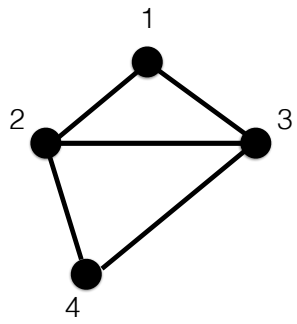
Homework 1

SOC 208A W16

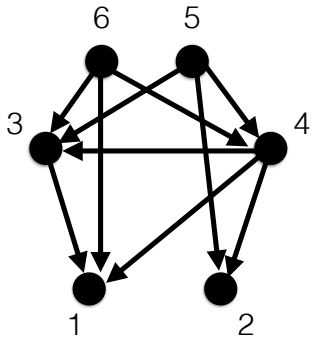
January 19, 2016

Questions 1 - 4 refer to the following undirected network:



1. Write down the adjacency matrix for this network.
2. What is the degree vertex 1? Of vertex 3? By writing out the sums explicitly, show how these can be calculated from the adjacency matrix.
3. What is the average degree? Compute this two ways; once directly, and once from the number of edges and the number of nodes.
4. Write down the number of paths of length 2 from node 1 to node 4, in terms of the adjacency matrix. Then carry out the sum explicitly.

Questions 5 - 7 refer to the following directed network

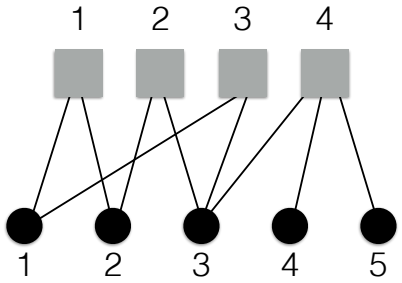


5. **Using R**, calculate the in- and out-degrees for the nodes in this network.

6. **Using R**, calculate the bibliographic coupling matrix of this network. Write out the formulae by hand, first.

7. Prove that the bibliographic coupling matrix is always symmetric. Explain why this allows the elements of the bibliographic coupling matrix to be used in constructing the adjacency matrix of an undirected network (the bibliographic coupling network).

Questions 8 - 13 refer to the following bipartite network



8. Write down the incidence matrix for this bipartite network.

9. **Using R**, compute the projection matrix for the projection of this network onto people (equation 6.17). Write out the formulae by hand, first.

10. Interpret the diagonal elements of the projection matrix onto people. What do these elements count? Derive this formally, and verify it using the example network.

11. **Using R**, plot the projection of this bipartite network onto people. Use the most "lossy" version of the projection, in which there is an edge between i and j in the projected network if $P_{ij} > 0, i \neq j$. In other words, don't use the weighted version. Make sure you use vertex labels on the plot.

12. What is the difference between the triangle connecting $1, 2, 3$ and the one connecting $3, 4, 5$? How does this illustrate the information lost by projection?

13. For a $g \times n$ incidence matrix, show that the projection onto groups can be represented as a $g \times g$ matrix $\mathbf{P}'$. Explain each step.

An open ended question

14. Reflect on your area(s) of substantive interest. Pick a particular structure/phenomenon/pattern of relations and describe how it might be represented using networks. What would the nodes represent? What would the edges represent? Should you use an undirected or a directed network? Weighted or binary? Unipartite or bipartite? Reflect on the advantages and disadvantages of your chosen representation. What important features do you capture? What features might be distorted or left out? You should aim to write a half page. *Hint: This can get you started on your research paper!*