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# GAME THEORY IN THE SOCIAL SCIENCES

Political Science 135/Econ 110

## Instructor and GSIs

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## Location and time

- Lecture: Thu 6:30-9:30 PM Wheeler 150
- Discussion section: See CalCentral for the location and time of your section.

## Introduction

The course presents some of the main topics in game theory. Game theory is about what happens when decision-makers (coworkers, managers, presidents, spouses…) interact. In the past fifty years, game theory has gradually become a standard language in economics. The power of game theory is its generality and (mathematical) precision; and because game theory is rich and crisp, it is applicable to many business situations. But the spread of game theory outside of economics has suffered because of the misconception that it requires a lot of fancy math…

As Robert Aumann (2005 Nobel Economics Laureate "for having enhanced our understanding of conflict and cooperation through game-theory analysis") said "... game theory is a sort of umbrella or `unified field' theory for the rational side of social science, where `social' is interpreted broadly, to include human as well as non-human players (computers, animals, plants)." As I hope you will be convinced, game theory is not just a normative theory (how people ought to choose), but also a descriptive theory (how people actually choose) and even a prescriptive theory (as a practical aid to choice).

A "game" is a strategic situation. A situation involves strategic interaction if your best course of action depends on what others are going to do and vice versa. Some examples in recent memory include:

- In a crowded primary campaign, whether a second-tier candidate directly attacks the frontrunner is likely to depend on whether s/he believes other second-tier candidates will.
- As tensions between Iran and the United States rise, one state's willingness to escalate by shooting down a drone or seizing a tanker should depend on how this state expects the other state to react.

- Former Speaker of the House Nancy Pelosi has said that one reason for not moving forward with impeachment is that there is virtually no chance that the Senate would convict the President and remove him from office.
- Facebook, according to a report in the *New York Times*, is taking steps that make it harder to break up in anticipation of efforts to break it up and possible action from the Federal Trade Commission.

Game theory is now commonly used in economics, political science, and other social sciences to model strategic interaction. This course offers a non-technical introduction to game theory with a special emphasis on examples and applications drawn from these fields. A question game theorists often hear is what is game theory good for, or more precisely, is game theory meant to predict what decision-makers do, to give them advice, or what?! The answer is that (only) the tools of analytical game theory can be used to *predict*, *postdict* (explain), and even *prescribe*, taking into account that even if game theory is not always accurate, descriptive failures are prescriptive opportunities…

**Readings**

The class will rely on handouts that will be available for download in PDF format from the course web page on bCourses. The notes will contain all the material for the course. The bCourses site is "PS135/Econ110". Students enrolled in the class or on the waitlist should already have access. Handouts and problem sets will be posted there. Please check the site before each lecture in case there are handouts for that lecture.

The only required textbook is Prajit Dutta, *Strategies and Games* (MIT Press). This book presents the main topics of game theory at a level suitable for our purposes and emphasizes the theory's foundations as well as recent topics in game-theoretic research.

An excellent book for those with a good background in calculus and looking for a somewhat more challenging text is Steven Tadelis, *Game Theory: An Introduction* (Princeton University Press). Another excellent book is Martin Osborne, *An Introduction to Game Theory* (MIT Press). These books provide precise definitions and proofs of a broad range of results.

These books are lighter reading on game theory: (1) Avinash Dixit and Barry Nalebuff, *The Art of Strategy* (WW Norton), and (2) Adam Branderburger and Barry Nalebuff, *Co-opetition* (Currency Doubleday).

**Problem Sets**

The course will rely heavily on problem sets. Each week a problem set will be assigned and will generally be due the following week. The problem sets are meant to be learning tools and will therefore not count for the course grade. All questions in the problem sets are required material. Please work on the problem sets with each other. My working assumption is that carrots and sticks are not needed to induce learning and active class participation and discussion. Full answer keys will be distributed and the GSIs will review them in sections.

**Exams**

The requirements for a grade in the class are in-class, closed-notes midterm exam, and final exam. The exams are noncumulative and have equal weight. There are no alternative exam dates and/or makeup exams. The exams will test your basic knowledge of the course material and your ability to apply this material to new problems. The midterm exam will take place during class time on Thu Oct 12, and the final exam will take place at the designated time during the final examination period.

**Office hours**

The GSIs are the first line of defense... Instructor's office hours by appointment only, after meeting with the GSIs. Further details will be given in the first lecture. Feel free to ask any questions. You can e-mail us any questions, and we will try to respond promptly. You can also message us using the bCourses system. In case you have any trouble, there are plenty of opportunities for help.

