MS&E 232H: Introduction to Game Theory (Accelerated)
SYLLABUS

Instructors	Irene Lo ilo@stanford.edu
Office Hours	W 5-6pm PT @ Huang 259 and on Zoom
Class	M,W 10:30am-12:20pm PT @ 380-380D
Discussion Session	F 10:30-11:30am PT @ Shriram 052
Course Assistant (CA)	Kaleigh Mentzer kmentzer@stanford.edu Office hours Th 5:15-6:45pm PT @ Huang B007
Course Website	http://canvas.stanford.edu
PollEverywhere	pollev.com/irenelo284
Ed Discussion	https://edstem.org/us/courses/31160/ (accessible from Canvas)

Course Overview. Game theory uses mathematical models to study strategic interactions and situations of conflict and cooperation between rational decision-makers. This course provides an accelerated introduction to tools, models and computation in non-cooperative and cooperative game theory. Technical material includes normal and extensive form games, zero-sum games, Nash equilibrium and other solution concepts, repeated games, games with incomplete information, auctions and mechanism design, the core, and Shapley value. Students will also explore applications of this material through playing stylized in-class and class-wide games and analyzing real-life applications. **Pre-Requisites. MATH51 and MS&E 120, or equivalent.**

Course Objectives. By the end of this course, students will achieve the following goals:

- Learn to apply mathematical models of games for analyzing a range of situations of conflict and cooperation
- Develop a lexicon of games commonly used to describe simple strategic interactions
- Develop an understanding of game theoretic solution concepts, how to compute them, and when, why and how they are useful for analyzing strategic interactions

Course Textbooks:

Lecture notes will be accompanied by optional readings from the following textbooks, available online in course reserves:

- Karlin, Anna R., and Yuval Peres. "Game Theory, Alive." Vol. 101. American Mathematical Soc., 2017.
- Leyton-Brown, Kevin, and Yoav Shoham. "Essentials of game theory: A concise multidisciplinary introduction." Synthesis lectures on AI and ML 2, no. 1 (2008): 1-88.
- Hoffman, Moshe, and Erez Yoeli. "Hidden Games: The Surprising Power of Game Theory to Explain Irrational Human Behavior." Hachette UK, 2022.

You may find the following textbooks to be helpful supplements:

- Fudenberg, Drew, and Jean Tirole. Game theory. MIT press, 1991.
- Osborne, Martin J., and Ariel Rubinstein. A course in game theory. MIT press, 1994.
- Shoham, Yoav, and Kevin Leyton-Brown. Multiagent systems: Algorithmic, game-theoretic, and logical foundations. Cambridge University Press, 2008.
- Tadelis, Steven. Game theory: an introduction. Princeton University Press, 2013.

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POLICIES AND PROCEDURES

Academic integrity

Please familiarize yourself with the Stanford Honor Code (honorcode.stanford.edu); violations will be prosecuted to the fullest extent of the (Stanford) law.

Consulting with instructors and feedback

Please ask any questions for instructors via Ed Discussion or at office hours. You can post privately to the instructors, or publicly so that your classmates can also see the responses. You can also post anonymously. Please post questions in the relevant section of Ed Discussion (e.g. Lectures, Problem Sets, Games and Applications). A member of the teaching team will respond to questions on Ed Discussion within 24 hours. **Before posting, please check Canvas / Ed Discussion** to see whether the answer to your question is already there.

If you are having difficulty (for whatever reason), find help right away – **do not wait until you fall even further behind! Instructors are available for advice and questions. We encourage you to use Ed Discussion and to come to office hours if you have any questions whatsoever.**

If you have feedback throughout the course, please feel free to share it with us in person, on Ed Discussion or in the anonymous comment box**.**

Exam and homework grading

If you believe that an error was made in grading homework or an exam, please **write a short justification of your claim within 1 week** and resubmit the justification and homework/exam (via gradescope) to the instructor or grader who graded the homework/exam. We will review your concern and respond to you directly. **Note that we reserve the right to completely regrade any resubmitted homework assignments, and your grade may go up or down.**

Diversity and inclusion

MS&E is committed to creating diverse, equitable, and inclusive learning spaces for all students. To do so, **we must all commit in this course to treat every individual with respect.** We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus.

