Exam Eligibility Assignment

Finish test

117 hr 26 min | End at 2:00 PM hour

1. Knowledge Tasks (20 Points)
   - 1.1. True/false (15 Points) 1
   - 1.2. Single Choice Questions (5 Points)
     - Q1 (1 Point) 1
     - Q2 (1 Point) 1
     - Q3 (1 Point) 2
     - Q4 (1 Point) 1
     - Q5 (1 Point) 1
2. Practical Tasks (40 Points)
   - 2.1 Directed Graphs (20 Points) 2
   - 2.2 Undirected Graphs (20 Points) 1
3. Programming Tasks (40 Points)
   - 3.1 PageRank (26 Points) 1
   - 3.2. Breadth First Search (14 Points) 1

1.1. True/false (15 Points)

15 points Answered

- Each correct answer gives 1 point.
- Each wrong answer deducts 1 point.
- Unanswered questions give 0 points.
- The maximum number of points is 15, and the minimum is 0.

Unanswered	Right	Wrong	
☐	☐	☑	In a directed network, the adjacency matrix is always symmetric.
☐	☑	☐	A bipartite network can never contain triangles in its structure.
☐	☐	☑	In a weighted network, the degree of a node is equal to the sum of the weights of its links.
☐	☑	☐	Removing a high-degree node (hub) from a scale-free network has a greater impact on connectivity than removing a random node.
☐	☑	☐	In a simple undirected graph, the sum of all node degrees is equal to twice the number of edges.
☐	☐	☑	The density of a network remains constant as the number of nodes increases, assuming the number of links grows linearly.
☐	☑	☐	The density of a complete undirected network is always 1.
☐	☑	☐	A node's clustering coefficient is always zero if it has less than two neighbors.
☐	☑	☐	A network with low average path length but also low clustering is more likely to resemble a random network than a small-world network.
☐	☐	☑	The average path length is always equal to the diameter of the network divided by two.
☐	☐	☑	In real networks, all nodes with high betweenness centrality also have high degree centrality.
☐	☑	☐	Increasing k in k-core decomposition yields a smaller, denser subnetwork of nodes with degree ≥ k.
☐	☑	☐	The robustness of a network can be assessed by tracking the size of the largest connected component as nodes are removed.
☐	☐	☑	The World Wide Web can be considered a strongly connected component.
☐	☑	☐	The damping factor in PageRank prevents rank sinks and guarantees convergence.

✓ Submit answer Next question >

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1.2. Single Choice Questions (5 Points)

- Each correct answer gives **1 point**.
- Each wrong answer **deducts 1 point**.

Hide

Q5 (1 Point) 1 point Answered

Which of the following best characterizes the degree distribution in random (ER) networks?

- (●) Binomial
- ( ) Power-law
- ( ) Heavy-tailed
- ( ) Exponential

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1.2. Single Choice Questions (5 Points)

- Each correct answer gives **1 point**.
- Each wrong answer **deducts 1 point**.

Hide

Q4 (1 Point) 1 point Answered

Which scenario would most likely increase the risk of rapid misinformation spread in a social network, based on homophily and assortativity principles?

- ○ Low homophily, high degree assortativity
- ○ Low homophily, low assortativity
- ○ Random connections
- ◉ High homophily, high assortativity

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1.2. Single Choice Questions (5 Points)

- Each correct answer gives **1 point**.
- Each wrong answer **deducts 1 point**.

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Q3 (1 Point) 1 point Answered

In the context of social networks, what is the primary risk associated with high homophily?

- (●) Formation of echo chambers and polarization
- ( ) Decreased average degree
- ( ) Increased network diameter
- ( ) Randomness in connections

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1.2. Single Choice Questions (5 Points)

- Each correct answer gives **1 point**.
- Each wrong answer **deducts 1 point**.

Hide

Q2 (1 Point)

1 point Answered

The Watts–Strogatz model is useful in capturing which property of real-world social networks **not** found in Erdös– Rényi random graphs?

- ○ Short average path lengths
- ◉ High clustering coefficient
- ○ Long average path lengths
- ○ Low clustering coefficient

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1.2. Single Choice Questions (5 Points)

- Each correct answer gives **1 point**.
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Q1 (1 Point)

1 point Answered

Given a complete network A with N nodes, and a bipartite network B also with N nodes, which of the following holds true for any N>2:

- ○ Network A has the same number of links as network B
- ◉ Network A has more links than network B
- ○ None of these hold true for all such N>2
- ○ Network A has fewer links than network B

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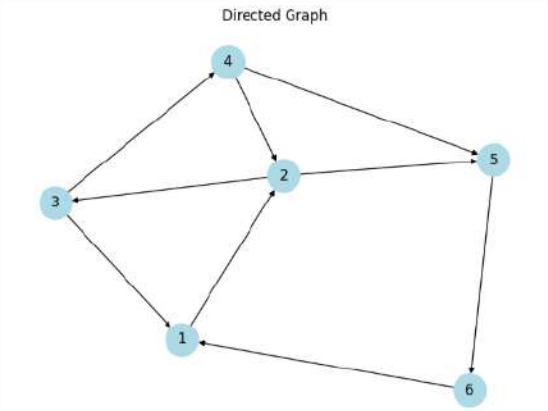
2.1 Directed Graphs (20 Points)

20 points Answered

You are given the following graph.



