

## **Econ 281: Intro to Game Theory**

### **Professor Shelton**

#### **I. Introduction**

Game Theory was created to provide a mathematical language for describing strategic social interaction. Game theory is the study of choice of optimal behavior when the costs and benefits of each option are not fixed, but depend upon the choices of other individuals. It has become a standard tool in economics, is increasingly used in biology and political science, and is sporadically used in sociology, psychology, and anthropology. Price setting by oligopolists, bargaining in its many settings and incarnations, nuclear deterrence, and species development by natural selection are all amenable to game-theoretic analysis.

#### **Goals:**

- Introduce you to non-cooperative game theory as a framework for modeling strategic situations.
- Learn the tools and how to apply them from translation of a situation into game theory to solving the resulting model.
- As a result, enable you to use and understand game-theoretic models and arguments in your future coursework and beyond the classroom as workers and citizens and by so doing to gain a better understanding of strategic situations.

Specifically, this will involve:

- gaining familiarity with the terms of non-cooperative game theory
- understanding of the parts of a game
- introduction to basic equilibrium concepts
- understanding the common (and often unspoken) assumptions of the field and their impact
- developing the ability to solve a game
- exposure to situations, largely from fields of economics, commonly analyzed using game theory.

The class will be in several parts. In the first segment we will learn the basic taxonomy and tools of non-cooperative game theory and discuss both the strengths and limitations of this core. In the next two sections we will explore some of the modeling conventions used to extend game-theoretic analysis to a broader set of situations. In the second section, we will relax first the assumption that participants have the same set of information and next (as time permits) the assumption that participants have infinite brain power to calculate the “rational” solution to complicated strategic situations. Students who wish to explore this material further are encouraged to take Professor Rosenblat's course on Experiments and Strategic Behavior.

#### **The Importance of a Deeper Understanding**

It is especially important for you to develop an understanding of game theory that runs deeper than a simple reading of its results. This is first so that you can use game theory to its fullest potential by applying it to understand the nuanced situations that arise in your

own lives and careers and that differ importantly from the canonical examples. But second so that, should you do disagree with certain conclusions, you can, by understanding where they came from, change or challenge that aspect of an analysis rather than rejecting the game-theoretic approach in entirety.

Some degree of patience will be required. In the beginning we will learn the basics: how to write down a game, how to solve the simplest games, and the general results which have been proven about simple games. You will quickly see the cracks—the assumptions that don't make sense, the behaviors that can't be explained, the trouble generating predictions. Have patience: you are learning a lens through which to view the world and this takes time.

Many people despair at this point, throw their hands in the air, and give up on game-theory altogether. (These are often the same people who reject rational choice in much the same manner.) Unfortunately, this leaves us back at square one: there simply isn't a better set of tools for modeling behavior in social situations. The mature approach is to understand the limitations and figure out ways of mending them with better assumptions.

Usually this comes at the cost of increased complexity. There is a methodological tradeoff between simplicity/tractability/comprehensibility and realism/predictive power. Just like the map-maker, the modeler faces the challenge of which features to include and which to omit. Too much and the result is a clutter of poorly understood effects with little conveyed; too little and the model is trivial. We will start from the simple end of the spectrum as we build an understanding of the basic tools of game theory. As our understanding grows, we will gradually introduce the additional tools that have been developed to address and explain more complex phenomena.

### **Prerequisites**

The formal prerequisite is a semester of introductory economics. Perhaps more important are the mathematical prerequisites. While the mathematics associated with formal game theory can be quite formidable, this course will not require a sophisticated mathematical background. The main challenge will not be in doing the mathematics, but in reasoning out which equations to write down and solve. If you are satisfy the following prerequisites, you should be fine.

- Facility with basic algebra and ability to write down and solve systems of equations.
- Ability to calculate expected values.
- Comfort with graphing and graphical arguments.

General comfort with logical, mathematical, and statistical reasoning.

