Analysis of Game of Thrones Network

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IT-454, Introduction to Complex Networks

***Abstract*—The American fantasy drama Television series created by David Benioff and D. B. Weiss - Game of Thrones is a modification of A Song of Ice and Fire, George R. R. Martin's extensive series of fantasy novels. The series registers the vicious dynastic struggles among the kingdom's high-born families for the Iron Throne, while other families fight for liberty from it. With so many characters to keep track of in this sprawling chronicle, it can be more than a challenge to completely understand the dynamics between them and interweaving plotlines. The aim of this term project is to identify different characteristics of a small subgraph of this underlying complex network and to make sense of the complicated character relationships and their significance on the future plot by analyzing the network step by step using the techniques learnt in class.**

I. Introduction

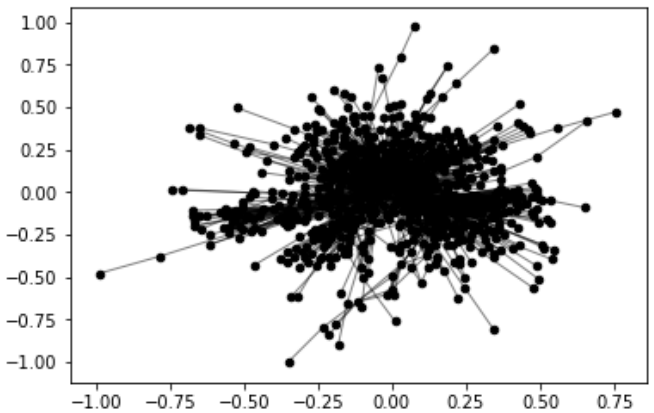
In the present paper, we will be considering the character co-occurence network of this immense Game of Thrones series book 1-book 5 and will be analyzing it with the assistance of various measures like degree centrality, clustering coefficient, closeness centrality,betweenness centrality and many more. We would also be detecting various communities within the network. In this network, nodes represent characters in the ctional novel, with edges between characters determined by the number of their interaction with each other. We also consider character networks as weighted graphs, where the weights are positive integers determining the co-appearance or co-occurrence of character names within a specied range of a scene. Not surprisingly, character networks are of smaller order than many other types of complex networks. Then too, they exhibit many of the interesting features of complex networks including clearly dened community structure, with communities centered on the various central characters of the story, degree distributions, and their constantly changing behaviours. Character networks dened over larger ctional universes, just like the Marvel Universe, even grow to over 10,000 nodes [1,12]. There is an holistic approach using the techniques of graph theory and big data to mine and model character networks. Our approach in this work is studying those networks with these tools to replicate some of the findings as well as study network models of these data.

Network analysis can be used to learn about the relationships in social or professional networks. We will try to answer the questions like:

1) How many connections does each person have in the network?
2) Who is the most connected (i.e. powerful or important) person?
3) Are there any clusters of tightly connected people (communities)?
4) Are there a few key players that connect groups of people?

These answers will give us a lot of information about the patterns of how people interact.

Below is the network depicting nodes as Character and the edges between them. It is clearly visible that the network is highly dense around the center.



II. Centrality

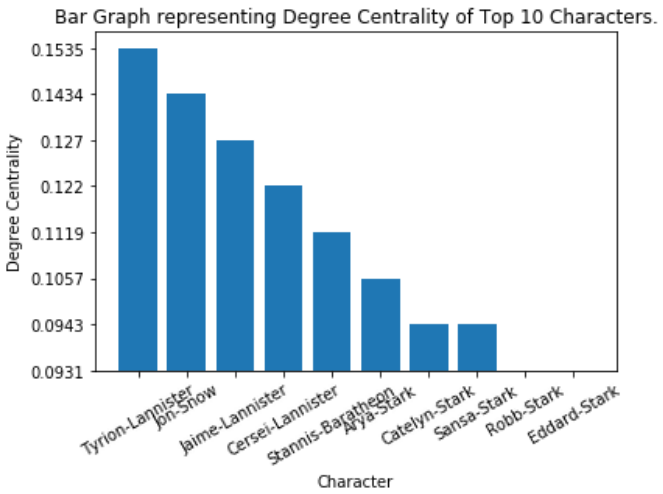
Centrality measures the number of edges incoming or outgoing to/from nodes. That is,it measures the importance of a person in a network. Networks having high centrality have dense connections with a smaller number of nodes while them with low centrality have same connections with more number of nodes.

