Syllabus, Spring 2023, for OIDD 3190:
Advanced Decision Systems:
Agents, Games, and Evolution (AGE)
1:45–3:15p.m., Tuesdays and Thursdays. Room: TBA
Canvas: 
https://canvas.upenn.edu/courses/1689796
GitHub:
https://github.com/stevenokimbrough/AGE/

Professor Steven O. Kimbrough, Instructor
Office hours: T & R 10:00–11:30 and by appointment

October 29, 2023

Masking in class is required until further notice, due to the ongoing community transmission of Covid, flu, monkey pox and polio.
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1 Highlights

- This course is about interdependent (alias strategic) decision making. In these situations there are at least two players (alias agents, decision makers) who make choices and receive rewards in part based on the choices made by other decision makers.

- Interdependent decision making suffuses business, government, politics, and everyday life.

- Doing strategic decision making well is often hugely challenging. The course is in part about making good decisions in strategic contexts.

- Game theory is a branch of applied mathematics that models contexts of strategic interaction (CSIs, alias games). We will advert to game theory as appropriate, but our scope of attention is much broader than game theory in the narrow sense. (More broadly, people speak of the theory of games.)

- There are many reasons to study interdependent decision making. In this course we will focus on:
  
  a. Supporting individual decision making (“the problems of players”)
  b. Explaining and understanding social phenomena (“problems of societies”)
  c. Supporting interventions, especially design of institutions

2 In a nutshell...

OIDD 3190, “Agents, Games, and Evolution,” is about interdependent decision making, also known as strategic or game-theoretic decision making. This kind of decision situation arises everywhere there is social interaction. It is a lively area of study, with negotiation just one of many contexts of strategic interaction. It has been studied and applied in business, government, military, policy, interpersonal, and many other contexts. The main goal of the course is to survey the topic of strategic decision making and, in doing so, to teach how to do it well by arranging for experiences and reflections on them (i.e., we’ll play games in the course). The course has two main foci. The first is strategic decision making “in the wild,” as evidenced in war, foreign policy, business, governance, romance, etc. The second is modeling of contexts of strategic interaction. Here our principal tools will be Game Theory and its analytics results, and game simulations. We shall touch lightly on Game Theory, although we will cover its basics and its essential concepts will be useful throughout
the course. We will conduct simulations using Agent-Based Modeling and NetLogo. Prior programming experience is not required. Students will, however, be exposed to agent-based models (ABM) and related AI techniques.

3 Class Description

OPIM 3190, “Agents, Games, and Evolution,” explores applications and fundamentals of strategic behavior.

The course is about strategic decision making in the sense of game theory. That is, we study decision making situations in which what an agent gets depends upon its decisions as well as decisions made by other agents.

The main goal of the class is:

- To deepen the student’s understanding of strategic interactions—games—in the social and economic spheres.

To this end, our objectives are to study and explore:

1. The key concepts and findings of the theory of games (broadly, the study of interdependent decision making, subsuming game theory).
   These will be useful for understanding and analyzing contexts of strategic interaction.

2. Strategic analysis.
   This is the interpretation of circumstances in terms of agents, interests, strategies, and interaction. We will study good examples of strategic analysis and we will undertake exercises in it.

   This is about how to play games and play them successfully. We will study this by playing games and by observing computational investigations of games.

4. Institution design.
   This is about choosing rules of play that result in desired outcomes. We will focus on common pool resource problems.

5. Strategic modeling and explanation.
   This is about developing game models that can explain observed phenomena. We focus on problems of cooperation as well as a variety of other phenomena.

The design of the course emphasizes learning about decision making in games by actually playing (making decisions in) games and reflecting upon what ensues. Thus, the new design of the course makes it resemble in many ways the design of the negotiations courses. There, students
engage in a series of negotiations and discussions about them. Here, we will engage in a series of games calling for careful strategic decision making, and we will discuss what happened after play is complete. The games we play and discuss will range across a variety of applications, including business applications. Throughout, we will emphasize games that are realistic representations of real world situations, rather than stylized, very abstract games.

The course will continue to include topics that arise throughout the social sciences. The topics include—and we shall study—trust, cooperation, market-related phenomena (including price equilibria and distribution of wealth), norms, conventions, commitment, coalition formation, and negotiation. They also include such applied matters as design of logistics systems, auctions, and markets generally (for example, markets for electric power generation).

