RESEARCH

Network Analysis of the Philippine Senate Bill Co-authorship Network

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Abstract

The Philippine Senate is composed of 24 senators per congress batch. These senators are from different political parties, supporting different committees, and demonstrating different levels of competency. Studying the network of senators across different congresses can generate insights about underlying alliances and performance indicators which may serve as a useful guide in determining whom to vote for in the upcoming 2022 senatorial elections. Data from the Philippine Senate Website [1] is scraped to construct a Bill Co-authorship Network of the senators. After which, community detection is performed using the Louvain method resulting in three distinct communities characterized by the senators' congress batch, and performance in the senate. Performance is measured through degree centrality and total number of authored bills. It is observed that some communities performed better than others suggesting that senators from these communities might be more deserving of one's vote.

Keywords: Philippine senate; community detection; co-authorship network; Network Science

1. Introduction

The 2022 Philippine Senatorial election is scheduled to be held on May 9, 2022, less than a year from now. With this, 12 senatorial seats elected from the 2016 elections will be contested [2]. Given the drastic socio-economic impact of the pandemic in the country, the importance of good governance in dealing with such crisis becomes clear. Selecting competent government officials and policymakers is key to good governance. This project aims to study the Bill Co-authorship Network of the Senators to determine the underlying community structure and determine which group of senators are more competent than the others.

Similar work was done by Esclanda and Escleta [3], focusing on the House of Representatives co-authorship network. Their study also used community detection wherein the resulting communities are related to political bloc membership. The researchers used betweenness centrality and compared it to the number of bills that reached the final reading as they wanted to determine whether such metric relates to the legislative success of the representatives. For this study about the senate network, the objective is to generate clusters defined not by political parties but by the senators' performance indicators. Hence, two dimensions were defined: Collaboration, measured by degree centrality, and Activity, which refers to the total number of authored bills.

2. Data and Methodology

2.1. Data Collection

The dataset used was web scraped from the Senate of the Philippines website [2]. The Bills section contains the list of all recorded senate bills filed since June 30, 2004. For each bill, information about its full title, authors, congress, date filed, and committee are collected to construct the dataset. For this study, only the bills filed from the 13th to the 18th congress are considered. The data has 49 unique senators and senators with names written on multiple instances are preprocessed for standardization. A total of 15627 unique bills from 53 committees are included. To gain more insights about the senatorial network, information about the senator's political parties were also gathered.

2.2. Network construction

2.2.1. Congress Bipartite network

A bipartite graph is constructed using the senators and the congress as the two sets of nodes. A single edge is constructed for a senator serving at a particular congress. Senators that served for more than one term are connected to multiple congresses. However, it is important to note that a senator can only serve up to two consecutive terms and half of the 24 senatorial seats are being replaced every three years. Figure 1 shows the congress bipartite network of the senators.

2.2.2. Network of Bill Co-authorship

The Co-authorship network is constructed with all 49 senators as nodes. Each edge is constructed for a bill that was filed by the pair of senators. The weights parameter of each edge is defined to be the number of unique bills a senator-pair has co-authored. Edges between senators that co-authored multiple bills together will have higher weights indicating tighter connections. Figure 2 shows the Network of Bill Co-authorship. Nodes closer together with thicker lines mean more number co-authored bills between the senators. The size of nodes denotes the number of bills passed by the senator.

2.3. Community Detection

To gain insights about the senator's affiliations in relation to their performances in the senate, community detection is done with the use of the Louvain algorithm by Blondel et al [4]. This is the chosen method as it yields the best modularity among the other algorithms. It works by assigning all nodes a community of their own and iteratively reassigning them to the same community as their neighbors. This process will stop when reached the highest modularity possible.

