

SOCIAL NETWORKS - NPTEL July 2024

Week 7

1. Assume that actions X and Y yield every player a payoff of 5 and 10 respectively. Further assume that there are two friends, Alex and Blake. Alex decides to adopt action X while Blake decides to adopt action Y. What are the payoffs that they get?
 - (a) 5,10
 - (b) 5,0
 - (c) 10,5
 - (d) 0,10

Answer: (a) Explanation: In the scenario provided: Action X yields a payoff of 5 to the player who chooses it. Action Y yields a payoff of 10 to the player who chooses it. Given that: Alex chooses Action X, Alex will receive the payoff associated with Action X, which is 5. Blake chooses Action Y, Blake will receive the payoff associated with Action Y, which is 10.

2. In a company, a new software is being introduced. Employees will only adopt the software if at least a fraction q of their colleagues have started using it. If a few tightly-knit departments of employees work closely with each other, what could prevent the software from being adopted company-wide?
 - (a) The department has fewer than q of the employees
 - (b) The department has fewer than $1 - q$ of the employees
 - (c) The department has more than q of the employees
 - (d) The department has more than $1 - q$ of the employees

Answer: (d)

Explanation: In this scenario, the adoption threshold is q . For the software to be adopted company-wide, enough employees in every department must adopt it. However, suppose there is a department where more than $1-q$ of the employees are closely connected. In that case, they may resist the software adoption because they are more influenced by each other than by employees outside their department. Thus, a tightly-knit department with more than $1-q$ of the employees could prevent the software from being adopted company-wide.

3. In the context of viral marketing, a company aims to promote a new product by targeting key individuals in a social network. These individuals are selected based on their ability to influence others within the network. Given that the network has varying degrees of connectivity among its members, which of the following strategies is most effective for maximizing the spread of the product?
 - (a) Target individuals with the highest number of direct connections, regardless of their influence on others
 - (b) Target individuals who are central to the network, as they act as bridges between different groups
 - (c) Target the most isolated individuals, as they are less likely to have been influenced by others
 - (d) Target individuals who are closely connected within a small, dense cluster, as they can influence others within their immediate group

Answer: (b)

Explanation: Individuals who are central to a network, often referred to as "hubs" or "bridges," play a crucial role in connecting different parts of the network. By targeting these individuals, the product or message can quickly spread across the network, reaching various groups that are otherwise less connected. Option B is the most effective strategy for maximizing the spread of a product in viral marketing, as it leverages the central position of key individuals who can influence multiple groups within the network.

4. Given a node X having 10 friends/neighbors. 3 of its neighbors have decided to adopt the behavior/action A having a payoff of 10 while 7 of its friends have adopted the action B yielding a payoff of 4. What is the payoff that X gets from its friends who have adopted action A?

- (a) 30
- (b) 70
- (c) 12
- (d) 40

Answer: (a)

Explanation: To find the total payoff that node X gets from its friends who have adopted action A: Number of friends adopting action A: 3 Payoff from each friend adopting action A: 10 Total payoff = Number of friends adopting action A \times Payoff per friend So, the calculation is: Total Payoff = $3 \times 10 = 30$

5. For the node X mentioned in question 4, What is the payoff that X gets from its friends who have adopted B?

- (a) 30
- (b) 40
- (c) 28
- (d) 38

Answer: (c)

Explanation: To find the total payoff that node X gets from its friends who have adopted action B: Number of friends adopting action B: 7 Payoff from each friend adopting action B: 4 Total payoff = Number of friends adopting action A \times Payoff per friend So, the calculation is: Total Payoff = $7 \times 4 = 28$

6. For node X mentioned in question 4, What is the final action/behavior that X would adopt?

- (a) A
- (b) B
- (c) neither A nor B
- (d) cannot say

Answer: (a)

Explanation: Node X would adopt action A because the total payoff from friends who have adopted action A (30) is higher than the total payoff from friends who have adopted action B (28).

