Lecture 1:
Introduction

Jan Zouhar

Games and Decisions

Course Information

- *Lecturer*: **Jan Zouhar**
  - *e-mail*: zouharj@vse.cz
  - *web*: nb.vse.cz/~zouharj
  - *office*: room NB431
  - *office hours*: Tue 16:15 – 17:45
    Fri 10:30 – 12:00

- *Supervisor:* **Martin Dlouhý**
  - *e-mail*: dlouhy@vse.cz
  - *web*: nb.vse.cz/~dlouhy
  - *office*: room NB435
  - *office hours*: see InSIS

Course Information (cont'd)

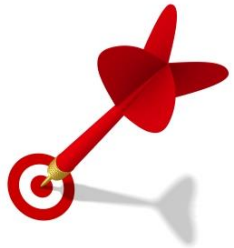
- *Course Requirements*:
  - **50** points: **assignments**
    - **5** problems, **10** points each
    - will appear on the website soon
    - due date: **December 11**
  - **50** points: **final written exam**
- *Grading scale*: standard ECTS points
  - **90 – 100** points: **excellent** (1)
  - **75 – 89** points: **very good** (2)
  - **60 – 74** points: **good** (3)
  - **0 – 59** points: **failed** (4)

Course Information (cont'd)

- *Recommended reading*:
  - Lecture notes and presentations
  - MAŇAS, M., DLOUHÝ, M.: *Games and Economic Decisions*, Oeconomica, 2009
  - DLOUHÝ, M., FIALA, P.: *Úvod do teorie her*, VŠE, 2007 (*in Czech*)
  - Virtually any other book on game theory
  - Internet sources (e.g. www.gametheory.net, www.wikipedia.org)

Game 1: Guess ⅔ of the Average

- *Prize money*: **20 Kč** for the winner



- *Rules*:
  - pick an integer between 0 and 100 and write it down onto a piece of paper
  - winner: the number closest to ⅔ of the average of all the guesses, without going over (i.e., the highest guess less than or equal to ⅔ of the average)
- *Empirical results*: winning guesses between **15** and **21**
- High guesses can mean two things:
  1. not understanding this is a strategic game
  2. believing the others do not understand this is a strategic game

Game 2: An "Unfair" Auction

- Compete in an *English auction* ("open-outcry" type) for a **100 Kč** banknote
- *Rules*:
  - starting price: **20 Kč**
  - buyers cry out increasing bids
  - the 100 Kč banknote sold to the highest bidder (at a price equal to his/her bid)
  - the **second-highest bid** is paid to the auctioneer **without any compensation**

Empirical results:

PAUL B. FARRELL: *Lizards, rats & the investor's primitive brain*.

What Is a Game?

- many types of games: board games, card games, video games, field games (e.g. football)
- we focus on games where:
  - there is more than one decision maker (*player*)
  - there is some choice of action where *strategy* matters
  - the game has one or more *outcomes*, e.g., someone wins, someone loses
  - the outcome depends on the strategies chosen by all players – there is *strategic interaction*
  - the players are *rational* (are aware of the strategic interaction and act accordingly)

→ not games of pure chance, such as Bingo

Game vs. Decision Problem

- *Example*: meal ordering: 4 people come to a restaurant
  1. every person pays for her own meal → *a decision problem*
  2. everyone agrees to split the bill evenly → *a game*

- when does a game become a decision problem?
  - players do not interact, no interdependencies between strategies
  - only 1 player (e.g., Solitaire)

Strategy Interactions in Practice

- *International trade*:
  - levels of imports, exports, prices depend not only on your own tariffs but also on tariffs of other countries
- *Production / market structure*:
  - price depends not only on your output but also on the output of your competitor
- *Labor*:
  - promotions like tournaments: your chances depend not only on your effort but also on efforts of others
- *Political economy*:
  - who/what I vote for depends on what everyone else is voting for
- *Public Goods*:
  - my benefits from contributing to a public good depend on what everyone else contributes

→ suitable application areas of **game theory**

Game theory

Definitions:

"…is a formal way to analyze interaction among a group of rational agents who behave strategically."

"*…can be defined as the study of mathematical models of conflict and cooperation between decision-makers.*"

"*…offers insights into economic, political, or any social situation that involves multiple participants with different goals.*"

a.k.a. :

