Analysis of Political Parties using a Self Organizing Feature Map

Deepthi Pathare

Hannes F. Kuchelmeister

Teja Kedar

Abstract

Analysing the political positions of parties in a Parliament based on their views and policies is a challenging task and a socially relevant area of research. In this work, we use self organizing feature maps (SOFM) to visualize and analyse the political landscape in Germany and United Kingdom, using the voting records of the members of the Parliament, over different election periods. We also compare our findings with equivalent results provided by the publicly available political compasses of each country.

1 Introduction

The political party landscape is vast and with many nuanced opinions. There are a large number of different political issues and this makes the classification of parties and their differences a non-trivial task. Commonly parties have been set on a spectrum ranging from left to right but this seems to be insufficient to display their differences. Political Compass [4] that plots parties on a two dimensional scale that classifies parties on a spectrum between *libertarian* and *authoritarian* and between *economic left* and *economic right*. In our project, we use self organizing feature maps (SOFM) to visualize and analyse the political landscape in Germany and the United Kingdom over different election periods.

We study the voting pattern of Members of Parliament(MPs) who are affiliated to different parties using the records of parliamentary votes on different issues over three election periods. The parties have different ideologies and policies on various issues. Most probably the party members would vote along these ideological lines. Therefore we analyse how the parties are correlated based on the votes from their members. From this analysis, we can identify which parties vote more uniformly and which parties' votes are more diverse. Additionally, we compare our visualisations to that of Political Compass.

2 Background

Currently, there are seven parties in the German parliament as described in Ref. [32]. The largest party is the Christlich Demokratische Union (CDU). It is considered to be a main center-right party that has been shifting more towards the center under the leadership of Angela Merkel. The party is overall conservative compared to left leaning parties. Its sister party the Christlich Soziale Union (CSU) is only active in Bavaria and on a national level these two parties act as on the national level which is why in this report they will be referred together. The CSU overall is considered to be more conservative on social issues than the CDU. The next party is the Sozialdemokratische Partei Deutschlands (SPD) which is the oldest poltical party. It is considered to be the center-left rival of the

CDU/CSU and follows a more progressive line on welfare and social policies. The CDU/CSU and SPD currently form a government coalition. Alternative für Deutschland (AFD) is the currently largest opposition party in the German parliament. It is also the youngest of the parties which are represented by members of parliament and the party's policies are far-right, eurosceptic, anti-immigration and anti-muslim. Traditionally when Germany only had three major parties (CDU/CSU, SPD and FDP) the Freie Demokratische Partei (FDP) was the party that helped the others to form a majority. It has formed multiple coalition governments and supports a low tax low government approach while being progressive on social issues like gay marriage and religion. The party failed to get into parliament in 2013 but managed to regain their seats in 2019 [5]. During the environmental movement in the 1980s Bündnis 90/Die Grünen (BÜ90/GR) were founded. This party supports efforts in environmental protection and to fight climate change. On social issues the party is progressive. Last, there is Die Linke which is the most left wing party in the German parliament. Its goals are major wealth re-distributions and they follow a pacifist policy for international issues. Moreover, the party is the successor of the SED which ruled East Germany.

The political landscape in the UK consists mainly of the Labour and the Conservative party. Ref. [26] introduces also the Scottish National Party and the Liberal Democrats which are the third and fourth largest parties. The fifth largest Party is the Northern Irish Democratic Unionist Party (DUP) followed by Sinn Féin [19]. This is followed by Plaid Cymru which gained 4 seats in the last election. All remaining parties reach only one or two seat and therefore are not considered in this paragraph. The main two parties in Northern Ireland are the DUP and Sinn Féin. The DUP [20] is considered to be a conservative protestant party. They are for example against same-sex marriage. In contrast, Sinn Féin, the second biggest Northern Irish party [15], is a party that works towards the unification of Ireland. They are considered to be a left leaning democratic socialist party. In Scottland, the party with the most seats by a large margin in the UK Parliament is the Scottish National Party (SNP) [17]. They fight for the Scottish Independence and are considered to be center-left. The largest parties in Wales are also the Conservative Party and the Labour Party. Plaid Cymru is the third largest party in Wales. It is considered to be pro European and social democratic [14]. The Liberal Democrats [16], are a party considered to be in between the Labour and the Conservative Party. They also are the most pro European and fight for civil liberties and social justice. They have won seats across the UK and are not present in only one region.

