VU Faculty of Mathematics and Informatics

Institute of Data Science and Digital Technologies – Annual Report 2022

Akademijos str. 4, LT-08412 Vilnius
Tel. (+370) 210 9300
E-mail: info@mii.vu.lt
http://www.mii.lt

Director – Prof. Dr. Habil. *Gintautas Dzemyda*

STAFF
71 research fellows (incl. 49 holding research degree), 12 teachers (all of them holding research degree), 36 doctoral students.

SUBDIVISIONS OF THE INSTITUTE

Blockchain Technologies Group
Cognitive Computing Group
Cyber-Social Systems Engineering Group
Education Systems Group
Global Optimization Group
Image and Signal Analysis Group
Intelligent Technologies Research Group
Statistics and Probability Group
Artificial Intelligence Laboratory

RESEARCH AREAS

Integrated development of mathematics, informatics and information technologies for the knowledge society advanced products and services

DOCTORAL DISSERTATIONS MAINTAINED IN 2022

Vaidas Jusevičius – *in Informatics (N 009) defended on 28th September*
Scientific Supervisor: *prof. dr. Remigijus Paulavičius*
"Research and development of an open-source algebraic modeling and mathematical optimization system"

Eglė Zikarienė – *in Informatics (N 009) defended on 29th September*
Scientific Supervisor: *prof. dr.Kęstutis Dučinskas*,
Scientific Consultant: *prof. dr. Julius Žilinskas*
"Spatial Contextual Classification Based on Conditional Distributions Belonging to Elliptical and Exponential Families"

MAIN CONFERENCES ORGANIZED IN 2022

- 13th Conference "Data Analysis Methods for Software Systems", December 1–3, 2022, Druskininkai, Lithuania
- 12th International Doctoral Consortium "Informatics Engineering Education Research", December, 2022, Druskininkai, Lithuania

BLOCKCHAIN TECHNOLOGIES GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 219 3299
E-mail: remigijus.paulavicius@mif.vu.lt

Head – Dr. *Remigijus Paulavičius*

STAFF
Research professor: Prof. Dr. R. Paulavičius.
Senior researchers: Dr. E. Filatovas, Dr. V. Medvedev, Dr. F. J. Orts.
Researcher: Dr. L. Stripinis.
Lecturer: Dr. A. Igumenov.
Junior researcher: Mindaugas Juodis.
Doctoral students: S. Grigaitis, J. Arsenjeva, A. Budžys.

RESEARCH INTERESTS

Blockchain technologies
Global optimization
Optimization software
Multi-objective optimization
High-performance computing

Artificial intelligence
Image processing
Big Data
Quantum computing

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Research and development of public, private, and consortium-type blockchain systems. Prof. Dr. R. Paulavičius, 2018–2023.
Investigation of the most popular and recent consensus algorithms, such as Proof of Work (PoW), Proof of Property (PoS), Proof of Authorship (PoA), Proof of Importance (PoI), Delegated Byzantium Fault Tolerance (dBFT), etc. A framework for selecting the most suitable consensus protocols depending on the identified criteria, priorities, and other requirements by incorporating Multi-Criteria Decision-Making (MCDM) techniques. Overview and empirical analysis of various metrics to evaluate the decentralization of the blockchain. New derivative-free optimization software for operational research. Investigation and application of Neural Architecture Search techniques for designing well-performing Convolutional Neural networks for image segmentation and object recognition in satellite imagery. Development of fault-tolerant carry lookahead adders that improve the cost in terms of quantum gates and qubits.

Main publications:

E. Filatovas, M. Marcozzi, L. Mostarda, **R. Paulavičius** (2022) A MCDM-based framework for blockchain consensus protocol selection. *Expert Systems With Applications*, 204, DOI: 10.1016/j.eswa.2022.117609

L. Stripinis, **R. Paulavičius** (2022) DIRECTGO: A new DIRECT-type MATLAB toolbox for derivative-free global optimization. *ACM Transactions on Mathematical Software*, p. 1-45, DOI: 10.1145/3559755.

L. Stripinis, **R. Paulavičius** (2022) An empirical study of various candidate selection and partitioning techniques in the DIRECT framework. *Journal of Global Optimization*, p. 1-31, DOI: 10.1007/s10898-022-01185-5.

F. Orts, G. Ortega, **E. Filatovas**, E.M. Garzón (2022). Implementation of three efficient 4-digit fault-tolerant quantum carry lookahead adders. *The Journal of Supercomputing*, p. 1-19, DOI: 10.1007/s11227-022-04401-x.

National Research Projects

Research Council of Lithuania. **Resolving research reproducibility problems in Artificial Intelligence using Blockchain Technologies** (No. P-MIP-21-196). Dr. E. Filatovas. 2021–2024.
Today, various Artificial Intelligence techniques have solved most real-world challenging decision problems (image analysis, voice and face recognition, planning, scheduling, routing, etc.). However, Artificial Intelligence research domains (as well as other research fields) face with Reproducibility Crisis. Researchers need help reproducing many key results due to the disconnection between publications and used codes, underlying data, parameter settings, etc., as they lack critical details. Solutions that improve code accessibility, data provenance tracking, research transparency, auditing of obtained results, and trust in Artificial Intelligence domains can significantly accelerate algorithm and model development, validation, and transition into real-world applications. Thanks to the features provided by Blockchain Technology, significant progress in resolving Reproducibility Crisis and full reproducibility can be achieved.
In this context, the project's main objective is to contribute to resolving research reproducibility problems in the Artificial Intelligence field and enhance the research cycle by developing a conceptual model of a blockchain-based decentralized platform, which would be efficient, scalable, interoperable, and adaptable in various Artificial Intelligence research domains.

Main publications:

F. Orts, G. Ortega, **E. Filatovas**, E.M. Garzón (2022). Implementation of three efficient 4-digit fault-tolerant quantum carry lookahead adders. *The Journal of Supercomputing*, p. 1-19, DOI: 10.1007/s11227-022-04401-x.

E. Filatovas, M. Marcozzi, L. Mostarda, **R. Paulavičius** (2022) A MCDM-based framework for blockchain consensus protocol selection. *Expert Systems With Applications*, 204, DOI: 10.1016/j.eswa.2022.117609

International Research Projects

E. Filatovas representing the Lithuanian side in project "High Performance Computing to Optimize Intensity Modulated Radiotherapy Schedules." UAL18-TIC-A020-B. Supported by Andalusian Board, Spain. 2019-2022.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

Imperial College London (UK)
Universidad de Almería (Spain)
Cardiff University (UK)
Systems Research Institute, Polish Academy of Sciences (Poland)
The Kharkiv National University of Radio Electronics, Computer Science Faculty (Ukraine)
Octeract Optimisation Intelligence (UK)

OTHER SCIENTIFIC ACTIVITIES

Dr. R. Paulavičius –
- member of the Young Academy of the Lithuanian Academy of Sciences;
- member of the *Artificial Intelligence and Digital Transformation* working group of the Arqus University Alliance;
- topic editor of *Mathematics*;
- affiliate member of the *European Network of Excellence on High Performance and Embedded Architecture and Compilation* (HiPEAC), www.hipeac.net;
- member of the Lithuanian Computer Society (LIKS);

Dr. E. Filatovas –
- member of the International Society on Multiple Criteria Decision Making (MCDM);
- member of the Lithuanian Computer Society (LIKS);
- member of Program/Scientific Committees:
  - ⊄ *BLOCKCHAIN'22: 4th International Congress on Blockchain and Applications*
- Reviewer in the following scientific journals:
  - *Expert systems with Applications*
  - *IEEE Transactions on Systems, Man and Cybernetics: Systems*
  - *Journal of Supercomputing*
  - *Informatica*

Dr. V. Medvedev –
- member of Lithuanian Computer Society, http://www.liks.lt/;
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/;
- member of Program/Scientific Committees:
  - program committee member of the International Workshop on Secure Mobile Cloud Computing (IWoSeMC-20, IWoSeMC-2022), http://iwosemc.eu/.
  - organizing committee member of the Conference on Data Analysis Methods for Software Systems (DAMSS), Druskininkai, Lithuania, https://www.mii.lt/damss

Dr. F. J. Orts
- https://hpca.ual.es/~forts/

Dr. L. Stripinis –
- project researcher in *National Research Project* (P-MIP-21-196)
- Reviewer in the following scientific journals:

- o *Journal of Global Optimization*
- o *Engineering Optimization*
- o *Mathematics*

Dr. A. Igumenov –
- member of Lithuanian Computer Society, http://www.liks.lt/.