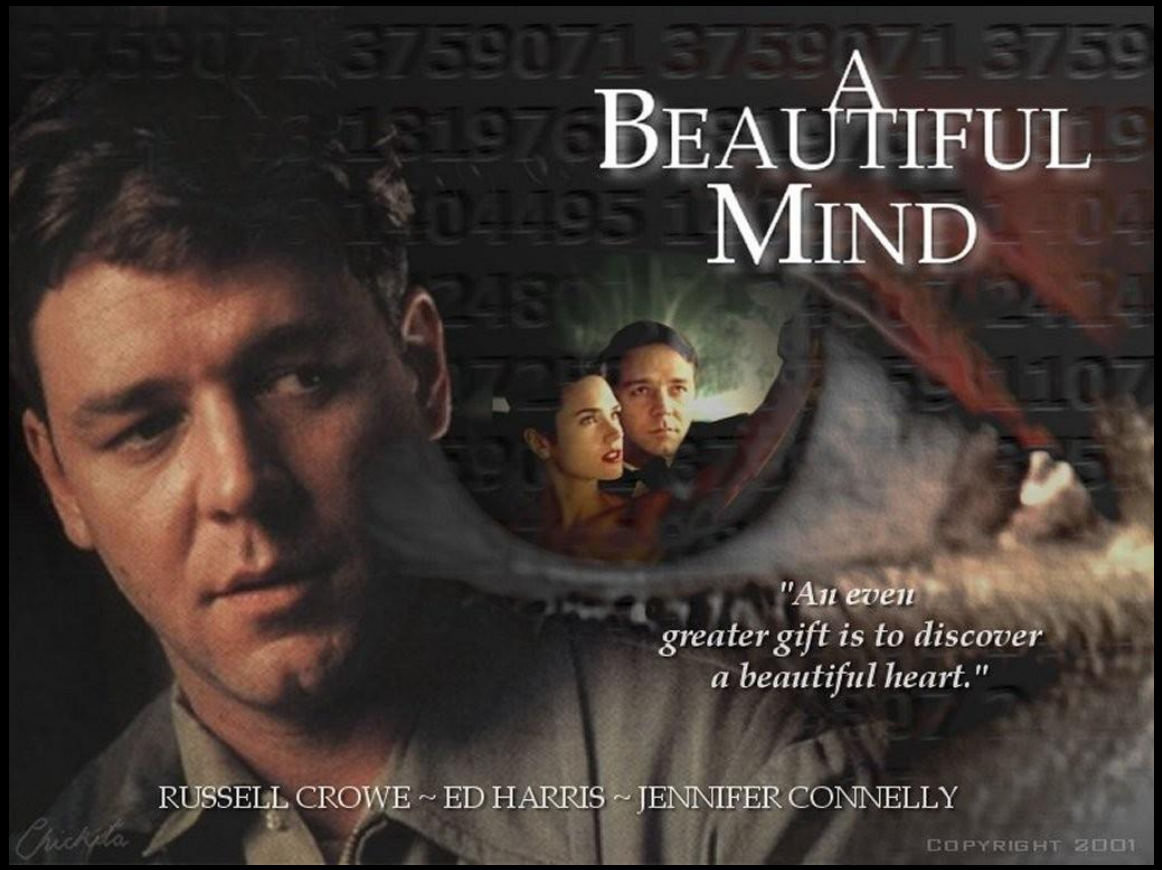
decision theory, conflict analysis, analysis of strategic behavior

Game Theory – Descriptive vs. Normative Use

- **normative approach**:
  - the analysis of rational behavior
  - goal = find the optimal, or "most rational" form of behavior (or sometimes, the winning strategy)
  - studies the way people *should decide*
- **descriptive approach**:
  - the analysis of the real-life behavior
    - sometimes, rational decisions are not obvious / people are not rational → normative approach gives us no clue (as in game 1)
  - goal = study the way people really behave (for predictions etc.)
  - studies the way people *decide in practice*
- **normativity** of a given game:
  - on average, 80% real-life players act according to the normative analysis → *the game is 80% normative*

Game Theory – Historical Milestones

- 1838: AUGUSTIN COURNOT, *Researches into the Mathematical Principles of the Theory of Wealth*
- 1913: ERNST ZERMELO – existence of winning strategies in games like chess
- 1920s and 1930s: works of ÉMILE BOREL and JOHN VON NEUMANN
- 1944: J. VON NEUMANN and OSKAR MORGENSTERN, *Theory of Games and Economic Behaviour*
- 1950s: works of JOHN NASH
  - (film: *A Beautiful Mind*)
- *Nobel prizes*:
  - 1994: NASH, HARSANYI, SELTEN
  - 2005: AUMANN, SCHELLING



↑ a film about John Nash ↑

→ John Nash (a recent photo) →

Game Theory – Applications

- *Economics and business*
  - oligopolies, market structure, auctions, bargaining, fair division
- *Political science*
  - voting systems, coalition formation, public choice, war bargaining
- *Biology*
  - evolutionary game theory, signaling and communication games
- *Computer science* and *Logic*
  - multi-agent systems, computational complexity
- *Philosophy*
  - cognitive theories (common knowledge), ethics
- *Theology*
  - Pascal's gambit

Game Theory – Terminology

Game theory	**Reality**
game	conflict situation, decision situation
player	decision-maker, participant, individual, firm, political party
strategy	decision
strategy space	list of alternatives, feasible decisions
payoff	results, outcomes, consequences
rational and intelligent	maximizing utility or profit, knowing the rule of the game

