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Debasis Giri · Anthony T. S. Ho · S. Ponnusamy · Nai-Wei Lo Editors

# Proceedings of the Fifth International Conference on Mathematics and Computing

**ICMC 2019** 



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## Preface

The Fifth International Conference on Mathematics and Computing (ICMC 2019) was held at the Kalinga Institute of Industrial Technology (KIIT) Deemed to be University, Bhubaneswar from February 6 to 9, 2019. Bhubaneswar is a smart city and capital of the Indian state of Odisha and KIIT is a premier institution training engineers and computer scientists for the past several years.

In response to the call for papers for ICMC 2019, 81 papers were submitted in 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, 20 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, etc. ICMC 2019 will have eminent personalities both from India and abroad (UK, Taiwan, Japan, Bangladesh, and Turkey), who will deliver invited addresses and tutorial talks. The speakers from India are recognized leaders in government, industry and academic institutions like Indian Statistical Institute Kolkata, Indian Statistical Institute Chennai, IIT Kharagpur, Maulana Abul Kalam Azad University of Technology, West Bengal, Jadavpur University, etc. All of them are involved in research dealing with the current issues of interest related to the theme of the conference. The conference was two invited talks on February 6, 2019 in the 1-day pre-conference workshop addressed by Dr. Debarshi Sanyal (Principal Project Officer (Research), National Digital Library of India, Indian Institute of Technology Kharagpur), and Dr. Kamalesh Acharya (School of Computer Sciences, National Institute of Science Education and Research, India). In addition to these there were the invited talks on the main conference during February 7-9, 2019 by Prof. T. S. Ho (University of Surrey, UK), Prof. Feng Hao (University of Warwick, UK), Prof. S. Ponnusamy (IIT Madras, India), Prof. Al-Sakib Khan Pathan (Southeast University, Bangladesh), Prof. Sarbani Roy (Jadavpur University, India), Prof. Goutam Kumar Paul (Indian Statistical Institute, Kolkata, India), Prof. Debasis Giri (Maulana Abul Kalam Azad University of Technology, West Bengal, India).

A conference of this kind would not be possible to organize without the full support from 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 for the conference and sending their constructive suggestions within the deadlines. Our hearty thanks to Springer for agreeing to publish the proceedings in its "Advances in Intelligent Systems and Computing" series.

We are indebted to the Kalinga Institute of Industrial Technology (KIIT) Deemed to be University, and Defense Research and Development Organization (DRDO) for sponsoring the event. Their support has significantly helped in raising the profile of the conference.

Last but not the least, our sincere thanks go to all authors who submitted papers to ICMC 2019 and to all speakers and participants. We sincerely hope that the readers will find the proceedings stimulating and inspiring.

Haringhata, India Chennai, India Guildford, UK Taipei, Taiwan Debasis Giri S. Ponnusamy Anthony T. S. Ho Nai-Wei Lo

### Message from Program Co-chairs

It was a great pleasure for us to organize the Fifth International Conference on Mathematics and Computing 2019 (ICMC 2019) to be held during February 6–9, 2019 at Kalinga Institute of Industrial Technology (KIIT), Deemed to be University, Bhubaneswar, Odisha, India. Our main goal in this conference was to provide an opportunity to the 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 themselves and with experts participating in the conference as the keynote speakers. It is our sincere hope that the conference will help the participants in their research and training and opened new avenues for work for those who are either starting their research or are looking for extending their area of research to a new area of current research Mathematics and Computing.

The inauguration ceremony of the conference was held on February 8, 2019. There were the keynote talks of one hour by **Prof. T. S. Ho** (University of Surrey, UK), **Prof. Feng Hao** (University of Warwick, UK), **Prof. S. Ponnusamy** (IIT Madras, India), **Prof. Al-Sakib Khan Pathan** (Southeast University, Bangladesh), **Prof. Sarbani Roy** (Jadavpur University, India), **Prof. Goutam Kumar Paul** (Indian Statistical Institute, Kolkata, India), **Prof. Debasis Giri** (Maulana Abul Kalam Azad University of Technology, West Bengal, India), **Dr. Debarshi Sanyal** (Principal Project Officer (Research), National Digital Library of India, Indian Institute of Technology Kharagpur), and **Dr. Kamalesh Acharya** (School of Computer Sciences, National Institute of Science Education and Research, India).

After an initial call for papers, 81 papers were submitted at the conference. All the submitted papers were sent to external referees. After a thorough referring process 20 papers were recommended for publication for the conference proceedings.

