ITAT 2021 Proceedings

21st Conference on
Information Technologies – Applications and Theory
Hotel Heľpa, Nízke Tatry and Muránska Planina, Slovakia

September 24 – 28, 2021

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 2021 took place in Hotel Heľpa, Nízke Tatry and Muránska Planina, Slovakia. Due to the epidemiological situation (COVID-19 pandemics), some researchers participated online. Yet, online participation did not decrease their interest and enthusiasm or the quality of submitted and presented contributions. ITAT 2021 hosted *Workshop on Computational Intelligence and Data Mining*, *Workshop on Natural Computing, Workshop on Automata, Formal and Natural Languages*, as well as one new workshop, namely *Data Analysis in Response to Epidemics*. In summary, four 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 to other international events. Despite its Czech-Slovak origin, workshop organizers open their workshops for participants from other countries.

The members of 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, Commenius University in Bratislava, Slovakia

The organizing committee of ITAT 2021 worked in the following format:

- Peter Gurský, Pavol Jozef Šafárik University in Košice, Slovakia

- Alexander Szabari, Pavol Jozef Šafárik University in Košice, Slovakia

- Ľubomír Antoni, 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 2021 conference.

The editors

9th International Workshop on Computational Intelligence and Data Mining – CIDM 2021
(preface)

The 9th International Workshop on Computational Intelligence and Data Mining has been organized as a part of the ITAT 2021 conference. The workshop is aimed at participants with research interests in any of these areas, but especially at PhD students and postdocs. Interested participants were invited to submit a paper in English, prepared according to the instructions at the ITAT 2021 web page.

At the start of this workshop series, eight years ago, we had only seven regular submissions from two countries. However, the interest in the computational intelligence and data mining workshops has grown over time. This year, we received 16 papers from four countries, among which 14 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. We are grateful to 29 reviewers from 14 countries who read the submitted papers and have provided competent, and in most cases very detailed, feedback to their authors. Each paper was reviewed by at least two anonymous reviewers. Most of reviewers have a great international reputation witnessed by hundreds of citations in the Web of Science.

The Program Committee:

- Dirk Arnold, Dalhousie University, Halifax

- Petr Berka, University of Economics, Prague

- Fabrizio Durante, Free University of Bozen-Bolzano

- Jan Faigl, Czech Technical University, Prague

- Pitoyo Hartono, University of Chukyo

- Martin Holeňa, Czech Academy of Sciences, Prague

- Tamás Horváth, Eötvös Loránd University, Budapest

- Jan Kalina, Czech Academy of Sciences, Prague

- Jiří Kléma, Czech Technical University, Prague

- Georg Krempl, University of Utrecht

- Tomas Krilavičius, Vytautas Magnus University, Kaunas

- Philippe Lenca, IMT Atlantique, Brest

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

- Rafael Gomes Mantovani, Federal Techonology University of Paraná

- Engelbert Mephu Nguifo, Blaise Pascal University, Clermont-Ferrand

- Mirko Navara, Czech Technical University, Prague

- Irina Perfilieva, University of Ostrava

- Tomáš Pevný, Czech Technical University, Prague

- Petr Pošík, Czech Technical University, Prague

- Jan Rauch, University of Economics, Prague

- Heike Trautmann, University of Münster

- Thomas Weise, University of Hefei

- Filip Železný, Czech Technical University, Prague

2nd Workshop on Automata, Formal and Natural Languages – WAFNL 2021 (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 second time as a part of the Information Technologies – Applications and Theory (ITAT 2021) conference from September 22 to September 23, 2021. 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, regular papers track, and an open session.

We thank Daniel Zeman (Charles University, Prague, Czech Republic) for accepting our invitation and presenting recent results in his invited talk "Universal Description of Morphology and Syntax of Natural Languages".

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 two reviewers. Six papers accepted for the presentation at WAFNL 2021 are included in the proceedings of ITAT 2021.

