NETWORKS: CONCEPTS AND ALGORITHMS
Problem Set 3

Remarks: This one is **individual** work. Each of you have to hand in an individual problem set. Deadline: Wednesday, March 17. Include all the networks you use in some standard format (some format that can be read with the Social Network Visualizer tool: see, for example, Formats for an explanation of some common network formats.) The idea is that if you use the Social Network Visualizer the following exercises should be very short. There are some concepts we have not covered in class and it is expected you are going to find about them.

Exerc1se 1 **Erdos-Renyi.**

a) Using the model $G(n, p)$, create an undirected Erdos-Renyi network with 100 nodes and probability of each link equal to 0.02. For each of these networks:
   i) use the Kamada-Kawai model to represent the network,
   ii) find its degree distribution; what is the degree of the more connected node? And what is the degree of the less connected one?
   iii) is there one or more than one connected components?
   iv) what is the average distance? And the diameter? Interpret the numbers you obtain.
   v) what is the number of type 300 triads (according to M-A-N labeling, as described by Holland, Leinhardt and Davis) in the triad census report?
   vi) find the local/individual clustering coefficient distribution. Compute the average clustering coefficient.

b) Repeat the exercise but with the probability of each link equal to 0.08.

Exerc2se 2 **Scale-Free (Barabasi-Albert's model)**

Now create a directed network with 100 nodes using a linear preferential attachment model: in each period one new node enters in the network and creates one link towards another one; initially there is just one single isolated node. There is another parameter, the zero appeal. Explain first of all what is the definition of this parameter.

i) create first a network in which the zero appeal is equal to 0. What happens in that case? Why?
ii) create now another network in which the zero appeal is equal to 1.
iii) plot the network using the Kamada-Kawai model.
iv) study the in-degree distribution.
v) transform the network you have obtained into an undirected one. What is the number of components in that network? What is the average distance? What is the diameter?
vi) explore what happens if we increase the zero appeal parameter.