Power Law

Social Networks - July 2020

MCQ Assignment - Week 9

1. In $G(n, \frac{1}{2})$ random network, the expected number of edges is:

   A. $n \cdot \frac{1}{2}$
   B. $\binom{n}{2} \cdot \frac{1}{2}$
   C. $n + \frac{1}{2}$
   D. $\sqrt{n}$

   ANSWER: B
   You have $nC2$ edges with probability of connecting $= p$. So the result.

2. Given a random graph on 50 nodes where each of the possible $\binom{50}{2}$ edges is present with a probability of $p = 0.5$. Let N_1 represent the number of nodes having the least degree (i.e. 0), N_2 represent the number of nodes having the highest degree (i.e. 49) and N_3 represent the number of nodes having the median values of degrees (i.e. 24 or 25). Choose the most appropriate statement.

   A. $N_1 < N_3$ and $N_2 < N_3$
   B. $N_1 > N_3$ and $N_2 > N_3$
   C. $N_1 > N_3$ and $N_2 < N_3$
   D. $N_1 < N_3$ and $N_2 > N_3$

   ANSWER: A
   The degree distribution of a random graph follows normal distribution. Here the number of very high degree and very low degree nodes is less as compared the number of nodes having medium degree. Hence the option A is correct.

3. Given set $E = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$. Let $S = a_1 + a_2 + ... + a_{10}$, where a_i's are picked uniformly at random from the set E. Let $p(i)$ be the probability that $S = i$. Which of the following is **false**?

   A. $p(50) < p(100)$
   B. $p(100) < p(50)$
   C. $p(50) > p(10)$
   D. $p(100) = p(10)$

   ANSWER: A
   There is a less probability that all the chosen values are 1 and hence the sum is 10. Similarly, there is a very less probability that all the chosen elements are 10 and the sum S is 100. Medium value of S are more likely to be seen as compared to the extreme values (very less or very high). Hence, the option A is correct.

4. Consider an undirected random graph with eight vertices. The probability that there is an edge between a pair of vertices is 1/2. What is the expected number of unordered cycles of length three?

A. 1/8
B. 1
C. 7
D. 8

ANSWER: C
A cycle of length 3 can be formed with 3 vertices. There can be total 8C3 ways to pick 3 vertices from 8. The probability that there is an edge between two vertices is 1/2. So expected number of unordered cycles of length $3 = (8C3) * (1/2)^3 = 7$

5. Which of the following is true with respect to Barabasi-Albert model?

A. Each node connects to other nodes with probability less than their degree
B. Each node connects to other nodes with probability greater than their degree
C. Each node connects to other nodes with probability proportional to their degree.
D. None of the above

ANSWER: C
In Barabasi-Albert model, each node connects to other nodes with probability proportional to their degree

6. Let G be a set of 5 graphs generated using Erdos-Renyi model while considering same parameters. Similarly, let H be a set of 5 graphs generated using Barabasi-Albert model with same parameters for all the 5 graphs. Which of the following holds true:

A. Average degree of all the graphs in G is same, average degree of all the graphs in H may vary
B. Average degree of all the graphs in H is same, average degree of all the graphs in G may vary
C. Average degree of all the graphs in G is same, average degree of all the graphs in H is same.
D. Average degree of all the graphs in both, G and H, varies in each iteration

ANSWER: B
No. of edges in all the graphs generated using Barabasi-Albert model with (r, s) as parameters will be same, while the no. of edges in all the graphs generated Erdos-Renyi model with (p, q) parameters may vary.Therefore, avg. degree of all the graphs generated using Barabasi-Albert model with (r, s) as parameters will be same, while the avg. degree of all the graphs generated Erdos-Renyi model with (p, q) parameters may vary.

7. In $G(1000, 0.5)$ random network, each edge will be placed with the probability:

A. 0.7
B. 0.9
C. 0.1
D. None of the above

ANSWER: D
In $G(n, p)$ network, each edge is placed with the probability p, so in the given graph each edge will be placed with probability 0.5.

8. How does the power law degree distribution come by in real world networks?:

   A. By preferential attachment
   B. By random linking
   C. By uniform edge connection
   D. No hypothesis is found.

ANSWER: A

Barabasi and Albert proposed a hypothesis that the real world networks are evolved using the preferential attachment and this gives birth to power law degree distribution.

9. Given a network being generated by '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 u will make an edge with C?

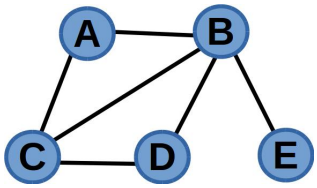

Figure 1: Network at time t

   A. 1/2
   B. 1/5
   C. 1/3
   D. 1/4

ANSWER: D

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