A visual analysis of power relations among people on time-series data using network visualization: Focusing on 19th National Assembly Data in Korea

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Abstract

Data analysis using visualization help user get information through viewing pattern in data. Especially, network visualization is an effective tool for recognizing the relationship of people, forms of clusters, etc., because a user can see relations among nodes at a glance. In this paper, we suggest the new approach through advanced data visualization. We design a network visualization using node-link-group diagram for analysis of power relationship among 19th national assembly members of the Republic of Korea. It displays overlapped node-groups that are before and after the period of specific event. Therefore, the user understands easily change of power group size and important peoples. Also, it provides subviews with additional data. For this visualization, we refine jointly proposed bill data and create a network. Then, we construct the power groups data by detecting cliques on the graph. We select the important political issue for evaluation of the visualization and then set the scenario for figuring out the change of power groups in the assembly. Our approach shows that is useful for understanding the change of power clusters, relationship with the passage of time and it contributes to analyzing the time-series network data effectively.

1. Introduction

Previous studies of joint legislative submission in Assembly of the Republic of Korea was not much more conducted than that of the roll call vote. In addition, previous studies were limited with only a few lawmakers. Using data visualization, it will be easy to identify the relationship between lawmakers and the political landscape of the entire National Assembly by taking into account numerous legislative data at a glance. According to Colin Warehouse (2012: 31-32), data visualization presents a large amount of information by cognitively framing the information to have strong advantage of grasp the overall dimension of data aspect. In addition, the overall flow can reveal the characteristics of hidden detailed data through the appearance of different patterns. This study aims to propose visualization applications to identify relationships among lawmakers through joint legislative submission data. To achieve this goal, the following steps were taken: First, we set up the goals that have to be provided kind of information and selected the tasks that need to be performed to achieve goals. Second, we collected joint legislative submission data and extracted network and group information based on this data. Third, the visualization of joint legislative submission network to achieve the task selected above was designed and implemented. Fourth we conducted a case study to validate two issues using implemented visualization applications.

2. Background

Joint legislative submission in assembly of the Republic of Korea

According to Lim (2007: 225-226), the U.S. Congress is assessed to be relatively autonomous of its own party. However, the Korean National Assembly does not have much autonomy for its own party. It is common for Korean lawmakers to follow the party line rather than express individual opinions on certain issues. In Korea, the party has a strong binding force on its lawmakers. According to Kim (2012: 149), This is based on the historical background that the legislature was subordinate to the administration under the authoritarian regime in the past, and the political parties were organized and acted around local political leaders. Since the 1987 transition to democracy, many lawmakers have shown their own "confidence" in the proceedings and in defiance of the party's opinion, but it is hard to say that they have been freed from their party's restraint. Political burdens such as political isolation and degradation of the party leadership's status are high in rejecting party opinions on key political issues that the party leadership values, and there is a risk that they will be excluded from the nomination of the next general election. Therefore, according to Lim (2007: 228) it is possible to infer that

Korean lawmakers are more influential in the party than they believe in individual lawmakers, even in legislative activities, which can be a fundamental function of the legislature. Lawmakers can propose a bill on his own. Unlike the U.S., which does not have a separate requirement, lawmaker's legislative motion in Korea takes the form of a "joint legislative submission." Article 79 of the National Assembly Act (proposed or submitted) requires at least 10 lawmakers to approve the bill for it to be valid. The 10 or more lawmakers are divided into the "majority lawmakers" who propose a bill, and those who support the bill and support it. The National Assembly Act does not specify the expression of this series of actions. However, by practical necessity and practice, the act of supporting the 'head of the National Assembly' by more than nine 'strong-footed' members is expressed under the name of 'joint feet.'

