, and technical quality by at least two reviewers per paper. After a careful blind refereeing process, 29 papers were selected for inclusion in the conference proceedings. The papers cover current research in cryptography, security, abstract algebra, functional analysis, fluid dynamics, fuzzy modeling, and optimization. ICMC 2018 was supported by eminent researchers from India, USA, UK, Japan, and Finland, among others. The invited speakers from India are recognized leaders in government, industry, and academic institutions such as the Indian Statistical Institute Chennai, IIT Madras, University of Surrey, UK, University of Central Florida, Orlando, USA, University of Turku, Finland, Kettering University, USA, Oracle's Systems Technology, USA, University of Turku, Finland, Haldia Institute of Technology, India, Kyushu University, Fukuoka, Auburn University, Alabama, USA, Banaras Hindu University, India, IIT (BHU), and SCUBE India.

A conference of this kind would not be possible to organize without the full support of different people across different committees. All logistics and general organizational aspects are looked after by the Organizing Committee members, who spent their time and energy in making the conference a reality. We also thank all the Technical Program Committee members and external reviewers for thoroughly reviewing the papers submitted to the conference and sending their constructive suggestions within the deadlines. Our hearty thanks to Springer for agreeing to publish the proceedings in its *Communications in Computer and Information Science* (CCIS) series.

We are truly indebted to the Science and Engineering Research Board (Department of Science and Technology), Council of Scientific and Industrial Research (CSIR), Defense Research and Development Organization (DRDO), and Indian Institute of Technology (BHU) Varanasi and SCUBE India for their financial support, which significantly helped to raise the profile of the conference.

The Organizing Committee is grateful to the research students of the Department of Mathematical Sciences, IIT (BHU), for their tireless support in making the conference a success.

Last but not the least, our sincere thanks go to all the Technical Program Committee members and authors who submitted papers to ICMC 2018 and to all speakers and participants. We fervently hope that the readers will find the proceedings stimulating and inspiring.

March 2018

Debdas Ghosh
Debasis Giri
R. N. Mohapatra
Ekrem Savas
Kouichi Sakurai
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