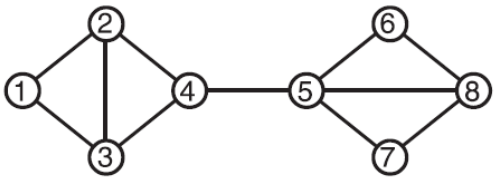
Network Science

HW-5 (12 points)

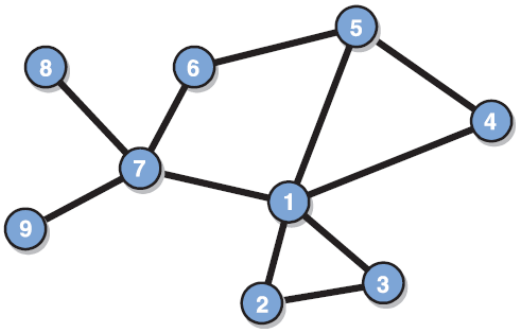
Exercise 1 (2 points)



Consider the fractional threshold model for the network on the left. The threshold is $1/2$ for all nodes.

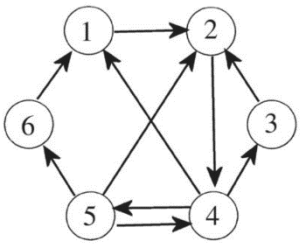
1. Suppose only one node can be chosen as an initial adopter. Which node should be chosen to obtain the largest cascade?
2. Find any set of initial adopters whose activation causes the complete cascade.

Exercise 2 (2 points)



Consider the fractional threshold model for the network on the left. Suppose all nodes have the same threshold. What is the maximum threshold such that the activation of a single initial adopter causes the complete cascade? Why?

Exercise 3 (2 points)



Consider the linear threshold model for the directed network on the left. The threshold for all nodes is 2. The influence weight of all edges is 1. Let A denote a set of initial adopters. Recall that the influence of A is the number of active nodes at the end of the iteration process, given A as the set of initial adopters.

1. What is the influence of A if $A = \{1,5\}$?
2. Find A such that (a) A consists of three nodes and (b) the influence of A is 6.

Exercise 4 (3 points)

Apply the SIR model to analyze an epidemic on a contact network, assuming that every node has 10 contacts per day. Let

- p be the per-day probability of disease transmission from an infected node to a susceptible one;
- q be the per-day probability that the node has recovered and got immunity to the disease;
- r be the per-day probability that an infected node has died.

Answer the following questions.

1. Will the epidemic spread or shrink if $p = 0.01, q = 0.3, r = 0.1$? Why?
2. Will the epidemic spread or shrink if $p = 0.03, q = 0.1, r = 0$? Why?
3. Will the epidemic spread or shrink if $p = 0.03, q = 0.1, r = 0.1$? Why?

Exercise 5 (3 points)

Apply the SIS model to analyze an epidemic on a contact network, assuming that every node has 10 contacts per day. Also assume that the expected length of the infection period (counted in days) is a week. Let p be the per-day probability of disease transmission from an infected node to a susceptible one. Answer the following questions.

1. Will the epidemic spread or shrink if $p = 0.03$? Why?
2. Will the epidemic spread or shrink if $p = 0.02$? Why?
3. Will the epidemic spread or shrink if $p = 0.01$? Why?