The Flows of Democracy: Visual Analysis of the Rise and Fall of Political Parties

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Abstract. Political parties emerged in the 17th and 18th centuries as an important aspect of democratic organization, and remain a prominent aspect of political participation to this day. The importance of political parties is underscored by the vast research that has focused on all aspects of political parties, their relationship to legislative bodies and their relationship to the voters that they represent and mobilize. The study of political parties has paradoxically increased in recent years as they are seen by many to be in a state of transition if not outright decline. With this increased access to data, the analytic community requires reproducible political analytics that can be applied to normalized data. To this end, this paper presents a visual analysis for visualizing political party evolution in the context of dynamic political environments.

1 Introduction

Formal political parties and informal political factions are a quintessential aspect of representative democratic structures and processes. Emerging in England in the 17th century and France and the United States in the 18th century [11], political parties became an important aspect of participatory governments. Their importance is acknowledged by the sheer volume of research that surrounds their formation and function, with an estimated 11,500 books and articles published on just European political parties since the last world war [16].

The debate surrounding political parties has been as dynamic as the parties themselves. Leading founding fathers in the United States outright opposed political parties, as James Madison noted in Federalist Papers No 10 [12]. The rise of political parties in the face of this opposition is evidence of their necessity. While not required by democracy, many modern political scientists claim that "legislative politics is unstable without parties" [22].

Today we watch as parties are in transition if not decline. [3] points to the increasing political detachment, rise of independent or third party actors, naming of parties after people over principle, and increasing reliance of parties on government "life support" over grass roots vibrancy. [16] addresses this change in the context of increasing education levels facilitating more individual thought on the part of voters and and increasing mass media giving candidates direct

access to those educated voters. These emerging political and social phenomena underscore the need for continued research into party roles and dynamics.

While studying informal factions derived from roll call data, our team found numerous political environments where politicians frequently changed party affiliation as new parties arose and old ones evolved. This movement was dynamic enough that we could model it as a *network flow* and visualize it with the re-purposed Sankey Diagram. This paper seeks to document the algorithms necessary for manipulating legislator data into a flow network and visually model it with the Sankey Diagram (also called flow chart or swim lane diagram).

We will begin this paper by discussing the history of political party theory and models as well as the history of the Sankey graphical model. We will then thoroughly describe the data and algorithm required to transform ubiquitous legislative data into the weighted and directed edge list data that is required for Sankey diagram implementation. Finally we will illustrate the use of this algorithm and re-purposed visual model for both the United States Congress (1815–1840) and Russian Duma (1993 to Present)

2 Related Work

Below we will briefly discuss historical work on political parties, then discuss the history of the Sankey graphical model, and finally note previous attempts to leverage Sankey graphical models in political science.

2.1 Models of Political Parties

With entire journals dedicated to the study of political parties (*Party Politics* emerged in 1995 [16]), there exist a myriad of theories and models that attempt to help us understand parties. The study of the theory and activities of political parties started in the early 20th century with initial works by Ostrogosrski [19], Michels [14], and Weber [26], and later by Schattsschneider in the 1940's [21]. Building on these works, scholarship of political parties increased in the 1950's through 1970's where critical works include Neumann [17] and Eldersveld [5].

Krouwel (2006) highlights five clusters of political party models, which he summarizes as 1) *Elite, caucus and cadre models* (1860-1920), 2) *Mass-parties* (1880-1950), 3) *Catch-all, electoralist parties* (1950-Present), 4) *cartel parties* (1950-Present), and 5) *business-firm parties* (1990-Present) [9]. Krouwel elaborates on how each cluster of models affect the electoral appeal (broad or narrow), the type of recruitment, and the basis for party competition. This (arguably growing) list of model groups illustrates how political parties evolve across time and space, and require an increasing number of models to understand, describe, and predict their behavior.

2.2 Sankey Diagram

Early hand drawn infographics provided the concepts of what would become known as the Sankey Diagram. Notable among these is Charles Joseph Minard's

information graphic detailing Napoleon's invasion of Russia [15]. This renowned graphic is provided in Figure 1. Edward Tufte, a world renowned scholar on the display of quantitative information, has identified Minard's information graphic as possibly the most important statistical graphic ever created [24].