Previous Works

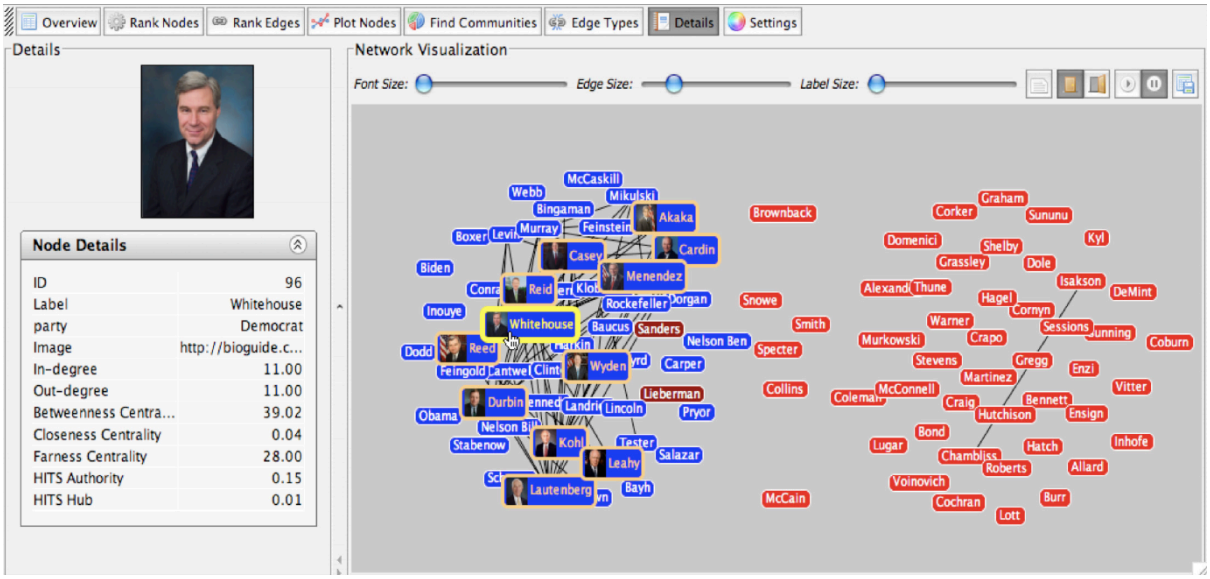


Figure 1 The US Senate Voting Pattern Visualized by Peter (2008: 269)

In refer to Peter and Shneiderman(2008: 269-270), Congressional analysts are interested in partisan unity. For instance, Congressional Quarterly in the United States Senate calculates such unity by identifying every vote in which a majority of Democrats voted opposite a majority of Republicans, and then counts, for each senator, the percentage of those votes where they voted with the party. This metric can be useful for tracking an individual senator's party loyalty from year to year, but it does not tell much about the overall patterns in the body.

Lee(2011: 109-112) set a joint legislative submission at his study in 2011 by the 18th Culture, Sports and Tourism Broadcasting and Communications Commission(hereinafter referred to as CSTBCC) in Republic Of Korea and a social network of lawmakers to analyze, and found that cooperation between parties was not well established or achieved in certain areas by using

clique which is one of the graph theories. After looking at the landscape of the CSTBCC members due to social network factors in the data set, Lee found that the network of the joint legislative submission is closely linked according to party, regional and social organization experience.

Therefore, we aim to discover the factors affecting the relationship between assembly members by analyzing the tendency of the Republic of Korea's 19th National Assembly member's joint legislative submission, selecting the group of people, clique, who share arguments and interests. We also provide a visual representation of our findings.

Design Goals

This study explores a visual method to analyze joint legislative submission relationships based on this data, and aims to discover factors affecting relationships between 19th national assembly members of the Republic of Korea.

The following articles are the visualization design tasks and goals of our study.

Goals

G1. Visualizing a network of joint legislative submission by period

The goal of this study is making it easy to see the time varying joint legislative submission relation among Assembly members by providing our own visualization tools. Through this visualization tool, users can see the network of joint legislative submission over time and understand the relationships among Assembly members.

G2. Showing clusters that can be found in the network

Our research aims to draw out groups of co-sponsored proposals that mainly propose bills together within the network of relationships of co-sponsor proposals and helps to identify relationships between groups and groups within them.

G3. Observing changes in the relationship between Assembly members by period.

Determining how networks change over time and how the reasons for these changes were due to.

G4. Identifying the cause of the cluster creation

Users can identify the relationship of joint legislative submission between the Assembly members and the cause of the group creation. Using this visualization tool, users can identify a myriad of repeated situations of meeting and parting due to various social issues, including

interests of individual member or group.

Tasks

T1. Finding a network from data of joint legislative submission

The leader of joint legislative submission and coworkers provides a bassi for confirming the familiarities between Assembly members. In order to identify the relationship between members through a group of joint legislative submission, we deduct the network from data on the joint legislative submission [G1].

T2. Deriving a cluster within the network and visualizing it as a node-group diagram.

By creating a cluster within the network created by the T1 phase, it is possible to identify the positions of Assembly members in the intention of joint legislative submission. The derived clusters can be visualized as node-group diagrams to identify common ground among members for a particular bill [G2].

T3. Reflection of network data on the timeline

To compare the changing aspects of a relationship over time, we reflected the network data of the created network onto the timeline [G1, G3].

T4. Visualizing the trend of legislative submission

In order to make it easier for users to select a certain period of time in the timeline area to compare changes in the cluster over time, we provide visualization tools that summarized trends of legislative submission. This visualization tool is useful for analyzing the participation of Assembly members selected by the user in the main view, or for analyzing keywords in submission bill at a time when the user selects them on the timeline [G4].