The open session was organized in order to encourage further cooperation and sharing of information among investigators in automata and natural language processing. This offered an opportunity for anyone to present her/his work without writing a paper. Nevertheless, the text or at least the abstract of all open session contributions are published in separate proceedings available online on the web page of ITAT 2021.

We also thank the members of the program committee of WAFNL 2021 for reviewing the submitted papers:

- Gabriela Andrejková (Pavol Jozef Šafárik University, Košice, Slovakia),

- Jaroslava Hlaváčová (Charles University, Prague, Czech Republic),

- Tatiana Jajcayová (Comenius University, Bratislava, Slovakia),

- Markéta Lopatková (Charles University, Prague, Czech Republic),

- David Mareček (Charles University, Prague, Czech Republic),

- Peter Mlynárčik (University of Prešov, Prešov, Slovakia),

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

- Friedrich Otto (University Kassel, Kassel, Germany),

- Dana Pardubská (Comenius University, Bratislava, Slovakia), co-chair,

- Martin Plátek (Charles University, Prague, Czech Republic), co-chair,

- Daniel Průša (Czech Technical University, Prague, Czech Republic),

- Rudolf Rosa (Charles University, Prague, Czech Republic),

- Peter Vojtáš (Charles University, Prague, Czech Republic).

František Mráz, Prague
Dana Pardubská, Bratislava
Martin Plátek, Prague

Workshop on Natural Computing – WNC 2021 (Preface)

The Workshop on Natural Computing was hosted as part of the ITAT conference on September 24 – 28, 2021 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.:

- Cell-inspired computing (membrane computing)

- Biologically inspired grammatical models of complex systems (e.g., grammatical systems, reaction systems, Lindenmayer systems)

- Deep learning systems and applications

All published papers were referred by at least two anonymous reviewers. Seven regular papers were complemented by an invited talk by Rudolf Freund (TU Wien), entitled "The Power of Parallelism in Membrane Computing".

The WNC 2021 Workshop Program Committee:

- Luděk Cienciala, Silesian University in Opava

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

- Erzsébet Csuhaj-Varjú, Eötvös Loránd University

- Marian Gheorghe, University of Bradford

- Alberto Leporati, Università degli Studi di Milano-Bicocca

- Andrei Paun, University of Bucharest

- Mario J. Pérez Jiménez, University of Seville

- Agustín Riscos-Núñez, University of Seville

- Jose M. Sempere, Universitat Politècnica de València

- Petr Sosík, Silesian University in Opava

- György Vaszil, University of Debrecen

- 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 2021.

Data Analysis in Response to Epidemics – DARE 2021 (Preface)

The COVID-19 pandemics is accompanied by unprecedented levels of data collection, including epidemiological, genetic, economic, and sociological data sets. This presents us with almost real-time opportunities to study and understand various processes underlying this world-wide crisis and to adjust public response policies accordingly.

The DARE workshop, which has been a part of the ITAT 2021 conference, included papers focusing on various aspects of data analysis in the context of COVID-19 pandemics. The workshop included 11 contributions, each of which was reviewed by at least two anonymous reviewers solicited by the members of the workshop program committee. The workshop also included a session devoted to research highlights and current topics, and an invited talk by Ewan Birney, director of EMBL-EBI, entitled "Big Data in Biology: what the pandemic has taught us." The DARE workshop was organized in part as an activity of PANGAIA project (project number 872539 funded by the European Union Horizon 2020 research and innovation programme).

The Program Committee:

- Paola Bonizzoni, University of Milano-Bicocca

- Broňa Brejová, Comenius University in Bratislava

- Katarína Boďová, Comenius University in Bratislava

- Jaroslav Budiš, Comenius University Science Park

- Boris Klempa, Slovak Academy of Sciences

- Matúš Medo, Inselspital and University of Bern

- Jozef Nosek, Comenius University in Bratislava

- Martin Smatana, independent data analysis expert

- Jens Stoye, Bielefeld University

- Martin Šuster, National Bank of Slovakia

- Tomáš Vinař, Comenius University in Bratislava (chair)