**Bowdoin College, Department of Economics, Fall 2023**

**ECON 3305: Game Theory and Strategic Behavior**

**Time & Location:** T, R, 2:50-4:15, Hubbard 213
**Professor:** Dan Stone, dstone@bowdoin.edu
**Office hrs:** M, W, 1:30-3:30 (or by appointment), Hubbard 108.

**Prerequisite:** Intermediate micro (Econ 2555). I will teach/review appropriate math methods as they come up (e.g. probability theory, set theory, methods of proof).

**Course description and learning goals:** This course will cover the main topics of non-cooperative game theory in a mathematically rigorous way. Game theory is the mathematical study of behavior in strategic settings: situations in which an individual must think about other individuals' perspectives and choices to determine one's own optimal choice(s). Game theory began as a sub-field of applied mathematics and is now immensely influential and widely used across the social and natural sciences.

We'll emphasize mathematical rigor for three reasons: 1) to discuss game theoretic ideas with more precision and clarity; 2) to improve the precision and clarity of your thinking in general; and 3) to help prepare students for potential future research and/or graduate study in economics, which involves plenty of math. We will be following the textbook closely, as it uses the appropriate level of math for our purposes, and still includes many applications, but there will also be a number of readings from other contexts, including academic journal articles.

In addition to learning the fundamental concepts and models of game theory, and improving your mathematical skills and logical thinking, I'm hoping this class will help enhance your understanding of strategic interactions—and to improve your own performance (i.e., your strategic thinking and choices, and your understanding of the perspectives and choices of others)—in everyday life.

**Books/resources:** Watson, J., *Strategy: An Introduction to Game Theory, 3/e*. I like this book because it is concise, clear, complete, uses the right level of math, and provides a good number of well-written problems. You're very welcome to use an earlier (cheaper) edition; the material will be only slightly different. I'll provide a handful of other readings on Canvas or email.

There are also many free game theory resources on the web you might find useful or interesting to check out. Here are a few examples. The site for Yale's free course: http://oyc.yale.edu/economics/econ-159#sessions. Shorter video lessons on many key topics - http://gametheory101.com/Home.html. An Excel 'calculator' by creator of those videos: https://williamspaniel.com/game-theory-calculator/. Another website that allows you to create and solve games (but not with Excel): http://www.gametheoryexplorer.org/. Here's a good open access book, slightly too advanced/technical for us, but some material is maybe useful, includes solutions to problems: http://faculty.econ.ucdavis.edu/faculty/bonanno/PDF/GT_book.pdf. Another good open source book with network focus: Easley, D. and Jon Kleinberg. *Networks, Crowds, and Markets: Reasoning about a Highly Connected World*. https://www.cs.cornell.edu/home/kleinber/networks-book/networks-book.pdf. Game theory in 1954 (free download): https://www.rand.org/pubs/commercial_books/CB113-1.html. Good non-technical books: *Thinking Strategically* and *Art of Strategy* (both by Dixit and Nalebuff), *Game-changer* (McAdams). *Spectrum Auctions* (Geoffrey Myers) is a new one on designing auctions I haven't read yet.

**Web/email:** All essential course documents (including slides, homework and test solutions) and grades will be posted to Canvas or emailed to you. In general, I'll make announcements/reminders in class, but will also sometimes email you announcements and clarifications of material from class. You can provide anonymous feedback to me anytime here:
https://bowdoincollege.qualtrics.com/jfe/form/SV_0kzKfDZxgkn5F9I.

**Teaching philosophy/methods for this course:** I'll use a combination of interactive lecture, classroom versions of game theory games, in class group and individual problem solving, and teaching technologies (Canvas, clickers). I encourage you to interrupt me during lecture with questions and comments often—this will usually help to clarify something that others were wondering about as well, keep you more engaged, improve your public speaking skills (yes, not really public speaking, I know, but close), help me learn from you, and will help prevent me from doing too much of the talking. If your question is on a topic most appropriately addressed outside of class, I'll let you know. I'll occasionally (or maybe more than occasionally) randomly call on students to keep you engaged and answer questions or play games—but I'll never force you to speak/play. And I'll do my best to make the teaching environment inclusive and welcoming for all students, and to show the diverse range of applications of game theory.

