

# ITAT 2024 Proceedings

24th Conference on  
Information Technologies – Applications and Theory  
Hotel Javorna, Drienica, Čergovské vrchy, Slovakia

September 20 – 24, 2024

ITAT (Information Technologies – Applications and Theory) is an annual Czech-Slovak conference gathering scientists and experts working within a broad scope of computer science. The conference serves as a platform for workshops focused on results produced by senior scientists and young researchers fostering an exchange of ideas and informal discussions among participants.

ITAT 2024 took place in Hotel Javorna, Drienica, Čergovské vrchy, Slovakia. ITAT 2024 hosted *Workshop on Computational Intelligence and Data Mining*, *Workshop on Natural Computing*, *Workshop on Automata, Formal and Natural Languages*, *Workshop on Applied Security* and *Computational Aspects of Large-Scale Problems in Discrete Mathematics*. In summary, five international workshops provided an extensive overview of many interesting fields of computer science.

The first ITAT was organized in Zuberec in 2001. Accompanying workshops were introduced for the first time in 2013 in Donovaly. The popularity of such workshops has grown over time, attracting more international submissions. Based on this development, the ITAT steering committee in 2019 has decided to discontinue the main track of the conference and transform ITAT into a platform for hosting international workshops. By focusing on a smaller number of areas of interest, we are able to secure internationally recognized expert reviewers in workshop areas, which improve the papers under review and help to increase the quality of future papers by ITAT authors, whether submitting again to ITAT workshops or other international events. Despite its Czech-Slovak origin, workshop organizers open their workshops to participants from other countries.

The members of the steering committee of the ITAT series of conferences:

- Peter Gurský, Pavol Jozef Šafárik University in Košice, Slovakia
- Martin Holeňa, Czech Academy of Sciences, Czech Republic
- Tomáš Horváth, ELTE University, Budapest, Hungary, and Pavol Jozef Šafárik University in Košice, Slovakia
- Markéta Lopatková, Charles University in Prague, Czech Republic
- Tomáš Vinař, Comenius University in Bratislava, Slovakia

The organizing committee of ITAT 2024 worked in the following format:

- Peter Gurský, Pavol Jozef Šafárik University in Košice, Slovakia
- Šimon Horvát, Pavol Jozef Šafárik University in Košice, Slovakia
- Dávid Varga, Pavol Jozef Šafárik University in Košice, Slovakia
- Zoltán Szoplák, Pavol Jozef Šafárik University in Košice, Slovakia

We would like to thank members of the steering committee, the members of the program committees, the organizers of workshops and conference, the authors, the reviewers, and all the other people who significantly contributed to the successful ITAT 2024 conference.

The editors

# 12th International Workshop on Computational Intelligence and Data Mining – IWCIDM 2024 (Preface)

As a part of the workshop bundle ITAT 2024, the 12th International Workshop on Computational Intelligence and Data Mining (IWCIDM 2024) has been organized. It is aimed at participants with research interests in any of these related areas, especially at PhD students and postdocs. Interested participants were invited to submit a paper in English, prepared according to the instructions at the ITAT 2024 web page.

This year, we received 7 papers with authors from 6 countries, among which 6 have been accepted for oral presentation and inclusion into the CEUR proceedings.

A key factor influencing the overall quality of the workshop and of the final versions of the submitted papers is the workshop's program committee. The 12th International Workshop Computational Intelligence and Data Mining is grateful to the 22 reviewers from 12 countries who read the submitted papers and have provided competent, and in most cases very detailed, feedback to their authors. Most of them have a great international reputation witnessed by hundreds of WOS citations.

