Game Theory

module 3, 2019-2020

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Course information

Instructor's Office Hours: Monday, Wednesday 4pm

Course description

Game theory investigates the interaction of interdependent agents along with the prevailing outcomes. We will discuss specific elements of the formal theory, involving mostly non-cooperative games, including: games in the strategic and the extensive form, solution concepts, epistemic conditions needed to predict outcomes of games, equilibrium refinements, dynamical models of equilibrium selection, and folk theorems of indefinitely repeated games. We will discuss results in experimental economics that test some of the assumptions of classical game theory. Throughout the course we will examine applications of the formal concepts of game theory to problems in economics, biology, political science etc.

Course requirements, grading, and attendance policies

The grade will be a combination of the Final Exam (80%) and 3 Home Assignments (20% in total). The final exam will be closed book.

Course contents

The course surveys a series of equilibria concepts and corresponding areas of application. A brief outline of topics the course touches on goes as follows:

1. Strictly Competitive Games and Maxminimization- *Osborne*, Chapters 11
2. Games in Strategic Form: (Dominant Strategies, Mixed Strategies, Nash Equilibrium, Existence of a Nash Equilibrium)- *Fundenberg and Tirole,* Chapter 1
3. Extensive Form games: (Definitions, Sub-game Perfect Equilibria, Backward Induction, Critiques of Backward Induction)- *Fundenberg and Tirole,* Chapter 3
4. Incomplete information: Bayes-Nash Equilibria - *Fundenberg and Tirole,* Chapter 6

5. Imperfect Information: Sequential Equilibrium- *Fundenberg and Tirole,* Chapter 8
6. Imperfect Information: Trembling Hand Perfection- *Fundenberg and Tirole,* Chapter 8
7. Repeated games and Folk theorems – *Osborne*, Chapter 14
8. Nash Bargaining - *Osborne*, Chapter 16

Description of course methodology

The theory is developed and discussed during class. The tutorials are reserved for applications and exercises. Game theory bears a vast and diverse array of applications. The tutorials will focus on economic applications (paradigms drawn from industrial organization, auction theory, public economics etc). Applications on voting, political science and biology will also be surveyed.

The following is a sample application to be reviewed during a tutorial.

3.5.3 First-price sealed-bid auctions

A fist-price auction differs from a second-price auction only in that the winner pays the price she bids, not the second highest bid. Precisely, a **first-price sealed-bid auction** (with perfect information) is defined as follows.

Players The n bidders, where $n \geq 2$.

Actions The set of actions of each player is the set of possible bids (nonnegative numbers).

Preferences The payoff of any player i is $v_i - b_i$ if either b_i is higher than every other bid, or b_i is at least as high as every other bid and the number of every other player who bids b_i is greater than i. Otherwise player i's payoff is 0.

This game models an auction in which people submit sealed bids and the highest bid wins. (You conduct such an auction when you solicit offers for a car you wish to sell, or, as a buyer, get estimates from contractors to fix your leaky basement, assuming in both cases that you do not inform potential bidders of existing bids.) The game models also a dynamic auction in which the auctioneer begins by announcing a high price, which she gradually lowers until someone indicates her willingness to buy the object. (Flowers in the Netherlands are sold in this way.) A bid in the strategic game is interpreted as the price at which the bidder will indicate her willingness to buy the object in the dynamic auction.

One Nash equilibrium of a first-price sealed-bid auction is $(b_1, \ldots, b_n) = (v_2, v_2, v_3, \ldots, v_n)$, in which player 1's bid is player 2's valuation v_2 and every other player's bid is her own valuation. The outcome of this equilibrium is that player 1 obtains the object at the price v_2.

? EXERCISE 84.1 (Nash equilibrium of first-price sealed-bid auction) Show that $(b_1, \ldots, b_n) = (v_2, v_2, v_3, \ldots, v_n)$ is a Nash equilibrium of a first-price sealed-bid auction.

Sample tasks for course evaluation

(1) Devise and write down in extensive form some game of imperfect information such that for each of the *Nash Equilibria* (it may be unique, if you so choose) of the game there exists an outcome equivalent *Weak Sequential Equilibrium*. Demonstrate that by solving for both types of equilibrium.

(2) What is/are the *Weak Sequential Equilibrium/a* of the game depicted in Figure 1? For each *Weak Sequential Equilibrium* you identify determine whether its is *Sub-game Perfect*.

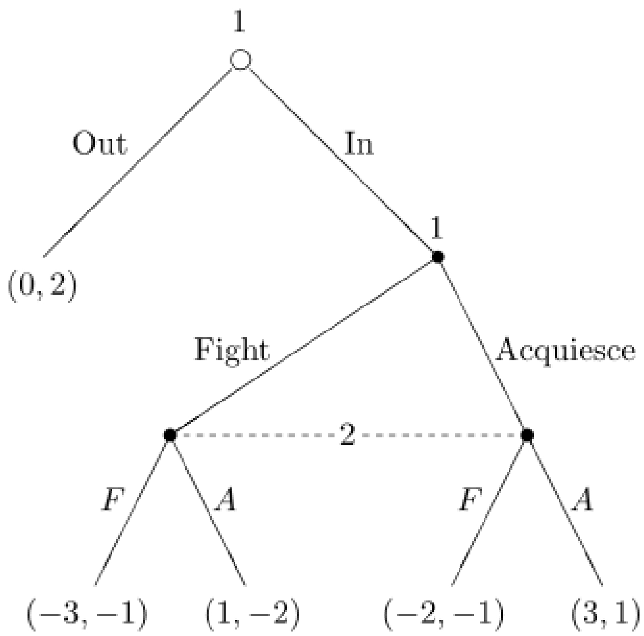

FIGURE 1. Exercise 2

(3) What is/are the *Weak Sequential Equilibrium/a* of the game depicted in Figure 2? Note that 'Nature' plays first and selects either A or B with equal probability.

Course materials

Required textbooks and materials

- Game Theory, D. Fudenberg and J. Tirole, MIT Press, 1991.
- An Introduction to Game Theory, M. J. Osborne, Oxford UP, 2003.
- Game Theory: An Introduction, E. N. Barron, Wiley Series in Operations Research, 2013.

Additional materials

- A course in Game Theory, M. J. Osborne and A. Rubinstein, MIT Press, 1994.
- Algorithmic Game Theory, N. Nisan et al. (eds), Cambridge UP, 2007

Academic integrity policy

Cheating, plagiarism, and any other violations of academic ethics at NES are not tolerated.