In a related work [24], the authors studied the Swedish parliamentary data to obtain the relative stance of the parties and the members on different issues. The data is analyzed from three different aspects which check how close parties and the members are to others on various issues in terms of the voting record, how close the individual members on a party are on different issues and how the views of the individual members of the party and parties themselves are clustered. To check these three different aspects, they also use different tools. The first issue is analyzed using agglomerative hierarchical clustering[13]. Intraparty Variation Chart shows the standard deviation of the existing votes of Members of Parliament within each party, averaged across the votes of each committee as well as for all votes. Principle component analysis[9] is used to visualize the data in a lower dimensional space. Members of Parliament are plotted in two-dimensional space by different pairs of principal components and it is analogous to a political compass.

3 Method

3.1 Data

We gathered our data from the websites of the UK parliament [22] and the German Parliament [2], where the voting behaviour of each member of parliament for each vote is presented.

3.2 Self Organising Feature Map

A Self Organising Feature Map (SOFM) [6] [11] is a type of unsupervised learning which produces a map of usually two dimensional discretized representation of the input space of the training samples, by performing compression of input space onto a set of codebook vectors. Self Organizing Feature Maps compress information but keep the most important topological relationships between data points. Self Organizing Feature Maps are different from other neural networks, because they use a competitive learning process to effectively cluster the input vectors, and it updates not only the winner weights but also its closest neighbour nodes in the grid. Due to this, the distances are computed in the

input space(to compute winner) and in the grid(to update neighbours), by which the two vectors are close in input space as well as on map and this is a neighbourhood function to preserve the topological properties of input space. A SOFM uses the grid to approximate the probability density function of the input space. A SOFM is trained in two phases one is to find approximate locations called Ordering Phase and the other is to decide exact locations called Tuning Phase.

The grid size of SOFM is chosen such that the total number of nodes in the grid $M = 5\sqrt{N}$ [30] where N is the size of input data.

3.3 Visualisation

We build different types of visualizations to analyze the voting patterns in the parliamentary data. The self organizing feature map produces a two dimensional output grid and associates each MP to one of the nodes in the output grid. The grid positions of MPs are visualized in **MP Scatter Plot** (see Figure 1 and Figure 6). However, we add a random offset o to the position coordinates where $o \in [-0.5, 0.5]$ so that no two MPs land on the same coordinates and all members would be visible.

These member positions are aggregated into average party positions. Also, we calculate the distances of the each output node to its neighbours to be able to plot them together with the party positions in the **Party Scatter Plot** (see Figure 2a, Figure 5, Figure 7a, Figure 10). Further, the distance between the coordinates of each party is extracted from the scatter plot and created the **Party Distance Plot** (see Figure 2b and Figure 7b). Even though this plot does not consider the actual distance between neighbour nodes in the output grid, it can give us an idea about the correlation among the parties.

3.4 Evaluation

The results from the model are evaluated by computing the Mean Squared Error[25] between our results and the existing political compass[4]. To deal with the differences in scale, we normalize the party distances in the data given by the political compass and by our method. The normalized distances are then used to compute the squared error for each party to visualise effects on individual party distances. Based on that, we compute the Mean Squared Error(MSE) which is the average squared distance between parties. Similar to the Party Distance Plot, the actual distance between neighbour nodes is not considered here.

4 Implementation

The project requires multiple implementation parts which are published on GitHub [23]. The implementation consists of three parts, acquisition, preprocessing and analysis. To acquire the data, Python [29] in combination with Selenium [27] is used. The German dataset requires files to be converted from xls/xlsx to csv which is done using Pandas [12]. Due to the difference in the data files, the preprocessing needs to be done by python scripts that are tailored to the data source. These scripts combine the data from each vote-file election period wise to a data frame that looks like Table 1. The voting behaviour of each member of parliament is presented as row vectors. This provides some challenges as members of parliament can change their party affiliation during an election period. However, this seems to be quite rare which is why we assume that a member of parliament keeps the same party membership over the whole election period. Further, it is possible that members of parliament step down from their parliament seat, which causes them to only have voted on some votes out of the given ones. These members of parliament are removed from the dataset. Furthermore, we strip out independent members and speakers of the house.

