PartyTracker: Visualizing Changes in Party Affiliation over Time

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ABSTRACT
Information visualization has become an increasingly important tool for political and social scientists in the age of “big data”. In this paper, we present PartyTracker, a new visualization tool that allows users to analyze temporal and geographic party affiliation survey data from people with different demographic backgrounds. By switching between a “map” view and a “time” view, users can explore many different aspects of this large, multivariate dataset. We conducted usability testing and expert review to evaluate the effectiveness of this tool. The outcome of our work provides an interactive way to visualize historical changes in party affiliation. PartyTracker is capable of revealing insights about political survey data that are of interest to researchers studying partisanship as well as the general public.

Keywords
information visualization, political science, geographic visualization, themeriver, d3

1. INTRODUCTION
During the past few decades, political and social sciences have accumulated a large amount of data from various sources such as public opinion polling, demographic surveys and other empirical social science researches [3, 14]. As a result, current work in political data analysis relies much more heavily on quantitative analysis of large datasets than in the past. Consequently, the sheer volume and complexity of modern-day political survey data exceeds the human capacity to interpret such data in a raw format. Thus, it is important to use data visualization techniques to present multivariate data in a meaningful way for both policy makers and the general public.

In this study, we focus on the problem of visualizing changes in political party affiliation over time. The United States’ political landscape is dominated by two parties: the Republican party and the Democratic party. In every campaign cycle, political parties pay close attention to the voting results of every election. Understanding how various social and demographic factors affect political party affiliations has long been an important area of political research [7].

Our contribution to this field, PartyTracker, allows users to track the change in affiliation of groups of interest over time. In addition, we provide variable granularity by displaying this change at both the state and national level. Users are able to rapidly compare states or regions against each other in a map overview. Tooltips provide more detailed information about the party affiliation breakdown in a state at a particular time. Finally, demographic filters allow users to focus on particular groups of people. Our data comes from surveys conducted by the Pew Research Center from the years 1990 to 2013.

2. RELATED WORK
The Pew survey dataset has both geographical (across states) and temporal (over years) aspects, as well as several additional dimensions specifying demographic variables (age, gender, income, education, state). Although we did not find many studies addressing the same problem (visualization of party affiliations), there are two related problems that are well studied in the field of information visualization, which are (1) visualization of large high-dimensional geographic datasets [8] and (2) visualization of multiple thematic variations over time [10]. We will discuss work pertaining to these two areas in this section.

Changes in party affiliations do not develop uniformly over space. Geography is an important factor when trying to explain spatial aspects of election outcomes and voter behavior. In fact, electoral geography, which focuses on the spatial variation of voting behavior, has been an important...
subfield of political geography since the 1970s [2]. One major explanation for these variations argues that social and political interests in a particular region may be very different from the national trends [1]. As a result, “people in similar socio-economic conditions may vote differently depending on where they live” [24]. This is because people that live in the same area share the same local factors. Individuals tend to join the dominant political opinion regardless of their backgrounds, which is known as the “neighborhood effect”.

Geographical data can be naturally presented with a geographic map and several layers of information on top (known as semantic layers or thematic maps). Geographical information systems (GIS), which have been very well-developed by researchers in the field of information systems, are designed to capture, store, analyze and present geographical data. GIS is particularly helpful to visualize spatial location and densities/quantities of data. As such, it has been very useful in analyzing voting behavior [16, 4] in a single election or time slice. However, exploring the change in election results or party affiliation over time with a single map remains a challenge. Even with animation, it can be difficult to discover trends from successively presented maps.

Another prevailing view in electoral studies argues that “similar people vote similarly, independent of their location” [19], also known as the compositional view. According to this view, voters should be studied as a national unit, not necessarily regionally [24]. For this purpose, it would be suitable to visualize the electoral results or public opinion polling data with temporal data visualization techniques. Line charts and scatter plots are two commonly used methods for temporal data visualization. However, they are not very space-efficient and it is hard to visualize trends when many time series are simultaneously displayed. The horizon graph is a recently proposed temporal visualization technique with high data density and better graphical perception than a simple line chart [13]. In a horizon graph, a line chart is divided into bands and overlaid to reduce the space. The ThemeRiver is another popular method for temporal data visualization, where the strength of multiple themes over time are shown as “rivers” with changing width [10]. More sophisticated methods transform the time series into a symbolic representation, such as trees [17] or glyphs [9].

