Module Description, available in: EN

Multi-Agent Systems

General Information

Number of ECTS Credits

3

Module code

FTP_MultiASys

Valid for academic year

2026-27

Last modification

2024-10-15

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**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 competencies to be acquired

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

Module content with weighting of different components

- 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

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

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.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

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.