ETH zürich

Game Theory, Experience, Rationality

(Reinhard Selten)

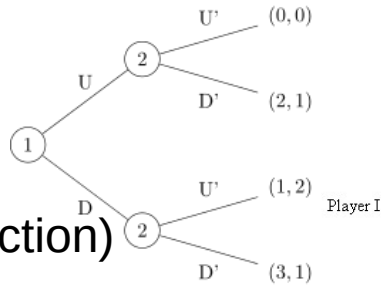
Leonie Bauer – Paola Daniore – Konstantinos Patelis

06.10.2017

Game Theory

- What is Game Theory?
  - ➢ Game Theory is the mathematical modelling and analysis of *purposeful* interaction in conflict and cooperation.

- 1944 – Von Neumann and Morgenstern developed the basic modelling approaches used today:
  - Extensive Game
  - Normal Form Game
  - Coalition Game (Characteristic Function)



	Player II	
	Confess	Refuse
Confess	2,2	4,0
Refuse	0,4	3,3

- Their idea about ***rationality***?
  - Individual Behaviour: Maximization of objectively expected utility
  - Group Behaviour: Exhaustion of all Cooperative Possibilities (Coase Theorem)

Experience I - Experiments

What is the relation between rationality and experience?

- **Naïve Rationalism**: What is rational is real and what is real is rational.

- 1954 – Kalish, Milnor, Nash and Nering conduct the **first** experiment on cooperative game theory.

- 1968 – 1989
  - Series of experiments by other researchers were conducted.
  - Several theories were developed: Equal Share Analysis, Equal Division Payoff Bounds, Proportional Payoff Bounds.

- **Result**: Emergence of **descriptive theory** aimed at *boundedly rational behavior* observed in laboratory experiments.

Experience II – Evolutionary Games

- Emergence of ***Biological Game Theory*** : A game theoretic explanation of animals and plants, where natural selection tends to maximize fitness.
  - Fitness is defined as the expected number of offspring; in social interaction between members of the same species
  - Developed by Maynard Smith and Price in 1973

- ***The Streetcar Theory*** (Hammerstein and Selten, 1994) makes a distinction between:
  a) Short run evolution, through adaptation of gene frequencies without mutation (fixed gene pool).
  b) Long run evolution, through the invasion of mutants.

➢ Biological game theory *really* intends to **describe** the behaviour and the morphological structure of animals and plants.

Rationality

Methodological dualism

Normative Game Theory	Descriptive Game Theory
Strives to mold balanced mathematical structure of *ideal rationality* out of conflicting inherent tendencies of the human mind.	Aims to explain the observed behaviour of man, animals and plants.

- Experimental evidence on human game playing refutes naïve rationalism.
- Thus, a *descriptive game theory about human players* must be developed.

Example 1: Limits to Rationality

A sells firm to B

Value for A: v v random, uniformly distributed over $0 \leq v \leq 100$

Value for B: 1.5*v

A knows v, but B only knows distribution of v

B places bid x

A accepts if $x \geq v$

What would you bid?

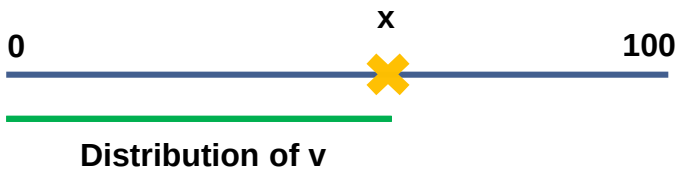
Example 1: Limits to Rationality

A sells firm to B

Value for A: v v random, uniformly distributed over 0≤ v ≤100

Value for B: 1.5*v

What would a rational agent bid?



- B receives firm only **if 0 ≤ v ≤ x**
- **E(v|x)** = ½ x
- **Expected Payoff** for B when bidding x: 1,5 * E(v|x) = 1,5 * ½ x = **¾ x**
- **Expected Loss** for B when bidding x: ¾ x – x = **¼ x**

→ Optimum **x = 0**

Not observed in experiments

- Winner's curse

Non-Cooperative Games – An Overview

Nash (1951)

- Game theoretical notion of equilibrium
- The distinction between non-cooperative and cooperative theory

The Nash Program

- Non-cooperative modeling of cooperation
- Nash: cooperative Nash solution
- Aumann: Super Games
- Selten: Proposal Model

Incomplete Information

Harsanyi – Reduction to complete information by distributions over combinations of player types

Example 2: Non-Cooperative Games

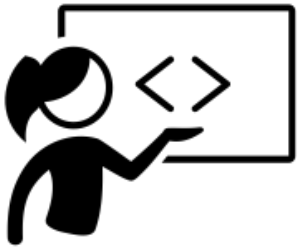
Experimental study to investigate the behaviour of agents in an asymmetric quantity duopoly

Player 1: Fixed Costs > Marginal Costs

Player 2: Marginal Costs > Fixed Costs

Students received the task to write a computer program specifying strategies for both roles

These students are then matched with each other in a computer tournament



What will be the result of this game after three rounds?

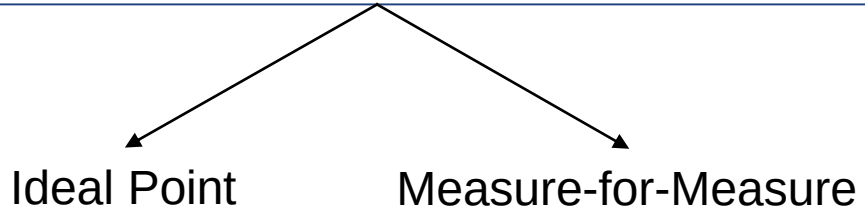
Example 2: Non-Cooperative Games

Students were graded on performance, so they were highly motivated to do well

After rounds 1, 2 and 3: Each player got the results and they could revise their programs

After the three rounds, the participants reached the solutions that they **must cooperate to be successful**

However, a notion of **sub-game perfectedness** excluses rational cooperation in this game; the students were not impressed by this argument!



Summary

*Game Theory is the mathematical modelling and analysis of **purposeful** interaction in conflict and cooperation.*

- Naive rationalism (Neumann & Morgenstern)

  „Apart from unimportant deviations, what is rational is real, and what is real is rational“

Normative Game Theory

Observations / Experiments

- Bounded rational behaviour

Descriptive Game Theory

ETH zürich

Thank you for your attention!
Any questions?