T5. Determining the elements needed to create a group

To explore the power transition between the 19th Assembly members, we determine the elements of the node that composing the node-group diagram. The elements are comprised of the name of a member, political ideology represented by a party, and ideology score calculated by roll call vote data [G4].

Data Processing

Data

In this study, the 19th National Assembly members of the Republic of Korea used a bill that participated in co-sponsor at the National Assembly Standing Committee. The total number of

bills proposed by the 19th National Assembly was 18,926, including the name of each proposed bill and information on the co-sponsored bill and status of whether the bill was promulgated. During the 19th National Assembly, all figures who served as lawmakers were 330, and 326 lawmakers participated in the co-sponsor, which was extracted from data. We collected additional data on the number of times elected members of the National Assembly and used them for analysis.

Network creation

We created a network centering on the co-sponsored bill data to grasp the relationship between the legislators' initiative. Each member on the network was set to vertex and the relationship between the members was set to edge. the relationship score, which is the weight of the edge by vertices, was calculated. The formula for obtaining the scores $S_{(a,b)}$between lawmakers a and b in one bill is as follows.

$$S_{(a,b)} = \frac{1}{\#\ of\ cosubmitting\ members}$$

In other words, the fewer people who proposed the bill together, the closer the relationship, the higher the scores were given. We divided The 19th National Assembly session into eight equal periods. Scores of relations between the co-proponents of the bill was calculated along all the bills proposed each period.

Community detection

In order to confirm the existence of a joint legislative submission group among the members of assembly, we conducted community detection based on the joint legislative submission relationship at each period. The algorithm for community detection is based on Greedy Clique Expansion (GCE) proposed by Conard Lee et al. (2015).

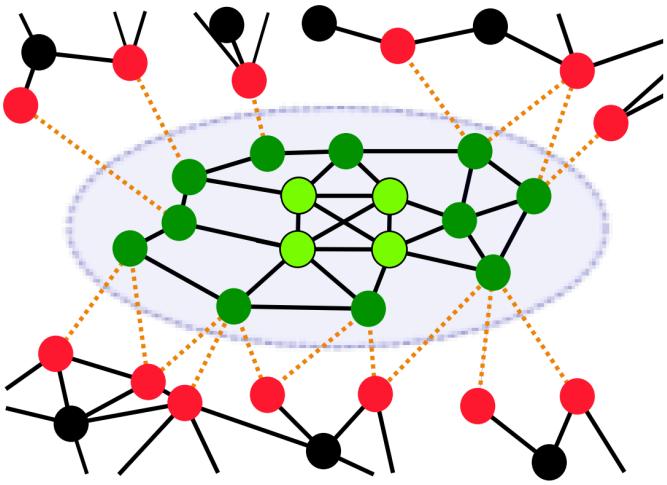


Figure 2 Concept sketch in which clique is expanded through GCE algorithm. From the central seed clique, nodes surrounding it are added via GCE.

In the following, we give a brief overview of the most important details of GCE. GCE is the algorithm that set distinct cliques as seeds and expand those greedily through the fitness function. The existing clique-based community detection algorithms select only one complete subgraph connected to each other as clique. However, GCE admits any graphs that pass the fitness function. Fitness function F_S is as follow.

$$F_S = \frac{k_{in}^S}{(k_{in}^S + k_{out}^S)^\alpha}$$

S is a community, k_{in}^S and k_{out}^S are internal and external degree of S and α is parameter for tuning. This function means the rate of internal degree per external degree. In other words, even if the interconnection is not a perfect graph, it is classified as a community if the internal interconnection is high. This resolves the fragmentation of existing clique-based subgraphs within a huge network.

Deriving political ideology score by assembly member

In order to determine whether the Ideology of each member of the parliament affect the initiative of the legislature among the members of the parliament, the ideological score of the members of the parliament was used. The ideological score was derived using the nominate scaling method. NOMINATE is a multidimensional scaling application developed by political scientists Keith T. Poole and Howard Rosenthal in the early 1980s to analyze preferential and choice data, such as legislative roll-call voting behavior. This method of diminishing dimensions based on voting similarity has been used in several studies to divide lawmakers

into progress and left-right or liberal conservative. Therefore, we derived the ideological scores of each member of the National Assembly based on the voting data for the entire 19th National Assembly.

