

Module 3: "Dynamic games of complete information"

Lecture 17: "Subgame perfect Nash Equilibrium (SPNE)"

The Lecture Contains:

- What do we mean by SPNE ?
- What is a Subgame?
- Examples of sub games
- How to find SPNE ?
- How to find SPNE: Example

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Subgame perfect Nash Equilibrium (SPNE)**What do we mean by SPNE?**

- If a combination of strategy profiles form an equilibrium, then at that equilibrium , no player has any incentive to deviate from his/her strategy **at any point of the game tree** → **Concept of SPNE**
- Acceptable equilibrium among the set of NE are those strategy profiles which ensure equilibrium for any truncated version of the game.
- Truncated version of the game For any ***sub game***

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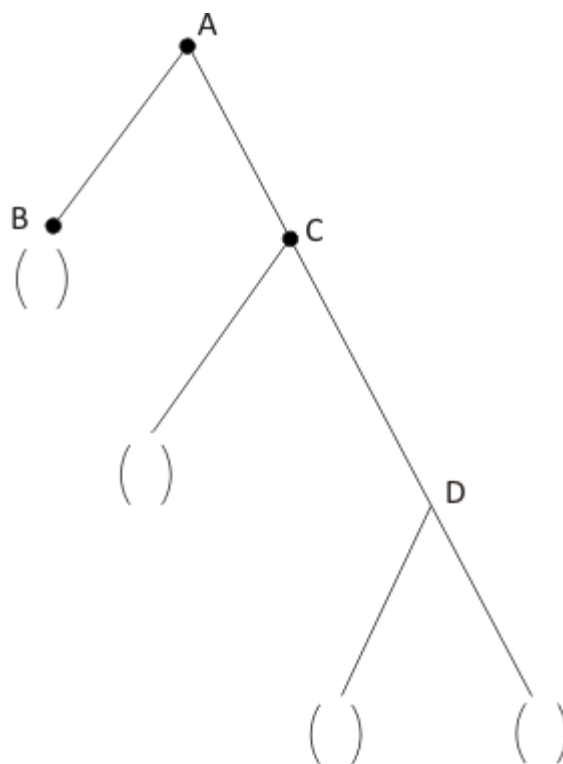
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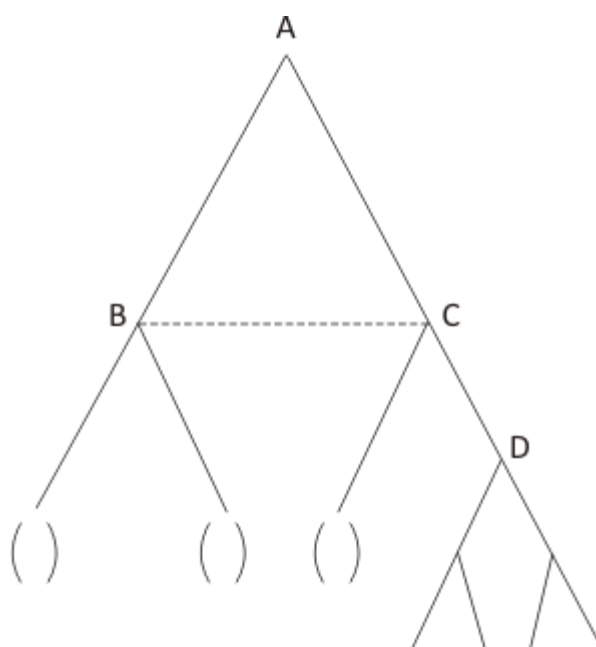
What is a Subgame?

A subgame in an extensive form game

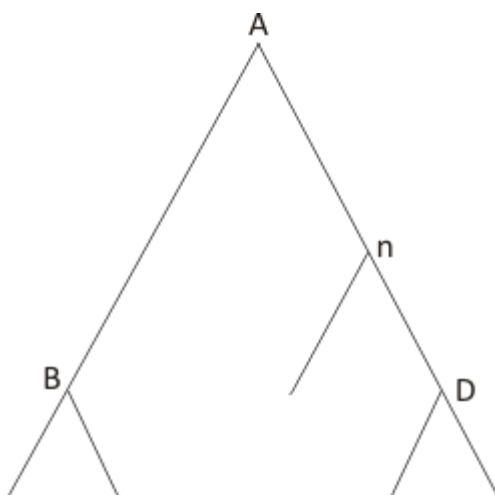
- a. Starts with a singleton information set say n
i.e. at any particular decision node which is itself an information set but not the initial node



Sub game cannot start from nodes
A or B or C



- b. Contains all the decision and terminal nodes that follow n in the game tree but not the decision nodes that do not follow n .



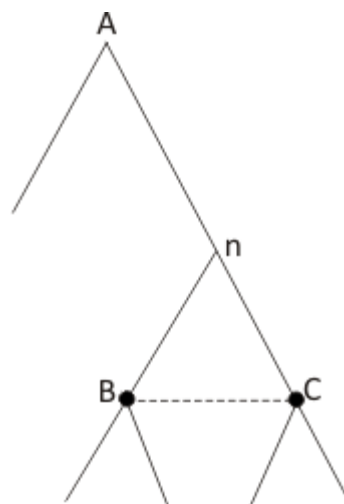
n is the decision node from which the sub game starts. So D must be included in this subgame but not B .

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What is a sub game? [contd.]

- c. Does not cut any information set i.e. if a decision node n^1 following n is included in the subgame, then all the nodes in the information set containing n^1 must also be included in the subgame.



