

Sentiment Analysis of U.S. Presidential Speeches: Inaugural and State of the Union Addresses from 1789 to 2019

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Abstract

This paper examines the question of whether or not U.S. presidents became *less positive* as administrations age. My hypothesis is that presidents came into office with a certain expectation that must have been adjusted by the reality of politics, bureaucracy, and day-to-day duty once in office. This change in expectation, I argue, is captured by the inaugural and State of the Union addresses which should become less positive over time. Based on the sentiment analysis using a dictionary approach, I did not find a general pattern that all U.S. presidents became less positive as administrations age. On the contrary, 17 presidents became less positive while 20 presidents became more positive. This finding leads us to a more interesting question of what the cause of this heterogeneous finding would be — an excellent question for future researchers.

1 Introduction

Can we draw any insights from presidential speeches and rhetoric? From literature in political science, the answer is yes. American presidential rhetoric has been a fruitful field of research in American Politics, but it is not without controversy. In Bimes' excellent survey article of the field, rhetorical presidency has been on the research agenda of both political scientists and political communication scholars although there have not been many synergies between the

two. In 1996, George Edwards shook the field by equating the study of presidential rhetoric to literary criticism because the study lacks clear hypotheses and evidence.¹ With the advent of advanced techniques in natural language processing and statistical models, I believe that there are insights to be gained from studying presidential speeches in a systematic way. Studying past speeches may not necessarily inform the future policy agenda, but it will help us understand the context in which they were made.

This paper aims to utilize sentiment analysis and topic modeling as tools to test a hypothesis on the evolution of presidential speeches over the course of a presidential administration. The question that I am interested in answering is whether a U.S. president became less positive as administration ages. This paper hypothesizes that U.S. presidents became *less positive* as administrations age. I assume that speeches (which are text) can reflect expectations of presidents. Specifically put, after having won an election, a new president may come into the office being optimistic about how administration, bureaucracy, and day-to-day presidential responsibility are. However, after having been in a presidency, the president's expectation will be adjusted by the reality of the duty. I argue that the inaugural addresses which were delivered at the beginning of an administration capture the initial expectation while the State of the Union addresses capture the adjustment of this expectation which should become less positive over time. If our hypothesis were to be correct, we should see a similar decline in speech positivity for each administration.

It is undeniable that inaugural addresses and the State of the Union addresses are intrinsically different. This is because the inaugural address is not required by the Constitution. It is more of a convention whose precedent was set by George Washington. On the other hand, the State of the Union address is mandatory, required by Article II,

1. Terri Bimes, "Understanding the Rhetorical Presidency," in *The Oxford Handbook of the American Presidency*, ed. George C. Edwards and William G. Howell (Oxford University Press, May 2010), ISBN: 9780199238859, <https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199238859.001.0001/oxfordhb-9780199238859-e-10>.

Section 3 of the Constitution for the president to report the state of the union and make policy recommendations to Congress annually. However, three factors justify the rough comparability of these types of speeches.

Firstly, both inaugural addresses and State of the Union are comparable in terms of the level of formality. Both speeches were delivered in official settings unlike other presidential speeches that were made while they were on tours or occasional speeches to the people. The merit of this aspect is it controls the choice and level of language so that the noise in different language levels is minimized.

Secondly, both speeches have delivery consistency. As the State of the Union is required by the Constitution, the presidents delivered them every year. Since the inaugural addresses have become a norm or a convention for every U.S. president, the addresses have been delivered every time a new president was sworn into office. Therefore, we can the sample size does not vary a lot.

Finally, I would like to argue that both speeches have audience comparability. Other presidential speeches that we have access to are often delivered to specific groups of audiences. For example, a presidential speech at a rally is aimed at the president's supporters. However, generally, we may be able to argue that both inaugural addresses and State of the Union are delivered for the American people. Certainly, it is more difficult to make the same argument for early State of the Union addresses since they were exclusively delivered to Congress in a written format. However, after the radio and television were invented, the State of the Union addresses have been broadcast. Therefore, the audience pool has been widened over the years. With the volume of the addresses that we have, it is still possible to make a fairly appropriate comparison. In addition, it is convenient to use inaugural addresses as a starting point since it marks the beginning while the last State of the Union marks the end of an administration.

The main contribution of this research paper lies in the novelty of the hypothesis. Based on the literature survey, computer-based analysis of presidential speeches have been used by various scholars including Hart who studies the verbal style and sentiments (including optimism) of presidential speeches from Truman to Nixon.² However, it does not appear to be a systemic quantitative analysis on the evolution of presidential sentiments from George Washington to Donald Trump. This paper aims to contribute to this gap and builds upon our knowledge on U.S. presidential rhetoric from Tulis.³ In the next section, the discussion continues on the method used in this research project.

This paper proceeds as follows. First, I review the tools and methods that I use in this analysis. Second, the data section describes the data sources and provides an exploratory analysis on the data. The next section presents the research findings. The paper concludes with a summary and provides recommendations for future research.

2 Methodology

2.1 Data Preprocessing

Since the data that I am interested in are mainly speeches in a text form, standard text processing procedures apply. Discussion on the data sources will be left to the next section, but I would like to briefly summarize the text cleaning procedure used in this paper. Firstly, I employed standard procedures including transforming the text into lower cases, stop words, punctuation and white space removal. I retain hyphenated words such as compound nouns. Moreover, I decided not to remove common words such as shall, may, can because I believe that these words convey the tone of these speeches. The results from the analysis before

2. Roderick P. Hart, *Verbal Style and the Presidency* (Florida: Academic Press, Inc., 1984).

3. Jeffrey K. Tulis, *The Rhetorical Presidency* (New Jersey: Princeton University Press, 1987), ISBN: 0691077517.

lemmatization or stemming do not generate a large number of redundant words in the sentiment analysis stage; therefore, I decided to proceed without this step. These steps were repeated for every speech used in the analysis.

