Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

FAKULTÄT
FÜR BETRIEBSWIRTSCHAFT

PhD Course

Matheuristics

Block course (rooms will be announced shortly; some lectures will be online):

10 April 2025 (Thursday)	18:00 – 20:00 h room no. 3136/42
16 April 2025 (Thursday)	18:00 – 20:00 h (online)
17 April 2025 (Friday)	18:00 – 20:00 h (online)
08 May 2025 (Thursday)	18:00 – 20:00 h room no. 3136/42
09 May 2025 (Friday)	16:00 – 20:00 h room no. 3136/42
10 May 2025 (Saturday)	10:00 – 16:00 h room no. 3136/42

Further lecture dates will be provided on demand and discussed throughout the course. This will allow a flexible appointment for student presentations.

Some course parts may be held in a hybrid fashion using zoom (online). Further information to follow during the first meeting.

Course Instructor: Prof. Dr. Stefan Voß

Language: English

Student evaluation: Participation in the course, written term paper (incl. implementation)

How to register: Please register in STiNE until April 10, 2025

Course Value: 2 SWS or 5 credit points (Leistungspunkte)

Course Overview:

Introduction

Part of the introduction will be done in connection with Advances of Information Systems; we shall introduce generative artificial intelligence tools and use them to teach us about Heuristics, Metaheuristics and Matheuristics.

Heuristics

Local Search and Metaheuristics

Foundation (Complexity, Maths, etc.)

Matheuristics: Hybridizing Metaheuristics and Mathematical Programming

Various Approaches (POPMUSIC, Corridor Method, Feasibility Pump etc.)

Applications

Conclusions

In between: Interludes / How to compare numerical results?

Student Presentations

Course Contents:

After World War 2 the main application area for optimization shifted from the military to the industry. Industrial activities, and related functions, yield a cornucopia of applications for optimization algorithms, often backed by substantial money for finding good solutions. Unsurprisingly therefore, we have records of several decades of efforts dedicated to the solution of the induced problems. And unfortunately almost all of them are recognized as “provenly” hard.

How do we deal with this hardness, when a good solution is needed with limited computational resources? By means of heuristics. So we have several decades of research on heuristic algorithms to exploit. As the limit on the available computational resources has been increasingly lifted, the set of utilizable methodologies progressively widened. First heuristics were very simple, constructive and local search, then we had metaheuristics as generic guiding mechanisms for heuristics. Now, we are moving forward, and one of the pursued paths leads to including mathematical programming techniques into the solution framework, giving rise to matheuristic algorithms.

The course will feature some hands-on experience on these progressively complex approaches to the solution of some (one? two? many?) combinatorial optimization problems, arising in an industrial context, presumably logistics, unless the attendants wish otherwise. Given the no free lunch theorem, and the deriving relevance of the instance source, we will utilize or generate real world (-like) instances to work upon. Simple heuristics and metaheuristics for the problem will be sketched and the corresponding code will be applied to the instance of concern.

Then, some matheuristic approaches will be introduced, with reference to the example problem. As matheuristics methods are deeply rooted into mathematics, we will agree whether to delve into the maths and justify few approaches, or to be shallow and present more approaches.

Matheuristics of interest include decomposition methods, for example Lagrangian or Dantzig-Wolfe / column generation, MIP constraining, for example local branching or the corridor method, kernel problem identification, very large neighborhood search, POPMUSIC and possibly others. For some of these (e.g. matheuristic fixed set search), the implemented code will be shown and validated or provided on Github.