

ICCGI 2025

The Twentieth International Multi-Conference on Computing in the Global Information Technology

ISBN: 978-1-68558-231-9

March 9th –13th, 2025 Lisbon, Portugal

ICCGI 2025 Editors

Petre Dini, IARIA, USA/EU

ICCGI 2025

Forward

The Twentieth International Multi-Conference on Computing in the Global Information Technology (ICCGI 2025), held between March 9th, 2025, and March 13th, 2025, in Lisbon, Portugal, continued a series of international events covering a large spectrum of topics related to global knowledge concerning computation, technologies, mechanisms, cognitive patterns, thinking, communications, user-centric approaches, nanotechnologies, and advanced networking and systems.

The conference topics focused on challenging aspects in the next generation of information technology and communications related to the computing paradigms (mobile computing, database computing, GRID computing, multi-agent computing, autonomic computing, evolutionary computation) and communication and networking and telecommunications technologies (mobility, networking, biotechnologies, autonomous systems, image processing, Internet and web technologies), towards secure, self-defendable, autonomous, privacy-safe, and context-aware scalable systems.

We take the opportunity to warmly thank all the members of the ICCGI 2025 technical program committee, as well as all the reviewers. The creation of such a high-quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and effort to contribute to ICCGI 2025. We truly believe that, thanks to all these efforts, the final conference program consisted of top-quality contributions. We also thank the members of the ICCGI 2025 organizing committee for their help in handling the logistics of this event.

We hope that ICCGI 2025 was a successful international forum for the exchange of ideas and results between academia and industry for the promotion of progress in the field of computing in global information technology.

ICCGI 2025 Chairs

ICCGI 2025 Steering Committee

Constantin Paleologu, Polytechnic University of Bucharest, Romania Peter Kieseberg, St. Pölten University of Applied Sciences, Austria Yasushi Kambayashi, Sanyo-Onoda City University, Japan Ulrich Reimer, University of Applied Sciences St. Gallen, Switzerland Kathryn E. Stecke, University of Texas at Dallas, USA Juho Mäkiö, Hochschule Emden / Leer, Germany

ICCGI 2025 Publicity Chairs

Francisco Javier Díaz Blasco, Universitat Politècnica de València, Spain Ali Ahmad, Universitat Politècnica de València, Spain José Miguel Jiménez, Universitat Politècnica de València, Spain Sandra Viciano Tudela, Universitat Politècnica de València, Spain

ICCGI 2025 Committee

ICCGI 2025 Steering Committee

Constantin Paleologu, Polytechnic University of Bucharest, Romania Peter Kieseberg, St. Pölten University of Applied Sciences, Austria Yasushi Kambayashi, Sanyo-Onoda City University, Japan Ulrich Reimer, University of Applied Sciences St. Gallen, Switzerland Kathryn E. Stecke, University of Texas at Dallas, USA Juho Mäkiö, Hochschule Emden / Leer, Germany

ICCGI 2025 Publicity Chairs

Francisco Javier Díaz Blasco, Universitat Politècnica de València, Spain Ali Ahmad, Universitat Politècnica de València, Spain José Miguel Jiménez, Universitat Politècnica de València, Spain Sandra Viciano Tudela, Universitat Politècnica de València, Spain

ICCGI 2025 Technical Program Committee

Ahmed M. Abdelmoniem, KAUST, Saudi Arabia

António Abreu, ISEL/IPL, Portugal

Abdelouhab Aitouche, EEA - French School of High Studies in Engineering, France

Abdullah Al-Alaj, Virginia Wesleyan University, USA

Mohammad Yahya Al-Shamri, King Khalid University, Saudi Arabia

Alma Y. Alanis. University of Guadalajara, Mexico

Fernando Almeida, INESC TEC & University of Porto, Portugal

José Antonio Apolinário Junior, Military Institute of Engineering (IME), Rio de Janeiro, Brazil

Nancy Arana Daniel, University of Guadalajara, Mexico

Jocelyn Aubert, Luxembourg Institute of Science and Technology (LIST), Luxembourg

Michaela Baumann, NÜRNBERGER Versicherung, Germany

Robert Bestak, Czech Technical University in Prague, Czech Republic

Dorota Bielinska-Waz, Medical University of Gdansk, Poland

Fernando Bobillo, University of Zaragoza, Spain

Zorica M. Bogdanovic, University of Belgrade, Serbia

Eugen Borcoci, National University of Science and Technology POLITEHNICA Bucharest, Romania

Jean-Louis Boulanger, CERTIFER, France

Christos Bouras, University of Patras, Greece

Juan Carlos Burguillo-Rial, Universidade de Vigo, Spain

Pricila Castelini, Federal University of Technology, Brazil

DeJiu Chen, KTH Royal Institute of Technology, Sweden

Albert M. K. Cheng, University of Houston, USA

Rebeca Cortazar, University of Deusto, Spain

Pietro Cunha Dolci, Santa Cruz do Sul University, Brazil

Beata Czarnacka-Chrobot, Warsaw School of Economics, Poland

José Carlos da Silva Freitas Junior, UNISINOS (Vale do Rio dos Sinos University), Porto Alegre, Brazil