2.2 Sentiment Analysis

This paper uses a dictionary approach to conduct sentiment analysis on presidential speeches. It uses a readily available sentiment dictionary compiled by Bing Liu which is available from Tidytext package in R.⁴ The idea is to label each word in the document with positive and negative categories. Since Bing only gives categorical value, I manually converted words that are labeled “positive” to receive a score of 1 and “negative” to receive a score of -1. The reason that I selected Bing is that after having run an analysis with AFINN which is an alternative, Bing generated more labeled words than AFINN. Because I am interested in the number of words that are labeled, Bing is a superior choice in this context. A sentiment score of a single speech (Y_i) is obtained by the following equation:

$$Y_i = \sum_{m=1}^M \frac{s_m w_{im}}{N_i} \quad (1)$$

s_m is the sentiment score of the word m (in this case $s_m \in \{1, -1\}$). w_{im} is the number of times word m appears in the document i . N_i is the total number of all labeled words in the speech which acts as a normalization term. Without N_i the sentiment scores would not have been as accurate since the length of these speeches highly vary as we will see in the next section. This approach is used for all speeches and graphs were generated using the average sentiment score of each speech.

4. Julia Silge and David Robinson, “tidytext: Text Mining and Analysis Using Tidy Data Principles in R,” *JOSS* 1, no. 3 (2016), doi:10.21105/joss.00037, <http://dx.doi.org/10.21105/joss.00037>.

2.3 Topic Modeling

Although topic modeling is only used in the exploratory portion of this paper, I would like to provide a summary of the method since it is utilized for discovering the differences in terms of a variety of topics between inaugural addresses and State of the Union addresses. Topic modeling is an unsupervised method for uncovering latent structure in the data which is topics in documents. The model groups terms in a corpus into categories based on co-occurrence of terms across documents. The algorithm used for the groupings is Latent Dirichlet Allocation (LDA) where the number of topics has to be specified in advance. Since this paper's emphasis is on sentiment analysis, I did not conduct a rigorous robustness check on topics. I selected a few number of topics from $2, 5, 10, \dots, 25$ and ran the model several times to see the change in topic distribution and perplexity score. Based on eyeball inspection, I presented my findings with the number of topics that, I believe, best represented the inaugural and the State of the Union addresses.

With the research question, hypothesis, and methods on hand, I will proceed with the discussion on the data set and several exploratory analysis in the next section.

3 Data

My analysis employs two data sources. U.S. presidential inaugural addresses come from Kaggle.⁵ The data is in a comma separated value format where fields contain presidential names and the text of inaugural addresses. The addresses begin with George Washington's 1789 speech and end with Donald Trump's 2017 speech, totaling 58 different speeches.

The texts of State of the Union addresses from 1790 to 2017 come from *United States Presidential State of the Union Addresses*, an R package maintained by Taylor B. Arnold.

⁵. AdhokshajaPradeep, *Presidential Inaugural Addresses*, 2017, <https://www.kaggle.com/adhok93/presidentialaddress/data>.

The State of the Union Addresses from 2018 to 2019 by Donald Trump were manually obtained and added to the analysis from the University of California Santa Barbara's The American Presidency project.⁶ There are 238 speeches in total. The package also includes metadata such as the presidents, the year of the speeches and party affiliation.

Prior to conducting the main analysis, I examined several aspects of the text data. Firstly, the average lengths of all inaugural addresses and the State of the Union addresses are 2,328.47 words and 8,263.59 words respectively. Figure 1 shows that the length of the inaugural addresses fluctuates over the years. Recent inaugural addresses return to the length of the early 19th century presidential inaugural addresses. The longest inaugural address belongs to William Henry Harrison who began his short presidency in 1841.

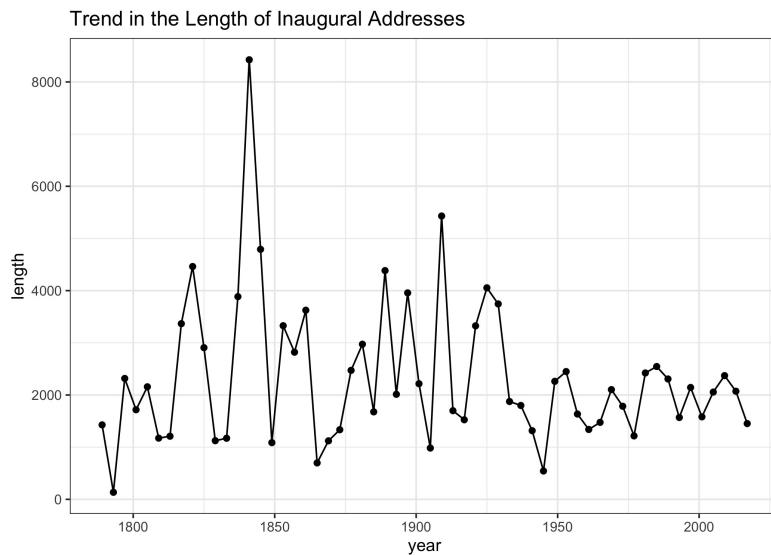


Figure 1: Length of Inaugural Addresses

Likewise, the trend in the length of the State of the Union addresses is not starkly different. Figure 2 also shows that the length of the State of the Union addresses have increased between the 18th and 19th centuries. However, the length of the recent State of

6. "Annual Messages to Congress on the State of the Union (Washington 1790 - Trump 2019)," 2019, accessed November 28, 2019, <https://www.presidency.ucsb.edu/documents/presidential-documents-archive-guidebook/annual-messages-congress-the-state-the-union>.

