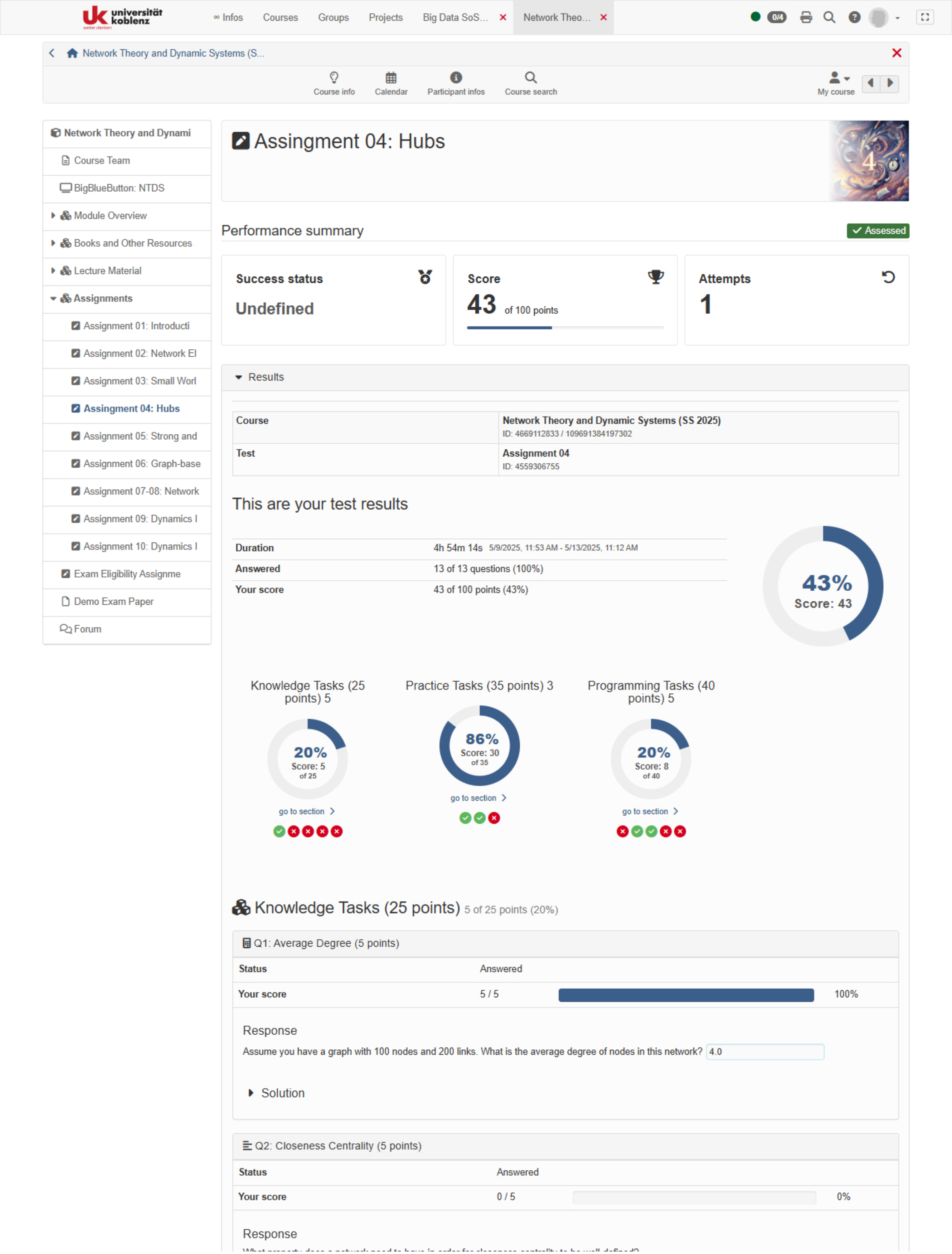
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Performance summary

✓ Assessed

Success status
Undefined

Score
43 of 100 points

Attempts
1

Results

Course	**Network Theory and Dynamic Systems (SS 2025)** ID: 4669112833 / 109691384197302
Test	**Assignment 04** ID: 4559306755

This are your test results

Duration	4h 54m 14s 5/9/2025, 11:53 AM - 5/13/2025, 11:12 AM
Answered	13 of 13 questions (100%)
Your score	43 of 100 points (43%)

Knowledge Tasks (25 points) 5

✓ ✗ ✗ ✗ ✗

Practice Tasks (35 points) 3

✓ ✓ ✗

Programming Tasks (40 points) 5

✗ ✓ ✓ ✗ ✗

Knowledge Tasks (25 points) 5 of 25 points (20%)

Q1: Average Degree (5 points)

Status	Answered		
Your score	5 / 5		100%

Response

Assume you have a graph with 100 nodes and 200 links. What is the average degree of nodes in this network? 4.0

Solution

Q2: Closeness Centrality (5 points)

Status	Answered		
Your score	0 / 5		0%

Response

What property does a network need to have in order for closeness centrality to be well defined?

