Parshwanath Charitable Trust's
A. P. SHAH INSTITUTE OF TECHNOLOGY
(Approved by AICTE New Delhi & Govt. of Maharashtra, Affiliated to University of Mumbai)
(Religious Jain Minority)

Subject: Mathematics for AI & ML

Extensive form Games →

So far the games that we have seen are classified as normal form games. we also call them strategic form games. we have

- players
- stratagies &
- payoffs

} All players moves simultaneously ↑ Big limitation of strategic games.

simultaneous means → when a player takes an action, he is not aware of the actions taken by all the other players.

But, there are many instances in which when a player takes an action, he/she knows the moves of other players. lets take an example.

eg → lets say a firm is thinking of entering into a market. The firm that is already there in the market will see that other firms entered into the market or not & take the necessary actions accordingly.

eg → A variation of cournot games, in which a firm first observes the production decision of other firm & then decide the quantity it would like to produce.

Eg → Bargaining between buyer & seller.

Modelling these games as normal strategic games will not be a good idea.

To describe such interactions, we should consider :

1 → List of players participating in strategic interactions
2 → when does a player get to move in a game (order of Moves)
3 → what are the actions available to the player when she gets to move ?
4 → How much does a player know when he gets to move ? [Information]
5 → Payoffs.
   Notice: 1,3,5 were required in normal form games.

Entry Game Example :

                                        already
                                present in the
                                        market
→ A market is characterized by a monopolist (Incumbent)
  {monopolist Eg: only T.V. seller in the market, No other
              TV. seller available}

→ A rival firm (potential Entrant) is thinking whether to enter into the market or remain out.

→ The incumbent can engage in costly advertisement or price cut to fight the rival or do nothing (accomodate)

Lets assume that <u>entrant</u> moves first:

➡ How to represent such strategic Interaction?

Players → Incumbent, Potential Entrant.

Actions
  └→ Potential Entrant → Enter (E) or Not Enter (N) in the market.
  └→ Incumbent → Accomodate (A) or fight (F)

Payoffs →

Entrant (Best to worst)
  └→ Entry and accomodate   1
  └→ ~~No entry~~ No entry   0
  └→ Entry & fight   -1

Incumbent → (Best to worst)
  └→ No entry   3
  └→ Entry & Accomodate   2
  └→ Entry & fight   1

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Game Tree → A simple and useful way of representing an extensive form game.

→ A game tree is a graph, consist of nodes & branches.

→ ● Nodes → labels
  Initial Nodes → Beginning of the games
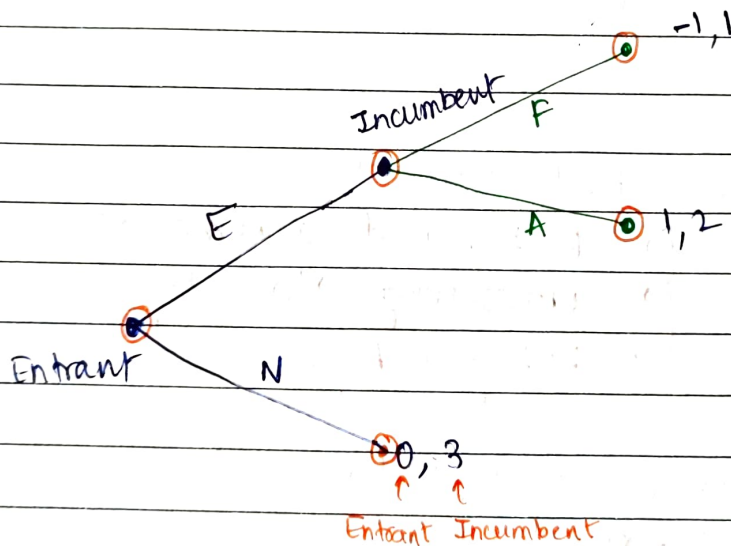 Decision Nodes → Player Labels
  Terminal Nodes → Pay offs.

→ Nodes → Information
→ Branches → Actions.

Represent Entry game using normal form game →

		Incumbent	
	Coke/Pepsi	Fight	Accomodate
Entrant	Entry	-1, 1	1, 2
	Out	0, 3	0,3

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Backward Induction-Equillibirum →

→ look forward, and Reason Back.
→ Begin at the end
→ Assumption : Rationality & common Knowledge.
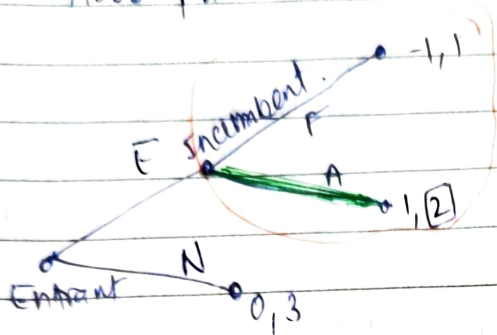
start from incumbent, It can take action F, A. It gets more payoff (2) if it chooses action A.
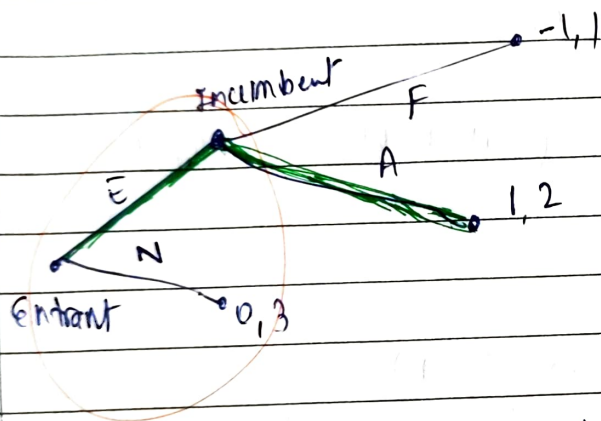
Entrant knows that incumbent is a rational player & given an opportunity to move, Incumbent is going to Accomodate, so entrant know that if he takes action E, game would move in A (Accomate) direction & payoff woul be [1]. If entrant Remains out, then payoff will be [0]. So 1>0, so entrant would choose to move in E direction.

So, (E,A) is Nash Equillibirium.

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	Incumbent	
	Fight	Accomodate
Entrant Entry	$-1, 1$	$\boxed{1}, \boxed{2}$
Out	$\boxed{0}, \boxed{3}$	$0, \boxed{3}$

☐ If Incumbent fights, Best Response (BR) for Entrant is to remain Out.

☐ If Incumbent Accomodates, BR for entrant is to Enter. (Entry)

☐ If entrant enters, BR for Incumbent is to Accomodate

☐ If entrant stay out, BR ——————— fight or Accomodate

So, Here we get, (Out, fight) & (Entry, Accomodate) as NE.

So,

Backword Induction → (E, A)

NE ————→ (E, A), (F, O)

✳ Using belief & sequential Rationality it can be shown that Backward induction recomendation is better that NE recomendation.