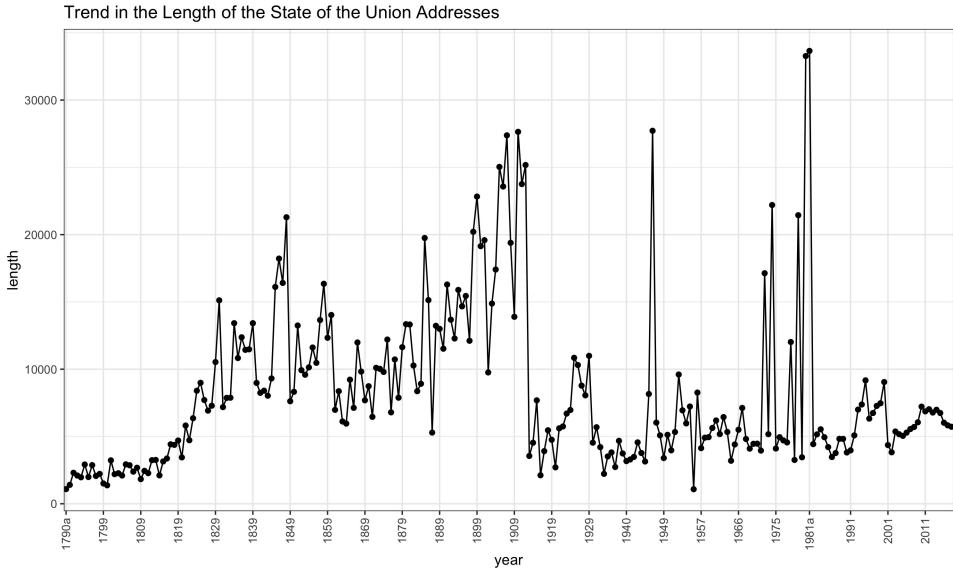


Figure 2: Length of State of the Union Addresses

the Union addresses has declined and stayed below 10,000 words. One explanation for the fluctuation in the length of these addresses is the change in the method of delivery. Prior to Woodrow Wilson, the State of the Union addresses were written and delivered to Congress without being orally spoken.⁷ However, Wilson, who believed in popular leadership, for the first time, orally delivered the State of the Union addresses and shifted to more popular rhetoric. A few presidents after Wilson still delivered the written addresses to Congress; nevertheless, most presidents after Franklin D. Roosevelt completely changed from written to spoken addresses.

To examine if the issues appearing in the inaugural addresses and the State of the Union addresses differ, topic modeling as described in the methodology section was applied to each type of address. Figure 4 in the appendix shows that the topics in the inaugural addresses are mostly about government, country, and people. In fact, the results from 5 topics do not add more information since the topics are redundant. My analysis shows that even when the number of topics is 2, we still see that the two topics only slightly differ.

7. Bimes, "Understanding the Rhetorical Presidency."

On the contrary, topics in the State of the Union addresses are more varied as shown in 5 in the appendix. This finding comports with our understanding of the State of the Union addresses since their objective is to describe the “state” of the country. A variety of issues such as foreign policy, energy, economy, and lawmaking would be addressed in detail. This is in contrast with the inaugural addresses which are supposed to be forward-looking and set the stage for the administration.

Nevertheless, the choice of words and their frequencies are very similar. Word clouds constructed from all inaugural and the State of the Union addresses in figure 6 and 7 show that the choice of words is forward-looking (e.g. will, may, shall) and communicative of the sense of duty (e.g. must). Based on the literature on presidential rhetoric, scholars tend not to eliminate these common words in their analyses even though, for other text analysis projects, these words would have been done away with. Both types of speeches revolve around government, nation, and America, which is to be expected. The next section will provide the results of the research hypotheses.

4 Analysis Results

4.1 Positivity in Presidential Speeches

The hypothesis in question is to test if presidential speeches become *less positive* compared to the beginning of an administration. As described in the methodology section, this analysis is conducted by calculating the average sentiment of every speech per individual president. Each word that appears in a single speech was given a score and the average sentiment score is calculated by taking the mean of all the scored words combined. Then, a chart is made to visualize how the sentiments changed over time for each president. For instance, George Washington had two inaugural addresses and eight State of the Union addresses.

Therefore, he will have eight different average sentiment scores. The process is repeated for 37 presidents. Since some presidents did not have State of the Union addresses or some did not have the official inaugural addresses, seven presidents were dropped from the analysis. It is important to note that some presidents such as Gerald Ford took over the presidency after an incumbent president died or left the office and they did not have official inaugural addresses. What they delivered is a remark to accept the presidency. I am unsure if it would be a fair comparison since these remarks may be different from traditional inaugural addresses, I decided to exclude them for the analysis. The presidents that were dropped are:

- 1 William Harrison (no State of the Union address)
- 2 James Garfield (no State of the Union address)
- 3 John Tyler (no inaugural address; there is a remark)
- 4 Andrew Johnson (no inaugural address; remark not found)
- 5 Chester A. Arthur (no inaugural address; there is a remark)
- 6 Millard Fillmore (no inaugural address; remark not found)
- 7 Gerald R. Ford (no inaugural address; there is a remark)

Overall, the results presented in table 4.1 fail to validate our hypothesis that U.S. presidents became less positive as their administration age. Individual evolution plots presented in the appendix (figure 8 - 13) reiterate this finding. There is no across-the-board trend which suggests that presidents' sentiments have changed in a similar fashion. The individual plots are grouped by century because the literature in presidential rhetoric frequently refers to a group of presidents based on the century.

Nevertheless, what is notable is in the second half of the 20th century, the majority

Table 1: Presidential Sentiments Evolution Breakdown

| presidents that became less positive (overall) | presidents that became more positive (overall) |
|--|--|
| George Washington | John Adams |
| Andrew Johnson | James K. Polk ¹ |
| Franklin Pierce | James Madison ¹ |
| John Quincy Adams | James Monroe |
| Martin Van Buren | Zachary Taylor |
| Thomas Jefferson | Benjamin Harrison |
| Abraham Lincoln ¹ | Rutherford B. Hayes |
| Grover Cleveland | Ulysses S. Grant |
| James Buchanan | William McKinley ¹ |
| Harry S. Truman ¹ | Calvin Coolidge |
| Herbert Hoover | Franklin D. Roosevelt ¹ |
| Theodore Roosevelt | William Howard Taft |
| Warren G. Harding | Dwight D. Eisenhower ¹ |
| Woodrow Wilson ¹ | Jimmy Carter |
| George Bush ¹ | John F. Kennedy ¹ |
| Barack Obama | Lyndon B. Johnson ¹ |
| Donald Trump | Richard M. Nixon ¹ |
| | Ronald Reagan |
| | Bill Clinton |
| | George H. W. Bush ¹ |

¹ Presidents who were in their administrations when a war started or during a major war. These wars are the War of 1812, Mexican-American War, Civil War, Spanish American War, World War I, World War II, Korean War, Vietnam War, Persian Gulf War, Iraq War

of the presidents have become more positive in contrast to mixed trends in another era.

