

Syllabus, Spring 2019, for OIDD 319:  
Advanced Decision Systems:  
Agents, Games, and Evolution (AGE)  
3:00-4:20 p.m., Tuesdays and Thursdays. Room: JMHH G55  
[sic]  
Canvas: `https://upenn.instructure.com/courses/1344759`  
[sic]

Professor Steven O. Kimbrough, Instructor  
Office hours: 565 JMHH  
1:30–2:45 Tuesdays and Thursdays, and by appointment  
Mary Payton (MP) Sanford, TA  
Office hours: TBA

November 27, 2019. Syllabus-OIDD319-2019A, Revision 0

## 1 Class Description

OPIM 319, “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.

3. Strategy discovery and selection.

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 is neither required nor discouraged for 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/>). Students are not, however, at all required to undertake programming exercises, in NetLogo or in any other environment.

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.

Computer programming is neither required nor discouraged for 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/>). Students are not, however, at all required to undertake programming exercises, in NetLogo or in any other environment.

## 2 Required Texts

- *The Evolution of Cooperation*, by Robert Axelrod, (Axelrod, 1984).
- *Agents, Games, and Evolution*, by Steven Orla Kimbrough, (Kimbrough, 2012).

See <http://opim.wharton.upenn.edu/~sok/agebook/errata1.zip> for fixes to earlier printings of the book.

In addition, various other readings will be assigned. These will generally be handed out or made available online. Including excerpts from *Growing Artificial Societies*, Joshua Epstein and Robert Axtell, (Epstein and Axtell, 1996) and *Decision Games* by Clark and Kimbrough.

### 3 Class Schedule

#### 1. Introduction and overview of the course.

Strategic interaction and how we study it and use it.

Read: “Contexts of Strategic Interaction,” (Kimbrough, 2012, chapter 1).

#### 2. Canonical games.

Examples of standard games. Handout and exercise. How would you play? See lecture notes posted on Canvas: *2\_AGE-canonical\_games\_beamer.pdf*.

Assignment #1 posted. Due: At start of class 7.

Strategic (normal) form games. Nash equilibrium. Pareto optimality. Conditions of play: one-shot, anonymous, payoffs, utility, etc.

#### 3. Games in the wild.

Read: “Games in the Wild and the Problems of Play” (Kimbrough, 2012, chapter 2); *Micromotives and Macrobbehavior* (Schelling, 1978, pages 11–43).

(File: *MicromotivesAndMacrobbehavior.pdf*.)

Note: Schelling (10 October 2005) won a Nobel Prize for doing this sort of work. <http://nobelprize.org/economics/laureates/2005/press.html>.

#### 4. A Brief on Orthodox Game Theory.

Instructor handout.

Required reading (Kimbrough, 2012, Appendix A; B.3).

Recommended reading: Ross, Don, “Game Theory”, *The Stanford Encyclopedia of Philosophy (Spring 2006 Edition)*, Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/spr2006/entries/game-theory/>.

#### 5. Positional Goods and Games

Reading: (Hirsch, 1976, Chapters 1 and 2). File *Fred Hirsch - selections for FRG.pdf* on Canvas.

6. The Problems of Cooperation, 1.

Assignment #1 due before class.

Read: “The Tragedy of the Commons,” by Garrett Hardin (Hardin, 1968) (File: *hardin-tragedy-commons.pdf*) and “Cues of Being Watched Enhance Cooperation in a Real-World Setting” (Bateson et al., 2006). File on Canvas: *Biology Letters 2006 Bateson.pdf*.

7. Cooperation, 2: Axelrod’s Tournaments.

Read: (Axelrod, 1984, chapters 1–3) Recommended: (Axelrod and Hamilton, 1981).

8. Tournaments

Read: (Kimbrough, 2012, Chapter 3). Read: (Axelrod, 1984, chapters 4–6)

9. In-class game exercise and Spatial and Evolutionary Models.

Read: (Kimbrough, 2012, chapter 4)

10. Fairness and ultimatum games; commitment; reciprocity.

Read: Brian Skyrms, *Evolution of the Social Contract*, (Skyrms, 1996) chapters 1-2 (“Sex and Justice,” pp. 1-21; “Commitment,” pp. 22-44), Cambridge University Press, 1996. Posted on Canvas as *skyrms-evo-soc-contract-1and2.pdf*.

11. Trust, Framing, and the Stag Hunt.

Read: Brian Skyrms, *The Stag Hunt and the Evolution of Social Structure*, (Skyrms, 2004) “Preface” (pp. xi-xiv) and chapter 1, “The Stag Hunt” (pp. 1-14), Cambridge University Press, 2004. (File: *Skyrms-StagHunt-Pref-Ch1.pdf*).

12. Framing.

13. The Stag Hunt and Affording Cooperation.

Read: “The Stag Hunt,” (Kimbrough, 2012, Chapter 5) and “Affording Cooperation,” (Kimbrough, 2012, Chapter 7).

Replicator dynamics exercise.

**\*\*\*\* Spring break March 2–10 \*\*\*\***

14. Strategic analysis.

Read: Kennan, “The Sources of Soviet Conduct” on Canvas (X, 1947), file: *KennanSourcesOfSovietConduct.pdf* posted on Canvas. View: 1988 PBS interview; transcript: *Kennan-Dec211988part1ofinterview.rtf* posted on Canvas.

15. Game day.

Play various decision games. TBA.

16. Quiz #1.

17. Agent-based modeling, 1-2.

Compressed because of the snow day last time.

Discussion of data from the Hide and Seek game.

