ECON 390-Economics of Networks-Micro II
Test 1 -Spring 2023

NAME:

Part 1: Short questions (40 points)
Answer the following questions (4 points each)

1. In a social graph from Facebook, which type of link best represents the "friend" relation? Directed or undirected?

2. In a social graph from Twitter, which type of link best represents the "follower" relation? Directed or undirected?

3. Consider a network with N nodes. Given a single link, what is the maximum number of nodes that link can connect? Given a single node, what is the maximum number of links that can connect to that node?

4. Consider a directed network of N nodes. Now consider the total in-degree (i.e. the sum of the in-degree over all nodes in the network). Compare this to the analogous total out-degree. Which of the following must hold true for any such network?

   a) Total in-degree must be less than total out-degree.

   b) Total in-degree must be greater than total out-degree.

   c) Total in-degree must be equal to total out-degree.

   d) None of these hold true in all instances

5. Consider this adjacency matrix:

$$\begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 2 & 1 & 3 & 1 & 1 & 0 \end{pmatrix}. \tag{1}$$

   The rows identify nodes A, B, C, D, E, and F. How many nodes are in this network? How many links? Are there any self-loops?

6. Consider the network defined by the adjacency matrix in Eq. (1.11). A sin k is defined as a node with in-links but no out-links. Which nodes in the network, if any, have this property?

7. Consider the network defined by the adjacency matrix in Eq. (1). What is the in-degree of node **C** ? What is its out-degree?

8. What is the central idea behind the notion of "six degrees of separation"?

    a) Social networks have high clustering coefficients
    b) Social networks are sparse
    c) Social networks have many high-degree nodes
    d) Social networks have small average path length

9. Let us introduce a special class of undirected, connected networks such that the deletion of any one link will disconnect the network into two components. Such graphs are called trees. What is the maximum clustering coefficient for a node in a tree?

10. Consider an arbitrary non-complete undirected network. Now add a single link. How has the number of nodes in this network's giant component changed as a result of this addition?

    a) It has strictly decreased
    b) It has decreased or stayed the same
    c) It has increased or stayed the same
    d) It has strictly increased

Part 2: In the following questions you need to use the information contained in the respective networks. (30 Points)

1. Consider the social network depicted in Figure 2.11.

    (a) Compute the clustering coefficient for node B. (10 Points)
    (b) Compute the embeddedness of edges B-F, B-D, and B-C. (10 Points)

2. In the social network depicted in Figure 3.23 with each edge labeled as either a strong or weak tie, which two nodes violate the Strong Triadic Closure Property? Provide an explanation for your answer. (10 Points)

QUESTION 4 (30 Points)
Based on *The Spread of Obesity in a Large Social Network over 32 Years* by Nicholas A. Christakis and James H. Fowler (2007), answer the following

1. Explain the main research idea in the paper. (10 Points)

2. Describe what is the role of social networks in the problem studied by the authors. (10 Points)

3. What is the main conclusion of the article? (10 Points)

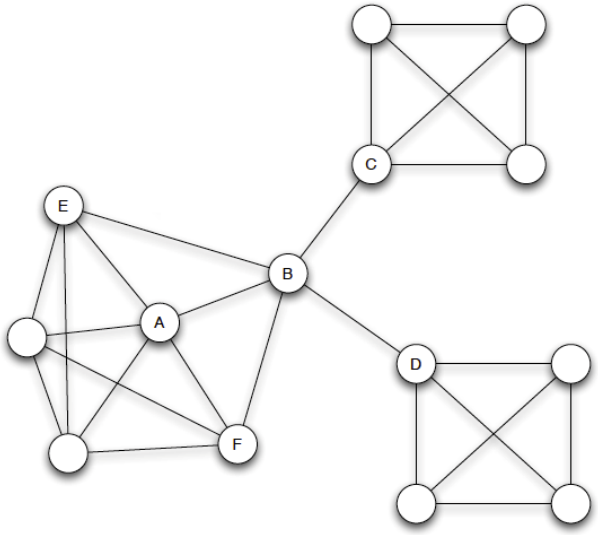

Figure 3.11: The contrast between densely-knit groups and boundary-spanning links is reflected in the different positions of nodes A and B in the underyling social network.

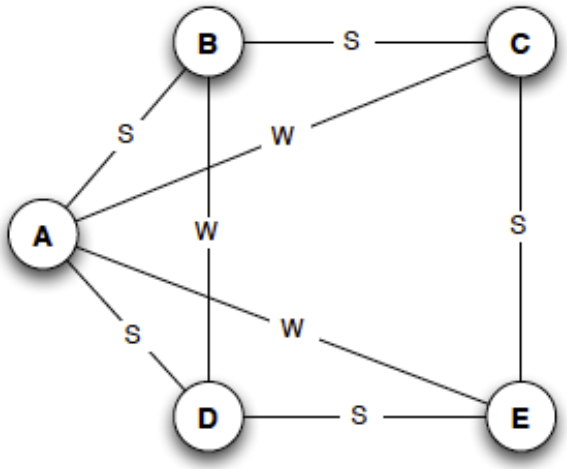

Figure 3.23: A graph with a strong/weak labeling.