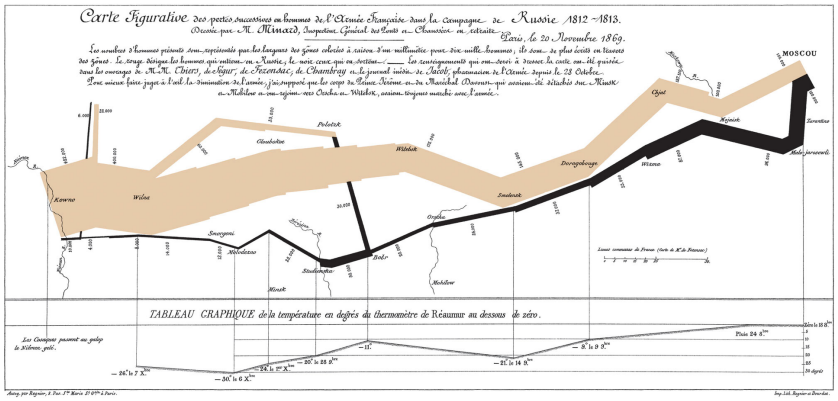

Fig. 1: Charles Joseph Minard's seminal information graphic displaying the successive losses of the French Army in the Russian campaign 1812–1813 [15]

Thirty years after Minard finished his chart detailing Napolean's invasion of Russia, Irish Captain Matthew Henry Phineas Riall Sankey used a similar approach to demonstrate the energy flows in the steam engine in 1998 [10]. Henry Sankey seemed to tangentially re-invent the diagram in order to compare an actual steam engine to an idealized steam engine. With rising interest in his diagram, Sankey would later elaborate on it in a 1905 article entitled *The Energy Chart: Practical Applications to Reciprocating Steam-engines* [20], and by 1908 his diagram was being used internationally, primarily by German engineers [1]. In the 1930's, its use went beyond modeling heat and energy and was adopted to model material management [6] and economic value flows [25].

Since Henry Sankey first used the graphic that was later named after him, it has been extensively used, primarily in modeling energy and other physical flows. This paper demonstrates its usage in the social sciences.

The closest research we found to our effort was found in two separate and unconnected blogs. Political scientist Kevin Deegan-Krause posted a similar graphical model on his blog site in 2008 [4], and Buenos Aires political science graduate student Andy Tow posted another similar graphic on his blog in 2012 [23]. While similar in intent and purpose, neither blog post clearly publishes to the research community the concept and required algorithms to model and visualize legislative representatives as a network flow.

While the use of the Sankey Diagram for documenting dynamic political timelines was briefly introduced in two blogs, this paper seeks to clearly docu-

ment the required data, algorithms, and resulting Sankey graphical model. This reproducible process is then illustrated in two illustrative case studies.

3 Modeling Legislators as a Network Flow Through Parties

The Sankey Diagram is, by its very nature, a network diagram. A network is characterized by nodes (or vertices) with links (or edges) connecting them. In a Sankey Diagram, nodes represent initial, intermediate, and terminal physical objects or organizations through which entities flow (represented as directed weighted links). Some nodes represent *source* nodes where flows (sometimes modeled as a *supply*) are created or originate, while others represent *sink* nodes where flows terminate (sometimes modeled as a *demand*).

