1. Given the friendship graph below, calculate and plot the degree distribution of the graph. Be sure to label the plot axes.

A whiteboard with blue writing on it

Description automatically generated

1. Draw the graph specified in the adjacency matrix below. Is this graph connected? If yes, is it weakly connected or strongly connected? Note that aij is the weight of the edge from vi to vj

A whiteboard with blue text and a diagram

Description automatically generated

1. Use Dijkstra’s or Prim’s Algorithm to create a shortest path table for the friend graph from problem 1. What is the diameter of this graph? Show a minimum spanning tree of this graph as an adjacency matrix.

I am using python with netwrokx library to replicate the graph and get the answers.

The adjacency matrix used to create the graph is listed below from the

**order or rows** as cindy, alfredo, komal , Akshat, priyanka, tushar, Nicholas, ahmed, wushang, Layla.

**Order of columns** as cindy, alfredo, komal , Akshat, priyanka, tushar, Nicholas, ahmed, wushang, Layla.

The graph is represented as nodes cindy =0, alfredo = 1, komal =2 … and so on.

A screen shot of a computer

Description automatically generated

A computer screen shot of text

Description automatically generated

A diagram of a graph

Description automatically generated

Now that we have the graph, we generate the minimum spanning tree using the network library nx.minimum\_spanning\_tree () 🡪 it uses prim’s algorithm internally to generate the MST.

A computer screen shot of text

Description automatically generated

A diagram of a graph

Description automatically generated

Now the diameter of the graph  
A black screen with yellow and white text

Description automatically generated

As per the results 🡪 The diameter of the graph is 3.

MST in the form of adjacency matrix is shown below,

A grid with blue dots

Description automatically generated with medium confidence

1. Given the following flow network from v0 (source) to v7 (sink), use the Ford-Fulkerson algorithm to determine the maximum flow. Provide the resulting flow, and draw and label the flow network and residual network. Edge list: {(v0,v1,1),(v0,v2,3),(v0,v3,3),(v1,v6,4),(v2,v1,2),(v2,v5,1),(v3,v2,3),(v3,v4,2),(v4,v7,4), (v5,v1,5),(v5,v4,3),(v5,v7,3),(v6,v2,3),(v6,v5,2),(v6,v7,3)}

A whiteboard with colorful lines and numbers

Description automatically generated

Max flow is from source to sink is 6.

A diagram of a diagram

Description automatically generated

1. For the friendship graph in problem 1, calculate the degree centrality, betweenness centrality and closeness centrality for each node. Provide a table showing the rank of each node for each measure.

**Degree centrality**

A computer screen shot of a program

Description automatically generated

**Betweenness centrality**A screenshot of a computer program

Description automatically generated

**Closeness Centrality**A screen shot of a computer

Description automatically generated

**Rank table:**

| **Node** | **Degree Centrality Rank** | **Betweenness Centrality Rank** | **Closeness Centrality Rank** |
| --- | --- | --- | --- |
| 0 | 3 | 3 | 2 |
| 1 | 8 | 8 | 9 |
| 2 | 4 | 6 | 7 |
| 3 | 8 | 10 | 9 |
| 4 | 4 | 4 | 4 |
| 5 | 4 | 5 | 4 |
| 6 | 1 | 2 | 2 |
| 7 | 8 | 9 | 7 |
| 8 | 1 | 1 | 1 |
| 9 | 4 | 7 | 4 |

1. For the friendship graph in problem 1, what is the clustering coefficient?

As the given question is unclear, I am calculating both local (each node) and global clustering coefficients.A screenshot of a computer program

Description automatically generated

1. For the friendship graph in problem 1, assume that Cindy is a foe of Nicholas and Priyanka, Tushar is a foe of Wusheng and Komal and all the other edges in the graph represent friendship. According to social balance theory, is this new friend/foe graph balanced?

Not balanced.

A screen shot of a computer program

Description automatically generated

1. A diagram of a graph

   Description automatically generated
2. A computer screen shot of a code

   Description automatically generated
3. A screenshot of a computer

   Description automatically generated
4. A screenshot of a computer code

   Description automatically generated
5. A screen shot of a computer

   Description automatically generated

When designing a classifier to decide on admissions for a CS graduate program, the following pieces of information from the application could be used as input:

**Final Grade Point Average (GPA):**

Cleaning/Transformation: Normalize the GPA on a common scale (e.g., 0 to 4) if different schools have different grading scales. Handle missing values appropriately.

Data Type: Ratio, because GPA has a true zero point and the intervals between values are equivalent.

**Transcript:**

Cleaning/Transformation: Extract relevant courses related to computer science and their grades. Calculate the GPA for these courses separately as a 'CS-related GPA'.

Data Type: Ratio, similar to the overall GPA, but more focused on the subject matter relevant to the program.

**Address:**

Cleaning/Transformation: Geocode addresses to determine the student's country or region. This can help identify diversity in the student body or give context to the educational background.

Data Type: Nominal, as countries and regions are categories without inherent order.

**Mobile Phone Number:**

Cleaning/Transformation: Likely not useful for classification purposes, except perhaps to extract country codes as a proxy for location if the address is missing.

Data Type: Nominal, as the numbers are used to label or identify.

Three additional pieces of information that would be helpful:

**Letters of Recommendation:**

Why Helpful: They provide qualitative assessments of the student's abilities, work ethic, and potential for success in graduate studies.

Data Type: Could be treated as ordinal if a rating system is applied based on the positivity of the recommendation.

**Research Experience:**

Why Helpful: Practical experience, especially in research, can be a strong predictor of success in a graduate program that is research-oriented.

Data Type: Ordinal, if categorized by extent and relevance of research experience.

**Statement of Purpose (SoP):**

Why Helpful: The SoP can provide insight into the student's goals, motivation, and alignment with the program's objectives.

Data Type: Nominal, although it may require natural language processing to extract themes or keywords that could then be used for classification.

**Standardized Test Scores (e.g., GRE):**

Why Helpful: They offer a common measure to compare applicants' quantitative, verbal, and analytical skills.

Data Type: Ratio, as scores are measured on a continuous scale with equal intervals and a true zero point.

**Undergraduate Institution Reputation**:

Why Helpful: The reputation or ranking of the undergraduate institution may correlate with the preparedness and quality of the students.

Data Type: Ordinal, if categorized into tiers or rankings.