Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Subject
Mining multifaceted information on the performance of metaheuristics with use of parametrized benchmarks

Supervisor and co-supervisor
Prof. Olgierd Hryniewicz (Olgierd.Hryniewicz@ibspan.waw.pl, tel. +48 22 38 10 120)
Dr Karol Opara (Karol.Opara@ibspan.waw.pl, tel. +48 22 38 10 378)

Institute, in which the topic will be conducted
Systems Research Institute, Polish Academy of Sciences, ul. Newelska 6, 01-447 Warszawa, Poland

Scientific discipline	Information and Communication Technology
Recruitment form	Interview
Available positions	1 (one person)

Project description

Nature-inspired metaheuristics, such as swarm and evolutionary algorithms, form an important branch of artificial intelligence. Although according to the *no free lunch* theorem the universally best optimizer does not exist, some algorithms perform much better for particular groups of tasks. One of the great research challenges is the identification of these groups. This project aims to develop a systematic method for finding effective algorithms for particular types of tasks [1].

Comparing the performance of global optimization algorithms is crucial to their evaluation and guides the mainstream research. Its methodology is being actively developed. Commonly used benchmarks [2, 3] consist of a series of basic functions, which undergo several transformations such as rotation, scaling or shifting to create the final optimization tasks. Such transformations can be separated and applied in different combinations, leading to several, parameterized variants of each test function [1]. The relations between the tasks' properties and the algorithmic effectiveness can be investigated by evaluating the optimization performance. The newly proposed design of the simulation experiment includes both controlled and observed variables obtainable through exploratory landscape analysis [4]. This opens space for a variety of original analyses such as the quantitative assessment of relative strengths and weaknesses of optimizers. Decomposing the overall performance into the partial influences of different task properties will unpack the mechanics of the algorithms facilitating their gradual development. Finally, swarm and evolutionary algorithms can themselves be parameterized and compared leading to insights about the roles of their constitutive elements.

Completion of this project will provide experience in the development of state-of-the-art metaheuristics and advanced statistical modelling. The latter includes the design of experiments, the use of linear models, robust and non-parametric methods as well as explainable artificial intelligence. Parameterized benchmarking comes at a high computational cost that will be addressed by parallelization in the supercomputing centres. The choice of programming technology is of secondary importance, however, most of the reference code is available in Matlab/Octave and C++. Statistical analyses will be done either in R package or Python.

Bibliography

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2. N. H. Awad, M. Z. Ali, J. J. Liang, B. Y. Qu, P. N. Suganthan (2016). Problem definitions and evaluation criteria for the CEC 2017 special session and competition on single objective real-parameter numerical optimization. Technical Report.
3. N. Hansen, A. Auger, O. Mersmann, T. Tusar, D. Brockhoff. (2016). COCO: A platform for comparing continuous optimizers in a black-box setting. arXiv preprint arXiv:1603.08785.
4. O. Mersmann, B. Bischl, H. Trautmann, M. Preuss, C. Weihs, G. Rudolph, (2011). Exploratory landscape analysis. In proceeding of Genetic and Evolutionary Computation Conference, (pp. 829-836).

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