Table 1: Example of the preprocessed input data.

	Member	Party	vote_0	vote_1	···
0	Dr. Michael von Abercron	CDU/CSU	0	0	···
1	Stephan Albani	CDU/CSU	0	0	···
2	Norbert Maria Altenkamp	CDU/CSU	0	0	···
3	Peter Altmaier	CDU/CSU	0	0	···
⋮	⋮	⋮	⋮	⋮	⋱

We use NeuPy's [28] implementation of a SOFM. For computations NumPy [8] is used. Lastly visualisations are done using Matplotlib [10] and Seaborn [31] (which internally also uses Matplotlib).

5 Results & Discussion

In this section, the results are analysed by visualising the relative positions of parties and members in a two dimensional space. The results are also compared with the existing political compass.

German Parliament

We studied the voting behaviour of members affiliated with different parties and visualized the patterns to understand their correlation. Figure 1 shows the scatter plot of MPs predicted by the model which is trained with their votes in the election period 2017. MPs are coloured based on their party affiliation. As expected, MPs within the same parties are mostly clustered together. There are 6 parties in this election period, however we could see only 5 clusters. This is because the members from the parties `SPD` and `CDU/CSU` are highly overlapped which shows a similar voting behaviour among them.

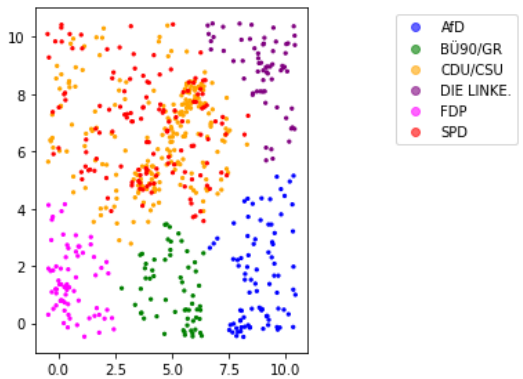
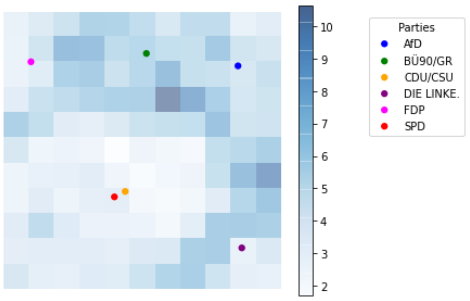
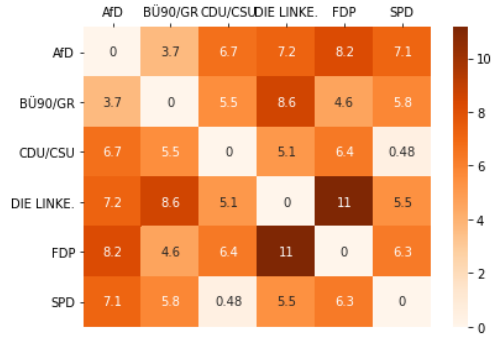


Figure 1: MP Scatter Plot (Election period 2017)

Figure 2a shows how the parties are positioned based on the votes from their MPs on the output grid. The darker cells indicate a higher weight difference from neighbour nodes where light cells indicate the neighbour nodes are closer. It can be seen that the party `SPD` and `CDU/CSU` have a very similar voting behaviour whereas `DIE LINKE` and `FDP` are very different. This can be easily understood from the distance Figure 2b. The darkest cells show the parties with extremely opposite voting pattern whereas the lightest cells show the parties with the closest voting pattern.



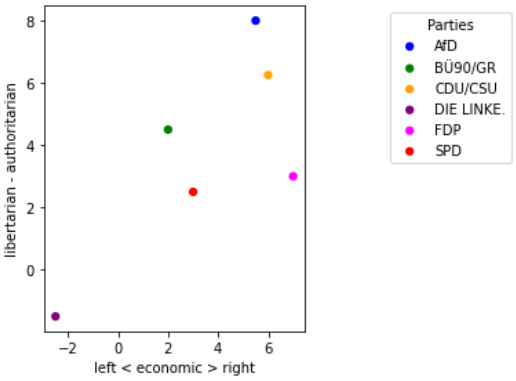
(a) Party Scatter Plot (The color bar shows the weight difference between grid nodes)



