Data Cleaning & Sentiment Score

Minyoung Do

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Data Prep

Read tweets from the files & Find the overlapping time frame

```r
# Read data from csv files
bernie_original <- read_csv("bernie_tweets.csv")
warren_original <- read_csv("warren_tweets.csv")
pete_original <- read_csv("buttigieg_tweets.csv")
bloomberg_original <- read_csv("bloomberg_tweets_updated.csv")
amy_original <- read_csv("klobuchar_tweets.csv")

# Convert ID to character from numeric.
bernie_original$user_id <- as.character(bernie_original$user_id)
warren_original$user_id <- as.character(warren_original$user_id)
pete_original$user_id <- as.character(pete_original$user_id)
bloomberg_original$user_id <- as.character(bloomberg_original$user_id)
amy_original$user_id <- as.character(amy_original$user_id)


# check the time frame of each data
date_check <- function(df){
  df %>%
  group_by(1) %>%
  summarise(max = max(created), min = min(created))
}

# apply tthe new function to each data frame
bernie_date <- date_check(bernie_original)
warren_date <- date_check(warren_original)
pete_date <- date_check(pete_original)
bloomberg_date <- date_check(bloomberg_original)
amy_date <- date_check(amy_original)

# find overlapping time period
date_frame <- bind_rows(bernie_date, warren_date, pete_date, bloomberg_date, amy_date, .id = "id")[, -2]
```

Preparing/cleaning the data

The first step of data cleaning process entails removing:

1. *url*s
2. character strings between "<" and ">" to deal with smileys and other encoded text.
3. retweet marks, @RT
4. quotation marks and apostrophes
5. any @userid
6. punctuation and blank spaces
7. stopwords and single letters

```r
clean_tweets <- function(df) {
  # Remove URLs
  df$text <- gsub("http[^[:space:]]*", "",df$text)
  # Remove retweet entities
  df$text <- gsub("(RT|via)((?:\\b\\W*@\\w+)+)"," ", df$text)
  # Remove quotes
  df$text <- gsub("'s|'s|[...]", "", df$text)
  # Remove at people
  df$text <- gsub("@\\w+", " ", df$text)
  # Remove punctuation
  df$text <- gsub("[[:punct:]]", " ", df$text)
  # Remove single letters.
  df$text <- gsub(" *\\b[[:alpha:]]{1}\\b *", "", df$text)
  # Remove unnecessary spaces
  df$text <- gsub("[ \t]{2,}", " ", df$text)
  # Remove leading and trailing whitespaces
  df$text <- gsub("^\\s+|\\s+$", "", df$text)

  ## parsing, tokenizing, and re-grouping text column
  df <- df %>%
    unnest_tokens(output = word, input = text) %>%
    anti_join(stop_words) %>%
    filter(!str_detect(word, "^[0-9]*$")) %>%
    group_by(username, created) %>%
    summarize(text = str_c(word, collapse = " ")) %>%
    ungroup()
    # creating a date column without time
    df$date <- as.Date(df$created, "%Y-%m-%d")
    # setting date objects
    start <- as.Date("2020-01-02")
    end <- as.Date("2020-02-26")
    # subsetting by date range
    df <- df %>%
      subset(date >= start & date <= end) %>%
      select(-created)
}

bernie_clean <- clean_tweets(bernie_original)
warren_clean <- clean_tweets(warren_original)
pete_clean <- clean_tweets(pete_original)
bloomberg_clean <- clean_tweets(bloomberg_original)
amy_clean <- clean_tweets(amy_original)
```

Check for duplicates (Sample Data: Bernie Sanders)