There are also several techniques dealing with hierarchical temporal data. For example, Theron et al. [22] proposed a tree-ring layout and Lammarsch et al [15] developed a pixel-based visualization that overlays several time granularities to utilize the inherent hierarchical structure of time.

The existing work in visualizing electoral results or partisanship affiliations use either geographical visualization techniques (NYTimes 29 Nov 2012[23]) or temporal visualization methods (e.g., NYTimes 7 Nov 2012 [6]). We decided to break from this trend by blending both geographical and temporal visualization into PartyTracker. This decision allows our users to answer more interesting questions about the dataset than they could have if we only implemented one of those two types of visualization.

### 3. DATA DESCRIPTION

The data used in the Party Tracker visualization is the result of 442,262 telephone surveys conducted by the Pew Research Center from 1990 to 2013. Each data point contains demographic information including the respondent’s age, gender, income level, race, education, and geographical location. In addition, the data points include the date that the survey was conducted, as well as the survey’s post stratification weight.

The post stratification weight is needed to ensure that the survey data is a representative sample of the overall population [12]. When computing statistics about the data, we take this weighting into account by counting each data point by its post stratification weight. Since we used survey data, we were also limited in the results we could present to users. For a result to be significant and accurate, it needs to be supported by at least 100 weighted data points. When filtering the data in the visualization, it is possible for this condition not to be true. As a result, the visualization indicates to the user that there is insufficient data whenever this happens.

### 4. DESIGN AND IMPLEMENTATION

We decided to implement two different views, the map view and the time view, in our visualization in order to make it easy for our users to investigate both nationwide variations and temporal changes in partisanship affiliation. Both views share the same basic layout, which consists of a main panel for the view, a filter panel that allows users to select demographics of interest, and a legend panel. Since Pew wants to post our visualization on their website, we designed it with the client-side experience in mind. Early on it became apparent that our dataset was too large to send to the client, and so we created a web service that queries data on the server-side and sends very small data files to the client every time a filter is updated.

#### 4.1 Map View

The map view, which is by default the first view the user sees, displays a map of the United States where each state is colored on a red / blue spectrum depending on its ratio of Republicans to Democrats (Figure 1). The color used in the map has been adapted from [5]. While early versions of our visualization modified the color domain every time the filters were changed, we found that the map is more intuitive with a fixed color domain. The final version of PartyTracker associates the extreme red (Republican) value with a Republican / Democrat ratio of 5 and the extreme blue value with a Democrat / Republican ratio of 5. Users are able to click on states and zoom in, which is useful for smaller states such as those in the Northeast. For zooming out the user needs to click the same state which was clicked for zooming in. In addition, mousing over a state activates a hover window that shows a detailed break-down of the party affiliations within that state. We implemented the map using a combination of jQuery and d3.js [5].

Above the map is a range slider that facilitates moving forward and backward in time over the domain 1990-2013. In addition, the slider features two adjustable handles that control the number of years over which to perform aggregation (the window size). We initially created the visualization with a fixed five-year window, but our mentor suggested that we give users the ability to increase and decrease it. At smaller window sizes, comparisons between individual years can be made. However, the finer granularity comes at a cost: more states have statistically insignificant data at these smaller window sizes. Similarly, while more states have significant data at higher window sizes, users are only able to compare a small number of time periods. We imple-
Figure 1: User interface for map view. The map view contains a geographical map of the United States. Each state is colored on a red/blue spectrum depending on its ratio of Republicans to Democrats. The user can specify the time range with the slider above the map and select a demographic group of interest with the panel on the right.