Visualization

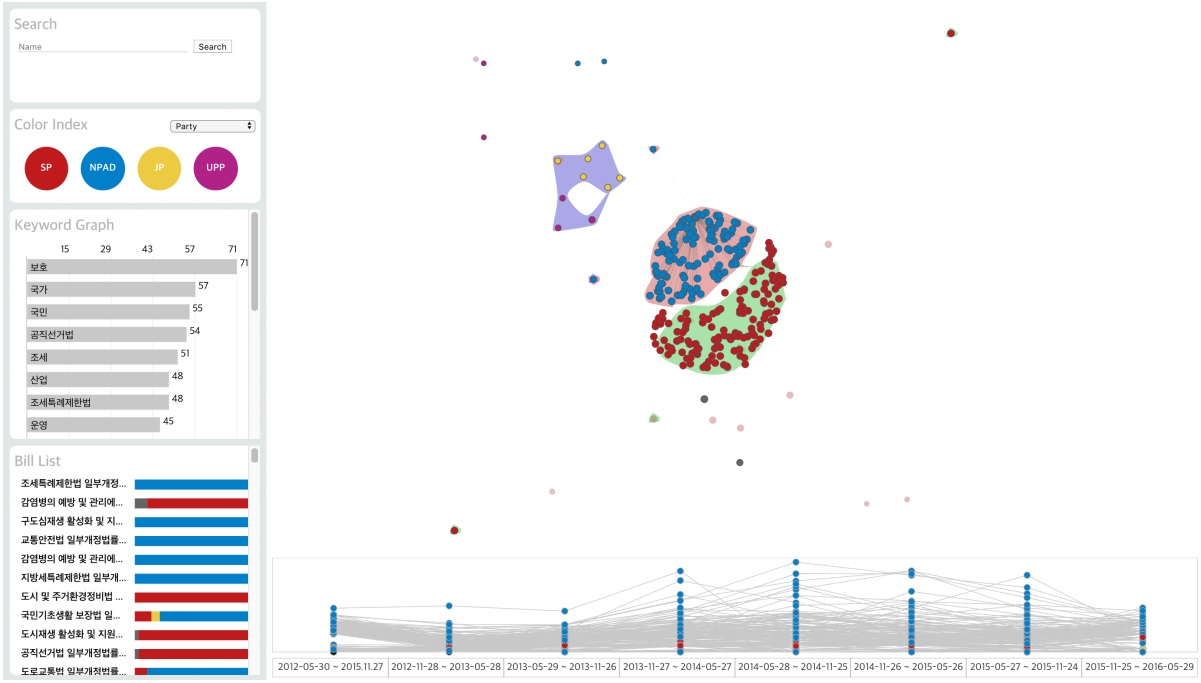


Figure 3 The result of joint legislative submission network visualization

Main Network View

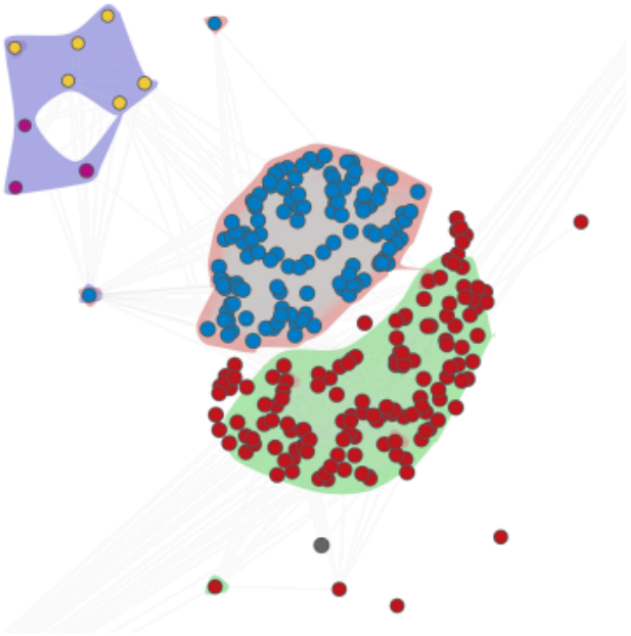


Figure 4 Main network view

The network of joint submission by time shows the relationship between lawmakers to jointly propose bills at different times. The entire period is divided into eight equal parts and the network is derived from the joint submission data during each period. And it is visualized in a node-link diagram [T1]. The node represents each lawmaker and the link refers to the relationship score between the two lawmakers.

A node has color, size, and position. The color of the node represents the party (default value), ideological score, or the school her (or him) came from. The size of the node is proportional to the number of linked lawmakers. A large number of linked nodes means that the lawmaker has interacted with many other lawmakers. The location of the node is determined relative to the linked nodes. The nodes are located by Force-directed Layout. Since this method locates the connected nodes close to each other, the relationship between the members of the parliament can be grasped at a glance through the location information of the nodes.

