# *SOCIAL NETWORKS - NPTEL July 2024*

Week 10

1. In the percolation model of the SIR epidemic model, a node in the network becomes infected if:

   (a) There is a direct edge between the node and the initially infected node, regardless of its state

   (b) The infection rate is greater than 0.5 for all edges in the network

   (c) There exists a path of open edges from the initially infected node to the node in question

   (d) The node has at least one neighbor that is not infected

   Answer: (c)

   Explanation: According to the percolation model, a node becomes infected only if there is a path of "open" edges connecting it to the initially infected node.

2. Which of the following correctly describes the behavior of a disease in a population based on the basic reproductive number, $R_0$?

   (a) When $R_0 < 1$, every infected person infects less than one secondary person, and the disease persists with a high probability

   (b) When $R_0 > 1$, every infected person infects more than one secondary person, and the disease always dies away

   (c) When $R_0 < 1$, the disease dies out with probability 1, since each infected person causes less than one secondary infection

   (d) When $R_0 > 1$, the disease persists in the network with a probability of 1

   Answer: (c)

   Explanation: The basic reproductive number $R_0$ represents the average number of secondary infections caused by a single infected individual. When $R_0 < 1$, each infected person infects fewer than one other person on average, meaning the infection rate is insufficient to sustain an outbreak. Over time, the disease will die out, and thus the disease dies out with probability 1. When $R_0 > 1$, each infected person is causing more than one secondary infection, so the disease has the potential to spread and persist within the population. However, there remains a small probability that the disease may still die out (e.g., due to random fluctuations in transmission), but overall, the disease persists with positive probability. Thus, the correct statement is that when $R_0 < 1$, the disease will die out with probability 1

3. Which of the following best represents the SIS (Susceptible-Infected-Susceptible) disease model

   (a) Chickenpox, where people who recover gain lifelong immunity

   (b) Common cold, where individuals can recover but remain susceptible to reinfection

   (c) Measles, where recovery typically leads to permanent immunity

   (d) Rabies, where infection usually leads to death without the possibility of reinfection

   Answer: (b)

   Explanation: The SIS model describes diseases where individuals do not gain permanent immunity after recovery and can become susceptible to the infection again. The common cold is a classic example of such a disease, as people can catch the cold multiple times throughout their lives.

4. If there exist a graph G, in which there are 10 nodes in level 1 and every node has 10 children then, number of nodes in $5^{th}$ level will be

   (a) 50

   (b) $5^{10}$

(c) $10^5$

(d) $10^{10}$

Answer: (c)

Explanation: Each node in 1st layer has 10 children so in 2nd layer there will be 10 x 10 Each node in 2nd layer has 10 children so in 3rd layer there will be 10 x 10 x 10 .. Each node in 5th layer has 10 children so in 5th layer there will be $10^5$

5. Given the probability of spreading disease is 0.3, what is the probability that the same person is not infected for the second time?

   (a) 0.3

   (b) 0.7

   (c) 1

   (d) 0

   Answer: (b)

6. In an SIS model, if the probability of transmitting the disease is 0.4, what is the likelihood that an individual who has recovered will be reinfected?

   (a) 0

   (b) 0.4

   (c) 0.6

   (d) 1

   Answer: (b)

   Explanation: In SIS model, person who recovers remains susceptible to the disease with the same probability.

7. Consider the example of digital music streaming services, where we plot a graph between a song's popularity and its number of streams, following a power law distribution. The most popular songs receive a significantly high number of streams, while lesser-known songs receive far fewer streams. Assuming that top-charting songs account for 30% of total streams, which of the following is true?

   (a) Streaming only top-charting songs is profitable

   (b) Streaming niche songs will lead to a loss

   (c) Streaming both top-charting and niche songs is profitable

   (d) None of the above

   Answer: (c)

   Explanation: In a power law distribution scenario, focusing only on top-charting songs can yield profits due to their popularity. However, combining both top-charting and niche songs is more profitable, as it maximizes revenue by catering to both mainstream and niche markets. Streaming niche songs alone does not guarantee a loss, as they can still contribute significantly to overall profitability through the long-tail effect.

8. If the basic reproductive number ($R_0$) of contagion is greater than 1, meaning each infected individual, on average, infects more than one other person, which of the following strategies would be most effective in reducing the spread and curbing the contagion?

   (a) Implementing widespread vaccination to increase immunity in the population

   (b) Allowing large public gatherings to promote herd immunity through natural infection

   (c) Reducing healthcare services to manage the number of new infections

   (d) Ignoring the infection and focusing on treatment after symptoms appear

   Answer: (a)

   Explanation: When $R_0 > 1$, the disease spreads quickly. To control this, vaccination is an effective way to reduce the number of susceptible individuals, thereby lowering the reproductive number and curbing the spread. Options B, C, and D would lead to an increase in the spread and are not effective in controlling the contagion..

9. According to Zipf's law, the frequency of the nth most common word in a language is proportional to

   (a) $1/n$
   (b) $log(n)$
   (c) $1/log(n)$
   (d) $nlog(n)$

   Answer: (a)

   Explanation: Zipf's Law states that in natural languages, the frequency of a word is inversely proportional to its rank. This means that the frequency of the nth most common word is approximately proportional to $1/n$, where $n$ is the word's rank in terms of frequency.

10. In the given network K, each infected node has edges to two nodes in the next layer; since it infects each with probability 2/3, the expected number of new cases caused by a node is

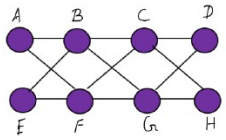


Figure 1: Network K

   (a) $\frac{2}{3}$
   (b) $\frac{4}{3}$
   (c) $\frac{1}{3}$
   (d) $\frac{1}{4}$

   Answer: (b)