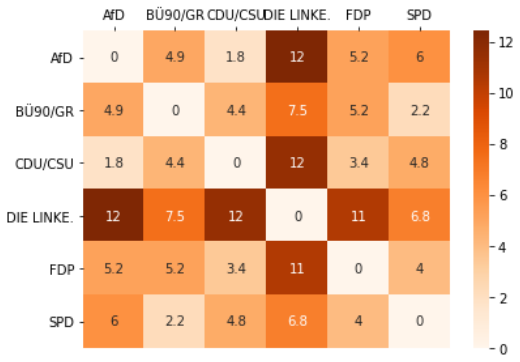
(b) Party Distance Plot, (The color bar shows the distance between parties)

Figure 2: Plots showing the distance between parties based on the model predictions (Election period 2017). The model is trained for 500 epochs with a *grid size* of 11×11, *learning radius* of 2 and *step size* 0.5

The patterns derived by the model can be compared to the existing political compass, which is visualized in Figure 3. The positions for the political compass were extracted visually as the actual position data is not available. Of note however is that the period 2017 had `CDU` and `CSU` separate so the average position was taken. Even though the closest and furthest parties are not same in Figure 3a and Figure 2a, the relative positions are similar for some parties. For example, the parties `DIE LINKE` and `FDP` are positioned further in both plots.



(a) Party Scatter Plot (Political Compass)



(b) Party Distance Plot (Political Compass)

Figure 3: Plots showing the distance between parties based on the official political compass (Election period 2017)

In order to evaluate the model performance, the mean squared error of party distances is computed by comparing it with the distance in the official political compass as shown in Figure 4. A *mean squared error* of 0.06 is achieved for the election period 2017 when the model is trained for 500 epochs with a *grid size* of 11×11, *learning radius* of 2 and *step size* 0.5. This MSE value seems to be good as it represents a similar correlation among the parties when comparing to the political compass.

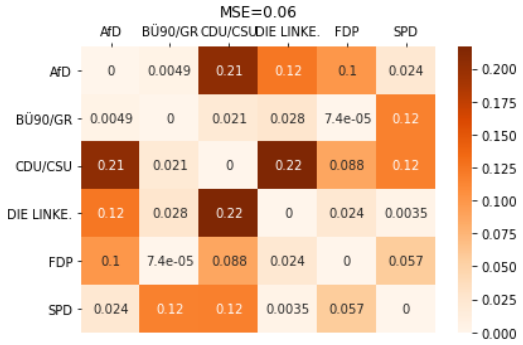
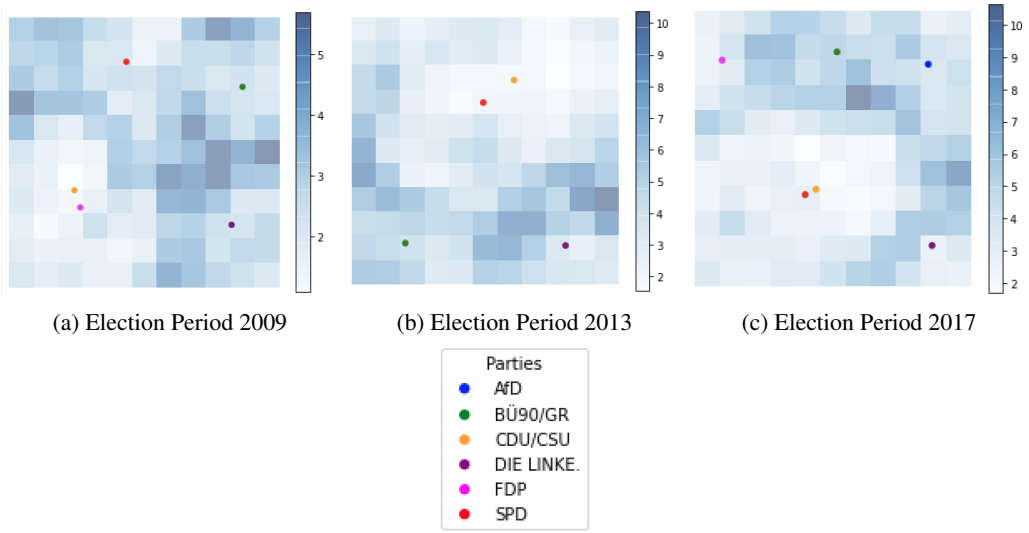


