2020 NetSci Midterm Exam

To avoid losing work, note that you can submit and resubmit as many times as you want. Answer each question, then click submit, then click on edit your answer so come back to this screen.

Answer the questions that require a photo AT THE END -- do them on paper first, then upload them during the last 10 minutes of the exam. Those answers cannot be edited. Everything else can be edited.

Use your @estudiant.upf.edu e-mail address

* Required

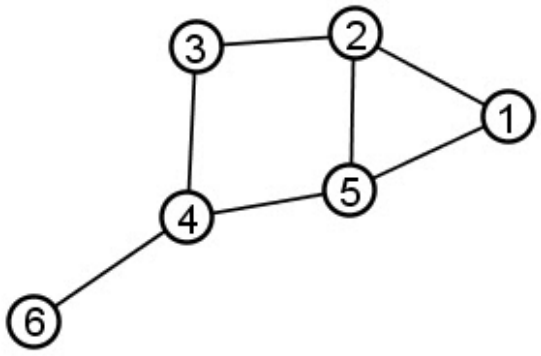
1. Email *

2. Q1. What does it mean that a network is sparse? [1 point]

3. Q2. What is the average degree of nodes in a network having X links and Y nodes? [1 point]

   Answer <k> = _____

4. Q3. Given the network in this image, draw its adjacency matrix [1 point] and its degree distribution [1 point] next to each other, so you can photograph in one photo -- https://drive.google.com/file/d/1DddHBieeUD5_RCoW4rBTXMwspi2KpSLR/view?usp=sharing



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5. Q4. How does a self-loop manifest in the adjacency matrix of a graph? [1 point]

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6. Q5. What is the maximum number of links in a directed graph of X nodes that admits self-loops? [1 point]

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7. Q6. What is the maximum number of links in an undirected graph of X nodes that does not admit self-loops? [1 point]

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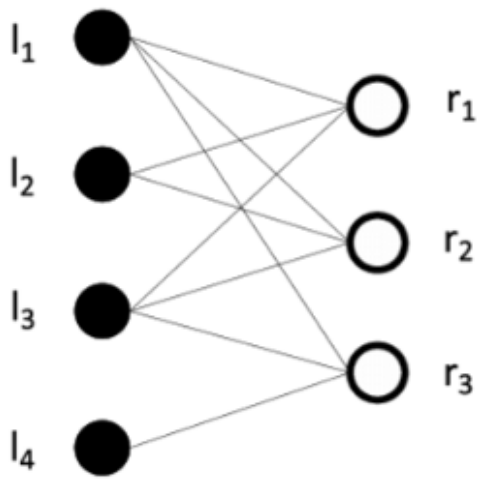
8. Q7. If you consider the left-projection and right-projection of this bi-partite graph https://drive.google.com/file/d/1Z6ZxRp4nlDTMUhdq0kWjFYiEmzS0jcyn/view?usp=sharing [1 point]

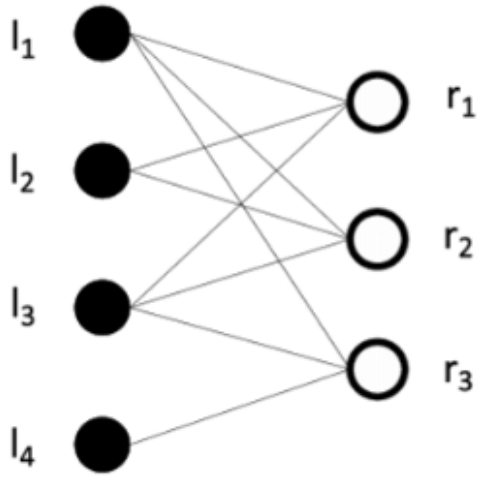


Mark only one oval.

- ◯ The left projection is a complete graph, the right projection is not a complete graph
- ◯ The left projection is not a complete graph, the right projection is a complete graph
- ◯ Both the left and the right projection are complete graphs
- ◯ Neither the left nor the right projection are complete graphs

9. Q8. Considering the same bi-partite graph, what are the maximum values of a,b, such that the graph contains an (a,b)-clique? https://drive.google.com/file/d/1Z6ZxRp4nIDTMUhdq0kWjFYiEmzS0jcyn/view?usp=sharing [1 point]

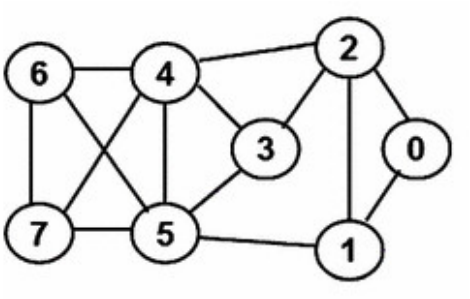
   Answer, e.g., "(500, 120)" (without the quotes)



10. Q9. Why would we use "effective diameter" instead of "diameter" for characterizing some graphs? [1 point]

11. Q10. Indicate the clustering coefficient of each node of this graph https://drive.google.com/file/d/1wgCBwq0VYWsnad7RQqBlqhQuRzxbqB4k/view?usp=sharing [2 points]

