SOCIAL NETWORK ANALYSIS
BATMAN RETURNS

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Social Network Analysis - Batman Returns 1992

1. **Question 1:**
   A. **High Degree, Low Closeness, Low Betweenness –**
   An example character - The Penguin.
   Penguin has brief interactions with many different groups in Gotham (eg criminals, politicians, and business leaders), making him a central figure in those interactions:
   - **High Degree -** Penguin has direct interactions with many characters but does not develop deep or lasting relationships, illustrating a high degree of connectedness.
   - **Low Proximity -** Despite its many ties, it is not particularly close to any group, symbolized by a greater average distance between it and other nodes in terms of relational depth or trust.
   - **Low Betweenness –** If these relationships do not necessarily rely on it to interact with each other (they may have separate encounters or interactions independent of it), then its betweenness centrality remains low.

   B. **High Closeness, Low Degree, Low Betweenness –**
   An example character - Alfred.
   Batman's butler often plays a role where he is closely involved with several key characters, such as Bruce Wayne and occasionally with others such as Commissioner Gordon.
   - **High Closeness -** Alfred has a close relationship with Bruce, which places him at the center of Bruce's personal network, allowing for quick communication or influence.
   - **Low Degree -** Does not have many relationships or connections outside of this close-knit circle.
   - **Low betweenness -** Alfred's role is more supportive and less strategic, meaning he is rarely a bridge for critical information between groups or other characters, hence lower betweenness.

   C. **High Betweenness, Low Degree, Low Closeness –**
   An example character - Catwoman.
   - **High Betweenness** - Catwoman can be seen as important in the dynamic between Batman and Penguin. Often in a situation where her actions or decisions affect both parties.
   - **Low Degree** - Despite her central role, she doesn't form many alliances or friendships, which keeps her real connections limited.
   - **Low Closeness** - Her relationships with Batman and Penguin are complex and not based on trust or kinship, reflecting larger average distances in relational terms within the network.

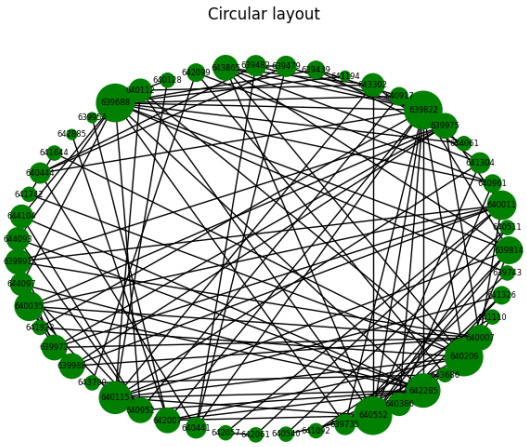
   D. **Number Of Nodes** – 51, **Number Of Edges** – 124.

2. Question 2: Different Visualizations

A. Circular Layout –

Nodes are evenly spaced around a circle, making it easy to see all nodes and their labels. Edges between nodes overlap significantly, which can make it difficult to track specific connections, especially in the center.

