UNIVERSITY OF WATERLOO

ECE700T07
Game Theory with Engineering Applications

Instructor

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Course Description

System architects are increasingly confronted with settings in which multiple self-interested parties interact. Examples include computer networks and electronic marketplaces. To interact optimally, each party must take into account the actions of other parties. Game theory has proven itself to be an effective and powerful tool for studying these interactions.

This course is an introduction to fundamental topics in game theory and their applications in engineered computing and communication systems. In addition to theoretical foundations and mathematical models, the course focuses on practical applications, including distributed control of communication networks, incentive-compatible resource allocation, pricing and investment decisions, and multi-agent systems.

Audience

The course is geared towards engineering and computer science students who need to use game theory in their research. The course is also open to interested students outside of these fields, for example students in operation research, economics or mathematics. Such students are advised to talk to the instructor before the start of the course to discuss background issues and what they hope to get out of the course.

Prerequisites

Basic knowledge of algorithms, complexity, probability, and optimization would be helpful, but is not required. No prior knowledge of economics or game theory is required.

Grading

Coursework will include the following components:

- Participation/Quizzes: 10%
- Assignments: 20%
- Midterm: 30%
- Project: 40%

Textbook

There is no required textbook or official textbook for the course. There are, however, several texts that can serve as auxiliary or reference texts:

- Y. Shoham and K. Leyton-Brown, Multi-agent Systems
- D. Fudenberg and J. Tirole, Game Theory
- M. J. Osborne and A. Rubinstein, A Course in Game Theory
- A. Mas-Colell, M. D. Whinston, J. R. Green, Microeconomic Theory
- N. Nisan, T. Roughgarden, E. Tardos, V. V. Vazirani, Algorithmic Game Theory
- D. Fudenberg and D. Levine, The Theory of Learning in Games

Main Topics

The course covers the following topics in game theory and their applications in engineering.

- **Introduction to game theory**
  Course at a glance, example apps: autonomous cars, energy markets, resource allocation
- **Strategic form games**
  Rationalizability, Nash equilibrium, mixed and correlated equilibrium
- **Learning in games**
  Fictitious play, Bayesian learning, no regret learning, minimax Q-learning
- **Extensive form games with perfect information**
  Backward induction and subgame perfect equilibrium, Nash bargaining solution
- **Repeated games**
  Infinitely/finitely repeated games, trigger strategies, Folk theorems
- **Games with incomplete information**
  Mixed and behavioral strategies, Bayesian Nash equilibrium
- **Mechanism design**
  Revenue-equivalence theorem, revelation principle, incentive compatibility