Advanced Game Theory

David A. Siegel

Course information:
Course Number: POLSCI749S
Time: T 8:30 - 11:00 am
Place: Gross 111
Course website: Sakai

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OH: W 1:30-2:30 pm by Zoom, or by appt.

Course Description

This course is the second in the department's game theory sequence. The course has three primary aims. The first is a better understanding of the formal modeling literature. By the end of the course you should be ready to read and understand original modeling articles and have a good idea as to why authors made the choices they did, and what they gained or lost by making them. The second is an enhanced ability to write models of your own. Throughout the course you will be exposed to an array of different theoretical modeling techniques, both to familiarize you with them and to indicate which may be of best use for a given problem. That will prepare you to write your own models in the future. The third is an appreciation of the context in which formal models are written. We'll discuss their assumptions, their presentation, and their intended messages.

There are two main differences between this course and the department's introductory course. One is that it employs a greater breadth of math. I will assume that students are comfortable with the material that is covered by the department's math camp: calculus in one dimension, probability, and linear algebra. If your math is rusty, you may want to revisit material from the camp or from other classes, particularly material involving optimization and solving systems of equations. In the beginning of the semester we will cover additional math, including calculus in more than one dimension, that will be of use during the rest of the semester.

The second difference is that we will be tackling more advanced material, at a quicker rate. I will assume that students will enter the course having already taken the introductory class. Of course, I recognize that students may not have perfect recall of previously learned material. The first few weeks will provide some opportunity to review, though in the course of solving more sophisticated versions of the kinds of problems students have already solved in the introductory course.

Course Format

I believe the best way to learn modeling is by doing, and the class structure reflects this. I have partitioned the course into five parts. Each covers a key component of formal modeling: the building blocks of models, how actors individually respond to their decision environments, how actors respond to each other, how actors handle uncertainty, and how actors may manipulate systems of other actors. You can find examples of important topics that fall under each component in the schedule below. Topics that will be familiar to you from introductory game theory will be covered more quickly and with a more mathematically sophisticated treatment than they were in the introductory course, leaving more time for new topics. I have provided a rough estimate allotted to each part of the course in the tentative schedule below. Note that the course difficulty ramps up as the semester progresses.

Within each part of the course, I will assign one or more problem sets. Those problem sets will require a significant input of time, and represent the most important mechanism for developing mastery of the material. They also represent the largest component of your grade. To maximize

the value of these problem sets to you, it will be *you*, not me, who will provide the first assessment of your own problem sets. The procedure will be as follows. Each problem set will appear under Assignments on Sakai one week before it is due. After the due date, you will get access to a new assignment that will be due in three days. That second assignment will require you, with the aid of solutions to the problem set, to figure out which problems you answered correctly, and where your answers may have deviated from the solutions on the others. For those others, you will provide detailed comments on your original problem set that both identify and explain the reasoning behind any incorrect problems you had on your original submission, and describe how you would now solve them instead. In doing so you will not assign any grades. After you turn in your commented problem set to appropriate Sakai Assignment, I will grade both your original problem set and the one on which you provided comments. The goal of the exercise is to ensure that by the conclusion of the process you understand fully the logic underlying each problem.

Though I will be primarily lecturing during class, it will be absolutely vital to be engaged during class time. More than most other courses you will take, this class builds on itself, and falling behind can lead to a great deal of confusion down the road. No question that helps anyone avoid falling behind is a bad one. Also, from experience, it is highly likely that many other students also will have had your same question. In service of that point, I *strongly* encourage frequent interruptions. I have left the schedule below tentative precisely because I want to take however much time is needed to accommodate your questions.

In addition to completing problem sets, as the course progresses, you should be thinking of substantive scenarios of interest to you that might benefit from the construction of a formal model. At the conclusion of the course you will write and solve a model of your own designed to address a question of substantive interest to you. The purpose of that model is not to produce an immediately publishable work of formal theory. It is instead to take some early steps in formalizing your thoughts, to understand what that entails, and to help you to discern your future interests in this area.

