STAT-S 470 Mini Project 2

Zining Qi, Yexin Lu, Mengchu Li

April 4, 2021

1 Polarization in two years

We use PCA on the senators by bills matrix to analysis the voting records. And we use un-standardized method to do this analysis, because each senator's vote on each of the bills is record as "Yea", "Nay", "Not voting", which can be viewed as same scale. And two years that we choose to analysis polarization are 1989 and 2014.

1. **Analysis of Year 1989**

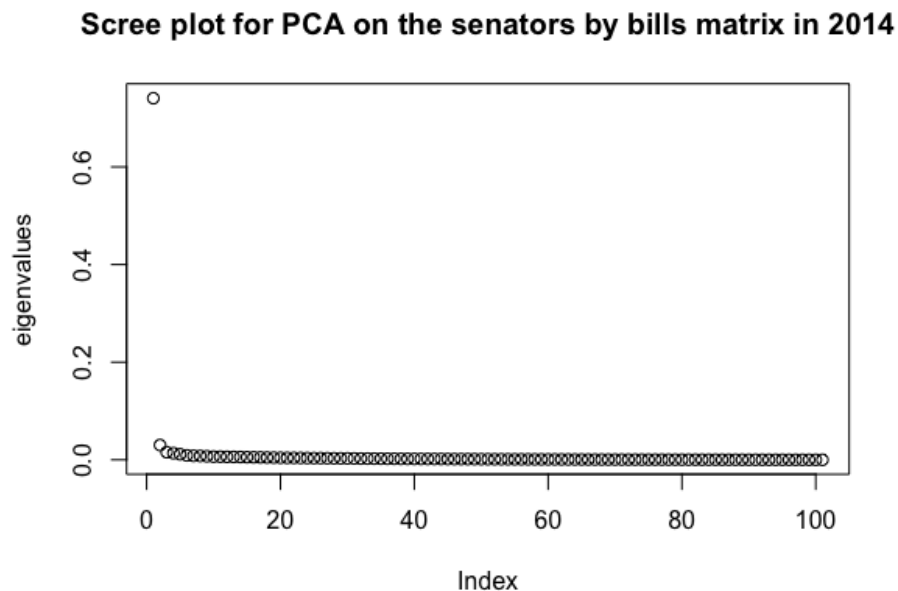### Scree plot for PCA on the senators by bills matrix in 1989
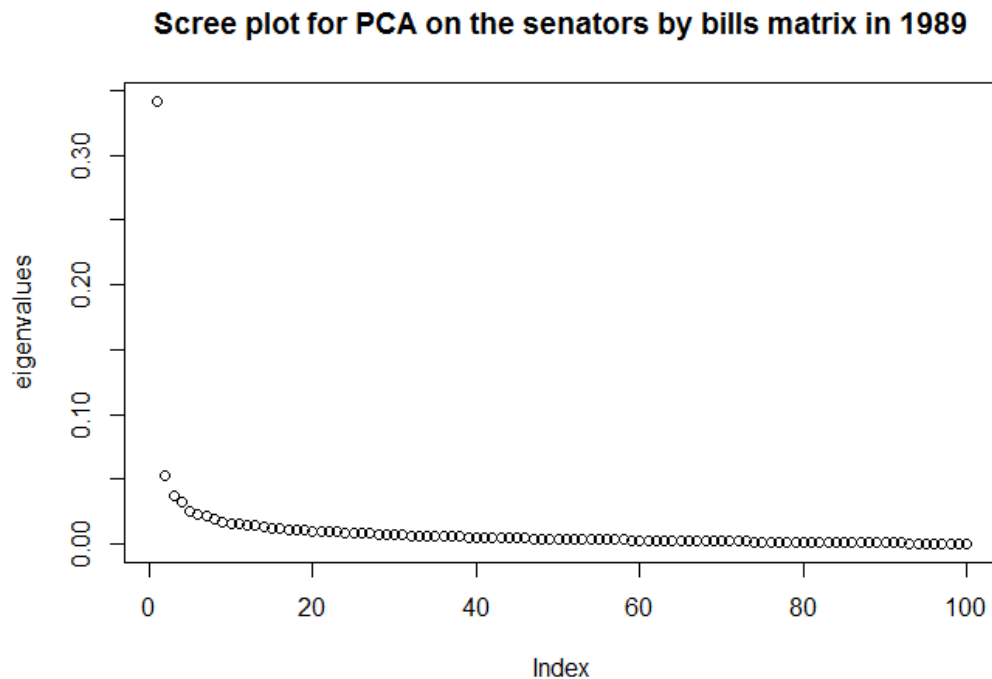
From the above scree plot for PCA in 1989, we can see that the variance explained by the first component is very large and the variance explained by the other components are very small which approximately zero. Thus, one-dimensional structure is enough to explain the relationships between the senators.