COGNITIVE COMPUTING GROUP
4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9300
E-mail: gintautas.dzemyda@mii.vu.lt

Head – Prof. Habil. Dr. *Gintautas Dzemyda*

STAFF
Principal researchers: Prof. Habil. Dr. G. Dzemyda, Prof. Dr. A. Jakaitienė, Prof. Dr. O. Kurasova, Prof. Dr. Audris Mockus
Principal researchers of projects: Dr. R. Dukynaitė, Dr. G. Dzemydaitė, Dr. G. A. Melnik-Leroy, Dr. S. Raižienė, Prof. habil. dr. Želvys.
Researchers: Dr. R. Karbauskaitė, Dr. G. A. Melnik-Leroy, Dr. A. Usovaitė, Dr. M. Sabaliauskas, Dr. D. Stumbrienė.
Junior researchers: A. Šubonienė, V. Tiešis, J. Vaitekaitis.
Professors: Prof. Dr. Dučinskas, Prof. Habil. Dr. G. Dzemyda, Prof. Dr. O. Kurasova.
Assistants: Dr. M. Sabaliauskas, Dr. D. Stumbrienė, Dr. L. Ringienė.
Junior assistants: Dr. I. Katin, Ž. Vaišnoras.
Other staff: R. Gipiškis, L. Mikalauskienė, V. Palkevič, Dr. L. Ringienė, Dr. M. Sabaliauskas, V. Tiešis.
Doctoral students: D. Breskuvienė, V. Bulavas, R. Gipiškis, P. Gudžius, M. Karaliutė, G. Krasauskas, N. Kondrat, M. Motiejauskas, I. Pocė, R. Puronaitė, Ž. Vaišnoras, R. Vaišnorė.

RESEARCH INTERESTS
Artificial neural networks
Big data
Bioinformatics
Data mining
Deep learning
Global optimization methods
Multi-objective optimization
Image analysis, feature detection, image reconstruction, medical image processing
Internet data mining
Fractal dimensionality
Local optimization methods
Machine learning
Medical data analysis and decision support
Multiple criteria decision support
Operations research
Optimal control applications

Parallel computing
Simulation models in epidemiology, education, economics, and energy with uncertainty
Statistical simulation
Stochastic programming
Swarm intelligence
Visualization of multidimensional data
Web service development
Psychology in multiple criteria decisions

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Developing cognitive computing capabilities for data visualisation, image analysis and decision-making. Prof. Habil. Dr. G. Dzemyda, Prof. Dr. O. Kurasova. 2020–2022.

Main publications:

1. **Stumbrienė, Dovilė; Jakaitienė, Audronė; Želvys, Rimantas**; Žilinskas, Julius; **Dukynaitė, Rita**. Efficiency and effectiveness analysis based on educational inclusion and fairness of European countries // Socio-economic planning sciences. New York : Elsevier. ISSN 0038-0121. eISSN 1873-6041. 2022, vol. 8, part. B, art. no. 101293, p. [1-17]. DOI: 10.1016/j.seps.2022.101293. [DB: Scopus; Science Citation Index Expanded (Web of Science)]. https://doi.org/10.1016/j.seps.2022.101293
2. **Daranda, A., Dzemyda, G.** (2023). Reinforcement learning strategies for vessel navigation. *Integrated Computer Aided Engineering*, vol. 30, no. 1, pp. 53-66, 2023, DOI: https://doi.org/10.3233/ICA-220688. Published: 15 August 2022 (Web of Science). DOI: https://doi.org/10.3233/ICA-220688
3. **Dzemyda, Gintautas; Sabaliauskas, Martynas**. Geometric multidimensional scaling: efficient approach for data dimensionality reduction // Journal of global optimization. Dordrecht : Springer Nature. ISSN 0925-5001. eISSN 1573-2916. 2022, first published online, p. [1-25]. DOI: 10.1007/s10898-022-01190-8. [DB: Scopus; Science Citation Index Expanded. https://doi.org/10.1007/s10898-022-01190-8
4. **Melnik-Leroy, Gerda Ana**; Bernatavičienė, Jolita; Korvel, Gražina; Navickas, Gediminas; Tamulevičius, Gintautas; Treigys, Povilas. An overview of Lithuanian intonation: a linguistic and modelling perspective // Informatica. Vilnius : Vilniaus universiteto leidykla. ISSN 0868-4952. eISSN 1822-8844. 2022, first published online, p. [1-38]. DOI: 10.15388/22-INFOR502. [DB: Scopus; Science Citation Index Expanded (Web of Science)]. https://doi.org/10.15388/22-INFOR502

National Research Projects

Research Council of Lithuania. **Geometric Method for Solving the Problem of Multidimensional Scaling**. No. MSF-LMT-4. Prof. Habil. Dr. G. Dzemyda. 2019–2022.

The main goal of the project is to consider the stress function and multidimensional scaling, in general, the geometric point of view, and to develop the so-called Geometric MDS that creates a basis for a new class of algorithms to minimize the MDS stress. The new interpretation of the stress allows finding the proper step size, and the descent direction forwards the minimum of the stress function analytically if we consider and move a separate point of the projected space.

Main publications:

1. **Dzemyda, Gintautas; Sabaliauskas, Martynas**. Geometric multidimensional scaling: efficient approach for data dimensionality reduction // Journal of global optimization. Dordrecht : Springer Nature. ISSN 0925-5001.

eISSN 1573-2916. 2022, first published online, p. [1-25]. DOI: 10.1007/s10898-022-01190-8. [DB: Scopus; Science Citation Index Expanded (Web of Science)]

2. **Dzemyda, Gintautas; Sabaliauskas, Martynas**; Medvedev, Viktor. Geometric MDS performance for large data dimensionality reduction and visualization // Informatica. Vilnius : Vilniaus universiteto leidykla. ISSN 0868-4952. eISSN 1822-8844. 2022, vol. 33, no. 2, p. 299-320. DOI: 10.15388/22-INFOR491. [DB: Scopus; Science Citation Index Expanded (Web of Science)]

Research Council of Lithuania. **Effectiveness and Efficiency Analysis of Education Systems in EU Countries Employing Secondary Big Data (EFECTAS)** (No. DOTSUT-39 (09.3.3-LMT-K-712-01-0018) / LSS-250000-57) Dr. A. Jakaitienė. 2018–2022.

The main idea of the project is to assess the factors influencing the effectiveness and efficiency of the EU education systems, to develop effectiveness and efficiency measuring instruments in order to implement sound evidence-based educational policy.

The focus of the analysis was on two types of centralised national examinations (the 10th grade tests and Matura examination) that are being carried out in Lithuania for two decades. The purpose of the research is to analyze the assessments of mathematics and the Lithuanian language and literature for the entire Lithuanian secondary school population that do not have sampling errors while considering the factors of location, school ownership, and gender as important indicators when judging educational effectiveness in terms of quality and equity. We analyse the results of the 10th grade tests for the 2011–2015 period and the results of the same cohorts participating in the Matura examination. The conclusions drawn from national assessment data are somewhat different from international data; thus one cannot neglect national information for the development of educational policy. The variables analysed in the analysis have limited predictive power for achievements in both mathematics and the Lithuanian language and literature, and further analysis is required.

Main publications:

1. Stumbrienė, Dovilė; Jakaitienė, Audronė; Želvys, Rimantas; Žilinskas, Julius; Dukynaitė, Rita. Efficiency and effectiveness analysis based on educational inclusion and fairness of European countries // Socio-economic planning sciences. New York : Elsevier. ISSN 0038-0121. eISSN 1873-6041. 2022, vol. 8, part. B, art. no. 101293, p. [1-17]. DOI: 10.1016/j.seps.2022.101293.

2. Jakaitienė, Audronė; Želvys, Rimantas; Raižienė, Saulė; Dukynaitė, Rita; Stumbrienė, Dovilė; Vaitekaitis, Jogaila; Ringienė, Laura; Žilinskas, Julius; Žilinskas, Antanas. (Ne)išmatuojamas švietimo efektyvumas ir našumas. Vilnius : Vilniaus universiteto leidykla, 2022. 538 p. ISBN 9786090707197. eISBN 9786090707203.

Research Council of Lithuania. **Correcting misperceptions of Covid-19 data: an Innovative E-platform CognitiveSTATS for Training Statistical Intuitions in the General Public** (No. 01.2.2-LMT-K-718-05-0042), Dr. G. A. Melnik-Leroy. 2021/11-2023/09

The objective of this project is to create a prototype of the innovative e-platform for statistical intuition training in the general public, cognitiveSTATS, which will help to correct misperceptions of Covid-19 data. In order to implement this project, two activities have been planned: 1. to carry out scientific research and experiments in order to identify the most important problems in Covid-19 data interpretation (statistical and / or cognitive) and the most effective ways of training statistical intuitions; 2. based on the results of this research, to develop and test a prototype of the public's statistical intuition training platform. The platform CognitiveSTATS will help people understand some crucial phenomena inherent to the pandemic situation (the spread of the infection, the effectiveness of safety measures and vaccines, the probability to get infected, the economic consequences of the pandemic etc.) and evaluate more critically data and information, spreading in the public sphere, including those shared on social media. In order to ensure the effectiveness and the attractiveness of the platform, three innovative milestones will be used for its development: evidence from cognitive science, principles of gamification, and visualizations of Covid-19 data. In this way, the project aims at educating the society, training their skills, and as a

consequence, significantly influencing the attitudes and behavior of the public. The research carried out during the project and the developed prototype of the e-platform will be presented in international-level scientific articles. Given that the project idea is adaptable to future pandemic or crisis situations and that population attitudes and behavior are an essential factor in managing any emergency situation, CognitiveSTATS has a long-term perspective and can be widely applied in a data-driven world.

