SOCIAL NETWORKS

LECTURE #13

Game Theory:

Study of strategic Interactions.

- Choices
- Rational Decisions

} Strategic Choices.

1) Static Games.
2) Dynamic Games { Signalling, Bargaining
3) Evolutionary Games.

Why are games important in Social Networks?

i) Privacy (Information Asymmetry)
ii) TRUST. (Correlation of Encounters)
   - Anonimity
   - Liquidity
iii) Signaling
   - Deception
   - Cost (Cheap Talk)
iv) Coordination.
   - Bargaining
   - Pricing (Honest Auction)

Example (Advertisement)

Advertiser ← Two Players.

(Non-cooperative Non-Zero-Sum)

User	No Ad	Show Ad
$\neg$Click	(0,0)	(0,-1)
Click $\wedge$ $\neg$Buy	(-1,0)	(-1,-1)
Buy	(1,2)	$(1-\epsilon,1)$

From an Advertiser's point of view, for every strategy of the user, the advertiser is better off by <u>not</u> showing any ad.

"Show Ad is dominated by No Ad".

However, for a user (who ~~[illegible]~~ is inclined to buy) Show Ad is better than No Ad.

⇒ Solution : User Information { Cookie, Similarities, Key Words, 3rd Party Cookies.

One needs to define two games (Both Signaling Games).

User ⟷ Publisher ⟷ Advertiser

Key Words
(Signals)

User Data
(Cookies)

SEARCH
(Browser)

AUCTION
(Ad Exchange)

SSP
(Supply Side
Platforms)

DSP
(Demand Side
Platforms)

RTB
(Real Time Bidding)
Second Price Auctions.

GAME THEORY.

KEY ASSUMPTIONS (often violated).

1) Rationality (or Bounded Rationality).
2) CKR (Common Knowledge of Rationality).

An Individual →
- Knows his options/strategies.
- knows his utilities/pay offs.
- knows he is rational (i.e. utility optimizing)

→ Interacts strategically with other individuals
- → knows similar information about other players (perfect information)
- knows that others are rational and others know that he is rational, ... etc. ad infinitum

In selecting an option, he behaves strategically (while anticipating how others will behave) so that he optimizes his (and only his) payoff.

Rational & Greedy.
(Sometimes Evil.)

Note.

- Payoff need not be just <u>monetary</u>
- Rationality should be treated as an idealization
  - Learning
  - Statistical Inference / Data Science / Computation
  - Evolutionarily stable Strategy.

NASH EQUILIBRIUM

A Simultaneous selection of strategies by a set of rational players so that no individual player can improve his utility by changing his strategy.

→ Locally optimal
→ Locally stable (no deviation).

John Nash.

"A Beautiful Mind"

JN \ JNF	Blonde	Brunnette
Blonde	(0,0)	(2,1)
Brunnette	(1,2)	(1/2,1/2)

"If everyone competes for the blonde, we block each other and no one ~~d~~ gets her. So then we all go for her friends. But they give us the cold shoulder, because no one likes to be second choice. Again, no winner. But what if none of us go for the blonde. We don't get in each other's way, we don't insult the other girls. That's the only way, we win."

What's Wrong?

Where's the Nash Equilibrium?

STRATEGIC FORM GAMES

Defn: A strategic form game is a triplet

$$\langle I, (S_i)_{i\in I}, (u_i)_{i\in I} \rangle$$

- Index Set: $I \equiv$ Finite set of players.
  $\equiv \{1, 2, 3, \ldots, l\}$
- Strategy Set: S_i, $i \in I$
  $\equiv$ Set of available strategies/actions for a player $i \in I$.
- Strategy Profile:

$$S = \prod_{i\in I} S_i$$

- Utility Function:

$$u_i : S \longrightarrow \mathbb{R}.$$

$\equiv$ The payoff function of player $i \in I$.

<u>Example</u>: BoS (Battle of the Sexes).

Two Player Game.

$I = \{F, M\}$

Female $= F$
$=$ Row Player
Male $= M$
$=$ Column Player

$S_F = S_M = \{\mathcal{O}, \mathcal{F}\}$

Opera $= \mathcal{O}$
Football $= \mathcal{F}$.

$S = S_F \times S_M = \{\langle \mathcal{O}, \mathcal{O}\rangle, \langle \mathcal{O}, \mathcal{F}\rangle, \langle \mathcal{F}, \mathcal{O}\rangle, \langle \mathcal{F}, \mathcal{F}\rangle\}$

Both choose to goto opera.
etc.

F \ M	$\mathcal{O}$	$\mathcal{F}$
$\mathcal{O}$	(3,2)	(0,0)
$\mathcal{F}$	(0,0)	(2,3)

Utility Function.

$u_F(\langle \mathcal{O}, \mathcal{O}\rangle) = u_M(\langle \mathcal{F}, \mathcal{F}\rangle) = 3$

$u_F(\langle \mathcal{F}, \mathcal{F}\rangle) = u_M(\langle \mathcal{O}, \mathcal{O}\rangle) = 2$

$\begin{cases} \text{Otherwise,} \\ 0 \end{cases}$