CSL7390: Social Network Analysis (January-May, 2024)

Minor Exam 1, February 10th, 2024

Department of Computer Science and Engineering

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Duration: 1 hour **Full Marks: 32**

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Question 1. [1+2+2+1+3]=8

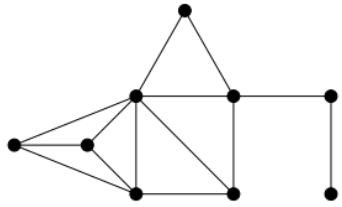
i. In a social network, each vertex must represent a person while edges represent their associations. True or false?

ii. What is not a social network? Please explain with an example.

iii. Which notation is more suitable for representing social networks and why: G=(V, E) vs $G^{(t)}=(V^{(t)}, E^{(t)})$?

iv. An adjacency matrix is a vertex-vertex matrix and an incidence matrix is a _____ matrix. Please fill in the blank.

v. Please find the largest k-core(s) in the following graph.



Question 2. [4+2+3+3]=12

i. Derive the system of equations that extends the PageRank centrality

$\boldsymbol{x} = \boldsymbol{D}(\boldsymbol{D} - \alpha \boldsymbol{A})^{-1}\boldsymbol{\beta}$ [here α is the only scalar]

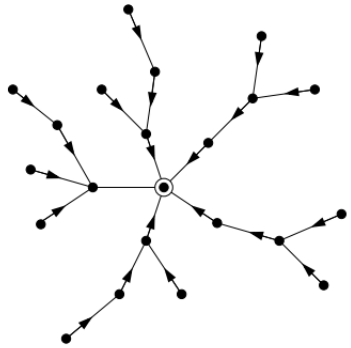
from the equation $x_i = \alpha \sum_j A_{ji} \left(\frac{x_j}{\max(k_j^{(out)}, 1)} \right) + \beta_i$.

ii. The Google search engine has been preferred by most of the users not only for its ability to find the most relevant webpages but also for its ability to rank the relevant webpages in a way that is most suitable for a user. Justify or discredit this statement.

iii. In an undirected graph, when can a vertex rank very high in the betweenness centrality but not that high in the closeness centrality? On the other hand, when can a vertex rank high in both of those centralities?

iv. The following directed graph represents a spy master (the central node) and a hierarchy of spies providing intelligence directly or indirectly to the spy master. A spy network can be a union of many such graphs with multiple spy masters and their spy subnetworks. A spy master can also report to a

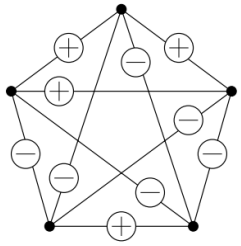
higher spy master. Which centrality measure would you use to identify the top spy masters?



Question 3. [1+3+4+1+3]=12

i. There are a total of 35 students in our course. Suppose, only 5 of your classmates are your direct friends and 15 are mutual friends. Is there any additional information you require to calculate your clustering coefficient in this particular class?

ii. Do there exist any unbalanced loops in the following social network?



iii. A signed undirected graph can be coloured with just two colours such that (a) each positive edge is incident on two same-coloured vertices and (b) each negative edge is incident on two differently coloured vertices. Prove that the statement is true if and only if the graph is structurally balanced.

iv. Suppose, A has strong ties with B and C. Then B and C must have at least a weak tie. True or false?

v. On the IITJ campus, social groups can only be formed through strictly assortative or strictly disassortative mixing. Prove or disprove the statement.