- Dirk Arnold, Dalhousie University, Halifax
- Petr Berka, University of Economics, Prague
- Daniela Chudá, Kempelen Institute of Intelligent Rechnologies, Bratislava
- Carola Doerr, Sorbonne University, Paris
- Jan Faigl, Czech Technical University, Prague
- Johannes F<sup>́</sup>rnkranz, Johannes Kepler University, Linz
- Pitoyo Hartono, University of Chukyo
- Martin Holeňa, Czech Academy of Sciences, Prague
- Tomáš Horváth, Edinburgh Napier University
- Ján Hric, Charles University, Prague
- Jan Kalina, Czech Academy of Sciences, Prague
- Jiří Kléma, Czech Technical University, Prague
- Tomas Krilavičius, Vytautas Magnus University, Kaunas
- Antoni Ligęza, AGH University of Science and Technology, Krakow
- Rafael Gomes Mantovani, Federal Techonology University of Paraná
- Mirko Navara, Czech Technical University, Prague
- Ostap Okhrin, Technical University of Dresden
- Irina Perilieva, University of Ostrava
- Tomáš Pevný, Czech Technical University, Prague
- Jan Rauch, University of Economics, Prague
- Fabio Vandin, University of Padova
- Filip Železný, Czech Technical University, Prague

# 5th Workshop on Automata, Formal and Natural Languages – WAFNL 2024 (Preface)

The Workshop on Automata, Formal and Natural Languages was focused on automata, formal languages, natural language processing, as well as on computational linguistics. It was held for the fifth time as a part of the Information Technologies – Applications and Theory (ITAT 2024) conference on September 2024. The workshop’s main aim was to encourage cooperation among researchers in formal languages and natural language processing in Middle Europe. In order to attract young researchers, master and doctoral students of formal languages and computational linguistics were invited to participate.

The workshop consisted of an invited lecture, a regular papers track, and an open session.

We thank Šárka Zikánová (Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic) for accepting our invitation and presenting recent results in her invited talk “Text Structure and Its Ambiguities: Corpus Annotation as a Helpful Guide”.

The regular papers track comprised research papers as well as overview and work-in-progress papers. All such contributions presented new scientific results not published elsewhere. Each submitted paper was reviewed by at least two reviewers. Five papers accepted for the presentation at WAFNL 2024 are included in the proceedings of ITAT 2024.

We thank the members of the program committee of WAFNL 2024 for reviewing the submitted papers:

- Gabriela Andrejková, Pavol Jozef Šafárik University, Košice
- Ondřej Dušek, Charles University, Prague
- Jaroslava Hlaváčová, Charles University, Prague
- Markéta Lopatková, Charles University, Prague
- David Mareček, Charles University, Prague
- Peter Mlynárčik, University of Prešov
- František Mráz, Charles University, Prague (co-chair)
- Karel Oliva, Prague
- Friedrich Otto, University of Kassel
- Dana Pardubská, Comenius University, Bratislava (co-chair)
- Martin Plátek, Charles University, Prague (co-chair)
- Martin Procházka, Prague
- Daniel Průša, Czech Technical University, Prague
- Rudolf Rosa, Charles University, Prague
- Alexandr Rosen, Charles University, Prague
- Jana Straková, Charles University, Prague
- Peter Vojtáš, Charles University, Prague

# Workshop on Natural Computing – WNC 2024

## (Preface)

The Workshop on Natural Computing was hosted as part of the ITAT conference on September 20 – 24, 2024, and encouraged especially young researchers and PhD students to present their work and exchange ideas in a collaborative environment of four workshops with inspiring thematic overlaps. During the workshop, contributions were presented in the field of natural computation, i.e. computational processes observed in nature, and human-designed computation inspired by nature. Topics included, e.g.:

- Molecular computing (e.g., DNA computing),
- Cell-inspired computing (membrane computing, amorphous computing),
- Cellular automata, swarm intelligence, nature-inspired algorithms,
- Artificial immune systems, artificial life,
- Synthetic biology, biological networks (genetic networks, protein-protein networks, transport networks),
- Deep learning systems and applications.

All published papers were refereed by at least two anonymous reviewers. Four regular papers were complemented by an invited talk by György Vaszil (University of Debrecen, Hungary) entitled Describing computations of membrane systems with Petri nets.