3. Discussion of Results

3.1. Collaboration vs. Activity

The network of bill co-authorship shows two dimensions in evaluating a senator's performance: Collaboration and Activity. Collaboration, for the purpose of this study, is defined to be how likely a senator will co-author a bill with another senator. It is measured by the node's degree centrality. Activity, on the other hand, refers to the total number of bills passed by a senator. These two aspects can be used

to evaluate a senator's productivity in the senate in terms of co-authorship and total number of bills passed. Figure 3 shows the scatterplot of collaboration vs. activity. Senators in the network fall into three quadrants. The first quadrant is characterized by low to average activity but with high collaboration. This means that senators in this area have low to average number of bills passed with these bills having multiple authors. The plot shows Senator Ramon "Bong" Revilla Jr. as the senator with the greatest number of collaborations or co-authorship. The second quadrant shows senators with average collaboration but has the highest number of bills passed indicating competency in the senate without needing much collaboration. The late Senator Miriam Defensor Santiago belongs to this quadrant. with the most number of bills passed. Lastly, there are senators showing both low numbers of collaboration and activity. A notable name in this part of the graph is former Senator Benigno Simeon Cojuangco Aquino III having the least number of bills passed and the lowest collaboration. However, it is worth noting that the former Senator served only three years in the senate during 2007-2010 [5] before he ran and won the 2010 Presidential elections.

3.1. Community Detection

With the use of the Louvain algorithm, three distinct communities are uncovered in the bill co-authorship network. Figure 4 shows the network with the labeled detected communities. The first community (blue) is composed mainly of the senators from the 13th-15th congress. They are considered to be the 'veteran' senators. Some notable names are Miriam Defensor Santiago, Joker Arroyo, and Juan Ponce Enrile. This community is characterized by having a low degree centrality indicating less collaboration from its senators. However, this group also has the senators with the most number of bills passed. Aside from Miriam Defensor Santiago, Joseph Victor Ejercito, with the second-highest number of bills passed also belongs to this community. The second community (red) shows a good balance of collaboration and activity. Nodes from this community have average degree centrality and size. Senators from this community have lower total number of bills passed compared to the first community, however, they are connected more closely to each other and to other senators from other communities. Finally, the third community (green) are the senators from the 17th-18th congress, most of whom are incumbent senators. This community shows the highest collaboration or degree centralities but with the lowest number of bills passed individually. Notable names are Senators Bato Dela Rosa, Bong Go, and Imee Marcos. Bills passed by the senators of this community are mostly from multiple authors.

It is observed that while collaboration increases from the first to the third community, the activity, or the total number of bills passed by each senator is decreasing. To support this finding, Figure 5 shows the trend of the number of bills passed for each senate congress. Congresses 17th-18th show a significant drop in the number of bills passed as compared to the earlier congresses. This implies that despite the increase in collaboration, the overall productivity of the more recent senators has been declining.

4. Conclusion

The analysis of the Bill Co-authorship Network revealed key insights about the network's properties in relation to the senators' performance in the senate. This is defined into two dimensions namely: Collaboration, which is measured by degree centrality, and Activity, which refers to the total number of bills passed by a senator. The community detection uncovered three distinct communities present in the network. The first community shows low collaboration but high activity highlighting senators with high contributions in the senate without the need for much collaboration with other senators. The second community has a good balance between collaboration and activity. These senators are both collaborative and active in passing bills. Lastly, the third community involves senators with high collaboration but low activity indicating that the majority of the bills under this community are passed by multiple authors. Considering the decline in the total number of bills passed for the third community, it is evident that activity should be the primary basis in deciding which candidate to vote for as collaboration can be easily influenced by political parties. Therefore, senators from the first and the second communities show superior performance compared to senators from the third community. The project was able to uncover senator communities grouped not by political affiliations but by their past performances which can be a useful tool in defining which set of senators are competent and worthy of re-election.

5. Recommendation

The project's results can be further developed into an interactive web application of the network. It will contain the network structure and properties, as well as the key insights obtained from the network analysis. Other relevant data and statistics about the senators will also be included. With this, voters will have an easily accessible guide in selecting a roster to vote for. One reason why people refrain from voting is the lack of information they have about the candidates. And having to engage with all of the candidate's election campaigns can be cumbersome. Therefore, having this online platform with all the relevant information consolidated in one place will encourage more citizens to participate in the elections.

Availability of data and materials

Datasets and codes used in the study are available from the authors upon request

Competing interests

The authors declare that they have no competing interests.