Answer the following questions. Give the numerical answers rounded to **three** decimal places, e.g., 0.185. Round the last digit as follows: 0.1856 → 0.186, 0.1851 → 0.185, 0.1855 → 0.186, 0→ 0, 0.5 → 0.5. Do not add blank spaces!

1. What is the diameter of the above graph? 4.0
2. What is the average path length of the above ? 2.033
3. If edge 6->2 is added to the original graph, what is the new diameter? 4.0
4. Consider the original graph, if edge 1→2 is removed, what is the new diameter of the directed graph? 0
5. What is the density of the original directed graph? 0.3

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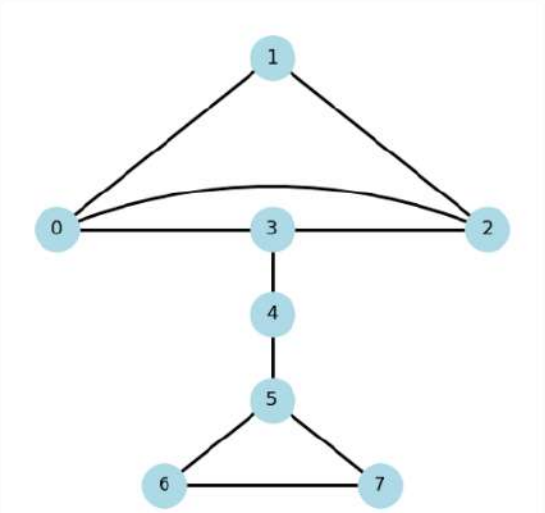
2.2 Undirected Graphs (20 Points)

20 points Answered

You are given the following graph.



Answer the following questions. Give the numerical answers rounded to **three** decimal places, e.g., 0.185. Round the last digit as follows: 0.1856 → 0.186, 0.1851 → 0.185, 0.1855 → 0.186, 0→ 0, 0.5 → 0.5. Do not add blank spaces!

1. Calculate the **closeness centrality** for node **5**? 0.467 (3 points)
2. Which node(s) has (have) the highest **betweenness centrality**, and what is the value? If there is more than one node, separate them with a comma. Nodes: 3.4 (3 Points) Betweenness: 0.571 (3 Points)
3. Compute the **clustering coefficien**t for node 0? 0.667 (3 Points)
4. What is the **average clustering coefficient** for the network? 0.625 (3 Points)
5. For node 5, what is the **average degree of its neighbors**? 2000.0 (1 Points)
6. Will **friendship paradox** hold for node 5? (yes, no) no (1 Points)
7. If node **3** is removed, what is the **size** of the largest connected component? 4.0 (3 Points)

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3.2. Breadth First Search (14 Points)

14 points Answered

The following code implements the **Bread First Search (BFS)** algorithm. Fill in the gaps with the correct code snippets. Each right answer gives 2 points. No negative points are given for wrong answers.

```
from collections import deque

def bfs(graph, start):
    if start not in graph:
        raise ValueError("Start node not in graph")
    visited = {node: False for node in graph}
    distance = {node: -1 for node in graph}
    predecessor = {node: None for node in graph}
    queue = deque()
    visited[start] = [True]
    distance[start] = 0
    queue.append([start] )

    while queue:
        current = queue.[popleft] ()
        for neighbor in graph[current]:
            if not visited[neighbor]:
                visited[ [neighbor] ] = True
                distance[neighbor] = distance[current] + [1]
                predecessor[neighbor] = [current]
                queue.[append] (neighbor)

    return distance, predecessor

graph = {
    'A': ['B', 'C'],
    'B': ['A', 'D', 'E'],
    'C': ['A', 'F'],
    'D': ['B'],
    'E': ['B', 'F'],
    'F': ['C', 'E']
}

start_node = 'A'
distance, predecessor = bfs(graph, start_node)
```

Submit answer

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3.1 PageRank (26 Points)

26 points Answered

The following code implements the PageRank algorithm. Fill in the gaps with the correct code snippets. Each right answer gives 2 points. No negative points are given for wrong answers.

```
import networkx as nx

def pagerank(G, alpha=0.85, max_iter=100, tol=1.0e-6):
    N = len(G)
    nodes = list( G.nodes() )
    rank = {node: 1.0 / N for node in nodes}

    for _ in range( max_iter ):
        new_rank = {}
        for node in nodes:
            incoming = list(G. predecessors(node) )
            total = 0
            for neighbor in incoming:
                out_deg = G. out_degree(neighbor)
                if out_deg > 0 :
                    total += rank[ neighbor ] / out_deg
            new_rank[node] = (1 - alpha ) / N + alpha * total

        diff = sum( abs (new_rank[n] - rank[n]) for n in nodes )
        rank = new_rank
        if diff < tol:
            break

return rank
```

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