# Evolutionary Multi-Objective Optimization

Summer

(in German: Evolutionary Multi-Objective Optimization )

**Module-ID: FIN-INF-120469**

| Abbreviation | Credit Points | Semester | Term | Duration | Language | Level |
|---|---|---|---|---|---|---|
| EMO | 6 | Summer | starting at 1. | 1 Semester | english | Master |

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|---|---|
| **Link:** | LSF |
| **Limited accessability:** | |
| **Responsibility:** | Sanaz Mostaghim |
| **Lecturer:** | Sanaz Mostaghim |
| **Classes:** | • Lecture *Evolutionary Multi-Objective Optimization*<br>• Exercises *Evolutionary Multi-Objective Optimization* |
| **Applicability in curriculum:** | - M.Sc. INF: Informatik<br>- M.Sc. INGINF: Informatik<br>- M.Sc. WIF: Informatik<br>- M.Sc. DKE: Learning Methods and Models for Data Science<br>- M.Sc. DE: Methoden der Informatik<br>- M.Sc. VC: Computer Science |

**Intended learning outcomes:**
The students...

- have a full understanding of optimization and decision-making algorithms using evolutionary algorithms.
- are able to develop EMO algorithms
- can design optimization algorithms, model optimization problems and perform experiments.

**Content:**
In our daily life, we are inevitably involved in optimization. How to get to the university in the least time is a simple optimization problem that we encounter every morning. Just looking around ourselves, we can see many examples of optimization problems, even with conflicting objectives and higher complexities. It is natural to want everything to be as good as possible, in other words optimal. The difficulty arises when there are conflicts between different goals and objectives. Indeed, there are many real-world optimization problems with multiple conflicting objectives in science and industry, which are of great complexity. We call them Multi-objective Optimization Problems.
Over the past decade, many new ideas have been investigated and studied to solve such optimization problems as any new development in optimization which can lead to a better solution of a particular problem is of considerable value to science and industry. Among these methods, evolutionary algorithms are shown to be quite successful and have been applied to many applications. This course addresses the basic and advanced topics in the area of evolutionary multi-objective optimization and contains the following content:

- Introduction to single-objective optimization (SO) and multi-objective optimization (MO), classical methods for solving MO, definitions of Pareto-optimality and other theoretical foundations for MO
- Basics of evolutionary algorithms (algorithms, operators, selection mechanisms, coding and representations)
- Evolutionary multi-objective algorithms (NSGA-II, EMO scalarization methods such as MOEA/D)
- Constraint handling in SO and MO, robust optimization in EMO, surrogate methods for expensive function evaluations
- Evaluation mechanisms (Design of experiments, test problems, metrics, visualization)

**Workload:**
56 h contact time + 124 h self study

| **Pre-examination requirements:** | **Type of examination:** | **Teaching method / lecture hours per week (SWS):** |
|---|---|---|
| | Written exam (120 Min) Exercises | • 2 SWS lecture<br>• 2 SWS exercise class |

| Prerequisites according to examination regulations: | Recommended prerequisites: |
| --- | --- |
| none | |

| Media: | Literature: |
| --- | --- |
| | • Deb, Kalyanmoy. Multi-Objective Optimization Using Evolutionary Algorithms, Wiley, 2001.<br>• Coello, Carlos A. Coello, Gary B. Lamont, and David A. Van Veldhuizen. Evolutionary algorithms for solving multi-objective problems. Vol. 5. New York: Springer, 2007.<br>• Miettinen, Kaisa. Nonlinear multiobjective optimization. Vol.12. Springer Science & Business Media, 2012.<br>• Ehrgott, Matthias. Multicriteria optimization. Vol. 491. Springer Science & Business Media, 2005.<br>• Kruse, Rudolf, et al. Computational intelligence: a methodological introduction. Springer, 2016. |

## Comments:

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