7. For the given figure, what is the density of community formed by nodes A, B, C and D?

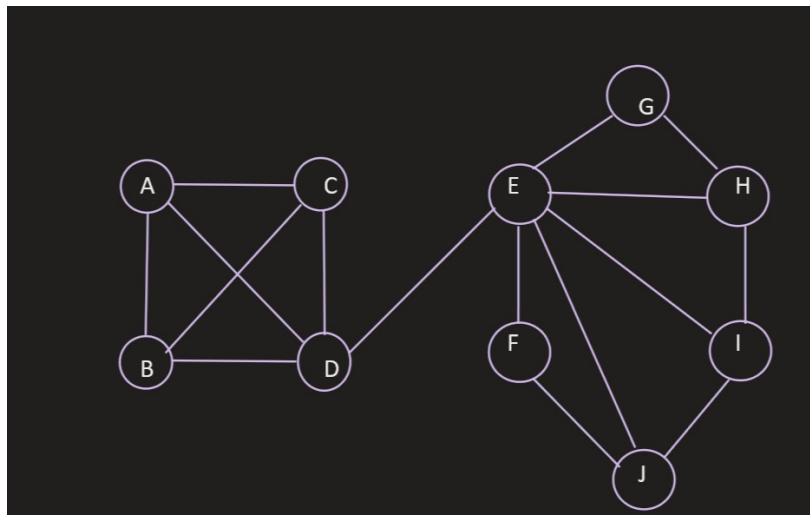


Figure 1: Network G

- (a) 0
- (b) 1
- (c) 2

(d) 3

Answer: (b)

Explanation:

The density of a community is given by the ratio of the actual number of edges to the total number of possible edges in that community. $\text{Density} = 6/6C2 = 6/6 = 1$.

8. Given the network below, if the value above the node is its threshold value to join the protest, is the protest likely to happen?

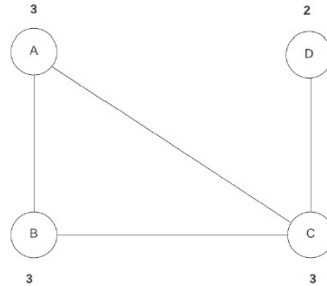


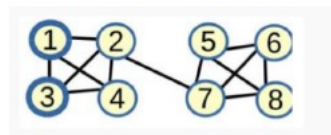
Figure 2: Network H

- (a) Yes
(b) No
(c) Cannot say

Answer: (a)

Explanation: The threshold value for each node is satisfied so protest is likely to happen

9. Given a network as shown in the following Figure, assume that initially, every node in this network has adopted behavior B. Next, a new behavior A is introduced in the network and nodes 1 and 3 are the initial adopters of this behavior A, i.e., nodes 1 and 3 now have adopted behavior A and the rest of the nodes have adopted behavior B. The payoff associated with A is $a = 3$ and the payoff associated with B is $b = 2$. After the introduction of this new behavior A in the network, all the nodes will start weighing their options and might change their behavior. This leads to a cascade in the network. When the cascade ends, identify the nodes that will adopt the behavior A.



- (a) 1,3,2
(b) 1,3,2,4
(c) 1,3,2,7
(d) 1,3,2,7,5

Answer: (b) Explanation: For Node 2: Payoff to adopt behavior A is Neighbors who adopted A x payoff for A = $2 \times 3 = 6$ Payoff to adopt B = Neighbors who adopted B x payoff for B = $2 \times 2 = 4$ As $\text{payoff}(A) > \text{payoff}(B)$, Node 2 adopts A

For Node 4: Payoff to adopt behavior A is Neighbors who adopted A x payoff for A = $2 \times 3 = 6$ Payoff to adopt B = Neighbors who adopted B x payoff for B = $1 \times 2 = 2$ As $\text{payoff}(A) > \text{payoff}(B)$, Node 4 also adopts A

For all the other nodes, there is no neighbor who has adopted behavior B, hence they do not adopt B.

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10. Let v be a node in a graph. Suppose that a fraction α of the neighbors of v has adopted behavior X, and a fraction $1 - \alpha$ has adopted behavior Y. In other words, if v has k neighbors, then αk neighbors adopt X, and $(1 - \alpha)k$ neighbors adopt Y. Behavior X yields a payoff of x , and behavior Y yields a payoff of y . Behavior X is a more advantageous choice for v if:

- (a) $\alpha \geq x/y$
- (b) $\alpha \geq y/x$
- (c) $\alpha \geq x/(x + y)$
- (d) $\alpha \geq y/(x + y)$

Answer: (d)