CAP 5993/CAP 4993 Game Theory

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- Game theory is the study of strategic interaction. It has been applied to every scientific discipline -- most notably economics, but also political science, business, military, biology, and many others. Recently it has been a major area of research in computer science, as the field of artificial intelligence, which initially studied settings with a single agent, is expanding its scope to domains with multiple strategic (and potentially adversarial) agents. Topics will include game representations, solution concepts, imperfect information, repeated games, learning, auctions, and voting. There will be a project to pursue an application (or theoretical topic) of interest. The class could be of interest to students in computer science, mathematics, physical sciences, business, social sciences, engineering, and life sciences (including medicine). It would be helpful to have familiarity with mathematical proofs, and some problems will involve computational implementation.

- Me: It has been applied to every scientific discipline -- most notably economics, but also political science, business, military, biology, and many others.

- Aaron: Has game theory been applied to geology?

35   Irrationality in Game Theory

The history of game theory has been evolutionary rather than revolutionary. Over the years, the fundamental concepts of the theory have been used in an ever-increasing circle of contexts; some of the most important developments consisted of innovative ways of recasting the theory so as to apply to problems that previously appeared not to fit in. A prime example is Harsanyi's historic work (1967–68) on games of incomplete information. Before this work, it had been universally thought that for game theory to be applicable, the payoff matrix of the game must be commonly known. Harsanyi's achievement consisted of formulating games of incomplete information so that they could be seen and analyzed as games of complete information; by this achievement, he opened the door to the development of the enormous fields of informational game theory and economics as we know them today. Similarly, the theory was extended from perfect information (Zermelo) to imperfect information (Borel and von Neumann); from strategic (normal) form to extensive; from two-person to n-person; from zero-sum to non-zero-sum; and from TU (transferable utility) to NTU (non-transferable utility).

The current frontier—the one discussed here—is that of rationality. Briefly, it is suggested that game theory need not assume that the players must be rational (i.e., utility maximizers).

This may sound paradoxical to the reader. After all, rationality is what game theory is all about; game theory without rationality sounds like geology without rocks or biology without life. Yet some of the most challenging problems facing the theory concern the interface between rationality and irrationality; they are about situations that cannot be dealt with on a purely rational basis, much like geological phenomena that depend on living organisms (such as cracking of rocks by plants) or biological phenomena that are the result of the nonliving environment.

1   Approach

The underlying game model from which we take off is that presented in Aumann 1987. It starts by considering the set of all "states of the world," where the specification of a state includes all relevant factors, including the (pure) strategy that each player uses in the given game, and what he knows

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Relation to fields and other courses

- Economics
  - http://web.stanford.edu/~gdc/286syllabus-aut16.pdf
- Theoretical computer science
  - http://theory.stanford.edu/~tim/f13/f13.html
- Artificial intelligence
  - https://www.coursera.org/learn/game-theory-1
  - https://www.youtube.com/user/gametheoryonline

friv·o·lous

/ˈfrivələs/ 🔊

adjective

not having any serious purpose or value.
"rules to stop frivolous lawsuits"
synonyms: flippant, glib, facetious, joking, jokey, lighthearted; More

- (of a person) carefree and not serious.
  synonyms: skittish, flighty, giddy, silly, foolish, superficial, shallow, irresponsible, thoughtless, featherbrained, empty-headed, pea-brained, birdbrained, vacuous, vapid; More

Translations, word origin, and more definitions

Feedback

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- Online poker is the game of poker played over the Internet. It has been partly responsible for a huge increase in the number of poker players worldwide. Christiansen Capital Advisors stated online poker revenues grew from $82.7 million in 2001 to $2.4 billion in 2005,[1] while a survey carried out by DrKW and Global Betting and Gaming Consultants asserted online poker revenues in 2004 were at $1.4 billion.

1-card poker

- Here are the rules of the game: you and the computer each get one card and ante $1. You bet first, either $0 or $1. Then the computer gets a chance to match you (if you bet $1) or raise you (if you bet $0). If you bet $0 and the computer raised you, you get a chance to call. Betting $0 when your opponent has already bet $1 means you fold and lose your ante. If no one folds before the end of betting, the higher card wins the pot; that results in a net gain of either $1 or $2, equal to the other player's ante plus the bet of $0 or $1.

1-card poker

- http://www.cs.cmu.edu/~ggordon/poker/

- http://www.bestgametheoryclass.com/
- http://netcast.cs.fiu.edu/
- https://moodle.cis.fiu.edu/

Evaluation

- Homeworks (every 1-2 weeks), midterm exam, final exam, class project. For graduate students, each component is worth 25% of the final grade. Undergraduate students have a choice of either taking the final exam or doing the class project (while graduate students do both). The choice must be specified by 4pm on the third day after the midterm exam by email to the instructor. Each of the three components will be worth 1/3 of the final grade.

Project

- Students can apply a topic from class to an application of interest (e.g., formulate a problem game-theoretically and compute/analyze equilibrium strategies), study a new theoretical topic, or present a novel survey and discussion of recent literature on a topic (e.g., opponent modeling in security games, medical applications of equilibrium computation). Ambitious original projects are encouraged even if they are not complete or successful.

Textbooks

- Game Theory by Michael Maschler, Eilon Solan, and Shmuel Zamir (required)

- Game Theory with Engineering Applications by Dario Bauso (optional)

- Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations by Yoav Shoham and Kevin Leyton-Brown (optional)

- University drop date: 3/20

- Attendance is encouraged but not mandatory. Lectures will be recorded and made available.

- Students can use laptops during class provided it is not disruptive to others.

Software

- Game Theory Explorer
  - http://www.maths.lse.ac.uk/Personal/stengel/TEXTE/largeongte.pdf
  - http://banach.lse.ac.uk/
- Gambit
  - http://gambit.sourceforge.net/gambit15/gui.html

Homework for next class

- Handout <u>Introduction to mathematical arguments</u>
- Chapter 1 from Maschler textbook

Proofs

- Square root of 2 is irrational
- Infinitely many primes
- Sum of integers from 1 to n