CSCI 357: Algorithmic Game Theory

Fall 2020 (Hybrid)

Instructor:	Shikha Singh	**Time:**	TR 11:30-12:45
Email:	shikha@cs.williams.edu	**Place:**	TCL 217A

Course Links:

- Course webpage: https://williams-cs.github.io/cs357-f20-www/
- GLOW page: https://glow.williams.edu/courses/3010562
- Office hours: See course calendar

Textbooks: Readings will be given from a collection of several different textbooks, and appropriate chapters will be provided via GLOW.

- Twenty Lectures in Algorithmic Game Theory by Roughgarden
- Algorithmic Economics: A Design Approach by Parkes and Sueken
- A Course in Game Theory by Osborne and Rubinstein
- Mechanism Design and Approximation by Jason D. Hartline

Objectives: This course focuses on topics in game theory and mechanism design from a computational perspective, with the primary goal of understanding and analyzing selfish behavior and whether it can or should influence system design. At the end of the course, students should be able to:

- model strategic interactions in games and reason about them using appropriate solution concepts
- design tractable, yet effective, agent strategies for participants in a mechanism
- analyze properties of a mechanisms such as strategyproofness and pareto efficiency
- understand the design behind various online markets such as sponsored search, dating markets, etc.

Prerequisites: CS 256 or equivalent. Familiarity with basic probability theory will be needed. The course may have a few programming assignments, for which some familiarity with Python is assumed.

Course Topics: Schedule and readings will be posted on the course webpage.

- Game Theory: Normal-form games, dominant strategy equilibrium, pure and mixed Nash, incomplete-information (Bayesian) games, extensive-form games and subgame-perfect equilibrium
- Auction Theory and Mechanism Design with Money: first and second price auction, revenue equivalence, single parameter mechanism design and Myerson's theorem, VCG auctions for welfare maximization, optimal mechanisms and revenue maximization
- Application Domains: Ad markets (sponsored search auctions), wireless spectrum auctions and, prediction markets
- Mechanism Design Without Money: Matching markets, such as, stable matching and kidney exchange voting, fair division, etc.
- Incentives in P2P Networks: Strategic behavior in BitTorrent and incentives in BGP routing

Grading Policy: The final grade will be calculated based on the following breakdown:

- Assignments (35%)
- Attendance and Class Participation (5%)
- Midterms (20 + 20%)
- Final Project (20%).

Course Slack: We will be using Slack for informal classroom discussions, asynchronous questions, and staying in touch in a mostly-virtual semester.

Attendance and Class Participation: Attendance is required in the course. However, in light of the ongoing pandemic and the hybrid nature of the course, this policy will be flexible. Students are encouraged to contact the instructor if they miss lectures due to any reason.

Learning is a collaborative endeavor and class participation is encouraged and rewarded in this class. Participation can take various forms such as coming to class prepared, being active on Slack, answering and asking questions, coming to office hours, etc.

Academic Honesty: For a full description of the Computer Science Honor Code, please see: https://csci.williams.edu/the-cs-honor-code-and-computer-usage-policy/. If you have any doubt about what is appropriate, please email me at shikha@cs.williams.edu. Specific rules are outlined below.

- You must not search the internet or external resources using problem-specific keywords.
- You must always cite external resources used for background reading, and cite the names of students you worked with on any problem in the assignment
- You should never turn in a solution that you do not understand.

Weekly assignments will be specified as single-person or paired.
Solo assignments: In single-person assignments, your work must be entirely your own. While you can exchange high-level ideas with other students, you must not engage in any joint writing or step-by-step problem solving.
Paired assignments: Some assignments may be completed in groups of 2, and for these you and your partner must design and implement the solutions together. You may discuss with other groups but should not share any written work or source code with them.

Assignments: There will be weekly problem sets (which may include occasional programming assignments) to test understanding of materials and prepare students for the exams. Release and due dates along with links to actual assignments will be posted on course website/GLOW page.

- All assignments must be submitted through https://www.gradescope.com/ (course code: M3V8PY)
- Assignments must be typeset using LaTeX, using the template provided.

Late Work: Each student may use a total of two late days during the semester, with at most one late day towards any particular problem set. A single late day enables you to hand in the problem set up to 24 hours after the original due date. After late days have been used, late work will incur a 20% penalty per day.

Midterms: We will have two 24-hour open-book take-home midterm examinations. Tentative dates are: October 13 and November 16. No collaboration is allowed on the exams and the solutions must be typeset in LaTeX, similar to homework assignments.

Final Project: There will be a final project, the goal of which is to allow you to explore a topic related to the course that you find most interesting. The additional learning goals are to practice reading research papers on the topic, technical writing, and presentation.

Projects will be done in groups of 2 or 3, may be theoretical or programming, and can include an exposition of an advanced topic related to the course. Example topics and further guidelines will be provided.

The project will have several checkpoints and deliverables:

- A project proposal (due tentatively Nov 20)
- Group meetings with instructor during final weeks
- Short presentation during last week of class
- A final paper summarizing your work will be due during finals period

Health and Accessibility Resources: Students with disabilities of any kind who may need accommodations for this course are encouraged to contact Dr. GL Wallace (Director of Accessible Education) at 597-4672. Also, students experiencing mental or physical health challenges that are significantly affecting

their academic work or well-being are encouraged to contact me and to speak with a dean so we can help you find the right resources. The deans can be reached at 597-4171.

Inclusion and Classroom Culture: The Williams community embraces diversity of age, background, beliefs, ethnicity, gender, gender identity, gender expression, national origin, religious affiliation, sexual orientation, and other visible and non visible categories. As a group, I expect that us to contribute to a respectful, welcoming and inclusive environment. If you have any concerns about classroom climate, please reach out to me to share your concern.

Public Health and COVID-19: In an attempt to keep our classroom environment as healthy as possible, you are required to wear a mask at all times, and keep 6 feet between you and your classmates. If possible, please wash your hands or use hand sanitizer before entering the classroom. If you feel ill, please do not come to class. I will be happy to work with you to make sure you can make up missed portions of class.

Recording in-person Classes: Classes will be recorded for the benefit of students enrolled remotely and those who may be unable to attend live. By participating with your camera on, using a profile image, or with audio unmuted, you are consenting to having your video, image, and audio recorded. If you do not want to be recorded, please be sure to keep your camera off, do not use a profile image, and keep your microphone muted. Students who choose to not be recorded may participate by means of the chat feature.