International Research Projects

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

University of Almeria (Spain)
University College London (UK)
Bar-Ilan University (Israel)
University of Ferrara (Italy)
Southwestern University of Finance and Economics (China)
Belarus State University (Belorussia)
University of Calabria (Italy)
National Cancer Institute of Lithuania
Hospital of Lithuanian University of Health Sciences *Kauno klinikos* (Lithuania)
Maribor University (Slovenia)
Vilnius University Hospital Santaros Kinikos (Lithuania)
Ecole Normale Supérieure (France)

OTHER RESEARCH ACTIVITIES

Prof. Habil. Dr. G. Dzemyda –

- member of Lithuanian Academy of Science, http://lma.lt;
- recently elected as the head of Division of Technical Sciences of the Lithuanian Academy of Sciences;
- member of programme committees of the international conferences:
  - The WorldCist'21 - 9th World Conference on Information Systems and Technologies;
  - ESSE 2021, 2nd European Symposium on Software Engineering;
  - IEEE INISTA 2021, International Conference on INnovations in Intelligent SysTems and Applications (INISTA);
  - SENSORNETS 2021 : 10th International Conference on Sensor Networks;
- chairman of the 12th International Workshop *Data Analysis Methods for Software Systems*, Druskininkai, Lithuania, 2021, http://www.mii.lt/DatAMSS/;
- editor-in-Chief of
  Baltic Journal of Modern Computing http://www.lu.lv/baltic-journal-of-modern-computing/;
  international journal *Informatica* (IOSPress/VU), https://www.mii.lt/Informatica/;
- editorial board member of 8 international journals: *Financial Innovation; International Journal of Computers; Communications and Control; Applied Computer Systems; Informatics in Education; Journal of Civil Engineering and Management; Nonlinear Analysis: Modelling and Control; Mathematics and Informatics. Journal of the Belarusian State University;*
- member of IFIP Technical Committee 12 Artificial Intelligence;
  http://www.ifiptc12.org.uk/ifiptc12/members.php;
- member of Lithuanian Computer Society, http://www.liks.lt/;

- ❖ member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/;
- ❖ member of Lithuanian Operational Research Society, http://www.mii.lt/LitORS/ .

Prof. Dr. O. Kurasova –

- member of editorial boards of international journals:
    - *Nonlinear Analysis: Modelling and Control*, http://www.mii.lt/NA/,
    - *Information Technology and Control*, https://itc.ktu.lt/index.php/ITC/about/editorialTeam
    - *Baltic Journal of Modern Computing*, http://www.lu.lv/baltic-journal-of-modern-computing/editorial-board/,
    - *Computational Science and Techniques,* http://journals.ku.lt/index.php/CST/about/editorialTeam,
    - *Informatics*, http://www.mdpi.com/journal/informatics;
- member of Association for Computing Machinery, https://www.acm.org/,
- member of IEEE, https://www.ieee.org,
- member of Association of European Operational Research Societies https://www.euro-online.org/
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/,
- member of Lithuanian Operational Research Society, http://www.mii.lt/LitORS/.
- Chairwoman of the doctoral committee of Informatics, Vilnius University.
- Member of the doctoral committee of Informatics Engineering, Vilnius University.
- Chairwoman of the doctoral committee of Informatics, Vilnius University.
- Member of the doctoral committee of Informatics Engineering, Vilnius University.

Prof. Dr. A. Jakaitienė –
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/index.html;
- board member of Lithuanian Statistics Society, http://www.statistikusajunga.lt/;
- member of International Biometric Association, https://www.biometricsociety.org;
- country representative of International Biometric Association in Nord Baltic Region, http://ibsnbr.org;
- country representative at European Statistical Advisory Committee, https://ec.europa.eu/eurostat/web/european-statistical-advisory-committee-esac.

Dr. R. Karbauskaitė –

- managing editor of *Informatica* (IOSPress/VU), https://informatica.vu.lt/journal/INFORMATICA/information/INFORMATICA-Editorial

Prof. Dr. K. Dučinskas
- board member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/index.html;
- board member of Lithuanian Statistics Society, http://www.statistikusajunga.lt/;
- member of International Biometric Association, https://www.biometricsociety.org;

Dr. G. A. Melnik-Leroy
- member of the Cognitive Science Society
- member of the programme committee of the international conference: New Sounds 2021

Doctoral student R. Puronaitė
member of the International Society for Clinical Biostatistics, https://www.iscb.info/

CYBER-SOCIAL SYSTEMS ENGINEERING GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9306
E-mail: saulius.gudas@mii.vu.lt
www: https://www.mii.lt/en/structure/scientific-groups/cyber-social-systems-engineering-group

Head – Prof. Dr. *Saulius Gudas*

STAFF
  Professor: Prof. Dr. Saulius Gudas.
  Senior research fellow: Prof. Dr. Dalė Dzemydienė (till 31.08.2022).
  Research fellows: Dr. Romas Alonderis, Assoc. Prof. Dr. Audronė Lupeikienė, Dr. Saulius Maskeliūnas.
  Assistant professors: Dr. Jolanta Miliauskaitė, Dr. Asta Slotkienė.
  Assistant research fellow: Laima Paliulionienė.
  Affiliated researchers: Prof. Habil. Dr. Stasys Jukna, Assoc. Prof. Habil. Dr. Regimantas Pliuškevičius, Assoc. Prof. Dr. Aida Pliuškevičienė.
  Doctoral students: Karolis Noreika.

RESEARCH INTERESTS

  Causality driven business process modeling and enterprise application software (EAS) engineering methods:
- Foundations of causality-based enterprise software engineering;
- Integration of causal models in the MDA / MDD and Agile processes;
- Causal modeling of enterprise management activities and business processes;
- Model-based application development (MBD) methods for different types of domains (enterprises, Internet of Things, smart systems, etc.);
  Mathematical logic:
- Automated deduction;
- Knowledge analysis methods;
- Deductive systems.

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Research of cyber-social systems and development of engineering methods at the intersection of cyber-physical and cyber-social systems
Prof. Dr. S. Gudas (leader), Dr. R. Alonderis, Prof. Dr. D. Dzemydienė, Assoc. Prof. Dr. A. Lupeikienė, Dr. S. Maskeliūnas, Dr. J. Miliauskaitė, Dr. A. Slotkienė, L. Paliulionienė, Affil.

Assoc. Prof. Habil. Dr. R. Pliuškevičius, Affil. Assoc. Prof. Dr. A. Pliuškevičienė, Affil. Habil. Dr. S. Jukna, doctoral student K. Noreika. 2021–2023.

Main results obtained in 2022:
1. Application of domain causality modeling (S. Gudas, K. Noreika, A. Lupeikienė):
   A causal model of Agile project management using a management transaction (MT) concept was developed. The notion of the space of processes was used to identify the MTs location along the axes of aggregation, generalization, and time. Taxonomy of the coordination meta-types and types was developed using the identifiers of the MTs.
   The direction of development of Enterprise Resource Planning (ERP) systems and Business Process Management Suites (BPMS) from the point of view of business requirements is determined for Industry 4.0 and Industry 5.0.
2. Classes of sequents of linear discrete tense logic have been established. Backward proof-search of any sequent in any of the class does not require global condition checks when the proof-search is performed using earlier obtained loop-type sequent calculus. (R. Alonderis, R. Pliuškevičius, A. Pliuškevičienė).

Main publications:

1. **Gudas, Saulius.; Noreika, Karolis**. Causal Interactions in Agile Application Development. Mathematics 2022, 10, 1497. https://doi.org/10.3390/math10091497 .
2. Szelągowski, Marek; **Lupeikienė, Audronė**; Berniak-Woźny, Justyna. Drivers and evolution paths of BPMS: state-of-the-art and future research directions // Informatica. Vilnius : Vilniaus universiteto leidykla. ISSN 0868-4952. eISSN 1822-8844. 2022, vol. 33, iss. 2, p. 399-420. DOI: 10.15388/22-INFOR487.
3. **Alonderis, Romas; Pliuškevičius, Regimantas Ričardas; Pliuškevičienė, Aida**; Giedra, Haroldas. Loop-check specification for a sequent calculus of temporal logic // Studia logica. Dordrecht : Springer. ISSN 0039-3215. eISSN 1572-8730. 2022, vol. 110, p. 1507-1536. DOI: 10.1007/s11225-022-10010-9.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

Riga Technical University (Latvia)
University of Tartu (Estonia)
Warsaw University of Technology (Poland)
Systems Research Institute Polish Academy of Sciences
University of Geneva (Switzerland)
University of Frankfurt (Germany)

OTHER SCIENTIFIC ACTIVITIES

Prof. Dr. Saulius Gudas
- reviewer of the *Baltic Journal of Modern Computing*, http://www.bjmc.lu.lv/;
- reviewer of the journal *Informatica*, https://www.mii.lt/informatica/;
- reviewer of the journal *Information Systems and e-Business Management,* https://www.springer.com/journal/10257;
- member of the Technical Committee TK8 of the Lithuanian Standardization Department;
- IFIP TC8 Information Systems member;
- representative of the National Digital Coalition from LIKS;

- program committee member of the 15th International Baltic Conference on Digital Business and Intelligent Systems (Baltic DB&IS 2022), Riga, Latvia, 4–6 July 2022, https://dbis2022.lu.lv/about/organisation/;
- program committee member of the 27th International Conference on Information and Software Technologies, ICIST 2022, held in Kaunas, Lithuania, https://icist.ktu.edu/#Programme-Committee-members.