## **II. Assignments and Grades**

### **Assignments**

There will be eight problem sets, two short (three to four pages each) written assignments, two midterms, and one final. Papers and problem sets must be submitted in class at the beginning of class. E-mail submissions will not be accepted. Late submissions will not be

accepted. The lowest problem set will be dropped. Missing problem sets receive a grade of zero. The lowest problem set grade will be dropped. There are no make-up exams. If either midterm is missed, the final will count for 40%. If either a second midterm or the final is missed, the student will receive a zero for that portion of the grade. Individual assignment grades will be given as a percentage. The final numerical grade will be calculated as the weighted average of the individual assignment grades using the following weights:

7 of 8 Problem Sets:	35%
2 Written Assignments:	10%
Midterm 1:	15%
Midterm 2:	15%
Final:	25%

Letter grades for the course will be assigned based on a curve applied to the set of final numerical grades.

### **Legibility**

Grading papers and exams is repetitive at best and can be a frustrating task when papers are messy. Be nice to your grader and make your assignments legible. Written assignments must be typed. Problem sets need not be typed but points may be lost due to illegible handwriting, poorly organized answer sheets, or other obstacles for the grader. We always try to search for the hidden glow of understanding and award as many points as possible, but please do not lead us on a treasure hunt across your assignment in search of your train of thought. If your initial write-up is a messy, recopy to a clean sheet. Such reiteration will not only please your grader but also further your understanding through repetition and help you to catch mistakes. Allowances will be made on exams for time-pressure, stress, cramped hands and so on but there too, legible and organized answers are appreciated.

### **Collaboration**

Students must write their own papers and turn in their own problem sets. Students may collaborate with, at most, one other student on problem sets. In this case, one problem set may be handed in with both students' names written on the finished problem set.

### **Regrades**

Requests for re-grades are strongly discouraged but not prohibited. The grading rubrics are designed to be as simple as possible but there is still room for error. If you think I missed the brilliance of your answer, first recheck the solutions to be sure your answer was actually correct. If you are still convinced you deserved better, submit the assignment to my office with a brief explanation of the error. Regrade requests will be accepted within one week of the return of the assignment. A word to the wise: consider how many points you have lost and the strength of your case before submitting a request. Graders are usually willing to correct clear mistakes but being forced to re-explain why a previous grade was deserved is a slight annoyance. If you really think you've missed points, please do resubmit; we don't want injustice. But don't be "that guy" who argues to gain an extra half-point on an answer

that only skirted the mark. You'd be surprised how quickly "grade grubbers" gain a reputation among faculty.

### **III. Readings**

#### **Required Readings**

The primary textbook for the course is *Games of Strategy*, 2<sup>nd</sup> edition, by Avinash Dixit and Susan Skeath (DS). The secondary text is *Strategy of Conflict* by Thomas Schelling (S). They are both available at Broadstreet Books and through online retailers.

If you choose to buy a first edition of DS, I cannot guarantee that the page numbers and exercises will be equivalent.

#### **Other Readings**

Reading another textbook concurrently can help fill in gaps or flesh out your understanding. Even textbooks which cover the same topic at similar levels differ slightly in the material covered, the approach, and the illustrative examples. Here are three recommendations for further readings. These are not required.

Gibbons, Robert; *Game Theory for Applied Economists*; Princeton University Press, 1992.

This book is for the advanced undergraduate. The treatment is more formal, with mathematically correct definitions of games and strategies and proofs of general results in the field. The examples and sample problems are particularly good, drawn from a wide array of subfields of economics. But they usually require a grasp of the sort of linear optimization learned in intermediate micro and macroeconomics courses. If you are comfortable with greater mathematical sophistication, this is a highly useful book.

Morrow, James; *Game Theory for Political Scientists*; Princeton University Press, 1994.

This text is another favorite for undergraduates. It is somewhat more accessible than Gibbons and the examples are taken from a broader array of social science contexts.

Kreps, David; *Game Theory and Economic Modeling* (Clarendon Lectures in Economics); Oxford University Press, 1990.

The Clarendon lectures are an outstanding annual series. They are the publication of a set of three lectures on an important topic in economics, given at Oxford by an economist who has made important contributions to understanding the topic. They are written for an intelligent lay-audience but are of interest even to highly trained economists. Reading a good set of lectures gives a glimpse of how the visionary sees the field and gives great insight into the topic. These lectures are a bit old and contain no mention of the current hot topic in game theory—behavioral game theory—but Kreps was a true pioneer in non-cooperative game theory and his point of view is instructive nonetheless.