Figure 4: Error plot for election period 2017

The above analysis is performed on the dataset for different election periods. Figure 5 shows the results of 2009 and 2013 and Figure 2a shows the results of 2017. It can be seen that the relative positions of the parties `BÜ90/GR` and `DIE LINKE` remain the same over the election periods. The parties `SPD` and `CDU/CSU` were quite far away during the election period 2009, but they came closer in later periods. This might be because the two parties formed a grand coalition following the 2013 election [5] [21]. It can also be observed that `CDU/CSU` and `FDP` are closer in the election period 2009. These parties were in a coalition following that election [5]. However, in the next election in 2013, `FDP` failed to win any seats due to which we cannot see that party listed in Figure 5b. In the 2017 election, FDP regained its representation in the parliament. However, they did not enter into a coalition with `CDU/CSU` which is why the two parties are not very close in Figure 2a.



(a) Election Period 2009 (b) Election Period 2013 (c) Election Period 2017

Figure 5: Comparison of party correlations over different election periods of the German Parliament. The important factor is the relative position of a party in comparison to other parties and not its absolute position.

United Kingdom Parliament

Voting behaviour of the members affiliated to their respective parties in the parliament of the United Kingdom is visualised for their patterns to find out the correlation. Figure 6 shows the scatter plot of parliament members for the election period 2019 predicted by the model trained by the votes of this election period. The colours of MPs are based on their party affiliation. Members affiliated to the same party are clustered together. The major parties in the united kingdom parliament are

conservative and Labour parties compared to other parties [18] [7]. It can be observed that the voting pattern of the MPs belonging to the same party is diversified.

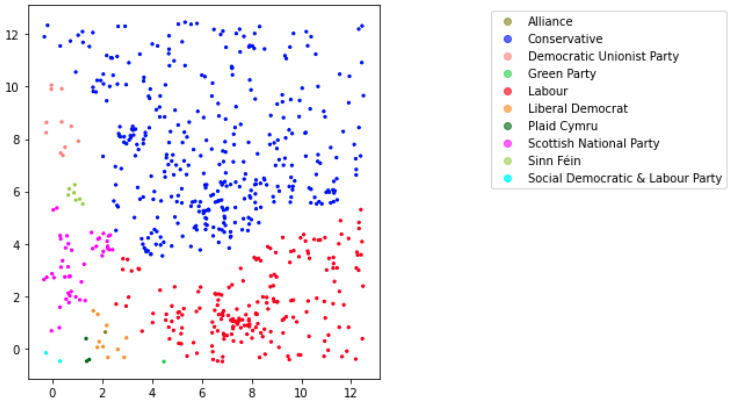
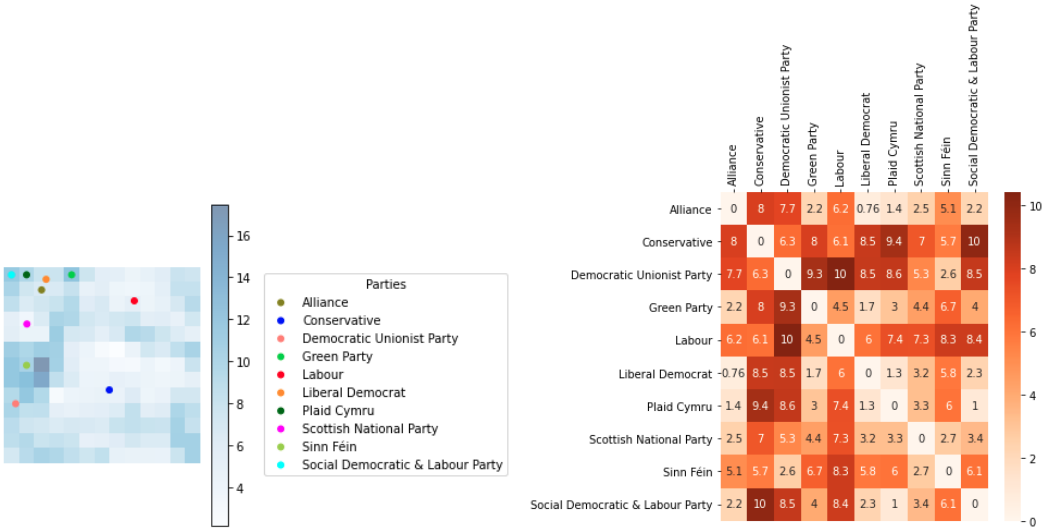