Maria de los Angeles Cosio León, Universidad Politécnica de Pachuca, Mexico

Laura-Maria Dogariu, National University of Science and Technology POLITEHNICA Bucharest, Romania

Inês Domingues, Politécnico de Coimbra | ISEC | DEIS, Portugal

Rajesh Doriya, National Institute of Technology, Raipur, India

António Dourado, University of Coimbra, Portugal

Jun Duan, IBM T. J. Watson Research Center, USA

Ahmed El Oualkadi, Abdelmalek Essaadi University, Morocco

Sylvia Encheva, Western Norway University of Applied Sciences, Norway

Ângela Ferreira, Polytechnic Institute of Bragança, Portugal

Manuel Filipe Santos, University of Minho, Portugal

Dirk Frosch-Wilke, University of Applied Sciences Kiel, Germany

Apostolos Gkamas, University of Ioannina, Greece

Valery Y. Glizer, ORT Braude College of Engineering, Karmiel, Israel

Octavio González Aguilar, Felizmente Verde, Mexico

Shuyang Gu, Texas A & M University-Central Texas, USA

Carlos Guerrero, University of Balearic Islands, Spain

Juncal Gutiérrez-Artacho, University of Granada, Spain

Songlin He, New Jersey Institute of Technology (NJIT), USA

Gabriel Henrique de Souza, Federal University of Juiz de Fora, Brazil

Manolo Dulva Hina, ECE Paris School of Engineering, France

Wladyslaw Homenda, Warsaw University of Technology, Poland

Tzung-Pei Hong, National University of Kaohsiung, Taiwan

Wei-Chiang Hong, School of Education Intelligent Technology - Jiangsu Normal University, China

Orest Ivakhiv, Lviv Polytechnic National University, Ukraine

Jyoti S. Jagasia, S.P. Jain Institute of Management and Research, India

Maria João Ferreira, Universidade Portucalense, Portugal

Yasushi Kambayashi, Sanyo-Onoda City University, Japan

Paweł Karczmarek, Lublin University of Technology, Poland

Andrzej Kasprzak, Wrocław University of Technology, Poland

Ahmed Khaled, Northeastern Illinois University, USA

Aminollah Khormali, University of Central Florida, USA

Peter Kieseberg, St. Poelten University of Applied Sciences, Austria

Sangpil Kim, Purdue University, USA

Emmanuel Awuni Kolog, University of Ghana, Accra, Ghana

Boris Kovalerchuk, Central Washington University, USA

Panos Kudumakis, Queen Mary University of London, UK

Ganesh Lakshmana Kumar Moganti, VIT-AP University, India

Alex Laier, Universidade Federal Fluminense, Brazil

Bobby Law, Glasgow Caledonian University, Scotland

Olga Levina, TH Brandenburg, University of Applied Science, Germany

Nan Li, The University of Newcastle, Australia

Francisco Carlos Lopes Da Silva, Universidade Federal de Pernambuco, Brazil

Carlos Lopez-Franco, University of Guadalajara, Mexico

Giuseppe Loseto, Polytechnic University of Bari, Italy

Durval Lucas Jr., EPPEN-UNIFESP, Brazil

Oswaldo Luiz Agostinho, University of Campinas / University of São Paulo, Brazil

Ivan Luković, University of Novi Sad, Serbia

Volodymyr Lytvynenko, Kherson National Technical University, Ukraine

Stephane Maag, Institut Mines Telecom / Telecom SudParis, France

Paulo Maio, School of Engineering (ISEP) of Polytechnic of Porto (IPP), Portugal

Alexander Makarenko, Institute of Applied System Analysis at National Technical University of Ukraine

(Igor Sikorski Kiev Politechnic Institute), Ukraine

Juho Mäkiö, Hochschule Emden / Leer, Germany

Henrique S. Mamede, INESC-TEC | Universidade Aberta, Lisboa, Portugal

Goreti Marreiros, Institute of Engineering | Polytechnic of Porto, Portugal

Hanna Martyniuk, Mariupol State University, Ukraine

Juan Carlos Montes de Oca López, Autonomous University of the State of Mexico, Mexico

Sobhan Moosavi, Ohio State University, USA

Fernando Moreira, Universidade Portucalense Infante D. Henrique, Portugal

Elaine Mosconi, Université de Sherbrooke, Canada

Paulo Moura Oliveira, UTAD University | INESC-TEC, Portugal

Mary Luz Mouronte López, Universidad Francisco de Vitoria, Spain

Marco Mugnaini, University of Siena, Italy

Rafael Nogueras, University of Malaga, Spain

Robert Ohene-Bonsu Simmons, University of Ghana-BS-OMIS / Zenith University College, Ghana