Readings

There is no required text for the course. However, we will be drawing from several texts during class, some of which will be reflected in the class notes that I will sometimes distribute on Sakai before class. The three texts I will primarily be drawing from are:

- McCarty, Nolan and Adam Meirowitz. 2014. *Political Game Theory: An Introduction*
- Gehlbach, Scott. 2022. *Formal Models of Domestic Politics: Second Edition (Analytical Methods for Social Research)*
- Tadelis, Steven. 2013. *Game Theory: An Introduction*

All are available in the usual places. I recommend those sources for reading *after* the corresponding class sessions. I will also reference a handful of journal articles, and will post them to Sakai's Resources prior to doing so.

Course Requirements

- Problem Sets (80%): This is by far the most important part of the course. You are welcome to work together on these on your first submissions, but each person must write up the solutions on their own, either by hand (assuming your handwriting is legible and you are comfortable

scanning or taking pictures of your answers and uploading them to Sakai) or by computer (doc, docx, and pdf are all acceptable formats). You are strongly encouraged to make sure that you understand each thing you write down, and I encourage you to come talk to me if this is proving difficult. This is for your benefit, not mine: you will get much more out of the class this way. You will turn in an electronic copy of each problem set on its due date, and there will be no extensions. At that time, I will distribute solutions as an attachment to a second assignment. You will then have three days to provide your self-assessment of the original problem set discussed above (in a different color, if handwritten), and turn it in electronically to that second assignment. You will be graded on both your original solutions and your assessment. Generous credit will be given for making a real attempt at a difficult problem and then working out later the full solution, even if the solution is not found at first, so don't worry if your initial answers are not flawless. No credit, however, will be given for a cursory first attempt, followed by a detailed assessment. Note: in your self-assessment, I am looking for a discussion of how your answer deviated from the solution, not your merely copying my solution over, and no credit will be given for that. *Do not put problem sets off to the last minute!* The earlier you start, the more help you can expect.

- Paper (20%): You are to produce by the last class a paper comprising an original model and its solution. This paper must contain a formal presentation of the model (no more than two pages), substantive justifications for all modeling assumptions and parameters (no more than three pages), a brief (no more than one paragraph) introduction detailing the question the model is intended to address, a brief (no more than three pages) discussion of insights derived from the model, and an appendix with a formal solution of the model. The model may be on any topic, as long as it uses methods discussed in class. It must be typewritten, though you can attach a picture of handwritten solutions as an appendix. *The goal of this assignment is to address a question formally, not to produce a complex model. Simple is completely fine; the focus is on whether the model captures the substance well.*

Very Tentative Schedule:

Part I: The Building Blocks of Formal Modeling (1 week)

Topics covered include: Actors; Actions; Outcomes; Systems and System States; Examples of Papers Employing Formal Models; Additional Math.

Part II: Actions of a Single Actor (1 week)

Topics covered include: Preferences and Stimuli; Behavioral Rules; Beliefs and Rationality; Bounded Rationality; Uncertainty; Discounting; Decision Theory; Computational Methods.

Part III: Multiple Actors given Accurate Beliefs (2 weeks)

Topics covered include: Strategic vs. Non-strategic Behavior; Multi-actor Bounded Rationality; Game Theory and Nash Equilibrium; Simultaneous, Sequential, and Repeated Games; Game Trees and Histories; Subgame Perfect Equilibrium; Comparative Statics and Testing Game Theory; Behavioral Game Theory.

Part IV: Managing Uncertainty (7 weeks)

Topics covered include: Varieties of Uncertainty; Mixed Strategies; Quantal Response Equilibrium; Actor Types; Bayesian Nash Equilibrium; Varieties of Learning and Belief Formation; Bayes Rule; Perfect Bayesian Equilibrium and Refinements; Signaling and Screening; Reputation;

Bayesian Persuasion; Bargaining; Global Games; Markov Perfect Equilibria.

Part V: Manipulation and Social Planners (3 weeks)
Topics covered include: Social Choice Theory; Principal-Agent Problems; Mechanism Design.