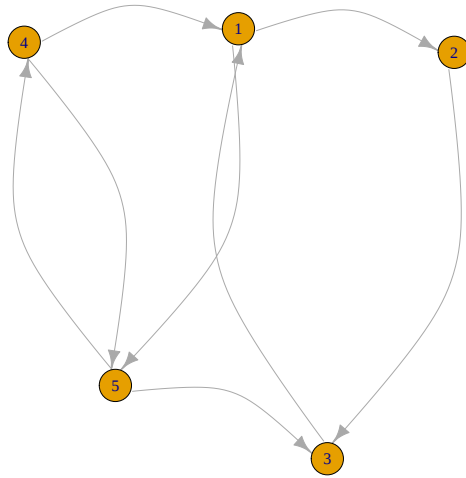


Homework 1 — Networks

January 29, 2019

1. Consider the following network:

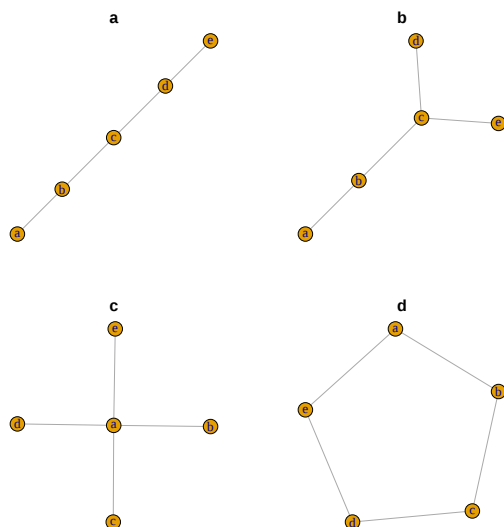


- Give the adjacency matrix for
 - Give the edge-list
 - Plot the degree distribution.
2. Consider an undirected, unweighted network of n vertices that contain two subnetworks of size n_a and n_b that are connected by a single edge. That is, there is node A in one subnetwork that is connected to node B in the second subnetwork. No other connections between the two exist. Show that the closeness centralities for nodes A and B , denoted c_A and c_B respectively, are related by

$$\frac{1}{c_A} + \frac{n_a}{n} = \frac{1}{c_B} + \frac{n_B}{n}$$

where $c_A = n / \sum d_{Aj}$ for d_{ij} the length of a path from A to j .

3. Consider the following 4 undirected graphs:



- Give the `plot_from_literal` commands to plot these four graphs.
 - Before doing anything else in R, comment on which nodes you believe to be most central and why.
 - Report in one table per graph the degree, closeness and betweenness centralities (make sure to specify if you normalize by anything).
4. Power laws for degrees: Find a closed form formula for higher order expectations: $E[X^k]$ where X has a power law distribution.