Prof. Dr. Dalė Dzemydienė
- editorial board member of the *Scientific Journal of Riga Technical University: Applied Computer Systems*, https://acs-journals.rtu.lv/;
- editorial board member of the *International Journal of Electronic Security and Digital Forensics*, https://www.inderscience.com/jhome.php?jcode=ijesdf;
- editorial board member of the *International Journal of Strategic Property Management*, https://journals.vgtu.lt/index.php/IJSPM/editorialboard.
- program committee member of the 15th International Baltic Conference on Digital Business and Intelligent Systems (Baltic DB&IS 2022), Riga, Latvia, 4–6 July 2022, https://dbis2022.lu.lv/about/organisation/;
- member of the Council of the Lithuanian Computer Society (LIKS);
- head of the Section of Legal Informatics at the Lithuanian Computer Society (LIKS);
- member of the Council of the Lithuanian Operation Reasearch Society, https://www.mii.lt/litors/index.php?page,council.en;
- member of the European Artificial Intelligence Association;
- member of the European Operation Research Association.

Assoc. Prof. Dr. Audronė Lupeikienė
- editorial board member of the *Scientific Journal of Riga Technical University: Applied Computer Systems*, https://acs-journals.rtu.lv/;
- steering committee and program committee member of the 15th International Baltic Conference on Digital Business and Intelligent Systems (Baltic DB&IS 2022), https://dbis2022.lu.lv/about/organisation/;
- program committee member of the 14th International Conference on Agents and Artificial Intelligence (ICAART 2022), http://www.icaart.org/.

Dr. Saulius Maskeliūnas
- chairman of the Council of the Lithuanian Computer Society https://www.liks.lt/en/contacts/;
- head of the Technical Committee TK4 "Information technology" of the Lithuanian Standards Board LST;
- member of the Rules of Participation (RoP) working group of the European Open Science Cloud (EOSC), https://www.eoscsecretariat.eu/working-groups/rules-participation-working-group;
- Lithuania representative at the International Federation for Information Processing (IFIP) https://ifip.org/index.php?option=com_content&task=view&id=125&Itemid=441&ref=25
- International AIQT Foundation Advisory Board member (in Artificial Intelligence) https://www.inaiqt.com/about/foundation-advisory-board/
- member of the Ministry of Transport and Communications project "Development of New Generation Internet Access Infrastructure (RAIN-3)" Steering Committee;
- program committee member of the 15th International Baltic Conference on Digital Business and Intelligent Systems (Baltic DB&IS 2022), https://dbis2022.lu.lv/about/organisation/;

- member of the State Commission of the Lithuanian Language Sub-Commission of Language Technologies.

Dr. Jolanta Miliauskaitė
- reviewer of the *Baltic Journal of Modern Computing*, http://www.bjmc.lu.lv/;
- reviewer of the journal *Informatica*, https://www.mii.lt/informatica/
- scientific committee member of ICNAE 2022 (1ˢᵗ International Conference on New Approaches in Engineering)
- member of the Council of the Lithuanian Computer Society (LIKS).

Laima Paliulionienė
- organizing committee member of the 13th International Workshop on Data Analysis Methods for Software Systems (DAMSS), Druskininkai, Lithuania, December 1–3, 2022, https://www.mii.lt/damss/index.php/organizers.

Prof. Habil. Dr. Stasys Jukna
- scientific board member of the *Electronic Colloquium on Computational Complexity* (ECCC), http://eccc.hpi-web.de/colloquium/scientific_board/;
- editorial board member of the *Lithuanian Mathematical Journal*, https://www.mii.lt/en/lithuanian-mathematical-journal#editorial-board.

Assoc. Prof. Habil. Dr. Remigijus Pliuškevičius
- editorial board member of the *Lithuanian Mathematical Journal*, https://www.mii.lt/en/lithuanian-mathematical-journal#editorial-board.

Assoc. Prof. Dr. Asta Slotkienė
- reviewer of the journal *Informatica*, https://www.mii.lt/informatica
- program committee member of the 38th ACM/SIGAPP Symposium on Applied Computing, technical track on Intelligent Systems for Digital Era (ISDE) https://ati.ttu.ee/sac-isde/

EDUCATION SYSTEM GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9732
E-mail: valentina.dagiene@mii.vu.lt
https://www.mii.lt/struktura/moksliniai-padaliniai/edukaciniu-sistemu-grupe

Head – Prof. Dr. *Valentina Dagienė*

STAFF

    Chief research fellow: Prof. Dr. V. Dagienė

    Senior research fellow: Dr. T. Jevsikova

    Research fellows: Dr. V. Dolgopolovas, Dr. A. Juškevičienė, Dr. G. Stupurienė

    Doctoral students: V. Masiulionytė-Dagienė, T. Šiaulys

    Affiliated senior research fellows: Assoc. Prof. Dr. G. Grigas, Dr. L. Markauskaitė.

RESEARCH INTERESTS

- Application of intelligent technologies in education
- Computer science (Informatics) education research
- Computing engineering education research
- Software localisation
- Technology enhanced learning

RESEARCH THEME FOR 2021-2023:

Research on educational environments and technologies to improve the quality of education.
Prof. Dr. V. Dagienė, 2021–2023.

Main objective of the theme: To study the problems of designing, integrating and personalising interactive educational environments and technologies in education.

Main publications:

Dagienė, Valentina; **Dolgopolovas, Vladimiras**. Short tasks for scaffolding computational thinking by the global Bebras challenge // Mathematics. Basel : MDPI. eISSN 2227-7390. 2022, vol. 10, iss. 17, art. no. 3194, p. [1-30]. [Scopus; Science Citation Index Expanded (Web of Science)] [Indėlis: 1,000] [Citav. rod.: IF: 2,592; AIF: 1,291; kvartilis: Q1 (2021, Clarivate JCR SCIE)] [Citav. rod.: CiteScore: 2,90; SNIP: 1,162; SJR: 0,538; kvartilis: Q1 (2021, Scopus Sources)] [M.kr.: T 007]

Dagienė, Valentina; **Jevsikova, Tatjana**; **Stupurienė, Gabrielė**; **Juškevičienė, Anita**. Teaching computational thinking in primary schools: Worldwide trends and teachers' attitudes // Computer science and information systems. Novi Sad : University of Novi Sad. ISSN 1820-0214. eISSN 2406-1018. 2022, vol. 19, iss. 1, p. 1-24. [INSPEC; Scopus; Science Citation Index Expanded (Web of Science)] [Indėlis: 1,000] [Citav. rod.: IF: 1,170; AIF: 3,559; kvartilis: Q4 (2021, Clarivate JCR SCIE)] [Citav. rod.: CiteScore: 1,90; SNIP: 0,562; SJR: 0,350; kvartilis: Q3 (2021, Scopus Sources)] [M.kr.: N 009,T 007]

Dolgopolovas, Vladimiras; **Dagienė, Valentina**. On semiotics perspectives of computational thinking: unravelling the "pamphlet" approach, a case study // Sustainability. Basel : MDPI. eISSN 2071-1050. 2022, vol. 14, no. 4, art no. 1956, p. [1-19]. [Scopus; Science Citation Index Expanded (Web of Science)] [Indėlis: 1,000] [Citav. rod.: IF: 3,889; AIF: 4,719; kvartilis: Q2 (2021, Clarivate JCR SSCI); IF: 3,889; AIF: 6,732; kvartilis: Q2 (2021, Clarivate JCR SCIE)] [Citav. rod.: CiteScore: 5,00; SNIP: 1,310; SJR: 0,664; kvartilis: Q1 (2021, Scopus Sources)] [M.kr.: T 007]