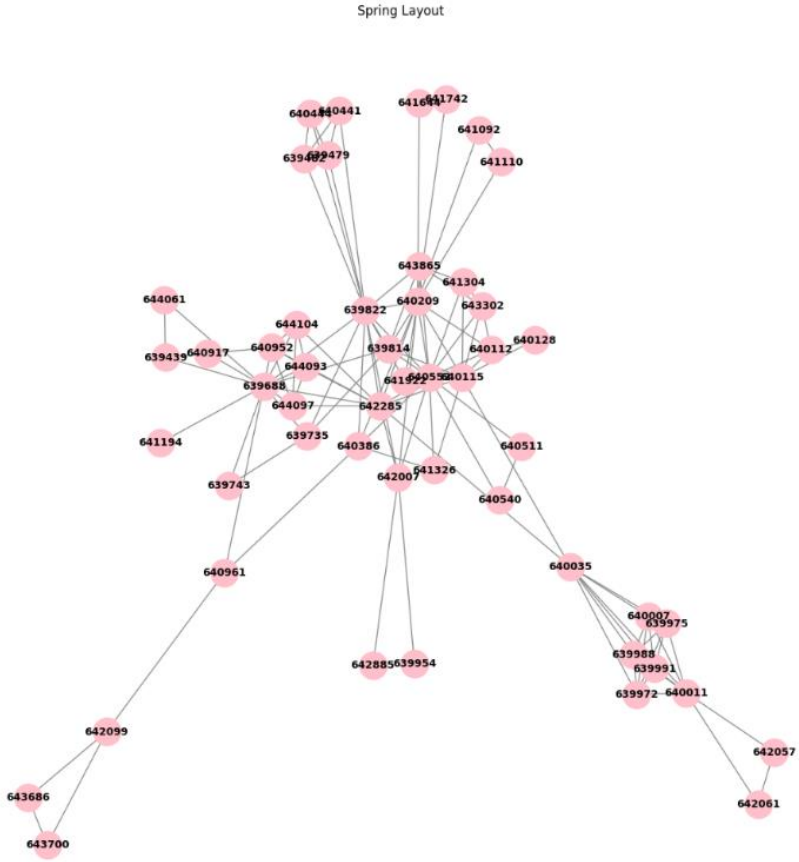
Advantages - Excellent for displaying all nodes and their labels equally, ensuring that no node is pushed to the margins.



B. Spring Layout –

Nodes are placed based on their connections, with a natural clustering effect that pulls connected nodes together while pushing less connected nodes apart. A more visually appealing layout, with clear clusters and separations between groups of nodes.

Advantages - Highlights clusters within the network, showing which nodes are more connected.



C. K

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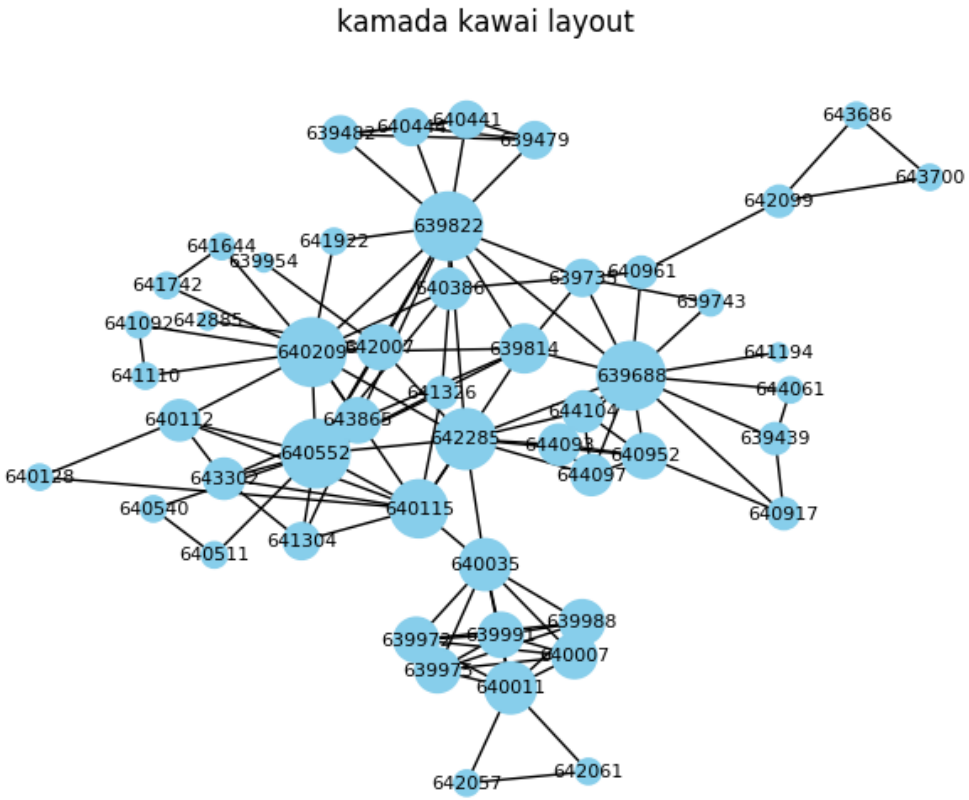
other, like charged particles, while the edges act as springs connecting these particles. This layout tends to spread nodes more evenly than the spring layout, reducing overlap and potentially making the grid more readable. **Advantages** - Good at showing true distances and relationships between nodes, which can be essential to understanding the underlying dynamics of the network.