In addressing these topics we focus on the practical problem of finding effective strategies for agents in strategic situations (or games). Our method of exploration will be experimental: we review and discuss experiments on the behavior of agents in strategic (or game-theoretic) situations.

Computer programming in NetLogo is introduced in the course. The instructor invites, and will support, projects using NetLogo (as well as other environments). Many of the computational demonstrations and experiments we will examine are available as NetLogo programs ([http://ccl.northwestern.edu/netlogo/](http://ccl.northwestern.edu/netlogo/)).

Students completing the course can expect to come away with:

- Substantial experience with decision making in realistic games.
- Solid understanding of what is known and what is not known about the problem of designing procedures for strategic behavior,
- Familiarity with the principal methods, and results of applying those methods, for the modeling of human agents and design of artificial agents in strategic contexts, and
- Deepened appreciation for contexts of strategic interaction.

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Strategic, or game-theoretic, topics arise throughout the social sciences. The topics include—and we shall study—trust, cooperation, market-related phenomena (including price equilibria and distribution of wealth), norms, conventions, commitment, coalition formation, and negotiation. They also include such applied matters as design of logistics systems, auctions, and markets generally (for example, markets for electric power generation).

In addressing these topics we focus on the practical problem of finding effective strategies for agents in strategic situations (or games). Our method of exploration will be experimental: we review and discuss experiments on the behavior of agents in strategic (or game-theoretic) situations.

In focusing on the design and behavior of artificial agents in strategic (or game-theoretic) situations, we will be especially concerned with strategic contexts of commercial import, such as markets, bargaining, and repeated play. We shall dwell on effective agent learning techniques, including evolutionary methods and reinforcement learning. A main theme in the course is the inherent difficulty, even unknowability, of the problem of strategy acquisition.
We will rely mainly on computational experiments (or simulations), in distinction to analytic mathematical methods, for studying strategy formation and strategic behavior (either by individuals or by groups). Much of the class work will be devoted to discussing and interpreting computational experiments that have been reported in the literature, or that can be undertaken with tools provided in class. In doing so, we draw upon the rapidly growing literature in agent-based modeling and agent-based simulation. Agent-Based Computational Economics (for example, http://www.econ.iastate.edu/tesfatsi/ace.htm) and other terms have come to denote active communities of research and application. We shall draw upon them.

4 Required Texts and Materials

There is nothing necessary to purchase. Our main texts will be:

  
  This should be available as an ebook on Canvas via the library. See [https://github.com/stevenokimbrough/AGE/errata1.zip](https://github.com/stevenokimbrough/AGE/errata1.zip) for fixes to earlier printings of the book.

- NetLogo. Software tool for agent-based modeling. Available at [https://ccl.northwestern.edu/netlogo/](https://ccl.northwestern.edu/netlogo/)

- *Lecture Notes* are posted on Canvas. These notes are required or suggested readings, as indicated.


In addition, various other readings will be assigned. These will generally be handed out or made available online.

Other readings and handouts will be freely available on Canvas.

5 Class Schedule

5.1 Interdependent decision making

Main topics:

- Core concepts: strategic decisions, parametric decisions, etc.

- Course overview
• A quick overview of decision theory

Assigned reading(s):

a. AGEbook, chapter 1. ([Kimbrough] 2012 chapter 1)

Slide deck: AGE-classintro-beamer.pdf

Reference material:


c. Extended reading: Steele and Stefansson (2020)

5.2 Non-Cooperative Game Theory

Main topics:

1. Strategic (normal) form games.

2. Games in extensive form

3. Other game forms

4. Nash equilibrium

5. Pareto optimality

6. Conditions of play: one-shot, anonymous, payoffs, utility, rationality, mutual knowledge of play

7. Solution as equilibrium

8. Discuss some standard games, canonical games. Use existing slides if possible. IPD, Stag Hunt, Chicken, public goods games, ultimatum, dictator.

Slide deck: Brief_Orthodox_Game_Theory-beamer.pdf

Assigned reading(s):

5.3 Utility and Rational Choice Theory (RCT)

Main topics:

- Certainty, risk, ignorance, uncertainty, ambiguity
- Utility

Assigned reading(s):


Reference material:

b. Peterson [Peterson](2017) chapters 3 and 4.
c. Peterson [Peterson](2017) chapters 5 and 11.