What property does a network need to have in order for closeness centrality to be well-defined?

The network must be connected for closeness centrality to be properly defined.

This indicates that there must exist a route for every two nodes in the network. If certain nodes cannot reach others, then the distances between those nodes become infinite, and the closeness centrality cannot be accurately determined.

48 words

▸ Solution

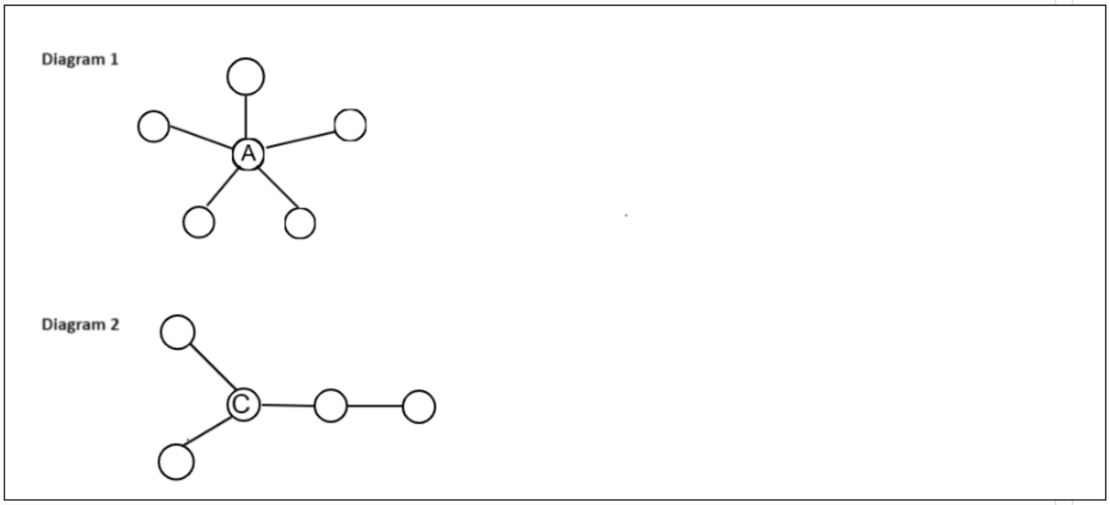
Q3: Closeness and Betweeness (5 points)

Status	Answered		
Your score	0 / 5		0%

Response

Provide examples of networks such that;
1. The node with the highest degree is not the one with the largest closeness

2. The node with the highest betweenness is not the one with the largest closeness



▸ Solution

Q4: Avg Neigbors and Avg Degree (5 points)

Status	Answered		
Your score	0 / 5		0%

Response

Are there networks such that the average number of neighbors of a node's neighbors matches the average degree? If there are, what property must they have?

Yes, there are networks where the average number of connections the neighbors of a given node have is equal to the average degree of the network. In these cases, the network must be regular.

Such a network is also termed as a regular network - a network in which every node has the same number of neighbors, that is, all the nodes have uniform degree. In such networks, because all nodes have the same degree with their neighbors, the average degree of neighbors equals the average degree of the network.

On the contrary, in most real-life networks, high-degree nodes tend to have more neighbors. This means that the average degree of neighbors is almost always greater than the average degree of the network. This phenomenon is known as the friendship paradox.

128 words

▸ Solution

Q5: Vulnerability to Attacks (5 points)

Status	Answered		
Your score	0 / 5		0%

Response

Are networks with heavy tailed degree distributions more vulnerable to random or targeted attacks? And what about grid-like networks of similar size?

In networks exhibiting degree distributions with heavy tails, such as social networks or the internet, a few nodes (hubs) have an especially high number of connections, while the majority of other nodes possess very few connections. These networks possess a greater degree of structural integrity when randomly decimating nodes. Because random attacks are unlikely to remove any of the hubs, the structure remains intact and connected. Strongly directed attacks, however, will

```
erode the network’s structure as deliberately removing the hubs causes the network disconnection to happen almost
instantaneously.

Grid-like networks, where each node connects to a roughly equal number of nodes—like a lattice or road map—do not have
hubs at all. As such, random and targeted attacks on these networks will have an equal effect. Each node holds the same
value, meaning removing any node will cause localized structure damage, but overall, damage occurs more gradually.

In short:
Heavy-tailed networks are resistant to random failure, but are fragile under targeted attacks.
Grid-like networks possess uniform vulnerability, with no particular weaknesses to either type of attack.
```

176 words

▸ Solution

‹ go back to overview

Practice Tasks (35 points) 30 of 35 points (86%)

Q6: Jupyter Book Tutorial

Status	Answered		
Your score	0 / 0		0%

Response

Go through the Chapter 3 Tutorial on the book & GitHub repository.

https://github.com/CambridgeUniversityPress/FirstCourseNetworkScience/tree/master/tutorials

```
ok, I reviewed chapter 3 tutorial.
```

4 words

▸ Solution

Q7: Mode, Clique, Hubs (20 points)

Status	Answered		
Your score	20 / 20		100%

Response

Consider a network formed by 250 students in a dormitory. The links in this network represent room-mate relationships: two nodes are connected if they are currently room-mates. In this dorm, the rooms are mostly double occupancy with a few triples and quads.