Centralization of a graph measures this value from the centrality measures of individual nodes.

The degree centrality of a given character is given by the formula,

$$C(i)=d(i)/(n-1)$$

Where d(i) is the number of interactions with other characters and (n-1) is the maximum possible degree. The degree centrality results show us that Tyrion Lannister tops the list with degree centrality of 0.1535 which depicts his importance in the series. It is clear from TV series also how, in all the seasons due to his large network all over from the North to the south, he was quite famous and played a major role in the alliances of wars against all. And he was also connected to many other people of different houses like Greyjoys, Starks, Lannisters, Baratheon and the Targaryens. Jon Snow comes at second position due to his witty character and fearless expeditions. He was the leader of Night's Watch and also was the one who had endless connections from the Wall to beyond the wall (the Wildlings). Jaime Lannister, the high born who had many ties at the King's Landing and ends at third place.

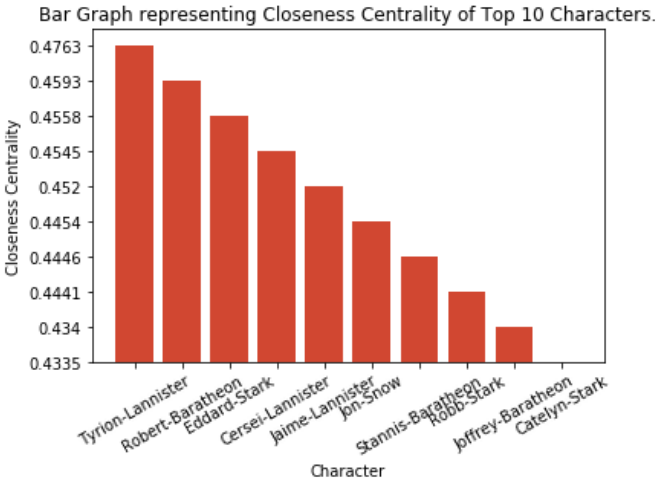


III. Closeness Centrality

The closeness of a character describes the distance to all the other characters in the network. The character with the highest closeness is very central and can transmit information very easily to many other characters. Due to this, this characters possesses a prime importance in the progress of the story. Based on the distance between two actors, d(i,j) which is defined as the shortest path between i and j is given as :

$$C(i) = (n-1) / \sum_{j=1}^{n} d(i,j)$$

Again in this measure of centrality, Tyrion Lannister tops over other characters due to his high interaction and contacts with other houses.Tyrion surrounded many central characters and therefore connected storylines and houses in Game of Thrones. It is also clear that people like to remain close to the king and these is the reason, the King Robert Baratheon finishes at the second place in this measure. Eddard Stark being a prime character of the first season, ranks third in this list which is also thus clear.