Acknowledgments

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Figures

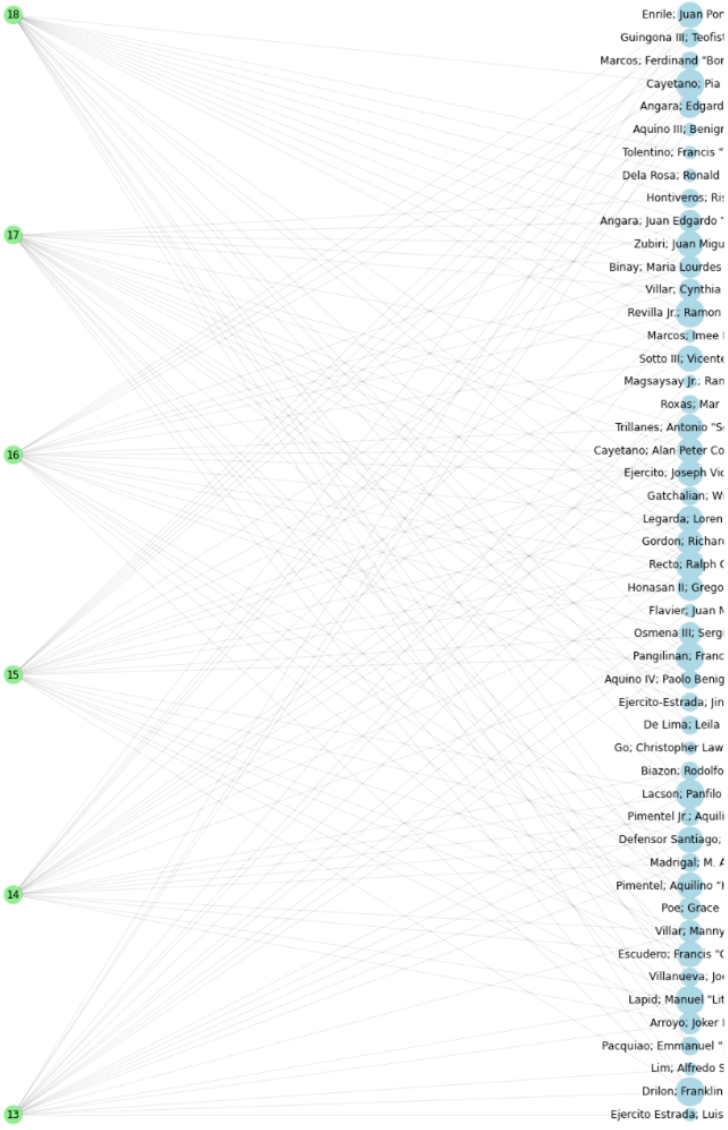

Figure 1 Congress Bipartite Network of Senators. Nodes at the left are the different senate congress from 13th -18th. Nodes at the right are the Senator. A link is made for senators serving a specific congress.

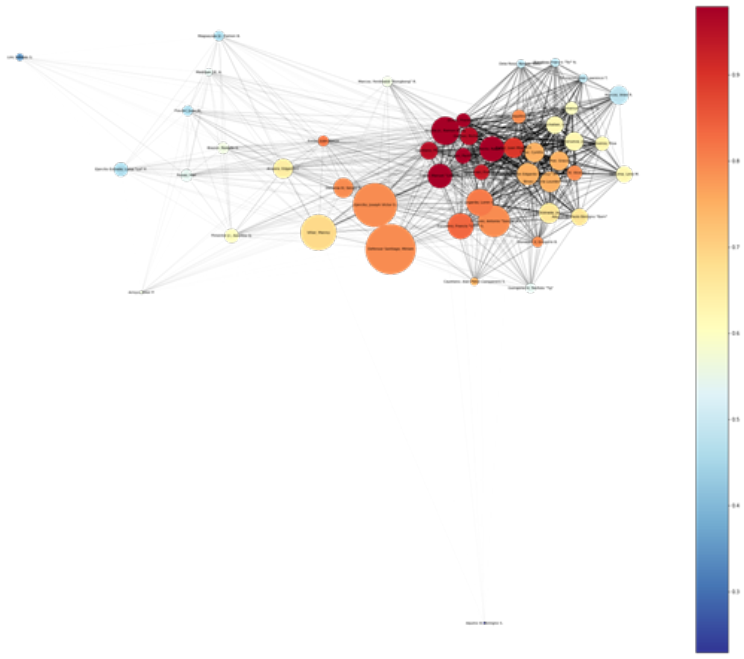

Figure 2 Senator's Bill Co-authorship Network. Each node is a senator. Nodes closer together with thicker lines shows higher number of bills filed together. Node sizes refers to the number of bills passed by a senator. Color legend denotes a node's degree centrality.