Figure 6: MP Scatter Plot

The positions of the parties based on MPs votes on the output grid are displayed Figure 7a. Figure 7b shows the distance among the parties. It can be observed that the voting behaviour of the Conservative party and Labour party differ substantially from other parties, however they both do not vote similarly either. The parties Plaid Cymru and Social Democratic & Labour Party are similar.

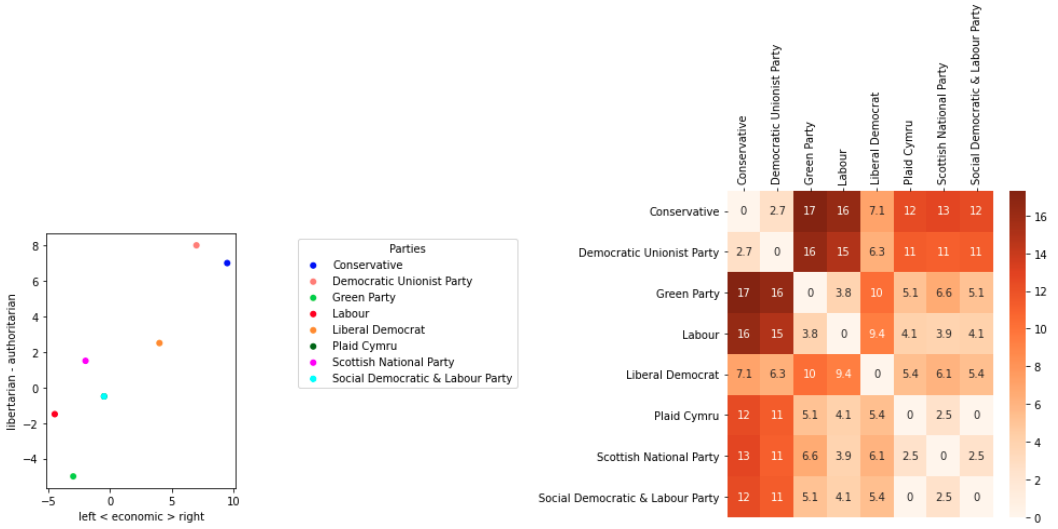


(a) Party Scatter Plot

(b) Party Distance Plot

Figure 7: Plots showing the distance between parties based on the model predictions (Election period 2019)

As in the results section for the dataset of the German parliament, we compared the derived patterns of our model to the official political compass of the United Kingdom, which is visualized in Figure 8a. The official political compass is visualised by considering different parameters along with parliament voting data. This model predicts only using voting data as the input and maps the voting pattern of the parties. When comparing Figure 7 and Figure 8 the weights of the neighbour nodes are quite similar with slight error difference for few parties, this can be seen in Figure 9. The parties Plaid Cymru and Social Democratic & Labour Party are similar in the official political compass model and the predicted model. The conservative party has the opposite voting pattern compared to other parties.



(a) Party Scatter Plot (Political Compass)

(b) Party Distance Plot (Political Compass)

