

Group - E

8. (a) Describe Louvain method for detecting communities in social networks. State all the stages and describe them separately. Clearly mention the equation which helps calculating change in modularity. Comment on the time complexity of the method.
- (b) What is label propagation algorithm (LPA)? What is the main advantage of using LPA?

(5 + 2 + 1) + 4 = 12

9. (a) Explain Girvan Newman disjoint community detection algorithm with a diagram. What are the advantages and disadvantages of it?
- (b) What are the advantages and disadvantages of Clique percolation method?

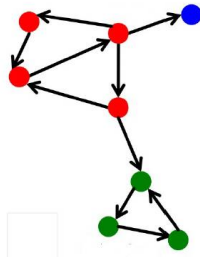
8 + 2 + 2 = 12**SOCIAL NETWORK ANALYSIS
(CSEN 4245)****Time Allotted : 3 hrs****Full Marks : 70*****Figures out of the right margin indicate full marks.******Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.******Candidates are required to give answer in their own words as far as
practicable.*****Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Betweenness can be calculated in
 (a) $O(n)$ (b) $O(n^2)$
 (c) $O(n \log n)$ (d) $O(n^3)$.
- (ii) Hub and authority values can be calculated by
 (a) HITS (b) PageRank
 (c) Bonacich's power centrality (d) Betweenness.
- (iii) Propagation probability is a model parameter in the following model
 (a) Linear Threshold model (b) SIRS model
 (c) Independent Cascade model (d) SIS model.
- (iv) Which of the following is not a compartmental model for epidemics
 (a) SIR (b) SIS
 (c) SISR (d) SIRS.
- (v) For $\beta=0$, Bonacich centrality leads to
 (a) PageRank centrality (b) Degree centrality
 (c) Betweenness centrality (d) Closeness centrality.
- (vi) Which of these community detection methods is the fastest?
 (a) Girvan Newman (b) Louvain
 (c) Clauset-Newman-Moore (d) Clique Percolation.
- (vii) The problem of finding the cover that maximizes the modularity, is a/an _____ problem
 (a) polynomial time solvable (b) NP-Complete
 (c) NP-Hard but not NP-Complete (d) none of these.

- (viii) "The edges connecting the communities will have high Edge Betweenness"- This is the central idea of
 (a) Independent Cascade model
 (b) Linear Threshold model
 (c) Greedy approximation algorithm by Kempe et. al
 (d) GN algorithm.
- (ix) Which one of these may not be a good metric to judge quality of community in social networks?
 (a) Modularity (b) Clustering Co-efficient
 (c) Conductance (d) PageRank.
- (x) Diameter of a network is the
 (a) shortest of all shortest paths
 (b) longest of all longest paths
 (c) longest of all shortest paths
 (d) shortest of all longest paths.

Group - B

2. (a) How can we calculate PageRank by power iteration method? What is an important characteristic of the transition matrix used?
 (b) If we want to calculate the PageRank of the following graph, what would be the problem?

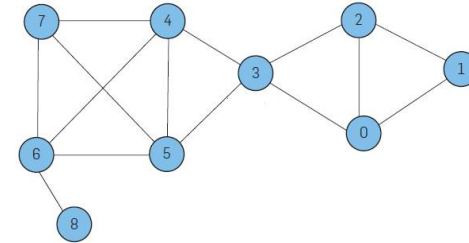


- (c) How to avoid the problem(s) in 2(b) and formulate an improved equation for finding PageRank?

$$(4 + 1) + 3 + 4 = 12$$

3. (a) What do you mean by a scale-free network? Why social networks are considered to be scale-free networks?
 (b) Define betweenness and closeness centralities and explain their significance in social networks.

- (c) Calculate betweenness centrality for all nodes in the following graph.



$$4 + 4 + 4 = 12$$

Group - C

4. (a) Establish a relationship between Beta function and Gamma function.
 (b) Using the results from 4(a), show that Preferential Attachment Model leads to power-law degree distribution.

$$4 + 8 = 12$$

5. (a) Find out the clustering co-efficient for a uniform circle graph (with n vertices), where, every node is connected to its c nearest neighbours (c/2 on each side). If s random shortcuts are added without replacing edges by following rules of Small-World networks (with mean c_p), then find out the modified equation for finding clustering co-efficient.
 (b) Prove that, in ER Model degree distribution of vertices obeys Poisson distribution for a large n (number of vertices).

$$3 + 3 + 6 = 12$$

Group - D

6. (a) Using Fisher's equation find out the speed of an epidemic in an SI model. Start by writing the differential equations for SI model using t and x.
 (b) What is conductance? How is it related to the finding of communities in social networks?
7. (a) Find out the relationship between I(t) and I(0) in SI model. Draw a plot that characterizes I(t) and S(t) in SI model.
 (b) Express I(t) in terms of I(0), R(t) and R(0) in SIR Model.

$$(4 + 2) + 6 = 12$$