Alexandru Onea, Technical University "Gh. Asachi' of Iasi, Romania

Constantin Paleologu, National University of Science and Technology POLITEHNICA Bucharest, Romania

Ronak Pansara, Tesla, USA

Thanasis G. Papaioannou, Athens University of Economics and Business (AUEB), Greece

Dhaval Patel, IBM TJ Watson Research Center, USA

Bernhard Peischl, AVL List GmbH, Austria

Mansah Preko, Ghana Institute of Management and Public Administration (GIMPA), Ghana

Kornelije Rabuzin, University of Zagreb, Croatia

M. Sohel Rahman, Bangladesh University of Engineering & Technology (BUET), Bangladesh

Ferdinand Regner, University of Vienna, USA

Fernando Reinaldo Ribeiro, Polytechnic Institute of Castelo Branco, Portugal

Éric Renault, ESIEE Paris, France

Federica Rollo, "Enzo Ferrari" Engineering Department - University of Modena and Reggio Emilia, Italy

Lyazid Sabri, El Bachir El Ibrahim University, Algeria

Carlos D. Santos Jr., Universidade de Brasilia, Brazil

Wieland Schwinger, Johannes Kepler University Linz (JKU), Austria

Floriano Scioscia, Polytechnic University of Bari, Italy

Isabel Seruca, Portucalense University, Porto, Portugal

Ashok Sharma, Keshav Memorial Institute of Technology, Hyderabad, Telangana, India

Shwadhin Sharma, California State University, Monterey Bay, USA

Alessio Signorini, Evidation Health, USA

Luis Silva Rodrigues, Politécnico do Porto / ISCAP, Portugal

Pornpat Sirithumgul, Rajamangala University of Technology Phra Nakhon, Thailand

Pedro Sousa, University of Minho, Portugal

Kathryn E. Stecke, University of Texas at Dallas, USA

Sergey Subbotin, National University "Zaporizhzhia Polytechnic", Ukraine

Vitalyi-Igorevich Talanin, Khortytsia National Academy, Zaporozhye, Ukraine

Francesco Tedesco, University of Calabria, Italy

Ion Tutanescu, University of Pitesti, Romania

Radu Vasiu, Politehnica University of Timisoara, Romania

Victoria Vysotska, Lviv Polytechnic National University, Ukraine

Piotr Waz, Medical University of Gdansk, Poland

Yair Wiseman, Bar-Ilan University, Israel

Ouri Wolfson, University of Illinois at Chicago / University of Illinois at Urbana Champaign, USA

Krzysztof Wolk, Polish-Japanese Academy of Information Technology, Poland

Kuan Yew Wong, Universiti Teknologi Malaysia (UTM), Malaysia

Mudasser F. Wyne, National University, USA

Muneer Masadeh Bani Yassein, Jordan University of Science and Technology, Jordan

Ali Yavari, Swinburne University of Technology, Australia

Eduard Zharikov, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute",

Ukraine

Jiawei Zheng, University of Edinburgh, UK

Copyright Information

For your reference, this is the text governing the copyright release for material published by IARIA.

The copyright release is a transfer of publication rights, which allows IARIA and its partners to drive the dissemination of the published material. This allows IARIA to give articles increased visibility via distribution, inclusion in libraries, and arrangements for submission to indexes.

I, the undersigned, declare that the article is original, and that I represent the authors of this article in the copyright release matters. If this work has been done as work-for-hire, I have obtained all necessary clearances to execute a copyright release. I hereby irrevocably transfer exclusive copyright for this material to IARIA. I give IARIA permission or reproduce the work in any media format such as, but not limited to, print, digital, or electronic. I give IARIA permission to distribute the materials without restriction to any institutions or individuals. I give IARIA permission to submit the work for inclusion in article repositories as IARIA sees fit.

I, the undersigned, declare that to the best of my knowledge, the article is does not contain libelous or otherwise unlawful contents or invading the right of privacy or infringing on a proprietary right.

Following the copyright release, any circulated version of the article must bear the copyright notice and any header and footer information that IARIA applies to the published article.

IARIA grants royalty-free permission to the authors to disseminate the work, under the above provisions, for any academic, commercial, or industrial use. IARIA grants royalty-free permission to any individuals or institutions to make the article available electronically, online, or in print.

IARIA acknowledges that rights to any algorithm, process, procedure, apparatus, or articles of manufacture remain with the authors and their employers.

I, the undersigned, understand that IARIA will not be liable, in contract, tort (including, without limitation, negligence), pre-contract or other representations (other than fraudulent misrepresentations) or otherwise in connection with the publication of my work.

Exception to the above is made for work-for-hire performed while employed by the government. In that case, copyright to the material remains with the said government. The rightful owners (authors and government entity) grant unlimited and unrestricted permission to IARIA, IARIA's contractors, and IARIA's partners to further distribute the work.

Table of Contents