The elements of a Game

- **players**
  - number of players (2+)
  - possibilities of cooperation
  - existence of coalitions
  - does nature/chance play a role?
  - perfect/imperfect information
- **strategies**, **strategy spaces**:
  - discrete/continuous
  - *simultaneous* games (game 1) and *sequential* games (game 2)
- **payoffs**
  - constant-sum games vs. variable-sum games

→ different modeling techniques for different games

Prisoner's Dilemma

- 2 players (suspects, potential prisoners *A* and *B*)
- insufficient evidence for a conviction
- questioned separately, offered to cooperate with the police (*betray*)
- each player 2 strategies: *betray* or *remain silent*
- 4 possible outcomes:
  - *neither betrays* — **1** year sentence for both
  - *A betrays* — *A* goes free, *B* **10** years
  - *B betrays* — *B* goes free, *A* **10** years
  - *both betray* — both **5** years

- what would you do if you were one them?

Prisoner's Dilemma (cont'd)

- a game in **normal** (or **strategic**) **form**
- mathematical model: a **bimatrix game**

Player B

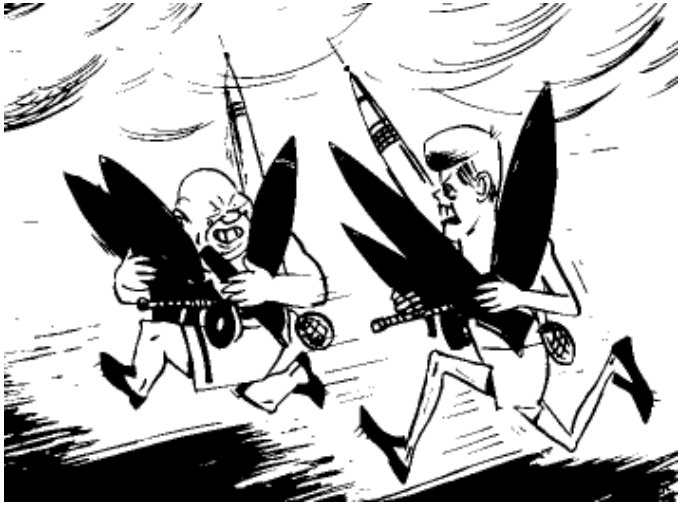
A \ B	Stay silent	Betray
Stay silent	**–1 , –1**	**–10 , 0**
Betray	**0 , – 10**	**– 5 , – 5**

Player A

- strategy "stay silent" strictly dominated: no matter what B does, A is better off betraying him

Prisoner's Dilemma (cont'd)

Real-life examples:



- **Politics**
  - arm race → *betrayal* = *military expansion*
- **Environment**
  - CO_2 emissions → *betrayal* = *not cutting down on emissions*
- **Sport**
  - steroid use → *betrayal* = *taking steroids*
- **Economics**
  - advertising → *betrayal* = *advertising*

Battle of the Sexes

- young couple dating without means of coordination (i.e., batteries gone in the mobile phones)
- preliminary discussion: two options
  - *football game* (meet at 6 PM by the stadium)
  - *shopping* (6 PM at the entrance of a shopping mall)
- model
  - another *normal form game*
  - strategies: *football* and *shopping*
  - outcome quantification: *utility*

Battle of the Sexes (cont'd)

		Boy	
	Girl \ Boy	Football	Shopping
Girl	Football	2 ; 3	0 ; 0
	Shopping	1 ; 1	3 ; 2

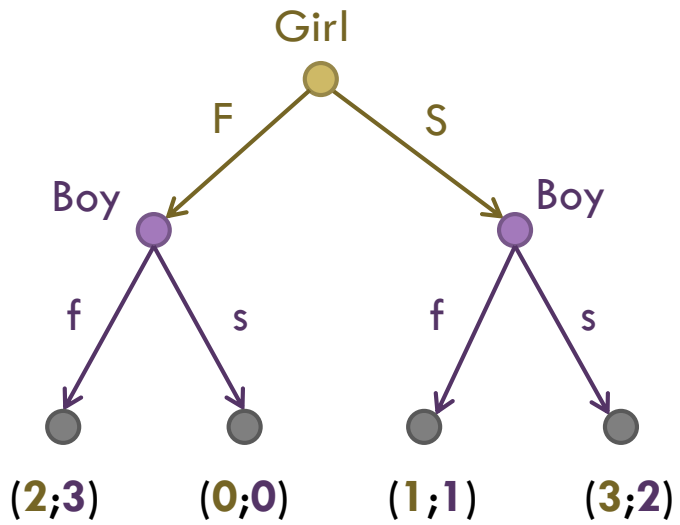
- two "stable" solutions: (F,F) and (S,S)

→ *Nash equilibrium* (see lecture 2)

Battle of the Sexes (cont'd)

Modification:

- the girl leaves earlier, decides where to go, manages to catch the boy on the phone at home, and tells him where she is
- a significant change: a *sequential* game (decisions go in turns)
- modeled as a game in **extensive form**
  - models use decision trees



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