### GROUP OF GLOBAL OPTIMIZATION

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**Head** – Prof. Dr. (HP) Julius Žilinskas

***STAFF***

**Principal researchers**: Prof. Dr. (HP) Julius Žilinskas, Prof. Habil. Dr. Antanas Žilinskas

**Senior researchers:** Doc. Dr. Algirdas Lančinskas, Doc. Dr. Rimantas Pupeikis

**Researchers:**

**Doctoral students:** Rima Kriauzienė, Eglė Zikarienė, Saulius Tautvaišas, Karolis Noreika

***RESEARCH INTERESTS***

Optimization and high-performance computing.

***RESEARCH PROJECTS CARRIED OUT IN 2019***

**Projects Supported by University Budget**

***Project title:* Global optimization.** Prof. dr. Julius Žilinskas

Aim: Development of global optimization algorithms and application of them to optimization problems.

*Main results:*

1. Global optimization algorithms with constraints;
2. Heuristic algorithms for competitive facility location problems;
3. Bi-objective decision making in Bayesian global optimization;
4. Linear convolution computations online optimization algorithm.

*Publication:*

* Stripinis L., Paulavičius R., Žilinskas J., Penalty functions and two-step selection procedure based DIRECT-type algorithm for constrained global optimization // *Structural and Multidisciplinary Optimization*, **59**(6), 2019, p. 2155 – 2175.
* Žilinskas A., Calvin J., Bi-objective decision making in global optimization based on statistical models // *Journal of Global Optimization*, **74**, 2019, p. 599–609.
* Žilinskas A., Gimbutienė G., A hybrid of Bayesian approach based global search with clustering aided local refinement // *Communications in Nonlinear Science and Numerical Simulation*, **78**, 2019, p. 104857.
* Pupeikis R., Revised linear convolution // *Lietuvos matematikos rinkinys*. **60**, Ser. A, Proc. LMS, 2019, p. 33–38.

**National Research Projects**

Research Council of Lithuania. ***Development and parallelization of ranking-based optimization algorithms* (**No. 09.3.3-LMT-K-712-02-0087) Dr. A. Lančinskas, 2017-2019.

*Description*: The project will deal with combinatorial optimization algorithms and their application to high-performance computing systems.

The objective of the project is to develop a ranking-based algorithm for solving combinatorial optimization problems using high-performance computing systems.

The project is based on two activities: development of the ranking-based algorithm and its application to high-performance computing systems.

The goal of the first activity is to develop the ranking-based algorithm suitable to solve combinatorial optimization problems. Beside well-known combinatorial optimization test problems, various instances of competitive facility location problems will be used in an experimental investigation. It is planned to organize a research visit at University of Murcia, where researchers have experience in modelling and solving facility location problems.

The goal of the second activity is to develop parallel versions of the algorithm ensuring effective communication between processors. For this purpose, it is necessary to search for novel solution in high-performance computing in order to create an optimal communication strategy. Computational experiments will be performed using high-performance computing system at Vilnius University. It is also planned to collaborate with Edinburgh Parallel Computing Centre in developing the parallel algorithm for large-scale high-performance computing systems.

In the case of success, a ranking-based algorithm for solving combinatorial optimization problems using high-performance computing systems will be proposed and experimentally investigated. The proposed algorithm will allow to solve complex combinatorial optimization problems encountered in various research and industry areas. The proposed principal solutions to create and parallelize the algorithm will contribute to further researches in development and parallelization of similar algorithms.

Research Council of Lithuania. (No. S-MIP-17-97/LSS-580000-1328) Prof. Habil. Dr. Antanas Žilinskas, 2017-2019.

*Description:* The of goal of the project is the creation of a unified stochastic global optimization (GO) theory. It is aimed at the breakthrough in the development of GO algorithms which will be based on fundamental postulates of the theory of rational decision making under uncertainty supplemented by the statistical models which represent considered classes of problems. The research is aimed at the reduction of complexity of auxiliary computations, and increase of dimensionality of practically solvable problems. The research is focused on single objective algorithms but some theoretical results are also generalized for multi-objective case. In the field of random search, the rate of convergence of general algorithms in the case of large dimension is investigated. In particular, we study precision of statistical estimates of the global minimum in the case of large dimensions, and show the degree in which these estimates suffer the so‐called curse of dimensionality. Additionally, we study advantages and disadvantages of the use of quasi‐random points in place of the random ones in large dimensions. Special versions of the algorithms are developed for the perspective computer patented as “the infinity computer” and their theoretical efficiency is assessed. The results of application of the developed algorithm to a real world problem are provided.

**International Research Projects**

1. COST action **Improving Applicability of Nature-Inspired Optimisation by Joining Theory and Practice** (ImAppNIO) CA15140. Member of Managing Committee Dr. A. Lančinskas. 2016–2020.

*Description:* Nature-inspired search and optimisation heuristics are easy to implement and apply to new problems. However, in order to achieve good performance it is usually necessary to adjust them to the problem at hand. Theoretical foundations for the understanding of such approaches have been built very successfully in the past 20 years but there is a huge disconnect between the theoretical basis and practical applications. The development of powerful analytical tools, significant insights in general limitations of different types of nature-inspired optimisation methods and the development of more practically relevant perspectives for theoretical analysis have brought impressive advances to the theory-side of the field. However, so far impact on the application-side has been limited and few people in the diverse potential application areas have benefitted from these advances.

