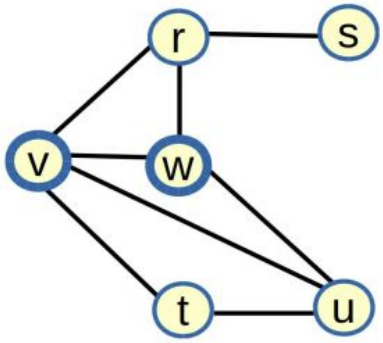
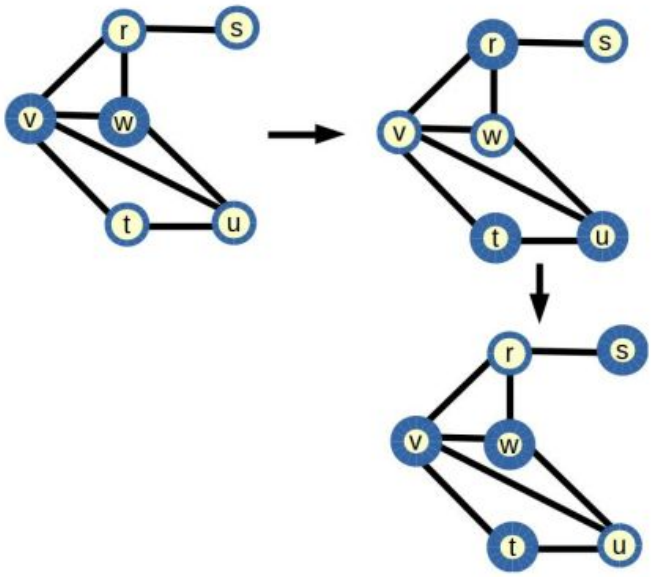
Assignment Week 7
(Social Networks)

1. 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 the nodes ‘v’ and ‘w’ are the initial adopters of this behavior A, i.e., nodes ‘v’ and ‘w’ 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. After two iterations, which nodes would have adopted the behavior A?

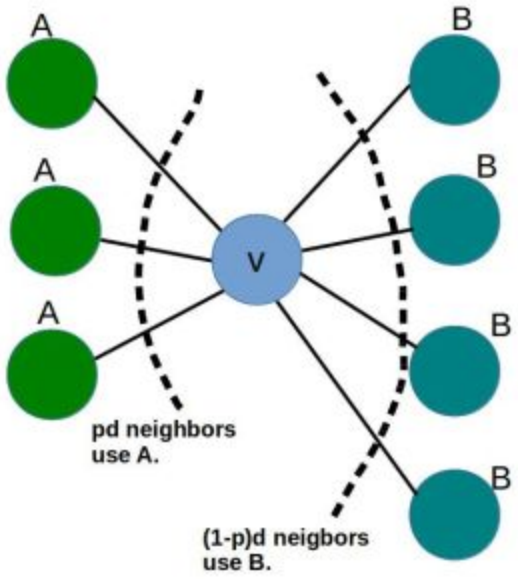


   a. v, w, r
   b. v, w, t, s
   c. v, w, r, s, t
   d. v, w, r, s, t, u

Explanation:
Refer to the following Figure. Nodes in thick boundaries are the ones who have adopted behavior A.



2. Let ‘v’ be a node in a graph. Suppose that a ‘p’ fraction of the neighbors of ‘v’ have behavior A, and a (1 − p) fraction have behavior B; that is, if ‘v’ has ‘d’ neighbors, then pd adopt A and (1 − p)d adopt B, as shown in the following Figure. Behavior A has a payoff of ‘a’ and behavior B has a payoff of ‘b’. Then A is a better choice for ‘v’ if

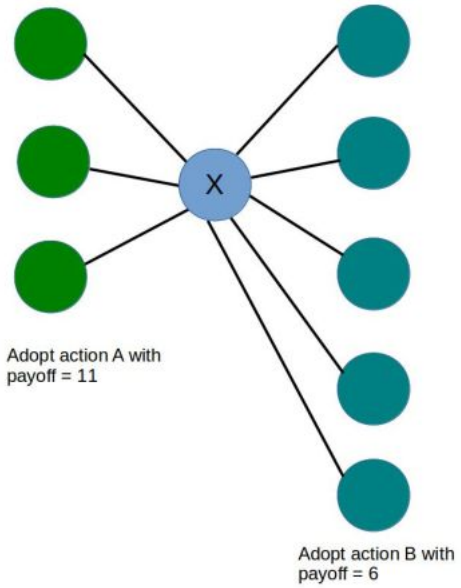


a. p ≥ a/b
b. p ≥ b/a
c. p ≥ a/(a+b)
d. p ≥ b/(a+b)

