Complex Systems 535/Physics 508: Homework 3

Here are the results of the in-class social network questionnaire. I included only those people who filled in a form and were named on the form. (Apologies to those I omitted.)

number	name	numbers of the people they know
1	Acton	6, 10, 16, 17
2	Allen	3, 14, 15
3	Anderson	2, 14, 15
4	Belding	7, 9
5	Gastner	4, 6, 7, 9, 10, 12, 13
6	Hansis	5, 10
7	Hassmiller	4, 9, 10, 12, 18
8	Helfstein	11
9	Koelle	4, 7, 15
10	Leicht	1, 5, 6, 7, 12, 16, 17
11	Menning	8
12	Park	5, 10, 18
13	Radev	5, 18
14	Shrestha	2, 3, 15
15	Stein	2, 3, 4, 9, 14
16	Strycker	1, 6, 10, 17
17	Waddell	1, 6, 10, 16
18	Wu	7, 12, 13

If it's more convenient, you can also download the same info as a computer file from:

`http://www-personal.umich.edu/~mejn/courses/2004/cscs535/classnet.dat`

1. Construct the adjacency matrix for the network. Call this **A**. Now construct the symmetrized adjacency matrix **S**, with elements $S_{ij} = 1$ if there is either a link from j to i *or* from i to j and zero otherwise. Draw a picture of the symmetrized network using any means you like (pencil and paper, graph drawing software, paper clips and rubber bands, whatever).

2. It will be most easy to do the following calculations using a computer—you can feed the adjacency matrices into Mathematica, Matlab, Octave, Maple, etc. and then have the machine do most of the work for you. However, it is also possible to do all of these calculations by hand. So, find the following:

   (i) The numbers n and m of vertices and edges in the directed and undirected networks.

   (ii) The degree centrality of each vertex in the symmetrized network. The in-degree of each vertex in the directed network. List the top three individuals for each. Which do you think is a better measure of influence and why?

   (iii) The PageRank centrality of each vertex in the undirected and directed networks with $\alpha = 0.85$. List the top four for each. Comment briefly on what you see.

   (iv) The strongly connected components of the directed network. Describe briefly how you found these.

   (v) The clustering coefficient C for the undirected network.

(vi) The local clustering coefficient C_i for each vertex in the undirected network. Make a scatter plot of C_i against the degree k_i of the vertices (i.e., a plot with axes for C_i and k_i and n dots at the points corresponding to the n vertices).

(vii) The reciprocity of the directed network.

3. **Extra credit:** The following will require the use of network analysis software such as UCInet or Pajek. You can get 100% on this problem set without doing them. Still, it might be worthwhile learning to use the software if this is the sort of thing you might want to do in the future.

   (i) Calculate the betweenness centrality for each vertex in the undirected network and list the top three winners in this case.

   (ii) Calculate the mean vertex–vertex distance (mean closeness) between connected vertex pairs in the network.