Through the link in the node-link diagram, a pair of lawmakers who have made a lot of joint submission are shown in time. However, it is difficult to identify a group that had a lot of joints submission. To solve this, we show the cluster together on the node-link diagram. Clusters are derived from the network through a community detection algorithm. These clusters are then visualized as a node-group diagram [T2]. The regions of each cluster are represented by concave hulls of different colors.

There are two interactions in the main network view. First, the user can change the node color set by the party to the default value through the interaction to indicate the ideological score [T5]. This allows the user to deduce the factors that have influenced the relationship between lawmakers or the cause of the joint submission group. When the color option is set as a party, the color is given to the node through the representative color for each party. When the user changes the setting to ideological score, the color of the node changes to represent the ideological score value. If the legislator is progressive, it has a red color. If it is conservative, it has a blue color. The closer to neutral, the lower the color saturation. The closer to the extreme, the higher the color saturation.

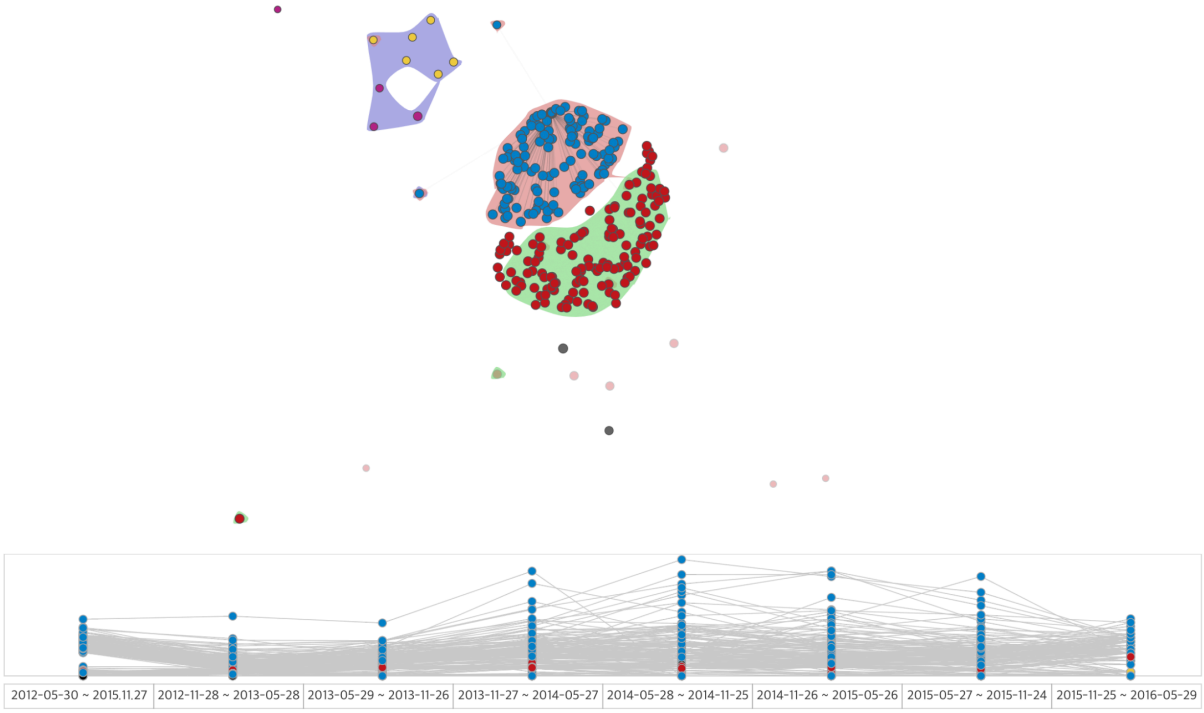


Figure 5 The result of note select interaction

Second, additional information is shown by selecting the lawmaker nodes. A user might want to explore more about the initiative of a legislator in a particular legislator, or a node that wants to look more closely at the network topography of the main view. the user can select the lawmakers through a node click or search by name and explore through the summary view of the bill. At this time, the node that is searched or clicked changes the lower time-line view. The node and the nodes connected to it are selected together to change the graph in the bill summary view.

If more than one node is selected in the network view, transparency is assigned to the unselected node to distinguish the selected node from the non-selected node.

