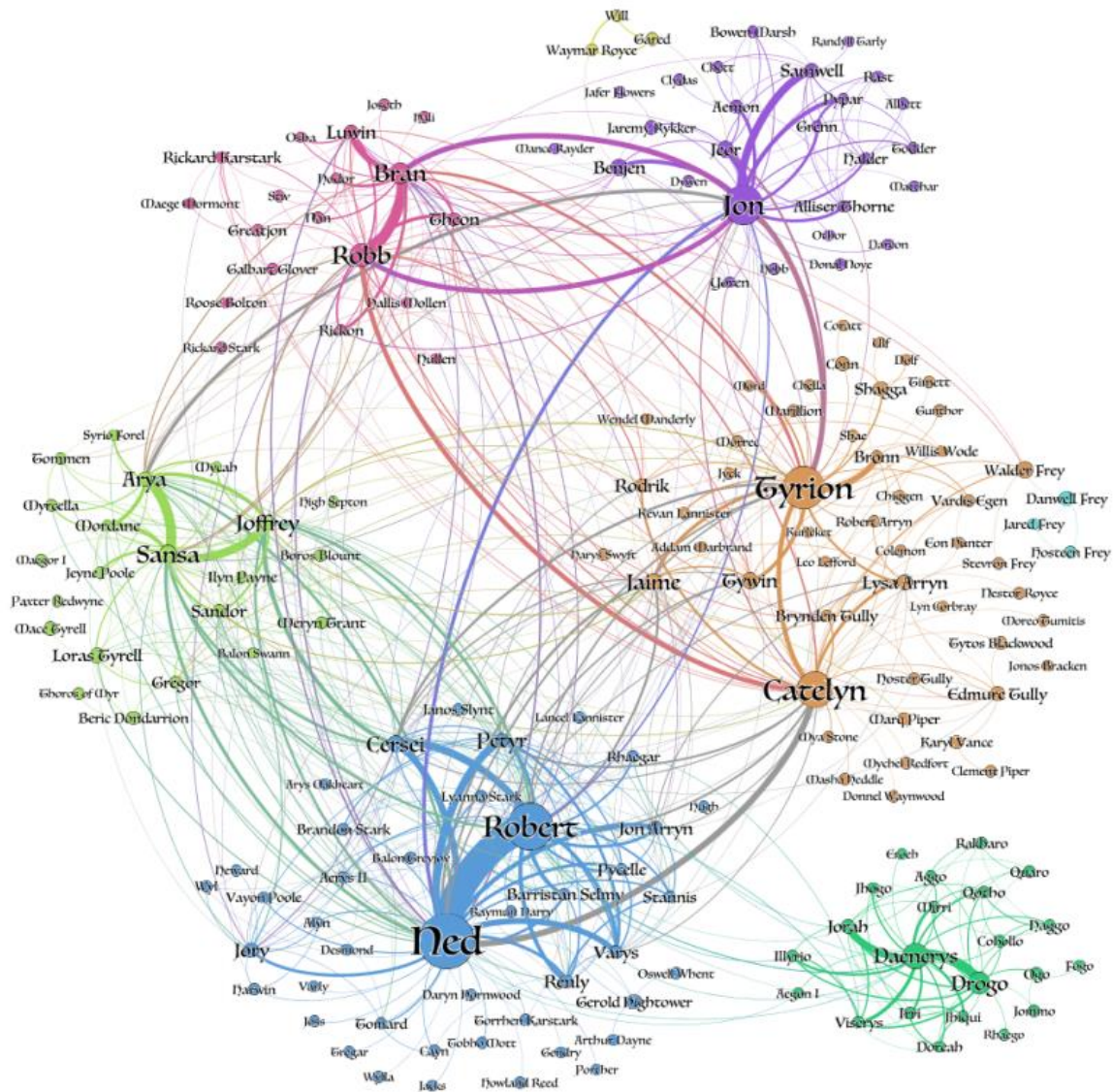


Project 1:

Network Analysis and Visualization with R and igraph

“A Song of Ice and Fire” network



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1 “A Song of Ice and Fire” network

In this assignment, it is required to create a network graph based on the characters of the famous novel series "A Song of Ice and Fire" by George R.R. Martin. We will use a csv file containing a list of edges to construct an undirected weighted graph. The network will represent the relationships and connections between the characters in the series, with the characters represented as vertices and their relationships as edges. By visualizing and analyzing this network, we can gain insights into the complex relationships between the characters and how they impact the story's plot.

