SPECIES Scholarships

Application as Host Institution

Prof. Dr. Olaf Mersmann & Prof. Dr. Boris Naujoks

Institut für Data Science, Engineering, and Analytics

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Advisors

The student will be advised by two professors from the interdisciplinary Institute for Data Science, Engineering, and Analytics (IDE+A) at TH Köln - Cologne University of Applied Sciences (THK). Both are esteemed researchers in the Evolutionary Computation community with a notable number of high-quality publications in the field.

Prof. Dr. Olaf Mersmann

Olaf Mersmann is a Professor for Data Science at TH Köln. He received his BSc, MSc and PhD in Statistics from TU Dortmund and worked as a public servant before joining THK in 2020. His research interests include using statistical and machine learning methods on large benchmark databases to gain insight into the structure of the algorithm choice problem. In particular he co-developed the idea of exploratory landscape analysis (ELA) as a tool to empirically characterize the relationship between problem landscape and optimizer performance. Before working on ELA, he applied ideas from social choice theory and voting to aggregate the results of large benchmark studies using consensus ranking methods.

Prof. Dr. Boris Naujoks

Boris Naujoks is a professor for Applied Mathematics at TH Köln. He joint THK directly after he received his PhD from Dortmund Technical University in 2011. During his time in Dortmund, Boris worked as a research assistant in different projects and gained industrial experience working for different SMEs. Meanwhile, he enjoys the combination of teaching mathematics as well as computer science and exploring EC and CI techniques at the Campus Gummersbach of THK. He focuses on multiobjective (evolutionary) optimization, in particular hypervolume based algorithms, and the (industrial) applicability of the explored methods.

Research Group

The interdisciplinary "Institut für Data Science, Engineering, and Analytics" (IDE+A) brings together scientists from the disciplines of computer science, mathematics, mechanical engineering, industrial engineering, statistics, automation and electrical engineering. It was established to apply cutting edge research from the fields of data science, machine learning and optimization to industrial problems.

In recent years, more than a dozen research projects with a combined volume of more than seven million Euros have been carried out with national and international partners. In cooperation with universities in Amsterdam, Berlin, Dortmund, and Leiden, 10 PhD projects are currently being carried out. Additional close research connections exist with the cities of Glasgow and Ljubljana.

Project: Continuous Optimizer Benchmarks using Ranking (COBRA)

Comparing and aggregating the outcome of competitors in multiple disciplines is complex and depends on the considered ranking and consensus methods. Judging the outcome of evolutionary algorithms on different test problems considering multiple runs falls into this area. It becomes even harder if one wants to compare evolutionary multiobjective optimization algorithms (EMOA) as different performance measures, with very different properties, have to be taken into account as well.

We have developed a framework to systematically compare EMOA under different settings [1]. We then introduced methods to combine these rankings from different benchmark scenarios into a consensus ranking to choose the 'best' algorithm. Here, we saw that there is no such thing as a universally best consensus and therefore there cannot exist a best algorithm for everyone. To illustrate this we analyzed a competition dataset from the CEC 2007 EMOA competition.

A comprehensive survey of voting literature could reveal more criteria which might ease the choice of a consensus method. In addition, benchmarking is a very important issue for single-objective evolutionary optimization as well. Modifications of the proposed methodology itself are not required. It will be investigated which performance indicators are suited best for deriving consensus rankings for single-objective evolutionary algorithms and which kind of test functions form a representative test set in order to perform benchmarking studies in a systematic and statistically sound way.

Thus, the work to be carried out by the student is thought to be closely connected to (consensus) rankings but can go into different directions like

- a comprehensive survey of voting literature to explore more/new ways to apply adequate ranking mechanisms in the field of evolutionary computation
- using distances between the ranking to discover subsets of similar benchmark instances

Furthermore, we are interested in practical realizations of these methods, like

- investigating well suited consensus rankings for single-objective evolutionary algorithms,
- setting up "ready to use" consensus ranking methods for different use-cases in EMOA
- exploring Bayesian ranking approaches and their applicability in the field of EC and many more

References

[1] Mersmann, O., Trautmann, H., Naujoks, B., and Weihs, C. *Benchmarking evolutionary multiobjective optimization algorithms.* In: IEEE Congress on Evolutionary Computation. IEEE Press, 2010. pp. 1-8.

Other relevant information

Location

The IDE+A is located on the Campus in Gummersbach, a small city located approx. 40km East of Cologne. We are however open to the possibility for the student to work at one of the other Campuses in Cologne. This would be decided together with the student based on their preferences. While Cologne is certainly the more lively city, it is also quite a bit more expensive and the natural beauty and calm of Gummersbach makes for a great research atmosphere.

Gummersbach

Gummersbach, center and district capital of the Oberbergisches Land, cultural and economic center, shopping city and service center of the region with about 52,000 inhabitants and an area of 95 sqr. km, is located in the middle of the nature park Bergisches Land.

Gummersbach is well connected to the metropolitan areas of Rhine and Ruhr by the "Sauerlandlinie" Dortmund-Gießen-Frankfurt (A 45), the federal highway Aachen-Cologne-Olpe (A 4). The regional train RB25 connects Cologne and Gummersbach. The international airport Cologne/Bonn is only about 55 km away.

Accomodation Arrangements

If the student decides to work at the Campus Gummersbach, we will try to arrange for a student dormatory if one is available during the stay. Otherwise we will assist the student in finding private boarding either in Gummersbach or Cologne during their stay.