Recommended reading:


5.4 The Problem of Cooperation

Main topics:

- Problems of cooperation
- The tragedy of the commons
- Introducing NetLogo

Assigned reading(s):

b. PNbook, chapter 0, “Getting Started Using NetLogo.”

Reference material:

5.5 Axelrod on Cooperation

Main topics:
- Prisoner’s Dilemma game
- Axelrod on the problem of cooperation

Assigned reading(s):
- *The Evolution of Cooperation* (Axelrod, 1984, chapter 1)

Reference material:
- *The Evolution of Cooperation* (Axelrod, 1984, Appendix B)

5.6 Axelrod’s Tournaments

Main topics:
- Prisoner’s Dilemma tournaments
- Axelrod’s interpretation of the results

Assigned reading(s):
- *The Evolution of Cooperation* (Axelrod, 1984, chapter 2)
- *Agents, Games, and Evolution* (Kimbrough, 2012, chapter 3)

Reference material:
- *The Evolution of Cooperation* (Axelrod, 1984, Appendix A)

5.7 NetLogo, Replicator Dynamics, BehaviorSpace

Main topics:
- Introduction to NetLogo
- The replicator dynamics
- BehaviorSpace in NetLogo

Assigned reading(s):
5.8 Evolutionary Models and Skyrms

Main topics:

- Beyond tournaments, replicator dynamics
- “Sex and Justice”
- “Commitment”

Assigned reading(s):


5.9 Territorial Models

Main topics:

- Spatial considerations and the differences they make
- Local interaction
- The shadow of society

Assigned reading(s):

a. (Kimbrough, 2012 chapters 4 and 5)

Recommended reference material:

a. Axelrod chapter 8, pages 158–168

5.10 Quiz #1 and Positional Goods

Main topics:

- Quiz, 50 minutes, closed book, one two-sided crib sheet permitted.
- The positional goods game
- Hirsch and positional goods

Assigned reading(s):

10
5.11 Framing and the Cooperation Afforder Game

Main topics:
- Framing
- The cooperation afforder game

Assigned reading(s):

5.12 Naturalizing Cooperation

Main topics:
- Summary and review on cooperation
- The evolving preferences account of cooperation
- The cultural affiliation account of cooperation

Assigned reading(s):
- Freedman, (Freedman, 2013, chapter 37) “Beyond Rational Choice”

5.13 Heuristics and ABMs

Main topics:
- Heuristics
- ABMs and interdependent decision making
- Heuristic choice science

Assigned reading(s):
- Teaching notes, this chapter

Reference material:
5.14 Self-Organization and Emergence

Main topics:

- Self-organization
- Emergence
- Applications in interdependent decision making

Assigned reading(s):


5.15 Quiz #2 and TBA

Quiz, 50 minutes, closed book, one two-sided crib sheet permitted.

5.16 ABM, 1: NetLogo

Main topics:

- Introduction to agent-based modeling
- Introduction to NetLogo programming

Assigned reading(s):


(Has free PDF at this location. File: ABMA_color_version.pdf posted on Canvas.)

b. PNbook, chapter 1

Reference material:

a. *NetLogo Users Manual*
5.17 ABM, 2: NetLogo

Main topics:

- Programming in NetLogo

Assigned reading(s):


(Has free PDF at this location. File ABMA_color_version.pdf posted on Canvas.)

b. PNbook, chapter 2.

Reference material:


5.18 Two-Sided Matching

Main topics:

- Stable matching problems
- Computational solutions
- Applications

Assigned reading(s):


b. AGEbook: (Kimbrough, 2012, chapter 13)

5.19 Competitive Markets

Main topics:

- The standard account
- Variants
- Zero-intelligence Agents
- Trade on the Sugarscape
5.20 Monopoly and Oligopoly Markets

Main topics:

- Monopoly and PROBE AND ADJUST
- Cournot competition in oligopolies with PROBE AND ADJUST
- Bertrand competition with PROBE AND ADJUST
- Supply curve bidding with PROBE AND ADJUST

Assigned reading(s):

a. “Monopoly Stories” (Kimbrough 2012 chapter 9)

b. “Oligopoly: Cournot Competition” (Kimbrough 2012 chapter 10)