To see if there are clearer trends across all presidents, I also present a chart that plots the average sentiments across all speeches of each president in figure 3. Each data point in the chart corresponds to an average sentiment score of all speeches per president. It is obvious from the chart that the average sentiments of the inaugural and State of the Union addresses are positive across every president. This comports with our expectations because these speeches are positive in their tones by nature. However, it is crucial to point out several discrepancies to our general impression about presidents. For instance, the cultural mainstream remembers Kennedy as being more positive than Eisenhower.

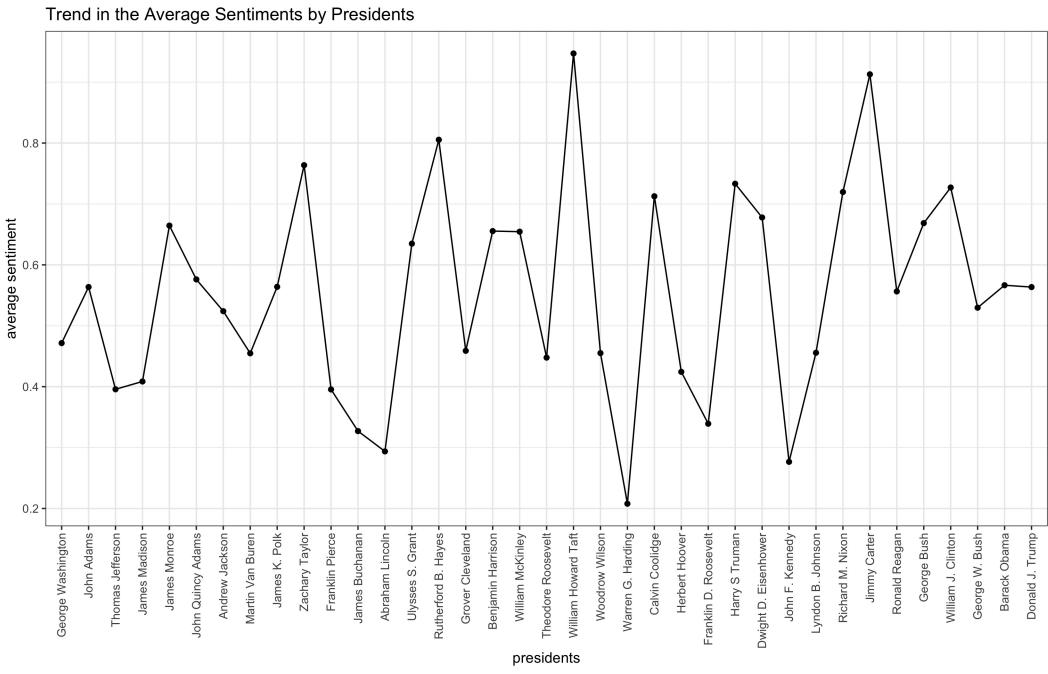


Figure 3: Average Sentiments Across U.S. Presidents

The findings raise several issues pertaining to the methods and theoretical justification to the comparison which I will address here. Firstly, it may not be appropriate to use a readily available dictionary (such as Bing) that is compiled using the modern use of English words to assess the sentiments of earlier presidents. This is because the choice of words and style of English usage in the 18th and 19th centuries can be very different from current English usage. According to various scholars in presidential rhetoric research, it is undeniable that there is potentially a shift in the word choices and style as a result of the change in presidential doctrine.⁸ Tulis (1987) argues that early presidents, especially the founding fathers, resented demagoguery which was understood interchangeably with a popular leader (p. 27-28).⁹ Thus, the style of the early inaugural addresses, for example, were heavily influenced by Washington's first inaugural address which "used the occasion to praise virtuous men, to display his own character and virtue, and to implore fellow offi-

8. Bimes, "Understanding the Rhetorical Presidency."

9. Tulis, *The Rhetorical Presidency*.

cers of the government to take their guidance from the Constitution...”¹⁰ However, this was transformed under Woodrow Wilson who believed that presidents were supposed to reach out and connect to the public, hence resorting to more popular rhetoric.¹¹ Tulis’ argument was heavily debated and critiqued; for example, some scholars view that the U.S. Constitution is, in fact, ambiguous about presidential practice. In other words, there is no clear guideline if the presidency should prohibit popular leadership. With these debates in mind, one approach to minimize the discrepancy of sentiments arising from different English usage is to create a customized dictionary where words and English usage in the early presidency are taken into account. This will assure us that the source of differences in the sentiment scores come from other factors than English usage per se.

The second concern is on the comparison of 44 presidents over a span of 230 years. This is a deeper issue that requires careful theoretical justification since the context of American politics, demography, and, the economy has substantially changed. A direct comparison of George Washington to Donald Trump may not be appropriate at all. As mentioned earlier, the majority of literature on presidential rhetoric seems to categorize presidents based on a century or pre-/post-Wilson presidency. This paper utilizes the first approach. However, it does not correct for the potential mismatch comparison. One way to improve this analysis is to construct a regression model that searches for explanatory factors that clearly partition presidents into groups such as wartime, economic recession, or presidential popularity in public opinion polls that could have influenced the sentiments of the presidents and then make the comparison.

Since our findings do not yield across-the-board trend for all presidents, the logical next step is to try to understand what makes the two groups differ; i.e., what causes the heterogeneous effects among the presidential sentiments? Answering this question may lead

10. Tulis, *The Rhetorical Presidency*.

11. Bimes, “Understanding the Rhetorical Presidency.”

us to new insights and patterns about the American presidency.

5 Conclusion and Future Research

This paper begins with a question: do presidential speeches become less positive compared to the beginning of an administration? The hypothesis is that presidential speeches became less positive as administration ages. The assumption is that a president's expectation and positivity are reflected by the speeches that he made. As the administration ages, his expectation should be adjusted according to reality, hence being less positive over time.

As the result section suggests, we fail to find an overall pattern that verifies this hypothesis. In fact, more presidents became more positive over time as shown in table 4.1. Additionally, the majority of the presidents in the second half of the 20th century became more positive. These findings raise the question of what causes some presidents to be less positive while others more positive over time. The question is suitable for a future research where one can conduct a regression analysis on sentiment scores over a wide range of predictors such as wartime, economic recession, presidential approval ratings, or experiences in previous administrations.

