Modern approaches for Benchmarking in Evolutionary Computation

Abstract:

Many real-world scenarios involve optimization problems, for example, when minimizing risks, minimizing cost, maximizing reliability, and maximizing efficiency. For this reason, evolutionary computation focuses on development of algorithms for global optimization inspired by biological evolution. These algorithms are efficient for finding good solutions to NP-hard problems for which solutions cannot be computed in analytical or semi-analytical form, or by using deterministic algorithms. Additionally, in combination with machine learning algorithms they represent powerful techniques for solving many prediction problems in industry. Benchmarking in evolutionary computation is a crucial task and is used to evaluate the performance of an algorithm against other algorithms. Existing approaches for assessing the performance of algorithms are based on a statistical comparison of the algorithms' results. Even if it is crucial for research that state-of-the-art performance assessment approaches are related to statistical significance, there is still a large gap between theory and real-world scenarios. This is because sometimes the statistical significance that exists is not significant in a practical sense. Further, the performance metric usually transforms the optimization result into one-dimensional data that is further analyzed, without considering the information that exists in the high-dimensional space, which could give additional insight into the algorithm's performance. To make in-depth understanding of an algorithms' behavior, especially focusing on identifying practical significance, obtaining knowledge about performance using the information from solutions' space distribution (high-dimensional data), and making a more general benchmarking conclusion using a set of performance metrics, we proposed Deep Statistical Comparison approach and its variants that are able to address some of the issues that arise in the benchmarking theory. Finally, we will show the general applicability of the proposed methodology through identifying cases from research domains other than evolutionary computation, such as machine learning, recommender systems, and signal processing.

Bio:

Tome Eftimov is a research fellow at the Jožef Stefan Institute, Ljubljana, Slovenia. He was a postdoctoral research fellow at the Department of Biomedical Data Science, and the Centre for Population Health Sciences, Stanford University, USA, and a research associate at the University of California, San Francisco, USA (UCSF). He was awarded his PhD degree from the Jožef Stefan International Postgraduate School, Ljubljana, Slovenia, in 2018. His main areas of research include statistics, natural language processing, heuristic optimization, machine learning, and representational learning. His work related to benchmarking in computational intelligence has been invited to be presented as tutorials to the highest-ranked conferences in the field of stochastic optimization (GECCO and IEEE SSCI). He is also one of the main organizers of the benchmarking workshops at GECCO, IEEE CEC, and PPSN. His work was presented as invited lectures to several universities: Stanford University, University of California, San Francisco, University of California, Berkley, University of Salzburg, Radboud University, and Ss. Cyril and Methodius University - Skopje. He is a coordinator of the ARRS Postdoc project "Mr-BEC: Modern approaches for benchmarking in Evolutionary Computation" (2019) and is highly involved in leading several tasks in European projects.