We are truly thankful to the speakers, participants, referees, organizers, and student volunteers for their support and help without which it would have been impossible to organize the conference. Our special thanks go to Prof. P. K. Saxena, Prof. P. D. Srivastava, Prof. Sudarshan Nanda, Prof. Tanmoy Maitra and Prof. Monideepa Roy for their hard work and support. In addition, we would like to thanks the sponsors and host university, i.e., KIIT Deemed to be University and funding agency i.e., DRDO for supporting Fifth ICMC 2019.

Debasis Giri S. Ponnusamy Anthony T. S. Ho Nai-Wei Lo

### Message from the General Co-chairs

As we all are aware, Mathematics has always been a discipline of interest not only to theoreticians but also to all practitioners irrespective of their specific profession. Be it Science, Technology, Economics, Commerce or even Sociology, new Mathematical principles and models have been emerging and helping in new research and in drawing inferences from practical data as well as through logic. The past few decades have seen enormous growth in applications of Mathematics in different areas, which are multidisciplinary in nature. Cryptography, Security, and Signal processing are such areas which have got more focus recently due to need for secure communication while connecting with others. With emerging computing facilities and speeds, a phenomenal growth has happened in the problem-solving area. Earlier, some observations were made and conjectures were drawn, which remained conjectures till somebody either could prove it theoretically of found counterexamples. But today, we can write algorithms and use computers for long calculations, verifications, or generation of huge amount of data. With available computing capabilities, we can find factors of very large integers of the size of hundreds of digits; we can find inverses of very large size matrices and solve a large set of linear equations and so on. Thus, Mathematics and Computations have become more integrated areas of research these days and it was thought to organize an event where thoughts may be shared by researchers and new challenging problems could be deliberated for solving these.

Apart from many other interdisciplinary areas of research, cryptography and security have emerged one of the most important areas of research with discrete mathematics as a base. Several research groups are actively pursuing the research on different aspects of cryptology not only in terms of new crypto-primitives and algorithms but a whole lot of concepts related to authentication, integrity, and security proofs/protocols are being developed, many times with open and competitive evaluation mechanism to evolve standards.

As Conferences, Seminars, and Workshops are the mechanisms to share knowledge and new research results giving us a chance to get new innovative ideas for futuristic needs as threats and computational capabilities of adversaries are ever increasing, it was thought appropriate to organize the present Conference focusing on Mathematics and Computations covering theoretical as well as practical aspects of research, Cryptography and Security being ones of these.

Eminent personalities working in Mathematical Sciences and related areas have been invited from abroad as well as from within the country, who would deliver invited talks and tutorials for participants. The talks by these speakers intend to cover a wide spectrum, viz., Number Theoretic Concepts, Cryptography, Algebraic Concepts like Quasi-Groups and applications, etc. The Conference is spread over 5 days (February 6–9, 2019), where the first day was dedicated to a 1-day workshop. The main conference was planned with special talks by experts and paper presentations in each session.

I hope that the conference would meet the aspirations of the participants and meet its objective of ideas and current research being shared and new targets/problems identified; more so the young researchers and students would get new directions to pursue their future research.

The conference would not have been possible without the enthusiasm and hard work of a number of colleagues. We wish to express my sincere appreciation to the extended Technical Program Committee. We would like to thank the host university KIIT Deemed to be University, Bhubaneswar, Odisha, India for funding and supporting this conference Last, but certainly not least, our thanks go to all the authors who submitted papers and all the attendees.

> P. K. Saxena P. D. Srivastava Sudarshan Nanda

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### **About the Editors**

Debasis Giri is currently working as an Associate Professor in the Department of Information Technology, Maulana Abul Kalam Azad University of Technology (Formerly known as West Bengal University of Technology), West Bengal, India. Prior to this, he also held academic positions as Professor in the Department of Computer Science and Engineering and Dean in the School of Electronics, Computer Science and Informatics, Haldia Institute of Technology, Haldia, India. He did his masters (M.Tech. and M.Sc.) both from IIT Kharagpur, India, and also completed his Ph.D. from IIT Kharagpur, India. He is tenth all India rank holder in Graduate Aptitude Test in Engineering (GATE) in 1999. He received a certificate from All India Science Teachers' Association in Science Aptitude & Talent Search Test in 1988. His current research interests include Cryptography, Information Security, E-commerce security and Design & Analysis of Algorithms. He has authored more than 75 research papers in reputed international journals and conference proceedings. He is editorial board member and reviewer of many International journals. He is the founder of the International Conference on Mathematics and Computing. He is also program committee member of several international conferences. He is a member of IEEE, and a life member of Cryptology Research Society of India, and the International Society for Analysis, its Applications and Computation (ISAAC).