Time-line View

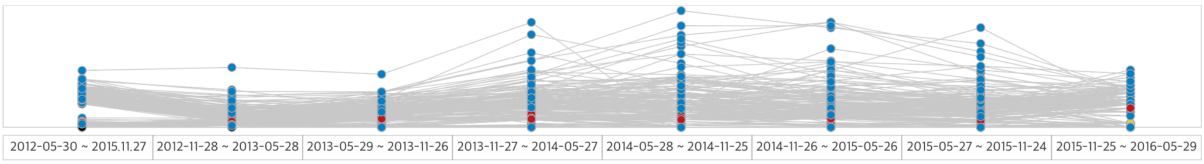


Figure 6 Time-line view

Below the Network View is a Timeline View. The selected period in this timeline is displayed in the Network View. The Network View shows information on initiating a joint legislative bill in one of the eight periods but does not provide a summary of the entire period. In the timeline

view, there is a visualization that intensively shows the network of the whole period in order to solve it. This visualization shows the change in the support rate of initiatives in the network during the entire session of the remaining members of Parliament for a single member of Parliament selected through a node click or by name search.

Bill information view

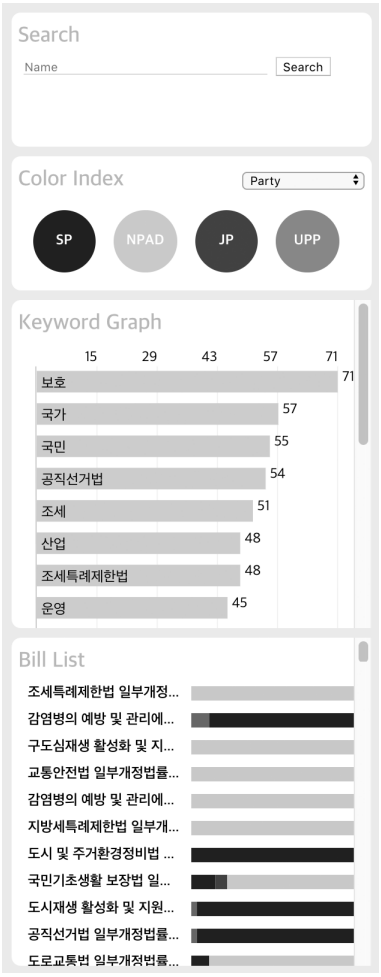


Figure 7 Bill information view

Our network is designed not just to show the network image, but to analyze it through the discovery and interpretation of the network. Therefore, we made four sub-views to explain the search and interpretation of main view and the cause of its creation.

In search, we defined user access to our visualization in two ways: The first can be accessed through the click of a node in the main view. The second way is to use search to find the name of the node. When searching for names through Search bar, the names of lawmakers searched at the bottom of the search menu are activated, and the corresponding nodes are activated in the main view. We have made it easy for users to access the information they want in a complex

network structure through a search menu. It is also possible to accumulate searchable figures through search. The names of the searched characters will be accumulated at the bottom of the Search bar, and additional characters will continue to be entered. In the main view, all the characters accumulated in the search menu were highlighted so that they could see the relationship between the characters.

In color index, we have formed a network using data from members of the National Assembly's joint motion. Two categories could be interlaced into the network to interpret the network in a variety of ways without stopping there. It shows how different categories relate within the network formed by substituting the current academic background and regional data of lawmakers.

In keyword graph, we analyze keywords for bills jointly developed by lawmakers and provide a preview of bills using bar charts in order of the most commonly used words sequentially. When a node is selected, a bar graph is formed based on bills proposed by lawmakers corresponding to the node. In addition, when a node is selected multiple times, a keyword bar graph is formed based on legislation proposed by all of its nodes. The keyword graph allows users to easily identify common denominator (objection) among lawmakers. Furthermore, it provides a summary of bills proposed by lawmakers at different times using bar charts and eight time lines.

