Industrial Engineering Department

IE 495 - Algorithmic Game Theory (Summer 2026)

Course Syllabus

Instructor Details

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Office Hours:

Course Information

Days: T/Th **Time:** TBD **Location:** TBD

Course Description

This course will provide an algorithmic perspective to problems involving strategic interactions modeled using game theory. The first part of the course will introduce non-cooperative games, e.g. prisoners' dilemma, coordination or anti-coordination games, zero-sum, potential games, network games, and cooperative games with relevant applications and solution concepts, Nash equilibrium or Shapley value. The second part will provide an algorithmic perspective on these problems tackling how players can learn through repeated interactions and find the best strategy.. The third part will focus on assignment and resource allocation in games and mechanism design by introducing concepts e.g., welfare, price of anarchy, different types of auctions, and mechanism design.

Course Learning Outcomes

The goal of this course is to

- Formulate and analyze strategic interaction models
- Compute equilibrium solutions and cooperative game allocations
- Evaluate and compare learning algorithms in repeated games
- Design incentive-compatible mechanisms for allocation problems

Prerequisites

This will be a mathematically rigorous course for advanced undergraduates. Students should have taken courses in optimization/algorithms & probability and statistics. Prior knowledge in game theory or economics is helpful, but not necessary. Everything will be presented from the first principles.

Grading Policy

Grading will be based on problem sets/quizzes, a midterm exam, and a final project.

Exam	30%
Project	30%
Assignments and quizzes (equal weight)	40%

Exam and Quizzes are in-class, closed book, notes and calculators.
Exam: There will be one exam. **Tentative Exam date:**
Quizzes: 20 minute in-class quizzes will be based on assignments and will be given on or after the corresponding homework due date. Expect 3-4 quizzes. Quizzes will be announced in advance.

Homework assignments will be due every two weeks. Expect six assignments. Canvas is set up to allow multiple submissions and only the last submitted assignment will be graded.
Late homework policy: Two at most 3-day late submissions allowed (no questions asked!). Other than these NO LATE submissions allowed.
Quiz and assignments will be equally weighted.

Project: In the project you will design and implement a learning agent in a gaming environment. The core objective is to develop an intelligent agent capable of playing the game competitively. At the end of the project, your agent will compete against benchmark agents and your classmates' agents.
This is a team project.
Project Timeline: Project given on **TBD**. Due **TBD**.

Course Topics and Schedule

- Part 1: Game Theory and Applications
  Week 1-2: Decision-making, utility theory, normal form games
  Week 3-4: Best Response Dynamics, rationality and equilibria
  Week 5: Zero-sum-games, max-min solutions
  Week 6-7: Extensive form games, imperfect information, repeated games
- Part 2: Game Dynamics
  Week 8: Bayesian Games, Stochastic games & respective solution concepts
  Week 9: Online (bandit) learning
  Week 10: Evolutionary algorithms
  Week 11-12: Multi-agent reinforcement learning
- Part 3: Assignment and Resource Allocation Problems and Social Choice
  Week 13: Network games, cooperative games and Shapley Value
  Week 14: Social Choice
  Week 15: Price of anarchy and price of stability: Definition, routing games, hoteling games

Course Textbook

There is no required textbook. Recommended texts: 1) Algorithmic Game Theory edited by Nisan, Roughgarden, Tardos and Vazirani; 2) Multiagent Systems by Shoham and Leyton-Brown; 3) Networks, Games, and Markets by Easley and Kleinberg.