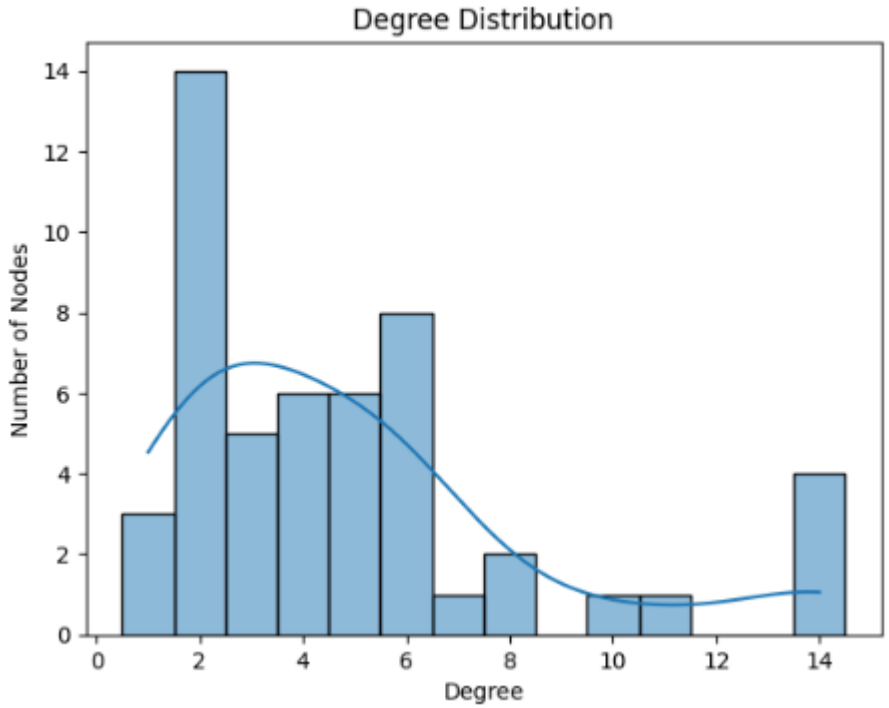


D. Conclusion - My goal is to get a clear view of how nodes are interconnected and to analyze the structural characteristics of the network, so the Kamada-Kawai layout is the most efficient. This avoids the visual clutter of the circular layout and provides a more balanced view than the spring layout, making it suitable for detailed structural analyses.

3. Question 3: Statistics

A. **Network Density –** 0.09725490196078432

B. **Degree Distribution –**



C. **Conclusions:**

- Most notes have a low number of connections (degrees), as shown by the 2-degree high bar. This suggests that most characters only interact with a few others.
- There are some highly connected figures, as indicated by the bars at higher ranks (eg, around 10 and 14). These characters are probably central to the plot, and act as main nodes or foci in the network of relationships.

