

# Hauptseminar Algorithmen und Optimierung (S2C2) Algorithmic Game Theory

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# Algorithmic Game Theory

- Field at the intersection of game theory and computer science
- Motivated and necessitated by the emergence of the Internet and electronic commerce since the 1990s
- *Analyze* computational aspects of strategic interactions between agents
- *Design* mechanisms that facilitate strategic interactions between agents
- We will cover chapters of the Nisan–Roughgarden–Tardos–Vazirani Algorithmic Game Theory book

# Equilibrium computation

- Classical results in mathematical economics assert the existence of equilibria in games and markets.
- Non-constructive proofs via fixed point theorems. How hard is it to find an equilibrium as a computational problem?

# Mechanism design

Classical area of economics through a computational lens.

- **Algorithmic Mechanism Design:** design rules that enable efficient outcomes from selfish agent behaviour
- **Electronic Market Design:** find ways to implement mechanisms for preference aggregation, auctions, and other social interactions in large scale computational environments.

# Price of Anarchy

- How efficient does a solution achieved by selfish agents compare to a centrally computed social optimum?
- Routing, network formation, resource allocation...

# Structure of seminars

Each seminar session is structured as follows:

**1 First part of the talk (10-20 minutes)**

Introduce the topic of the talk.

Explain what the main goal or main result will be.

Give some motivation and provide some context — why is the result interesting/relevant?

**2 Questions**

One or two (multiple-choice) questions from the speaker to the audience.

Take questions from the audience.

# Structure of seminars

Each seminar session is structured as follows:

- 1 First part of the talk (10-20 minutes)
- 2 Questions
- 3 Second part of the talk (55-65 minutes) Present proofs, but focus on the main ideas rather than detailed calculations.
- 4 Discussion  
Questions from the audience.

Parts 1 and 3 must not take more than 75 minutes in total.

Recall definitions and results from previous talks when you use them.

## What we expect

- Prepare a talk on your assigned topic, including questions for the audience.
- Prepare a 1-2 pages summary containing the most important results and definitions.
- Give an approval talk approximately 2-3 weeks before your talk.
- Participate actively in the discussions during the seminar.
- In addition to reading the assigned chapter, it might be necessary to look into some other chapters or papers.



# List of Chapters

- 1 Chapter 1: Basic Solution Concepts and Computational Issues
- 2 Chapter 2: The Complexity of Finding Nash Equilibria
- 3 Chapter 5: Combinatorial Algorithms for Market Equilibria
- 4 Chapter 6: Computation of Market Equilibria by Convex Programming
- 5 Chapter 9: Introduction to Mechanism Design (for Computer Scientists)  
2 students

# List of Chapters

- ⑥ Chapter 10: Mechanism Design without Money  
2 students
- ⑦ Chapter 15: Cost Sharing  
2 students
- ⑧ Chapter 17: Introduction to the Inefficiency of Equilibria
- ⑨ Chapter 18: Routing Games
- ⑩ Chapter 28: Sponsored Search Auctions

## Topic assignment and registration

- Website includes these slides, papers, and assignment:  
<https://www.laszlovegh.eu/agt-seminar>
- If you would like to participate, send an email to Hannaneh Akrami (hakrami@uni-bonn.de) indicating your name and topic preferences, including at least 3-5 topics, by **Friday 14 February**.
- You can also choose other chapters from the book that are not on the list.
- We will inform you by email about the assignment of topics.
- Each participant will also be assigned a supervisor, Hannaneh or Wenzheng, who can help with questions.
- All participants must register via BASIS.