Advanced Game Theory

David A. Siegel

Course information:	**Contact Information:**
Course Number: POLSCI749S	E-mail: david.siegel@duke.edu
Time: M 7:00 - 9:30 pm	Tel: 660-4306 (not this semester)
Place: Online via Zoom	Office: 293 Gross Hall (not this semester)
Course website: Sakai	OH: W 1:30-3:00 pm, or by appt.

Course Description

This course covers game theory at an intermediate level. There are two main differences between it and typical introductory courses. One is that it employs a greater breadth of math. The department's math camp, or its equivalent, is a real prerequisite for the class. If your math is rusty, you may want to revisit the camp's material, particularly optimization and solving systems of equations. The math camp can be found here. We will also go a little further into mathematical formalism than you did in math camp, but this material will be taught in class. Of course, I will be happy to answer questions in class or help out of class with this math as well as game theory. A second difference is that we will move more quickly than would an introductory class, and cover more material at greater depth.

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 choices, from sequential and simultaneous games to signaling and bargaining games to agency problems to behavioral models and computational methods, both to familiarize you with them and to indicate which may be of best use for a given problem. This 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.

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 tentative schedule below.

Within each part of the course, I will assign one or more problem sets. These 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. After turning in a *copy* of your problem set to Sakai's dropbox, you will gain access to detailed solutions for the problem set. You will then have a week to figure out which problems you answered correctly, and how and why you might have gone wrong on the others. For those others, you will provide detailed comments, on your original problem set, that provide those hows and whys. In other words, you will 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, however. After you turn in your commented problem set, also to Sakai's dropbox, I will grade both your original performance and your assessment. The goal of the exercise is to ensure that by the conclusion of the process you understand fully the logic underlying each problems.

Before the semester begins, I will post a set of lecture notes to Sakai that will address a good portion of what we will cover in class, including some examples we will work through. I will also be posting additional notes as they become available. My suggestion is that you read those notes *after* we cover the corresponding topics in class. Many topics can seem daunting on paper before encountering them, but much less so after talking through them. Reading the notes after topics have been discussed can both reduce stress and reinforce learning.

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. Further, 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 a formal model. At the conclusion of the course you will write and solve a simple model of your own designed to address a question of substantive interest to you. The purpose of this model is not to produce an immediately publishable work of formal theory. It is instead to take some early steps in formalizing your thoughts, understand what this entails, and help you to discern your future interests in this area.

Readings

There is no required text for the course. Should you want a text, however, there are many from which to choose. The first set of notes posted to Sakai come from the following text: McCarty, Nolan and Adam Meirowitz. 2014. *Political Game Theory: An Introduction*. Other texts at a similar level include: Tadelis, Steven. 2013. *Game Theory: An Introduction* and Gehlbach, Scott. 2013. *Formal Models of Domestic Politics (Analytical Methods for Social Research)*. I will also be posting other notes as the semester goes on that comprise my own take on the material. Again, I recommend these sources for reading *after* the corresponding class sessions.

Course Requirements

- Problem Sets (80%): This is by far the most important part of the course. You are welcome to work together on these, but each person must write up the solutions on his or her 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 (preferably in LaTeXbut other formats are acceptable). 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. I will distribute solutions at this time. You will then have a week to provide the self-assessment discussed above on the original problem set (in a different color, if handwritten). At the end of that week you will turn in the assessed original to me. 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. *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 (again, preferably in LaTeX). *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 the substantive side.*

Very Tentative Schedule:

Part I: The Building Blocks of Formal Modeling
Topics covered include: Actors; Actions; Outcomes; Systems and System States; Examples of Papers Employing Formal Models.

Part II: Actions of a Single Actor
Topics covered include: Preferences and Stimuli; Behavioral Rules; Beliefs and Rationality; Bounded Rationality; Uncertainty; Discounting; Decision Theory.

Part III: Multiple Actors given Accurate Beliefs
Topics covered include: Strategic vs. Non-strategic Behavior; Multi-actor Bounded Rationality; Game Theory; Simultaneous, Sequential, and Repeated Games; Nash Equilibrium; Subgame Perfect Equilibrium; Game Trees and Histories; Behavioral Game Theory.

Part IV: Managing Uncertainty
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; Bargaining; Global Games.

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