

Graph Theory Project

SNA & Measurement



Submitted by:

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Task 1: Network Analysis Metrics of the Graph: Average Degree, Clustering Coefficient, Path Length, Diameter, Highest/Lowest Degree Nodes

SEC	Average Degree	Average Clustering Coefficient	Average Path Length	Diameter	Node with highest degree	Node with lowest degree
A	6.42	0.57	2.73	6	623	693
B	9.27	0.60	2.18	4	671	694
AB	8.36	0.54	2.93	6	671	709

The data shows that students in SEC B have the highest average degree, which means they are connected to more edges on average than students in SEC A and SEC AB. This could suggest that they are more likely to collaborate with a larger number of classmates, potentially leading to more diverse and varied learning experiences.

In terms of clustering coefficient, students in SEC A have a slightly lower value compared to students in SEC B and SEC AB, indicating that they are less likely to be connected to each other than students in SEC B. This may suggest a less tightly knit community within the section, but could also foster exposure to a wider range of perspectives and ideas.

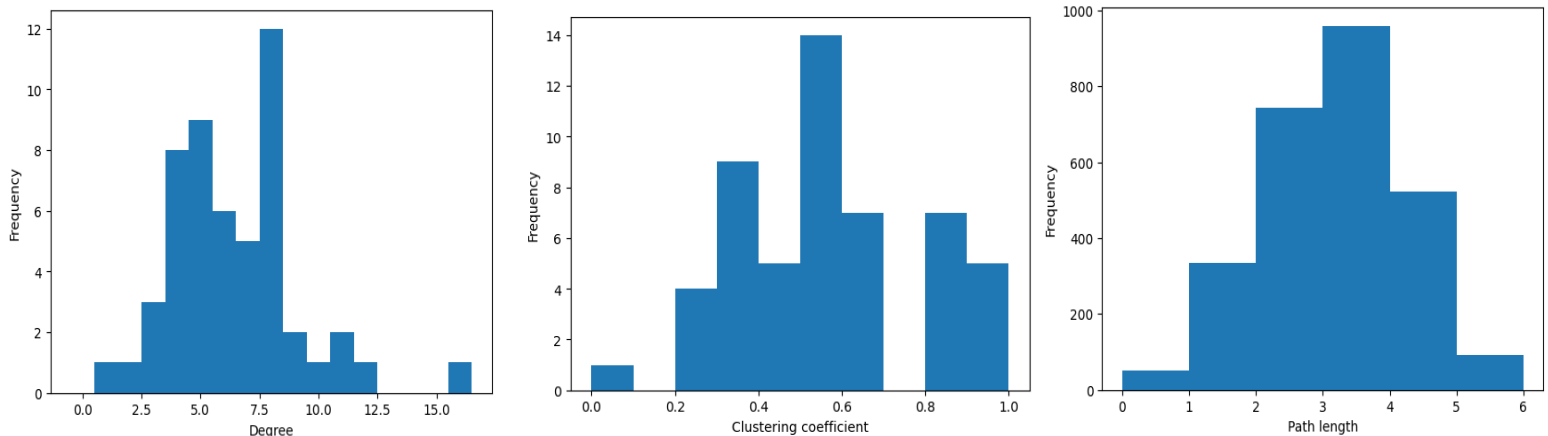
However, the data also reveals that students in SEC B have the lowest average path length, indicating that it takes fewer steps on average to travel from one student to another in this section compared to the other two. This may suggest a more homogeneous and less diverse network of connections, which could limit exposure to different perspectives and ideas.

Furthermore, SEC A and SEC AB both have a larger diameter than SEC B, indicating that the longest path between any two students in these sections is six steps. This could suggest a slightly less tightly knit community within these sections, but also potential exposure to a wider range of perspectives and ideas.

Finally, when comparing SEC AB to its constituent sections, the data reveals that students in SEC AB have a higher average degree and diameter than students in SEC A, but a lower clustering coefficient. This suggests that students in SEC AB are more connected overall, but less likely to be connected to each other than the students in SEC A. This could indicate a more diverse and varied network of connections within SEC AB, which could foster exposure to a wider range of perspectives and ideas.