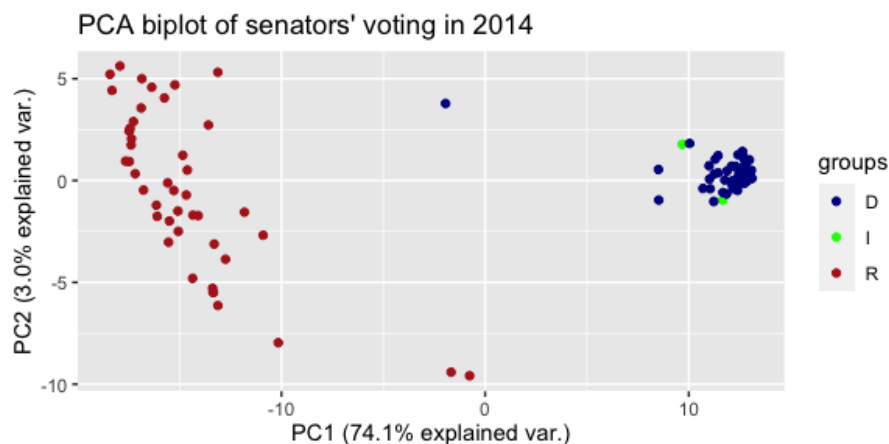
PCA biplot of senators' voting in 1989
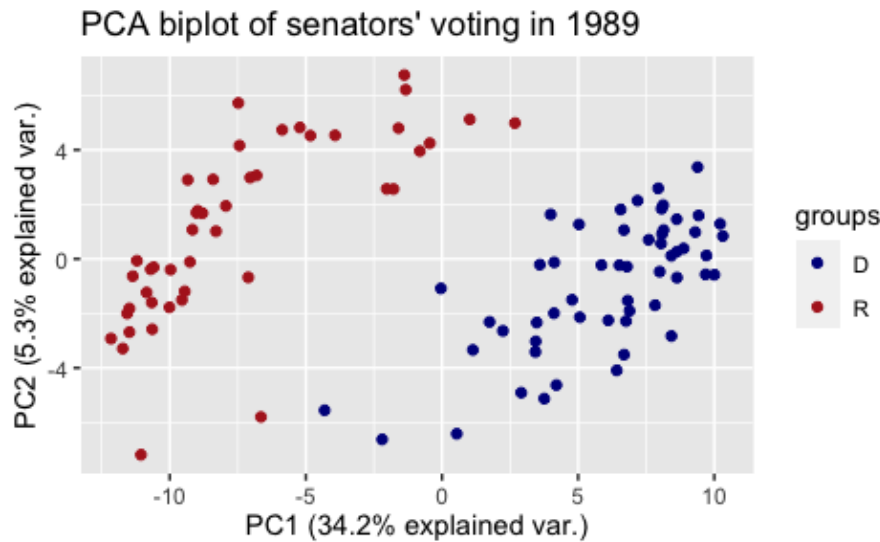
From the PCA biplot of senators' voting in 1989, we don't see any obvious outliers. And the pattern of the points is very obvious. Points in the plot are separated into two groups. For example, most of the points for Democrats lies on the positive part of PC1. However, most of the points for Republicans lies on the negative part of PC1.

2. **Analysis of Year 2014 & The Comparison between 1989 and 2014**

Scree plot for PCA on the senators by bills matrix in 2014

From the above scree plot for PCA in 2014, we can see that the variance explained by the first component is also very large and the variance explained by the other components are very small which

approximately zero. Thus, one-dimensional structure is enough to explain the relationships between the senators in 2014.