1. Is this graph connected? (yes or no) no
2. What is the mode (most frequent value) of the node degree distribution? (numeric answer, e.g. 1, 2, 3,etc) 1.0
3. How many nodes are in the largest clique? (numeric answer) 4.0
4. Would you expect this graph to have any hubs? (yes or no) no

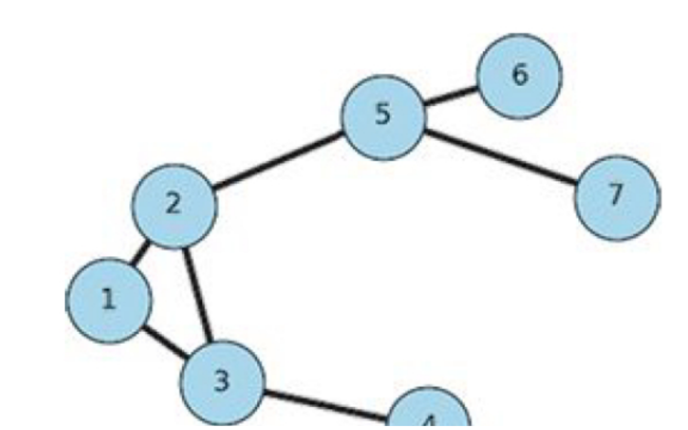
▸ Solution

Q8: Degree, Closeness, Betweeness (15 points)

Status	Answered		
Your score	10 / 15		67%

Response

Consider the network of following figure in order to answer the next few questions. For each question, in case of a tie, answer with all the tied top nodes.



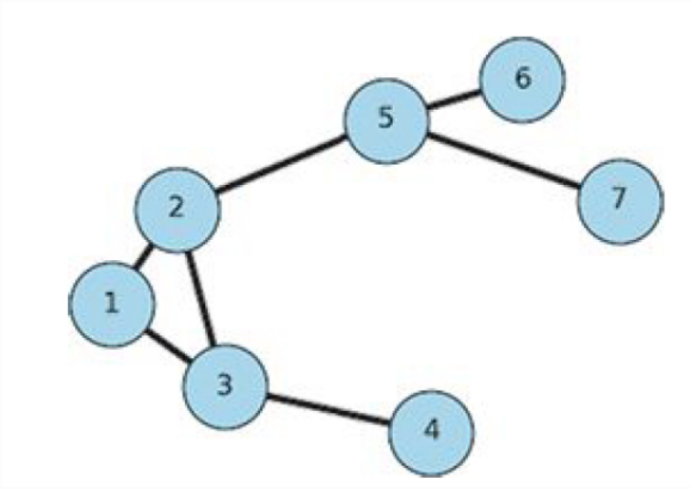
1. Which node(s) have the highest degree centrality? (If more than one node, use commas to list the node in numerical order) 2, 5

2. Which node(s) have the highest betweenness centrality? (If more than one node, use commas to list the node in numerical order) 2, 5

3. Which node has the highest closeness centrality? 2

▼ Solution

Consider the network of following figure in order to answer the next few questions. For each question, in case of a tie, answer with all the tied top nodes.



1. Which node(s) have the highest degree centrality? (If more than one node, use commas to list the node in numerical order) 2,3,5
2, 3, 5

2. Which node(s) have the highest betweenness centrality? (If more than one node, use commas to list the node in numerical order)
2,5 2, 5

3. Which node has the highest closeness centrality? 2

‹ go back to overview

Programming Tasks (40 points) 8 of 40 points (20%)

Q9: Centrality (5 points)

Status	Answered	
Your score	0 / 5	0%

Response

In NetworkX, how can you find a node with the largest degree of centrality in a network? And how would you also get the degree of that node?

```
# To find the node with the largest degree centrality in a NetworkX graph, we can use the degree_centrality() function,
which returns a dictionary mapping each node to its degree centrality value. To get the node with the highest value and
its degree centrality, we can use the max() function with the dictionary’s items() method.
import networkx as nx

Python Programm :
G = nx.Graph()
G.add_edges_from([(1, 2), (1, 3), (2, 4), (3, 4), (4, 5)])

centrality = nx.degree_centrality(G)
max_node = max(centrality, key=centrality.get)
max_centrality = centrality[max_node]
node_degree = G.degree[max_node]

print(f"Node with highest degree centrality: {max_node}")
print(f"Degree centrality: {max_centrality}")
print(f"Degree: {node_degree}")
```

90 words

▶ Solution

Q10: Atributes (2 points)

Status	Answered	
Your score	2 / 2	100%

Response

Assume you have a NetworkX graph G of employees. The node names are employee IDs, and the nodes have attributes for full name, department, position, and salary.
Which of the following will give you the salary for the employee with ID $567?