I use powerpoint slides to guide the lectures (these are my lecture notes) and will post the slides to Canvas. But to be clear, the slides are incomplete and only make complete sense in conjunction with class notes/experience. I recommend that you take notes in class as if the slides won't be posted, and then just refer to them as necessary. If you have questions later, first try asking classmates, then ask me. Some of the material we'll discuss in class is background you won't be tested on; some of the material you need to know will be straightforward and basically common sense; and some is abstract and fairly deep. I will try to go over the background and straightforward parts quickly, assuming you can easily clarify with the book if necessary, and spend more time on the tougher and more interesting material, including going beyond the textbook where I feel it is useful and/or appropriate.

Since learning this material requires hands-on work—problem solving—some class time will be devoted to working through problems, and I will also ask you to work on problems on your own as homework. This will prepare you for tests, where you will also be asked to solve problems on your own, as this is the best way to demonstrate knowledge of the material. And since game theory is indeed the study of games, we'll explore playing games ourselves in the classroom. This is useful pedagogically (for learning!)—and fun.

**Assignments and accessibility:** There will be six homeworks, one journal article presentation, two midterms, and a final. The homeworks can be completed with a partner, but I may implement a rule that you have to switch partners at some point in the semester. All non-test assignments are due at start of class and there is a 10% penalty per day turned in late (0-24] hrs late = 10% off; (24-48] hrs later = 20% off, etc). Please do your best to submit on time and if you can't submit on time, submit early. The homeworks are intended to keep you on track and help you prepare for the tests.

The journal article presentation will be brief, approximately 5 minutes, in which you summarize and briefly analyze a game theory research article I'll assign to you (from the list of articles below). This is to help you gain a more in-depth understanding of these ideas and related scholarship. Details to come. Journal articles I'm currently planning to draw from are:

- Rationalizability, iterated dominance: Duffy and Nagel, EJ, 1997; Bosch-Domènech et al, AER, 2002; Kocher and Sutter, EJ, 2005; Grosskopf and Nagel, GEB, 2008; LeVeck, 2018; Brocas and Carillo, JPE, 2021; Di Tella et al, NBER WP, 2023.

- NE, coordination, mixed strategies: Holm et al, EE, 2019; Chiappori et al, AER, 2002; Palacios-Huerta, Ectca, 2003; Palacios-Huerta and Volji, Ecta, 2008; Levitt et al, Ecta, 2010; Farrell, EL, 1988; Berk et al, AER, 1996.
- SPNE, Bargaining: Neelin et al, AER, 1988; Ochs and Roth, AER, 1989; Hoffman et al, GEB, 1994; Cameron, EI, 1999; Heinrich, AER, 2000; Levitt et al, AER 2011; Spenkuch et al, AER, 2018; Sheffer et al, APSR, 2023.
- Repeated PDs/collusion: Andreoni and Miller, EJ, 1993; Dal Bo, AER, 2005; Dreber et al, Nature, 2008; Dal Bo and Frechette, AER, 2011; Miller, AER, 2009; Ashenfelter, et al, RAND, 2013; Bresnahan, JIE, 1987; McCutcheon, JPE, 1997; Reuben and Suetens, EE, 2012; Akata et al, WP, 2023.
- Auctions: Lucking-Reiley, AER, 1999; List and Lucking-Reiley, AER, 2000; Kagel and Levin, Ecta, 2000; Bajari and Hortascu, Rand, 2003; Carpenter et al, EJ, 2008; Azevedoy et al, WP, 2018; Offerman et al, QE, 2022.
- Signaling: Prendergast and Stole, JPE, 1996; Morris, JPE, 2001; Gentzkow and Shapiro, JPE, 2006; Han et al, JM, 2010; McDevitt, JPE, 2014; Stone, SEJ, 2016; Fudenberg and Vespa, AEJ:Micro 2019; Williams, Mind&Language, 2021; Konovalov and Krajbich, EJ, 2023.

The final will emphasize the material covered after midterm 2 but will also cover key topics from earlier in the semester. The tentative dates for all assignments and readings are on the course schedule below. Make-up finals/midterms will only be given when you are not able to attend for a verifiable reason, with documentation. You should email me as soon as possible if you require a make-up test.

It is my goal to create a learning experience that is as accessible and inclusive as possible. If you anticipate any issues related to accessibility or accommodations, please meet with me outside of class so we can explore potential options to facilitate your learning experience.

**Grading:** Your final course numerical grade will be a weighted average of homework (15%), journal article presentation (5%), two midterms (25% weight on each) and final (30%). I use a 10 pt grading scale for the course letter grade with 3 pt ranges for +/- (>=93.0 is A; >=90 and < 93.0 is A-; etc) with the possibility of curving up, which tends to happen more often for the lower scores. Following a policy used in other classes in the department, final grades on the margin between two letter grades (e.g. B+/A-) may be adjusted based on class participation.