PCA biplot of senators' voting in 2014

From the PCA biplot of senators' voting in 2014, we can see two green dots indicates intermediate in plot. We ignore this group of observation, because there are only two dots in the data set, which is very small.

From this biplot, we can see that there ares several outliers lies in middle of the plot. For example, there are one blue dot, which indicate Democrats, lies in the center of the plot, And there are two red dots, which indicate Republicans, lies in the bottom of the plot. However, the pattern of the points is still obvious if we ignore the outliers. Points in the biplot are separated into two groups. For example, all points for Democrats lies on the negative part of PC1, and all points for Republicans, lies on the positive part of PC1, which is opposite from what we got for 1989 senators' voting.

Another difference in the PCA biplots in the 1989 and 2014 is the distance between two parties. In 1989, the distance between two parties is very small. However, in 2014, the distance between two parties is very large. This observation shows that the polarization has a huge increase in 2014 compare with 1989. More generally, the polarization in later year are more aggravate than the polarization in earlier years.

2 Polarization over time


Variance explained by PC1 from 1989 to 2014
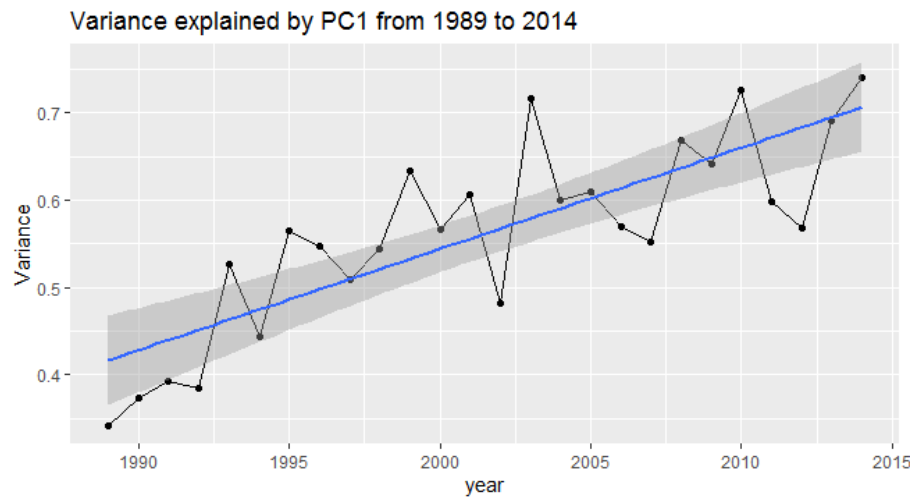
To answer this question, we use variance explained by the first principal component as a measure to describe polarization over time. From the plot above, we can see that the polarization does increase over time, because the variance is generally increasing from 1989 to 2014. However, more complicated situation happened in this period, because there are lots of fluctuations during this period. For example, the variance has huge increasing and decreasing during 2001 to 2003. Another interesting thing happened from this plot is from 1989 to 2003, the increase of variance is very obvious although there are lots of fluctuations. However, from 2003 to 2014, the increase of variance is very small and the fluctuation becomes larger. For example, there are three peaks during 2003 to 2014 in the plot, which are 2003, 2010 and 2014.