4. Question 4: Analyzing Key Network Metrics

A. **Average Closeness Centrality:** 0.34811609540685357

B. **Minimum Closeness Centrality:** 0.21551724137931033

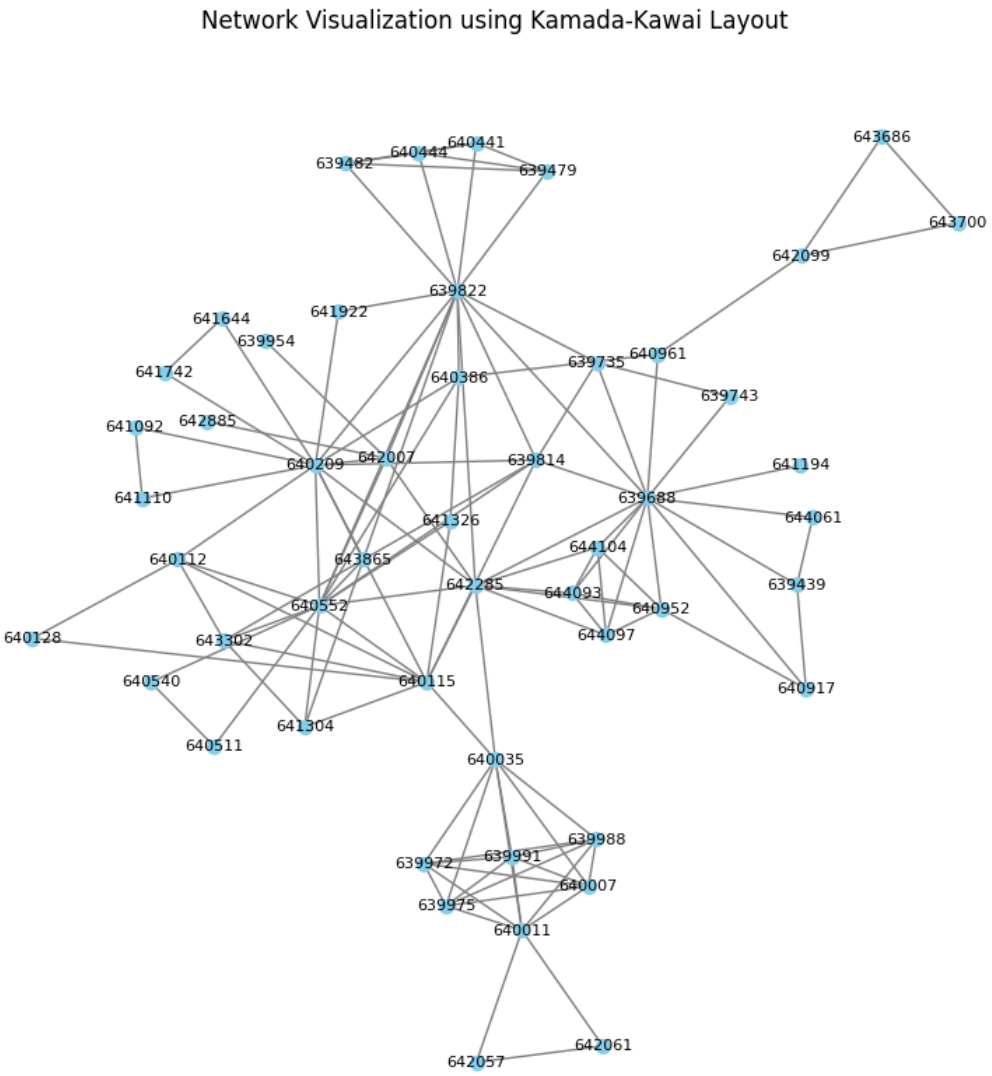
C. **Average Degree Centrality:** 0.09725490196078435

