Decision Theory (80-305/80-605)

Fall 2021

Tuesday/Thursday 11:50–1:10, POS 151

`https://canvas.cmu.edu/courses/25319`

Instructor: Adam Bjorndahl
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Office hour: Monday 2:00, `https://cmu.zoom.us/my/bjorndahl`

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Office hour: Friday 3:00, `https://cmu.zoom.us/j/7146981677`

Course Description: This course is an introduction to formal models of choice and decision-making. We begin by examining choice under certainty, developing both qualitative and quantitative models of preference. We then expand our analysis to take into account uncertainty, focusing on the von Neumann-Morgenstern theory of expected utility and Savage's classic axioms. Empirical challenges to models are emphasized throughout, in response to which we will consider a variety of alternative representations of uncertainty (e.g., Dempster-Shafer belief functions, non-unique probability measures) and preference (e.g., framing effects, prospect theory).

Text: Course notes will be provided; no textbook is necessary.

Course Objectives: The primary objective of this course is to develop mathematical competence in modeling decision making, along with the ability to apply this competence in useful ways. This means being able to:

- distinguish different models of choice in a variety of contexts;
- navigate alternative representations of belief and preference, and understand the connections between them;
- formalize intuitions and analyze real problems using decision-theoretic tools;
- probe and critically assess the underlying assumptions of standard models.

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

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

For many of us, these are stressful times. My hope is for this class to be useful and interesting for you, and not yet 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/`.

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

Weekly topics are subject to change; the below should only be considered a rough guideline. However, the evaluation schedule will *not* change.

Date	**Topic**	**Evaluation**
8/31 9/2	introduction · Allais paradox · properties of relations	– –
9/7 9/9	preference relations · indifference and equivalence	Quiz 1 PS1 released
9/14 9/16	ordinal utility representation theorem · choice functions	Quiz 2 –
9/21 9/23	uncertainty as probability · choosing between gambles	PS1 due; Test 1 PS2 released
9/28 9/30	independence · dominance · continuity	Quiz 3 –
10/5 10/7	von Neumann-Morgenstern expected utility representation	PS2 due; Test 2 PS3 released
10/12 10/14	overflow *no class (mid-semester break)*	*no quiz* –
10/19 10/21	acts, states, and outcomes	Quiz 4 –
10/26 10/28	Savage's theory of choice	PS3 due; Test 3 PS4 released
11/2 11/4	qualitative probability	Quiz 5 –
11/9 11/11	Ellsberg paradox · risk vs. ambiguity	PS4 due; Test 4 PS5 released
11/16 11/18	alternative representations of uncertainty	Quiz 6 –
11/23 11/25	overflow *no class (Thanksgiving)*	PS5 due; Test 5 PS6 released
11/30 12/2	topics (e.g., belief update, framing effects, prospect theory)	Quiz 7 PS6 due; *no test*

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.