PCA biplot of senators' voting in 2014

PCA biplot of senators' voting in 2003
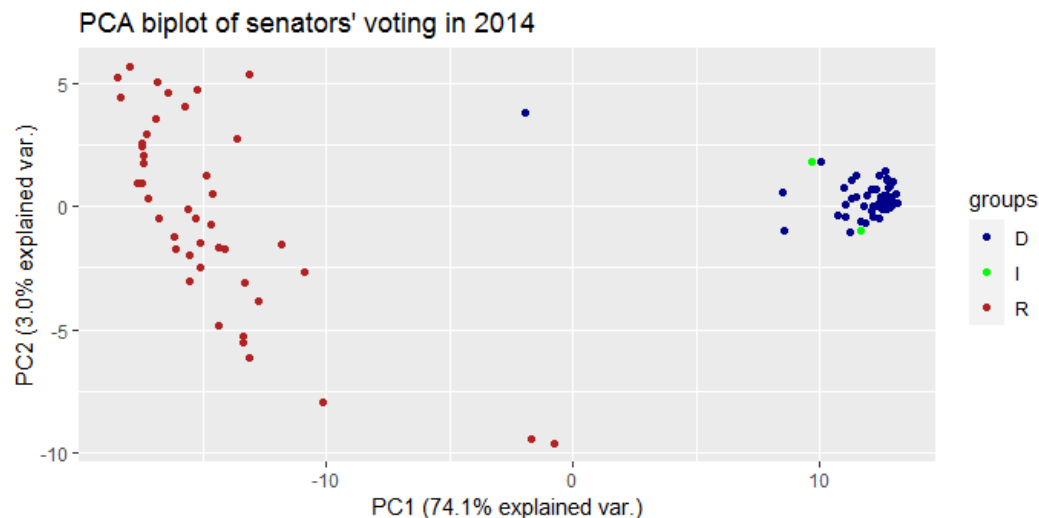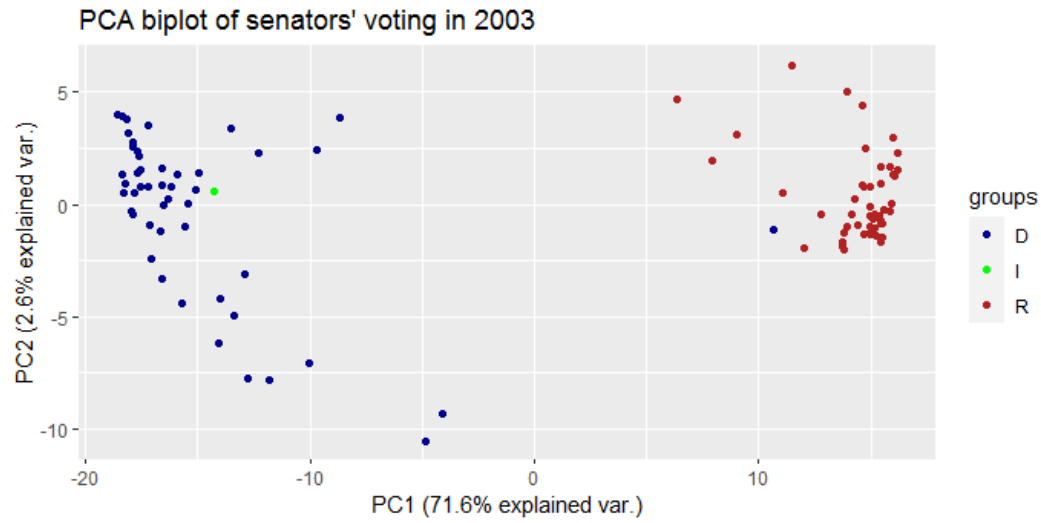
The differences of variance between them is less than 4 percents, which is very small. We can see this aspect by comparing the PCA biplot of senators' voting in 2003, 2010, and 2014, we can see that there are not very large differences in distance between each party, which means that the polarization doesn't have a very large increase during 2003 to 2014.

PCA biplot of senators' voting in 2010
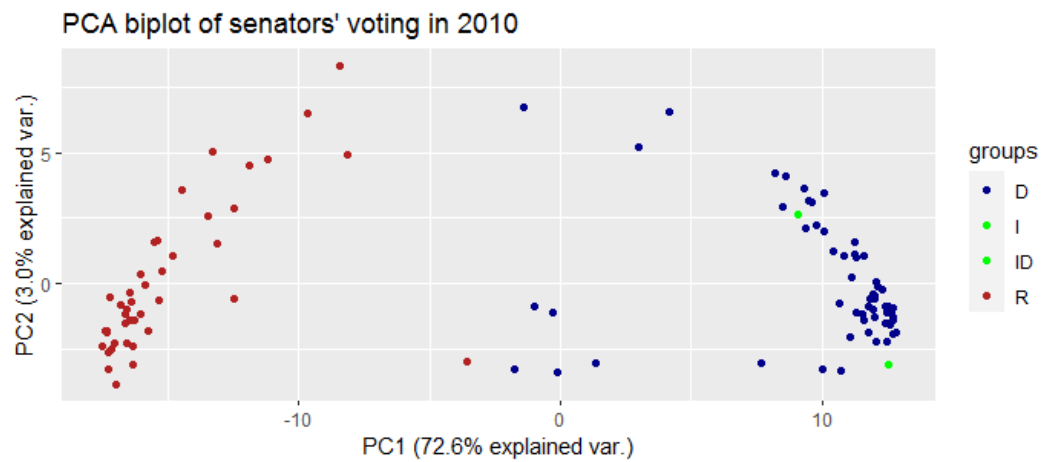
3 Ideological position of one senator

We derive two kinds of methods to do the part 3.