Stupurienė, Gabrielė; **Jevsikova, Tatjana; Juškevičienė, Anita**. Solving ecological problems through physical computing to ensure gender balance in STEM education // Sustainability. Basel : MDPI. eISSN 2071-1050. 2022, vol. 14, iss. 9, art. no. 4924, p. [1-16]. [GEOBASE (Elsevier); GeoRef; Scopus; Social Sciences Citation Index (Web of Science); Science Citation Index Expanded (Web of Science)] [Indėlis: 0,332] [Citav. rod.: IF: 3,889; AIF: 4,719; kvartilis: Q2 (2021, Clarivate JCR SSCI); IF: 3,889; AIF: 6,732; kvartilis: Q2 (2021, Clarivate JCR SCIE)] [Citav. rod.: CiteScore: 5,00; SNIP: 1,310; SJR: 0,664; kvartilis: Q1 (2021, Scopus Sources)] [M.kr.: S 007,T 007]

International Research Projects

2020-2024 m. **COST: EUGAIN - CA19122** European Network for Gender Balance in Informatics**. (Dr. V. Dagienė, Dr. Anita Juškevičienė)**

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

Ankara University (Turkey)
ETH Zurich (Switzerland)

KTH Royal Institute (Sweden)
Lancaster University (UK)
Radboud University Nijmegen (The Netherlands)
Tallinn University (Estonia)
Turku University (Finland)

OTHER RESEARCH ACTIVITIES

Prof. Dr. V. Dagienė –
- editor-in-Chief of the journal *Informatics in Education*, https://infedu.vu.lt/journal/INFEDU (Clarivate Analytics Web of Science Core Collection; Scopus; etc.);
- editor-in-Chief of the journal *Olympiads in Informatics* (Scopus, etc), https://ioinformatics.org/page/ioi-journal-editorial-board/2;
- area editor (Computing Didactics) of the *Baltic Journal of Modern Computing*, https://www.bjmc.lu.lv (Clarivate Analytics Web of Science Core Collection; Scopus; etc.);
- editorial board member of the journals: *International Journal of Digital Literacy and Digital Competence; International Journal of Instruction*; *Acta Paedaogica Vilnensia*;
- coordinator of the Nordplus Network on Innovative Computing Engineering Education Research;
- representative of Lithuania in Education Committee TC3 under the International Federation for Information Processing (IFIP);
- chair of the Bebras Board (International Challenge on Informatics and Computational Thinking): https://www.bebras.org/?q=community.

Dr. V. Dolgopolovas –
- member of European AI Alliance https://futurium.ec.europa.eu/en/european-ai-alliance
- member of USERN: Universal Scientific Education and Research Network: https://usern.tums.ac.ir/

Dr. A. Juškevičienė –
- member for methodological group of EU co-funded project No. 01.1.1-CPVA-V-701-15-0001 „Development of Vilnius STEAM Center" activity „Preparation of the Methodological Part of STEAM Center activities: Development of Laboratory Descriptors and Integrated Methodologies for Robotics and Mobile Technology and Visual Programming Laboratory", http://steamlt.lt/

Dr. T. Jevsikova –
- member of International Federation for Information Processing (IFIP) TC3 WG 3.1 (Informatics for Secondary Education).
- member for methodological group of EU co-funded project No. 01.1.1-CPVA-V-701-15-0001 „Development of Vilnius STEAM Center" activity „Preparation of the Methodological Part of STEAM Center activities: Development of Laboratory Descriptors and Integrated Methodologies for Robotics and Mobile Technology and Visual Programming Laboratory", http://steamlt.lt/

Dr. G. Stupurienė –
- Executive Editor of the journal *Informatics in Education*, https://infedu.vu.lt/journal/INFEDU (Clarivate Analytics Web of Science Core Collection; Scopus; etc.).

- member of the Lithuanian Computer Society (LIKS);
- member of the European Commission's "SELFIE for TEACHERS" network of experts.

MOST IMPORTANT RESEARCH DISSEMINATION ACTIVITIES

Valentina Dagienė, Gabrielė Stupurienė, Tatjana Jevsikova have organized International Challenge on Informatics and Computational Thinking "Bebras", they create, translate, test tasks and develop methodological materials for teachers.

Valentina Dagienė and Gabrielė Stupurienė in cooperation with Institute of Educational Sciences have organized the 12th International Doctoral Consortium – School on Enginnering Education Research in Druskininkai, December 6-10, 2022.

International journal "Informatics in Education" *Scopus* citation index 4.0 (2021 year). *WoS* Journal Citation Indicator – 1.23 (not final).

GLOBAL OPTIMIZATION GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9304
E-mail: julius.zilinskas@mii.vu.lt

Head – Prof. Dr. *Julius Žilinskas*

STAFF
   Principal research fellows: Prof. Dr. J. Žilinskas, Prof. Habil. Dr. A. Žilinskas.
   Senior research fellows: Assoc. Prof. Dr. A. Lančinskas, Assoc. Prof. Dr. R. Pupeikis.
   Doctoral students: S. Tautvaišas, M. Kepalas.

RESEARCH INTERESTS
   Optimization and high-performance computing

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Global Optimization. Prof. Dr. J. Žilinskas.
The aim is development of global optimization algorithms and application of them to optimization problems.
The main results were: global optimization algorithms with constraints; heuristic algorithms for facility location problems; Bayesian global optimization; linear convolution computations online optimization algorithm.

Main publications:

P. Fernández, A. Lančinskas, B. Pelegrín, J. Žilinskas (2022). A discrete competitive facility location model with proportional and binary rules sequentially applied. Optimization Letters. DOI:10.1007/s11590-022-01938-x.

S. Tautvaišas, J. Žilinskas (2022). Scalable Bayesian optimization with generalized product of experts. Journal of global optimization. DOI:10.1007/s10898-022-01236-x.

D. Stumbrienė, A. Jakaitienė, R. Želvys, J. Žilinskas, R. Dukynaitė (2022). Efficiency and effectiveness analysis based on educational inclusion and fairness of European countries. Socio-economic planning sciences. vol. 8, part. B, art. no. 101293, p. [1-17]. DOI:10.1016/j.seps.2022.101293.

National Research Projects

LMT MIP proposal "Creation and development of optimization algorithms for facility location with uncertainty in customer behavior". Main proposer A. Lančinskas

International Research Projects

COST action proposal "Randomised Optimization Algorithms Research Network". Secondary proposer A. Lančinskas

COST action proposal "The European Network for Data-Driven Decision Making". Secondary proposer J. Žilinskas

MAIN RESEARCH ACHIEVEMENTS IN 2022

Heuristic algorithms for facility location problems.
Bayesian global optimization.
Linear convolution computations real time optimization algorithm.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

Universidad de Almería (Spain)
Universidad de Murcia (Spain)
Universidad de La Laguna (Spain)
Universidad de Malaga (Spain)
Universidade de Coimbra (Portugal)
University of Edinburgh (UK)
Università della Calabria (Italy)
Università degli Studi di Cassino e del Lazio Meridionale (Italy)
Cardiff University (UK)
New Jersey Institute of Technology (USA)

OTHER RESEARCH ACTIVITIES

Prof. Dr. J. Žilinskas –
- member of editorial boards of international journals:
  - Computational Management Science (Springer, https://www.springer.com/journal/10287/editors),
  - Computer Science (AGH, https://journals.agh.edu.pl/csci/about/editorialTeam), Informatica (IOSPress/VU, https://informatica.vu.lt/journal/INFORMATICA/information/INFORMATICA-Editorial),
  - Information Technology and Control (KTU, https://itc.ktu.lt/index.php/ITC/about/editorialTeam),
  - Journal of Global Optimization (Springer, https://www.springer.com/journal/10898/editors),
  - Mathematical Methods of Operations Research (Springer, https://www.springer.com/journal/186/editors),

- o Mathematical Modelling and Analysis (VGTU, https://journals.vilniustech.lt/index.php/MMA/editorialboard),
- o Open Computer Science (De Gruyter, https://www.degruyter.com/journal/key/comp/html#editorial),
- o Open Engineering (De Gruyter, https://www.degruyter.com/journal/key/eng/html#editorial),
- o Optimization Letters (Springer, https://www.springer.com/journal/11590/editors),
- o Operations Research Forum (Springer Nature, https://www.springer.com/journal/43069/editors).
- member of board of Lithuanian Operational Research Society (member society of EURO and IFORS), head of working group Optimization Methods and Applications, http://www.mii.lt/LitORS/;
- member of European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC), http://www.hipeac.net;
- member of Program/Scientific Committees:
  - o LION16: 16th Learning and Intelligent OptimizatioN Conference, Cyclades, Greece, June 5-10, 2022.