✓ G.node[5567]['salary']

○ G(5567)('salary')

○ G.node(5567)('salary')

○ G[5567]['salary']

▸ Solution

◉ Q11: Node Size List (2 points)

Status	Answered	
Your score	2 / 2	100%

Response

You have a NetworkX graph G and you are about to draw it with the following command:

```
nx.draw(G.node_size=node_size_list)
```

Which of the following is a correct way to obtain node_size_ list so that the nodes are sized according to their degree?

○ node_size_list = [G.degree() for n in G.nodes]

○ node_size_list = [d for d in G.degree()]

○ node_size_list = G.degree()

○ node_size_list = [G[n] for n in G.nodes]

✓ node_size_list = [G.degree(n) for n in G.nodes]

▸ Solution

••• Q12: Wikipedia (16 points)

Status	Answered	
Your score	4 / 16	25%

Response

Load the Wikipedia mathematics network-into a NetworkX digraph (see the datasets found here) in order to answer the following questions:

1. Compute the average in-degree and average out degree of this network.

In-degree: 12.75

Out-degree: 12.75

What do you notice? Why?

2. Which node has the highest in-degree? 1152126

3. Which node has the highest out-degree? 47738065

4. In this graph, which is greater the maximum in-degree or the maximum out-degree?

max. in-degree (numerical answer): 5171.0

max. out-degree (numerical answer): 1356.0

Would you expect this to be the same for other Web graphs? Why?

5. Compute the heterogeneity parameter for this graph's in-degree distribution. 38.2102

6. Compute the heterogeneity parameter for this graph's out-degree distribution. 6.622

▾ Solution

Load the Wikipedia mathematics network-into a NetworkX digraph (see the datasets found here) in order to answer the following questions:

1. Compute the average in-degree and average out degree of this network.

In-degree: 12.753153745072273

Out-degree: 12.753153745072273

What do you notice? Why?

2. Which node has the highest in-degree? Mathematics_Genealogy_P 'Mathematics_Genealogy_Project'

3. Which node has the highest out-degree? 'List_of_International_Cong
List_of_International_Congresses_of_Mathematicians_Plenary_and_Invited_Speakers

4. In this graph, which is greater the maximum in-degree or the maximum out-degree?

max. in-degree (numerical answer): 5171.0

max. out-degree (numerical answer): 1356.0

Would you expect this to be the same for other Web graphs? Why?

5. Compute the heterogeneity parameter for this graph's in-degree distribution. 38.21020457626352

6. Compute the heterogeneity parameter for this graph's out-degree distribution. 6.622016155632556

Q13 (15 points)

Status	Answered		
Your score	0 / 15		0%

Response

Write a Python function that accepts a Network X graph and a node name and returns the average degree of that node's neighbors. Use this function to compute this quantity for every node in the OpenFlights US network (see the datasets found here) and take the average. Does the Friendship Paradox hold here (i.e. is the average degree of nearest neighbors greater than the average node degree)?

```
import networkx as nx

def average_neighbor_degree(G, node):
    neighbors = list(G.neighbors(node))
    if not neighbors:
        return 0
    neighbor_degrees = [G.degree(n) for n in neighbors]
    return sum(neighbor_degrees) / len(neighbor_degrees)

graph_path = "openflights_usa.graphml"
G = nx.read_graphml(graph_path)

average_node_degree = sum(dict(G.degree()).values()) / G.number_of_nodes()
average_neighbor_degrees = [average_neighbor_degree(G, node) for node in G.nodes()]
average_neighbor_degree_overall = sum(average_neighbor_degrees) / len(average_neighbor_degrees)

# Print results
print(f"Average node degree: {average_node_degree:.2f}")
print(f"Average neighbor degree: {average_neighbor_degree_overall:.2f}")

if average_neighbor_degree_overall > average_node_degree:
    print("The Friendship Paradox holds: neighbors tend to have more connections.")
else:
    print("The Friendship Paradox does not hold in this case.")
```

88 words

▸ Solution

< go back to overview

Test execution

Information

Availability: Expired at 5/13/2025, 11:59 PM

Max. attempts: Unlimited

Results of this test are visible to administrators and tutors of this course.

Start test

▸ Change log

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