    Answer: "C0=___, C1=___, C2=___, C3=___, ..., C7=___" (without the quotes)



12. Q11. What is the expected number of links in an ER network of X nodes and average degree Y? [1 point]

    Answer: "<L>=___" (without the quotes)

13. Q12. What is the difference between the degree distribution produced by an ER network and the degree distribution of a complex network of the kind we find in nature and societies? Give the name of these distributions, and what makes them different. [1 point]

14. Q13. Suppose you have an ER network with average degree 6.3 and 192244 nodes. In which connectivity regime is the network, and why? [1 point]

15. Q14. What is the expected average distance in an ER network of with average degree 6.3 and 192244 nodes? [1 point]
Answer: "<d> = ____" (without the quotes)

16. Q15. If f(k) indicates the probability that a node has degree k, in a typical scale-free network what kind of function is f(k) as a function of k? [1 point]

Mark only one oval.

- Strictly increasing
- Strictly decreasing
- Non-increasing
- Non-decreasing

17. Q16. In a scale-free network of N=1000000 nodes and exponent gamma=2.3, approximately how many nodes do we expect to have degree 10? [1 point] (Riemann's Zeta of 2.3 is approximately 1.43242)

18. Q17. In a scale-free network of X nodes and exponent 2 < gamma < 3, what average distance do we expect? [1 point]
Answer: "<d> = ____" (without the quotes)

19. Q18. Briefly, what does the friendship paradox mean? [1 point]

20. Q19. The BA model is called "preferential" attachment. Why is it called like that, what is that preference, precisely? [1 point]

21. Q20. Briefly, describe the copy model for generating scale-free networks [1 point]

    Answer: "We initialize by _____. For every new node _____" (without the quotes)

22. Q21. Consider a bipartite graph G = (V_L union V_R) where V_L = {a, b, c, d}, and V_R = {1, 2, 3, ..., 10}, so that |V_L|=4, |V_R|=10. Suppose node "a" is connected to nodes 1, 2, 3, ..., 10, node "b" is connected to all even-numbered nodes (2, 4, 6, 8, 10), node "c" to all odd-numbered nodes (1, 3, 5, 7, 9), and node "d" exclusively to node 10. Starting from $\hat{H}(1) = 1$ for i in {a, b, c, d, 1, 2, ..., 10}, compute vectors A(1), $\hat{A}(1)$, and H(2). [3 points, one per each vector]

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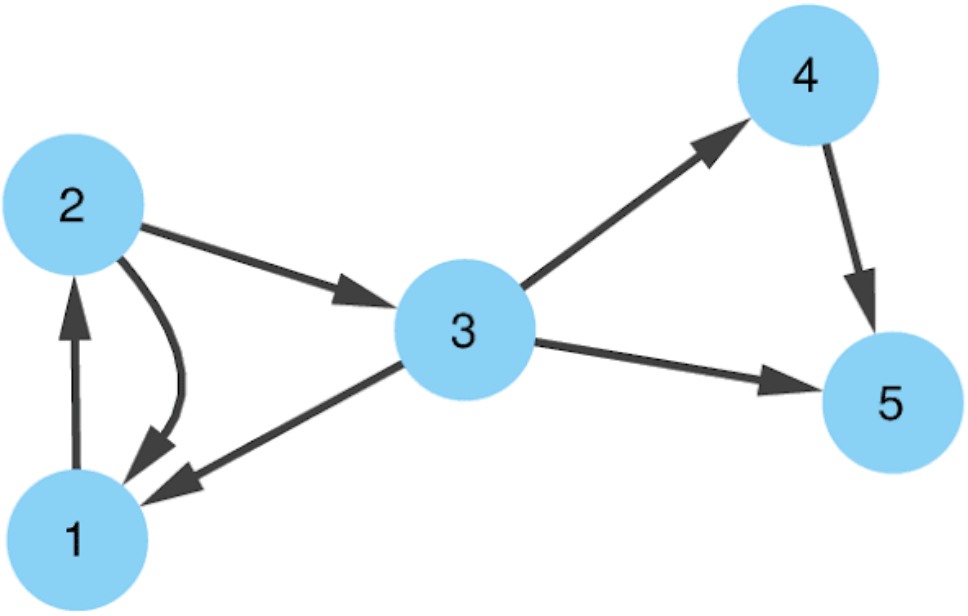
23. Q22. Run Simplified PageRank, starting from vector (1, 1, 1, 1, 1) for 3 iterations. Remember to normalize after each iteration. https://drive.google.com/file/d/1y8H3XrD9di6HzsWu9Eth5F8I0mKW-pyS/view?usp=sharing [3 points, one per each iteration]



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24. Q23. For the same graph, write the PageRank system of equations, with x_i indicating the PageRank of node i. This system has 6 equations, and the last equation is x_1 + x_2 + x_3 + x_4 + x_5 = 1. Assume all edges have the same weight. Separate equations by ";" in the system [1 point]