The analysis conducted in this project is far from being impeccable. One area that can be improved is to assure that the sentiment dictionary that is used with earlier presidents should take into account the English usage during that period to minimize inaccuracies in sentiment scores and stronger theoretical justification is needed for a direct comparison across 230 years of ever-changing historical context. Nevertheless, the value of this research still lies in the fact that it asks and answers a distinct research question in a systematic way which generates some useful insights for future work to build upon.

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Appendix

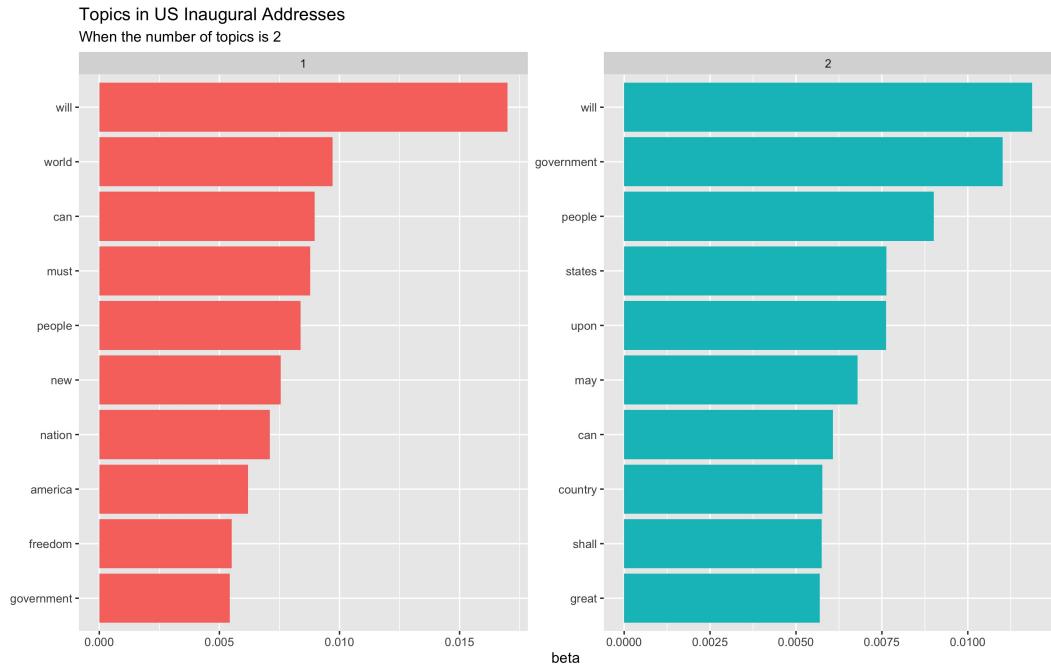


Figure 4: Topics in the Inaugural Addresses

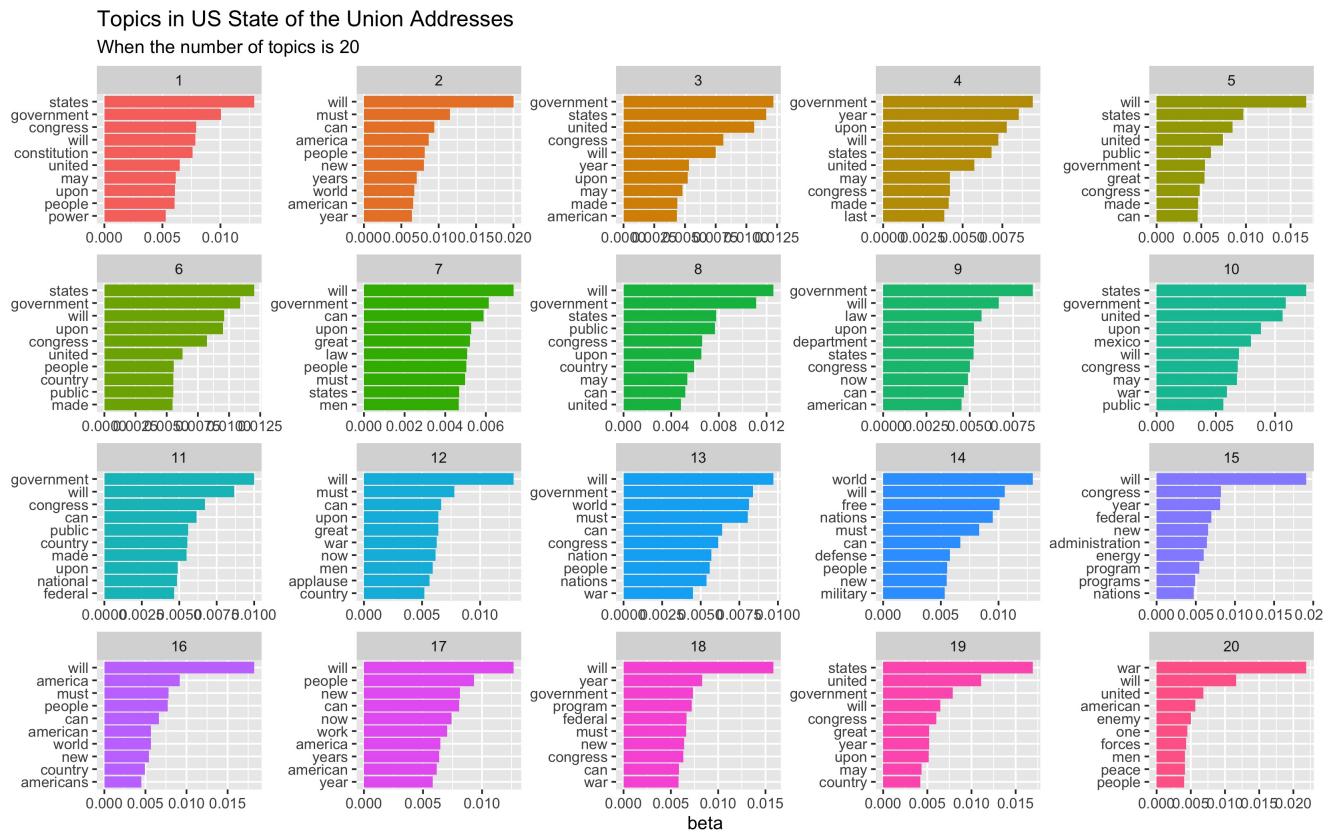


Figure 5: Topics in the State of the Union Addresses