1. **PC1 & Mean**

   We choose Mitch McConnell as a specific senator to analysis the absolute changes of ideological position over time. We measure the two parties' positions relative to Mitch McConnell, because Mitch McConnell is a senator whose ideology we might expect to have been constant over time. We calculate the average value of PC1 for each party over time, and compare with the PC1 for Mitch McConnell over time.

   The above plot describe Mitch McConnell's position relative to the two major parties over time. The red line indicates the distance between Mitch McConnell and Democracy over time. The blue line indicates the distance between Mitch McConnell and Republican over time.

   From the above plot, we can see that the distance between Mitch McConnell and Republican is very small during 1989 to 2014. That is because Mitch McConnell is a Republican, and the whole Republican party doesn't change their politics in a very large scale during this period.

   After we look at the line that represent Democracy, we realized that there are lots of changes during 1989 to 2014, because there are lots of fluctuations in the plot. This aspect shows that the senators from Democracy changed their politic position frequently during 1989 to 2014.

   However, we still can see some increase trend of distance between Mitch McConnell and Democracy in the plot. For example, when we compare the first year to the last year, we can see the difference between these two distances are increasing. This observation can show that Democracy is more to blame for polarization, because Republicans are holding their position almost constant.

   Moreover, this is a very limited explanation, because only compare two years' measure is not enough to explain the whole situation. And the whole situation is very complicated to explain due to the lots of fluctuations in the distance between Mitch McConnell and Democracy. Another limitation of our analysis is we calculate the distance only based on PC1, which is not very accurate to describe the two parties' relative to Mitch McConnell.

   Comparison of Position of Parties with respect to Mitch McConnell
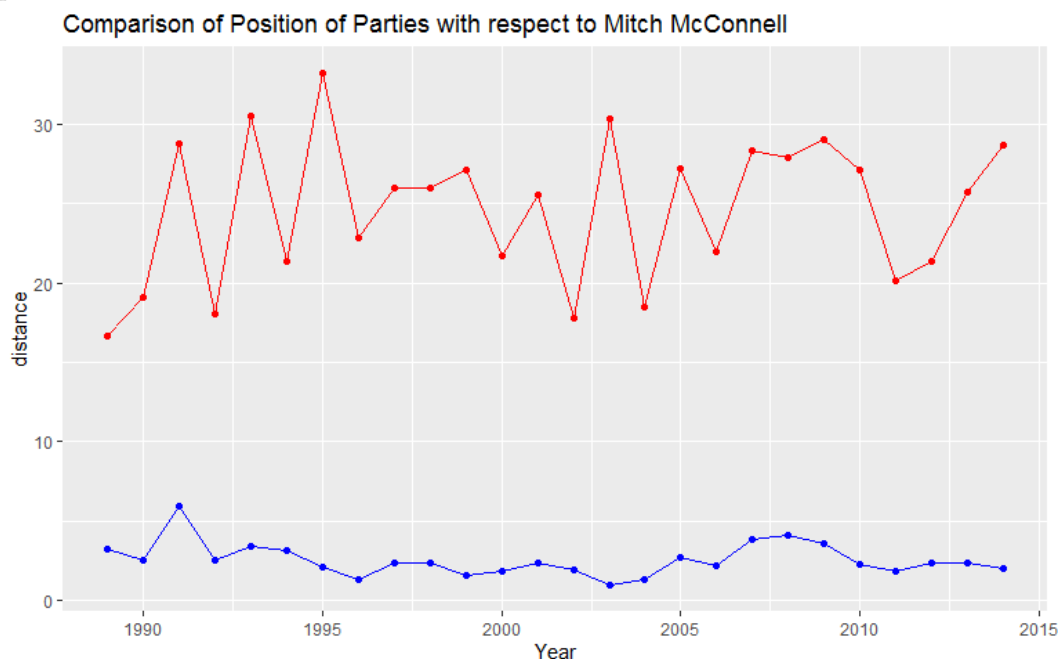
2. **Mean**

