Preliminary: Syllabus, Spring 2016, for OPIM 319: Advanced Decision Systems: Agents, Games, and Evolution (AGE) 3:00-4:20 p.m., Tuesdays and Thursdays. Room: **TBA** Canvas: **TBA**

Professor Steven O. Kimbrough, Instructor
Office hours: 565 JMHH
3:00-4:30 Wednesdays, 1:30–3:00 Thursdays and by appointment

2016-10-22

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.

* * *

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).
- *Growing Artificial Societies,* Joshua Epstein and Robert Axtell, (Epstein and Axtell, 1996).
- *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.

3 Grading

Grading is based on class participation (including performance on game exercises), assigned short essays undertaken during the term, one quiz, and a term project. For further information, contact the principal instructor for the course, Professor Steven O. Kimbrough (kimbrough@wharton.upenn.edu).

4 Class Schedule *** Provisional ***

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, 1.

3. Canonical games, 2.

4. Games in the wild.

   Read: "Games in the Wild and the Problems of Play" (Kimbrough, 2012, chapter 2); *Micromotives and Macrobehavior* (Schelling, 1978, pages 11–43).
   (File: MicromotivesAndMacrobehavior.pdf.)

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

   Daniel Yergin, *The Prize*, chapter 22, "Fifty-Fifty: The New Deal in Oil" (Yergin, 1992) and *The Quest*, chapter 19, "Breaking the Bargain" (Yergin, 2012).

5. Classical game theory, its elements and discontents, 1.

   Instructor handout. In-class material on ESS.

   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/.

6. Classical game theory, its elements and discontents, 2.

   Instructor handout. "Heuristic Optimization Concepts."

7. Decision Games versus Insight Games.

   Discuss: Military war games. Brief game 1.

8. Play game 1.

9. Debrief game 1. Brief game 2.

10. Play game 2.

11. Debrief game 2. Brief game 3.

12. Play game 3.

13. Debrief game 3. The problem of cooperation, 1.

    Read: (Axelrod and Hamilton, 1981).

14. Cooperation and its evolution, 2.

15. The problems of cooperation.

    Read: "The Tragedy of the Commons," by Garrett Hardin (Hardin, 1968)
    (File: `hardin-tragedy-commons.pdf`).

***** Spring Term Break Saturday–Sunday March 5–13, 2016. *****

16. 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`; "Fanning out: 2×2 Games and Models," (Kimbrough, 2012, chapter 4).

17. 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`.); and "Affording Cooperation," (Kimbrough, 2012, chapter 7). Recommended: "The Stag Hunt," (Kimbrough, 2012, chapter 5).

18. Agent-based modeling.

    Read: *Growing Artificial Societies: Social Science from the Bottom Up,* by Joshua Epstein and Robert Axtell, MIT Press, 1996, (Epstein and Axtell, 1996, Chapters 1-2-3).

19. Agent-based modeling.

    Read: *Growing Artificial Societies: Social Science from the Bottom Up,* by Joshua Epstein and Robert Axtell, MIT Press, 1996, (Epstein and Axtell, 1996, Chapters 4 to end).

20. Strategic Analysis.

    Read before class:

    - `http://future.state.gov/when/timeline/1946_cold_war/kennan_and_containment.html`,

- http://marshallfoundation.org/library/MarshallPlanSpeechfromRecordedAddr
000.html, and
- George Kennan, "The Sources of Soviet Conduct" (1947) X (1947), file: *Kennan-SourcesOfSovietConduct.pdf* on Canvas.

Recommended: The long telegram: http://www.gwu.edu/~nsarchiv/coldwar/documents/episode-1/kennan.htm

Handed out: Strategic Analysis Assignment.

21. Mid-term quiz. **Quiz #1**

22. Markets: Competitive.

    Discuss: Syllabus revisions; assignments (term project, strategic analysis, NetLogo experiments).

    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).

23. 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).

24. 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).

25. Evolutionary models and games.

    Read: Excerpt from *Blondie24*, file Blondie24/B-49127 Blondie 24.pdf, on Canvas (Fogel, 2002); "Evolutionary Models," (Kimbrough, 2012, chapter 18).

26. Lying & Other Abuses in Strategic Interaction.

    Read: "Lying and Related Abuses," (Kimbrough, 2012, chapter 17).

27. Backward induction and rationality redux.

    Slides: *marriage-matching-beamer.pdf*; recommended reading: (Kimbrough, 2012, chapter 13).

    Read: "Backward Induction," (Kimbrough, 2012, chapter 19).

28. Last class of the semester. Summing up and looking forward.

    Read: "Summing up," (Kimbrough, 2012, chapter 20).

5 Grades and Conduct of Class

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

20% Homework assignments. This will be given out occasionally. Mostly 1–2 pages of writeup.

35% Class participation (including attendance and in-class exercises).

15% Mid-term quiz.

30% Term project.

Thursday, April 21, 2016, noon, final (term) project due.

Term project due Thursday, April 21, 2016, noon

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.

6 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-Yo`

In plain text:
https://whartonstudentsupport.zendesk.com/hc/en-us/articles/203165417-Create-Your-Wharton-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.

7 Calendar, Spring 2016

Class meets on Tuesdays and Thursdays, 3:00–4:20 p.m. There are 28 sessions in all. First class, Thursday, 14 January 2016. Last class, Tuesday, 25 April 2016. Spring Term Break Saturday–Sunday March 5–13, 2016.

	0	1	2
0	—	T: 2016-02-16	T: 2016-03-29
1	R: 2016-01-14	R: 2016-02-18	R: 2016-03-31
2	T: 2016-01-19	T: 2016-02-23	T: 2016-04-05
3	R: 2016-01-21	R: 2016-02-25	R: 2016-04-07
4	T: 2016-01-26	T: 2016-03-01	T: 2016-04-12
5	R: 2016-01-28	R: 2016-03-03	R: 2016-04-14
6	T: 2016-02-02	T: 2016-03-15	T: 2016-04-19
7	R: 2016-02-04	R: 2016-03-17	R: 2016-04-21
8	T: 2016-02-09	T: 2016-03-22	T: 2016-04-26
9	R: 2016-02-11	R: 2016-03-24	—

Table 1: Class number :: date correlation, for Tuesday (T) and Thursday (R) classes, spring 2016

Reading days: April 28–29, 2016. Final examinations: May 2–10, 2016.

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.

Epstein, J. M. and Axtell, R. (1996). *Growing Artificial Societies: Social Science from the Bottom Up*. The MIT Press, Cambridge, MA.

Fogel, D. B. (2002). *Blondie24: Playing at the Edge of AI*. Morgan Kaufmann, San Francisco, CA.

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.

Gode, D. K. and Sunder, S. (1997). What makes markets allocationally efficient? *Quarterly Journal of Economics*, 112:603–630.

Hardin, G. (1968). The tragedy of the commons. *Science*, 162(3859):1243–1248.

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.

X (1947). The sources of soviet conduct. *Foreign Affairs*, 25(4):566–582. Author: George F. Kennan.

Yergin, D. (1992). *The Prize: The Epic Quest for Oil, Money & Power*. Free Press.

Yergin, D. (2012). *The Quest: Energy, Security, and the Remaking of the Modern World*. Penguin Books.

$Id: syllabus-oidd319-s2016.tex 4982 2015-10-24 15:29:40Z sok $