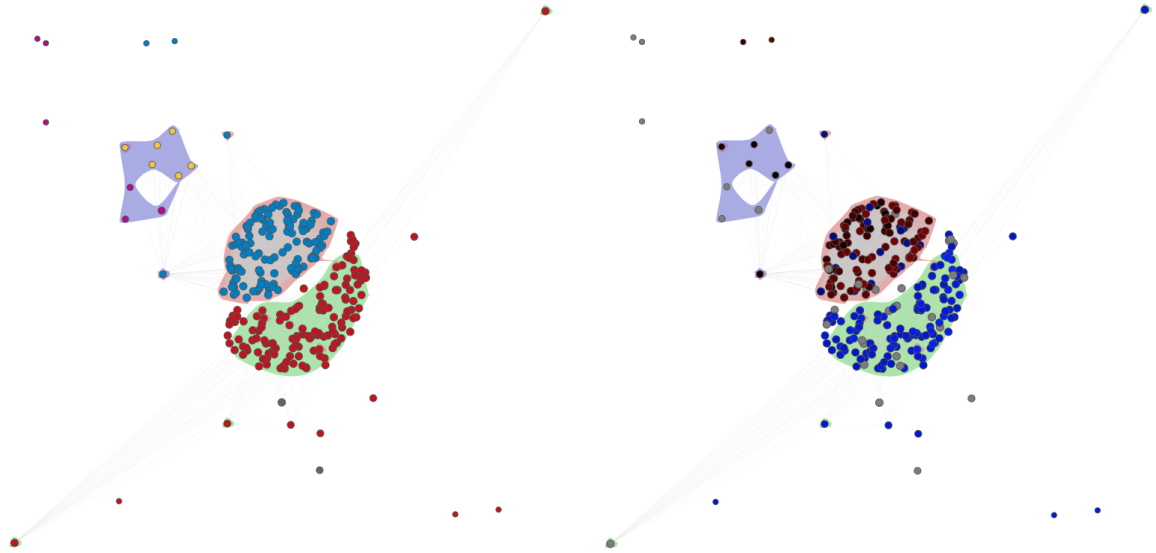
In bill list, we provide specific information on the bill to provide detailed information on the causes of the network formation. The bill list describes the bills that a member of the national assembly participates in a joint motion in order of the date of the motion. The reason why the bills are expressed in chronological order is to link with the line graph below. The line graph at the bottom was made to reflect the distance between one lawmaker and another during the entire period. The user can clearly see the causes of the network's formation in the main view through the chronological relationships of the bills in the foot, arranged in chronological order. bill info provides detailed information about the bill list if you click on the bill list. bill info consists of the name of the bill, the date the bill was proposed, the persons involved in the motion, and the content of the bill.

Case study

Cosponsorship Group in legislative process

In previous studies dealing with data on joint legislation by the Republic of Korea, the party concluded that the group of co-sponsored bill was the most influential in forming. We have

actually confirmed that the party is the most influential factor and how personal political ideology affects the proposal.



(a) (b)

Figure 8 Network view visualization results of the first period. (a) Party color mapping, (b) Political ideology color mapping

Figure 8 shows the main network view visualizing the network of joint legislative bodies between May 30, 2012 and November 27, 2012. (a) is mapped the color of the nodes to the color of each lawmaker's party, and (b) is mapped the lawmaker's political ideology score. As shown in (a) in Figure 8, every group of co-proposal seems to be strongly influenced by political parties. On the other hand, as in the (b) in Figure 8, political ideology does not seem to have much effect on the formation of groups. This trend appears to be a similar pattern for this period as well as for the whole time period. It was confirmed that this trend was also reflected in the relations between lawmakers.

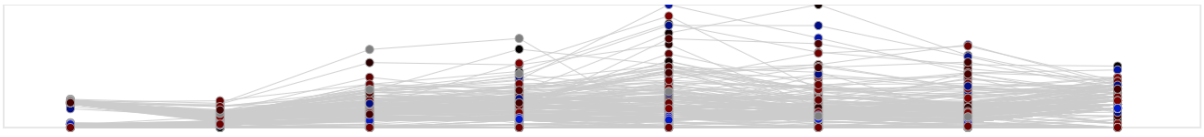
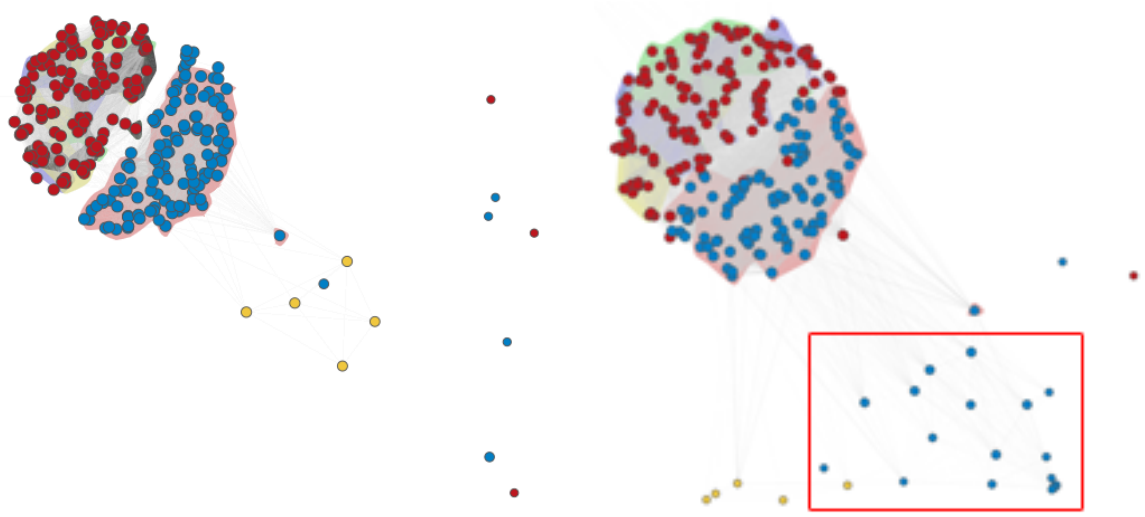