**Prof. Anthony T. S. Ho** holds a Personal Chair in Multimedia Security and served as Head of Department of Computer Science, University of Surrey from 2010 to 2015. He is also a Tianjin Distinguished Professor, Guest Professor of Tianjin University of Science and Technology and of Wuhan University of Technology, China, as well as Visiting Professor of University of Malaya, Malaysia. He was the recipient of the prestigious Institution of Engineering and Technology (IET) Innovation in Engineering Award under the Security category for his research and commercialization work on digital watermarking in 2006.

Professor Ho obtained his M.Sc. in Applied Optics from Imperial College London in 1980 and his Ph.D. in Digital Image Processing from King's College London, University of London in 1983. After graduation, he worked in technical management positions in industry for 11 years in the UK and Canada. From 1994 to 2005, He was a Senior Lecturer and then Associate Professor at Nanyang Technological University (NTU), Singapore. He has published more than 160 articles in international journals and conference proceedings as well as 8 international patents granted related to watermarking and steganography.

Professor Ho is Founding Editor-in-Chief of the International Journal of Information Security and Applications (JISA) and an Area Editor for Signal Processing: Image Communication, both published by Elsevier. He serves as an Associate Editor for IEEE Transactions on Information Forensics and Security (TIFS) and Associate Editor for IEEE Signal Processing Letters (SPL) (2014– 2016), as well as an Associate Editor for EURASIP Journal of Image and Video Processing published by Springer. He is a Fellow of Institution of Engineering and Technology (FIET), Fellow of Institute of Physics (FInstP) and Fellow of British Computer Society (FBCS).

**Dr. S. Ponnusamy** is a Senior Professor in the Department of Mathematics of IIT Madras. He has earned his B.Sc. (1980) and M.Sc. (1992) from the University of Madras. He completed his Ph.D. (1989) at IIT Kanpur. His current research interest includes Complex Analysis, Quasiconformal and Harmonic Mappings, Special Functions and Functions Spaces.

Dr. S. Ponnusamy is the Founding "Fellow of the Forum de Analystes, Chennai, India", 1992. He was elected as a "Fellow of The National Academy of Sciences, India" in the year 2002. He served five years as Head of the Indian Statistical Institute, Chennai Centre (Oct. 2012 to Oct. 2017). He is the currently the President of the Ramanujan Mathematical Society, India.

Dr. S. Ponnusamy has been associating with a number of organizations for popularization of science and serves on the editorial boards of several peer-reviewed international journals. He is often invited to give plenary talks at international conferences and to give lectures in universities all over the world. He took part as a researcher in many funded projects in India and Abroad. He has been refereeing for more than 100 journals.

Dr. Ponnusamy has written four books and another book with Herb Sivlerman. One of his books won the Best Selling Author award in 2002. He has edited several volumes, and international conference proceedings. He has published more than 250 technical articles in reputed international journals (such as Advances in Mathematics, Annales Academia Scientiarum Fennica Mathematica, Applied Mathematics and Computation, Archiv der Mathematik, Bulletin des Sciences Mathematiques, Bulletin/Journal of the Australian Mathematical Society, Complex Variables and Elliptic Equations, Complex Analysis and Operator Theory, Computational Methods and Function Theory, Indagationes Mathematicae, Journal of London Mathematical Society, Integral Equations and Operator Theory, Journal Computational and Applied Mathematics, Journal of Mathematical Analysis and Applications, Mathematika, Mathematishe Annalen, Mathematische Nachrichten, Mathematische Zeitschrift, Monatshefte fuer Mathematik, Nonlinear Analysis, Potential Analysis, Proceedings of American Mathematical Society, Results in Mathematics, Rocky Mountain Journal of Mathematics The Journal of Geometric Analysis) and has solved several long standing open problems and conjectures.

Dr. Ponnusamy has been a visiting professor of number of universities in abroad (eg. Hengyang Normal University and Hunan Normal University, China; Kazan Federal University and Petrozavodsk State University, Russia; University Sains Malaysia, Malaysia; University of Aalto, University of Turku, and University of Helsinki, Finland; Texas Tech University, Lubbock, USA).

**Nai-Wei Lo** received the B.S. degree in engineering science from National Cheng Kung University, Tainan, Taiwan, in 1988 and the M.S. and Ph.D. degrees in computer science and electrical engineering from the State University of New York at Stony Brook, Stony Brook, NY, USA, in 1992 and 1998, respectively. He is currently a Professor and the Chairman of Department of Information Management, National Taiwan University of Science and Technology, Taipei, Taiwan. His research interests include application and system security, IoT/IoV security, cloud security and Web technology. He currently serves as an associate editor of Journal of Information Security and Applications. He is a senior member of IEEE.