CV of Dr. Tatjana Davidović

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Short bio

Dr. Davidović received her B.Sc. degree at Faculty of Mathematics, University of Belgrade, in 1987. and M.Sc. degree at the same faculty, in 1992, with the thesis *An Approach to Parallelization of Symbolic Robot Model*. In 2006 she obtained PhD degree at Faculty of Mathematics, University of Belgrade with the thesis *Scheduling Tasks to Multiprocessor Systems by Applying Metaheuristics* under the supervision of Professors Nenad Mladenović and Dušan Tošić. She is engaged in doctoral courses on Parallel Programming, Metaheuristics, and Optimization at the Faculty of Technical Sciences, University of Novi Sad, Serbia. Dr. Davidović participated in a number of national and international scientific projects. Her main research interests include parallel computing, scheduling, combinatorial optimization, mathematical programming, metaheuristics. She has published 4 chapters in international monographs, 29 papers in refereed international journals, more than 60 papers in conference proceedings and she delivered three invited talks at the international conferences. She is a member of the Editorial Board of two scientific journals and Program Committees for several international conferences related to optimization, computer science and information technology fields. Dr. Davidović is a Deputy Chair of the Computer Science and Applied Mathematics Colloquium (weekly meetings with distinguished national and foreign lecturers). According to SCOPUS database, her results were cited (excluding self-citations) 266 times and her Hirsch index is 9 (Apr. 2022).

Relevant publications

1. Kovač, N., **Davidović, T.**, Stanimirović, Z., Population-based Metaheuristics for the Dynamic Minimum Cost Hybrid Berth Allocation Problem, *International Journal on Artificial Intelligence Tools*, 30(4), pp. 2150017:1-29, 2021.
2. **Davidović, T.**, Jakšić Kruger, T., Convergence Analysis of Swarm Intelligence Meta-heuristic Methods, In: Eremeev A., Khachay M., Kochetov Y., Pardalos P. (eds.), Proc. OPTA 2018, Omsk, Russia, July 08-14, 2018, (CCIS, volume 871), Springer, 2018, pp. 251-266.
3. **Davidović, T.**, Glišović, N., Rašković, M., Bee Colony Optimization for Clustering Incomplete Data, In: S. Belim et al. (eds.): Proc. OPTA 2018, Omsk, Russia, July 08-14, 2018, (OPTA-SCL 2018), CEUR Workshop Proceedings, 2018, pp. 94-108.
4. Jakšić Kruger, T., **Davidović, T.**, Teodorović, D., Šelmić, M., The Bee Colony Optimization Algorithm and its Convergence, *Int. J. Bio-Inspired Computation* 8(5), 340-354, 2016.
5. **Davidović, T.**, Teodorović, D., Šelmić, M., Bee Colony Optimization Part I: The Algorithm Overview, *YUJOR,* 25(1), 33-56, 2015.
6. Teodorović, D., Šelmić, M., **Davidović, T.**, Bee Colony Optimization Part II: The Applications Survey, *YUJOR,* 25(2), pp. 185-219, 2015.
7. Stojanović, T., **Davidović, T.**, Ognjanović, Z., Bee Colony Optimization for the Satisfiability Problem in Probabilistic Logic, *Appl. Soft Comput.*, 31, pp. 339-347, 2015.
8. Crainic, T. G., **Davidović, T.**, Ramljak, D., DESIGNING PARALLEL META-HEURISTIC METHODS, In *High Performance and Cloud Computing in Science and Education*, Despotović-Zrakić, M., Milutinović, V., Belić, A., (eds.), IGI-Global, pp. 260-280, 2014.
9. **Davidović, T.**, Jakšić, T., Ramljak, D., Šelmić, M., Teodorović, D., MPI Parallelization Strategies for Bee Colony Optimization, *Optimization*, Special Issue entitled "Advances in Discrete Optimization", dedicated to BALCOR 2011, 62(8), 1113-1142, 2013.
10. **Davidović, T.,** Šelmić, M., Teodorović, D., Ramljak, D., Bee Colony Optimization for Scheduling Independent Tasks to Identical Processors, *J. Heur.* 18(4), 549-569, 2012.
11. **Davidović, T.**, Ramljak, D., Šelmić, M., Teodorović, D., Bee Colony Optimization for the *p*-Center Problem, *Comput. Oper. Res.*, 38(10), pp. 1367-1376, 2011.
12. Maksimović, P., **Davidović, T.**, Parameter Calibration in the Bee Colony Optimization Algorithm, in Proc. BALCOR 2013, Beograd-Zlatibor, Sept. 07-11, 2013, pp. 255-264.

Research Group

Mathematical Programming and Optimization research group in the Mathematical Institute consists of 2 senior researchers, 3 young researchers and 4 PhD students. It also involves external collaborators from several Serbian universities and some foreign institutions. Our international collaboration includes universities and research institutions at all five continents. The main research topics include developing mathematical models and methods for various optimization problems. We apply different general purpose exact solution packages (CPLEX, Gurobi, LINGO, etc.) and develop problem specific exact and heuristic algorithms. Although working with various metaheuristic methods, we particularly promote the ones developed by Serbian researchers, Variable Neighborhood Search (VNS) and Bee Colony Optimization (BCO). Parallelization, theoretical and empirical evaluation of metaheuristics are also in the focus of our research. Among considered optimization problems the special attention is paid to optimization on graphs, scheduling, transportation, location, etc. We also work on real-life optimization problems raising in science and industry.

