Complex Systems 535/Physics 508: Homework 1

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	Bramson	3, 20, 29
2	Castro	10, 11, 14, 16, 17, 19, 23, 24
3	Cobey	1, 29
4	Copic	5, 14, 19, 20
5	Cully	2, 4, 5, 10, 19, 20, 24, 30
6	Dimitrov	9, 18, 25
7	Dowdall	18
8	Du	25, 31
9	Erkan	6, 25, 26
10	Feldt	2, 5, 11, 16, 19, 20, 23, 31, 32
11	Ghoshal	2, 10, 19, 20, 22, 23, 24
12	Golman	22
13	Jun	18, 22
14	Killewald	4, 19, 27
15	Kong	16, 17, 19, 24, 31
16	Li	4, 5, 10, 15, 17, 19, 24, 30, 31, 32
17	Lin	2, 31, 32
18	Maltsev	6, 13
19	O'Connell	2, 4, 5, 10, 11, 16, 20, 23, 24, 30
20	Oros	4, 10, 11, 19, 29
21	Rayle	
22	Sargsyan	2, 12, 18
23	Schneider-Mizell	2, 5, 10, 11, 16, 19, 20, 24, 31, 32
24	Sharma	2, 4, 5, 11, 15, 16, 19, 23, 30
25	Shen	6, 8, 9
26	Solomon	
27	Sonday	14
28	Tenney	
29	Wheeler	1, 13, 20
30	White	4, 5, 16, 19, 24
31	Wu	8, 10, 11, 14, 15, 16, 17, 23, 32
32	Zhang	

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

`http://www-personal.umich.edu/~mejn/courses/2005/cscs535/classnet.txt`

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. It is also possible to do all of these calculations by hand, with the exception of (iii) below, which would be a lot of work. So, find the following:

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

   (ii) The degree 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 cocitation and bibliographic coupling for each pair of vertices. List the three pairs having the highest of each.

   (iv) The lists of vertices in each component of the undirected graph.

   (v) The diameter of each component.

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

3. **Extra credit:** You can get 100% on this problem set without doing this part.

   The eigenvector centrality x_i of a vertex i in a network is defined to be the sum of the eigenvector centralities of its network neighbors, so the vector $\mathbf{x}$ of such centralities is given by $\mathbf{S}\mathbf{x} = \lambda\mathbf{x}$, where (as we will show later in the course) λ is the largest eigenvalue of $\mathbf{S}$. Find the eigenvector centralities of each of the vertices in the undirected network, and list the three with the highest centralities.