4.2 Time View

Many important questions can be answered with the map view alone, especially those focusing on regional trends. However, temporal trends aren’t immediately obvious from this view; the user has to drag the slider around to reveal them. In order to make this process easier, we implemented the time view, which presents all of the data for a specified set of filters in one easy-to-understand visualization (Figure 2). Users first select a filter category to display timelines by an attribute of interest (e.g. Race or Gender). For each of the options in the selected category, we display a separate timeline. For example, if “Gender” is selected, we display one timeline for males and one for females. We used the ThemeRiver to visualize the temporal trend [10]. The x-axis of each timeline represents the time in years, while the y-axis represents bands associated with political party affiliation (e.g. Republican, Democrat, Independent). The width of each band at a particular year represents the fraction of people who had the associated political affiliation in that year. While the time view doesn’t offer any regional insights, questions about the relative proportion of parties in the selected demographic can be answered quickly, which makes it valuable enough that we made it a separate view. The time view was implemented using only d3.

4.3 Web Service

The PartyTracker web service provides quick access to the Pew data, which is nearly 100MB in size. There are three services: one to update the map view as the filter choices or the time window is changed, a second for details shown as tooltips, and a third to update the time view when its filter or time line splitting options are changed. Each service queries the Pew data and calculates the results needed by the view so that the views can operate smoothly without substantial processing requirements. For example, the web service calculates percentages, ratios and rolling averages for the time slider in the map view. It also automatically applies the cutoff for statistical significance, which is dynamic and adjustable through service.

The web services are RESTful and implemented in Python with data analysis done using Pandas. To prepare the data for display, the service also joins the Pew data with FIPS state information.

5. USABILITY TESTING

We conducted usability tests on PartyTracker to understand both the effectiveness and the shortcomings of the tool. Before allowing the tester to interact with the visualization, we made the goals of the test clear and asked for their consent. The introduction phase consisted of describ-
ing the potential use cases of the software to the tester and emphasizing that the users would be subjects in a usability test for a course project. During the subsequent consent phase, we made it clear that participation is voluntary and that the tester can choose to quit at point during the process. People who read news via the internet comprise the target population for the PartyTracker usability tests, and we only chose people who fit this requirement. Before proceeding any further, participants were asked to fill in a form with their names and signature.

Next, we introduced the tester to the functionalities of the software by allowing them to explore the tool with some guidance. We refer to this process as the training phase. We maintained a checklist with us to make sure that we showed the tester all of PartyTracker’s features before continuing into the actual test.

As mentioned in the previous sections, our visualization software consists of two major views: the map view and the time view. For each view, we made sure the user understands the following:

**Map View:**

1. Coloring of the states based on Republican (red) or Democrat (blue) leaning
2. Hovering over a state provides relevant information for that state
3. Zoom-in and zoom-out feature of the map

**Range Slider in the Map View:**

1. The selection of the years as a range

**Time View:**

1. Coloring of the time view based on Republican or Democrat leaning
2. The different timelines based on Gender, Race, Age and Education

We have a common filter panel for both of our views, and we made sure that the user understands how to operate the filters to narrow down to a particular group of people.

After making it clear that the tester is free to ask us for clarification at any point during the test, we begin the testing phase. Subject behavior was carefully observed during this phase, and any difficulties encountered by our testers were documented. We asked a total of eleven questions related to identifying changes in partisanship affiliation over time which are listed below.

1. Which states switched partisanship from 2005 to 2006?
2. In what three-year window was California the most Republican?
3. Who was/were the President(s) during this window?
4. How has the partisanship of women changed over time?
5. How has the partisanship of college graduates and post-graduates changed over time?
6. Do Hispanics become more democratic or more republican over time?
7. In which age group do Independents currently make up the highest percentage?

8. Are people with at least some college education trending towards being more Republican or less Republican?

9. Are there clearer trends for minorities within age groups?

10. Which gender tends to have a higher percentage of Democrats?

11. For people with less than high school education, is there any trend towards a particular party in recent years?

After completing the testing phase, we asked the users to fill out a survey to rate their experience with using PartyTracker to accomplish the above tasks, which we refer to as the evaluation phase. On a scale of 1-10, with 10 being excellent and 1 being poor, we ask the following questions:

1. How intuitive was the tool and its controls?
2. How easily could you identify changes in partisanship over time?
3. What is overall impression of the map view?
4. What is your overall impression of the time view?

Apart from these survey questions, we also asked the user about any feedback/suggestions they might have for improving both views. We carefully considered these suggestions (along with those detailed in our classmates’ critiques) and fixed several issues that many testers had. We describe the results of the usability tests in the following section.

