Epidemics

Social Networks - July 2020

MCQ Assignment - Week 10

1. In the percolation model (static view of the SIR model), assume that $t_I = 1$. For every edge $E_{u,v}$ in the network, we toss a biased coin which shows head with a probability of p, which is the infection rate of the disease, i.e., the probability that v will become infected in the next iteration, given that u is infected. If head turns up, we assume an edge to be open, else blocked. According to this percolation model, a node w in the network will become infected

   A. if and only if there is a path consisting of blocked edges from any of the initially infected nodes to w.
   B. if and only if there is a path consisting of open edges from any of the initially infected nodes to w.
   C. if and only if there is a path from any of the initially infected nodes to w. The path may consist of any edges- open/ blocked.
   D. if and only if there does not exist any path from any of the initially infected nodes to w.

   ANSWER: B
   In the percolation model, a node gets infected if and only if there is a path comprising of open edges from the initial infected node to this node.

2. Choose the correct statement from the following.

   A. Both SIR and SIS model can run for an infinite number of steps on a network.
   B. Both SIR and SIS model should come to an end after running for a finite number of steps on a network.
   C. SIS model should come to an end after running for a finite number of steps on a network, while SIR model can keep running indefinitely on a network.
   D. SIR model should come to an end after running for a finite number of steps on a network, while SIS model can keep running indefinitely on a network.

   ANSWER: D.
   SIR model has a finite supply of nodes. Since, nodes can never be reinfected, the process should come to an end after a finite number of steps. An SIS epidemic, on the other hand, can run for an extremely long time as it cycles through the nodes potentially multiple times.

3. Suppose that a person carrying a new disease enters a population, and transmits it to each person he meets independently with a probability of p. Further, suppose that he meets k people while he is contagious. What is the expected number of secondary infections produced?

   A. p
   B. k
   C. $p \times k$
   D. p^k

   C. Pr(Infecting one person)=p. There are k neighbors.
   Expected number of secondary infections= pr(first neighbor infected)+ pr(second neighbor infected)+...+pr(k_{th} neighbor infected)
   $= p + p + ...k\ times + ...p$
   $=pk$

4. Consider the network as shown in Figure 1. Initially, the two nodes shown in red color are infected. Assume that the probability of infection across every edge, i.e. p is $2/3$ and the infectious period T_I is 1. What is the probability that the infection does not pass on from layer-1 to layer-2?

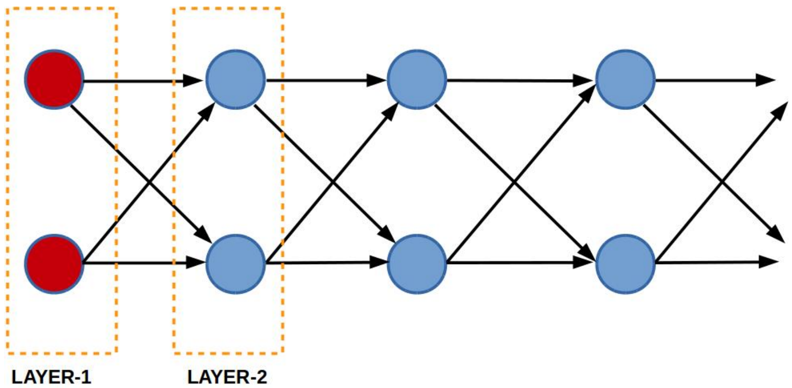

Figure 1: The network for SIR model

A. $2/3$
B. $1/3$
C. $(2/3)^4$
D. $(1/3)^4$

D. The disease does not pass to layer-2 if all the 4 links from layer-1 to layer-2 fail in transmitting the disease.
$Pr(one\ link\ fails) = 1 - (2/3) = 1/3$
$Pr(All\ links\ fail) = (1/3)^4$

5. In a tree network (shown in Figure 2), given that the probability of infection across every edge is p and every node has k children, the basic reproductive number R_0 is denoted by the formula

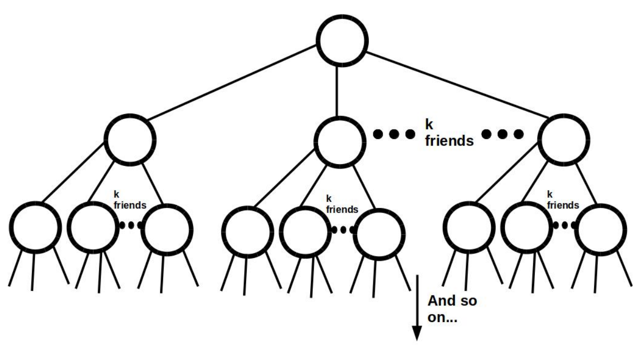

Figure 2: The tree network

A. $R_0 = p$
B. $R_0 = k$
C. $R_0 = p \times k$
D. $R_0 = p^k$

C. In a tree network, given that the probability of infection across every edge is p and every node has k children, the basic reproductive number R_0 is denoted by the formula pk. It is the expected number of secondary infections produced from an infected person.

6. Consider the following two cases:
Case 1- Basic reproductive number is less than 1.
Case 2- Basic reproductive number is greater than 1.
Choose the correct statement from the following:

A. In case 1, the disease dies away with a probability 1; while in case 2, the disease persists in the population with a probability greater than 0.
B. In case 1, the disease dies away with a probability greater than 0; while in case 2, the disease persists in the population with a probability equal to 1.
C. In case 1, the disease persists in the population with a probability greater than 0; while in case 2, the disease dies away with a probability 1.
D. In case 1, the disease persists in the population with a probability 1; while in case 2, the disease dies away with a probability greater than 0.

A. When basic reproductive number, $R_0 < 1$, every infected person infects less than one instance of secondary infection, hence the disease dies away with a probability 1. When $R_0 > 1$, there is an increased chance that the disease will persist in the network. But still there is a very small probability of the disease dying away. Hence, the disease persists in the network with a positive probability.

7. Suppose the basic reproductive number is estimated to be $R_0 = 1.5$ with standard error $s.e.(R_0) = 0.1$. If a vaccine giving 100% immunity is available next time and a fraction $v = 0.2$ of randomly selected individuals were vaccinated, an estimate of the new reproductive number would be

A. 1.0
B. 1.1
C. 1.2
D. 1.3

ANSWER: C
An estimate of the new reproductive number would be $R(U) = R(1 - v) = 1.5 * 0.8 = 1.2$.

8. In the modelling of mitochondrial eve using Wright-Fischer number would be

A. Population size can be anything in any generation.
B. Population size doubles every generation.
C. Population size remains the same in every generation.
D. Population size halves every generation.

ANSWER: C
Population size remains the same in every generation.