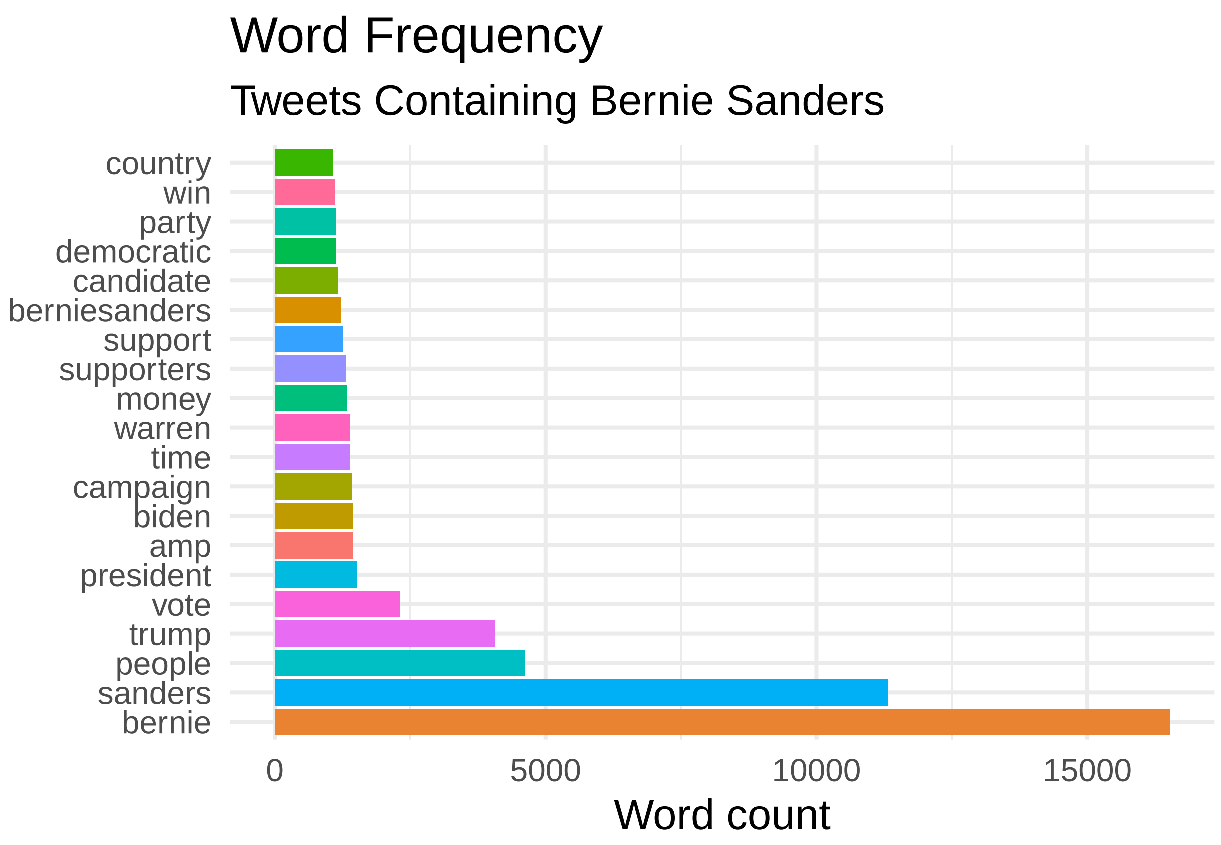
```r
# creating a data frame only containing the text column of the clean data
bernie_text <- as.tibble(bernie_clean$text)

# groupingn by frequency of the same texts/words
grouped_bernie_text <- aggregate(bernie_text, by = list(bernie_clean$text), FUN = length);
colnames(grouped_bernie_text) <- c("Text","TweetCount")

# reordering by frequency rate
grouped_bernie_text <- arrange(grouped_bernie_text, desc(TweetCount))

# duplicated words across the tweets
```

```
bernie_text_duplicates <- subset(grouped_bernie_text, grouped_bernie_text$TweetCount > 1)

# un-commen the code below to take a look
# head(bernie_text_duplicates, n = 20)

# finding any tweet that contains 4 words below as it's likely to be a meaningless tweet
# check Tweetcount for how many times they appear in the dataset
duplicates_bernie <- bernie_text_duplicates[grep("stock|retweet|follow|update", bernie_text_duplicates$Tex
```