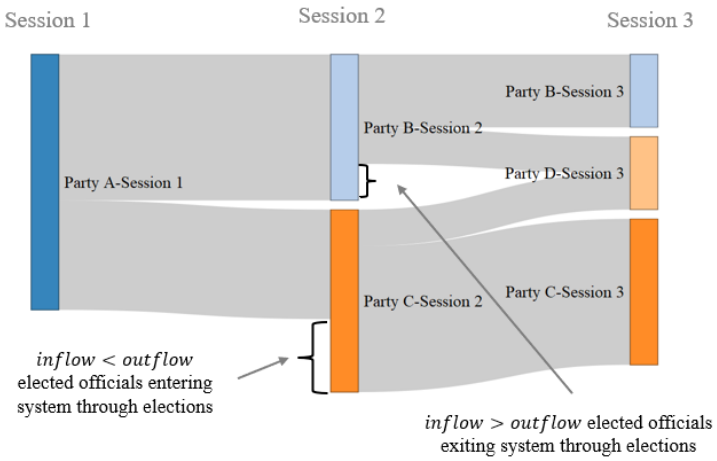

Fig. 2: Modeling flows of elected officials between political parties

As we re-purpose the sankey diagram for use in modeling dynamic political environments, we will model elected representatives as entities that "flow" from party to party in time. This is illustrated in Figure 2 where we see four parties (A, B, C, and D) represented at three time periods (Session 1 through 3). Nodes represent party X at time period N. For legislative bodies time is normally divided into terms of election. During each *term*, a given legislator will serve a single term in a session of their legislative institution. For example, a British *parliament* is 5 years, a Russian Duma *convocation* is typically 5 years, and a US *congress* serves for 2 year (the 115 Congress is currently in session). A Senator will serve a 6 year term that will extend across three 2-year Congresses.

In this model, links (or edges) represent the number of legislators that move between parties between sessions of their legislative body. For example $A1 \rightarrow B2$

is the weighted and directed link that represents the number of legislators that move from Party A in time period 1 to Party B in time period 2.

Legislative bodies are not closed systems. Elected representatives can enter and exit the system through elections. This can be visualized in the sankey diagram by differences of inflow and outflow. As illustrated in Figure 2, $inflow < outlflow$ means that a given party gained seats during that session, whereas $inflow > outflow$ means that a given party lost seats during a given session.

4 Data and Algorithm

Our goal is to develop a repeatable algorithm that could be applied to the public data sets that document legislators and their party for each congressional term or session across many democratic governments. These data sets are generally available on government websites or public data repositories like Wikipedia or Github. To be useful for our implementation, they must have a unique legislator name or identifying token, formal or informal party or faction affiliation, and the *term*, *session*, *congress*, or *convocation* number. This means that any legislator that serves multiple terms must have multiple records, one for each term.

Table 1: Example Legislator Party Affiliation Data by Congress

Name	Party	Type	Start year
John Adams	Federalist	senator	1803
John Adams	Federalist	senator	1805
John Adams	Federalist	senator	1807
John Adams	Whig	representative	1831
John Adams	Anti Masonic	representative	1833
John Adams	Anti Masonic	representative	1835
John Adams	Whig	representative	1837
John Adams	Whig	representative	1839
John Adams	Whig	representative	1841
John Adams	Whig	representative	1843
John Adams	Whig	representative	1845
John Adams	Whig	representative	1847

An example of this data from 19th century American congressional records is given in Table 1, specifically looking at the congressional career of John Quincy Adams. We observe that he regularly changed his party affiliation as the Federalist party declined in favor and the Whig party combined former Jeffersonian Democratic-Republicans and the Anti-masonic Party to counter the rising Jacksonian Democratic Party. Our goal is to model and visualize this dynamic movement between parties in young and dynamic political environments.

We highlight that the data must include multiple records for a single individual, each affiliated with a specific term in office that we can delineate by the *start year* feature. Note we observe a gap in his legislative service when he was

elected President and served in other government posts. We also observe that the *name* feature drops his middle name, and therefore will confuse him with two other John Adams that served (one in 1817 and one in 1885). In the case of the US data, a "govtrack" identifying key is provided (not shown in Table 1), that can be used as a unique key.