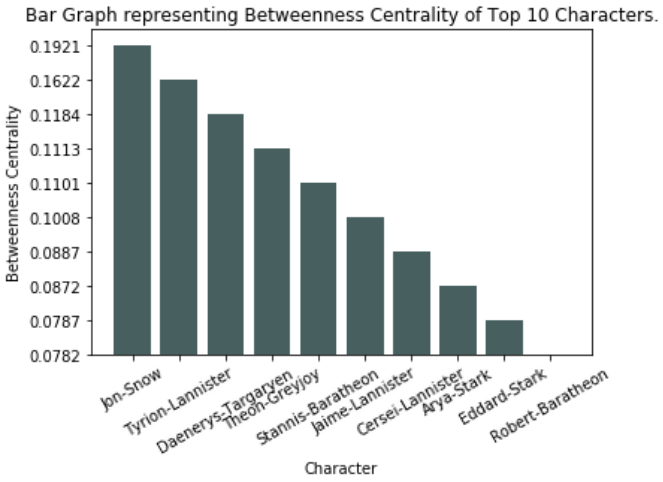
IV. Betweenness Centrality

Betweenness describes the shortest path between the shortest communicating path between any two characters. Characters with high betweenness centrality form a bridge for connections between a pair of group of characters. They thus have a key role in manipulating the information throughout the network. Betweenness can thus be calculates based on the number of shortest paths that pass though

any character i divided by the total number of all the shortest paths in the network. i.e.

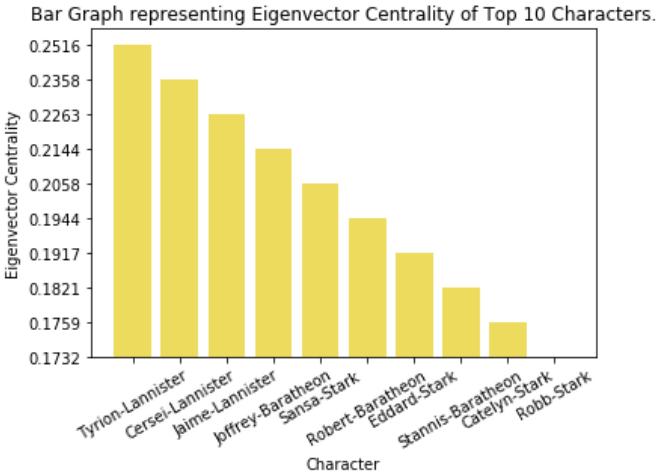
$$C(i)=\sum_{j<k} P_{jk}(i)/P_{jk}$$

In this ranking of betweenness centrality, Jon Snow acquires the first position because of his contacts with the other houses mainly Lannisters and Greyjoys and is the central point from which the story unfolds. Also he was the one through which different big houses used to send information to each other like the starks and the lannisters. Here Tyrion Lannister, although being a more central character than Jon Snow, ranked second because not most of the information was passed through him for communication between any two major houses. On the other hand, someone was trying to build their own network for the throne in some other part of the world (Westeros). This was Daenerys Targaryen.



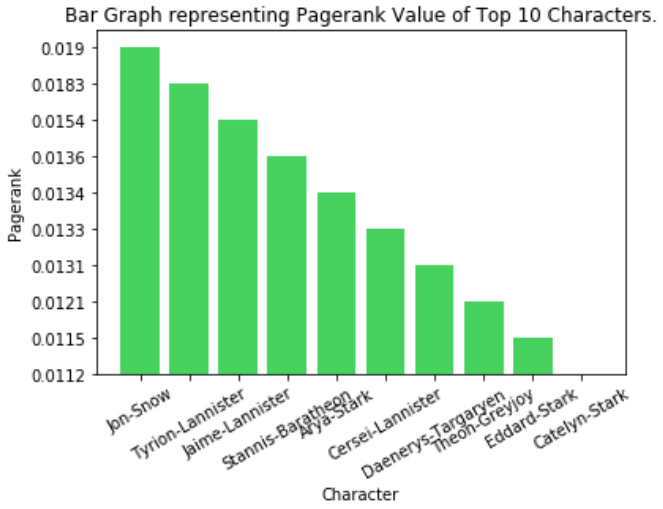
V. Eigen Vector Centrality

Having interaction with more important people makes you important as well. In this, having even minimal amount of interaction with superior characters gives you some credit. This measures how powerful your network is, despite the fact whether your utilization of your network is to its fullest. Eigenvector Centrality can be measured by the principal eigenvector of the adjacency matrix M by the formulae: $\lambda v = Mv$ Where v being the eigenvector and λ being the corresponding eigenvalue associated with it. The three lannisters (Tyrion, Cersei and Jamie) top the list here of eigenvector centrality because they all resided in the King's landing which is the central place for traders and marketing goods and it connects all the other important places in the westeros due to which it was the home to many important people. So this naturally enabled this lannisters to connect to more important people and thereby increasing their overall eigenvector scores.



