

Introduction to Game Theory and Strategic Thinking

[Econ 3801, Fall 2020]

Kaushik Basu
Cornell University

Course outline

This course is an introduction to game theory and the art of strategic decision-making. A modicum of game-theory is essential in today's age of complex diplomacy and strategizing. Important ideas and concepts, with real-life illustrations, will be discussed in this course, with minimal use of algebra. It is designed for students with an interest in economics, politics, logic, analytical philosophy and also corporate strategy.

Game theory began as a somewhat exotic discipline, with mathematicians analyzing board games from Chess to Hex, but soon it became clear that it applies to all situations where interactive decision-making is involved and where your well-being depends not just on what you do but what others do. In brief, it was soon evident that this is germane to modern economics and also other social sciences. The subject saw a burst of research from the mid-twentieth century and by the end of the twentieth century it had become an essential tool of analysis for economists, financial strategists and also researchers in diplomacy and, in more recent times, in some branches of psychology and behavioral economics.

In these lectures the student will learn the essential ideas of von Neumann, Nash, Schelling and several contemporary game theorists and economists, and how these ideas apply to real-life situations, such as competition among private corporations, war and diplomacy, as in the Cuban missile crisis, and also in understanding every day phenomena, such as addiction and procrastination. While parts of game theory are mathematically demanding, game theory is one of those disciplines where some of its most important ideas can be conveyed with no mathematics but simple deductive reasoning and logic. In this course a lot of the material will be covered with no mathematics but in small parts school algebra and elementary differential calculus will be used. Students will be taught all the important concepts of mainstream game theory, from normal-form to extensive-form games, and ideas of equilibrium, from Nash and subgame perfection to evolutionary stability. Students will learn how to pose new research questions, and to try and solve some open paradoxes of the discipline. Interestingly, the paradoxes of game theory have been of interest to not just economists but also philosophers, mathematicians, and computer scientists.

Within this full course, the first five lectures will be devoted to a completely non-technical introduction to the discipline with numerous everyday applications. These initial lectures reflect the fact that a minimal amount of game theory is a useful life skill. To handle problems in real life, from office politics to depression, we often pop pills and rush to counselors. While such measures are no doubt needed in some situations, there are also many everyday contexts where all we really need is clear-headed reasoning to lift the cloud, feel good and succeed. 'Reasoning with oneself' is one of the most under-utilized life-skills. Since game theory is about reasoning in interactive situations—from war and diplomacy and corporate conflict, to everyday decision-making for individual happiness or career success, it is a good way to learn how to reason with yourself. And even apart from this, doing some game-theory and trying to solve some of its puzzles is for the mind what jogging is for the body. It may not be directly productive but it trains the mind to do directly productive activities better, just like jogging trains you to undertake physically productive activities better. The five-lecture introductory segment within the course will be done keeping this self-help aspect in mind.

The two books from which some selected chapters and sections will be used are

Kaushik Basu: **Prelude to Political Economy** (Oxford University Press, 2000)

Prajit Dutta: **Strategies and Games** (MIT Press, 1999)

In addition to these, some papers and chapters from other books will be used, which will be made available on the course blackboard. A detailed description of the lectures will be available at the start of the semester and occasionally updated through the semester.

Thanks to the unusual circumstances caused by the pandemic this year, there will be some adjustment to the way the teaching happens as we go through the semester. However, all lectures will be recorded and available on canvas for watching later. Throughout the semester students will be given take-home problem sets (approximately one a week). Two of them will be part of the final grade. It will be specified in advance which two problem sets will count towards the final grade. The rest will be for the students' personal use and learning.

The teaching assistant for this course will be named later.

I normally enjoy person to person conversations with students during my office hours. But given the unusual circumstances of the year we will probably set up zoom office hours each week during the semester.

The Opening Lectures

What follows is a description of the topics to be covered in the first five lectures. These initial lectures will give a glimpse of how we can use game-theoretic reasoning in a variety of settings.

Game Theory and the power of strategic thinking: History and parlor games

The rise of game theory transformed the way economics is taught and practiced and also contributed to the art of diplomatic thinking. The first lecture will provide a history of game theory from Zermelo's theorem on chess published in 1912 to recent research and advances, and some comments on the personalities involved in it.

The Nash Equilibrium and some classic games

The idea of Nash equilibrium with illustrations from the Prisoner's Dilemma, the Battle of the Sexes, and the Assurance Game will be introduced. The concept of Focal Point, as developed by Thomas Schelling, and its many applications will be described.

