Game Theory

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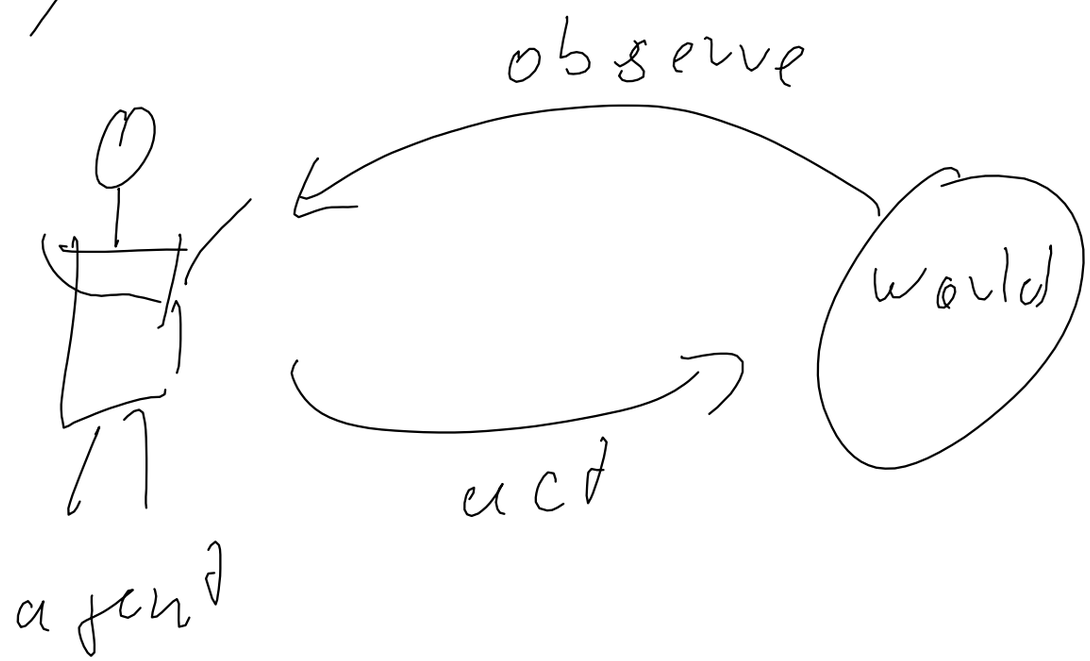
http://gki/teaching/ss15/gametheory/

1. Introduction

1.1 What is Game Theory?

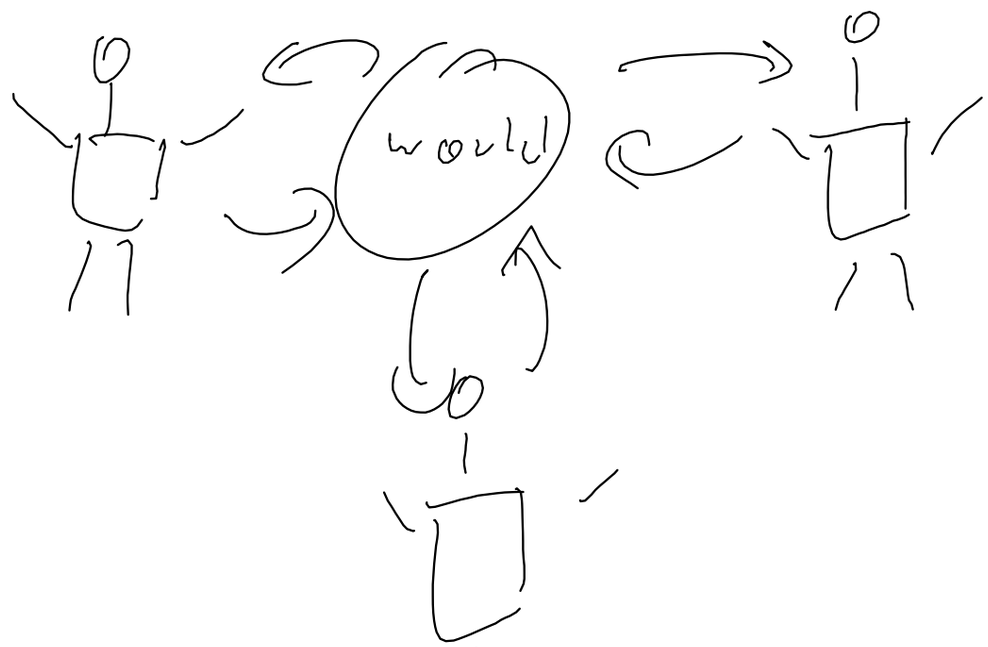
Rationally acting agents



Rational agents maximize their (expected) utility.

$\rightsquigarrow$ Decision theory, MDP, RL, Planning

Situation in game theory:



Many rational agents interacting in decision making:

- resulting utility depends on what other agents do
- all agents know that the other agents are rational

Interesting questions:

- How to model such <u>strategic situations</u>
- "Solving" such situations
- Design games that have a particular purpose

1.2 Example games

(a) Board and card games

These are very special, because what is good for one player is bad for the other player (strictly competitive games).

(b) Auctions (ebay, Google ads):

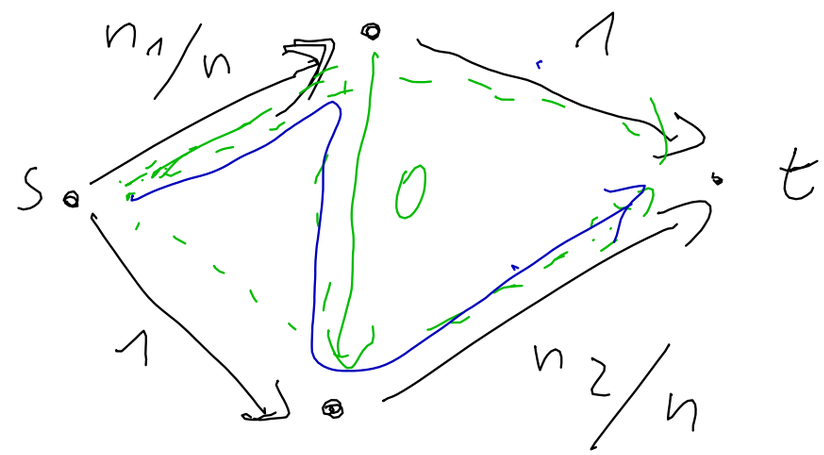
<u>setting</u>: One object should be allocated to one out of a number of bidders.

<u>Problems</u>:

- Bidding protocol
- Who is the winner?
- What does the winning bidder have to pay?

(c) Congestion games

Setting: Network of streets with travel costs that is related to the number of agents choosing a street



e.g. 2 agents which route to choose?

(d) Security:

Setting: a facility (e.g. airport) has to be guarded to avoid attacks.

Possible methods:

- visit all critical places
- choose the guard probabilistically ←
- Find a probability distribution for the routing that minimizes expected damage, even under the assumption that the attacker can observe the guards.

1.3 Rationality

<u>General assumption:</u> All players want to maximize their own utility and nothing else!

<u>Contrasts:</u>

- Altruistic agent: wants to maximize the utility of the other agents
- Cooperative agent: wants to maximize the group utility
- Byzantine agent: wants to minimize the utility of all the other agents.

Often agents cannot foresee all the consequences of their decisions (bounded rationality).

Often agents do not know all relevant information about the agents.

1.4 Overview of topics in GT

- strategic games
- extensive games, repeated game
- variations and special cases
- social decision theory
- mechanism design
- cooperative game theory