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Lecture 12

Game Theory – part I

micro2
first module

Games

- A ***Game*** is any situation in which the participants (*players*) make ***strategic*** decisions
- For ***example***
  - Firms competing with each other by setting ***prices***,
  - Individuals bidding against each other in an ***auction***
- Strategic decisions result in ***payoffs*** to the players:
  outcomes that generate rewards or penalties

Strategic decisions

- Game theory tries to determine ***optimal strategy*** for each player
- ***Strategy*** is a rule or plan of action for playing the game
  players usually have a ***set of available strategies***
- ***Optimal strategy*** for a player is one that yields the maximum expected payoff
- We consider players who are ***rational***
  they ***think through*** their actions

Strategic interaction

- In a game, your payoff ***depends on*** both
  - Your actions
  - Your opponents' actions
- If you want to maximize your payoff, you should take your opponent's actions ***into account*** when you make your own decision
- Thus, it would be very useful for you to ***understand*** what is the ***optimal response*** of your opponent

Noncooperative vs. Cooperative games

- In a Cooperative game players negotiate binding contracts that allow them to plan ***joint strategies***
  example: a joint venture by two firms (i.e., HSE and NES)
- In a Non-cooperative game negotiation of binding contracts between players is not possible because agreements are ***not possible*** or are ***not allowed***
  example: two competing firms, assuming each-other's behavior, independently determine ***pricing*** and ***advertising*** strategy to gain market share

Information structure in games

- Games of ***complete information***
  - ***Everyone knows*** the structure of the game (opponents, rules, set of actions, payoffs)
  - Players may ***ignore*** some past actions by rivals
  - ***Example:*** poker
- Games of ***perfect information***
  - ***Everyone knows*** the full history of actions by rivals
  - Players may ***ignore*** the rules or the full set of possible payoffs
  - ***Example:*** competing firms' objectives

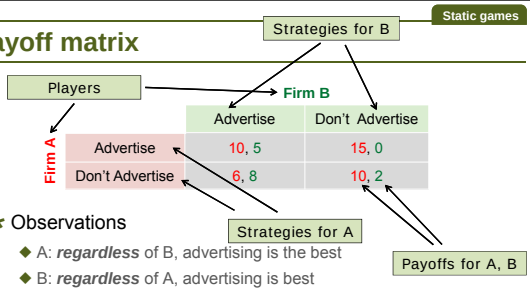
Timing in games

- ***Static*** games (one-shot games)
  - games where all players announce their strategies ***simultaneously***
- ***Repeated*** games
  - games where interaction is repeated ***more than once***
- ***Dynamic*** games
  - games where players move ***sequentially***

Choosing strategies

- A strategy may ***dominate*** another strategy, ***independently*** of what the opponent does
- Someone is giving you for free ***one of the following:***
  - An admission at the university of your choice
  - 1 million dollars
  - 100 thousand dollars
- A ***dominated strategy*** is one that is sub-optimal to another
  - dominated strategies are ***irrelevant*** for the game
- A ***dominant strategy*** is one that is optimal independently of what the opponent does

Payoff matrix



- Observations
  - A: ***regardless*** of B, advertising is the best
  - B: ***regardless*** of A, advertising is best
  - ***Dominant strategy*** for A and B is to advertise
  - Do ***not worry*** about the other player
  - ***Equilibrium*** in dominant strategies (DE)

DE

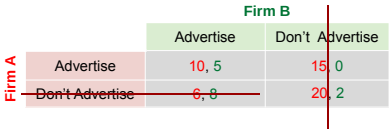
- Equilibrium in dominant strategies (DE):

  Outcome of a game *in which each firm is doing the best it can* ***regardless*** *of what its competitors are doing*
- ***Optimal strategy*** is determined without worrying about the actions of other players
- However, most games ***do not have*** a dominant strategy for each player

Games without a DE

- The optimal decision of a player without a dominant strategy will ***depend*** on what the ***other*** player does
- Now each player is ***concerned*** about the decisions of other players
- ***Altering*** the payoff matrix from the ***previous example***, we can see a situation where no dominant strategy exists

