Game Theory
Overview & Applications

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Today's Plan

- What: What is it: 'a game of strategy'?
- Why: Why to study this subject?
- How: How to approach games?
- Classification of Games
- Concepts and Techniques
- Examples of Games

What, Why …

- What: What is it: 'a game of strategy'?
- Why: Why to study this subject?
- What … A game of strategy is a formal mathematical presentation of the game
- Why … Because we play games every day, almost all the time.
- Why … When we communicate with each other we ALWAYS play: whether we want it or not.

… & How

- How: How to approach games?
- How … Formal axiomatic analytical approach to games
- How … Our strategy for studying games: outline the formal approach and show how it works (on examples)

Subject & Structure

- Classification of Games:
  - One time (non-repeated) & repeated,
    - » Finitely repeated and infinitely repeated
  - Simultaneous move & sequential move
- Terminology, Concepts and Techniques
  - Definition of the Game
  - Solution Concept: **Nash** Equilibrium
- Examples of Games
  - Divide a Dollar Game
  - Prisoners Dilemma

Classification of the Games

- constant-sum games ≈ zero-sum games
- bargaining games & brinkmanship
- sequential moves games
- simultaneous moves games
- cooperative games **(we will not address)**

  [i.e. games with a possibility of enforceable joint-action agreements]

Classification of the Games (cont.)

- **non-cooperative games**
- non-repeated games (one-shot games)
- repeated games
  - » Finitely repeated
  - » Infinitely repeated (super games)
- repeated but with different opponents
- dynamic games (evolutionary games)

  [or, are the rules fixed or permit manipulation?]

Terminology

- Definitions
  - Player
  - action
  - strategy
  - outcome
  - equilibrium
  - payoff
  - expectations

A Game: the Major Definition

- Our definition of the rules of the game
  - list of players
  - strategies available to each of them
  - payoffs of each player for all possible combinations of all player strategies
  - each player is a rational maximizer

More Definitions

- **Strategy** is a set of the choices (actions) available for the players
- **Payoff** is a number associated with each possible outcome of the game (and the notion of Expected payoff)
- **Nash Equilibrium -** each player strategy is a best response to the strategies of others

Example: Divide a Dollar Game

- Divide a Dollar Game (see a handout)
  - » `normal' version &
  - » dictator version
- Nash Equilibrium (via a backward induction) ("rollback methodology")
- What is a fair split?
- How to explain the results of strategy experiments?
  - The notion of Social (cultural) norm

When Social Norms are important

- information is incomplete [why clothing is more important for teenagers than for their parents?]
- information acquisition is costly
- if you want to signal information
- Who has social norm in possession?
- Leaders and followers
  - who? & why? & when?

When Do you Gain from Using Social Norm

- your information is
  - incomplete
  - inferior [or both]
- information acquisition is
  - costly or
  - time consuming [or both]
- you want to signal information
  - how about just signal, without social norm?

What is in the game?

- Chance
- Skill
- Strategy
- But the proportions differ in different games

What matters to win?

- Skill
- Strategy
- Luck
- Information
  - examples:
    - » About your opponent
    - » About the weather

Summary of Today

- Game Theory: Subject & Approach
- Why to study games &
- Who plays them?
- Further Reading: A Good Textbook:
  Games of Strategy by
  Dixit, Avinash & Skeath, Susan, 1999,
  W.W. Norton & Company: New York.

1994: Nobel Prize to Game Theorists

- 1994 Nobel Price in economics was awarded to John C. Harsanyi, **John F. Nash** and Reinhard Selten

  "for their pioneering analysis of equilibria in the theory of non-cooperative games."

http://www.nobel.se/economics/laureates/1994/press.html

- John Nash

  web page: http://www.math.princeton.edu/~jfnj/

John Nash: A Beautiful Mind

- **A Beautiful Mind:** *A Biography of John Forbes Nash, Jr.,*

Winner of the Nobel Prize in Economics, 1994, by Sylvia Nasar, (1998 - 1999).

- *First chapter on the web:*

  http://www.nytimes.com/books/first/n/nasar-mind.html

- "A beautiful mind" at amazon.com:

http://www.amazon.com/exec/obidos/tg/stores/detail/-/books/0684853701/excerpt/ref=pm_dp_ln_b_3/002-3531560-5797602

John Nash: A Beautiful Mind

- Professor Ariel Rubinstein: Review of Sylvia Nasar's book "Beautiful Mind" (on John Nash)

http://www.princeton.edu/~ariel/articles/nasarreview.html

or

http://www.princeton.edu/~ariel/articles/nasarE.pdf

- The reaction to the announcement of Nobel Prize award to John Nash was jubilation.

  "The main message to the world is that the academy says mental illness is just like cancer, nothing special," said Ariel Rubinstein, "It's great."