# ITAT 2025 Proceedings

25th Conference on
Information Technologies – Applications and Theory
Telgárt, Nízke Tatry, Slovakia

September 26 – 30, 2025

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 2025 took place in Hotel Telgárt, Telgárt, Nízke Tatry, Slovakia. ITAT 2025 hosted *Workshop on Computational Intelligence and Data Mining*, *Workshop on Natural Computing*, *Workshop on Automata, Formal and Natural Languages*, *Workshop on Applied Security* and *Workshop on Bioinformatics and Computational Biology*. 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, Edinburgh Napier University, Scotland, United Kingdom, 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 2025 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 2025 conference.

The editors

# 13th International Workshop on Computational Intelligence and Data Mining – IWCIDM 2025 (Preface)

As a part of the workshop bundle ITAT 2025, the 13th International Workshop Computational Intelligence and Data Mining (IWCIDM 2025) 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 2025 web page.

This year, we received 11 papers, among which 10 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 13th International Workshop Computational Intelligence and Data Mining is grateful to the 22 reviewers from 11 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.

- Petr Berka, University of Economics, Prague

- Daniela Chudá, Kempelen Institute of Intelligent Technologies, Bratislava

- Carola Doerr, Sorbonne University, Paris

- Jan Faigl, Czech Technical University, Prague

- Johannes Fürnkranz, 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

- Věra Kůrková, Czech Academy of Sciences, Prague

- Johannes Lengler, ETH Zürich

- Antoni Ligęza, AGH University of Science and Technology, Krakow

- Rafael Gomes Mantovani, Federal Techonology University of Paraná

- Mirko Navara, Czech Technical University, Prague

- Engelbert Mephu Nguifo, University of Clermont, Auvergne

- Irina Perilieva, University of Ostrava

- Tomáš Pevný, Czech Technical University, Prague

- Jan Rauch, University of Economics, Prague

- Pascal Welke, Lancaster University Leipzig

# 6th Workshop on Automata, Formal and Natural Languages – WAFNL 2025 (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 sixth time as a part of the Information Technologies – Applications and Theory (ITAT 2025) conference on September 2025.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 prof. Martina Ivanová (Filozofická fakulta PU v Prešove) and Peter Kostelník (Xolution Europe) for accepting our invitation and presenting recent results in their invited talk "Scenes-and-frames Semantics and its possibilities in building a knowledge database of the Slovak language".

The regular papers track comprised research papers as well as overview and work-in-progress papers.

All contributions presented new scientific results not published elsewhere. Each submitted paper was reviewed by at least two reviewers. All papers accepted for the presentation at WAFNL 2025 are included in the proceedings of ITAT 2025.

We thank the members of the program committee of WAFNL 2025 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, Catholic University, Ružomberok

- František Mráz, Charles University, Prague (co-chair)

- Karel Oliva, Prague

- 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

- Peter Vojtáš, Charles University, Prague

# Workshop on Natural Computing – WNC 2025 (Preface)

The Workshop on Natural Computing was hosted as part of the ITAT conference on September 26 – 30, 2025, and encouraged especially young researchers and PhD students to present their work and exchange ideas in a collaborative environment of five 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 Marian Gheorghe (Univerzity of Bradford, UK) entitled Kernel P systems and connections with membrane systems.

**The WNC 2025 Workshop Program Committee:**

- Luděk Cienciala, Silesian University in Opava

- Lucie Ciencialová, Silesian University in Opava (co-chair)

- Erzsébet Csuhaj-Varjú, Eötvös Loránd University

- 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

- Jose M. Sempere, Universitat Politècnica de València

- György Vaszil, University of Debrecen

- Sergey Verlan, University of Paris Est Créteil, IUT de Sénart-Fontainebleau

- Claudio Zandron, Dipartimento di Informatica, Sistemistica e Comunicazione, Universita' di Milano-Bicocca

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 2025.

# Wokshop on Bioinformatics and Computational Biology – WBCB 2025 (Preface)

The Workshop on Bioinformatics and Computational Biology was held at Hotel Telgárt in Telgárt, Nízke Tatry, Slovakia on September 26 – 30th, 2025 as part of the ITAT conference. While the conference is a traditional forum for Slovak and Czech computer scientists, the workshop follows a more recent tradition of a relatively irregular extension of topics into the realm of bioinformatics and computational biology. Similarly to the main conference (ITAT), it serves as a platform for the exchange of ideas in a friendly but stimulating environment. The workshop allows younger researchers to meet their more seasoned colleagues in an informal setting, sparking discussions that would be hard to initiate elsewhere. For example, the settings often allow for a short hiking trip in the Slovak mountains. This year the organizers secured a keynote speaker from University of California and also reached out with invitations to colleagues from neighboring countries, giving the workshop a more international tone.

The workshop program included 12 talks covering 5 papers and 7 abstracts on topics mostly related to:

- Algorithmic approaches to sequencing data analysis

- Algorithmic approaches and data structures in genome representation

- Molecular modeling

- Bioinformatics of repetitive sequences, and

- Medical bioinformatics

All published papers were reviewed by at least three anonymous reviewers and complemented by an invited talk by Fereydoun Hormozdiari (University of California, Davis), entitled Computational and machine learning methods to study genomics of diseases

This workshop is associated with the PANGAIA project.

**The Program Committee:**

- Monika Čechová, Masaryk University Brno, co-chair

- Luca Denti, Comenius University in Bratislava, co-chair

- Francesco Andreace, Institut Pasteur

- Andrej Baláž, Geneton, Bratislava

- Broňa Brejová, Comenius University in Bratislava

- Simone Ciccolella, University of Milano-Bicocca

- Davide Cozzi, University of Milano-Bicocca

- Pavel Jedlička, Institute of Biophysics of the CAS, Brno

- Matej Lexa, Masaryk University in Brno

- Samuel Pastva, Masaryk University in Brno

- Alessia Petescia, Comenius University in Bratislava

- David Šafránek, Masaryk University in Brno

- Yoshihiro Shibuya, Institut Pasteur

- Rahul Vegesna, Merck & Co Inc, Boston

- Riccardo Vicedomini, IRISA, Rennes

- Tomáš Vinař, Comenius University in Bratislava

- Matthias Weissensteiner, Institute of Avian Research

# Workshop on Applied Security – WAS 2025 (Preface)

The Workshop on Applied Security was hosted as part of the ITAT conference on September 28th, 2025. 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 7 regular papers, covering the following topics:

- Theoretical and applied cryptography
- Operating systems and programming systems security
- Security of hardware devices
- Network security and protocols
- Web applications security
- Intrusion detection and prevention systems
- Malware analysis and detection techniques
- Privacy-enhancing technologies
- Secure software development methodologies
- Cyber-physical systems security
- Cloud computing security
- Mobile and IoT device security
- Machine learning threats, attacks, and risks
- Applications of Artificial Intelligence in Security
- Digital Forensics and Incident Response

**The WAS 2025 Program Committee:**

- Václav Bartoš (CESNET)
- Dušan Bernát (Comenius University)
- Milan Cermak (Masaryk University)
- Ladislav Hudec (Slovak University of Technology)
- Martin Husák (Masaryk University)
- Daniela Chudá (Slovak University of Technology)
- Matúš Jókay (Slovak University of Technology)
- Rastislav Krivoš-Belluš (Pavol Jozef Šafárik University)
- Richard Ostertág (Comenius University), main organizer, co-chair
- Pavol Sokol (Pavol Jozef Šafárik University)
- Martin Stanek (Comenius University), co-chair