The main objective of the COST Action is to bridge this gap and improve the applicability of all kinds of nature-inspired optimisation methods. It aims at making theoretical insights more accessible and practical by creating a platform where theoreticians and practitioners can meet and exchange insights, ideas and needs; by developing robust guidelines and practical support for application development based on theoretical insights; by developing theoretical frameworks driven by actual needs arising from practical applications; by training Early Career Investigators in a theory of nature-inspired optimisation methods that clearly aims at practical applications; by broadening participation in the ongoing research of how to develop and apply robust nature-inspired optimisation methods in different application areas.

**MAIN SCIENTIFIC ACHIEVEMENTS IN 2019**

*Pateikiami svarbiausieji 2019 m. mokslinės veiklos pasiekimai (jeigu buvo) – max 3*

1. Global optimization algorithms with constraints;
2. Heuristic algorithms for competitive facility location problems;
3. Bi-objective decision making in Bayesian global optimization;
4. Linear convolution computations real time optimization algorithm.

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

1. Universidad de Almería (Spain)
2. Universidad de Murcia (Spain)
3. Universidad de La Laguna (Spain)
4. University of Edinburgh (United Kingdom)
5. Università della Calabria (Italy)
6. Cardiff University (UK)
7. New Jersey Institute of Technology (USA)

***OTHER SCIENTIFIC ACTIVITIES***

**Prof. Dr. (HP) J. Žilinskas –**

* Member of editorial boards of international journals:
  + *Computer Science* (AGH), https://journals.agh.edu.pl/csci/about/editorialTeam
  + *Informatica* (IOSPress/VU), http://www.mii.lt/informatica/editors.htm
  + *Information Technology and Control* (KTU), http://itc.ktu.lt/index.php/ITC/about/editorialTeam
  + *Journal of Global Optimization* (Springer), http://www.springer.com/business+%26+management/operations+research/journal/10898?detailsPage=editorialBoard
  + *Mathematical Methods of Operations Research* (Springer) http://www.springer.com/mathematics/journal/186/PSE?detailsPage=editorialBoard
  + *Mathematical Modelling and Analysis* (VGTU), https://journals.vgtu.lt/index.php/MMA/editorialboard
  + *Open Computer Science* (De Gruyter), https://www.degruyter.com/view/j/comp
  + *Open Engineering* (De Gruyter), https://www.degruyter.com/view/j/eng
  + *Optimization Letters* (Springer), http://www.springer.com/mathematics/journal/11590?detailsPage=editorialBoard
  + *SN 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
  + WCGO2019: 6th World Congress on Global Optimization, Metz, France, 8-10 July, 2019.
  + EUROPT2019: 17th Workshop on Advances in Continuous Optimization, Glasgow, UK, 28-29 June, 2019.
  + EURO2019: 30th European Conference on Operational Research, Dublin, Ireland, 23-26 June, 2019.
  + NUMTA2019: Numerical Computations: Theory and Algorithms, Le Castella, Italy, 15-21 June, 2019.

**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 5 following International conferences.
* Member of editorial boards of international journals:
* *Journal of Global Optimization* (Springer), <http://www.springer.com/business+%26+management/operations+research/journal/10898?detailsPage=editorialBoard>
* *Informatica* (IOSPress/VU), <http://www.mii.lt/Informatica/editors.htm>
* Control and Cybernetics, control.ibspan.waw.pl:3000/mainpage
* *Statistics, Optimization and Information Computing, www.iapress.org/index.php/soic*
* *Journal of Intelligent Learning Systems and Applications*, <http://www.scirp.org/journal/jilsa/>
* *International Journal of Grid and High Performance Computing*, <http://www.igi-global.com/Bookstore/TitleDetails.aspx?TitleId=1105&DetailsType=ReviewBoard>
* *The Open Cybernetics and Systemics Journal*, <http://www.bentham.org/open/tocsj/EBM.htm>
* *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>.
* Member of management committee of COST action CA15140 Improving Applicability of Nature-Inspired Optimisation by Joining Theory and Practice (ImAppNIO).
* Member of conference program committees:
  + *Black Box Discrete Optimization Benchmarking (BB-DOB) Workshop at the Genetic and Evolutionary Computation Conference (GECCO 2019)*
  + *3rd International Workshop on Theoretical Approaches to Performance Evaluation, Modeling and Simulation (TAPEMS 2019)*
  + *19th International Conference on Algorithms and Architectures for Parallel Processing (ICA3PP 2019)*
* Reviewer of international journals:
  + *Applied Mathematical Modelling*
  + *Baltic Journal of Modern Computing*
  + *Central European Journal of Computer Science*
  + *Computers and Industrial Engineering*
  + *Computers and Operation Research*
  + *Informatica*
  + *Journal of Global Optimization*
  + *Nonlinear Analysis: Modelling and Control*
  + *Open Engineering (Central European Journal of Engineering)*
  + *Optimization Letters*
  + *Research in Transportation Economics*