**Outline of Topics**

The course covers non-cooperative game theoretic models, which are those in which the set of actions of individual players is the primitive of the analysis (by contrast to cooperative models in which the sets of joint actions of groups of players are primitives). The course is divided into four parts:

I. Static Interactions and Strategic-Form Games.
II. Dynamic Interactions and Extensive-Form Games.
III. Repeated Games
IV. Asymmetric Information and Signaling Games.

I. Static Interactions and Strategic-form Games: A static situation is one in which each actor must make one decision and does so in ignorance of what the other actors are doing. For example, two firms may have to decide how much to invest in R&D at the same time or two states may secretly decide how much to spend on defense. Sealed-bid auctions are also static interactions. In this part of the course, we will see how these situations can be represented as strategic-form games and how we can solve these games.

A. The definition and some examples of strategic-form games.
B. Dominance Arguments.
C. Nash Equilibria.

Readings: Ch 3 (skip section 3.1.2); Ch 4: pp. 49-53, 55-59; Ch 5; Ch 6: 75-84; Ch 7, Ch 27; Ch 8: 103-108, 110-115.

II. Dynamic Interactions and Extensive-Form Games: An interaction is dynamic if at least one actor can respond to another actor's decisions when making her/his decision. Bargaining between a buyer and seller is dynamic. The buyer can decide how to revise its previous offer considering the seller's latest offer. Arms races are also dynamic. A state can decide how much to spend this year considering what the other side did last year. Extensive-form games

provide a natural setting for the analysis of dynamic interactions. An extensive form is something like a flowchart for the situation we are trying to model. The extensive form describes the order in which the actors make decisions or take actions, what options they must choose from, and what they know when they must make a decision. In his section, we will see how to specify and analyze games in extensive form.

A. Defining game trees and strategies within trees.
B. Translating extensive-form games into their strategic form.
C. Nash equilibria for extensive-form games.
D. Solving perfect-information extensive-form games through backward induction.
E. Applications
F. The failure of backward induction.
G. Subgame Perfection:

Readings: Ch 11-13.

III. Repeated Games: One important aspect of social relations is the repeated interaction of the members of a group. In an industry with few buyers and sellers, buyers and sellers are likely to interact repeatedly. For example, United and American Airlines deal repeatedly with Boeing and Airbus. Members of the United States Senate must deal with each other repeatedly in their efforts to pass desired legislation. The Israelis and Palestinians deal repeatedly with each other as do the competing factions in Iraq. In its simplest form, we might try to represent a situation of repeated interaction by supposing that a group of actors play the same game repeatedly. How does this repeated interaction affect what we would expect to happen? Does repetition make for a larger or smaller set of possible outcomes? This section will provide some answers.

A. Infinitely Repeated Games.
    1. Payoffs and strategies
    2. The folk theorem for Nash equilibria.
    3. The folk theorem for subgame perfect equilibria with Nash threats.
B. Finitely Repeated Games.

Readings: Ch 15: 224-234; Ch 14; Ch 17.

IV. Asymmetric-Information Games: In all of the games discussed so far, there has been complete information. At the start of the game, each player knew everything there was to know about the other players. For example, each firm knew exactly how much it cost the other firms to increase their levels of output. Or each state in a crisis knew exactly how much risk of disaster the other state was willing to accept. But most situations we want to understand entail some "private" information. That is, a firm has private information about its production costs, or a state knows how much risk it is willing to run but the other does not. Incomplete- or asymmetric-information games provide a way of modeling situations in which there is private information, i.e., situations in which the players do not have

"complete" information about each other. In this section, we will discuss some simple examples of incomplete-information games and how to analyze them.

A. Incomplete-Information Games.
B. Signaling Games
C. Perfect Bayesian Equilibria
D. The Intuitive Criterion

Readings: Ch 20: 309-18; Ch 19; Ch 24.

**Tentative Schedule**
**(subject to change)**

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|---|---|
| Aug 24: | Introduction and overview |
| Aug 31: | Strategic-form games |
| Sep 7: | Nash equilibrium |
| Sep 14: | Mixed-strategies Nash equilibrium |
| Sep 21: | Strategic-form games – applications |
| Sep 28: | Strategic-form games – more applications |
| Oct 5: | Review |
| Oct 12: | Midterm |
| Oct 19: | Games of social preferences |
| Oct 26: | Extensive-form games and subgame perfection |
| Nov 3: | Extensive-form games -- applications |
| Nov 10: | Strictly competitive (zero-sum) games |
| Nov 17: | Repeated games |
| Nov 23: | Thanksgiving Break |
| Nov 30: | Asymmetric information games |
| Dec 7: | Summary and review |