

NAME	Uxxxxxx	GRADE
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Introduction to Networks Science (2024-2025)

MID-TERM EXAM

WRITE YOUR ANSWERS BRIEFLY and CLEARLY IN THE BLANK SPACES. PLEASE: UNDERLINE KEYWORDS IN YOUR ANSWERS, INCLUDE INTERMEDIATE CALCULATIONS, AND CIRCLE THE FINAL RESULT. PLEASE USE ONLY CAPITAL LETTERS.

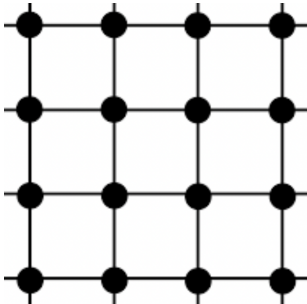
Problem 1

1 point

- a

Consider this *lattice* on the right. Is it usually considered a complex network? Why? (0.5 pts). *Answer:*
- b

Name at least three structural properties of real *complex network*. For each property, define the relevant quantity of interest. (0.5 pts). *Answer:*



Problem 2

2 points

Consider this adjacency matrix on the right.

- a

Which kind of graph does it define (complete or not, directed or undirected, weighted or not) and why? (0.5pts) *Answer:*
- b

What is the minimum in-degree, maximum out-degree, average degree, and total weight in this graph? (0.5pts) *Answer:*
- c

Is this graph strongly connected, weakly connected, or both? (0.5pt)
- d

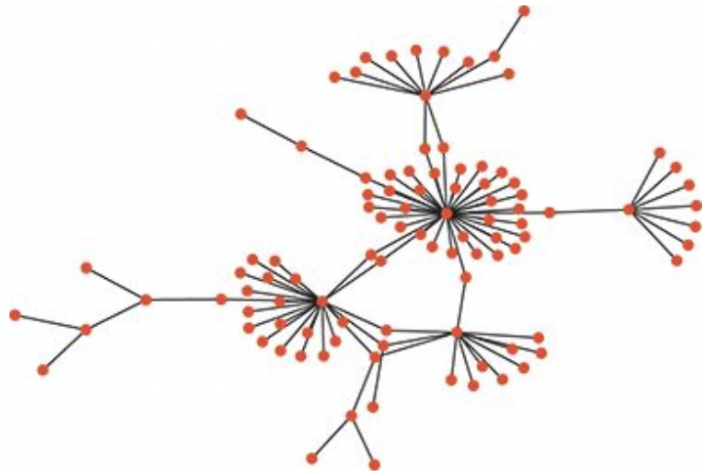
Convert the graph defined by the adjacency matrix to an undirected, unweighted graph. Write here the resulting adjacency matrix (0.5pt) *Answer:*

$$\begin{matrix} & A & B & C & D & E & F \\ \begin{matrix} A \\ B \\ C \\ D \\ E \\ F \end{matrix} & \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 2 & 1 & 3 & 1 & 1 & 0 \end{pmatrix} & \end{matrix}$$

Problem 3

1 point

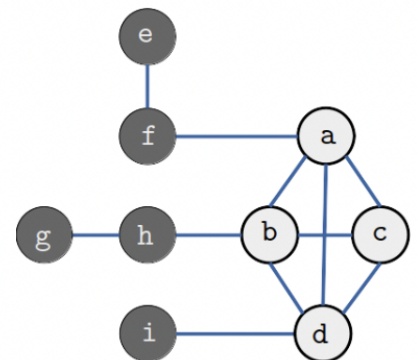
Consider this small graph on the right. What is a reasonable estimate of this network's diameter and why? Draw the path you used to estimate the diameter on the graph. *Answer:*

**Problem 4**

2 point

Consider this small graph on the right, composed of 5 black nodes (group B) and 4 white nodes (group W).

a Compute the local clustering coefficient of each node. (0.5pts) *Answer:*

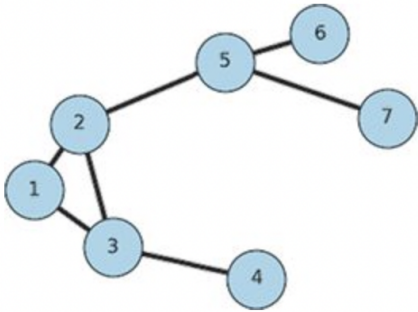


b Compute the average degree of the nearest neighbors of each node. (1pt)
Answer:

c Without performing calculations, indicate which group (W or B) is *homophilic* and why. (0.5pts) *Answer:*

Consider this small graph on the right. Which nodes have...

a the highest degree centrality? Indicate the values. Show calculations. In case of a tie, indicate all the tied top nodes. (0.5pts) *Answer:*



b the highest closeness centrality? Indicate the values. Show calculations. In case of a tie, indicate all the tied top nodes. (0.5pts) *Answer:*

c the highest betweenness centrality? Indicate the values. Show calculations. In case of a tie, indicate all the tied top nodes. (1pt) *Answer:*

Perform 4 iterations of *Simplified PageRank* for the graph on the right. Please express your calculations in *decimal notation* (not as fractions), with 3 digits after the decimal period.

Answer:

Node	Init	Iter 1	Iter 2	Iter 3	Iter 4
a					
b					
c					
d					
e					