There cannot be any sub game that start at n and contains C but not B .

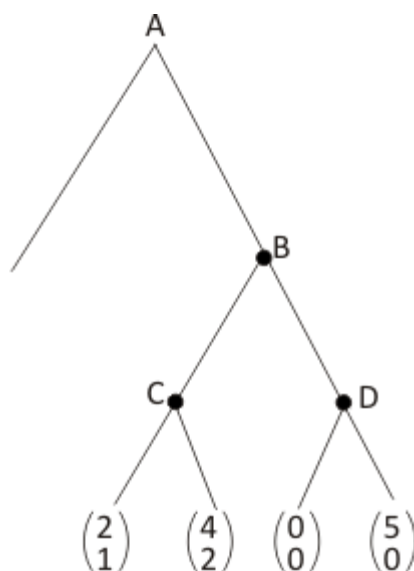
Examples of sub game

How many sub games are there?

1.

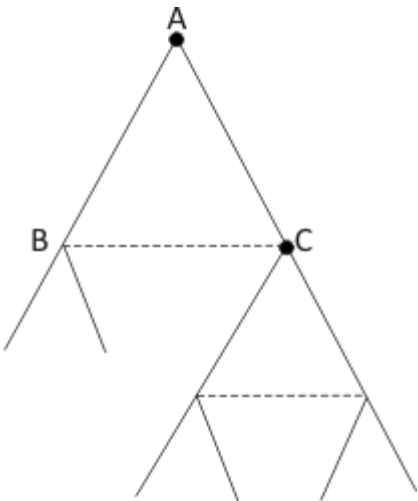
3 sub games

- One starting at B
- One at C
- One at D



2.

No subgame



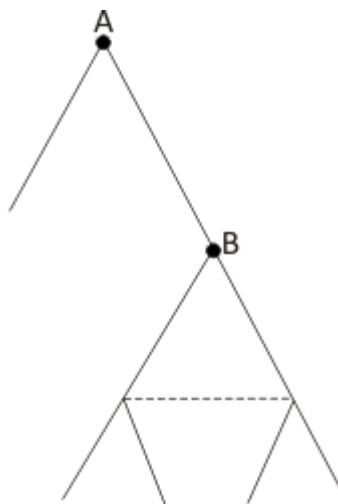
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Examples of sub games [contd.]

3.

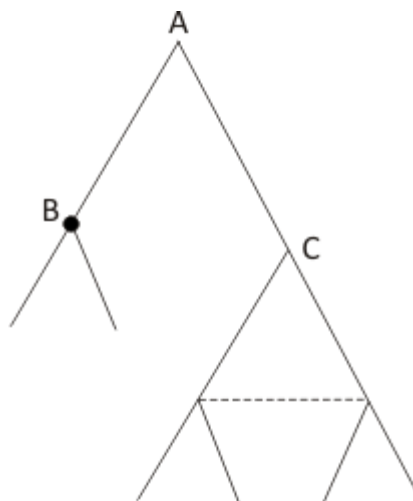
1 Subgame starting at B



4.

2 sub games

- One starting at B
- One starting at C



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How to find SPNE?

Use the method of backwards induction

Steps

1. Start with the smallest possible subgame that contains some terminal nodes
2.
 - i. Find out the NE for each of these sub games
 - ii. Replace the initial nodes of these sub games with the payoffs at these NE.
3.
 - i. Again identify the smallest possible subgame of this truncated version of the game and repeat the process.
 - ii. Proceeding backwards through the game tree one can find out at least one subgame perfect NE.

[**Note:** *If a sub game has more than one Nash equilibrium, then while using backward induction take turns to replace the subgame with NE payoffs one by one. Will get more than one SPNEs.*]

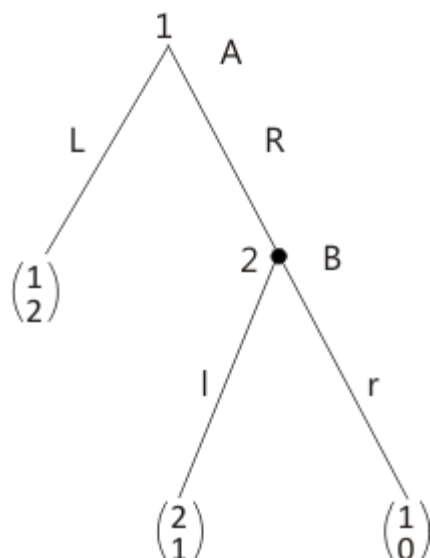
[**Note:** *If there is no subgame, then every NE is a SPNE.*]

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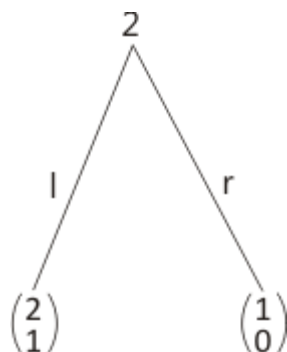
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How to find SPNE: Example

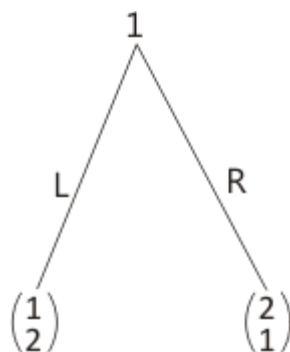


- Smallest subgame starting at B



Player 2 would choose l.

- Replace the node at B with the payoff $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$



Player 1 would choose R

SPNE $\rightarrow [R, l \text{ if } R]$