D. **Minimum Degree Centrality:** 0.02

E. **Maximum Degree Centrality:** 0.28

F. **Average Clustering Coefficient:** 0.717590035237094

5. Question 5: Remove isolated nodes

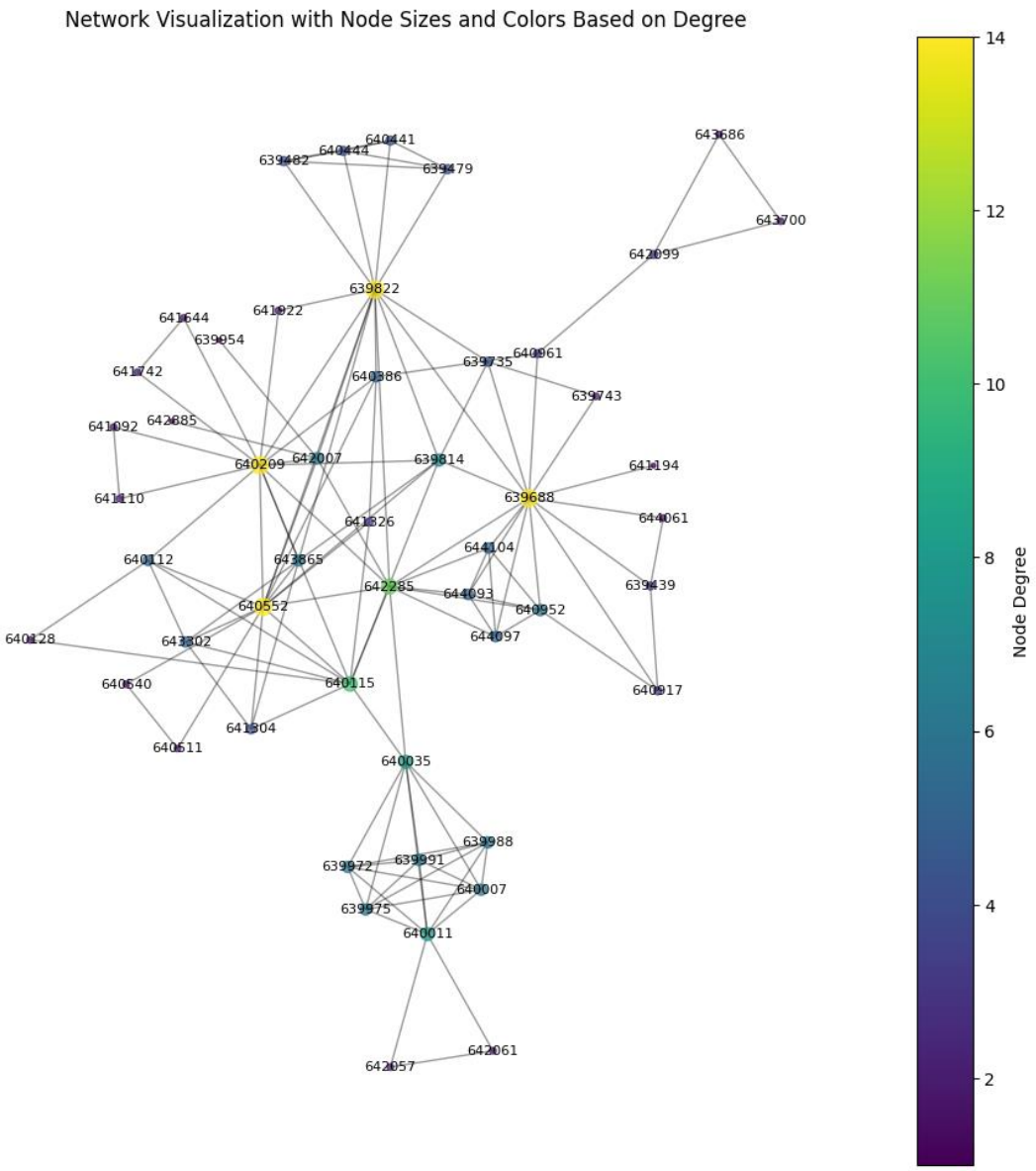


6. Question 6: Connected Components and Largest Component Fraction in the Network

A. **The relative size is equal to 1**, which means that this component includes every node in every network. There are no isolated nodes or separate small groups, and the network is completely interconnected. This connectivity may not necessarily mean that each character interacts directly with every other character, but it does mean that each character's actions or plot line affect or are linked to the others through a chain of interactions.

B. **This component consists of 51 nodes.** There are 51 characters in the film that are connected to each other, directly or indirectly within this component.