5.1 Evaluation Results and Refinements

Some of the questions asked during the testing phase were easier to answer using the map view (Q1–3), while others were designed with the time view in mind (Q4–11). The testers were able to correctly answer most of the questions, with an average score of 8.1 (Figure 3a). However, we found some questions were easier to answer than others. For example, only 5 out of 12 subjects correctly answered the first question, which involves identification of multiple changes in partisanship. Three of the subjects complained that it is hard to detect color switches with such a fine-grained color scheme. This made us reconsider our map coloring scheme: eventually, we reduced the number of colors representing the different Republican to Democrat ratios from eight to four. The new scheme is designed such that each color is noticeably different than the next. We also added a box on our legend for the gray color associated with states that have insufficient data, which was a common complaint among our testers. In response to another set of complaints, we also decided not to display any tooltip information for states below the cutoff. Other than these two fixes, the map view did not have many major issues.

While answering questions using the time view, many of our testers encountered a bug where all of the ThemeRivers belonging to a particular category disappeared when the first checkbox in that category is unchecked in the filter panel. For example, if the tester selected Gender in the time view using the drop down menu and unchecked “Female” in order to focus on the “Male” ThemeRiver, both ThemeRivers would disappear. This was a bug in our implementation that has been fixed in the final version of PartyTracker. Some users also had issues with the time view’s color scheme because it did not match with the colors used in the map view and was too harsh on the eyes. We changed the color scheme in the time view to a more muted set of colors that we took from the map view.

The other major issue that our testers raised was the absence of a reset button in the filter panel. Since there are a large number of checkboxes, users suggested that they would prefer to have a reset button that sends them back to the default options (all boxes checked). We implemented this suggestion and have found that it makes investigating different demographic groups much faster.

The users generally felt that PartyTracker is intuitive to use (8.1/10) and helps to identify changes in partisanship over time (8.2/10). The users had a good overall impression of the map view in particular (8.5/10), while the time
5.2 Feedback from Mentors

Before we conducted the usability tests, we asked our mentors at the Pew Research Center for comments and criticism. They had two major ideas that we eventually implemented into our design. The first suggestion was to provide the users the ability to increase and decrease the window of the range slider. Our initial slider design featured a fixed five-year window which prevented comparisons between states at a finer granularity. After implementing the adjustable range slider, users were able to identify trends over both small and large periods of time. Our mentors also suggested that we label the slider with the names of the US Presidents so that changes in partisanship could be related to parties in power over a time period. We found that this information also provides users with additional context in case they were lacking political knowledge about a particular time period.

6. PARTYTRACKER HEADLINES

While using PartyTracker, we found several interesting headlines that we wanted to include in this project report to demonstrate the tool’s effectiveness. In this section, we list these headlines and provide possible explanations for the trends we discovered.

- High-income white males in the age group 18-49 have become more Republican over the years, while low-income white males in the same age group have become more Democratic.

Figure 4 shows the party affiliation of white males in the age group 18–49. We observed that people within this age group were predominantly Republican during the years 1990–1995 irrespective of their income levels (Figure 4a and Figure 4c). Interestingly, the lower-income subpopulation of this group (earning less than 20K/year) has become more Democratic over time, while the higher-income subpopulation (earning more than 75K/year) have become more Republican. The latter change is more pronounced in Southern states (Figure 4b), while the former change is mostly apparent in the Northeast and Midwest (Figure 4d).

This trend was also noticed by Michael Lind from Salon magazine [18], who writes:

Among whites without a college degree, income has become a stronger predictor of the vote over time. But actually it’s those with less income,
not more income, who are more likely to support Democratic presidential candidates. And again, there is certainly no trend by which whites with below-average incomes and no college degree become more Republican.

The headline serves to contradict the popular notion that Tea Party radicalism originated from the working class’ anger over the Wall Street bailouts. In actuality, Lind points out in his article that the Tea Party movement is comprised mainly of small businessmen who desire lower taxes and less regulations.

