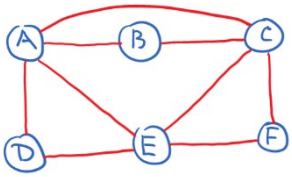
Network Science

HW-4 (12 points + 2 bonus points)

Exercise 1 (2 points)

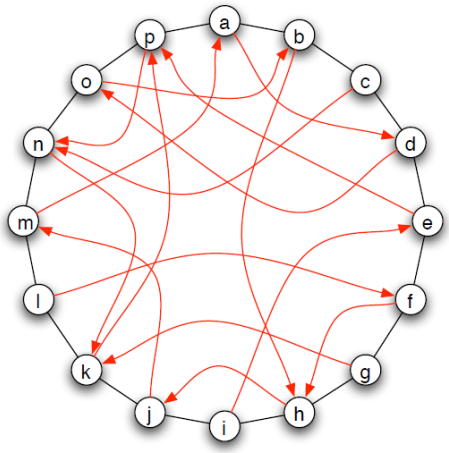
Calculate the local clustering coefficient of each node in the network below:



Exercise 2 (2 points)

Consider the graph on the right that has two types of edges: local edges and shortcuts. Suppose that node n wants to pass a message to node f.

1. What is the myopic-search path from n to f?
2. What is the shortest path from n to f?



Exercise 3 (2 points)

In the basic "six degrees of separation" question, one asks whether most pairs of people in the world are connected by a path of at most six edges in the social network, where an edge joins any two people who know each other on a first-name basis.

Now let's consider a variation on this question. 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. (Let's suppose for purposes of this question that each person is able to think of 30 people to list.) We then construct two different social networks:

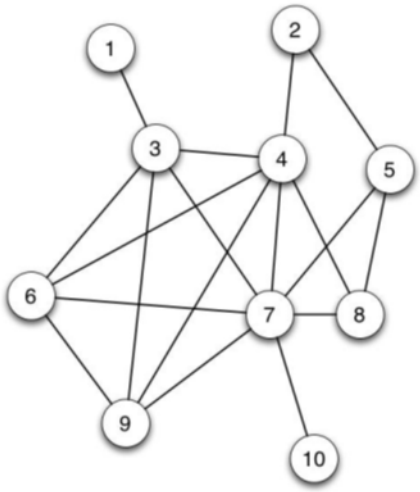
1. The "close-friend" network: from each person we create a directed edge only to their ten closest friends on the list.
2. The "distant-friend" network: from each person we create a directed edge only to the ten people listed in positions 21 through 30 on their list.

Let's think about how the small-world phenomenon might differ in these two networks. In particular, 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 (taking the average over all people in the world).

When researchers have done empirical studies to compare these two types of networks (the exact details often differ from one study to another), they tend to find that one of C or D is consistently larger than the other. Which of the two quantities, C or D, do you expect to be larger? Give a brief explanation for your answer.

Exercise 4 (2 points)

What is the degree distribution $\{p_k\}$ for the graph on the right?

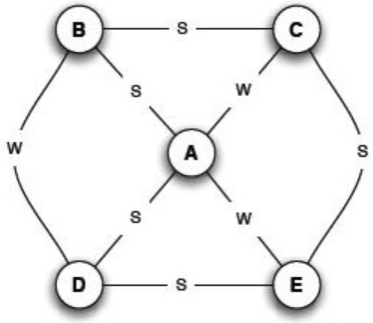


Exercise 5 (2 points)

A team of anthropologists is studying a set of three small villages that neighbor one another. Each village has 30 people. Everyone in each village knows all the people in their own village, as well as the people in the other villages. The anthropologists have found out that each person is a friend with everyone in their own village, and an enemy with everyone in the two other villages. This gives a network on 90 people (i.e., 30 in each village), with positive and negative signs on its edges. Is this network on 90 people balanced? Give a brief explanation for your answer.

Exercise 6 (2 points)

In the social network depicted below, which nodes satisfy the triadic closure principle and which do not?



Exercise 7 (2 points)

Given a random network with 50 nodes and average node degree $\langle k \rangle = 10$, which of the following is likely to be closest to the average path length of the network?

A. 1.5
B. 2.0
C. 2.25
D. 2.5