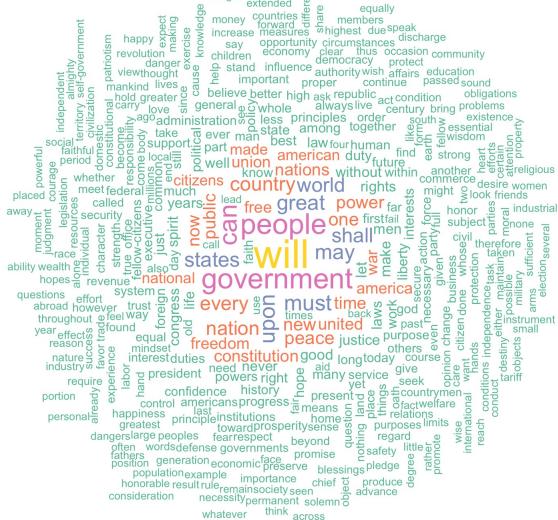


Figure 6: Common Words in the Inaugural Addresses

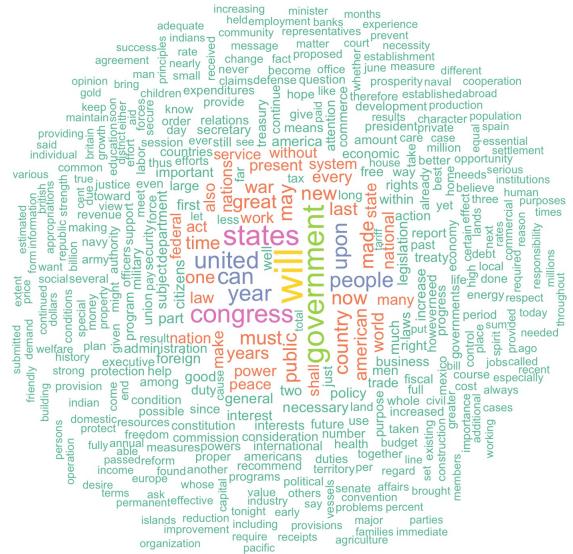


Figure 7: Common Words in the State of the Union Addresses

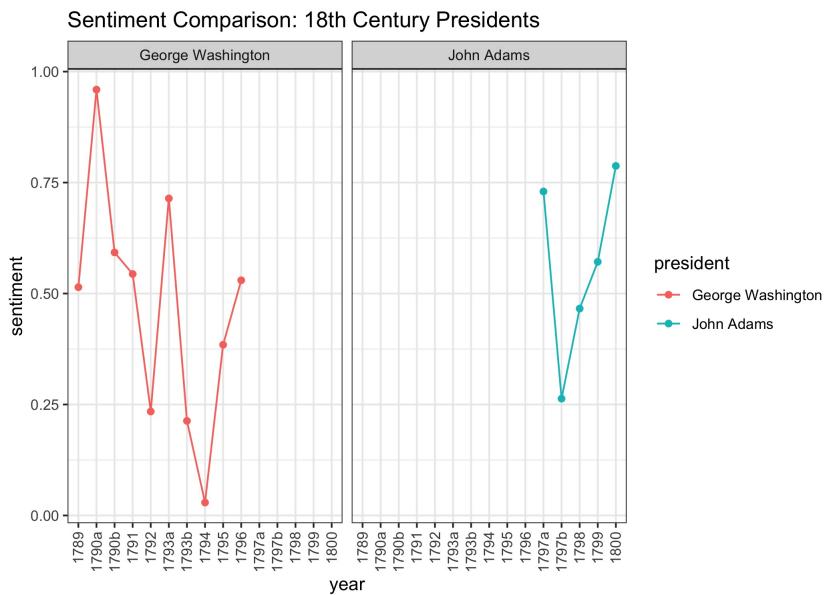


Figure 8: Sentiment Evolution Plots - 18th century

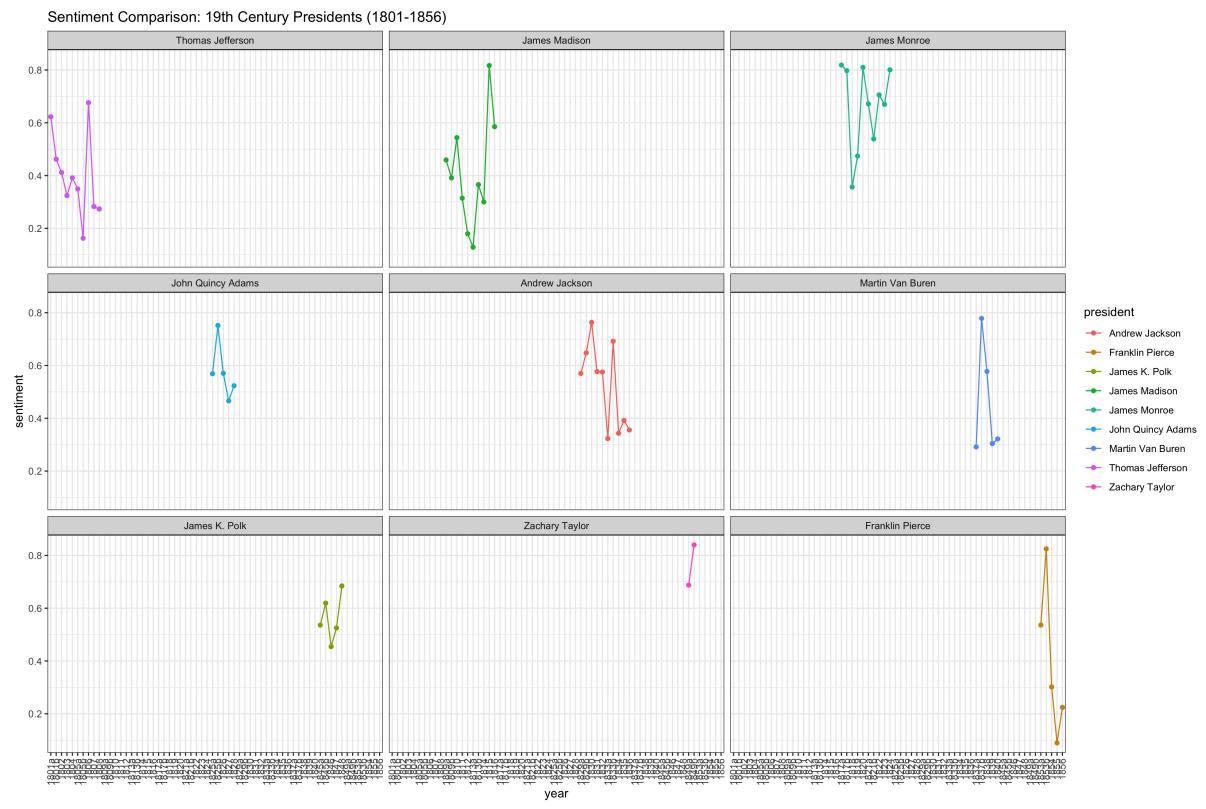


Figure 9: Sentiment Evolution Plots - 19th century