Current research trends in our field propagate the integration of Artificial Intelligence (AI) and optimization methods. Therefore, we started a project called Integrating Machine Learning and metaheuristics that completely follows this concept.

Work Proposal

The award winning candidate will work with other students at MISANU on integrating Machine Learning (ML) and metaheuristics (MH). This research project consists of two parts: Applying ML to improve performance of MH methods and increasing the efficiency of ML by the application of MH. We are specifically interested in the Bee Colony Optimization method (BCO). BCO is a promising MH method for designing powerful and efficient heuristic algorithms tailored to deal with some considered class of optimization problems.

Our objective related to the first part of the project is to incorporate ML techniques into the development of the BCO algorithm. More precisely, we want to apply ML for tuning parameters of the BCO MH method. The concrete optimization problem will be selected jointly with the potential candidate. The classical off-line techniques for fine-tuning of the BCO parameters are impractical and time consuming processes. Some alternatives, applying fuzzy systems, exist in the literature, however, more sophisticated approaches are required in order to ensure that BCO performance will be comparative (or even better) compared to other bio-inspired MH methods. We believe that ML techniques for BCO parameter calibration will significantly contribute to robustness, effectiveness and efficiency of the resulting optimization method.

Another possible line of research within the first part of the project would be to apply ML techniques to ensure better convergence properties of BCO. Although it has been demonstrated that BCO satisfies requirements of the model-based convergence, the practical exploitation of this fact is still limited due to the slow convergence rate. Theoretical analysis has shown that BCO needs to learn from previously visited solutions and to adjust solution transformation rules (more precisely, selection probability of possible transformations) according to the gained knowledge. However, the adjustment rule based on pure theoretical considerations ensures asymptotic convergence which is inapplicable in practice. Therefore, we aim to examine the application of statistical learning as well as ML techniques to define the adaptation of selection probabilities such that the BCO convergence rate increases.

Within the second part, objective could be to incorporate the BCO method into the ML techniques. A typical line of research involves using BCO for tuning of (hyper)parameters of some ML algorithms, for example, for training of artificial neural network (ANN). Calculating appropriate values for weighting coefficients of ANN can be formulated as an continuous optimization problem. The objective function is defined as the prediction error, i.e., the difference between the outputs provided by the trained ANN and the ones given as the labels in the instances from the training set. The goal of optimization is to find the weighting coefficients values that minimize this error. Classical training methods are time consuming, especially for the complex ANN or Deep Neural Networks (DMM) with multiple hidden layers. Several recent studies are reporting promising results in the application of various MH methods to ANN training. Especially population-based methods proved their efficiency in this domain. Therefore, we believe that BCO has potential to exhibit good performance when dealing with this task.

Other Information

The **Mathematical Institute of the Serbian Academy of Sciences and Arts** (**MISANU**), (http://www.mi.sanu.ac.rs/) was founded in 1946 as the first institute of the Academy. For many decades MISANU is the unique center for mathematically-oriented fundamental and technological research in Serbia, employing more than 70 full-time researchers. Recognizing its importance, Government of Serbia declared MISANU as National Institute of the Republic of Serbia in April 2021. MISANU is an institutional member of the European Mathematical Society. According to the Webometrics Ranking, http://research.webometrics.info/en, MISANU is the most influential Serbian institute at Internet. MISANU has a number of experts doing high-quality research in several areas of mathematics and computer sciences. The strongest research groups within MISANU (which are also the most internationally recognized: see, for example, https://www.scimagojr.com) are in mathematical logic and discrete mathematics (optimization, cryptology). Among other fields of research, mechanics, geometry, operator theory, and analysis are the most influential ones. As the service center for all Serbian mathematicians, MISANU has the largest library with books and journals in mathematics, computer science, physic and other relevant fields. High Performance Computing (HPC) laboratory contains two IBM clusters, several servers and the largest data flow Field-Programmable Gate Array (FPGA) board (developed by Maxeller Technologies) in the South Europe.

Belgrade is a capital of Serbia, situated at a joint of two large rivers Sava and Danube with many green surfaces and parks. It is a very dynamic city that never sleeps and has a lot of attractions for young people. It is known by many festivals, theatres, museums, restaurants.

Accommodation in Belgrade is not expensive and it will be easy to find something suitable for potential student that awarded SPECIES scholarship. MISANU does not have any special accommodation for visitors or students, however, depending on the time of visit, we may use a room in the student residence.

Unfortunately, there is a small chance for providing **additional financing** for the award winning candidate. On the other hand, having in mind the live expenses in Serbia, the funds provided as SPECIES scholarship may cover the extension of one or even two months.