

# Game Theory (80-405/80-705)

Spring 2023

Tuesday/Thursday 11:00–12:20, Doherty Hall A302

<https://canvas.cmu.edu/courses/33287>

Instructor: Adam Bjorndahl

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Office hour: Tuesday 9:30–10:30am, Baker Hall 145K

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Office hour: Thursday 2–3pm, zoom

Teaching Assistant: Shuyan Wang

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Office hour: Wednesday 3:30–4:30, Baker Hall 143

**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.<sup>1</sup>

**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.

**Evaluation:** Problem sets 60%; tests 30%; quizzes 10%.

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<sup>1</sup>Another 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/>.

Every other Thursday a problem set will be released, covering the previous 2 weeks of material, due 12 days after it is released (always on a Tuesday).

- These are the foundation of the class—where I will push you to *really* engage with what you’ve learned. The bulk of the work for this course is here.
- You are encouraged to collaborate with classmates—just be sure to write up your own solutions and clearly indicate on the first page with whom you have collaborated.
- All problem sets will be submitted via Gradescope, which is integrated with Canvas and can be accessed through the sidebar. They are due by the beginning of class; late submissions will be considered provided arrangements have been made in advance.

Each Tuesday there will be an in-class evaluation.

- On days when a problem set is due there will be a 20-minute test at the beginning of class. These tests are essentially in-class components of the problem sets; they cover exactly the same material as the problem set but consist of shorter/easier problems.
- On the weeks in between problem set due dates, there will instead be a 10-minute quiz based on the material covered during the previous two weeks. Quizzes are not worth very much; they are intended primarily as self-assessment tools.

There is no final exam.

### **Engagement & Community:**

- To the extent you feel comfortable doing so, please try to be an active participant in class.
- Post on the Piazza forum freely and frequently—not only to ask questions but also to help answer questions that others have raised.
- Treat each other with respect. I take this very seriously and invite you to reach out to me if at any point you feel uncomfortable for any reason.

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My hope is for this class to be useful and interesting for you, and not just another source of stress. If you find yourself struggling, you need help, or any aspect of this course is problematic for you (for any reason), please reach out to me. I’m also very happy to hear general feedback and constructive criticisms about the class at any time.

Take care of yourself. Try to get enough sleep, go for walks in the fresh air, and connect as you can with the people you love. Take 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 tough times. You are not alone—an important part of the college experience is learning how to ask for help. 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 or visit their website at <https://www.cmu.edu/counseling/>. More resources are available at <https://www.cmu.edu/student-affairs/resources/index.html>.

Finally, if you are worried about affording food or feeling insecure about food, there are resources on campus who can help. Email the CMU Food Pantry Coordinator to schedule an appointment:

Pantry Coordinator  
cmu-pantry@andrew.cmu.edu  
412-268-8704 (SLICE office)

## Schedule

<b>Date</b>	<b>Topic</b> (rough guideline; subject to change)	<b>Evaluation</b> (fixed)
1/17 1/19	introduction · <i>traffic flow</i> · strategic games & solution concepts	–
1/24 1/26	<i>guess 2/3 the average</i> · strict dominance · Nash equilibrium	quiz 1 PS1 assigned
1/31 2/2	finding Nash equilibria · <i>Cournot oligopoly</i>	quiz 2 –
2/7 2/9	first/second-price auctions · weak dominance	PS1 due + test 1 PS2 assigned
2/14 2/16	mixed extensions · mixed strategy Nash equilibria	quiz 3 –
2/21 2/23	correlated equilibrium	PS2 due + test 2 PS3 assigned
2/28 3/2	rationalizability · epistemic game theory	quiz 4 –
3/7 3/9	<i>no class (spring break)</i>	–
3/14 3/16	repeated games · <i>repeated prisoners' dilemma</i>	PS3 due + test 3 –
3/21 3/23	extensive form games with perfect information	quiz 5 PS4 assigned
3/28 3/30	subgame perfection · backward induction · bargaining games	quiz 6 –
4/4 4/6	extensive form games with imperfect information	PS4 due + test 4 PS5 assigned
4/11 4/13	overflow <i>no class (spring carnival)</i>	quiz 7 –
4/18 4/20	signalling games · sequential equilibrium	PS5 due + test 5 PS6 assigned
4/25 4/27	additional topics	quiz 8 PS6 due

## Campus Resources

**Academic Integrity** Carnegie Mellon's Policy on Academic Integrity is available here: <http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>. It applies to all courses at this university, including this one.

**Student Academic Success Center (SASC):** SASC focuses on creating spaces for students to engage in their coursework and approach learning through a variety of group and individual tutoring options. They offer many opportunities for students to deepen their understanding of who they are as learners, communicators, and scholars. Their workshops are free to the CMU community and meet the needs of all disciplines and levels of study. SASC programs to support student learning include:

- Academic Coaching  
<https://www.cmu.edu/student-success/programs/coaching.html>
- Peer Tutoring  
<https://www.cmu.edu/student-success/programs/tutoring.html>
- Communication Support  
<https://www.cmu.edu/student-success/programs/communication-support/index.html>
- Language and Cross-cultural Support  
<https://www.cmu.edu/student-success/programs/language-support/index.html>
- Supplemental Instruction  
<https://www.cmu.edu/student-success/programs/supp-inst.html>

For more information, visit <https://www.cmu.edu/student-success/>.

**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](mailto:access@andrew.cmu.edu).