Task2: Distribution of degree, clustering coefficient and path length of nodes.

Sec A:

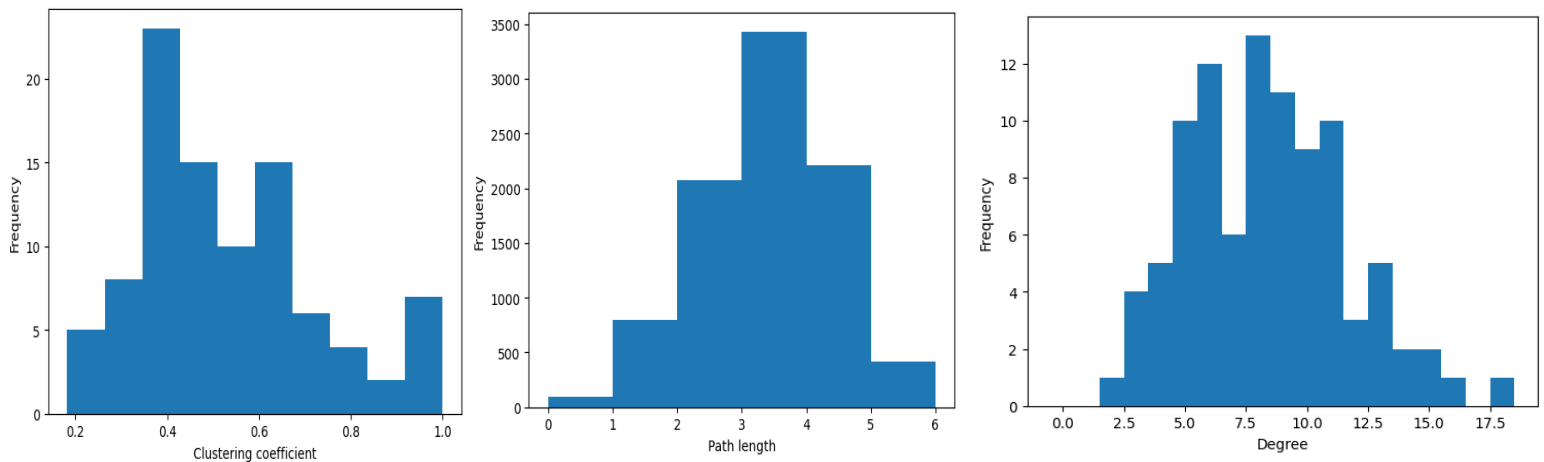


The degree sequence of a graph represents the number of edges connected to each vertex. The given sequence shows that the highest degree is 16, and there are 20 vertices with degree 8. The distribution of the degree coefficient of the graph indicates that it is a scale-free network, which means that a few vertices have a high degree, and the rest have a relatively low degree. This type of distribution is common in many real-world networks, such as social networks and the internet.

The clustering coefficient of a graph represents the tendency of the vertices to form clusters or communities. The given clustering coefficient sequence indicates that the network has a high tendency to form clusters. The clustering coefficient is maximum (1.0) for the vertices with the highest degree (16, 12, 11), indicating that these vertices are part of tightly-knit communities. The average clustering coefficient of the graph is around 0.6, which is relatively high and indicates that the graph has a significant amount of community structure.

The path length sequence of a graph represents the shortest distance between any two vertices. The given sequence shows that the shortest path between most of the vertices is relatively short, with the maximum path length being 11. The average path length of the graph is around 3.5, which is relatively small and indicates that the graph is well connected. This means that most vertices can be reached from any other vertex in the graph with few hops. The graph has some vertices with a path length of 1, which indicates that there are some isolated vertices that are not connected to the main component of the graph.