First of all, we imported the file from the GitHub repository (you can find the link [here](#)).

After that, we calculate the minimum and the maximum weight in order to know our data. The minimum weight was 3 and the maximum weight was 334. After that, we only kept the columns that we needed and made summary of our data to understand them. Below is the summary:

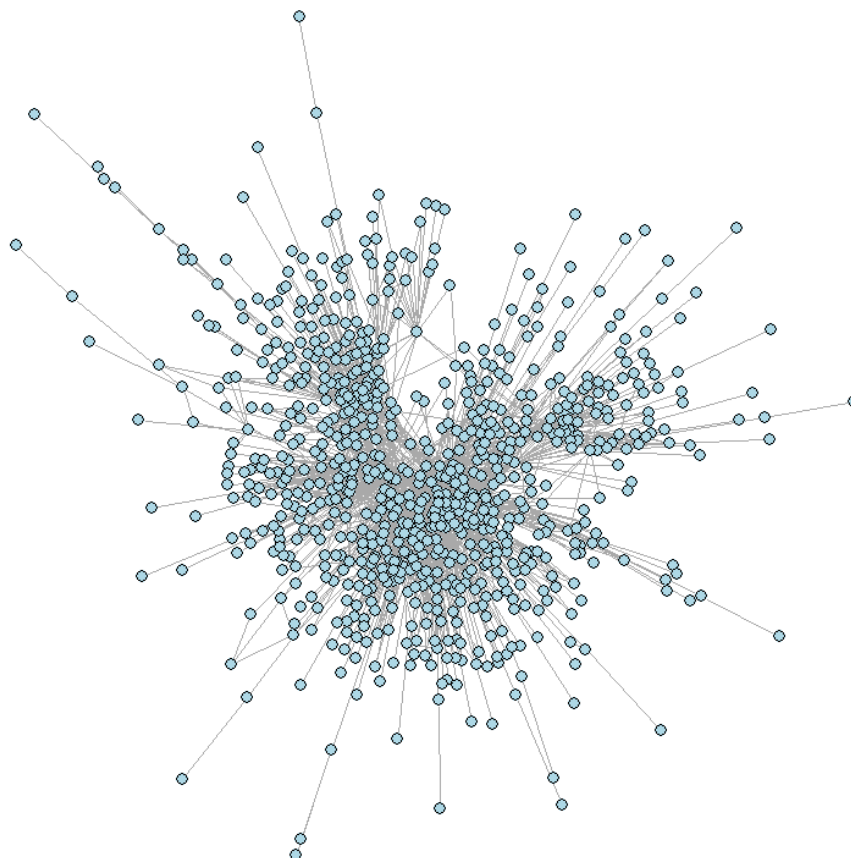
> summary(data)

Source	Target	weight
Length:2823	Length:2823	Min. : 3.00
Class :character	Class :character	1st Qu.: 3.00
Mode :character	Mode :character	Median : 5.00
		Mean : 11.56
		3rd Qu.: 11.00
		Max. : 334.00

So, the mean weight is 11,56 while the median is 5.

Below you will find the first plot of our data:

Q1 graph



2 Network Properties

- The number of vertices of the graph: There are **796** vertices in the graph.
- The number of edges of the graph: There are **2823** edges in the graph.
- The diameter of the graph: The diameter of the graph is **53**. This means that the longest shortest path between any two vertices in the graph is 53.
- The number of triangles in the graph: There are **5655** triangles in the graph. A triangle is a set of three vertices that are all connected to each other. 5655 is the unique triangles while all of them with duplicates in it (for example A-B-C and B-C-A will be counted twice) are 16965.
- The number of edges having weight more than 15: There are **478** edges in the graph that have a weight of more than 15.
- The top-10 characters of the network as far as their degree is concerned:
Top-10 characters by degree:
 - 1 - Tyrion-Lannister : 122
 - 2 - Jon-Snow : 114
 - 3 - Jaime-Lannister : 101
 - 4 - Cersei-Lannister : 97
 - 5 - Stannis-Baratheon : 89
 - 6 - Arya-Stark : 84
 - 7 - Catelyn-Stark : 75
 - 8 - Sansa-Stark : 75
 - 9 - Eddard-Stark : 74
 - 10 - Robb-Stark : 74
- The top-10 characters of the network as far as their weighted degree is concerned:
Top-10 characters by weighted degree:
 - 1 - Tyrion-Lannister : 2873
 - 2 - Jon-Snow : 2757
 - 3 - Cersei-Lannister : 2232
 - 4 - Joffrey-Baratheon : 1762
 - 5 - Eddard-Stark : 1649
 - 6 - Daenerys-Targaryen : 1608
 - 7 - Jaime-Lannister : 1569
 - 8 - Sansa-Stark : 1547
 - 9 - Bran-Stark : 1508
 - 10 - Robert-Baratheon : 1488
- The top-10 characters of the network as far as their local clustering coefficient is concerned:
Top-10 characters by local clustering coefficient:
 - 1 - Aegon-Frey-(son-of-Stevron) : 1
 - 2 - Albett : 1
 - 3 - Alerie-Hightower : 1
 - 4 - Allar-Deem : 1
 - 5 - Alys-Karstark : 1
 - 6 - Alysane-Mormont : 1
 - 7 - Amabel : 1
 - 8 - Arron : 1
 - 9 - Baelor-Blacktyde : 1
 - 10 - Baelor-I-Targaryen : 1

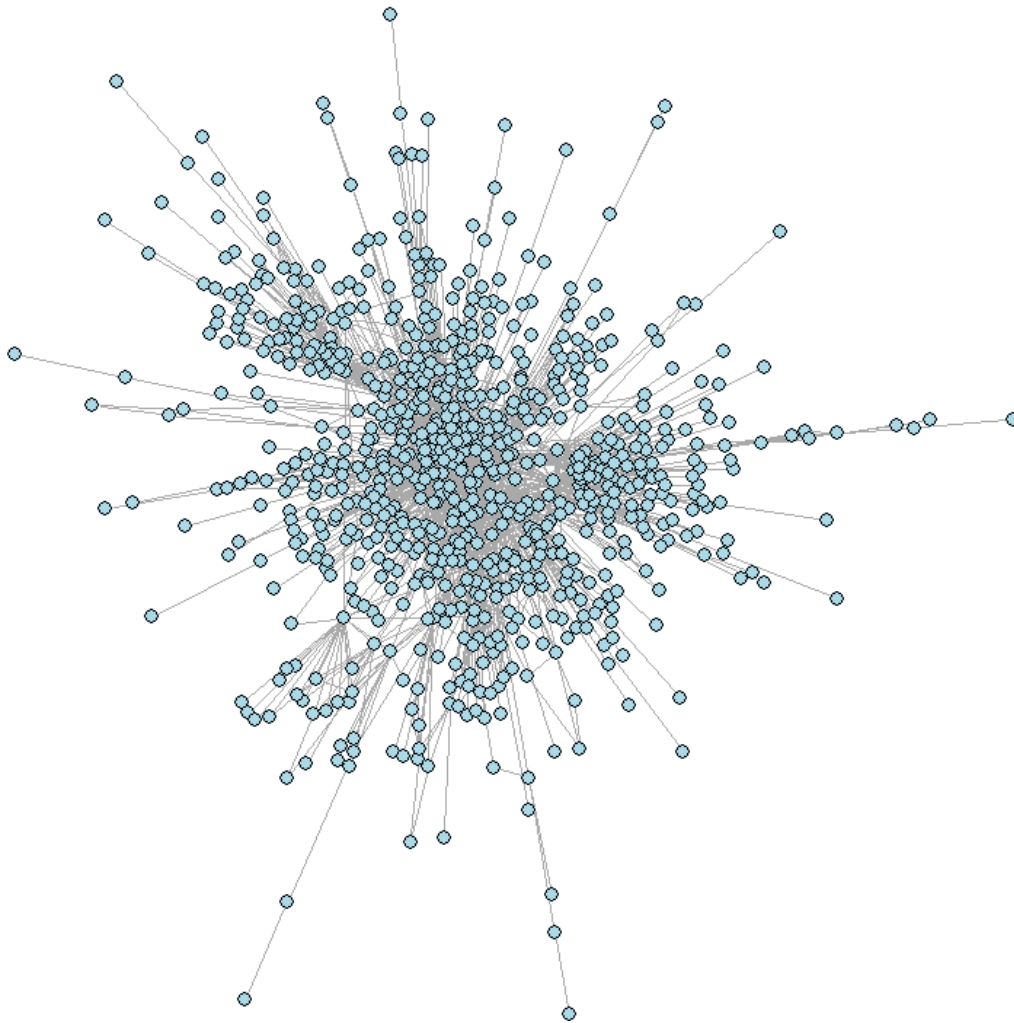
As far as the above result, we have **178** vertices which had 1 as local clustering coefficient so we chose to keep the first 10 alphabetically.