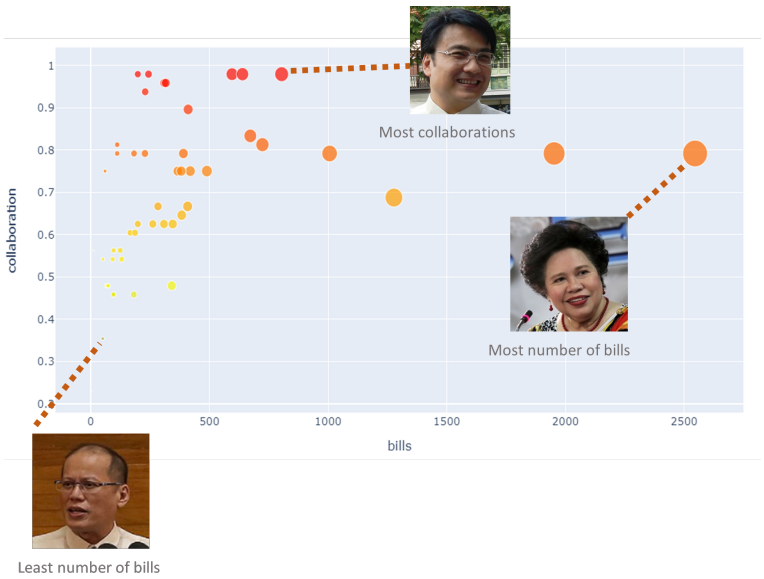

Figure 3 Collaboration vs. Activity Scatterplot. X-axis represents the number of bills passed by a senator. Y-axis is the degree centrality of a senator based on the co-authorship network.

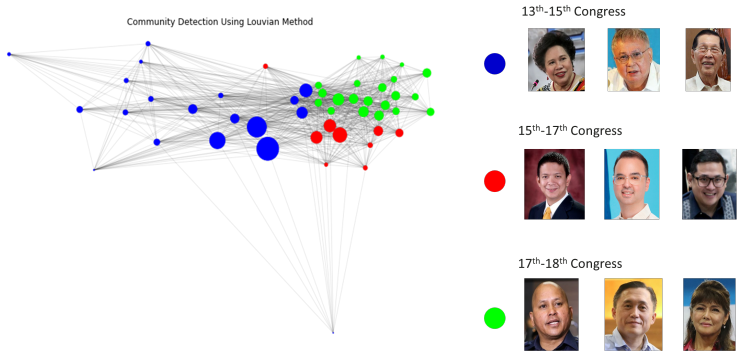

Figure 4 Bill Co-Authorship Network with detected Communities. The color represents each of the three communities. The detected communities can be described by its characteristic collaboration and activity.

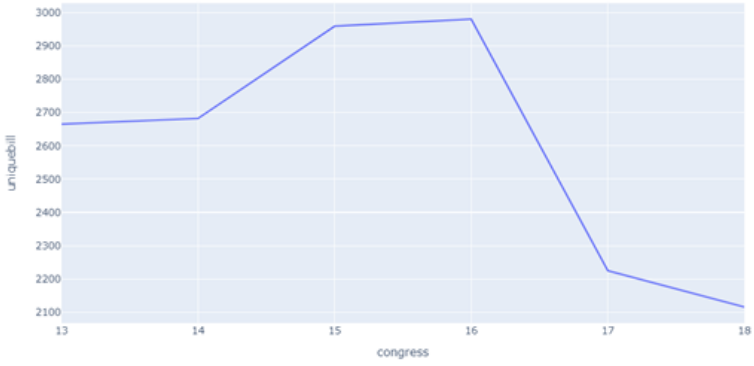

Figure 5 Total number of bills passed for each Senate Congress. It is observed that for congresses 17th-18th, there has been a significant decline in number of bills passed.