Sec A&B:

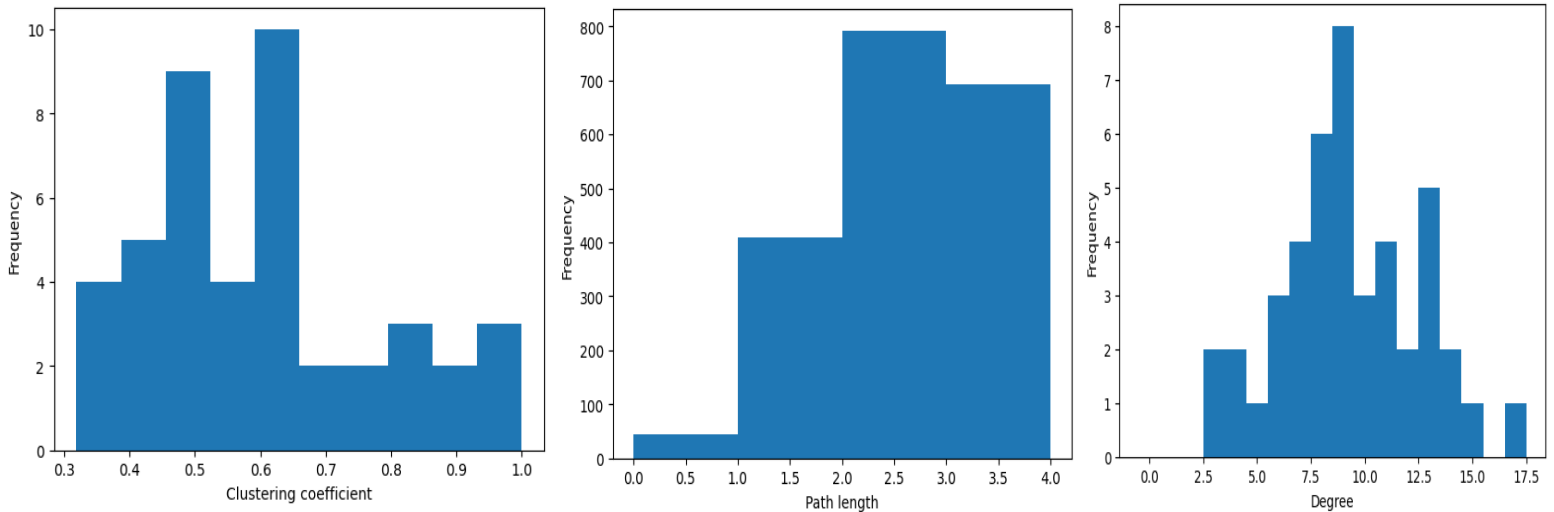


From the degree sequence, we can see that the maximum degree is 18, and there are 11 vertices with degree 13. This suggests that the graph may have a central hub with many edges connecting to a group of peripheral vertices. The degree sequence shows that there are nodes with a wide range of degrees, from 2 to 18. The highest degree is 18, which suggests that there might be one or a few nodes with a high number of connections.

The clustering coefficient sequence is relatively high across the network, with values ranging from 0.181818 to 1.0. This suggests that the nodes are relatively well-connected to each other, forming many triangles and small clusters in the network.

Overall, the degree sequence and clustering coefficient sequence suggest that the network might have a scale-free distribution, meaning that a few nodes have a very high number of connections while the majority of nodes have only a few connections.

SEC B:



The degree sequence of the graph indicates that there are 20 vertices with degree 8, and the highest degree is 16. The distribution of the degree coefficient suggests that the graph is a scale-free network, which is common in real-world networks.

The clustering coefficient sequence shows that the graph has a high tendency to form clusters or communities, with the maximum clustering coefficient of 1.0 for the vertices with the highest degree. The average clustering coefficient of the graph is around 0.6, indicating a significant amount of community structure.

The path length sequence indicates that the shortest path between most vertices is relatively short, with an average path length of around 3.5. This suggests that the graph is well connected, and most vertices can be reached from any other vertex in the graph with few hops. However, there are some isolated vertices that are not connected to the main component of the graph.

Overall, the given characteristics suggest that the graph has a scale-free structure, a significant amount of community structure, and is well connected.

