INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR
Date 22.02.2007 FN Time: 2 Hrs. Full Marks : 35 No. of Students: 19
Spring Semester: 2007 Department: Computer Science and Engineering
Sub. No: CS 60078 Sub. Name: Complex Network Theory

You can score 36 if you try hard !!!

Question 1

The following question is with respect to the society of actors in Bollywood. You are presented with the a set of data below

Movie (**M**)	Actors that have participated in **M**
MHN	SK, SAK, PZ
BLK	AB, RM
SN	SAK, PZ
KKKG	AB, SK, K, KK
BAZG	SK, K
DDLJ	SK, K
DN	SK, KK
EKLV	AB, SAK

i) Represent the above data of the movies and the actors in the form of a network $\mathbf{N_B}$. What is the name for this special category of networks?

[2.5+0.5 = 3]

ii) Which actor has participated in the largest number of movies? How many? How does this map to a specific property of $\mathbf{N_B}$. What is the probability that an actor chosen uniformly at random from the above set has done a) exactly two movies b) at least two movies?

[0.5+0.5+0.5+1.5+1.5 = 4.5]

iii) Suppose that a movie analyst wants to now build another network $\mathbf{N_W}$ which represents the actors and the relationship in terms of their co-acting in movie(s). What are the nodes and edges of $\mathbf{N_W}$? Illustrate the steps clearly to obtain $\mathbf{N_W}$ given $\mathbf{N_B}$?

[0.5+1.5 = 2]

iv) Given that $\mathbf{N_W}$ is a weighted network find out an exact expression for the average weighted-degree (sum of the edge-weights incident on a node) of its nodes assuming,

a) all movies cast an equal number (= $\boldsymbol{\mu}$) of actors and there are $\boldsymbol{n}$ movies and $\boldsymbol{m}$ actors in all

b) each movie $\mathbf{M_i}$ casts $\boldsymbol{\mu_i}$ number of actors and there are $\boldsymbol{n}$ movies and $\boldsymbol{m}$ actors in all.

For each of the above cases (a) and (b) also compute the average number of movies that an actor participates. What do these values boil down to in $\mathbf{N_B}$?

[1.5+1.5+2.5=5.5]

Question 2

a) Find out the betweenness centrality of a clique.

b) Find out the clustering coefficient of a clique.

[1 + 1 = 2]

Question 3

The questions enlisted below are related to the Wasserman-Faust network shown in Fig. 1.

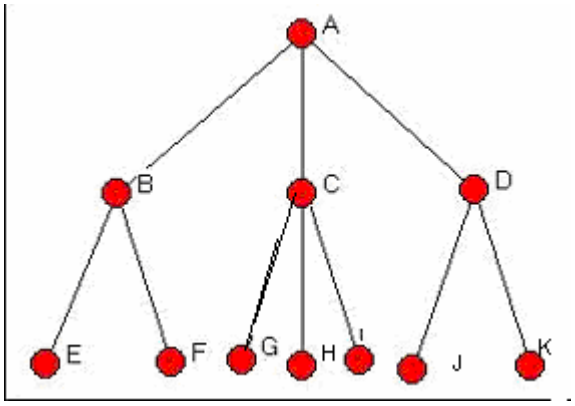


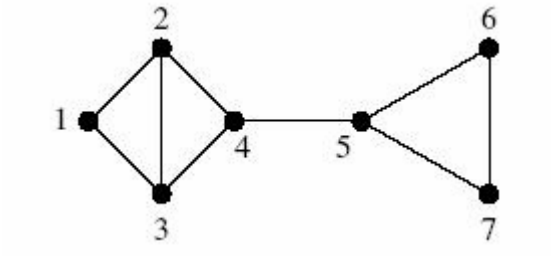
Fig. 1. Wasserman-Faust network

a) How many structurally equivalent classes can you find in this network?
b) What are these classes? List them through arguments.
c) Compute the similarity between the nodes by means of
   i) Pearson's correlation coefficient
   ii) Euclidian distance

   and present the result in a tabular form.
d) Which of the nodes are most similar in each of the above cases (i and ii)?
e) Suppose that the graph in Fig.1. described a franchise group of hamburger restaurants. Actor A is the central headquarters, actors B, C, and D are the managers of three different stores. Actors E and F are workers at one store; G, H, I are the workers at a second store; J and K are workers at the third store.
   i) Is there any kind of similarity pattern that you observe between the actors B and D? What is it better known as?
   ii) You can group the nodes into classes based on this similarity. Through arguments list these classes.
   iii) Identify some other example(s) where this kind of a similarity features quite often.

[1 + 2+ 5 + 1 + (1 + 2 + 1)]

Question 4



Explain the execution of the ***Radicchi et al.*** algorithm with the help of this network. Draw each step separately and form a dendogram. **[6]**