SOCIAL NETWORKS - NPTEL July 2024

Week 11

1. In Stanley Milgram's famous small-world experiment, which was designed to investigate the "six degrees of separation" concept, participants were asked to send a letter to a target individual using only acquaintances. What was a key finding of this experiment?

   (a) Most letters reached the target individual through a direct connection within three steps

   (b) The average number of steps required to reach the target individual was around 6, demonstrating the small-world phenomenon

   (c) Participants found that there was no measurable average number of steps to reach the target

   (d) The letters typically reached the target individual through a network of over 100 steps

   Answer: (b)

   Explanation: Milgram's small-world experiment aimed to understand the average number of steps required to connect two random individuals in a network. The finding demonstrated that despite the vast number of people, the average number of intermediary steps needed to connect any two people in the world was about 6, illustrating the small-world phenomenon.

2. Suppose each of your 50 friends has 30 friends (excluding you). Each of those friends also has 30 friends (excluding them), and this pattern of each having 30 friends continues. How many people can you reach at level i (where Level 1 refers to your direct friends, Level 2 refers to your friends' friends, and so on)?

   (a) 30^i

   (b) $50 + 30^i$

   (c) $50 + 30^{i-1}$

   (d) $50 \times 30^{i-1}$

   Answer: (d)

   Explanation:

   - At level 1, you can reach 50 friends.
   - At level 2, each of your 50 friends has 30 unique friends, giving $50 \times 30 = 50 = 50 \times 30^1$ people
   - At level 3, the same pattern continues, resulting in 50×30^2
   - For i levels, you can reach $50 \times 30^{i-1}$

3. Imagine you work in a company where most of your close connections are with colleagues from your own department. However, you occasionally attend industry conferences where you meet people from different companies and countries, building new, distant connections. According to Watts and Strogatz, which of the two phenomena are responsible for creating small-world networks?

   (a) Your close colleagues frequently form connections among themselves (triadic closure), while your occasional contacts at conferences represent weak ties.

   (b) Your colleagues form a tightly-knit group (community structure), while new connections are created within smaller subgroups (triadic closure).

   (c) You tend to connect with nearby colleagues due to shared work (homophily), while meeting distant professionals at conferences forms weak ties.

   (d) Your work department (a focus of shared activity) brings people together (foci closure), while you tend to form connections with similar colleagues (homophily).

Answer: (c)

Explanation: Homophily describes how people connect with those close to them or who share similar environments, like your colleagues. Weak ties are the connections you build with distant or unfamiliar people, such as those you meet at conferences, expanding your network.

4. Alex creates a social network graph on NetworkX by forming a 2D grid where each person is connected to their immediate neighbors. After constructing the grid, Alex randomly reconnects some of these relationships with a probability of 0.02. What is the expected average path length between any two people in this network?

   (a) 1

   (b) 2

   (c) 6

   (d) 20

   Answer: (c)

   Explanation: In a 2D grid network, the average path length between nodes (people) is relatively large due to the local connections. With a rewiring probability of 0.02, some edges are randomly replaced, introducing shortcuts and reducing the average path length. For small-world networks with a low rewiring probability, the average path length is typically reduced but not drastically. Given typical results, the average path length is often around 6 in such scenarios.

5. In a network of friends, the distance between Jordan and Taylor is 25. If the network is built using the Watts-Strogatz model with k=2, what is the probability that Jordan and Taylor are connected through a weak tie?

   (a) 1

   (b) 0.01

   (c) 0.04

   (d) 0.0016

   Answer: (d)

   Explanation: In the Watts-Strogatz model: k = 2 indicates that each node initially connects to two neighbors on either side. The probability of two nodes being connected through a weak tie can be approximated by: $Probability = \frac{1}{d^k}$ where d is the distance between the nodes and k is the number of neighbors.

6. In a professional network, suppose Ravi wants to connect with Priya through the shortest path. Ravi has four colleagues: Aarti, Manoj, Sunil, and Meera. The distances from each colleague to Priya are as follows: Aarti is 8 steps away, Manoj is 3 steps away, Sunil is 7 steps away, and Meera is 5 steps away. If Ravi uses a decentralized approach to find the shortest path to Priya, which immediate colleague should he choose?

   (a) Aarti

   (b) Manoj

   (c) Sunil

   (d) Meera

   Answer: (b) Explanation: In a decentralized search, Ravi should choose the colleague who has the shortest distance to Priya. Here, Manoj is the closest to Priya, with a distance of 3 steps.

7. Consider a social network where initially, each person is connected to their immediate neighbors in a 1-D grid. To introduce some randomness, the network applies a random rewiring process with a probability of 0.03. This means that each connection between two neighbors has a 3% chance of being rewired to connect with a random person in the network. What impact does this random rewiring have on the network?

   (a) It increases the average path length by creating more local connections

   (b) It has no effect on the average path length as the network remains a regular grid

   (c) It decreases the average path length by introducing shortcuts and creating a small-world effect

   (d) It decreases the number of connections in the network, making it less connected

Answer: (c)

Explanation: Random rewiring in a generative model, like the Watts-Strogatz model, introduces shortcuts by randomly replacing some of the existing connections. This process tends to reduce the average path length between nodes, creating a small-world effect where nodes are more interconnected despite the network's overall sparseness.

8. In a 2-D Watts-Strogatz model, which of the following is the ideal value of clustering exponent for an efficient decentralized search?

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

   Answer: (d)

   Explanation: In a 2-D Watts-Strogatz model, for an efficient decentralised search, the ideal value of clustering exponent is 2 so that random links follow an inverse-square distribution.

9. Consider a large online marketplace where each seller is connected to local buyers and a few random buyers across the platform to facilitate quicker connections. If this marketplace represents a small-world network, what is the typical average distance between any two random sellers?

   (a) n
   (b) $\log n$
   (c) $n \log n$
   (d) $\log n^2$

   Answer: (b)

   Explanation: In a small-world network, the average distance between any two random sellers scales as log n. This reflects how the random connections in the network significantly reduce the path length, even in large networks.

10. Imagine you are part of a local sports club (Cluster 'A') with many teammates. You also discover another club (Cluster 'B') that has a lot of team members who know each other well. When you meet someone from Cluster 'B' and become friends with them, this new friendship illustrates:

    (a) Social influence
    (b) Selection
    (c) Triadic closure
    (d) Weak tie

    Answer: (d)

    Explanation: In this example, befriending someone from a different sports club connects two previously separate groups. This new connection is an example of a weak tie, as it links different parts of the social network.