**Advice on how to succeed in this course, and feedback:** First and foremost, focus in class, and work hard on the homeworks. Read the chapters before and/or after lecture. If some topic doesn't make sense after lecture and looking at the book, talk to others (classmates and/or me) to clarify. If you miss a class, try to get notes from a classmate, and compare to slides from Canvas and make sure everything makes sense—if not talk to classmate(s) and/or me.

Start the homeworks early, work on them until you get stuck. Then refer to your notes, the book (especially helpful for end of chapter problems in the book!), etc, to see if you can make more progress. If you're still stuck, step away from it for a day. Fresh eyes can make a big difference. Think about the problem some more, and if you're still stuck after that, consult others for help. I will discuss this further as the exams approach. If you get homework/test problems wrong, and even if you get them right, check the solutions and be sure you understand them.

Given that the solutions are posted, I generally will not write detailed solutions/comments on your graded assignments. You'll get a lot of feedback just by doing problems and seeing how well you can solve them,

and what you need help with. But I'd be happy to discuss additional feedback with you anytime, and if I think I need to communicate something specific to you I will reach out to let you know.

**Course schedule and readings** (subject to change; readings from Watson unless noted):

Parts I-II: Representations and assumptions; simultaneous games

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|---|---|
| 31-Aug | Syllabus, intro to field, history |
| 5-Sep | Chs 1-2, Extensive form; Harford (Logic of Life), Rodrik (Economics Rules) |
| 7-Sep | Set theory; Ch 3, Strategy, normal form (skip 'classic normal-form games'), Appendix A section on Sets) |
| 12-Sep | Ch 4-5, Beliefs, mixed strategies, common knowledge (CK reading: Geanakoplos, JEP, 1992); Ch 6; Dominance, best response |
| 14-Sep | Ch 7, Rationalizability, iterated dominance; **HW 1** |
| 19-Sep | Ch 8 up to "Social Unrest" |
| 21-Sep | Ch 9 NE (skip "Congruous Sets"), **rationalizability papers** |
| 26-Sep | Ch 10 Nash applications; classic games/risk dominance/equilibrium selection |
| 28-Sep | Ch 11, Mixed strategy NE; **HW2** |
| 3-Oct | Review/catchup; **NE/mixed strategy papers** |
| 5-Oct | **Midterm 1** |
| 10-Oct | Fall break |

Part III: Sequential games

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| 12-Oct | Ch 14-15, Backward induction (up to "The SPE of the Stackelberg Duopoly Game" p.191) |
| 17-Oct | Ch 15 ( "The SPE of the Stackelberg Duopoly Game" and Guided Exercise) Ch 16, (skip "Dynamic Monopoly"), IO applications |
| 19-Oct | Ch 18, Bargaining |
| 24-Oct | Ch 19, Bargaining ctd (skip "Multilateral Bargaining"); **HW 3** |
| 26-Oct | Ch 22, Repeated games (up to "The equilibrium payoff set"); Robbett & Carpenter chs 9-10; **bargaining papers** |
| 31-Oct | Ch 23, Collusion (up to "Goodwill…") |
| 2-Nov | Review/catchup; **HW 4**; **repeated games/collusion papers** |
| 7-Nov | **Midterm 2** |

Part IV: Games of incomplete information

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| 9-Nov | Ch 24-5, Incomplete info; risk in contracting; principal-agent models |
| 14-Nov | Ch 26-27 (auctions section only for 27), Bayesian Nash (Milgrom/Harford (Undercover)/Easley-Kleinberg readings - TBD) |
| 16-Nov | Auctions ctd |
| 21-Nov | **Auctions papers**, **HW 5**, introduce signaling games |
| 23-Nov | Thanksgiving break |
| 28-Nov | Ch 28-29, Perfect Bayesian equilibrium, signaling games (we won't cover details of Bayesian updating; you can also skip the Reputation section of ch 29) |
| 30-Nov | PBE/signaling continued (Elephant signaling chapter(s)?) |
| 5-Dec | **Signaling papers**; Other PBE applications as time allows (cheap talk, disclosure, observational learning, counter-signaling, poker?) |
| 7-Dec | Review/catch-up; **HW 6 due** |

Final exam: TBD