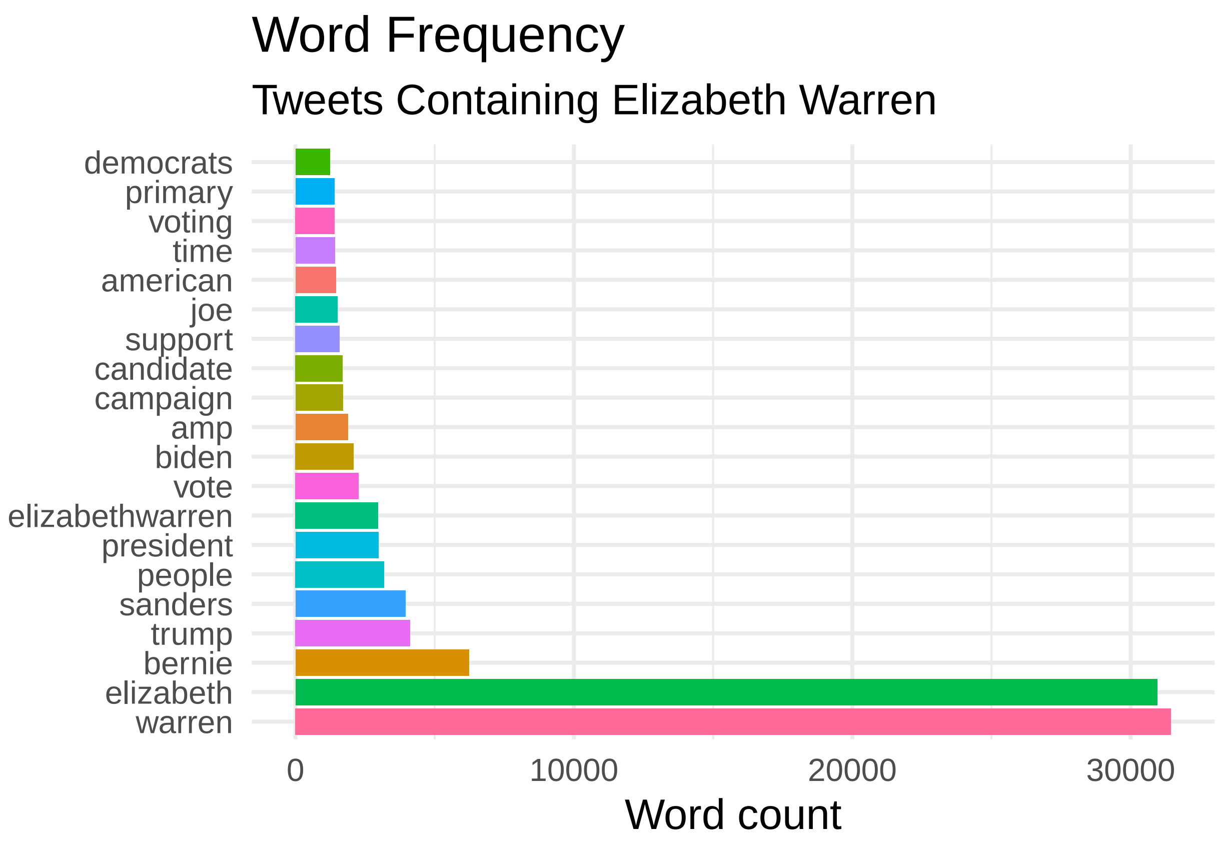
Still looking for a way to remove the duplicates in the data in an efficient manner.