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of students from all diverse backgrounds and perspectives. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Classroom Safety during the COVID-19 Pandemic

All faculty, staff and students are required to stay up to date on and adhere to the latest requirements or recommendations around COVID-19. Face masks are no longer mandatory in classrooms. If you wish to wear a face mask you are welcome to do so.

All students, staff, faculty, postdocs, and temporary community members are required to report their COVID-19 positive test results via HealthCheck. **Please do not attend in-person class activities (e.g. lecture, discussion session, office hours) if you are testing positive for COVID-19.**

Students who are unable to attend the lecture in-person for Classroom Safety reasons are required to read the lecture notes for the corresponding lecture and submit a lecture report by the lecture report due date. Lectures and discussion sessions will not be recorded.

If the instructor is unable to teach in person, an announcement will be sent via Canvas by the previous evening with a zoom link for attendance.

Course Privacy Statement

As noted in the University's recording and broadcasting courses policy, students may not audio or video record class meetings without permission from the instructor (and guest speakers, when applicable). If the instructor grants permission or if the teaching team posts videos themselves, students may keep recordings only for personal use and may not post recordings on the Internet, or otherwise distribute them. These policies protect the privacy rights of instructors and students, and the intellectual property and other rights of the university. Students who need lectures recorded for the purposes of an academic accommodation should contact the Office of Accessible Education.

Course Recordings

In the event course lectures are recorded, you will be notified at the start of the lecture, and video cameras will capture the instructor's presentation. For your convenience, such recordings will be made accessible to you on the course Canvas site. These recordings might be reused in other Stanford courses, viewed by other Stanford students, faculty, or staff, or used for other education and research purposes. Note that while the cameras are positioned with the intention of recording only the instructor, occasionally a part of your image or voice might be incidentally captured. If you have questions, please contact a member of the teaching team.

Accommodations

For all students: Please reach out to the course instructors if you are experiencing any difficulties that might be negatively impacting your learning experience so we can find a way to accommodate you. We are here for you and want to best help you learn and succeed.

In addition, Stanford is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the broad range of confidential mental health services available on campus here
https://vaden.stanford.edu/caps-and-wellness/counseling-and-psychological-services-caps.

If you are not able to complete coursework (e.g. class attendance, lecture reports, homework assignments) by the due date, please contact Prof. Irene Lo as soon as possible, and before the due date. Extensions will be granted only for special cases by request.

For students with documented disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty. Unless the student has a temporary disability, Accommodation letters are issued for the entire academic year. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (phone: 723-1066, URL: https://oae.stanford.edu/).
Please contact course instructors with your Accommodation Letter **by the end of the second week of class** so that all the necessary arrangements can be made.

For students testing positive for covid-19: Please reach out to the course instructors if you need any accommodations due to COVID-19. Short-term absence due to COVID-19 will approached in the same way as any other short-term absence. Long-term absence due to COVID-19 will be treated like other long-term absences. In some cases, a student may need to reduce their course load or take a leave of absence. **Reduced Course Loads** and **Leaves of Absence** are managed by the Office of Accessible Education and Undergraduate Academic Advising (undergraduates). In such cases please reach out to the appropriate office.

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EVALUATION AND GRADES

Evaluation

The breakdown for your course grade will be as follows:

Class attendance and participation	10%
Games and applications	40%
Problem sets	30%
Takehome final	20%

Class attendance

All lectures will be conducted live. **Lectures will not be recorded.** Live attendance is encouraged but not required. **Some form of class attendance is required for all MW lectures** – students can fulfill the class attendance requirement for each lecture either by attending live and signing in on the attendance sheet, or by reading lecture notes in their own time and submitting a short (one paragraph) written report for the lecture. Class attendance at discussion sessions is optional but highly encouraged. **Written lecture reports are due 5pm PT the following Monday**. **Late reports will NOT be accepted** except for special cases by instructor permission. Extra credit (up to 100% of attendance grade) will be awarded for engagement on Ed Discussion that results in instructor-endorsed answers.