The purpose of our algorithm is to computationally transform the data format discussed above into a weighted edge list (or list of links). The weighted edge-list format is generally the data format required by most open source packages that render the Sankey graphical model. In order to do this, the algorithm iterates through unique legislators that were elected to office in the respective legislative body. For each legislator, the model iterates through an ordered list of their terms and appends these to the *source* and *target* vectors.

```
Data: Legislature Data with Name, Party, and Session
Result: Weighted Edge List
for each legislator do
    get ordered list of legislator convocations;
    for each session from 2 to N do
        source[count] = convocation[n-1];
        target[count] = convocation[n];
        value[count] = 1 ;
        count += 1;
    end
end
for each (source → target) pair do
    sum value;
end
```

Algorithm 1: Creating Legislator Edgelist for Sankey Network Diagram

If the data is cleaned properly (primarily by resolving person and party names), the Sankey visualization algorithm will automatically render the parties in vertical "bands" that correspond to a given session of the legislative body. In very complicated data (such as we encountered in 19th Century American legislative data), we found times when a party arose without any movement from earlier parties, in which case it will be positioned earlier on the graph than appropriate. In this case, we were able to add a few *dummy* links that serve as scaffolding to adjust the graphical model so that it is temporally accurate. Note that we always added these "dummy" links to a "None" or "Other" node, so that it wouldn't distort any nodes of interest.

5 Case Studies

We will illustrate the use of this algorithm and re-purposed visualization for both the United States Congress (1815–1840) and Russian Duma (1993 to Present).

Note that in both cases the party environment was rather dynamic, with the number, names, and policy platforms for these parties rapidly changing. It is in these environments that this graphical model proves beneficial for discussing the macro level political evolution. The model can be used in stable two party political environments like we see in the United States and the United Kingdom today, but insights are limited. In these case studies below we used the *networkD3* package [2] in the R Programming Language to generate Sankey diagrams.

5.1 19th Century American Case Study (1815–1840)

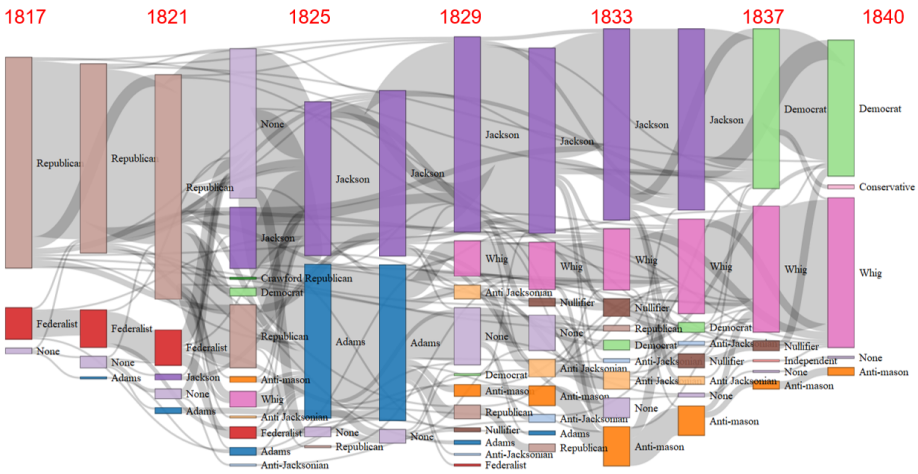

Fig. 3: American Political Party Evolution from 1815–1840

In this case study we will use the graphical model to explore 19th Century American political parties. This was a dynamic period for political parties in America, and laid the foundation from which the later two party system would eventually emerge. We have decided to start this in 1815, thereby including the decline of the Jeffersonian Republicans, even though some scholars have argued that true political parties did not emerge until the 1830's [8], and others claiming that they did not truly emerge until the Whig party much later [18].

The data for this was accessed from the US Congressional Data Repository located at https://github.com/unitedstates/congress. This is maintained by various public organizations (ranging from GovTrack to the NY Times), not the US Government. The only cleaning that was applied to the data involved resolving different spellings for political early party names (for example normalizing different naming conventions for the Anti-masonic Party).

The resulting Sankey Diagram is presented in Figure 3, organized chronologically from left to right. The period of US history from 1789 to 1803 experienced

dramatic events that led to the early formation of political parties [7]. From this early party formation we see emerge on the far left side of the graphic with the dominance of Thomas Jefferson's Democratic Republicans, or simply Republicans. This was offset by the much smaller Federalist party, primarily led by Alexander Hamilton and John Adams. We see the Federalist party clearly splinter following their opposition to the War of 1812 and the death of Alexander Hamilton after a duel with Vice President Aaron Burr in 1804 (who, with Thomas Jefferson, led the Republican Party).

