Benchmarking Single- and Multi-Objective Optimization Algorithms via the (MO-)IOH-Profiler

– Proposal for a Tutorial at CEC 2025 –

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1 Tutorial Description

Comparing and evaluating optimization algorithms by empirical means is an important – and probably the most commonly applied – approach to gaining insight into (evolutionary) optimization methods. However, while our community tends to agree that generating and analyzing sound benchmarking data is far from trivial, we treat the process in a rather wasteful manner, giving little importance to a standardization of data records, data sharing, and similar. With this tutorial, we will share our experience on how to boost the efficacy of benchmarking efforts at almost no cost when using the IOHprofiler software framework. We will put a strong focus on recent extensions of the IOHprofiler to multi-objective optimization including anytime performance measurement. A focus will also be on demonstrating the ease by which (MO-)IOHprofiler modules can be combined with other benchmarking and optimization toolboxes such as COCO, Nevergrad and Pymoo. These examples will also be made available online for participants to refer back to after the tutorial. We will discuss how benchmarking data can be more easily shared within the community and the benefits that this brings, in terms of core research contributions, but also towards more sustainable research practices in evolutionary computation.

2 Organizational Matters

Potential Target Participants

Anyone interested in comparing the empirical performance of optimization heuristics and understanding the different options for extracting information from benchmarking data. Basic knowledge of multiobjective optimization will be beneficial to follow the tutorial. No prior experience with the IOH tools is required.

Presenters (see more details below)

Anna Kononova, LIACS, Leiden University, Netherlands
Jeroen Rook, Data Management and Biometrics, Univ. of Twente, Netherlands
Heike Trautmann, ML and Optimization, Paderborn University, Germany
Thomas Bäck, LIACS, Leiden University, Netherlands

Length and Level of Tutorial

Introductory Tutorial, 2 hours

Previous History

While parts of this tutorial are based on our previous tutorials (Benchmarking iterative optimization heuristics with IOHprofiler) at GECCO (2020,22,23,24) and CEC (2023,24), the tutorial we are now proposing takes a wider view of the benchmarking pipeline and integrates aspects of other tools as well (e.g. COCO, Nevergrad, Pymoo). In this way, we hope to broaden the scope towards extracting information from benchmarking experiments more generally. Additionally, the previous tutorials were focused only on single-objective optimization. We now explicitly focus on benchmarking aspects in multi-objective optimization settings.

3 Detailed Information about the Organizers

The tutorial will be jointly organized by the following persons.

Anna V. Kononova is Assistant Professor at the Leiden Institute of Advanced Computer Science, Leiden University (The Netherlands) where, since December 2019, she has led her group on Efficient Heuristic Optimisation (EcHO) within the Natural Computing cluster and acts as a member of the cluster management team. Her research concentrates on identifying and delivering order-of-magnitude efficiency improvements to solving heuristic optimisation problems with elements of machine learning. She received her MSc degree in Applied Mathematics from Yaroslavl State University (Russia) in 2004 and her PhD degree in Computer Science from the University of Leeds (UK) in 2010. After 5 years of postdoctoral experience at Technical University Eindhoven (Netherlands) and Heriot-Watt University (Edinburgh, UK), Anna spent 5 years working as an engineer and a mathematician in industry, before returning to academia in December 2019. Dr Kononova is the author of over 75 peer-reviewed publications, she serves as an editorial board member of the Evolutionary Computation journal and is an active contributor to the organisation of conferences like PPSN, EMO, FOGA and GECCO.
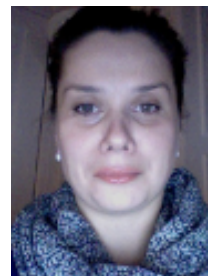
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Jeroen Rook is a PhD candidate in the Data Management and Biometrics group at the University of Twente and is supervised by Heike Trautmann, Holger Hoos, and Maurice van Keulen. He received his BSc and MSc in computer science at Leiden University in 2018 and 2021 respectively. His research topic focuses on creating multi-objective methods for automated algorithm configuration and selection to make them more statistically robust, versatile and powerful. More broadly, he is interested in multi-objective optimization and algorithm benchmarking.

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Heike Trautmann is Professor of Machine Learning and Optimisation at the University of Paderborn, Germany. Her research focuses on (Trustworthy) Artificial Intelligence, Machine Learning, Data Science, Automated Algorithm Selection and Configuration, Exploratory Landscape Analysis, (Multi-objective) Evolutionary Optimisation and Data Stream Mining. She is also (Guest) Professor of Data Science in the Data Management and Biometrics group at the University of Twente (NL) and until 2023, she was with the Department of Information Systems, University of Münster, Germany for ten years as Professor of Data Science: Statistics and Optimization. She is associate editor of the Evolutionary Computation Journal (ECJ) and the IEEE Transactions on Evolutionary Computation (TEVC) as well as member of the ACM Sigevo Executive Board.

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Thomas Bäck is Professor of Computer Science with the Leiden Institute of Advanced Computer Science (LIACS), Leiden University, Netherlands. His research interests include evolutionary computation, machine learning, and their real-world applications, especially in sustainable smart industry and health. Dr. Bäck has been elected as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW, 2021), as IEEE Fellow (class of 2022), and as a member of Academia Europaea (2022). He was a recipient of the IEEE Computational Intelligence Society (CIS) Evolutionary Computation Pioneer Award in 2015, was elected as Fellow of the International Society of Genetic and Evolutionary Computation in 2003, and received the best Ph.D. thesis award from the German society of Computer Science (GI) in 1995. He currently serves as Editor in Chief of the Evolutionary Computation Journal, Associate Editor for the IEEE Transactions on Evolutionary Computation and Artificial Intelligence Review journals and area editor for the ACM Transactions on Evolutionary Learning and Optimization. He is editorial board member of the Natural Computing Journal (Springer), Artificial Intelligence Journal, Journal of Big Data (Springer), and Journal of Intelligent Manufacturing (Springer). He was also co-editor-in-chief of the Handbook of Evolutionary Computation (CRC Press/Taylor & Francis 1997), co-editor of the Handbook of Natural Computing (Springer, 2013), author of Evolutionary Computation in Theory and Practice (OUP, New York, 1996) and co-author of Contemporary Evolution Strategies (Springer, 2013).

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