VI. Page Rank Centrality

The page rank centrality is a weighted degree centrality with feedback loop attached. So you would just get the 'fair share' of your neighbour's importance here. The neighbour's importance is divided between you and other characters connected to that neighbour proportional to the number of interactions you have to them. So it actually measures how effectively you are taking advantage of your network contacts. Effective developments thus result out two important characters interact. We can clearly see how Page Rank centrality and Eigenvector centralities are related to each other. Also, when a character's eigenvector centrality is more than their page rank centrality, such characters have a high potential for future developments provided they use this to capitalize their potential. The children from major houses(i.e. Starks and Lannisters) thus top the list here. This is quite obvious as, first of all they belonged to such high born families so had quite a huge network and second that they exerted themselves to utilize the best from this potential to being the most important characters in the game of thrones network.

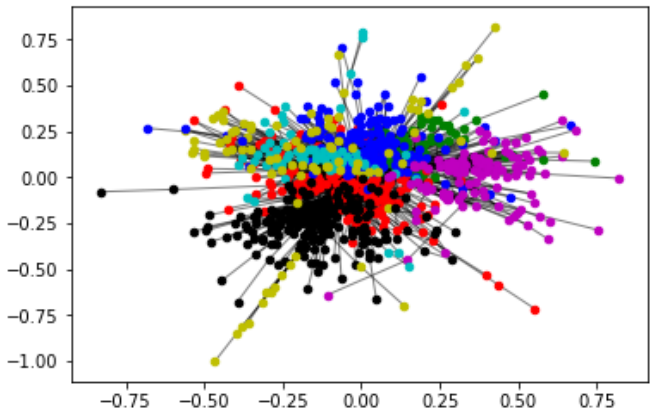


VII. Clustering Coefficient

Clustering coefficient measures the probability that adjacent vertices of a vertex are connected. This is also known as Transitivity. Average clustering coefficient of the network was found out to be 0.486. This indicates that, almost half of the neighbourhood of the vertices of a vertex u are connected to half of the vertices in the neighbourhood of u.

VIII. Community Detection

Community is kind of a coherent sub-network and is a subset of a network. For community detection, there should be maximum number of edges within the communities and minimal number of edges between the communities. This idea is captured by the term modularity. We split the network using the standard techniques to maximize modularity and have labelled the communities with different colors. There are a total of 9 major communities in this network and we have analyzed that most of the people from the same houses form a community. For example, the Starks have formed a community which is represented by the value 1 and have labelled with the color red. There were 9 major houses in Westeros namely Arryn, Stark, Tyrell, Baratheon, Tully, Greyjoy, Lannister, Martell and Targaryen which indeed our graph below has correctly depicted.



IX. Conclusion

The analysis of the Game of Thrones network gave us an initial idea about its complexity and massiveness in the terms of characters and co-relations between them. Then we saw how different characters were ranked by analyzing them through different measures like degree centrality, closeness centrality, betweenness centrality,eigenvector centrality and page rank centrality. Thereafter, from an overall analysis we can figure out how characters like Tyrion Lannister and Jon Snow ended up being the most important characters of the network. Also, through clustering coefficient we saw how nodes in the neighbourhood of any vertex were connected to each other neither too densely nor too sparsely. And finally we saw how our depicted communities complied with all the conventional Game Of Thrones great Houses.

X. Future Scope

With the help of this plotted network, we can also estimate the evolution of any specific character's importance over time (evolving seasons). We can also predict deaths in further season 8 by taking machine learning algorithms in use and developing features from this past data-set about the qualities the dying character possessed and therefore can estimate the deaths in the further season by comparing it with this data.

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