Without any opposition to solidify support, the Democratic-Republican party slowly eroded in the 1820's [13], but was energized in 1828 with the leadership of Andrew Jackson (whose stunning victory at New Orleans accelerated the dissolution of the Federalist Party). During this era we see the rise of the Jacksonian Democratic Party, and what historians have come to call the *Second Party System*. The Jacksonian Democratic Party that emerged from the Democratic Republican Party would later be renamed to simply the Democratic Party and remains one of the two dominant parties in American politics.

The Whig Party merged together the Anti-masonic and other Anti-Jacksonian Parties, and became the dominant second party in the *Second Party System*. The party remained a dominant force in American Politics through the 1850's when disagreements over slavery policy divided the party. Abraham Lincoln, originally a member of the Whig party, would eventually lead the Republican party that replaced it and which remains to this day.

5.2 Russian Duma Case Study (1993 - Present)

This case study will look at the Russian Duma from 1993 to 2018, and is seen in Figure 4. The 1993 Convocation of the Duma was the first election to the Russian Duma since 1907. This era of of Russian politics observed the rise and fall of many smaller parties in the 1990's, leading to eventual rise of a single dominant party (the *United Russia* party). The data for this was collected from the official Russian Duma website http://www.duma.gov.ru. Note that in the Russian Duma, legislative sessions are typically 5 years and are called *convocations*.

The most striking feature of this graph is the merging of multiple parties in Convocation 3 to form the *United Russia* Party. During the 3rd Convocation, the *Unity* and *Fatherland* parties merged to form the *United Russia* party, which consolidated power around Vladimir Putin. This also ushered in the era of single party rule, or what the Russians generally call the "party of power".

In this visualization we see the continued existence and evolution of the *Communist Party*. The *Communist Party* emerged as the successor to the *Communist Party of the Soviet Union* (CPSU) which President Boris Yelstin banned in 1991. The *Communist Party* was the dominant party through the 3rd Convocation, and it remains the second most popular party even today.

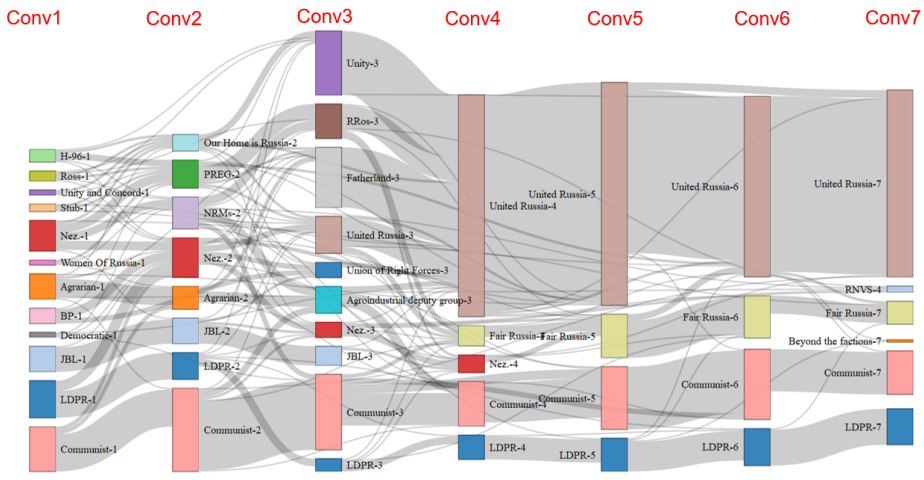

Fig. 4: Russian Duma Party Evolution from 1993–Present

6 Conclusion and Future Work

This paper details the required data and methods to model parliamentary faction data as a weighted and directed network edge list and then visualize it with a Sankey Diagram. In so doing this documents for the computational social science research community the repeatable process to produce this helpful graphical model for macro level political faction evolution. In using this process to understand 19th century American politics as well as modern Russian political party evolution, we demonstrate the value of this computational method in the political sciences.

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