Introduction to ABM. NetLogo overview.

Read: *Growing Artificial Societies: Social Science from the Bottom Up*, by Joshua Epstein and Robert Axtell, MIT Press, 1996, (Epstein and Axtell, 1996, Chapters I, II, IV).

Posted for reference purposes: *AGE-GAS-epstein-axtell-foils.pdf*.

18. Markets: Competitive.

Discuss:

- Revised syllabus (-r2)  
Play stylized redistricting game in class 27. In addition, will do a few other games during the remainder of the semester. Ad hoc.
- Assignment #2. Posted. Due April 4 at 3:00.
- Assignment # 3. Posted. Due April 18 at 3:00.
- Term project. See *term-project.pdf* on Canvas in the *Assignments* folder. Also see *Term Projects from Earlier Years*. Actually, last year. Nice projects. Many others were very nice, too.

Read: “Competitive Markets” (Kimbrough, 2012, chapter 8) and “Zero-Intelligence Agents,” Gode and Sunder (1993) (file: *gode-sunder-1993.pdf* on Canvas).

Recommended reading: Gode and Sunder (1997) (file: *gode-sunder-1997.pdf* on Canvas).

19. Markets: Monopolies, Oligopolies.

(a) The Beer Game

(b) Markets: Monopolies, Oligopolies.

Read: “Monopoly Stories” (Kimbrough, 2012, chapter 9), “Oligopoly: Cournot Competition” and “Oligopoly: Bertrand Competition,” (Kimbrough, 2012, chapters 10–11).

Recommended skim: “Supply Curve Bidding,” (Kimbrough, 2012, chapter 12).

20. Evolution and evolutionary algorithms.  
Read: (Kimbrough, 2012, chapter 18); (strongly recommended:) Darwin, concluding chapter of *The Origin of Species* Darwin-Origin-Chapt14-1st-ed.pdf on Canvas, online at <http://www.literature.org/authors/darwin-charles/the-origin-of-species/chapter-14.html>.  
Briefly on ANNs (artificial neural networks).
21. Evolutionary models and games.  
Read: Excerpt from *Blondie24*, file B-49127 Blondie 24.pdf, on Canvas (Fogel, 2002); “Evolutionary Models,” (Kimbrough, 2012, chapter 18).
22. Trust and Deception, 1.  
Read: “Lying and Related Abuses,” (Kimbrough, 2012, Chapter 17).
23. Trust and Deception, 2.  
Read: “Criminal Credentials,” (Gambetta, 2009, Chapter 1).
24. Quiz #2.
25. Background for zone design and special topics.  
Background for play in class 27: Redistricting and zone design.  
Special topics as time is available.
26. Conflict and Cooperation (in the Wild).  
Read:
  - (a) Chapter 3, “Enter Conflict,” from *Constant Battles: The Myth of the Peaceful, Noble Savage*, by Steven A. LeBlanc, who is an archeologist. It’s about 20 pages. File: LeBlancConstantBattlesChapt3.pdf on Canvas.
  - (b) Chapter 3, “Analyzing Long-Enduring, Self-Organized, and Self-Governed CPRs,” from *Governing the Commons*, by Elinor Ostrom, a political scientist who recently won a Nobel Prize in Economics for this work. It’s about 40 pages. File on Canvas: Ostrom\_1990\_chapt3.pdf.

Assignment on this is due before the start of class.
27. In-class game exercise and special topics.  
Play redistricting and zone design game.
28. Last class of the semester. Summing up and looking forward.  
Read: “Summing up,” (Kimbrough, 2012, chapter 20).

## 4 Grades and Conduct of Class

Grading will be based on several components, roughly as follows.

35% Class participation (including attendance, in-class exercises, homework assignments).

15% First quiz.

15% Second quiz.

35% Term project.

**Tuesday, 7 May, 2019, 11:59 p.m., final (term) project due.**

**Term  
project  
due  
Tuesday, 7  
May, 2019,  
11:59 p.m.**

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 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.

## 5 Computer Access for Non-Wharton Students

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

This link works:

<https://whartonstudentsupport.zendesk.com/hc/en-us/articles/203165417-Create-Your-Wharton-Class-Account>

In plain text:

<https://whartonstudentsupport.zendesk.com/hc/en-us/articles/203165417-Create-Your-Wharton-Class-Account>

\*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.)**



## References

- Axelrod, R. (1984). *The Evolution of Cooperation*. Basic Books, Inc., New York, NY.
- Axelrod, R. and Hamilton, W. (1981). The evolution of cooperation. *Science*, 211:1390–1396.
- Bateson, M., Nettle, D., and Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters*, 2:412–414. doi: 10.1098/rsbl.2006.0509 and <http://rsbl.royalsocietypublishing.org/content/2/3/412>.
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- Gode, D. K. and Sunder, S. (1993). Allocative efficiency of markets with zero-intelligence traders: Market as a partial substitute for individual rationality. *Journal of Political Economy*, 101(1):119–137.
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- Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859):1243–1248.
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- Kimbrough, S. O. (2012). *Agents, Games, and Evolution: Strategies at Work and Play*. CRC Press, Boca Raton, FL.
- Schelling, T. C. (1978). *Micromotives and Macrobehavior*. W.W. Norton & Company, New York, NY.
- Skyrms, B. (1996). *Evolution of the Social Contract*. Cambridge University Press, Cambridge, UK.
- Skyrms, B. (2004). *The Stag Hunt and the Evolution of Social Structure*. Cambridge University Press, Cambridge, UK.
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