

Game Theory (80-405/80-705)

Spring 2020

Tuesday/Thursday 12:00–1:20, Posner Hall A35

<https://canvas.cmu.edu/courses/13525>

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Course Description: Game theory is the study of interactive decision-making: making choices in the context of other agents who are also making choices. Famous examples include the Prisoners Dilemma (pitting rational self-interest against the benefits of cooperation), and the Cournot duopoly (a basic model of market competition and supply-and-demand). Game theory has been applied to situations as diverse as traffic flow, auctions, the search and competition for scarce resources, and bargaining. This course will develop conceptual and technical facility with the mathematical tools used to model and analyze such situations. We will cover games in strategic and extensive form and games of perfect and imperfect information; we'll also study solution concepts such as Nash equilibrium and rationalizability. Finally, throughout the course we will take the opportunity to actually play several of the games we study to help build intuitions and foster insights into the formal mathematical models we develop.

Recommended Text: *An Introduction to Game Theory* by Martin J. Osborne.¹

Course Objectives: The primary objective of this course is to develop *mathematical competence* in game theory along with the ability to apply this competence in useful ways. More precisely, this means being able to:

- read and understand game-theoretic models in a variety of contexts;
- navigate the landscape of solution concepts and find equilibria in games;
- formalize intuitions and analyze problems using game-theoretic tools;
- probe and critically assess the underlying assumptions of standard game theory.

Grade Distribution:

Problem sets	60%
Tests	30%
Quizzes	10%

¹Another good text, though it contains fewer examples and less discussion, is *A Course in Game Theory* by Martin J. Osborne and Ariel Rubinstein. It is accessible freely and legally here: <http://books.osborne.economics.utoronto.ca/>.

Course Outline: Weekly topics are subject to change; the below should only be considered a rough guideline.

Date	Topic	Evaluation
1/14 1/16	introduction: traffic flow game · strategic games & solution concepts	–
1/21 1/23	guess $2/3$ the average · strict dominance · Nash equilibrium	quiz 1 PS1 assigned
1/28 1/30	Nash equilibrium continued · Cournot duopoly	quiz 2 –
2/4 2/6	first/second-price auctions · weak dominance · mixed strategies	PS1 due; test 1 PS2 assigned
2/11 2/13	mixed strategy Nash equilibrium	quiz 3 –
2/18 2/20	existence of mixed Nash equilibria	PS2 due; test 2 PS3 assigned
2/25 2/27	correlated equilibrium	quiz 4 –
3/3 3/5	rationalizability · epistemic game theory	PS3 due; test 3 PS4 assigned
3/10 3/12	<i>no class (spring break)</i>	–
3/17 3/19	repeated games · extensive form games with perfect information	–
3/24 3/26	subgame perfection · backward induction · bargaining games	PS4 due; test 4 PS5 assigned
3/31 4/2	extensive form games with imperfect information	quiz 5 –
4/7 4/9	signalling games	PS5 due; test 5 PS6 assigned
4/14 4/16	overflow <i>no class (spring carnival)</i>	quiz 6 –
4/21 4/23	sequential equilibrium	PS6 due; test 6 PS7 assigned
4/28 4/30	selected topics	quiz 7 PS7 due

Evaluation: Most of the evaluation is based on take-home problem sets, which are paired with in-class, 20-minute tests that take place on the day the problem set is due (which is always a Tuesday). Each test covers the same material as the corresponding problem set, but generally consists in shorter/easier problems. On those weeks where no problem set is due, there will be a 10-minute quiz based on the material covered during the previous two weeks. There is no final exam.

Course Policies: Problem sets are due by the beginning of class. Collaboration is allowed and encouraged; however, each student must write up their solutions independently, and clearly indicate for each question with whom they shared ideas (<http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>). Problem sets should be submitted using Gradescope.

Campus Resources

Academic Development (AD): Academic Development is the place to go for help with your academic work. They offer everything from Academic Counseling in study skills to Peer Tutoring. They also offer Supplemental Instruction and EXCEL Groups for select courses. Their services are designed to help both students who are having academic difficulties and those who just want to improve their performance. For more information, visit <http://www.cmu.edu/acadev>.

Global Communications Center (GCC): The GCC, on the ground floor of Hunt Library, provides one-on-one tutoring in written, oral, and visual communication for any student, at any level, in any discipline, at any stage of the composing process (<http://www.cmu.edu/gcc>).

Intercultural Communications Center (ICC): The Intercultural Communication Center helps non-native English speakers (both international students and students who attended high school in the U.S.) develop the English language skills and cultural understanding needed to succeed at Carnegie Mellon. The center offers classes and noncredit workshops and seminars (for example, Presentation Basics, Communicating Data Effectively, and Language and Culture for Teaching (for international TAs)). For more information, visit <http://www.cmu.edu/icc>.

Disability Services: The Office of Disability Resources at Carnegie Mellon University has a continued mission to provide physical and programmatic campus access to all events and information within the Carnegie Mellon community. They work to ensure that qualified individuals receive reasonable accommodations as guaranteed by the Americans With Disabilities Act (ADA) and Section 504 of the Rehabilitation Act of 1973. For more information, visit: <http://www.cmu.edu/disability-resources/>.

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep, and taking some time to relax. You can't achieve your goals if you're sick from stress or burnt out.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus; an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is usually better.

If you or anyone you know needs help, consider reaching out to a friend, faculty member, or family member you trust. Counseling and Psychological Services (CaPS) is also here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>.