

## Multiagent Simulations and Applications

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# Overview of the Multi-Agent Systems Course

- A collection of formal models, algorithms, and perspectives when modeling situations with multiple (typically rational entities).
- Still fairly new, less settled than other areas (e.g., compared to planning, theory of algorithms, complexity theory, ...)
- Useful in your future industrial/academic career.
- Reactive Planning:
  - simulations of large systems (production systems, computer games, transport simulations, weather, disease spreading, ...)
  - robotics
  - internet of things (a truly open multi-agent system – e.g., a really smart fridge)

- Game Theory (direct, equilibrium computation):
  - security applications (designing/implementing security protocols)
  - robust optimization (zero-sum games)
  - computer games (board, puzzle – game-playing, creating a competitive opponent for players)
  - bounded rationality (quantal response equilibrium, ...)
- Game Theory (indirect, mechanism design):
  - designing rules (e.g., spectrum auctions, how to motivate users to do something)
  - resource allocation (e.g., computation time, cpu, mem; different from scheduling – you want the rational agents to participate, the allocation must be fair)

- Game Theory (cooperative):
  - cost/utility sharing (how to distribute costs/utility among teams in a fair way)
  - creating optimal teams (logistics, transportation, energy, finding and grouping users for sales)
- Social Choice
  - Crowdsourcing, finding the ground truth based on votes
  - design rules for voting (e.g., you want to give the opportunity to the users to improve your app)
- DCSP/DCOP
  - task completion by a collection of robots (drones, nanobots, ...)
  - example of nice distributed algorithms

# Incorrect Examples of Multiagent Simulations

Simple decentralization is not true multiagent system.

We do not have the true formal model of the system; hence, we cannot expect globally optimal behavior. There can be (inherently) a lot of uncertainty.

Many industrial applications focus on specification of protocols for communication, semantics used in the communication, however, one expects a deterministic outcome.

Typically, all agents have the common goal (revenue, developing products, etc.) and there is no need for interaction of rational agents (there is no need for voting, games, auctions, since they reduce to a direct optimization).

# Multiagent Systems



# Multiagent Systems

Interested in **diploma thesis / PhD** in Artificial Intelligence (Center)? **Stop by/Contact us.**

Many different topics from theoretic (**game theory, planning**), more applied (**computer network security, multiagent simulation, transportation**) to **robotics, UAVs**.

Please, fill out the **survey** (Did you like the course? Let us know. Didn't you like the course? Help us to improve the course).

# Invitations - Algorithmic Game Theory (XEP36AGT)

## [XEP36AGT](#)

## [Algorithmic Game Theory](#)

Guarantors:

[Bošanský B.](#)

Roles:

[S](#)

Extent of teaching: 2+0+4

Teachers:

[Bošanský B.](#)

Completion: ZK

Responsible Department:

13136

Credits:

4

Semester:

### **Anotation:**

This course extends the knowledge in multiagent systems and game theory by focusing on the algorithmic and computational problems - the computational complexity and current algorithms for finding and approximating different solution concepts, the impact of different representations of games, and the applications of learning techniques in game theory. The course is suitable for students that have already completed the course on Multiagent Systems (A4M36MAS) and either wish to strengthen their knowledge in game theory, or they are working on related problems from artificial intelligence such as machine learning, decision theory, planning.

### **Course outlines:**

1. Introduction to Game Theory
2. Fundamental Theorems (von Neumann, Nash, Kuhn)
3. Succinct Representations of Games
4. Finding Nash Equilibria
5. Approximating Nash Equilibria
6. Finding Correlated Equilibria
7. Finding Stackelberg Equilibria
8. Repeated Games
9. Learning and Dynamics in Games
10. Learning in Extensive-Form Games
11. Games of Incomplete Information, Auctions
12. Algorithmic Mechanism Design
13. Mechanisms Without Money
14. Stochastic Games

The structure of the lectures covers the important algorithmic topics in game theory. Besides attending the lectures, the students are assumed to work on their homework assignments that strengthen the understanding of the topic (4h per week).