Homework: Problem sets, games, and applications.

Assignments (problem sets, class-wide games, and applications) will be posted on the course website; due dates are shown on the course schedule. **Homework is due at 5pm PT** on the due date. Homework submissions will be on Gradescope on Canvas. **Late assignments will NOT be accepted** except for special cases by instructor permission**.**

You may work together on all homework. The course instructors will facilitate the formation of study and homework groups in the first two weeks of class. Each student must turn in **their own** solutions to the problem sets and class-wide games in their own words. **Do not use any other sources**. For some **applications**, you may submit solutions in teams; details will be posted in the application prompt**.**

Final Exam

The final exam will be an open-book 24-hour take home examination. You may select a 24-hour window from the one-week window in the course schedule for completing the exam, and your exam must be submitted within 24 hours of downloading the final pdf. If you are unable to attend one of the exam days, a written explanation and arrangements must be made **by the end of the first week of class**. **We will not offer any alternative times for the scheduled final examination unless there is a documented medical reason or family emergency.**

Incomplete Grades

A grade of I (Incomplete) may be granted in cases in which a student has requested an 'I' before the last class and satisfactorily completed a substantial part of the coursework.

COURSE SCHEDULE AND OUTLINE

Static games with complete information				
1	1/09-1/13	Mon Wed Fri	1. Introduction and normal-form games **(LBS Ch.1-2.1, HY Ch.2)** 2. Zero-sum games and equilibrium **(KP Ch.2)** Session 1 – Examples: Computing NE	
2	1/16-1/20	Mon Wed Fri	*Martin Luther King, Jr. Day – No Class* 3. Nash equilibrium existence **(KP Ch.4-5.1, HY Ch.5)** Session 2 – Examples: Computing mixed NE	
3	1/23-1/27	Mon Wed Fri	4. Other solution concepts: Dominated strategies, IESDS, rationalizability **(LBS Ch.3)** 5. Applications: Voting, Braess, Cournot Session 3 – Applications (cont.)	**Game 1 and Pset 1 due (1/27)**
Dynamic games with complete information				
4	1/30-2/03	Mon Wed Fri	6. Extensive-form games **(LBS Ch.4)** 7. Subgame perfect Nash equilibrium Session 4 – Examples: SPNE, backward induction	**Application 1 due (2/03)**
5	2/06-2/10	Mon Wed Fri	8. Repeated games **(LBS Ch.6, HY Ch.10)** 9. Applications: Tacit collusion, bargaining Session 5 – Applications (cont.)	**Game 2 due (2/10)**
Games with imperfect/incomplete information				
6	2/13-2/17	Mon Wed Fri	10. Knowledge, and imperfect/incomplete information **(LBS Ch.5)** 11. Bayesian games **(LBS Ch.7)** Session 6 – Examples: Bayesian Games	**Pset 2 due (2/17)**
7	2/20-2/24	Mon Wed Fri	*Presidents' Day – No Class* 12. Other solution concepts: **(Tadelis Ch.15)** Session 7 – Examples: Computing solution concepts	
8	2/27-3/03	Mon Wed Fri	13. Auctions **(KP Ch. 14)** 14. Applications: Signaling, Discrimination, Mechanism Design Session 8 – Applications (Auctions, cont.)	**Application 2 due (3/03)**
Cooperative game theory				
9	3/06-3/10	Mon Wed Fri	15. Cooperative solution concepts **(KP Ch. 12)** 16. Cooperative solution concepts (cont.) Session 9 – Examples: Computing solution concepts	**Pset 3 due (3/13)**
10	3/13-3/17	Mon Wed	Guest lecture (17. Applications: Bankruptcy, voting) 18. Course Review and AMA Session 10 – Final prep	**Application 3 due (3/17)**

Readings are from Karlin/Peres (KP), Leyton-Brown/Shoham (LBS), and Hoffman/Yoeli (HY), and are optional.

Students may select any 24-hour period from 3/18/2022 – 3/24/2022 (inclusive) to download, complete, and submit their takehome final. The final is due no later than 3/24.