### **The WNC 2024 Workshop Program Committee:**

- Artiom Alhazov, State University of Moldova
- Luděk Cienciala, Silesian University in Opava
- Lucie Ciencialová, Silesian University in Opava (co-chair)
- Erzsébet Csuha-j-Varjú, Eötvös Loránd University
- Marian Gheorghe, University of Bradford
- Alberto Leporati, Università degli Studi di Milano-Bicocca
- Radka Poláková, Silesian Univerzity in Opava
- Agustín Riscos Núñez, University of Seville
- Petr Sosík, Silesian University in Opava
- György Vaszil, University of Debrecen
- Claudio Zandron, Università degli Studi di Milano-Bicocca
- Gexiang Zhang, Chengdu University of Technology

The editors express their gratitude to the conference organizers, the program committee, the invited speaker, the authors of the papers, the reviewers, and all the participants for their contributions to the success of WNC and ITAT 2024.

# Computational Aspects of Large-Scale Problems in Discrete Mathematics – CADM 2024 (Preface)

CADM 2024 workshop was another installation of an equally named workshop that was a part of the ITAT 2023 conference. The 2024 workshop took place in hotel Javorná, Drienica, from September 21st to September 22nd, 2024.

The aim of the workshop was once again to bring together young researchers in Discrete Mathematics whose work has a significant computational component or includes problems of significant computational complexity. Participants were expected to prepare a short article about the specific computational aspects of problems they consider in their research and to present a 25 minute talk based on their article. In addition, talks not accompanied by an article were also allowed, as were active participants not presenting a talk. The workshop also included two longer survey talks. On-site collaboration and exchange of ideas, techniques, tricks or hints were encouraged, and doctoral students presenting preliminary reports on their work, wishing to learn more about problems of computational character, or simply looking for inspiration, were particularly welcome.

All topics involving computational aspects or actual use of computers in Discrete Mathematics were considered. Each submitted contribution was reviewed by two members of the Programme Committee and evaluated with regard to the relevance of the topic, the originality of the use of the computing techniques, and the contribution's potential in becoming a topic of shared interest among the participants of the workshop. All published articles were refereed by at least two anonymous referees.

We thank Primož Potočnik (University of Ljubljana, Slovenia) for accepting our invitation and presenting an invited talk entitled *Generating and cataloging symmetric graphs*. The two survey talks were presented by Gábor Korchmáros (Università degli Studi della Basilicata, Italy) and by Robert Jajcay (Comenius University, Slovakia).

The Program Committee of the workshop consisted of the following researchers:

- Marien Abreu, Università degli Studi della Basilicata, Italy
- Grahame Erskine, Open University, UK
- Jan Goedgebeur, KU Leuven, Belgium
- Štefan Gyürki, Slovak Technical University, Slovakia
- Tatiana Jajcayová, Comenius University, Slovakia, co-chair
- Robert Jajcay, Comenius University, Slovakia, co-chair
- Jan Karabáš, Slovak Technical University, Slovakia
- František Kardoš, Comenius University, Slovakia & Université de Bordeaux and LaBRI
- Petr Kovář, Technical University of Ostrava, Czech Republic
- Tereza Kovářová, Technical University of Ostrava, Czech Republic
- Martin Mačaj, Comenius University, Slovakia, co-chair
- Edita Máčajová, Comenius University, Slovakia

## Workshop on Applied Security – WAS 2024 (Preface)

The Workshop on Applied Security was hosted as part of the ITAT conference on September 22nd, 2024. The workshop created an opportunity for researchers and their students in the wide and complex field of computer systems security to come together and discuss current topics and trends in a welcoming environment. All submitted papers and extended abstracts were refereed by two reviewers. During the workshop, contributions were presented as 5 regular papers and 2 extended abstracts, covering the following topics:

- Operating systems security
- Forensics artifacts analysis
- Programming languages security
- Anomaly detection
- Behavioral biometrics
- Modeling memory access traces
- Password strength evaluation

### **The WAS 2024 Program Committee:**

- Dušan Bernát, Comenius University
- Ladislav Hudec, Slovak University of Technology
- Daniela Chudá, Slovak University of Technology
- Jaroslav Janáček, Comenius University
- Matúš Jókay, Slovak University of Technology
- Richard Ostertág, Comenius University (co-chair)
- Pavol Sokol, Pavol Jozef Šafárik University
- Martin Stanek, Comenius University (co-chair)