The Cuban Missile Crisis

Using game theory to understand defense and military strategy has a long history. This lecture will present the Cuban missile crisis of 1962 through game-theoretic lenses, the Hawk-Dove game and why, at times, it pays to appear irrational.

Repeated games, backward induction and philosophical paradoxes

The repeated Prisoner's Dilemma, paradoxes of backward Induction, and the Traveler's Dilemma will be introduced. Some philosophical paradoxes of game theory will be presented and students will be encouraged to try to solve them.

Social norms, political power and extensive-form games

An introduction will be given to some big topics in psychology and sociology that will be picked up in greater detail in later lectures.

Outline of the Full Course

Here is an outline of the full course. The opening five lectures, described above will be a broad overview of the discipline of game theory. Thereafter the course will proceed to train students to master some of the formal methods of game theory, which will enable them to solve simple problems, in the abstract and also in real-world settings.

The bulk of the course will deal with non-cooperative game theory. Cooperative games, in particular, bargaining theory, will be covered in the last weeks of the semester.

After the opening 5 lectures, the course will cover the formal structure of normal-form games and strategic form games. Both the use of pure and mixed strategies will be discussed and explained, and several equilibrium concepts will be taught—Nash equilibrium of course, but also strict Nash equilibrium, iterated deletion of dominated strategies, CURB sets. Students will learn about John Nash’s celebrated existence theorem (but not its proof). Applications to the “commons problem”, the challenge of over-exploitation of resources, and the breakdown of the “invisible hand of the market” will be taught. We shall also cover Hotelling’s theorem of location choice by firms and the applications of this to understanding electoral democracy and results like the median voter theorem.

Thereafter, the lectures will proceed to cover formally, glimpses of what would already have made cameo appearances, namely, extensive-form games and repeated games, both finitely and infinite repetitions. The material will include: Repeated Prisoner’s Dilemma, trigger strategies, tit-for-tat strategies. The equilibrium concept of sub-game perfection will be covered extensively.

The material covered thus far will then be used for students to learn about market competition, oligopoly behavior, the Cournot equilibrium and Bertrand equilibrium, how firms often collude to exploit consumers and workers, and the problem of entry deterrence. The role and efficacy of antitrust law will be covered. This segment of the course will entail using some simple differential calculus and optimization exercises.

I plan to devote a short segment—one week—on conceptualizing law and economics but whether I am able to do this will depend on how well I am able to cover the above material in this new world of lecturing by zoom.

Roughly, the last two weeks will involve the sharp turn from non-cooperative game theory to cooperative game theory. There will be a brief review of the whole discipline but what students will learn formally will be the theory of Nash bargaining and how to spot the Nash bargaining solution of two-player bargaining games and to apply it to various real-life problems such as corruption control and the understanding of bribery.

Though this is an introductory course in game theory, I will pause every now and then to give students a sense of how these ideas can be applied to broad domains of real-life and also to raise some open questions and unsolved problems to challenge them to think about these. There are real-world policy problems such as the problems of controlling corruption. The activists are often and rightly passionate about putting an end to this problem but not always sensitive to the fact that this is also an intellectual challenge—curbing corruption without bringing down the whole economy. Students will be encouraged to use the methods learned in this course to apply to such problems.

I plan to cover the following chapters from the two books mentioned above.

Kaushik Basu: **Prelude to Political Economy** (Oxford University Press, 2000)
Chapters 1, 2, 3, 4, 5, 6 and 10.

Prajit Dutta: **Strategies and Games** (MIT Press, 1999)

Chapters 2, 3, 4, 5, 6, 7, 8, 11, 13, 14.

In addition to these, some supplementary, optional readings will be given as the course proceeds through the semester.

Given all the disruption caused by the pandemic this will be a challenging year, but usually students enjoy the material that is covered in this course and I am hopeful that Fall 2020 will be no different.

Examination and Grading

There will be two take-home examinations for which students will be given a few days to submit answers. These will be for 5 points each. There will be two in-class (open-book) examinations. The students can be wherever they are and take the exam at the time of the class. Special time arrangement will be made for those who are taking the course from a very different time zone. These will be for 20 points each. There will be one final (open-book) exam. The final exam will be for 50 points. Hence, the total will be out of 100 points. The points received will be converted into grades and, at the end of the semester, students will receive grades for their performance. While all the exams will be open-book exams, students will be expected to follow the honor code of not talking to or consulting with anyone while taking an exam.

The teaching assistant for the course is Valeria Bodishtianu (yb285@cornell.edu).

Once lectures begin, I will announce my office hours for each week when I shall have an open zoom for students to reach me.