- **Working women have become more Democratic over time.**

  Paul Hitlin, our mentor at the Pew Research Center, was particularly interested in a small set of demographic groups that included working class women. We decided to define this group as all women between the ages of 18 and 65 with a maximum income of 50k/year. We observe that working class women have become more Democratic (Figure 5b) than they were back in the early and mid 90’s (Figure 5a). Also, it appears that this trend is not concentrated in a particular region but rather occurred nationwide. A 2009 Gallup study [21] on the gender gap came to a broader conclusion – women are becoming more Democratic regardless of income or location. The authors of the study also point out that this steady increase has been going on since the 1930s.

- **As people get older, they become less likely to affiliate themselves with independents.**

  Figure 6 shows the ThemeRivers for different age groups obtained using the time view. We observe that the proportion of independents is the highest for the age group 18–29, followed by 30–49, 50–64, and 65+ in that order. This implies that as people become older they tend to identify with one of the two major parties – in other words, they become less independent. We also observe that there is a steady decrease in the percentage of Republicans in recent years that is most noticeable in age groups 18–29 and 30–49. However, the percentage of Democrats remains almost the same across all age groups.
One possible explanation for this trend is the way both parties market themselves to senior voters, coupled with the observation that once a person decides to affiliate themselves with a particular party, they are very likely to continue voting for that party for the rest of their lives. Republicans, for example, promise lower taxes on retirement income. In contrast, Democrats may play up the Social Security and Medicare angle. Both parties use fear as an effective tool to keep senior voters from switching allegiances by asking them to imagine what life would be like for their children and grandchildren if the opposing party were in power [11].

7. CONCLUSION & FUTURE WORK

Data visualization has existed in politics since the end of 18th century. Politicians have used visual analysis tools to analyze previous elections to predict the results of the up-coming ones. A study that analyzed the 1869 Paris election [20] showed that even after more than a century, many districts have not changed their political preference. The study’s conclusion was that the preference for certain political parties has deep sociological and historical origin. During PartyTracker’s design process, we considered three important sets of factors that may influence the choice of political party affiliation: geographical locations, demographic groups, and temporal events.

According to Timothy Heleniak, the director of the American Geographical Society, geography plays an important role in politics of the United States, especially at the county and state level. Most of the 3,000 counties in the US are either strongly red (Republican) or blue (Democratic), with more than three-quarters of the electorate in many counties casting ballots for one party. While we did not have enough data at the county level to make a reliable visualization, we were able to display the party affiliation data on top of a map of the United States using a familiar red-blue color scheme. Future work might improve the zoom feature to show a county-level breakdown of party affiliation alongside more detailed information about a particular state. Similarly, we can also provide a higher-level view by aggregating data over regions (e.g. Midwest or Northeast).

Demographic factors are also important indicators for political attitudes. In fact, they have been used as causal variables to explain changes of party affiliations [7]. Instead of displaying party affiliation over a set of pre-defined demographic categories, PartyTracker let the users create demographic groups of interest using the filter panel. This flexibility gives users the chance to explore less-studied demographic groups. In the future, we would like to extend this feature by allowing users to compare multiple demographic groups on different maps, similar to how we split ThemeRivers by filter category in the time view.

Finally, certain important events, such as 9-11 or Hurricane Katrina, may also play significant roles in shaping political party preferences. Although it is possible to use a slider in the map view to analyze the effect of these events, the time view is better suited to this task. While the current time view only uses a static time axis, one possible improvement is to display important events over the axis via a hover.

8. CREDITS

All of the authors contributed to PartyTracker’s development, which includes the visualization, the report, and the presentation. While every author touched all aspects of the visualization, each author focused on specific pieces.

- Souvik contributed to making of the map view. He did a lot of internal and usability testing and analysis of usability and feedback. He also analyzed the data using the system to discover headlines and contributed extensively to the report.
- Yuwei made the time view. He also organized, made initial drafts, and contributed heavily to the report, slides and usability testing.
- Mohit also contributed to the design of the map view, doing a lot of internal and usability testing. He also worked over the visualization to discover the headlines and worked on the report and preparing the final draft.
- Alex made the web services, integrated the views with the services, helped split time lines in time view, hosted the demo and made the video.
- James made the filter panel and the overall layout and control system to integrate all the views. He also conducted usability tests and came up with the idea of splitting time lines in time view.

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10. REFERENCES


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