Figure 9 lawmaker Boo Jwa-hyun‘s time-line view

Figure 9 shows the visualization of the time-line view by selecting Boo Jwa-hyun, who is a member of The New Politics Alliance for Democracy(NPAD). The mapped color information is a political ideology score. Boo Jwa-hyun is a lawmaker with a conservative political ideology in blue. As shown in Figure 9, He has a close relationship with red nodes as well as blue ones. This trend is seen by many lawmakers as well as him. Therefore, it was confirmed that political ideology did not have much effect on the relations between lawmakers.

Formation People's Party

Members of the National Assembly composed of Ahn Chul-soo and Chun Jung-bae left The New Politics Alliance for Democracy(NPAD) in November 2015 and created the party of the people in January 2016. This case was a big issue that shook up the political situation of the opposition party, so we visualized how cosponsorship network in legislative process changed through this research.



(a) (b)

Figure 10 Aspects of changes in the network view before and after the formation of People's Party. (a) before party formation, (b) after party formation

Figure 10 shows the visualization of the network view before and after People's Party was created. a) is the network view prior to its creation, from 27 May 2015 to 24 November 2015, and (b) is the network visualization from 25 November 2015 to 29 May 2016. The nodes within the red border of (b) represent members of People's Party. As shown in the figure above, the party People's Party members (a) who belonged to group during the period (a) were excluded from group A (b), after the creation of party B. There is also no strong alliance between the lawmakers of People's Party, but it was geographically close.

Discussion

Expansion of datasets

South Korea's parliamentary term is four years, which indicates a change in the people who propose the bill. Lawmakers are elected by the people and the people judge a candidate's personal qualities, abilities, and political inclination and entitle him or her as a lawmaker. However, judging this because it is difficult to identify the candidate's political orientation, the

public can soon use the political inclination of lawmakers' parties as their political orientation and ideology. In other words, it depends on what kind of activities the members of the party belonging to the party or the party belonging to the party have in the future, which influences the election of the next member of the parliament. As such, the previous session of the National Assembly has a great influence on the composition of members of the National Assembly in the next period. The expansion from the use of the information on the 19th joint initiative used to the ongoing session from the past to the ongoing session is expected to provide insight into the changing network of lawmakers and the changing patterns of newly formed lawmakers. This could provide new direction of analysis and insight for visualizations users.

In South Korea, the National Assembly will take 10 steps to pass a bill before it becomes a proclamation. It will be reviewed and reviewed by the six-step committee, before reaching the seven-step plenary session. The seven-stage plenary review, like the preceding steps, determines whether the proposed bill should be dropped or not, has significant meaning because it is decided through the voting of all the lawmakers in the session. Finally, it is time for the opinions of the members of the National Assembly on the bill to become important. The opinion on whether to vote for or against the bill is the one that best reflects his ideology and tendency because it depends on the political ideology of his political party and on the political identity of the participants. Further use of this meaningful plenary vote data could lead to the creation of relationships among lawmakers using co-sponsored bill information, as well as provide additional information such as ideological and political identity extracted from the data as a variable in the creation of groups. This is expected to increase the capacity to describe network groups presented in visualization.

Generalization to other domain datasets

The visualization applications proposed in this study can be generalized to allow visualization of data with a similar form to the datasets used in this study. Meta network-based data that includes a variety of factors in relationship-based data and nodes that allow for network formation will be visualized through the visualization methodology of this study. This will help us understand the changing relationships of various networks, whether or not community exists, and the relationships between nodes and the background to create community.

Conclusions

In this study, we proposed a visualization application to derive relationships between lawmakers based on data from joint legislative submission. Based on this, we have compiled

methods for selecting and communicating the information to be provided in visualization applications. Then, data from the joint legislative submission was edited and information for visualization was derived and visualized. Finally, two case studies were conducted using this visualization application. We have confirmed through Case Study that the most influential factor in joint legislative submission of the Republic of Korea is its own party. On the other hand, the individual lawmaker's political ideology has confirmed that it does not significantly affect joint legislative submission. However, since we used only political and political ideological scores as information on nodes, there are limitations that we have only dealt with limited information. Also, it is unclear whether the same pattern will be seen at other times as it has been dealt with only the 19th National Assembly. Next studies will add these data to draw conclusions that can be further generalized. For example, additional factors that may affect the joint legislative submission include academic backgrounds, districts and regions from which lawmakers are from.

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