Modified advertising game



- Observations
  - Now, A has no dominated strategy
  - For B '*not advertise*' is still a dominated strategy
  - Firm A understands that B will choose '*advertise*' and makes its decision accordingly
  - The result is an Iterative DE (IDE)

The Nash Equilibrium revisited

- In many games, there are ***no dominated strategies***
- A ***more general*** equilibrium concept is the ***Nash Equilibrium***, which we used in oligopoly
  - ***NE:*** A combination of strategies from which no player has an incentive to ***deviate unilaterally***
- At the NE each player is doing its ***best, given*** the actions of its opponents
- ***Cournot equilibrium*** is an ***instance*** of Nash Equilibrium
  - each firm sets output assuming the other firm's outputs are ***fixed***
- Is the NE a ***stable equilibrium?***

Equilibrium concepts

- ***DE***
  - *"I am doing the best I can **no matter** what you do – you are doing the best you can no matter what I do"*
- ***NE***
  - *"I am doing the best I can **given** what you are doing – you are doing the best you can **given** what I am doing"*
- DE is a ***special case*** of NE

The Prisoners' Dilemma

- The ***most famous*** example in game theory is the Prisoners' Dilemma
  - *Bonnie* and *Clyde* are ***accused*** of committing a crime
  - They are both arrested and placed in ***separate*** cells
  - Each has been ***asked to confess*** to the crime
  - A confession will make the work of the prosecutor easier, so, she is offering them a ***deal*** to make them confess

Prisoners' Dilemma – offer

Bonnie \ Clyde	Confess	Deny
Confess	-5, -5	-1, -10
Deny	-10, -1	-2, -2

- The ***offer*** of the prosecutor to each prisoner is
  - If you confess and your partner does not, you get 1 year and your partner 10
  - If you both confess, you get 5 years each
  - If you both deny, you get 2 years each

Prisoners' Dilemma – equilibrium

Bonnie \ Clyde	Confess	Deny
Confess	-5, -5	-1, -10
Deny	-10, -1	-2, -2

- What is the ***outcome*** of this game?
- Do the players end up to the ***best possible*** outcome?
  - the NE is not necessarily the "best" outcome of a game – most of the times the NE is not the ***joint optimum***

The "sidewalk" game

P1 \ P2	LHS	RHS
LHS	1 , 1	0 , 0
RHS	0 , 0	1 , 1

- There might be ***more than one*** NE
- Which one is the ***outcome*** of the game?
- Depends on
  - Where the game ***begins*** from, or
  - How ***initial perceptions*** are formed

BMW vs. Benz: product choice problem

- ***BMW*** and ***Mercedes*** each wish to introduce a ***new type*** of vehicle in the market
  - Either a Compact Utility Vehicle (CUV) or
  - A Compact Cabriolet (Cabrio)
- Firms will be better off if they introduce a ***different type*** of vehicle
  - Because the demands in those markets are still small and ***cannot accommodate*** two competing sellers
  - Plus firms need to sell a high quantity to ***reach their MES***
- Decisions are ***non – cooperative***

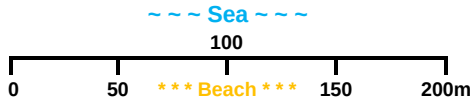
Product choice problem

		Mercedes: CUV	Mercedes: Cabrio
BMW	CUV	-6, -6	12, 10
BMW	Cabrio	10, 12	-5, -5

- If BMW ***hears*** that Mercedes is introducing a CUV, its best action is to produce a Cabrio
- Bottom left corner is ***Nash equilibrium***
- What is other Nash Equilibrium?

Beach location game

- Imagine a ***beach*** 200 meters wide
  - Sunbathers are spread ***evenly*** along the beach
  - Two ***vendors***, A and B, selling soft drinks
  - Both charge the ***same price***
  - Customer will buy from the ***closest vendor***
- ***Where*** will the competitors locate?
- ***Similar*** to groups of night clubs, car dealerships, etc.



What is the NE in this game?

		Zhanna: Left	Zhanna: Right
Alex	Up	0, 0	1, 1
Alex	Down	1.000.000, 1.000.000	0, 0

- What is the ***outcome*** in this game?
- Outcome (Down, Left) is a ***Focal Point***

ευχαριστώ!

(thank you!)

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