7. Question 7:

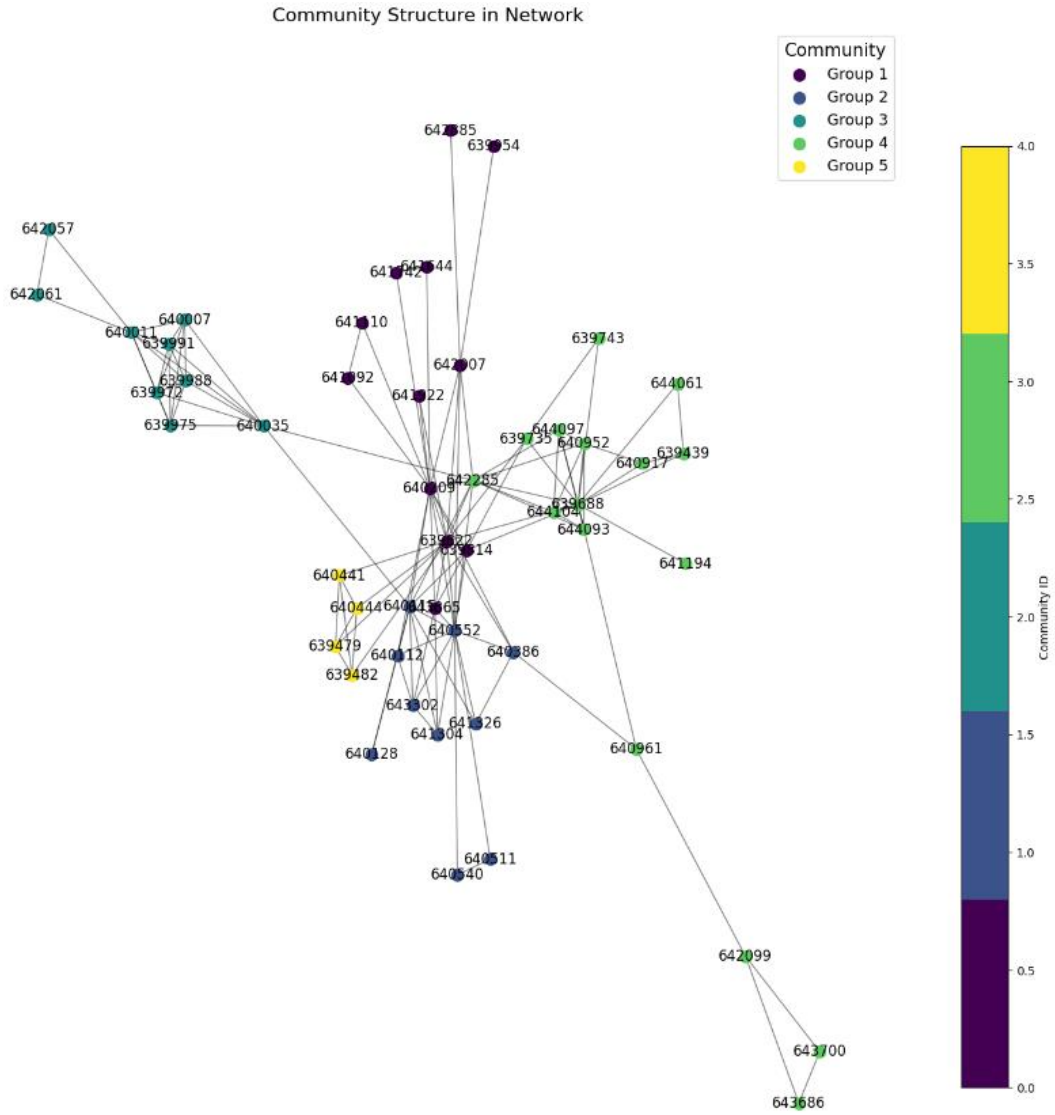

Network Visualization with Node Sizes and Colors Based on Degree
Node Degree
14
12
10
8
6
4
2
640441
640444
639482
639479
643686
643700
642099
639822
641644
641922
639954
640961
639735
641742
640386
639743
641092
642885
642007
640269
639814
641194
641110
639688
641826
644061
644104
640112
643865
642285
644093
639439
640552
640952
640128
643302
644097
640640
640115
640917
641304
640511
640035
639988
639991
639972
640007
639975
640011
642061
642057

8. Question 8: Split the network into groups (communities)

A. The nodes are colored based on the community they belong to. Each color represents a different group, indicating that nodes within the same color (community) are more densely connected to each other than to nodes in other communities.

B. There are visible lines connecting nodes from different communities, indicating interaction or relationships between different groups.

