# Swarm Intelligence

Winter

(in German: Swarm Intelligence )

## Module-ID: FIN-INF-102419

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

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| **Link:** | LSF |
| **Limited accessability:** | true |
| **Responsibility:** | Sanaz Mostaghim |
| **Lecturer:** | Sanaz Mostaghim |
| **Classes:** | • Vorlesung *Swarm Intelligence*<br>• Übung *Swarm Intelligence* |
| **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: Fachliche Spezialisierung<br>- M.Sc. VC: Computer Science |

**Intended learning outcomes:**
The students will get an understanding about Swarm Intelligence and its definitions. They will get the ability to develop swarm intelligence algorithms such as swarm aggregation, swarm movements, tracking, tracing and optimization. In addition, they learn the foundations in collective decision-making and their applications. The students can implement, analyse and evaluate swarm algorithms on several applications.

**Content:**
This course provides in-depth knowledge about swarm intelligence in technical systems. In swarm intelligence, we deal with a group of simple and usually homogenous individuals with simple rules. Usually, swarms can achieve a complex and intelligent behaviour using local interactions between its members. This collective property can be used in technical systems. One advanced application of swarm intelligence is in swarm robotics, in which simple small robots can collectively learn to achieve some predefined complex tasks. During this course, the algorithms of swarm intelligence are presented, analysed and compared. The following topics will be covered: Part 1: Fundamentals of swarm intelligence

- Swarm stability and stability analysis
- Swarm aggregation
- Swarm in known environments
- Swarm in unknown environments: Particle Swarm Optimization
- Dynamic Optimization
- Multi-Objective Particle Swarm Optimization

Part 2: Swarm and multiagent systems
- Division of labour and task allocation
- Swarm clustering and sorting
- Ant systems and optimization

Part 3: Applications
- Swarm localization and display
- Swarm robotics

**Workload:**
Präsenzzeit: 2 SWS Vorlesung 2 SWS Übungen Selbstständige Arbeit: Bearbeiten von Übungs- und Programmieraufgaben 180 h = 56 h Präsenzzeit + 124 h selbstständige Arbeit

| Pre-examination requirements: | Type of examination: | Teaching method / lecture hours per week (SWS): |
|---|---|---|
| All students that participate can take the exam. | Written Exam (120 min) | Vorlesung (2 SWS) Übung (2 SWS) |

| Prerequisites according to examination regulations: | Recommended prerequisites: |
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| keine | Informatik (Algorithmen und Datenstrukturen, Maschinelles Lernen) |

| Media: | Literature: |
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|---|---|
| | Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm In-telligence: From Natural to Artificial Systems, Oxford University Press, 1999Andries Engelbrecht, Fundamentals of Computational Swarm Intelligence, Wiley 2006 James Kennedy and Russel Eberhart, Swarm Intelligence, Morgan Kaufmann, 2001 Zbigniew Michalewicz and David Fogel, How to solve it: Modern Heuristics, Springer, 2001 Veysel Gazi, Stability Analysis of Swarms, The Ohio State University, 2002 Marco Dorigo and Thomas Stützle, Ant Colony Optimization, The MIT Press, 2004 C. Solnon: Ant Colony Optimization and Constraint Program-ming. Wiley 2010 Gerhard Weiss, Multiagent Systems: A modern approach to distributed artificial systems, The MIT Press, 2000 Christian Müller-Schloer, Hartmut Schmeck and Theo Ungerer, Organic Computing – A Paradigm Shift for Complex Systems, Springer, 2011 |

**Comments:**

Enrollment is limited to a maximum number of participants. If necessary, students will be selected based on a statement of purpose submitted at the beginning of the semester.

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