Prof. Habil. Dr. A. Žilinskas –
- member of IFIP working group WG 7.6 Optimization-Based Computer Aided Modeling and Design, http://www.ifip.org/bulletin/bulltcs/memtc07.htm;
- member of American Mathematical Society, http://www.ams.org/cml;
- member of programme committees of International conferences;
- member of editorial boards of international journals:
  - o *Journal of Global Optimization* (Springer), http://www.springer.com/business+%26+management/operations+research/journal/10898?detailsPage=editorialBoard,
  - o *Informatica* (IOSPress/VU), http://www.mii.lt/Informatica/editors.htm,
  - o Control and Cybernetics, control.ibspan.waw.pl:3000/mainpage,
  - o *Statistics, Optimization and Information Computing, www.iapress.org/index.php/soic*
  - o *Journal of Intelligent Learning Systems and Applications*, http://www.scirp.org/journal/jilsa/,
  - o *International Journal of Grid and High Performance Computing*, http://www.igi-global.com/Bookstore/TitleDetails.aspx?TitleId=1105&DetailsType=ReviewBoard
  - o *The Open Cybernetics and Systemics Journal*, http://www.bentham.org/open/tocsj/EBM.htm,
  - o *Baltic Journal of Modern Computing;* http://www.bjmc.lu.lv/editorial-board/ .
- member of the Lithuanian Academy of Sciences, http://lma.lt http://lma.lt/index.php?option=com_k2&view=item&layout=item&id=235&Itemid=243&lang=lt.

Dr. A. Lančinskas –
- affiliate member of European Network of Excellence on High Performance and Embedded Architecture and Compilation (HiPEAC), http://www.hipeac.net
- reviewer of journals:
  - ◦ Optimization Letters
  - ◦ Baltic Journal of Modern Computing

Assoc. Prof. Dr. R. Pupeikis –
- member of Lithuanian Computer Society, http://www.liks.lt;
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/;

- reviewer of the journal:
  International Journal of Adaptive Control and Signal Processing,
  https://onlinelibrary.wiley.com/journal/10991115

IMAGE AND SIGNAL ANALYSIS GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9328
E-mail: povilas.treigys@mii.vu.lt

Head – Assoc. Prof. Dr. *Povilas Treigys*

STAFF
Principal researchers: Prof., Dr. Povilas Treigys, Dr. G. Korvel
Senior research fellows: Assoc., Prof. Dr. G. Korvel, Assoc. Prof., Dr. G. Tamulevičius, Dr. Jolita Bernatavičienė
Affiliated research fellows: Prof. Habil. Dr. K. Kazlauskas
Projects specialist: G. Navickas
Doctoral students: B. Čiapas, J. Jucevičius, S. Virbukaitė, M. Danilovaitė, R. Jurkus, A. Vaitulevičius, R. Surkant
Study staff: L. Aidokas, A. Rasmusson, J. Globienė, M. Liutvinavičius, G. Navickas

RESEARCH INTERESTS

Audio and image signal processing; patern recognition; robotics; machine learning; natural language processing; machine learning.

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Project title: Digital signal analysis and modelling.

Tasks in 2023:

- Increase sea traffic anomaly detection algorithms accuracy.
- Investigate interclass distance impact on multiclass classification problem.
- Develop autoencoder-based models combining functional data analysis methods for cancerous prostate region detection.
- Investigate the impact of interpolation techniques on the segmentation results for the optic nerve disc and excavation using deep neural networks.
- Investigation of the Lombard effect for speech intelligibility improvement.
- Analysis and modeling of pathologic voices.
- Automatic speech recognition for Human-Robot interaction.
- Investigation and development of new synthesized speech quality evaluation methods.

Main results:

- Participated in the competition "The transport theme of students' final theses in the competition". The winner of the prize place, on the topic of water transport, entitled "Study of LSTM deep neural networks for predicting ship progress using big traffic data", Ministry of Communications, Vilnius, Lithuania.
- Investigated retail Self-checkout image classification performance: similar class grouping or individual class classification approach.
- Overview analysis of intonation modeling.
- Investigated noise interference on speech towards applying the Lombard effect automatically.
- Prepared manuscript on critical review of acoustic analysis-based voice pathology detection.
- Investigated cognitive approach methods for synthesized speech quality evaluation. Cognitive experiments with blind and sighted people.
- Enhancement of speech and audio signals.
- Investigated impact of COVID-19-related lockdown measures on economic and social outcomes in Lithuania, and office buildings occupancy analysis and prediction associated with the impact of the COVID-19 pandemic.

Main publications:

1. Markevičiūtė, Jurgita; Bernatavičienė, Jolita; Levulienė, Rūta; Medvedev, Viktor; Treigys, Povilas; Venskus, Julius. Impact of COVID-19-related lockdown measures on economic and social outcomes in Lithuania // Mathematics. Basel : MPDI. eISSN 2227-7390. 2022, vol. 10, no. 15, art. no. 2734, p. [1-20].
2. Motuzienė, Violeta; Bielskus, Jonas; Lapinskienė, Vilūnė; Rynkun, Genrika; Bernatavičienė, Jolita. Office buildings occupancy analysis and prediction associated with the impact of the COVID-19 pandemic // Sustainable cities and society. Amsterdam : Elsevier Ltd. ISSN 2210-6707. eISSN 2210-6715. 2022, vol. 77, art. no. 103557, p. 1-12.
3. Melnik-Leroy, Gerda Ana; Bernatavičienė, Jolita; Korvel, Gražina; Navickas, Gediminas; Tamulevičius, Gintautas; Treigys, Povilas. An Overview of Lithuanian Intonation: A Linguistic and Modelling Perspective // Informatica 2022. (accepted)
4. Korvel, Gražina; Kąkol, Krzysztof; Treigys, Povilas; Kostek, Bożena. Investigating noise interference on speech towards applying the Lombard effect automatically // ISMIS 2022: Foundations of intelligent systems: International symposium on methodologies for intelligent systems / Ceci, M., Flesca, S., Masciari, E., Manco, G., Raś, Z.W. (eds). Cham, 2022. ISBN 9783031165634. eISBN 9783031165641. p. 399-406. (Lecture Notes in Computer Science, ISSN 0302-9743, eISSN 1611-3349 ; vol 13515). DOI: 10.1007/978-3-031-16564-1_38

National Research Projects

- Nuasmenintų akių dugnų vaizdų bazės kūrimas. Vilnius Region Biomedical Research Committee approval no.:158200-18/11-1057-572, project duration 11-2018 – 10-2030.

- Postdoctoral Project "Investigating speech in the presence of noise interferences employing signal processing and machine learning methods", 2021-07-2023.07.

International Research Projects

H2020National Competence Centres in the framework of EuroHPC, Project duration 2020-9-1 – 2022-8-31, Project Reference: 951732.

- Within the EuroCC project under the European Union's Horizon 2020 (H2020), participating countries are tasked with establishing a single National Competence Centre (NCC) in the area of high-performance computing (HPC) in their respective countries. These NCCs will coordinate activities in all HPC-related fields at the national level and serve as a contact point for customers from industry, science, (future) HPC experts, and the general public alike. The EuroCC project is funded 50 percent through H2020 (EuroHPC Joint Undertaking [JU]) and 50 percent through national funding programs within the partner countries. The EuroCC activities—with 33 member and associated countries on board—is coordinated by the High-Performance Computing Center Stuttgart (HLRS). The project aims to elevate the participating countries to a common high level in the fields of **HPC, HPDA and artificial intelligence (AI)**. To this end, the EuroCC project will establish National Competence Centres (NCCs) in the participating countries, which will be responsible for surveying and documenting the core HPC, HPDA, and AI activities and competencies in their respective countries. Ultimately, the goal is to make HPC available to different users from science, industry, public administration, and society.

COST action CA18231 "Multi3Generation: Multi-task, Multilingual, Multi-modal Language Generation", Member of Managing Committee Dr. G. Korvel 2019-2023

- Language generation (LG) is a crucial technology if machines are to communicate with humans seamlessly using human natural language. A great number of different tasks within Natural Language Processing (NLP) are language generation tasks, and being able to effectively perform these tasks implies (1) that machines are equipped with world knowledge that can require multi-modal processing and reasoning (e.g. textual, visual and auditory inputs, or sensory data streams), and (2) the study of strong, novel Machine Learning (ML) methods (e.g. structured prediction, generative models), since virtually all state-of-the-art NLP models are learned from data. Moreover, human languages can differ wildly in their surface realisation (i.e. scripts) as well as their internal structure (i.e. grammar), which suggests that multilinguality is a central goal if machines are to perform seamless language generation. Language generation technologies would greatly benefit both public and private services offered to EU citizens in a multilingual Europe and have strong economic and societal impacts.

COST action CA21167 "Universality, diversity and idiosyncrasy in language technology (UniDive)", Member of Managing Committee Dr. G. Korvel 2022-2026

- Efficient access to the constantly growing quantities of data, especially of language data, largely relies on advances in data science. This domain includes natural language processing (NLP), which is currently booming, to the benefit of many end users. However, this optimization-based technological progress poses an important challenge: accounting for and fostering language diversity. The UniDive Action takes two original stands on this challenge. Firstly, it aims at embracing both inter- and intra-language diversity, i.e. a diversity understood both in terms of the differences among the existing languages and of the variety of linguistic phenomena exhibited within a language. Secondly, UniDive does not assume that linguistic diversity is to be protected against technological progress but strives for both of these aims jointly, to their mutual benefit. Its approach is to: (i) pursue NLP-applicable universality of terminologies and methodologies, (ii) quantify inter- and intra-linguistic diversity, (iii) boost and coordinate universality- and diversity-driven development of

language resources and tools. UniDive builds upon previous experience of European networks and projects which provided a proof of concept for language modelling and processing, unified across many languages but preserving their diversity. The main benefits of the Action will include, on the theoretical side, a better understanding of language universals, and on the practical side, language resources and tools covering, in a unified framework, a bigger variety of language phenomena in a large number of languages, including low-resourced and endangered ones.