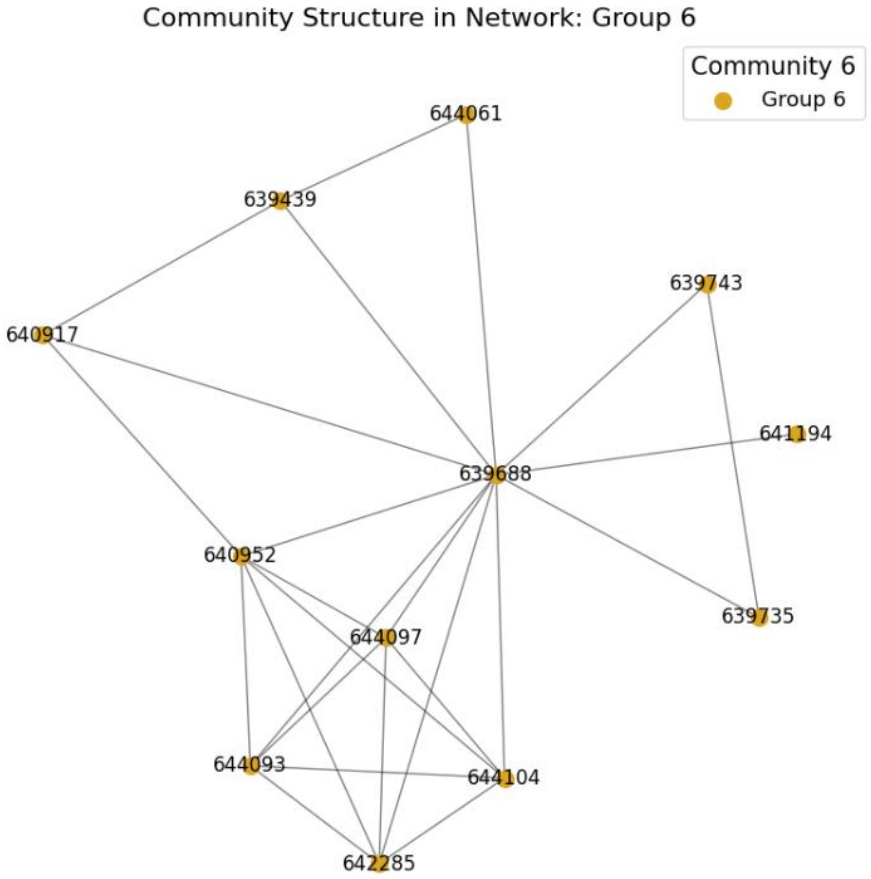
C. Some nodes seem more central within their communities and may play key roles in their groups. These nodes may be influencers or hubs within their communities, essential to the flow of information or resources.



D. I found 6 groups; these are the nodes in each group:

- **Group 1:** ['639814', '639822', '643865', '639954', '642885', '641644', '641742', '641922', '642007', '641092', '640209', '641110']
- **Group 2:** ['640011', '639975', '639991', '640035', '639972', '639988', '642057', '642061', '640007']
- **Group 3:** ['639479', '639482', '640444', '640441']
- **Group 4:** ['640961', '642099', '643700', '643686']
- **Group 5:** ['640511', '641304', '643302', '640128', '640112', '640115', '640540', '640552', '640386', '641326']
- **Group 6:** ['644061', '640917', '641194', '639439', '639688', '644104', '644093', '644097', '640952', '639735', '642285', '639743']