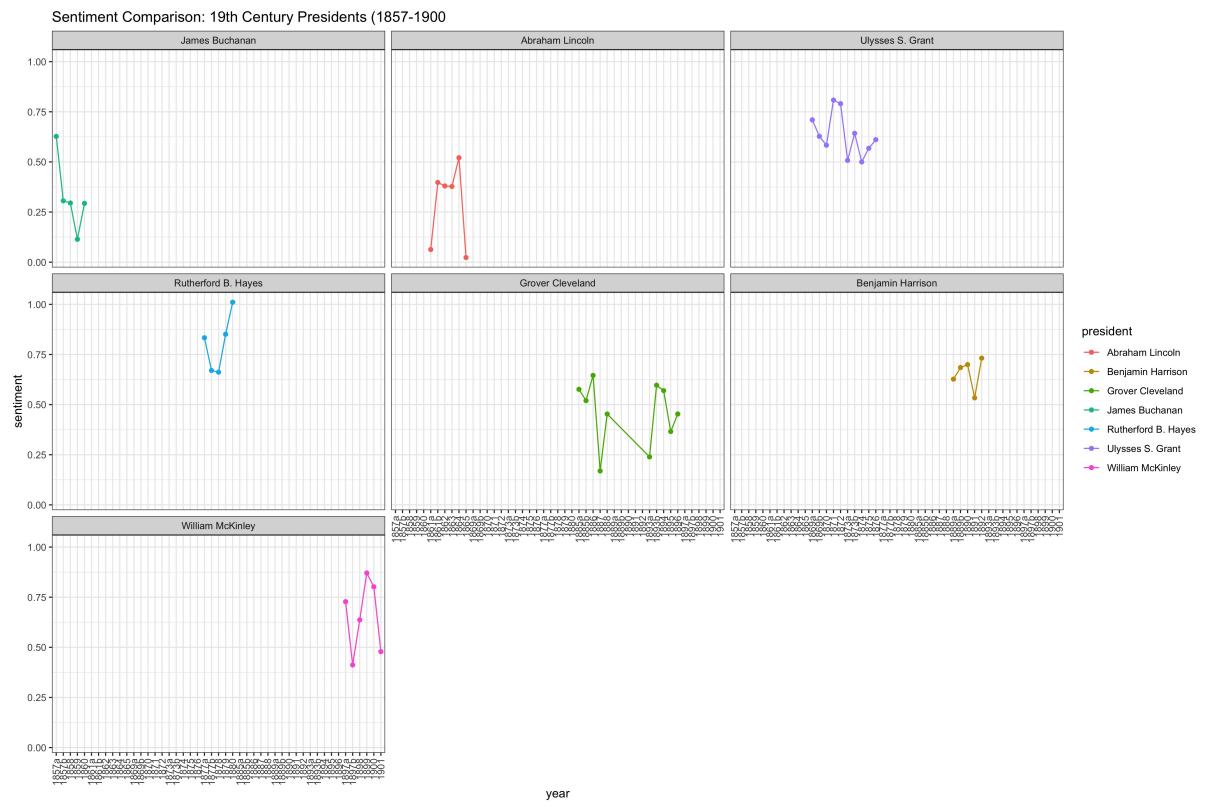


Figure 10: Sentiment Evolution Plots - 19th century

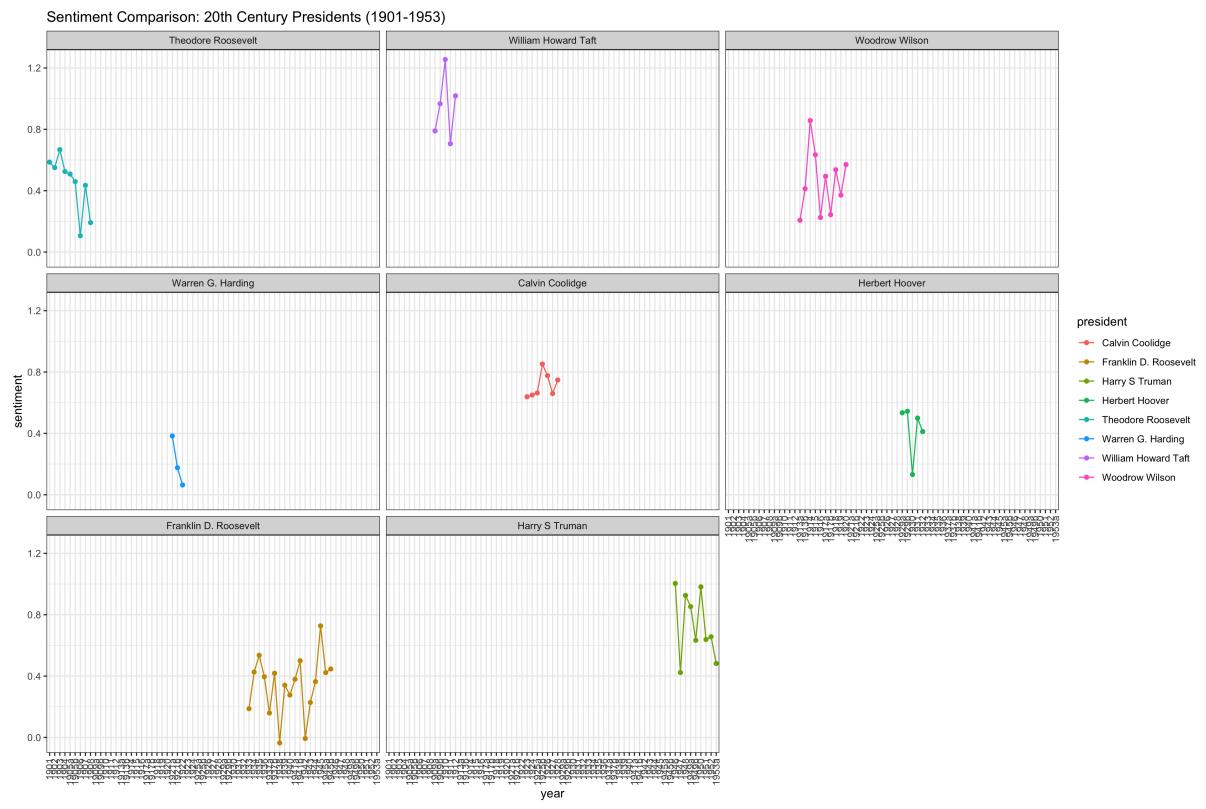


Figure 11: Sentiment Evolution Plots - 20th century

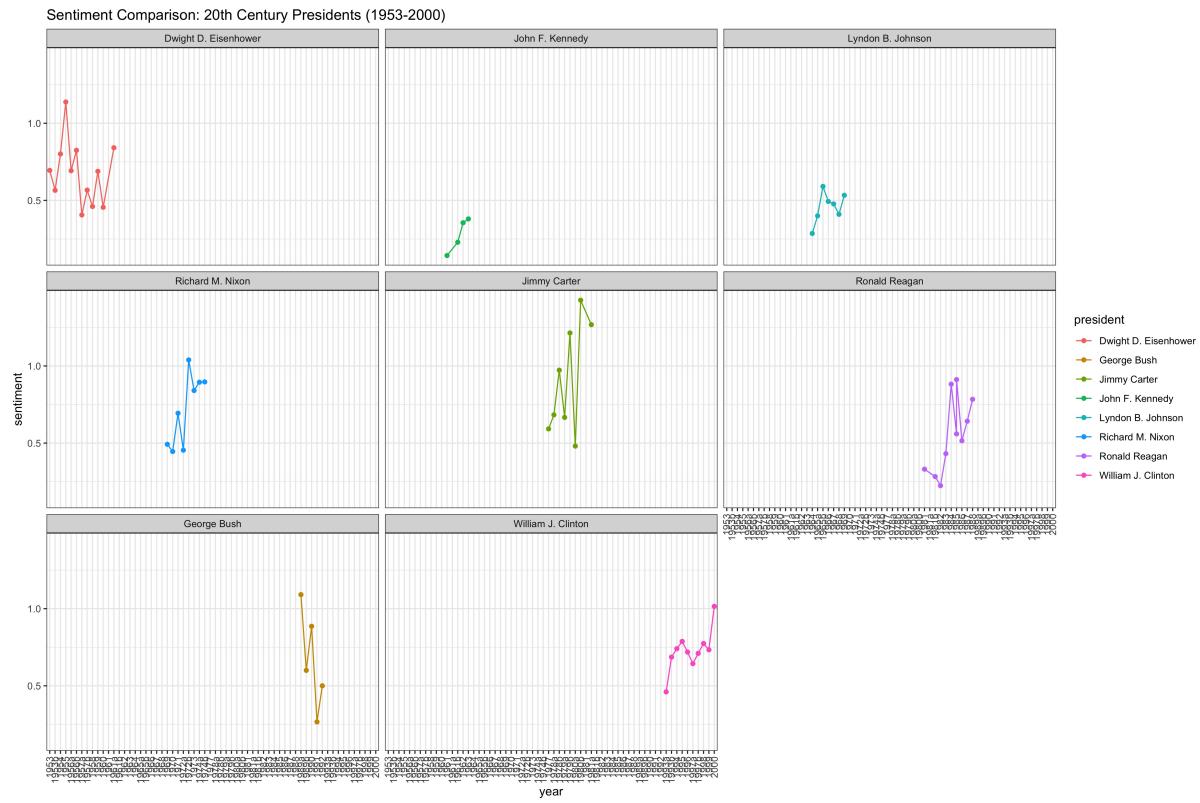


Figure 12: Sentiment Evolution Plots - 20th century

Sentiment Comparison: 21th Century Presidents

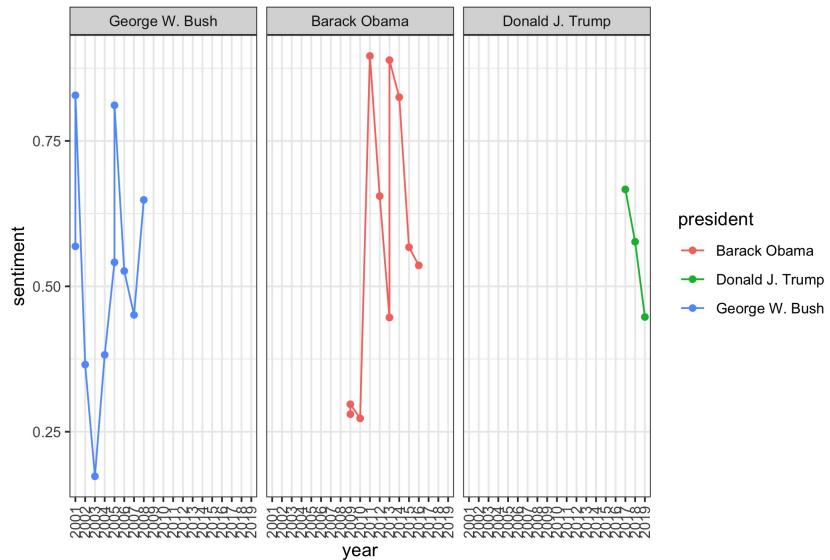


Figure 13: Sentiment Evolution Plots - 21st century