TEST - 1

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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?

- An undirected link is used to represent the "friend" relation in a social graph from Facebook.

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

- A directed link is used to represent the "follower" relation in a social graph from Twitter.

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?

- A single link can connect only 2 nodes.
- A single node can connect to a maximum of N-1 links, where N is the number of nodes in the network.

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?

- C) Total in-degree must be equal to total out-degree.
- In a directed network with N nodes, the sum of the in-degree over all nodes must equal the sum of the out-degree over all nodes. This is because each directed edge (u, v) contributes 1 to the in-degree of node v and 1 to the out-degree of node u.

5. Consider this adjacency matrix:

$$
\begin{matrix}
0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 2 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 \\
2 & 1 & 3 & 1 & 1 & 0
\end{matrix} \qquad . (1)
$$

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?

- There are 6 nodes in this network (A, B, C, D, E, F).
- There are 10 links in this network.

- There are no self-loops in this network. Self-loops are links that connect a node to itself and are represented in the adjacency matrix by non-zero diagonal entries. In this case, all diagonal entries are 0, so there are no self-loops.
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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?

- Node C has the property of in-links but no out-links, because of an in-degree of 2 and an out-degree of 0.
- Node C is therefore a sin k node in the network.

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?

- Node C has an in-degree of 2 in the network given by the adjacency matrix in Eq. (1).
- The out-degree of node C is 0 as well. This means that there are no links originating from node C.

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

- 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?

- A node in a tree has a maximum clustering coefficient of 0. Because nodes in a tree can only have two neighbors, there can be no triangles produced by linkages between neighbors. A node's clustering coefficient in a network is defined as the proportion of its neighbors that are also neighbors of each other, hence if a node's neighbors do not include any triangles, its clustering coefficient must be 0. Because every node in a tree has no more than two neighbors, the maximum clustering coefficient for each node in a tree is 0.

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?

- c) It has increased or stayed the same

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

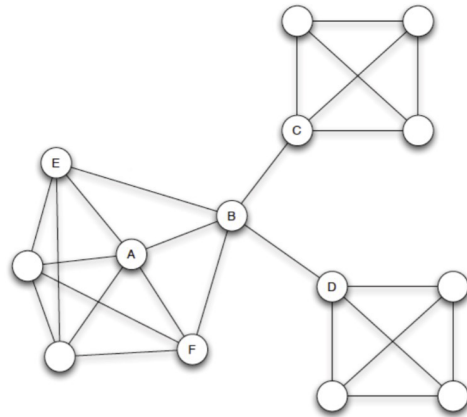1. Consider the social network depicted in Figure 2.11.

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.

(a) Compute the clustering coefficient for node B. (10 Points)

B = Node, K_B = Degree, N_B $=$ *No. of links between neighbours of B*

$K_B = 5 \mid N_B = 2$

- $\text{CC(B)} = \dfrac{2N_B}{K_B(K_B-1)}$

- $= \dfrac{2.2}{5.4}$

- $= \dfrac{1}{5}$

- $= 0.20$

(b) Compute the embeddedness of edges B-F, B-D, and B-C. (10 Points)
   - embeddedness of edges {B, F} = 1
   - embeddedness of edges {B, D} = 0
   - embeddedness of edges {B, C} = 0

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)

- The Strong Triadic Closure Property states that if two nodes are strongly connected to a third node, then there should be an edge connecting those two nodes. Nodes C and E violate this property because they are strongly connected to a common node (C and D respectively) but there is no edge between C and D. This is why nodes C and E do not adhere to the Strong Triadic Closure Property.

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.

The research proposes that obesity may spread through social networks and that the size and nature of these networks impact the spread of obesity. The authors explore the development of obesity in a broad, multigenerational social network over 32 years using data from the Framingham Heart Study, a long-running study of cardiovascular disease.

The authors discovered that having fat friends, siblings, or spouses makes people more likely to become obese and that this impact is most significant for close ties such as spouses and siblings. They also discovered that the size and structure of social networks impact the development of obesity, with bigger and more linked networks leading to a greater spread of obesity.

According to scientists, these findings have substantial implications for the prevention and treatment of obesity. They believe that obesity therapies should take into account the social network environment in which people live, as well as how obesity spreads within these networks. They imply that treatments aimed not only at individual behavior but also at the social network context in which behavior happens may be more successful in preventing and treating obesity.

Finally, the main research idea in the paper is that obesity may spread through social networks and that the size and structure of these networks impact the spread of obesity. The authors utilize data from the Framingham Heart Study to show that people are more likely to become obese if they have fat friends, siblings, or spouses and that this impact is largest for close ties like spouses and siblings.

2. Describe what is the role of social networks in the problem studied by the authors.

The research aims at the spread of obesity in a vast social network over 32 years. The authors utilize data from the Framingham Heart Study to demonstrate how obesity spreads across social networks, with people being more likely to become fat if they had obese friends, siblings, or spouses. The scientists also discovered that the size and structure of social networks impact the development of obesity, with bigger and more linked networks leading to a greater spread of obesity. This study's findings imply that therapies aiming at preventing or treating obesity should take into account the social network environment in which people live, as well as how obesity may spread within these networks.

The authors investigate the impact of social networks on the spread of obesity. They contend that social networks play an important role in molding human behavior and that the size and structure of these networks impact the spread of obesity.

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discovered that having fat friends, siblings, or spouses makes people more likely to become obese and that this effect is largest for close ties such as spouses and siblings.

According to the authors, these data demonstrate that social networks play an essential role in determining our behavior, particularly our health behaviors. They contend that social networks can impact human behavior in a variety of ways, such as the normalizing of harmful habits, behavior modeling, and the provision of social support.

In conclusion, The authors of this study highlight the relevance of social networks in the development of obesity and propose that therapies aiming at preventing or treating obesity should take into account the social network environment in which people live, as well as how obesity may spread within these networks. They contend that treatments that focus not just on individual behavior but also on the social network environment in which behavior happens may be more successful in preventing and treating obesity.

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

The article's key conclusion is that obesity may spread through social networks and that the number and nature of these networks impact obesity spread. The authors discovered that having fat friends, siblings, or spouses makes people more likely to become obese and that this impact is most significant for close ties such as spouses and siblings. They also discovered that the size and structure of social networks impact the development of obesity, with bigger and more linked networks leading to a greater spread of obesity.

Based on these findings, the authors propose that therapies targeted at preventing or treating obesity should take into account the social network environment in which people live, as well as how obesity spreads within these networks. They contend that treatments that focus not just on individual behavior but also on the social network environment in which behavior happens may be more successful in preventing and treating obesity.

In summary, the article's key takeaway is that social networks play a key role in the development of obesity and that the number and structure of these networks impact the spread of obesity. The authors underline the necessity of incorporating the social network setting in obesity prevention or treatment approaches.