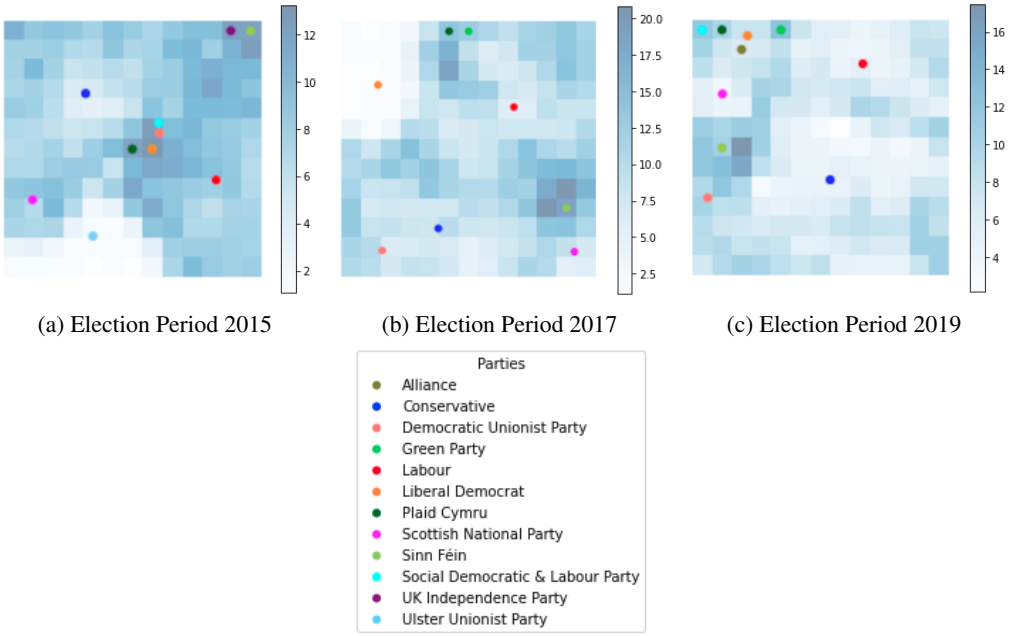
Figure 8: Plots showing the distance between parties based on the official political compass (Election period 2019)

Figure 9 represents the normalized party distance squared error for the election period 2019 and achieves a *mean squared error* of 0.06 for the model with *grid size* of 13×13 and a *learning radius* of 2 when trained. Grid size is chosen based on the data input size. And this grid is used to evaluate the model performance.

Figure 9: Error plot for election period 2019

The above analysis is also performed on the data set for different election periods. Plots in Figure 10 represents the results of election periods from 2015 to 2019. It can be observed that the voting pattern of the conservative party over three periods is different from most other parties. The parties Liberal Democrat and Green party voting pattern were similar over all the periods. The number of parties

varies by period due to the size of the parties which means they do not always get a seat in parliament [3][1][18].



(a) Election Period 2015 (b) Election Period 2017 (c) Election Period 2019

Figure 10: Comparison of party correlations over different election periods of the UK Parliament. The important factor is the relative position of a party in comparison to other parties and not its absolute position.

6 Conclusion & Future Work

In this work, we used Self Organizing Feature Maps (SOFM) to visualize and analyze the political landscape in Germany and UK over different election periods. The data we analyzed are the parliamentary votes of different Members of the parliament, who belong to different parties, on a variety of issues. For both the countries, in most of the cases, our analysis showed that the votes of the MPs affiliated to the same party are close to each other. However, in a few cases, we also found a large diversity in the voting behaviour of the individual MPs within the same party.

Our analysis also revealed further dynamics in the political orientation of the parties and indicated the coalitions formed among the parties. For example, `CDU/CSU` and `SPD` parties in Germany had very different voting behaviour in 2009, but when they coalesced in 2013, it became evident in the voting behaviour as well.

Finally, we also compared our results with the existing political compass for both countries. The results show some divergence between the political compass and our method. This can be caused due to the nature of data used in the political compass in comparison to the data we have used. The political compass considers parliamentary voting records, various political reports, manifestos and actions by the party and leaders to determine the position of a party whereas our method only considers the voting records. Moreover, the party positions in political compass situp on economic left-right and libertarian- authoritarian axes whereas our method does not consider any particular axes. Due to the difference in data, the error metric used by us should be considered carefully as there exist no true positions. It is merely a tool to compare where our method differs from the political compass.

This work can be extended to perform an analysis of voting behaviour based on the kind of issues addressed by the parliamentary bills. The categories of bills can be varied as social, economic, environmental etc. It might require some word processing techniques applied to the title of bills in the dataset to perform this categorization. This can be further extended by applying a sentiment analysis so that the purpose of bills can also be identified. It will help to predict how a particular party and its

members will vote when a bill is proposed in the parliament based on the issue it addresses and the purpose. By carefully choosing the right kind of bills, the results can be even visualized on two axes economic (left-right), social(authoritarian-libertarian) which will give more comparable results with the existing political compass. Furthermore, other dimensionality reduction techniques can be used and compared to SOFMs.

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