Question Paper

Exam Date & Time: 29-Dec-2022 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Department of Information & Communication Technology

VII Semester Makeup Examination

Social Network Analysis [ICT 4054]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

Missing data, if any, may be assumed suitably.

1) A) Consider the 3-node social network shown in Fig.Q.1A, in which all pairs of nodes know each other, and each pair is either friendly or hostile as indicated by the + or - label on each edge. A fourth node D wants to join this network, and establish either positive or negative relations with each existing node A, B, and C. Can node D do this in such a way that it doesn't become involved in any unbalanced triangles? (5)

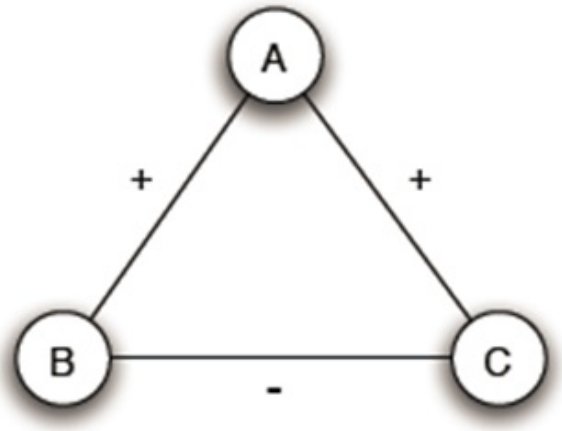
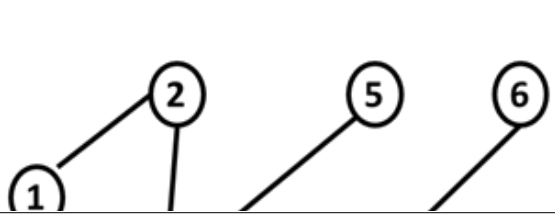
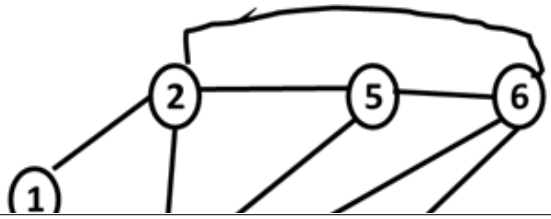
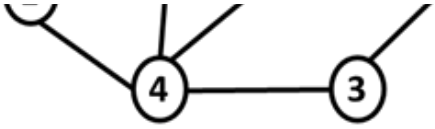


Fig.Q.1A

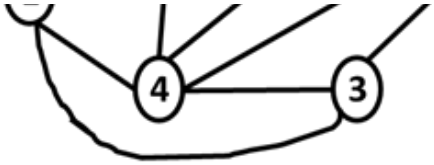
B) The study of Kossinets and Watts states that, the probability of link formation increases with the number of common friends. Illustrate their methodology by considering the snapshots of the network given in Fig.Q.1B. Show the detailed steps / calculations. (3)







NETWORK N1



NETWORK N2

Fig.Q.1B

C) Consider a 2-mode network shown in the Table.Q.1C which gives the information of the membership of people in different groups. Convert this into an *interpersonal network* in which ties between people are the number of groups in common and an *intergroup network* in which ties between groups are the number of people held in common. Draw neat diagrams of the resultant 1-mode networks. (2)

Table.Q.1C

	1	2	3	4	5
A	0	0	0	0	1
B	1	0	0	0	0
C	1	1	0	0	0
D	0	1	1	1	1
E	0	0	1	0	0
F	0	0	1	1	0

2) In a study, physicians were asked what the odds of lung cancer would be in a person who was initially thought to have a 1% risk of cancer but who ended up with a positive CT scan result (a CT scan classifies about 80% of cancerous tumors and 90% of benign tumors.) 95 out of a hundred physicians estimated the probability of lung cancer to be about 75%. Do you agree? Justify. (5)

A)

B) In the social network depicted in Fig.Q.2B with each edge is labelled as either a strong or weak tie. Which nodes satisfy the Strong Triadic Closure Property and which do not? Justify. (3)

