Problem Set #2

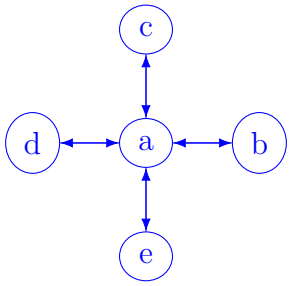
POLI 100F - Social Networks

August 15, 2022

Questions #1-#10 refer to the network described in Question #1.

1. Draw the network given by the following adjacency matrix ($A_{ij} = \{a...e\}$):

$$\begin{matrix} 0 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{matrix}$$



2. What is the average degree of the nodes in this network? $(4+1+1+1+1(in)+4+1+1+1+1(out))/5 = \frac{16}{5} = 3.2$ (give credit for 1.6 if #1 is undirected)
3. What is the average path length of this network? $(1+\frac{7}{4}+\frac{7}{4}+\frac{7}{4}+\frac{7}{4})/5 = 1.6$
4. What is the clustering coefficient of the node with the highest degree? *a* with 0
5. What is the clustering coefficient of the network as a whole? $\frac{0+0+0+0+0}{5} = 0$
6. Identify all structural holes in this network. *bc*, *bd*, *be*, *cd*, *ce*, *de*
7. If triadic closure is operating on this network, what should we expect to see over time? edges should replace the structural holes
8. How many directed edges would we need to add to make this network a clique? 12
9. Which node has the lowest eigenvector centrality? (no calculations necessary.) *a*
10. Describe a real-world scenario that could plausibly be modeled by this network. e.g. the communications between an FBI agent and a network of informants who don't know each other

Questions #11-#15 refer to the network in Figure 1.

11. How many strongly-connected components does the network in Figure 1 contain? 3

12. What is the embeddedness of the edge between a and e? 1

13. Identify a local bridge in this network, and give its span. e.g. a-f, span 5

14. Where might we expect to see triadic closure occur in this network? ai, ge, gf, ad, ef, id, fc, ic

15. Treat the network in Figure 1 as a multi-mode network with two node types, vowels (a, e, i) and consonants (b, c, d, f, g, h). Does this network exhibit homophily? Observed: 6 consonants and 3 vowels, 18 edges total, 8 heterogeneous, so $\frac{8}{18}$. Expected: $p_c = \frac{2}{3}, p_v = \frac{1}{3}, 2pq = \frac{4}{9} = \frac{8}{18}$. No homophily present.

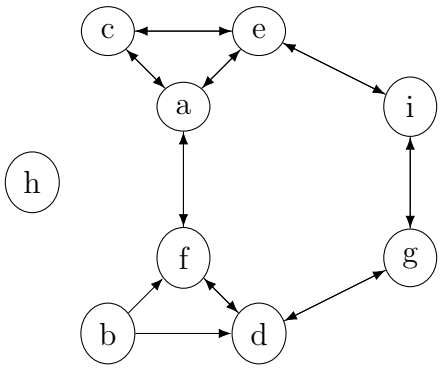


Figure 1: A social network.

Questions #16-#20 require an answer of several sentences (or at most one paragraph).

16. Why is it unlikely for a large network to feature more than one giant component? Because just a single connection between two giant components would merge them, and a single connection is increasingly likely with scale.

17. What role do embedded edges play in fostering social capital? They provide feedback mechanisms (such as reputation monitoring) that promote trust and honesty.

18. If a network grows via a process of preferential attachment, how will edges be distributed? According to a power law, which means the resulting network will be scale free. Exponentially few nodes will have many connections, and exponentially many nodes will have few connections.

19. How do Gilbert et al. explain the surprising success of surrogation in their experimental results? They claim that because our affective reactions are evolutionarily deep, they're fairly widely shared, and that because of homophily people we're connected to are likely to react in similar ways.

20. Why does Granovetter think that "removal of the average weak tie would do more "damage" to transmission probabilities than would that of the average strong one"? Because weak ties are likely to serve as local bridges providing unique connections to other parts of the network, whereas strong ties are often redundant in highly-clustered networks.

21. (Extra Credit) In the network shown in Figure 1, which node has the highest betweenness centrality? What is it? *a* with 10