Explanation:
Suppose that a p fraction of the neighbors of v have behavior A, and a (1−p) fraction have behavior B; that is, if v has d neighbors, then pd adopt A and (1 − p)d adopt B. So if v chooses A, it gets a payoff of pda, and if it chooses B, it gets a payoff of (1 − p)db. Thus, A is the better choice if pda ≥ (1 − p)db, or, rearranging terms, if p >= (b/a+b)

3. The spreading of a contagion on a network depends on
    a. only the pathogen
    b. only the contact network
    c. both the pathogen and the contact network
    d. None of the above

4. Given a node X having 8 friends/neighbors. 3 of its neighbors have decided to adopt the behavior/action A having a payoff of 11 while 5 of its friends have adopted the action B yielding a payoff of 6. This is shown in the following Figure. What is (i) the payoff that X gets from its friends who have adopted the action A, (ii) the payoff that X gets from its friends who have adopted B, (iii) The final action/behavior adopted by X?

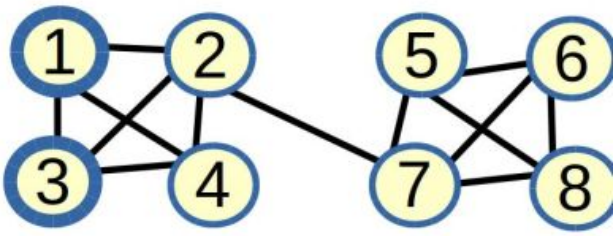


    a. (i) 33 ,(ii) 30, (iii) B
    b. (i) 33 ,(ii) 30, (iii) A
    c. (i) 11 ,(ii) 6, (iii) A
    d. (i) 11 ,(ii) 6, (iii) B

Explanation:
Node X has 3 neighbors who have adopted the behavior A having a payoff of 11. Hence, the total payoff X receives from these neighbors = 3 × 11 = 33. Node X has 5 neighbors

who have adopted the behavior B having a payoff of 6. Hence, the total payoff X receives from these neighbors = 5 × 6 = 30. Since the payoff in the first case (33) is greater than the payoff in the second case (30), node X adopts the behavior A.

5. 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 the 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, which all are the nodes who have adopted the behavior A.



a. 1, 3, 2
b. 1, 3, 2, 4
c. 1, 3, 2, 4, 7
d. 1, 3, 2, 4, 5, 6, 7, 8

Explanation:
First iteration-
• Node 2 calculates its payoff. It gets a payoff of 2 × 3 = 6 for action A since there are 2 of its neighbors 1 and 3 who have adopted A. It gets a payoff of 2 × 2 = 4 for action B since there are 2 of its neighbour, i.e. 4 and 7, who have adopted B. Hence, it adopts A since that is yielding a higher payoff.
• Node 4 calculates its payoff. It gets a payoff of 2 × 3 = 6 for action A since there are 2 of its neighbors 3 and 1 who has adopted A. It gets a payoff of 1 × 2 = 2 for action B since there is only one of its neighbour, i.e. 2, who has adopted B. Hence, it adopts A since that is yielding a higher payoff.
Second iteration-
• Node 7 calculates its payoff. It gets a payoff of 1 × 3 = 3 for action A since there is 1 of its neighbors 2 who has adopted A. It gets a payoff of 3 × 2 = 6 for action B since there are 3 of its neighbors who have adopted B- 5, 6 and 8. Hence, it does not adopt A since that is yielding a low payoff. Rest of the nodes 5, 6 and 8 have none of their neighbors having adopted A, hence they keep adopting B only and the cascade stops.

6. Consider a set of initial adopters of behavior A, with a threshold of q for nodes in the remaining network to adopt behavior A. Given the following two statements.
   Statement 1: If the remaining network contains a cluster of density greater than 1 − q, then the set of initial adopters will not cause a complete cascade.
   Statement 2: Whenever a set of initial adopters does not cause a complete cascade with threshold q, the remaining network must contain a cluster of density greater than 1 − q.
   Choose the correct option from the following.
   a. Both Statement 1 and Statement 2 are true.
   b. Both Statement 1 and Statement 2 are false.
   c. Statement 1 is true but Statement 2 is false.
   d. Statement 2 is true but Statement 1 is false.

7. Which of the following social network phenomenon can act as a barrier to the diffusion of an innovation?
   a. Triadic closure
   b. Homophily
   c. Small world phenomenon
   d. Core-Periphery structure