Main results:

- Feature space analysis for machine based recognition.
- Machine learning algorithms for multiscale data analysis.
- Machine learning methods for language generation.
- Efficient deployment of fractal theory to industry applications.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INNOVATION) PARTNERS

- Hospital Kauno klinikos of Lithuanian University of Health Sciences (Lithuania)
- MB Sauliaus Vaitkaus ausų, nosies, gerklės ligų klinika (Lithuania)
- Forensic Science Centre of Lithuania (Lithuania)
- Vilnius University Hospital Santaros klinikos (Lithuania)
- National Cancer Institute (Lithuania)
- Brno University of Technology (Czech Republic)
- Gdansk University of Technology, Faculty of Electronics, Telecommunications and Informatics, Audio Acoustics Laboratory
- Aveiro University, Portugal
- Konstantinos Diamantaras, Department of Information and Electronic Engineering, International Hellenic University, Greece
- Elena Lloret, Department of Software and Computing Systems, University of Alicante, Alicante, Spain
- Justino Laurenco, Porto, ISPGAYA Portugal

OTHER RESEARCH ACTIVITIES

Prof. Dr. P. Treigys –

- reviewer of the journals:
  - *Informatica*, http://www.mii.lt/informatica;
  - *Modelling and Control Journal,* http://www.mii.lt/NA;
  - Nonlinear Analysis
  - Baltic Journal of Modern Computing
  - MDPI Senesors
  - MDPI Electronics

Prof. Habil. Dr. K. Kazlauskas –

- member of Lithuanian Computer Society, http://www.liks.lt;
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/;
- reviewer of international journals:
  - *IEEE Trans. On Signal Processing;*
  - *IEEE Trans. On Circuits and Systems;*
  - *Informatica;*

- o *Information Technology and Control.*

Assoc. Prof. Dr. G. Tamulevičius –
- reviewer for the international journals:
  - o *Informatica*, http://www.mii.lt/Informatica/;
  - o *Baltic Journal of Modern Computing*, www.lu.lv/baltic-journal-of-modern-computing;
  - o *Nonlinear Analysis: Modelling and Control Journal,* http://www.mii.lt/NA;
  - o *IEEE Access, IEEE Access.*
  - o *Neurocomputing https://www.journals.elsevier.com/neurocomputing*
  - o *IEEE Journal of Biomedical and Health Informatics https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6221020*
  - o *International Journal of Applied Mathematics and Computer Sciences https://www.amcs.uz.zgora.pl/*
- Senior member of IEEE Computer Society, Signal Processing Society, and Computational Intelligence Society sections. Vice-chair of the IEEE Lithuania Section Computer Society section.

Dr. G. Korvel –
- member of Lithuanian Computer Society, http://www.liks.lt;
- member of Lithuanian Society of Young Researchers. http://www.ljms.lt/;
- member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/
- Member of INSTICC (the Institute for Systems and Technologies of Information, Control and Communication), https://portal.insticc.org/

editorial board member:
- A member of editorial board of The Journal of Intelligent Information Systems

reviewer of international journals:
- *Journal of the Audio Engineering Society* www.aes.org/journal;
- *Archives of Acoustics* acoustics.ippt.gov.pl**;**
- *Metrology and Measurement Systems* http://www.metrology.pg.gda.pl;
- *Journal of Intelligent Information Systems* https://link.springer.com/journal/10844;
- *Information Technology and Control* http://itc.ktu.lt;
- *Informatica* www.mii.lt/informatica;
- *Pattern Recognition Letters* www.journals.elsevier.com/speech-communicat;
- *Speech Communication* www.journals.elsevier.com/speech-communication;
- *Symmetry https://www.mdpi.com/journal/symmetry*
- *Applied Sciences https://www.mdpi.com/journal/applsci*
- Electronics https://www.mdpi.com/journal/electronics

Dr. J. Bernatavičienė –
- Managing Co-editor of Baltic Journal of Modern Computing, http://www.bjmc.lu.lv/editorial-board/;
- Member of Lithuanian Computer Society (Artificial Intelligence Section), http://www.liks.lt/;
- Member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/;
- Member of Lithuanian Operational Research Society, http://www.mii.lt/LitORS/;
- reviewer of international journals:
  - o *Informatica (IOSPress/VU),*

- *Baltic Journal of Modern Computing*
- *Sensors*
- *Applied Sciences*
- *Journal of Marine Science and Engineering*

G. Navickas –

- member of Lithuanian Computer Society, http://www.liks.lt;
- member of IEEE http://www.ieee.org .

INTELLIGENT TECHNOLOGIES RESEARCH GROUP

4 Akademijos, LT-08663 Vilnius.
Tel. (+370 5) 210 9311
E-mail: virginijus.marcinkevicius@mif.vu.lt

Head – Dr. *Virginijus Marcinkevičius*

STAFF
Senior researchers: Prof. Dr. Virginijus Marcinkevičius, Prof. Dr. Darius Plikynas, Prof. Dr. Igoris Belovas.
Affiliated researchers: Prof. Habil. Dr. Leonidas Sakalauskas**,** Dr. Stasys Steišūnas,
Junior Assistants: Aivaras Bielskis
Profesors: Prof. Dr. Virginijus Marcinkevičius , Dr. Igoris Belovas.
Doctoral students: Aivaras Bielskis , Chaževskas Andrius, Dulskis Vytautas, Gricius Rolandas, Ieva Rizgelienė, Brendonas Stakauskas, Urbonaitė Neringa, Vaitkevičius Paulius.
Other staff: Lukas Kuzma

RESEARCH INTERESTS

Machine learning and its application.
Artificial intelligence and its application.
Natural language processing.
Cyber security.
Mathematical modeling.
Image analysis.
Data mining and visualization.
Application of modeling, classification and clustering methods in medicine (e.g. in genetics) and economics.
Optimization. Application of stochastic optimization methods in engineering.
Multi-agent systems: simulation and application in social research.

Publications:

1 Plikynas D, Miliauskas A, Laužikas R, Dulskis V, Sakalauskas L. The cultural impact on social cohesion: an agent-based modeling approach. Quality & Quantity. 2022 Jan 21:1-32. [Q1; IF=3.65] 0.85 https://doi.org/10.1007/s11135-021-01293-6

2   Belovas, I., Sabaliauskas, M., Kuzma, L. (2022) Series with binomial-like coefficients for the investigation of fractal structures associated with the Riemann zeta function // Fractal and fractional, 6(6:300), 1-21. [Q1; IF=3,577] 1 https://doi.org/10.3390/fractalfract6060300

3   Belovas, I. (2022). Central limit theorems for combinatorial numbers associated with Laguerre polynomials. Mathematics, 10 (6:865). [Q1; IF=2.592]   1 https://doi.org/10.3390/math10060865

4   Belovas, I. (2022). Series with binomial-like coefficients for the Riemann zeta function. Annali Di Matematica Pura Ed Applicata, 201, p. 903–912. [Q2; IF=0.986]   1 https://doi.org/10.1007/s10231-021-01142-1

5   Belovas, I. (2022). Central and local limit theorems for the weighted Delannoy numbers. Analele Stiintifice Ale Universitatii Ovidius Constanta-Seria Matematica, 30(2), 25-44. [Q3; IF=0.886]   1 https://www.anstuocmath.ro/mathematics/anale2022v2/2_Belovas_Igoris.pdf

6   Belovas, I., Sakalauskas, L. Starikovičius, V. (2022). A method for accelerated computation of the Riemann zeta function on the complex plane. Publicationes Mathematicae Debrecen, 100(1-2), 167–184. [Q2; IF=0.810]   1 https://doi.org/10.5486/PMD.2022.9120

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS

SAP (Germany)
Neurotechnology (Lithuania)
University of Tartu (Estonia)
Vilnius Gediminas Technical University (Lithuania)
Ghent University (Belgium)
Warsaw University of Technology (Poland)
Lithuanian Culture Research Institute (Lithuania)