9. Question 9: Filter Group 6



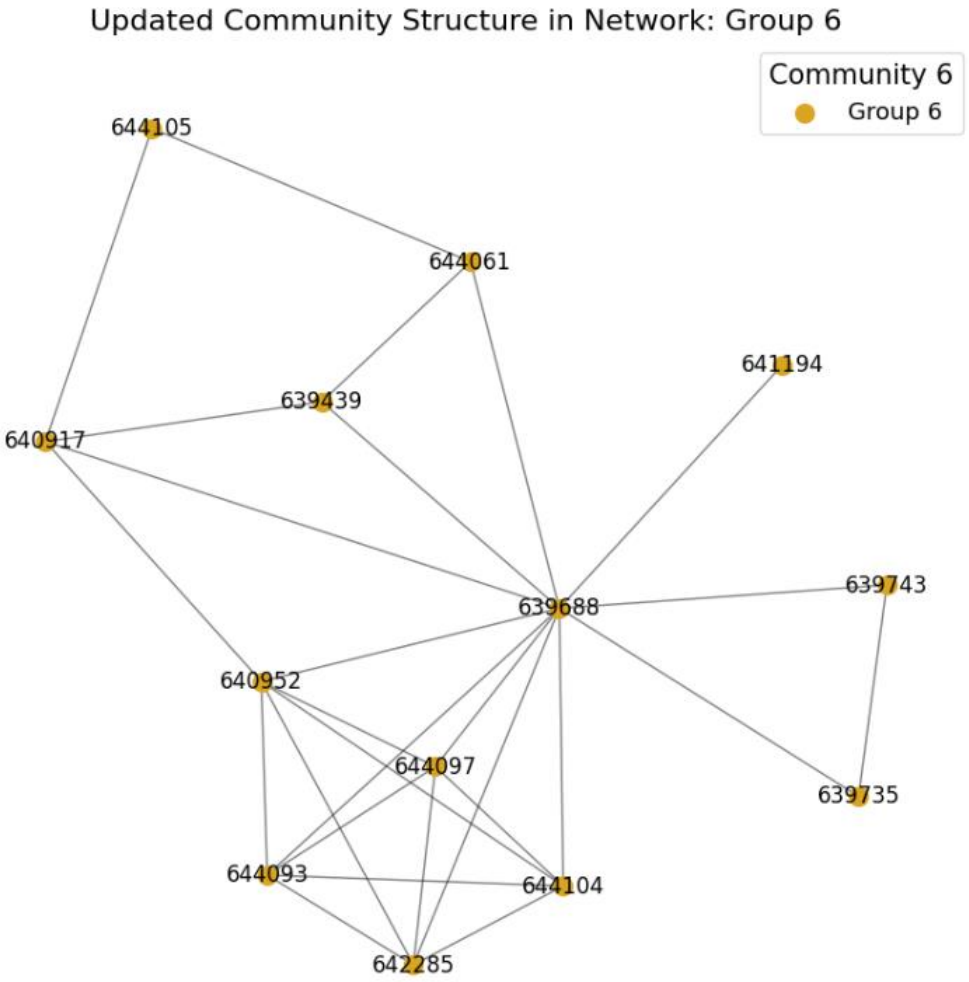
A. Group 6 Stats:

- **Number of Nodes:** 12
- **Number of Edges:** 25
- **Network Density:** 0.3788
- **Average Degree Centrality:** 0.3788
- **Average Closeness Centrality:** 0.6340
- **Average Betweenness Centrality:** 0.0621
- **Average Clustering Coefficient:** 0.7768

B. **Stats For All Batman Returns:**

- **Average Closeness Centrality:** 0.34811609540685357
- **Average Degree Centrality:** 0.09725490196078435
- **Average Clustering Coefficient:** 0.717590035237094

10. Question 10: adding node



A. New Stats:

- Number of Nodes: 13
- Number of Edges: 27
- Network Density: 0.3462
- Average Degree Centrality: 0.3462
- Average Closeness Centrality: 0.5915
- Average Betweenness Centrality: 0.0676
- Average Clustering Coefficient: 0.6401

B. Conclusions -

- **The mesh density has decreased from 0.3788 to 0.3462 -** This indicates that the mesh is becoming slightly less tight as it grows.
- **Average degree centrality decreased from 0.3788 to 0.3462 -** This indicates that, on average, nodes have fewer connections relative to the total possible, consistent with the increase in nodes and a less dense network.
- **Average closeness centrality decreased from 0.6340 to 0.5915 -** Nodes, on average, are now further apart in terms of path lengths, which can affect the speed of communication or interaction within the network.
- There is a significant decrease in the average clustering coefficient from 0.7768 to 0.6401 - this decrease indicates that there are fewer clusters around the new node compared to the existing nodes, which may imply that the new node is less integrated into tight cliques or subgroups within the network.

11. Question 11: Research Question

A. The Question is "**What factors predict the likelihood of nodes belonging to a particular community?**"

B. General conclusions:

- **Low Clustering** - The characters in "Batman Returns" tend not to form tight groups or clusters. This suggests that although characters interact, they do not form cohesive groups or alliances. For example, Batman, Penguin, and Catwoman interact with many other characters, but do not have a single group that they stay with throughout the film. This reflects the complex and sometimes contradictory relationships seen in the narrative.
- **Low-level centrality but strategic centrality** - Although individual characters such as Batman or Penguin do not have the highest number of direct ties (they are not involved in every interaction), they are strategically located within the network. This means they can easily reach or affect other characters in fewer steps, reflecting their central roles in the plot. For example, Batman may not interact directly with every minor character, but his actions affect them all.