Recommended material:

a. “Oligopoly: Bertrand Competition” (Kimbrough 2012 chapter 11)

5.21 Foraging

Main topics:

- Ideal Free Distribution
- Duck economics

Assigned reading(s):

5.22 Quiz #3 and Voting, 1

Main topics:

1. Quiz, 45 minutes, closed book, one two-sided crib sheet permitted.
2. The problems of voting
3. The problem of designing voting systems

Assigned reading(s):


5.23 Voting, 2

Main topics:

- Comparison of voting methods
- Voting systems based on ratings
- Approval voting
- Range voting

Assigned reading(s):


5.24 Meade at Gettysburg

Main topics:

- Overview of the campaign: Lee invades Pennsylvania in 1863.
- The battle of Gettysburg, standard story
- The battle of Gettysburg, told strategically

Assigned reading(s):
5.25 Grant, Paducah, and Grand Strategy

Main topics:

- The South’s strategic blunder at Columbus, KY
- Grant’s response: Paducah
- Fort Henry and Fort Donelson fall, the South’s cordon defense is punctured
- Levels of strategy
- Grand strategy
- Grand strategy in the Civil War

Assigned reading(s):


5.26 Kennan and Containment

Main topics:

- Context: Creating U.S. foreign policy after World War II.
- The Marshall Plan and containment.
- Video of interview with Kennan in 1988.

Assigned reading(s):


b. Lecture Notes
5.27 Argumentation

Main topics:

- Reasons and strategy
- Arguments: valid, invalid, sound, enthymemes
- Backwards induction

Assigned reading(s):

a. *Agents, Games, and Evolution* (Kimbrough, 2012, chapter 19), be sure to read the “errata” version with errors fixed.

Reference material:


5.28 Last Class: Summary and Outlook

Main topics:

- Summing up: from rational choice to heuristic choice
- Looking forward: ABM, common pool resources, role playing
- End of term essay assignment handed out and discussed.
6 Grades and Conduct of Class

Attendance: Mandatory. Please email me in advance if you have a good reason not to attend a particular session.

Electronics: No phones, laptops, tablets or other electronics, unless specifically directed otherwise.

Grading will be based on several components, as follows.

30% Homework assignments and class participation.

45% Three quizzes, 15% each.

25% End of term essay, due the last day of finals, May 9, 2023. Groups of two, self-organized.

Grading: $x > 95\%$, A+; $91\% \leq x \leq 95\%$, A; $85\% < x \leq 91\%$, A-/B+; $75\% < x \leq 85\%$, B; $65\% < x \leq 75\%$, C; $55\% < x \leq 65\%$, D; $x \leq 55\%$, F. With the caveat that I can give lots of As if merited but it’s very unlikely I can give lots of A+s.

Most of all, I want to see you engaged and involved in the class. I’ll prepare lectures for the classes, but much prefer to conduct class with lots of interactive, give and take, and discussion.

Also: I like jazz and will improvise during the semester. The syllabus may well (will likely) change as we go along. I’ll let you know when it does and the quiz dates will not be changed.

Two further items/requirements:

- Every student should come chat with me at least once during (online) office hours. If my posted hours conflict with your schedule, let me know and we’ll make arrangements. Also, you need not come alone. It’s fine to come with a group of up to four.

- You will occasionally need your laptop in class. I’ll let you know ahead of time. However, during lectures and similar periods when we are not actively using them, use of laptops, PDAs, etc. are forbidden.

7 Computer Access for Non-Wharton Students

Here is the link you should include with your announcements and instructions on future syllabi.

This link works:


In plain text:


*Wharton Class Accounts are needed so that when students try to login into the computers in the labs with their PennKey these PennKey link to active Wharton Class accounts. These class accounts also are needed if students intend to use the public printers.

*I have confirmed Study.net materials are all PennKey authentication now.
Also (for non-Wharton students): After you follow the link above and create a Wharton Class Account, you will then log in to the computers with your PennKey account. (But wait an hour the first time you try this.)

8 Calendar, spring 2023

Last class is on Tuesday, April 25, 2023.

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Table 1: Class number :: date correlation, for Tuesday (T) and Thursday (R) classes, spring 2023. Penn academic calendar [https://almanac.upenn.edu/penn-academic-calendar](https://almanac.upenn.edu/penn-academic-calendar)

References


