STA 352/662; MTH 359 (Spring 2024)

Coding homework

Due: Tuesday, April 30 (tentative).

Check your answers in R! Include your code with your submission.

1. Consider the following network.

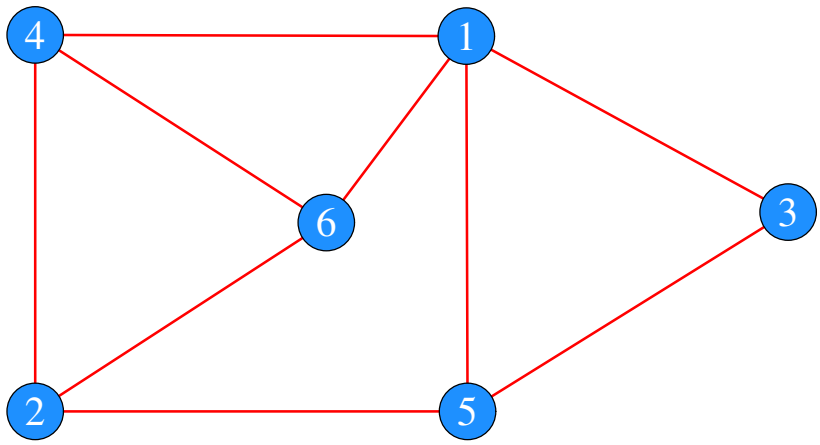

Figure 1: Network for Question 1

(a) Give the number of edges and the number vertices in the network.

(b) Compute the degrees for each of the vertices in the network. Give a degree distribution for the network.

(c) Find the average nearest neighbour degree for vertices 2, 3 and 4.

(d) Find the diameter of the network. List a pair not including nodes 2, 3 or 4, with the largest shortest path distance between them. List such a pair that includes node 1.

(e) Show that it is possible to remove one edge involving node 4, from the network, to increase the diameter by one? (remove this edge only for this part).

(f) Find the two nodes with closeness centralities not equal to 1/7 (the values are 1/6 and 1/8).

(g) Find the vertex betweenness values for the vertices in the network. Note that the sum of the betweenness values is 6.

(h) Find the edge betweenness values for the vertices in the network. Note that the sum of the betweenness values is 21, and the two smallest values are 1 and 11/6.

(i) How many cliques of size 1, 2 and 3 are there in network. List the cliques of size 3.

(j) Is it possible to add an edge to obtain a clique of size 4? (add this edge only for this part)

(k) List the one maximal clique of size 2 in the network.

2. Consider the network from Question 1.

(a) Find the density of the network.

(b) Find the clustering coefficient (transitivity value) for the network. Note that the value is slightly below 0.5.

(c) Find the local clustering coefficients (transitivity values) for the three vertices in the network, whose local clustering coefficient is not 1/3.

(d) Draw the neighborhood (ego) graph for node 1. What are the vertex and edge connectivity values for this (neighborhood) graph. Give vertex and edge cuts (of that size) that disconnect the graph.

(e) What is the vertex connectivity for the whole network. Give a vertex cut (of that size) that disconnects the graph.

(f) What is the edge connectivity for the whole network. Give an edge cut (of that size) that disconnects the graph.

3. Consider the following directed network.

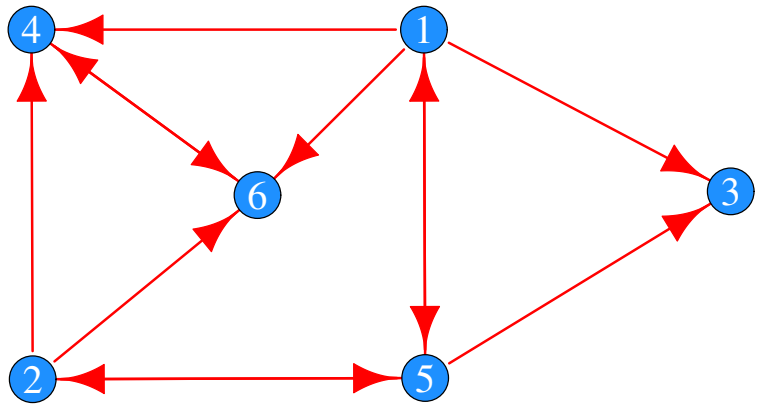

Figure 2: Network for Question 3 (directed)

(a) List the three mutual and six asymmetric dyads in the network. How many null dyads are there in the network?

(b) Are there any empty graph triads in the network?

(c) Give the one triad of the form `A->B<-C`, `A<->C`.

(d) Give the two triads of the form `A<->B`, `C`.

(e) Find the (default) reciprocity value for the network (i.e. the proportion of reciprocated edges in the network).

(f) Find the maximal strongly connected components (clusters) for the network.

4. Consider the following directed network.

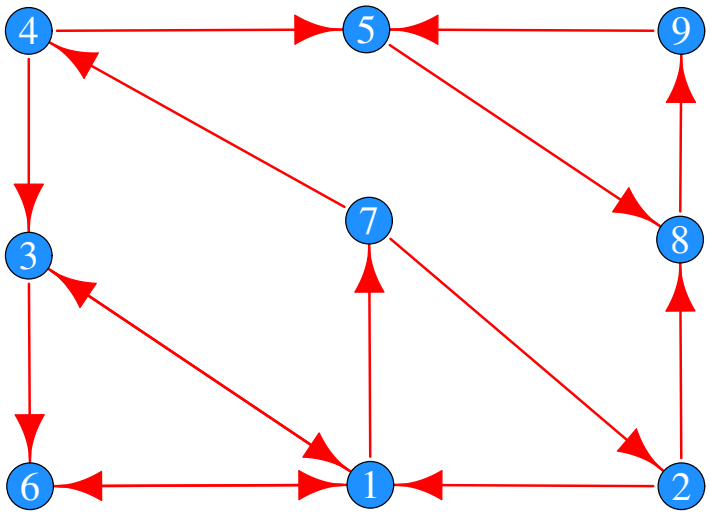

Figure 3: Network for Question 4 (directed)

(a) Show that it is possible to flip the direction of one of the edges in the network so that there is now one single maximal strongly connected component that includes all 9 nodes? There are two possibilities (one bonus point for locating both).

(b) Show that it possible to flip the direction of one the edges in the network so that there are now five separate maximal strongly connected components?