

Analysis of a Research Group Network(22424288)

1. Objective and Methodology

1.1 Objective

The objective of this report is to construct and analyze a directed graph representing the relationships among five members of our research group. By computing key graph metrics such as the number of nodes, number of edges, degree distribution, and presence of isolated nodes, the analysis seeks to provide insights into the structure and characteristics of the group's interaction network.

1.2 Methodology

The network was constructed using the Python networkx library. The following steps summarize the modelling approach:

1. Graph Model:

A *directed graph* (`nx.DiGraph`) was selected to represent the relationships. This model is suitable because interactions within a group may not always be reciprocal. For example, "Gidi asks Dominic for help" is a different relationship from "Dominic asks Gidi for help."

2. Nodes:

Five nodes were created, each representing a member of the research group: *Gidi*, *Dominic*, *Kharis*, *Adams*, and *Isaac*.

3. Edges:

The network was constructed as a complete directed graph. Every member was connected to every other member with a directional edge. This represents a fully interconnected structure where each person has a directed relationship with all other members.

Because the graph is directed, two edges exist between any pair of individuals—one in each direction.

2. Network Computation and Interpretation

2.1 Number of Nodes

Computation: `DG.number_of_nodes()`. Result: 5

The graph contains five distinct entities, corresponding to the five members of the research group.

2.2 Number of Edges

Computation: `DG.number_of_edges()`. Result: 20

A directed complete graph with N nodes has $N(N-1)$ edges.

For this network: $5(5-1) = 20$

This confirms that each member is connected to every other member in both directions. For example, "Gidi → Dominic" and "Dominic → Gidi" count as two separate edges. The large number of edges relative to the number of nodes indicates a highly dense network with maximum possible connectivity.

2.3 Degree Distribution

In a directed graph, each node has an in-degree (incoming edges) and an out-degree (outgoing edges).

Computation: `DG.in_degree()` and `DG.out_degree()`

Result: In-degree = 4 for every node. Out-degree = 4 for every node

The uniformity of the degree distribution shows that every member receives connections from all four colleagues and also sends connections to all four. No member has a higher or lower degree than others. This indicates a completely symmetrical and non-hierarchical structure where all members play an equally connected role in the network.

3. Visualizing the Network

Interpretation of the Visualization

The resulting figure appears as a pentagon with multiple intersecting arrows, forming a pentagram-like structure. The visual output reinforces the computational findings:

High Density: The large number of bidirectional edges creates a visually dense diagram, reflecting the fully interconnected nature of the group.

Symmetry: The automatic layout generated by `networkx` for small complete graphs produces an evenly spaced circular arrangement. This symmetry emphasizes that no single member occupies a central or peripheral position.

Reciprocal Relationships: The arrows pointing in both directions between each pair of nodes illustrate the reciprocal nature of all interactions in the network.

4. Conclusion and Summary

This analysis modeled a five-member research group as a complete directed graph to examine the structure of their relationships. The key findings are as follows:

Perfect Cohesion: The group forms a single, fully connected clique. Every member interacts directly with every other member.

No Hierarchical Structure: The uniform degree distribution indicates that no node is more central or influential than the others. The network demonstrates a flat and collaborative structure.

Complete Integration: With no isolated nodes, all members are fully integrated into the group's communication and interaction system.

From a theoretical perspective, such a network supports rapid and efficient information flow. Since every individual has a direct connection to all others, communication barriers are minimal, and collaboration is maximized.

Overall, the network represents a highly cohesive, balanced, and well-integrated research group with equal participation and strong interpersonal connections.