

**Module Description, available in: EN**

## Multi-Agent Systems

### General Information

**Number of ECTS Credits**

3

**Module code**

FTP\_MultiASys

**Valid for academic year**

2023-24

**Last modification**

2022-10-18

**Coordinator of the module**

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**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
<b>Instruction</b>				X E 100%			
<b>Documentation</b>				X E 100%			
<b>Examination</b>				X E 100%			

**Module Category**

FTP Fundamental theoretical principles

**Lessons**

2 lecture periods and 1 tutorial period per week

### Entry level competences

**Prerequisites, previous knowledge**

Basic knowledge of probability, algebra, calculus and differential equations. Basics of procedural programming and ability to implement small programs in an arbitrary language, e.g. Python, Matlab, R, Java, C#, C++, C, etc.

### Brief course description of module objectives and content

Natural, social, and engineered complex systems can be modelled as being composed of agents interacting with one another and their environment. This course introduces students to the theory, tools and techniques for understanding and solving problems related to such systems.

The course is composed of two parts. In the first one, both cooperative and selfish agents and interactions between them will be discussed. The methodological support will be provided by game theory.

In the second part, the focus will be on the study and analysis of models of systems in the aim of understanding the conditions under which certain properties can emerge and agent might learn certain strategies or behaviours by interacting with the environment and themselves.

Throughout the course, several application areas such as cooperation and competition, social influence and reinforcement learning will be discussed.

## Aims, content, methods

### Learning objectives and acquired competencies

A successful participant of this course is able to

- understand the rationale of multi-agent systems and their modelling.
- model scenarios with multiple interacting agents in the language of game theory
- evaluate the feasibility of achieving goals with agents using game theory
- understand the basic approaches to multi-agent learning, their peculiarities and their differences
- learn to choose the appropriate class of models with agents to characterise different complex systems
- implement in an efficient way a model of a system, then understand and analyse the corresponding outputs

### Contents of module with emphasis on teaching content

- Review of single-agent decision making and learning
- Multi-agent interaction:
  - games in normal form, dominant strategies,
  - Nash equilibria, Pareto optimality,
  - partial observability,
  - cooperative and coalition games, Shapley value,
  - repeated games,
- Multi-agent learning:
  - model based approaches: fictitious and rational learning
  - model-free approaches: no regret and reinforcement learning

### Teaching and learning methods

- Lectures
- Exercises and homework
- Practical work with appropriate tools
- Literature studies

### Literature

- *A Concise Introduction to Multi-Agent Systems and Distributed Artificial Intelligence*. Nikos Vlassis. Morgan & Claypool Publishers, 2007.
- *Introduction to Multi-Agent Systems* - 2nd Edition. Michael Wooldridge. John Wiley & Sons, 2009.
- *Multi-Agent Systems*. Yoav Shoham and Kevin Leyton-Brown. Cambridge University Press, 2009.
- *Artificial Intelligence, A Modern Approach* (4th Edition). Stuart Russell and Peter Norvig. Pearson. 2021

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Calculator.

**Other permissible aids**

3 handwritten A4 sheets (both sides). The use of a paper-based dictionary is permitted.

**Special case: Resit exam as oral exam****Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

The use of a paper-based dictionary is permitted.