OTHER SCIENTIFIC ACTIVITIES

Prof. L. Sakalauskas –
- Editorial board member of Journal Technological and Economic Development of Economy http://www.tandf.co.uk/journals/journal.asp?issn=2029-4913&linktype=145
- Elected member of International Statistical Institute (2001) http://isi-web.org;
- Member of European Working Group on Continuous Optimization http://www.iam.metu.edu.tr/EUROPT
- Member of European Working Group on Stochastic Optimisation http://www.mii.lt/EWGSO
- Member of European Working Group on Civil Engineering and Sustainable Development http://http://www.orsdce.vgtu.lt
- President of Lithuanian Operational Research Society, http://www.mii.lt/LitORS
- Chair of Lithuanian Conference on Operations Research and Application in Business and Technics http://www.mii.lt/OT-2016.
- Reviewer of international journals:
  - Annals of Operation Research (Springer)
  - European Journal of Operational Research (Elsevier)
  - Informatica (IOSPress/VU)

- o Central European Journal of Operational Research (Springer),
- o Information Technology and Control (KTU),
- o International Transactions on Operational Research (Wiley&Sons)
- o Methodology and Computing in Applied Probability (Springer)
- o Technological and Economic Development of Economy (Francis&Taylor)

Prof. D. Plikynas -
- Reviewer in
  - Computational and Mathematical Organization Theory (Springer)
  - Entropy (MDPI)
  - PeerJ
  - Economics (VU)
  - Information Technology and Control (KTU)
- Member of
  - Artificial Intelligence section of Lithuanian Computer Society (LIKS-AIS)
  - ESSA (European Social Simulation Association)
  - ECCAI (European Coordinating Committee for Artificial Intelligence)

Prof. Dr. I. Belovas –
- Member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/
- Member of editorial board of Lietuvos Matematikos Rinkinys journal

Prof. Dr. V. Marcinkevičius –
- Member of Council of Lithuanian Computer Society, http://www.liks.lt/en/modules/tinycontent/index.php?id=3
- Member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/
- Member of Lithuanian Operational Research Society, http://www.mii.lt/LitORS/
- Member of European Working Group on Stochastic Optimisation http://www.mii.lt/EWGSO
- Reviewer of international journal Informatica (IOSPress/VU)
- Member of editorial board of journal Applied Computer Systems
- Member of IST-141-RTG on Exploratory Visual Analytics group

Substitute in COST action Statistical and machine learning techniques in human microbiome studies.

STATISTICS AND PROBABILITY GROUP

4 Akademijos, LT-08663 Vilnius
Tel. (+370) 210 9731
E-mail kestutis.kubilius@mii.vu.lt

Head – Prof. Habil. Dr. *Kęstutis Kubilius*

STAFF
Principal research fellows: Prof. Habil. Dr. K. Kubilius, Dr. (HP) S. Norvidas.

Professor: Prof. Habil. Dr. M. Sapagovas (emeritus).
Senior research fellows: Dr. D. E. Otera, Dr. M., Dr. M. Vaičiulis.
Research fellows: Dr. A. Astrauskas, Dr. A. Čiginas, Dr. V. Kurauskas,
Dr. J. Novickij.
Affiliated research fellows: Dr. J. J. Mačys, Prof. Dr. R. Mikulevičius, Prof. Habil. Dr. R. Rudzkis,
Prof. Habil. Dr. J. K. Sunklodas.
Doctoral students: A. Medžiūnas

RESEARCH INTERESTS

Statistical inference for long memory processes
Heavy tails
Self-similar processes
Rough paths
Finite population statistics and statistical analysis of data
Differential equations with an integral boundary condition
Random graphs
Combinatorics
Discrete mathematics
Algebraic geometry

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget

Analysis and Application of Probabilistic and Deterministic Models. Prof. Habil. Dr. K. Kubilius. 2020–2022.

A review of several topological handedness conditions at infinity of finitely defined groups related to the concept of geometric simple connectivity, with special attention to the concept of simplicial resolvent developed by V. Poenaru (under the title "inverse representation"), is presented. The generalization of some existing results that correlate some of these properties is given

The stability of the alternating direction method for wave equation with integral boundary conditions in an energy norm is considered. The proof of the stability is based on the properties of eigenvalues and eigenvectors of the corresponding difference operators.

For one-dimensional stochastic differential equations driven by stochastic process with Holder continuous paths a backward approximation scheme is constructed. This approximation scheme demonstrates higher convergence rate than previous schemes by other authors in the field.

Main publications:

Otera, Daniele Ettore. On simplicial resolutions of groups // Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A. Matemáticas. Milan : Springer. ISSN 1578-7303. eISSN 1579-1505. 2022, vol. 116, no. 3, art. no. 138, p. [1-17]. DOI: 10.1007/s13398-022-01283-9

Sapagovas, Mifodijus; Novickij, Jurij. Alternating direction method for the wave equation with integral boundary conditions // Applied numerical mathematics. Amsterdam : Elsevier B.V. ISSN 0168-9274. eISSN 1873-5460. 2022, vol. 182, p. [1-13]. DOI: 10.1016/j.apnum.2022.07.017.

Kubilius, Kęstutis; Medžiūnas, Aidas. Pathwise convergent approximation for the fractional SDEs // Mathematics. Basel : MDPI. eISSN 2227-7390. 2022, vol. 10, iss. 4, art. no. 669, p. [1-16]. DOI: 10.3390/math10040669.

OTHER RESEARCH ACTIVITIES

Prof. K. Kubilius –

- co-editor-in-Chief of the *Modern Stochastics: Theory and Applications*, https://www.i-journals.org/vtxpp/VMSTA/ ;
- editorial board member of the *Lithuanian Mathematical Journal*, http://www.springer.com/mathematics/journal/10986?detailsPage=editorialBoard;
- editorial board member of the *Mathematical Modelling and Analysis*, http://inga.vgtu.lt/~mma/ .

Prof. S. Norvidas –

- editorial board member of the *Lithuanian Mathematical Journal*, http://www.springer.com/mathematics/journal/10986?detailsPage=editorialBoard.

Prof. Emeritus M. Sapagovas –

- editorial board member of the *Lithuanian Mathematical Journal,* http://www.springer.com/mathematics/journal/10986?detailsPage=editorialBoard;
- editorial board member of the journal *Nonlinear Analysis: Modelling and Control, https://www.mii.lt/NA/;*
- editorial board member of the journal *Informatica,* https://www.mii.lt/Informatica/;
- editorial board member of the *Mathematical Modelling and Analysis*, http://inga.vgtu.lt/~mma/ .

ARTIFICIAL INTELLIGENCE LABORATORY

Akademijos 4, LT-08663 Vilnius.
Tel. (+370 5) 210 9311
E-mail: virginijus.marcinkevicius@mif.vu.lt

Head – Dr. *Virginijus Marcinkevičius*

STAFF
Senior researchers: Dr. Virginijus Marcinkevičius.
Junior researcher: Dr. Jūratė Vaičiulytė, Linas Aidokas

Other staff: Neringa Urbonaitė
Doctoral students: Shubham Juneja, Vytautas Paura, Mantas Briliauskas.

RESEARCH INTERESTS

Advance machine learning in process automatization.
Natural language processing.
Image processing and analysis with deep neural networks.
Visual odometry and localization.

RESEARCH PROJECTS CARRIED OUT IN 2022

Projects Supported by University Budget
National Research Projects

The main goal is to investigate machine and imitational learning usage for robot navigation and localization in real environments. Research of natural language processing applications in human-machine interface

Main results:
1. Lasy, Ilya; Marcinkevičius, Virginijus. Dialogue system augmented with commonsense knowledge // Vilnius University Open Series: Konferencijos „Lietuvos magistrantų informatikos ir IT tyrimai" darbai", 2022 m. gegužės 16 d. Vilnius : Vilniaus universiteto leidykla, 2022. eISBN 9786090707425. eISSN 2669-0535. p. 68-76. DOI: 10.15388/LMITT.2022.7.

2. Chaževskas, Andrius; Belovas, Igoris; Marcinkevičius, Virginijus. Markov, probabilistic and rule-based password quessing methods: survey and comparison // Kriminalistika ir teismo ekspertologija: mokslas, studijos, praktika XVIII / Criminalistics and forensic expertology: science, studies, expertology: science, studies, practice : recenzuojamų mokslinių straipsnių rinkinys. Vilnius : Lietuvos eismo ekspertizės centras. ISSN 2783-7068. 2022, p. 114-123.

MAIN R&D&I (RESEARCH, DEVELOPMENT AND INOVATION) PARTNERS
SAP (Germany)
Neurotechnology (Lithuania)

OTHER SCIENTIFIC ACTIVITIES

Dr. V. Marcinkevičius –
● Member of Council of Lithuanian Computer Society,
  http://www.liks.lt/en/modules/tinycontent/index.php?id=3
● Member of Lithuanian Mathematical Society, http://www.mif.vu.lt/lmd/
● Member of Lithuanian Operational Research Society, http://www.mii.lt/LitORS/
● Member of European Working Group on Stochastic Optimisation
  http://www.mii.lt/EWGSO
● Reviewer of international journal Informatica (IOSPress/VU)
● Member of editorial board of journal Applied Computer Systems
● Member of IST-141-RTG on Exploratory Visual Analytics group
● Substitute in COST action Statistical and machine learning techniques in human microbiome studies.