Comparison of Position of Parties with respect to Mith McConnell
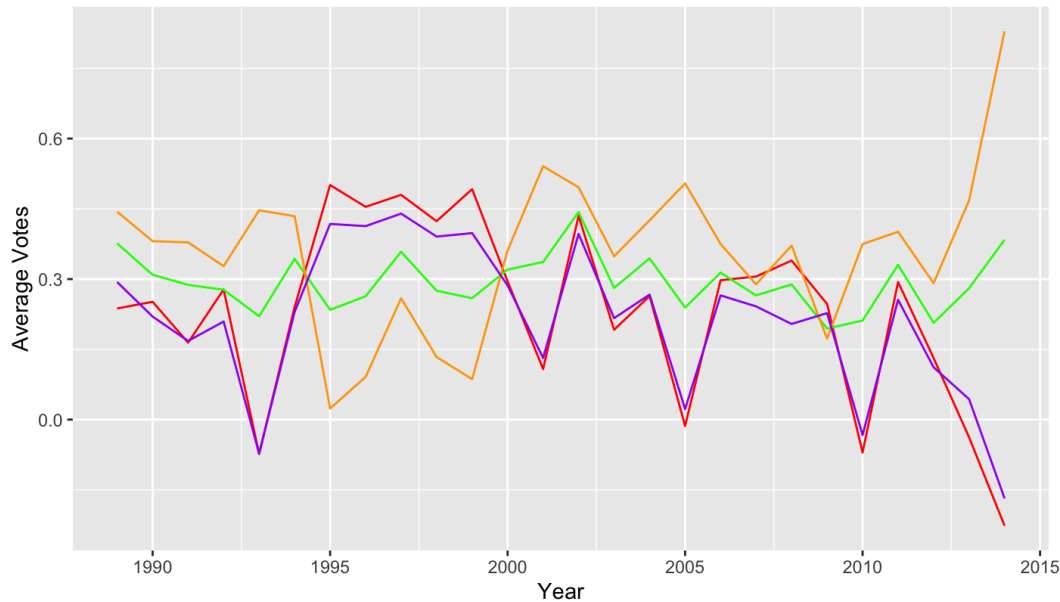
The Red line is Mith McConnell's average votes over years.

The Green line is the whole senate's average votes.

The Orange line is Democratic average votes.

The Purple line is Republican's average votes.

What we did is to calculate Mith McConnell's average votes, whole senate's votes, Democratic votes, and Republican's votes.Then plot these lines over years to get a plot that allow us to compare policies over years.

(a) Implication of Plot

The plot is lying around average vote=0.3. There are some years that the distance between Democratic and Republican (orange and purple) are larger than any other years, especially in 2014. The distance of average votes in 2014 is almost 0.9.

Compared McConnell and Democratic(red and orange), from 1992, the red line and orange line shows obvious opposite trend of line. This means McConnell and Democratic always had opposite policies, which means McConnell vote yes, Democratic vote no. The basic trends between McConnell and Democratic show the basic policies of these two aren't change too much, like they don't change from one side to a totalling opposite side.

Compared McConnell and Republican(red and purple), these two lines are almost overlap. It shows that McConnell and Republican basically stays the same policies over years, which means the policies held by these two also didn't change too much.

The plot overall doesn't show the change in policies. There is a big distance in 2014. But we can't say there is a polarization in two parties. There are no data after 2014, we can't predict how it goes without data. It is dangerous to conclude polarization after 2014. Maybe it is just one year thing.

(b) Limitation and other Possible Explanation

One limitation is there are no data after 2014, we can't see what happened after 2014. So, we can't really make a conclusion about the polarization. The other one is there are no each bill's name and description. The content of bill may also be an important thing can let us investigate. For huge distance in 2014, other possible explanation except parties' polarization maybe some global influence. There are some big event happened in 2014 that may amplified the distance, such as oil price crash. This kind of reason might be one year thing. It may not influence the next year that much.