ENG-466

# Distributed intelligent systems

Martinoli Alcherio

| Cursus | Sem. | Type |
|---|---|---|
| Biocomputing minor | E | Opt. |
| Computational science and Engineering | MA2, MA4 | Opt. |
| Computer science | MA2, MA4 | Opt. |
| Cybersecurity | MA2, MA4 | Opt. |
| Data Science | MA2, MA4 | Opt. |
| Electrical and Electronical Engineering | MA2, MA4 | Opt. |
| Energy Management and Sustainability | MA2, MA4 | Opt. |
| Energy Science and Technology | MA2, MA4 | Opt. |
| Environmental Sciences and Engineering | MA2, MA4 | Opt. |
| Microtechnics | MA2, MA4 | Opt. |
| Robotics, Control and Intelligent Systems | | Opt. |
| Robotics | MA2, MA4 | Opt. |
| SC master EPFL | MA2, MA4 | Opt. |

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| Language of teaching | English |
| Credits | 5 |
| Session | Summer |
| Semester | Spring |
| Exam | Oral |
| Workload | 150h |
| Weeks | 14 |
| **Hours** | **5 weekly** |
| Courses | 2 weekly |
| Exercises | 3 weekly |
| **Number of positions** | |


## Summary

The goal of this course is to provide methods and tools for modeling distributed intelligent systems as well as designing and optimizing coordination strategies. The course is a well-balanced mixture of theory and practical activities.


## Content

- Introduction to key concepts such as self-organization and tools used in the course
- Examples of natural, artificial and hybrid distributed intelligent systems
- Modeling methods: sub-microscopic, microscopic, macroscopic, multi-level; spatial and non-spatial; mean field, approximated and exact approaches
- Machine-learning methods: single- and multi-agent techniques; expensive optimization problems and noise resistance
- Coordination strategies and distributed control: direct and indirect schemes; algorithms and methods; performance evaluation
- Application examples in distributed sensing and action

## Keywords

Artificial intelligence, swarm intelligence, distributed robotics, sensor networks, modeling, machine-learning, control

## Learning Prerequisites

### Required courses

Fundamentals in analysis, probability, and programming for both compiled and interpreted languages

### Recommended courses

Basic knowledge in statistics, programming language used in the course (C, Matlab, Python), and signals and systems

## Learning Outcomes

By the end of the course, the student must be able to:

- Design control algorithms
- Formulate a model at different level of abstraction for a distributed intelligent system
- Analyze a model of a distributed intelligent system
- Analyze a distributed coordination strategy/algorithm
- Design a distributed coordination strategy/algorithm
- Implement code for single robot and multi-robot systems
- Carry out systematic performance evaluation of a distributed intelligent system
- Apply modeling and design methods to specific problems requiring distributed sensing and action
- Optimize a controller or a set of possibly coordinated controllers using model-based or data-driven methods

## Transversal skills

- Demonstrate a capacity for creativity.
- Access and evaluate appropriate sources of information.
- Collect data.
- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Write a scientific or technical report.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.

## Teaching methods

Ex-cathedra lectures, assisted exercises, and homework in team

## Expected student activities

Attending lectures, carrying out exercises and the course project, and reading handouts.

## Assessment methods

Oral exam (60%) with continuous assessment during the semester (40%).

## Supervision

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| Office hours | Yes |
| Assistants | Yes |
| Forum | Yes |

## Resources

### Bibliography

Lecture notes, selected papers and book chapters distributed at each lecture.

### Websites

- https://disal.epfl.ch/teaching/distributed_intelligent_systems/

### Moodle Link

- https://moodle.epfl.ch/course/view.php?id=15472

## Prerequisite for

R&D activities in engineering