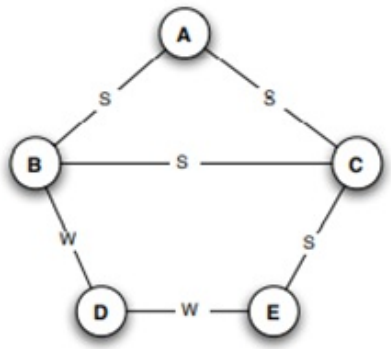


Fig.Q.2B

C) You have developed a new product that performs the same service as an established product, but your product is much better than the established product. Specifically, if the number of users of the two products were the same, then each potential purchaser's reservation price for your product would be twice their reservation price for the existing product. The difficulty that you face is that these are products with network effects, and no one wants to use more than one product. Currently, every potential purchaser is using the established product. Your cost of production and your competitor's cost of production are exactly the same, and let's suppose that they are equal to the price at which your competitor's product is sold. If all of the potential purchasers switched to your product, the maximum price that you could charge (and still have them all buy it) would be twice the current price. So clearly, you could make a nice profit if you could attract these potential purchasers. How would you attempt to convince users to switch to your product? You do not need to construct a formal model of the situation described in this question. It is sufficient to describe the strategies that you would try. (2)

3) Illustrate the usage of Baye's rule in herding experiment where students need to guess whether an urn containing 3 marbles is majority-red or majority-blue. (5)

A)

B) Consider an example of the fraction of news articles that are read by k people each day: if f (k) represents this fraction as a function of k, then f(k) approximately follows a power-law distribution of the form f(k) that is approximately equal to k^{-a} for some exponent a. What mechanisms for providing news to the public will tend to (3)

approximately equal to k-c for some exponent c. What mechanisms for providing news to the public will tend to accentuate this power-law effect, causing the most widely-read articles to be even more widely-read? What mechanisms will tend to diminish the power-law effect, more evenly balancing readership across more and less widely-read articles? Explain.

C) Early in the Web's history, people had a very basic version of the page popularity question, phrased as "As a function of k, what fraction of pages on the web have k in-links? ". Determine a simple hypothesis to answer this question for a random variable having a normal distribution with k=2. (2)

4) Suppose that initially everyone is using behaviour B in the social network shown in Fig.Q.4A, and then a new behaviour A is introduced. This behaviour has a threshold of q = 1/2: any node will switch to A if at least 1/2 of its neighbours are using it. (5)

A) (i) Find a set of three nodes in the network with the property that if they act as the three initial adopters of A, then it will spread to all nodes. (In other words, three nodes who are capable of causing a cascade of adoptions of A.)

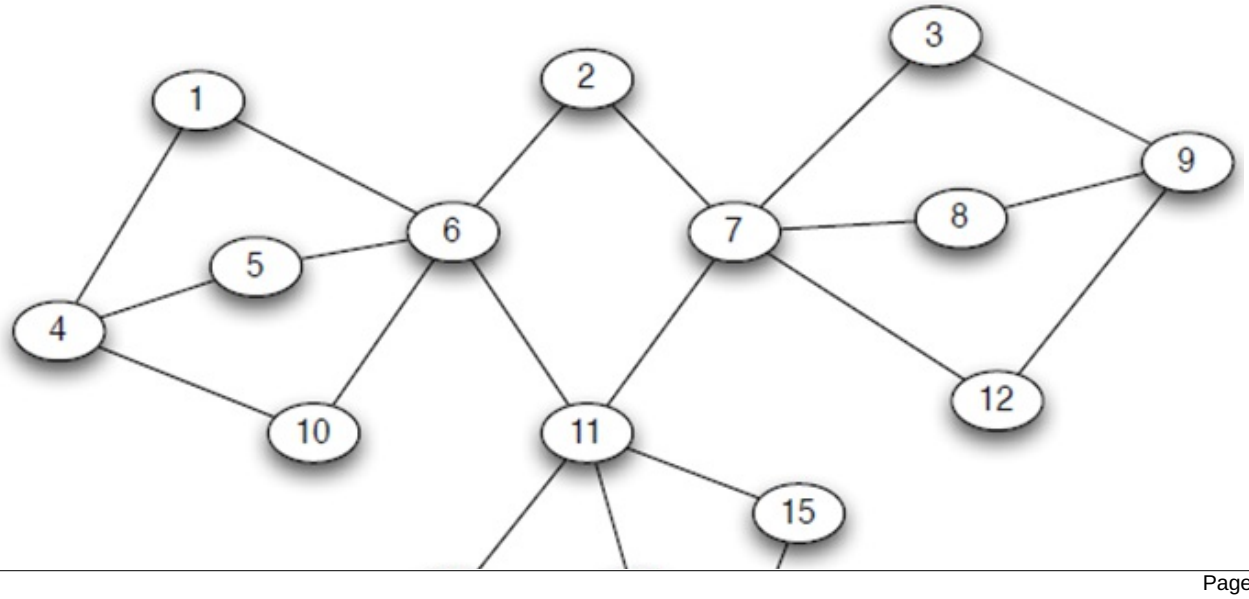
(ii) Is the set of three nodes you found in (a) the only set of three initial adopters

capable of causing a cascade of A, or can you find a different set of three initial

adopters who could also cause a cascade of A?

