# Midterm Exam I Topics

## Use Bloom’s Taxonomy verbs to create an exam-like question per topic. Each question is worth 2 points, which will be counted towards your Quiz grade.

1. Complex systems

Describe what a complex system is and provide an example.

How do you think studying of abstract complex systems might be beneficial? Explain with real-life example(s).

Your friend comes to you wanting to create the next big social media application. What type of complex system would best represent a social network and why? What are the nodes and what are the edges?

1. What is a network

A network has a total of 50 nodes. How many components does the graph have given that each node has a degree of k=n, where n is some arbitrary number?

Describe an example of a network that you encounter daily.

1. Representing networks
   1. Adjacency matrix

Given a network in graph format, represent it as an adjacency matrix.

If a network consists of nnumber of nodes, what would be the dimension of the adjacency matrix for that network? If n>>1and the network is very sparsely populated (very few number of edges/ links) , do you think implementing the adjacency matrix by a 2-D array representation would be memory efficient? Why/ Why not?

What does the sparseness of normal networks imply?

* 1. Bipartite networks

Describe what a bipartite network is and provide an example.

Does a binary search tree constitute a bipartite graph? Explain why or why not

Explain the concept of a bipartite network.

Produce two projections of a bipartite graph.

* 1. Directed vs Undirected networks

Provide an example of a directed network and an example of an undirected network. Explain the key difference between your examples that makes them directed/undirected.

Imagine ‘Net A’ and ‘Net B’ are two different networks but with the same number of nodes. Suppose, both of them are fully connected networks. That is, a node in Net Ais connected with all the other nodes in Net A and the same goes for Net B. However, Net A is undirected and Net B is directed. Which of these two networks above would have the higher number of links/ edges? Why?

* 1. Weighted vs Unweighted networks

Which one do you think would be more appropriate choice to represent the network of roads and highways in any state in the USA –(a) Weighted network (b) Unweighted network? Why? Explain what limitation(s) you might face if you make the other choice.

Evaluate the diameter of the following weighted and unweighted networks; the longest shortest path between two nodes.

1. Network degree

You are examining two directed networks representing the food chains of two ecosystems, where nodes are species and edges indicate which species they feed upon. One network has a much higher average degree than the other.Appraise the stability of these two ecosystems in relation to one another.

Explain how a node with a very high degree can become a vulnerability in any kind of network?

Suppose a network of 8 nodes consists of a single component. What is the maximum degree any one node can have?

1. Pathology
   1. Distances

A basic intra-city navigation app is built on a weighted network which represents intersections and destinations as nodes, and roads as links with the length of roads being the link’s weight.The app calculates distance between the user’s current location and their destination using a quick shortestpath algorithm.Judge how wellthe shortest path as calculated by the app would correlate to the shortest path in real life.

Evaluate the diameter of the given graph.

In graph A, what is the distance between node 0 and node 12? \*graph A would be on the bottom of the page\*

In the following weighted network, compute the geodesic distance of node N and M, and the average path length.

* 1. Routes

Please provide three networks that have a Eulerian path. For each, provide the path in the form of A->B->C...etc.

* 1. Dijkstra’s shortest path algorithm

Using Dijkstra’s shortest path algorithm, write a pseudocode function which takes a network, a starting point, and an ending point, and finds the length of the shortest path between the starting and ending point. Assume that the function willbe ran on an undirected, unweighted network.

In case of an unweighted network, what does the output of Dijkstra's shortest path algorithm for a node tells you?

Given the following graph, use Dijkstra's algorithm to find the shortest path. Show all steps.

Summarize in plain English how Dijkstra’s algorithm is used to find the shortest path between two given nodes.

* 1. Cycles

’Cycles can never occur in a directed graph’ -is this staetment true or false? Explain with example.

Given an arbitrary graph G, is there a path through the network such that it forms a Eulerian cycle? If so, please provide the path.

Why don’t we count cycles when finding paths?

1. Connectedness

How the info about the state of connectedness of any network be useful?

In the context of a complex system, what might be one of the reasons why understanding the connectivity of graph would be important? Provide an example

Desribe three metrics used to determine the connectedness of a network.

Produce a network such that there exists 3 bridges among 8 nodes.

1. Clustering Coefficients

Contrast the meaning of a node’s degree distributions with a node’sclustering coefficient.

Explain how clustering coefficients (local/ average) can help you in deciding alternate routes while traversing a network?

Find the clustering coefficient of three nodes in the network. What does this say about how critical they are for redundancy?

What does the clustering coeffiecient tell you about a network bridge?

Interpret what it means if a network has an average clustering coefficient of 1.

Calculate the clustering coefficients of each node

What are the local and global measurements of the clustering of nodes in a graph?

## Vocabulary (in no particular order)

network

link

node

degree

adjacency matrix

bipartite

directed

undirected

cycle

path

Hamiltonian path

Eulerian path

diameter

average path length

average degree

degree distribution

shortest path

Dijkstra’s SPA

geodesic distance

complex system