Homework 8: Chapters 15-16

DUE: Monday, Nov 29, start of class.

1. Social Network (a part of yours)
    a. Draw a part of your own social network. That is, make a list of a small number (say, 20) of your close friends and relatives. Draw a network similar to Figure 15.2 in the textbook in which you and the people in this list are nodes, and add links between all pairs of individuals who are close friends or relatives.
    b. Plot the degree distribution of this social network (similar to Figure 15.3).
    c. Choose 3 nodes and compute their local clustering coefficients. The clustering coefficient of a node *n* is defined as the number of links among pairs of *n*'s neighbors divided by the total number of possible pairings of *n*'s neighbors. From this sampling, do you think your social network is "small world" with high clustering, or has an approximately "scale-free" degree distribution, or both?

2. Draw a circle network of 8 nodes, similar to the one in Figure 15.4. (Show your work on all parts of this question.)
    a. Calculate the average path-length between pairs of nodes.
    b. Now choose two nodes at random and for each, rewire one of its two links to a randomly chosen node. Calculate the resulting average path length.
    c. What is the ratio of the average path lengths from parts (a) and (b)?

3. According to the short article, "Baby names a game of chance" (link on course website: http://sites.bio.indiana.edu/~hahnlab/MediaFiles/BabyMedia/BabyNature.html) the frequency of different baby names follows a power-law distribution.
    a. Summarize in a few sentences the authors' explanation of why there are a small number of very high-frequency names and a large number of low-frequency names.
    b. Can you name any other cultural phenomenon that you think is likely to follow a power-law distribution for the same reason? Explain your reasoning.

4. In class we discussed Zipf's law, which says that in English text, the frequency of a word is proportional to the inverse of its rank (the most frequent word is rank 1, the second most frequent is rank 2, and so on). Suppose in a particular novel the highest frequency words are (in order) "the", "of", and "and". Suppose that the word "the" appears 6,000 times. How often would you expect the words "of" and "and" to appear?

5. Summarize (in your own words) the "preferential attachment" mechanism proposed by Barabási and Albert for the development of scale-free networks.

6. Explain (in your own words) why scale-free networks are robust to random node failure but vulnerable to the failure of hubs.