CUR 412: Game Theory and its Applications

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Welcome to CUR 412

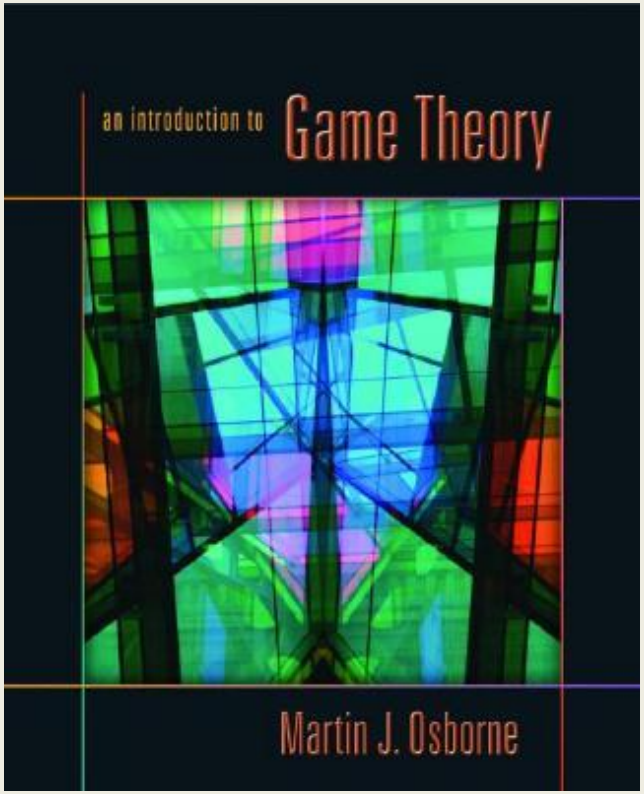
- This course is an introduction to Game Theory, the study of *strategic* situations (i.e. situations with more than one decision-maker).
- Course is taught in English
- Website: http://rncarpio.com/teaching/CUR412
- Announcements, slides, & homeworks will be posted on website

About Me: Ronaldo Carpio

- BS Electrical Engineering & CS, UC Berkeley
- Master's in Public Policy, UC Berkeley
- PhD Economics, UC Davis
- Joined School of Banking & Finance in 2012

Textbook

- *An Introduction to Game Theory* (2003) by Martin Osborne, published by Oxford University Press
- If you don't have the book, please come see me or email me
- A useful secondary textbook is *Games of Strategy*, (2nd or 3rd Edition) by Avinash Dixit and Susan Skeath: less technical, more intuitive



Grading

- Homework 15%, Midterm Exam 35%, Final Exam 50%
- Homework:
  - There will be 4 homework assignments, posted on the website
  - Write-ups must be individual; you may discuss the concepts in small groups
- Exam dates: to be announced

Contacting Me

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- Office Hours: 16:00-17:30 Monday & Tuesday, or by appointment

Course Outline

- Not all topics may be covered, depending on time.
  - Introduction and Motivation
  - Static Games
  - Nash Equilibrium: Theory
  - Nash Equilibrium: Applications
  - Mixed Strategies & Mixed Strategy Equilibrium
  - Extensive Form Games
  - Sequential Games and Backwards Induction
  - Games with Imperfect Information
  - Repeated Games
  - Bargaining

What is Game Theory, and Why do we Need It?

- *Game Theory* is the mathematical study of *strategic* situations, i.e. where there is more than one decision-maker, and each decision-maker can affect the outcome.
- Previously in microeconomics, you studied *single-person* problems. For example:
  - How much of each good to consume, in order to maximize my utility?
  - How much output should a firm produce, in order to maximize profits?
- Rational behavior: choose the level that maximizes utility (or profits, or payoffs).
- However, in multi-agent situations, *my* choice may change *your* problem.
- We need a method that takes *everyone's* choices into account.

Examples of Strategic Situations

- Business
  - Competition between firms: price, quality, location…
  - Market segmentation by firm: offer different levels of quality
  - Auctions
- Political Science
  - Voting Strategically: always vote for your candidate, or vote to ensure your least preferred candidate loses?
- Sports
  - Tennis Serving
  - Soccer Penalty Kicks
- Biology
  - Hawk-Dove game
- Real Life
  - Traffic Congestion: Driving is faster than the subway if only I drive, but if everyone drives the roads are congested.

Definition of a Strategic (or Normal-Form) Game

- Terminology:
  - The decision-makers are called **players**.
  - Each player has a set of possible **actions**. The *action profile* is a particular list of actions, based on what players choose.
  - Each player has **preferences** (i.e. a ranking) over the set of action profiles.
- A *strategic game* is a model of interaction in which each player chooses an action *without knowing* what other players choose
- We can think of this as players choosing their actions *simultaneously*.

Definition of a Strategic (or Normal-Form) Game

- We need to specify:
  - who the players are
  - what they can do
  - their preferences over the possible outcomes
- Definition: A *strategic game* consists of:
  - a set of *players*
  - for each player, a set of *actions*
  - for each player, *preferences* (i.e. a ranking) over the action profile
- We will usually use *payoff functions* that represent preferences, instead of using preferences directly.

A 2-Player Static Game: The Prisoner's Dilemma

- The definition above is very general. Let's consider a specific example.
  - There are two suspects in a crime.
  - Each suspect can be convicted of a minor offense, but can only be convicted of a major offense if the other suspect "finks" (i.e. gives information to the police).
  - Each suspect can choose to be *quiet* or *fink* (inform).
  - If both stay *quiet*, each gets 1 year in prison.
  - If only one suspect *finks*, he goes free while the other suspect gets 4 years.
  - If both suspects *fink*, they both get 3 years.

Modeling the Prisoner's Dilemma

- **Players**: The two suspects.
- **Actions**: Each player's set of actions is {Q, F}.
- **Preferences**: We'll write down the action profile as:

  (Suspect 1's choice, Suspect 2's choice).
- Suspect 1's preferences, from best to worst:
  - (F, Q) > (Q, Q) > (F, F) > (Q, F)
- Suspect 2's preferences, from best to worst:
  - (Q, F) > (Q, Q) > (F, F) > (F, Q)
- Instead of using preferences directly, we will use a *payoff function* that assigns a utility to each outcome:
  - Suspect 1: $u_1(F,Q) = 3$, $u_1(Q,Q) = 2$, $u_1(F, F) = 1$, $u_1(Q, F) = 0$
  - Suspect 2: $u_2(F,Q) = 0$, $u_2(Q,Q) = 2$, $u_2(F, F) = 1$, $u_2(Q, F) = 3$

Modeling the Prisoner's Dilemma

- We can collect the payoff values into a *payoff matrix*:

		Suspect 2	
		Q	F
Suspect 1	Q	2,2	0,3
	F	3,0	1,1

- The two rows are the two possible actions of Player 1.
- The two columns are the two possible actions of Player 2.
- In each cell, the first number if the payoff to Player 1, the second to Player 2.

What will happen in this situation?

- Next week, we will see what possible outcomes we can expect from rational players in the Prisoner’s Dilemma.
- For next week’s lecture, please read Chapter 1 and Chapters 2.1-2.5 in Osborne.