Task 3: Centrality Measures

For Graph A

Degree Centrality		Closeness Centrality		Betweenness Centrality		Eigenvector Centrality		Page Rank Centrality	
Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10
623: 0.314	637: 0.078	623: 0.510	628: 0.321	623: 0.198	612: 0.001	623: 0.370	649: 0.035	623: 0.042	704: 0.014
605: 0.235	615: 0.078	614: 0.468	610: 0.317	622: 0.161	637: 0.001	605: 0.314	640: 0.034	605: 0.031	642: 0.014
648: 0.216	635: 0.078	622: 0.455	625: 0.311	631: 0.110	624: 0.001	620: 0.242	628: 0.030	648: 0.031	615: 0.013
622: 0.216	609: 0.078	605: 0.455	630: 0.304	648: 0.107	606: 0.001	619: 0.240	610: 0.025	622: 0.030	612: 0.013
707: 0.196	649: 0.078	648: 0.451	640: 0.304	707: 0.102	644: 0.000	603: 0.236	625: 0.024	707: 0.027	637: 0.013
791: 0.176	644: 0.059	707: 0.447	709: 0.297	616: 0.099	640: 0.000	648: 0.232	646: 0.022	616: 0.025	644: 0.012
619: 0.176	640: 0.059	631: 0.447	646: 0.293	633: 0.086	642: 0.000	707: 0.223	644: 0.019	791: 0.025	604: 0.012
621: 0.157	604: 0.059	619: 0.443	604: 0.283	619: 0.079	604: 0.000	613: 0.217	604: 0.018	633: 0.024	640: 0.010
614: 0.157	709: 0.039	621: 0.440	644: 0.277	614: 0.079	693: 0.000	614: 0.197	709: 0.018	619: 0.024	709: 0.008
638: 0.157	693: 0.020	634: 0.436	693: 0.263	621: 0.074	709: 0.000	634: 0.184	693: 0.011	631: 0.024	693: 0.006

For graph B:

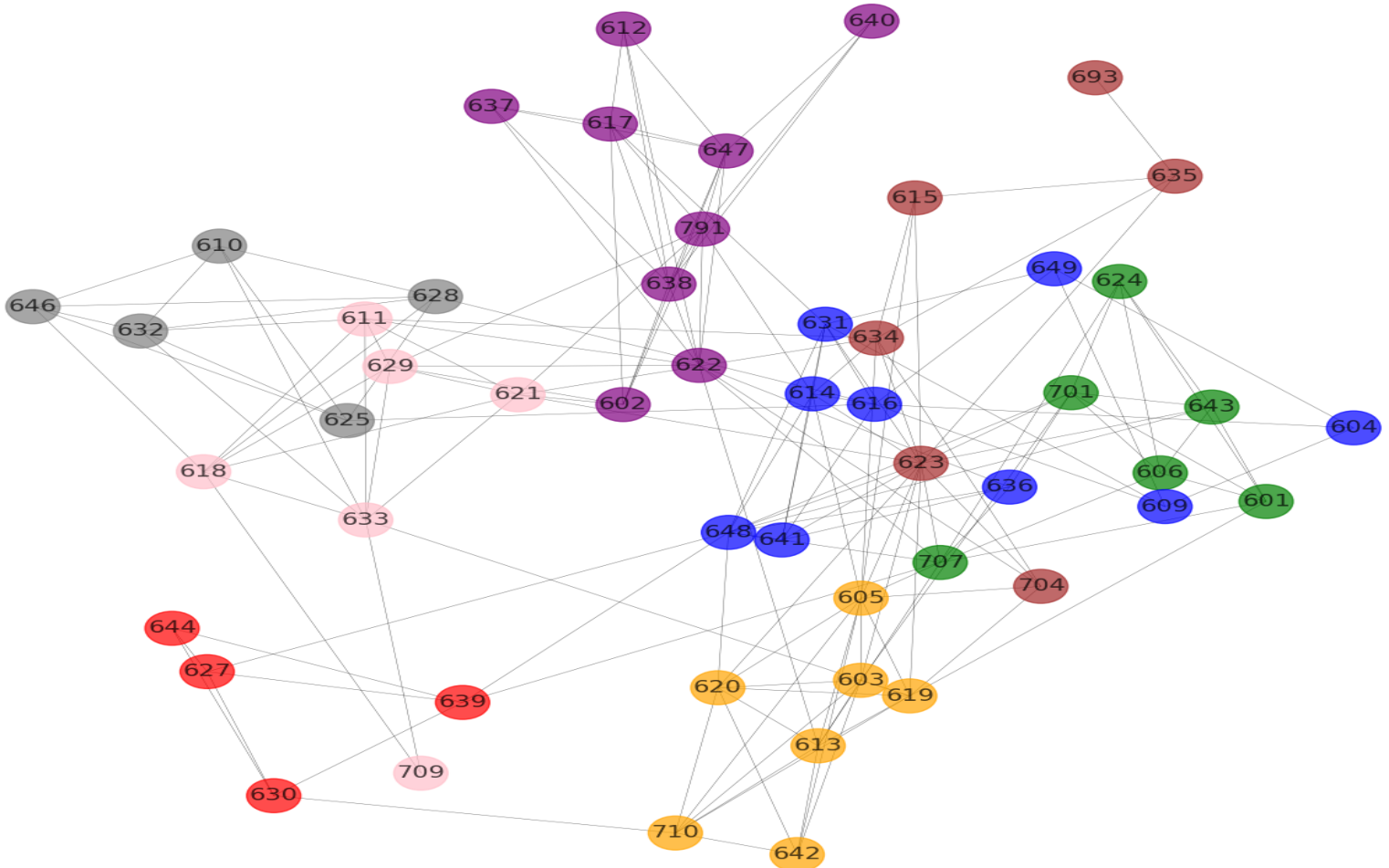
Degree Centrality		Closeness Centrality		Betweenness Centrality		Eigenvector Centrality		Page Rank Centrality	
Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10	Top-10	653: 0.041	Top-10	Bottom-10
671: 0.395	687: 0.163	671: 0.581	657: 0.406	692: 0.126	690: 0.003	671: 0.315	688: 0.036	671: 0.037	669: 0.019
699: 0.349	677: 0.163	699: 0.558	664: 0.406	671: 0.125	693: 0.003	708: 0.267	674: 0.033	692: 0.034	680: 0.017
652: 0.326	666: 0.140	692: 0.544	677: 0.394	703: 0.115	673: 0.002	705: 0.265	657: 0.028	699: 0.034	653: 0.017
692: 0.326	653: 0.140	651: 0.537	683: 0.387	699: 0.082	687: 0.001	652: 0.252	654: 0.028	652: 0.031	675: 0.016
667: 0.302	675: 0.140	652: 0.537	690: 0.387	652: 0.078	675: 0.001	699: 0.234	664: 0.026	662: 0.030	666: 0.015
705: 0.302	683: 0.116	684: 0.531	693: 0.387	660: 0.060	669: 0.001	673: 0.230	690: 0.021	684: 0.030	683: 0.014
708: 0.302	688: 0.093	703: 0.518	670: 0.387	662: 0.058	793: 0.001	667: 0.229	693: 0.021	667: 0.030	688: 0.012
662: 0.302	665: 0.093	708: 0.512	687: 0.384	663: 0.050	694: 0.000	661: 0.228	677: 0.019	663: 0.029	665: 0.012
684: 0.302	694: 0.070	696: 0.512	665: 0.374	651: 0.050	665: 0.000	662: 0.219	687: 0.019	696: 0.028	694: 0.009
663: 0.279	670: 0.070	667: 0.506	694: 0.371	667: 0.046	670: 0.000	700: 0.217	653: 0.041	705: 0.028	670: 0.009

For graph A&B:

Degree Centrality		Closeness Centrality		Betweenness Centrality		Eigenvector Centrality		Page Rank Centrality	
Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10	Top-10	Bottom-10
671: 0.191	665: 0.043	671: 0.425	624: 0.295	616: 0.085	612: 0.000	671: 0.315	632: 0.004	623: 0.020	704: 0.007
623: 0.170	635: 0.043	703: 0.425	627: 0.292	674: 0.077	624: 0.000	708: 0.266	624: 0.003	671: 0.018	683: 0.007
652: 0.160	627: 0.043	674: 0.425	612: 0.284	623: 0.070	675: 0.000	705: 0.262	630: 0.003	652: 0.016	612: 0.006
699: 0.160	630: 0.043	634: 0.410	610: 0.281	652: 0.070	694: 0.000	652: 0.253	612: 0.003	699: 0.016	644: 0.006
708: 0.149	612: 0.043	652: 0.407	665: 0.276	692: 0.067	665: 0.000	699: 0.232	610: 0.002	692: 0.015	635: 0.006
692: 0.149	694: 0.032	623: 0.405	694: 0.272	707: 0.064	670: 0.000	673: 0.227	646: 0.002	674: 0.015	665: 0.005
667: 0.138	670: 0.032	692: 0.400	646: 0.270	703: 0.064	644: 0.000	667: 0.226	627: 0.002	605: 0.015	640: 0.005
705: 0.138	644: 0.032	621: 0.400	644: 0.268	622: 0.057	640: 0.000	661: 0.226	640: 0.002	648: 0.015	694: 0.004
662: 0.138	640: 0.032	657: 0.397	640: 0.265	634: 0.054	642: 0.000	662: 0.216	644: 0.001	622: 0.015	670: 0.004
684: 0.138	709: 0.021	631: 0.395	709: 0.253	616: 0.085	709: 0.000	700: 0.214	709: 0.001	707: 0.015	709: 0.004

Task 4: Find Communities In Graph Of Sections

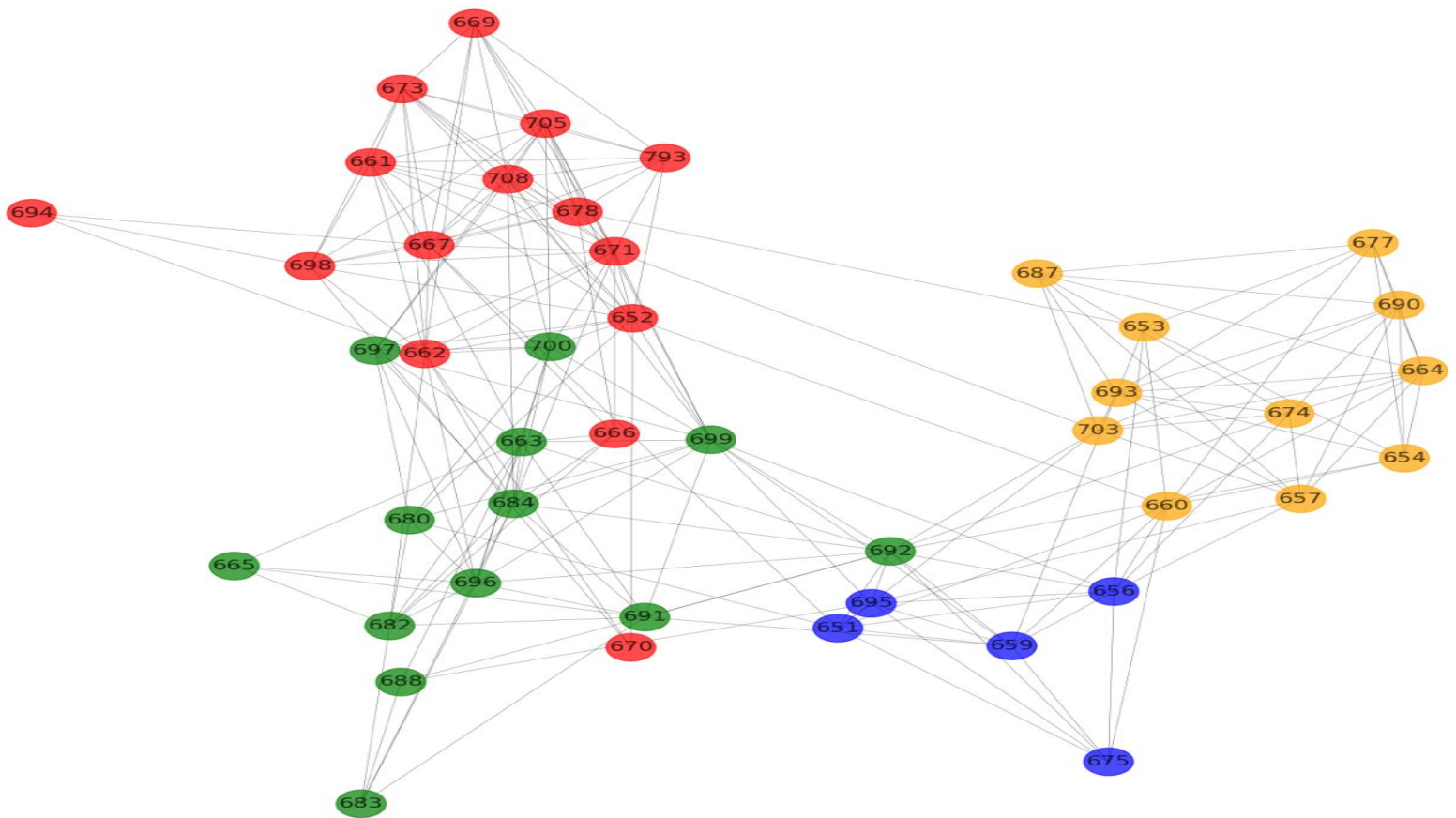
Communities In Section A:



There are a total of 8 communities in the graph of section A, each represented by a different color.

- "Red" community: Consists of 5 nodes (627, 644, 630, 639, 641)
- "Blue" community: Consists of 13 nodes (609, 614, 648, 616, 649, 631, 636, 604, 641, 630, 639, 644, 627)
- "Green" community: Consists of 7 nodes (707, 643, 624, 601, 701, 606, 642)
- "Orange" community: Consists of 7 nodes (613, 710, 619, 620, 603, 605, 640)
- "Purple" community: Consists of 9 nodes (602, 612, 647, 617, 622, 791, 637, 638, 641)
- "Pink" community: Consists of 6 nodes (611, 709, 618, 621, 629, 633)
- "Brown" community: Consists of 6 nodes (704, 615, 623, 693, 634, 635)
- "Grey" community: Consists of 5 nodes (610, 646, 625, 628, 632)

Communities IN SEC B:

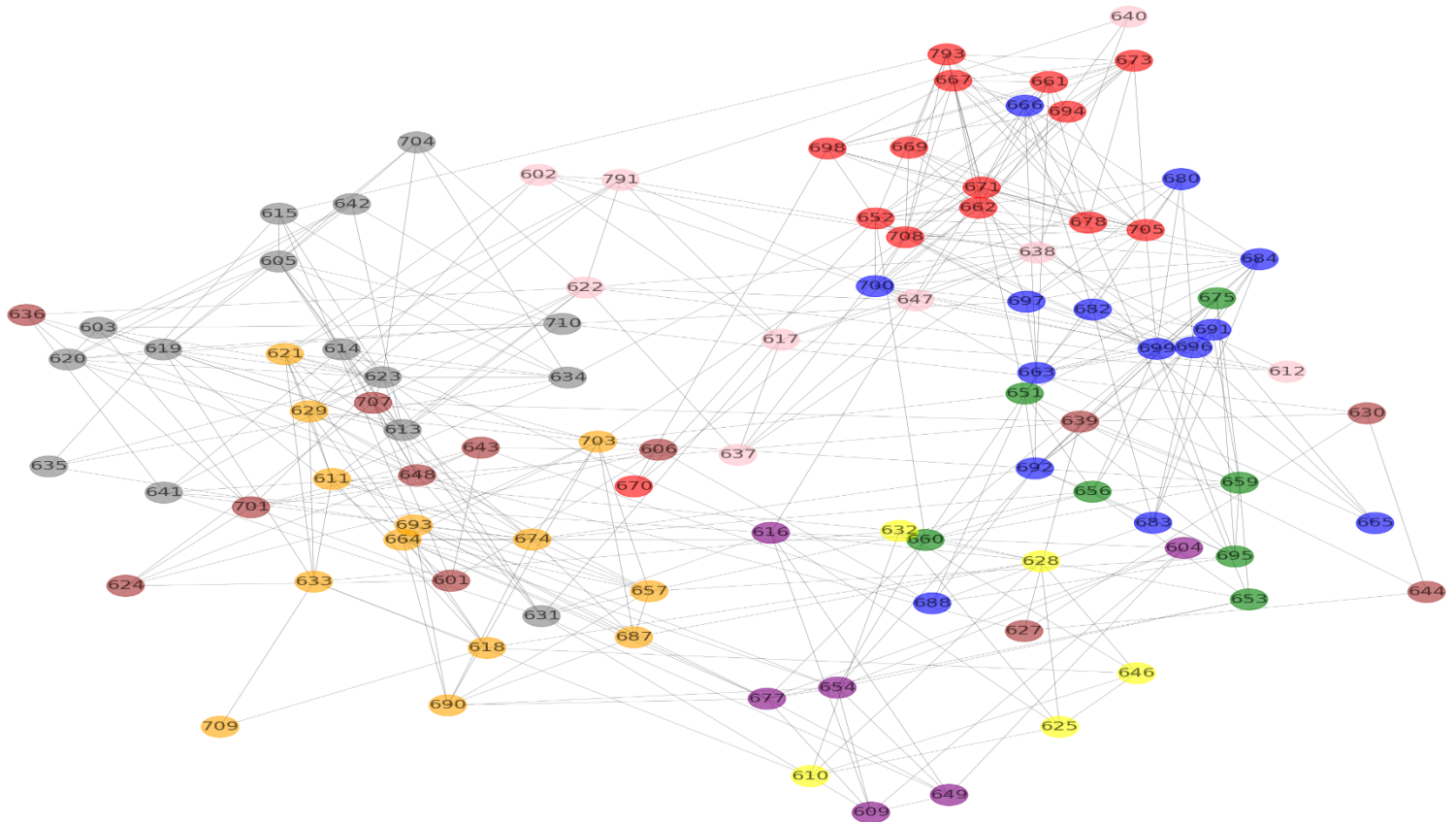


There are 4 communities in this graph:

- "Red" community: Consists of 14 nodes (673, 705, 708, 678, 652, 661, 694, 662, 698, 793, 666, 667, 669, 670, 671)
- "Blue" community: Consists of 5 nodes (675, 651, 656, 659, 695)
- "Green" community: Consists of 13 nodes (680, 682, 683, 684, 688, 665, 691, 692, 663, 696, 697, 699, 700)
- "Orange" community: Consists of 11 nodes (674, 677, 653, 654, 687, 657, 690, 660, 693, 664, 703)

It is worth noting that the "Red" community is the largest, consisting of 14 nodes, while the "Blue" community is the smallest, consisting of only 5 nodes.

Communities In SEC C:



There are 10 different communities in total, each represented by a different color: red, blue, green, orange, purple, pink, brown, grey, and yellow.

Here's a breakdown of the nodes in each community:

- Red: 12 nodes (673, 705, 708, 678, 652, 661, 694, 662, 793, 698, 667, 669, 670, 671)
- Blue: 13 nodes (680, 682, 683, 684, 688, 665, 691, 692, 663, 696, 697, 666, 699, 700)
- Green: 8 nodes (675, 651, 653, 656, 659, 660, 695, 674)
- Orange: 10 nodes (611, 709, 618, 621, 687, 657, 690, 693, 629, 664, 633, 703)
- Purple: 6 nodes (609, 677, 616, 649, 654, 604)
- Pink: 9 nodes (640, 612, 647, 617, 622, 791, 602, 637, 638)
- Brown: 11 nodes (707, 643, 644, 648, 624, 627, 630, 601, 636, 701, 606, 639)
- Grey: 12 nodes (704, 641, 642, 603, 613, 710, 615, 614, 619, 620, 623, 631, 634, 635, 605)
- Yellow: 5 nodes (610, 646, 625, 628, 632)

Task 5: Checking Graph Connectivity and Identifying Cut Vertices after Removing Nodes

After removing myself and my friends and friends of friends, the remaining nodes in the connected graph are 640, 612, 647, 617, 791, 602, 637, and 638. Furthermore, this graph has no cut vertices and is bi-connected.

This implies that there are no "isolated" students in this subset who are not connected to any other student. Instead, all of the students in the subset are still connected through their friendships, and no single student is crucial to maintaining that connection. Additionally, the fact that this subset is bi-connected means that there are at least two distinct paths between any pair of students in the subset, further strengthening their connections.

Overall, this connected graph with no cut vertices and bi-connected components represents a tightly knit group of students who are all connected to each other through various friendships, and who are all equally important in maintaining that connection.