The global clustering coefficient of the graph: The global clustering coefficient of the graph is **0.2090367**. The clustering coefficient measures the extent to which vertices tend to cluster together. A high clustering coefficient indicates that the graph has many tight knit clusters.

3 Subgraph

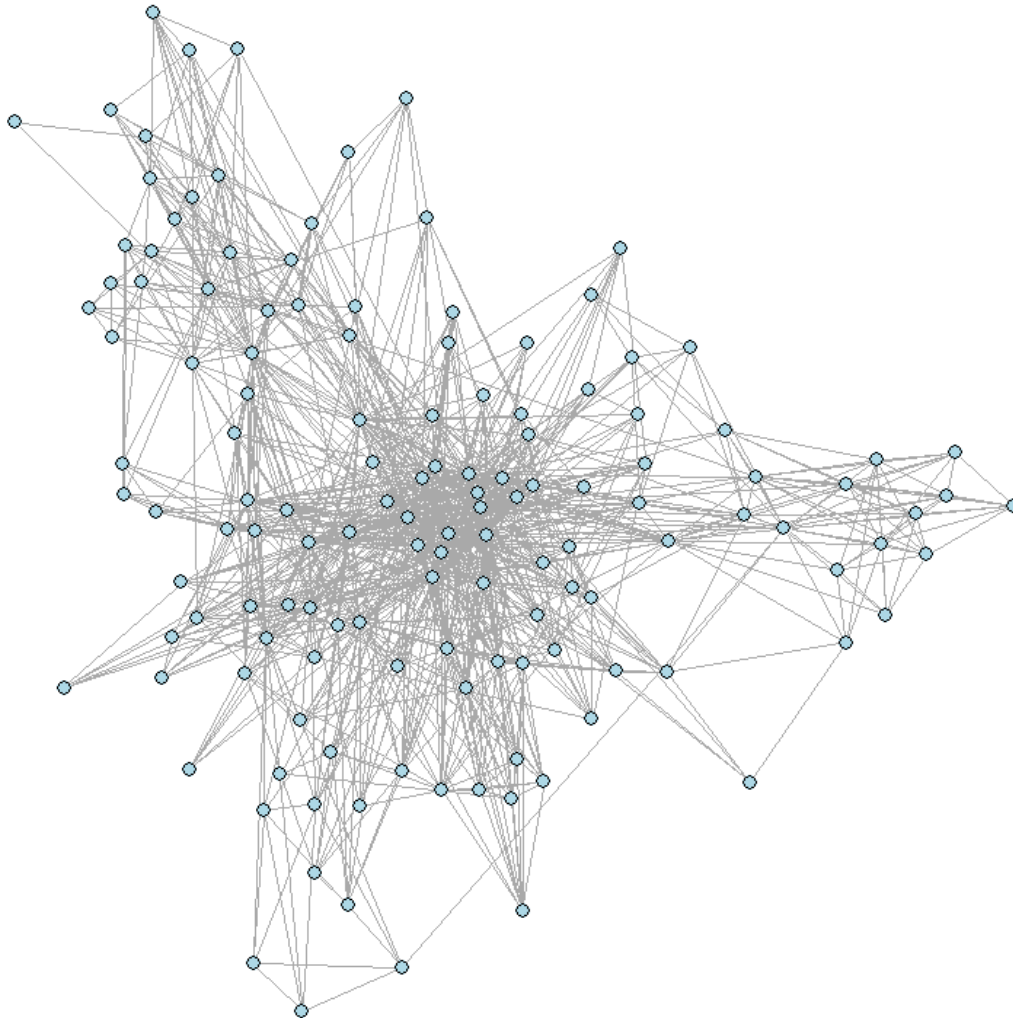
Below you will find the plot with the entire network:

Entire Plot



Below you will find the plot with the subgraph plot in which we kept only the vertices with 10 or more connections:

Subgraph with 10+ connections



Entire graph density: 0.008921968

subgraph density: 0.117003

The edge density of a graph is defined as the ratio of the number of edges in the graph to the maximum possible number of edges for the given number of vertices. For the entire graph of the "A Song of Ice and Fire" character network, the edge density was found to be **0.009**, which indicates a relatively sparse network. On the other hand, the subgraph obtained by discarding vertices with less than 10 connections showed a higher edge density of **0.117**, indicating a denser and more interconnected subnetwork. The higher edge density in the subgraph suggests that characters with more connections tend to be more closely related in the story, forming tightly knit communities within the larger network. In a few words, the subgraph is **13** times denser than the entire plot which was expected.

4 Centrality

Below you will find the top 15 nodes according to closeness centrality:

Top-15 nodes by closeness centrality:

- 1 - Jaime-Lannister : 0.0001205982
- 2 - Robert-Baratheon : 0.0001162791
- 3 - Stannis-Baratheon : 0.0001146921
- 4 - Theon-Greyjoy : 0.0001146132
- 5 - Jory-Cassel : 0.0001141553
- 6 - Tywin-Lannister : 0.0001137656
- 7 - Tyrion-Lannister : 0.0001130071
- 8 - Cersei-Lannister : 0.0001129688
- 9 - Brienne-of-Tarth : 0.000112448
- 10 - Jon-Snow : 0.0001118944
- 11 - Joffrey-Baratheon : 0.0001105094
- 12 - Rodrik-Cassel : 0.0001103631
- 13 - Eddard-Stark : 0.000109218
- 14 - Doran-Martell : 0.0001088613
- 15 - Robb-Stark : 0.0001088495

Below you will find the top 15 nodes according to betweenness centrality:

Top-15 nodes by betweenness centrality:

- 1 - Jon-Snow : 41698.94
- 2 - Theon-Greyjoy : 38904.51
- 3 - Jaime-Lannister : 36856.35
- 4 - Daenerys-Targaryen : 29728.5
- 5 - Stannis-Baratheon : 29325.18
- 6 - Robert-Baratheon : 29201.6
- 7 - Tyrion-Lannister : 28917.83
- 8 - Cersei-Lannister : 24409.67
- 9 - Tywin-Lannister : 20067.94
- 10 - Robb-Stark : 19870.45
- 11 - Arya-Stark : 19354.54
- 12 - Barristan-Selmy : 17769.29
- 13 - Eddard-Stark : 17555.36
- 14 - Sansa-Stark : 15913.44
- 15 - Brienne-of-Tarth : 15614.41

As far as Jon Snow ranks in both closeness and betweenness:

Jon Snow's ranking position:

Closeness centrality: 10th

Betweenness centrality: 1st

The ranking of Jon Snow in betweenness centrality is 1st, which implies that he plays a significant role in the communication between other characters in the network. This is expected, as Jon Snow is one of the main protagonists in the story and interacts with a wide range of characters. On the other hand, the ranking of Jon Snow in closeness centrality is 10th, which suggests that he may not be as closely connected to other characters in the network as some of the other main characters. This could be due

to various reasons, such as his physical separation from other characters, his role as a lone wolf, or his relationships with specific characters. Overall, these rankings provide insights into the centrality of Jon Snow in the network, as well as the relationships between different characters.

5 Ranking and Visualization

Finally, we executed a PageRank algorithm in order to rank the characters of the network.

Here you can see the summary of the PageRank:

```
> summary(pagerank)
```

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0002148	0.0003073	0.0005128	0.0012563	0.0009188	0.0357054

Below, you can see the results in which each node's size corresponds to its PageRank value. It is worth noting that the labels you can see below correspond to PageRank value over **0,02**:

Pagerank Plot