(iii) Find three clusters in the network, each of density greater than ½ with the

property that no node belongs to more than one of these clusters.



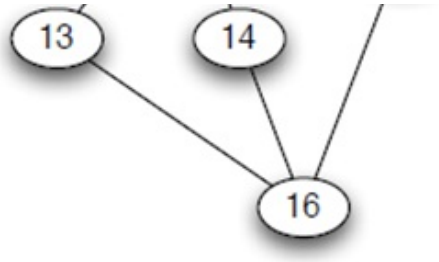


Fig.Q.4A

B) Consider a game played by two players, player-1 and player-2 in which the players can select one of the two options given to them in each move as given in Fig.Q.4B. Player-1 can choose either Red or Blue, and the player-2 can choose either Stripes or Dots. The payoffs to the two players from each possible outcome are shown below. The format for each outcome is (Player-1's payoff, Player-2's payoff). Find the Nash equilibrium for the player-1. (3)

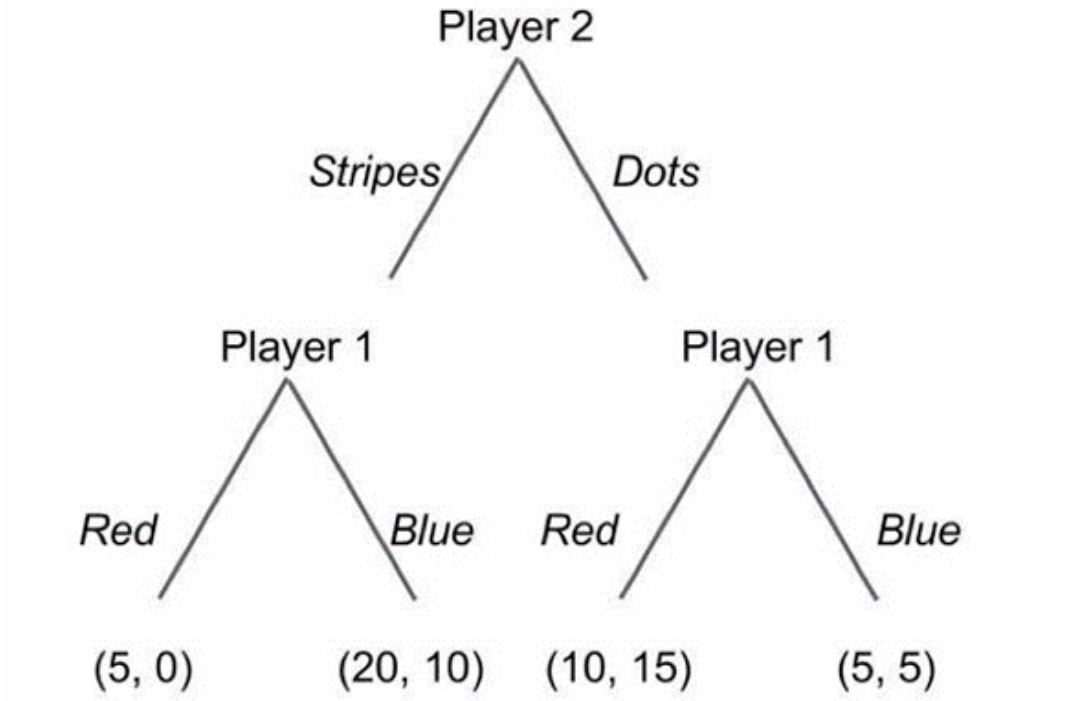


Fig.Q.4B

C) Have social networking tools made the world a smaller place? Whether these tools have any impact on how we function as individuals and how we are interacting with each other? Illustrate with examples. (2)

5) Consider a variation of "six-degrees-of-separation" as follows: For each person in the world, we ask them to rank the 30 people they know best, in descending order of how well they know them. Construct two different social networks (5)

A) (a)The "close-friend" network: from each person we create a directed edge only to their ten closest friends on the list.
(b) The "distant-friend" network: from each person we create a directed edge only to the ten people listed in positions 21 through 30 on their list.

Let C be the average number of people that a person can reach in six steps in the close-friend network, and let D be the average number of people that a person can reach in six steps in the distant-friend network.

Based on the empirical studies which compared these two types of networks it was found that one of C or D is consistently larger than the other. Which of the two quantities (C or D) is expected to be larger? Justify

B) Illustrate with an example how the normal and power-law differ for any social network. (3)

C) Gephi allows its users to alter graphs on-the-fly by offering capabilities such as adding edge(s) to the graph in just one click. Illustrate the procedure to add a new edge to the graph. (2)

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