SOCIAL NETWORKS - NPTEL July 2024

Week 9

1. Which of the following mechanisms is most likely responsible for the emergence of a power law degree distribution in complex networks?

   (a) Nodes are added with equal probability to all existing nodes.

   (b) Nodes connect randomly without preference to other nodes.

   (c) New nodes preferentially attach to existing nodes with higher degrees.

   (d) All nodes have an equal chance of forming connections.

   Answer: (c)

   Explanation: New nodes preferentially attaching to existing nodes with higher degrees is the process described by Barabási and Albert, leading to the power law degree distribution observed in many real-world networks.

2. Given a network G being generated by the 'rich get richer' phenomenon. Figure 1 shows the snapshot of the network at time t. A new node 'u' enters the network at time t + 1 and makes an edge with one of the existing nodes. What is the probability that node 'u' will make an edge with node 'B'?

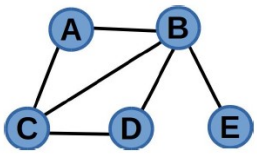

Figure 1: Network G

   (a) 1/2

   (b) 1/3

   (c) 1/4

   (d) 1/5

   Answer: (b)

   Explanation: The sum of degrees of all the nodes in the network is 12. The degree of the node C is 1. Hence, P(link formation = 4/12 = 1/3)

3. Consider the set $E = 2, 4, 6, \ldots, 28, 30$ A value a_1 is selected uniformly at random from this set. Then, a second value a_2 is chosen uniformly at random from the same set. This process is repeated until 10 values, $a_1, a_2, .., a_{10}$ are selected. The sum $S = a_1 + a_2 + .. + a_{10}$ is then calculated. Which of the following ranges represents all possible values that the sum can take?

   (a) $[20, 24, .., 300]$

   (b) $[20, 24, .., 200]$

   (c) $[10, 24, .., 240]$

   (d) $[2, 4, .., 300]$

   Answer: (a)

   Explanation:

4. In a random graph with 400 nodes and edges between any two nodes with a probability of 0.5, where can one expect the peak of the degree-distribution graph?

(a) 100

(b) 200

(c) 300

(d) 250

Answer: (b)

Explanation: In a normal distribution, the peak of the degree-distribution graph is seen around the middle of the domain. Thus here we can say the peak is expected to be around 400 x 0.5 = 200

5. Which of the following is an example of a real-world phenomenon that follows a power law distribution?

   (a) The heights of individuals in a population

   (b) The number of citations academic papers receive

   (c) The distribution of shoe sizes among adults

   (d) The daily temperature in a specific city

   Answer: (b) Explanation: The number of citations academic papers receive often follows a power law distribution, where a small number of papers receive a large number of citations, and most papers receive relatively few.

6. According to the power law, the frequency (shown on the y-axis) is inversely proportional to k, where k represents the values plotted on the x-axis. In this relationship, the exponent a is ideally between which values?

   (a) 0,1

   (b) -1, 1

   (c) 1,5

   (d) 2,3

   Answer: (d)

   Explanation: In many real-world cases, the exponent a in a power law distribution often falls between 2 and 3. This range is particularly common in networks like social networks, citation networks, and many others.

7. Which of the following statements is true about the Barabási-Albert (BA) model for scale-free networks?

   (a) Nodes are added randomly to the network

   (b) The BA model follows a preferential attachment mechanism

   (c) All nodes in the BA model have equal probabilities of forming connections

   (d) New nodes in the BA model are equally likely to connect to any existing node

   Answer: (b)

   Explanation: (a) Nodes are added randomly to the network—This is incorrect because, in the Barabási-Albert (BA) model, nodes are not added randomly. New nodes are added in a way that prefers connecting to existing nodes with higher degrees (more connections).
   (b) The BA model follows a preferential attachment mechanism—This is correct. The BA model is based on the principle of preferential attachment, meaning that new nodes are more likely to connect to nodes that already have a large number of connections, leading to the formation of hubs.
   (c) All nodes in the BA model have equal probabilities of forming connections—This is incorrect because, in the BA model, nodes with more connections (higher degrees) have a higher probability of attracting new connections.
   (d) New nodes in the BA model are equally likely to connect to any existing node—This is incorrect because the BA model's preferential attachment mechanism ensures that new nodes are more likely to connect to nodes with more connections, not randomly.

8. In the Erdos-Renyi $G(n, p)$ model for random graphs, which of the following statements accurately describes the model?

   (a) The model involves adding a fixed number of edges randomly to a complete graph with n nodes

(b) Each pair of nodes in a graph with n nodes has a probability p of being connected by an edge, independently of other pairs

(c) The model constructs a graph by preferentially attaching new nodes to existing nodes with higher degrees

(d) In this model, the probability p determines the number of nodes added at each step

Answer: (b)

Explanation: In the Erdos-Renyi $G(n, p)$ model, every possible edge between n nodes is included with a probability p and this connection is made independently of other edges.

9. Assume a network G is created having 100 nodes using Networkx. For each node, 'weight' should take a value uniformly at random from 100 to 200. Identify the code snippet to associate an attribute 'weight' with each of the nodes.

(a)
```
for each in G.nodes ( ) :
    G.node[each]['weight']=random.randint(100,200)
```

(b)
```
for each in G.nodes():
    G.node[each]['weight']=random.randint(99,201)
```

(c)
```
for each in G.nodes():
    G.node['weight']=random.randint(99,201)
```

(d)
```
for each in G.nodes():
    G.node['weight']=random.randint(100,200)
```

Answer: (a)

10. Consider the given network K, which of the following nodes does a new node 'X' entering the network choose to form an edge according to preferential attachment?

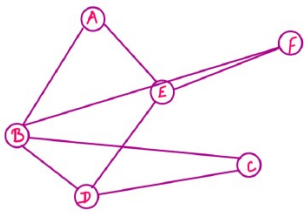

Figure 2: Network K

(a) A

(b) B

(c) C

(d) D

(e) E

(f) F

Answer: (b)

Solution: According to preferential attachment a new node chooses a node with maximum degree as compared to the other nodes.