Term Frequency

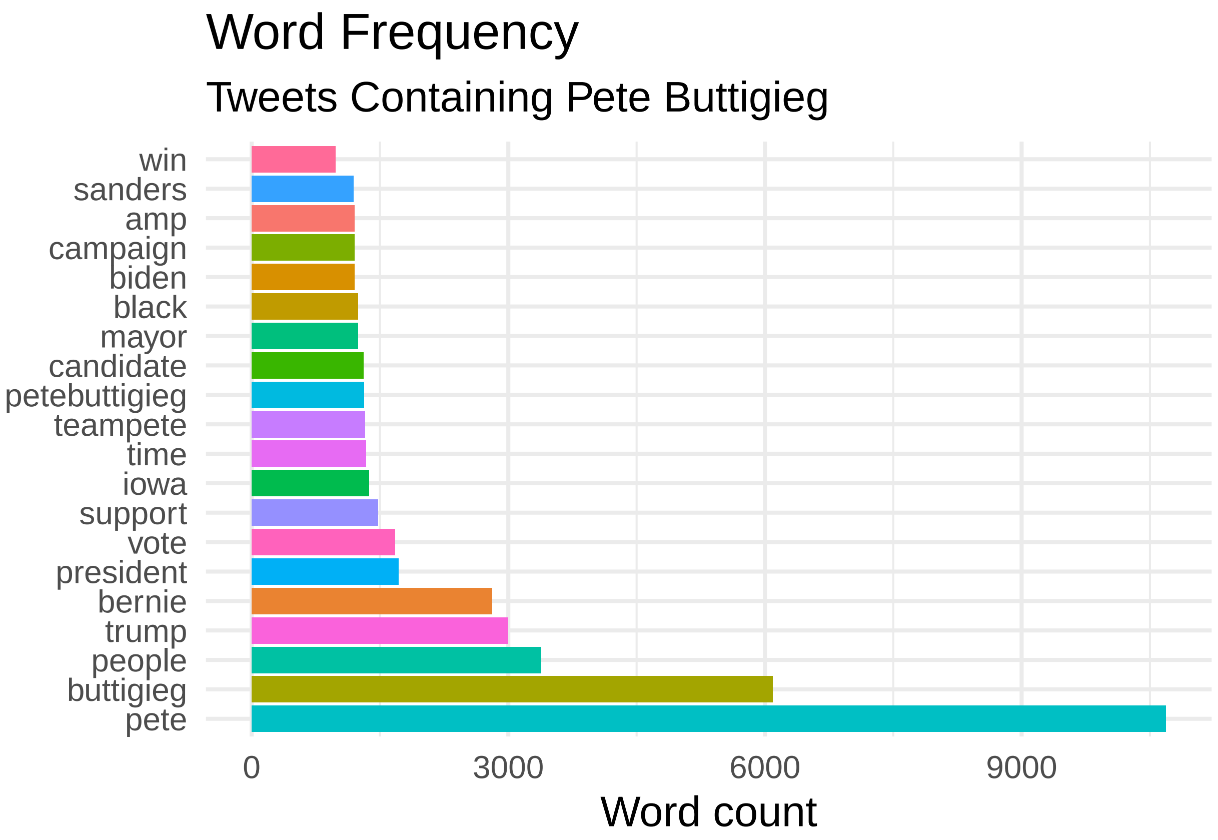
```
clean_frequency <- function(df){
  term_freq_df <- df %>%
                  unnest_tokens(output = word, input = text) %>%
                  anti_join(stop_words) %>%
                  count(word, sort = TRUE) %>%
                  arrange(desc(n)) %>%
                  drop_na()
  term_freq_df %>%
  top_n(20) %>%
    ggplot(aes(x = reorder(word, -n), y = n, fill = word)) +
      geom_bar(stat = "identity") +
      scale_x_reordered() +
    labs(x = NULL,
         y = "Word count") +
    coord_flip() +
    theme_minimal(base_size = rcfss::base_size * .65) +
    theme(legend.position = "none")
}

clean_frequency(bernie_clean) +
  labs(title = "Word Frequency",
       subtitle = "Tweets Containing Bernie Sanders",
       x = NULL,
       y = "Word count")
```



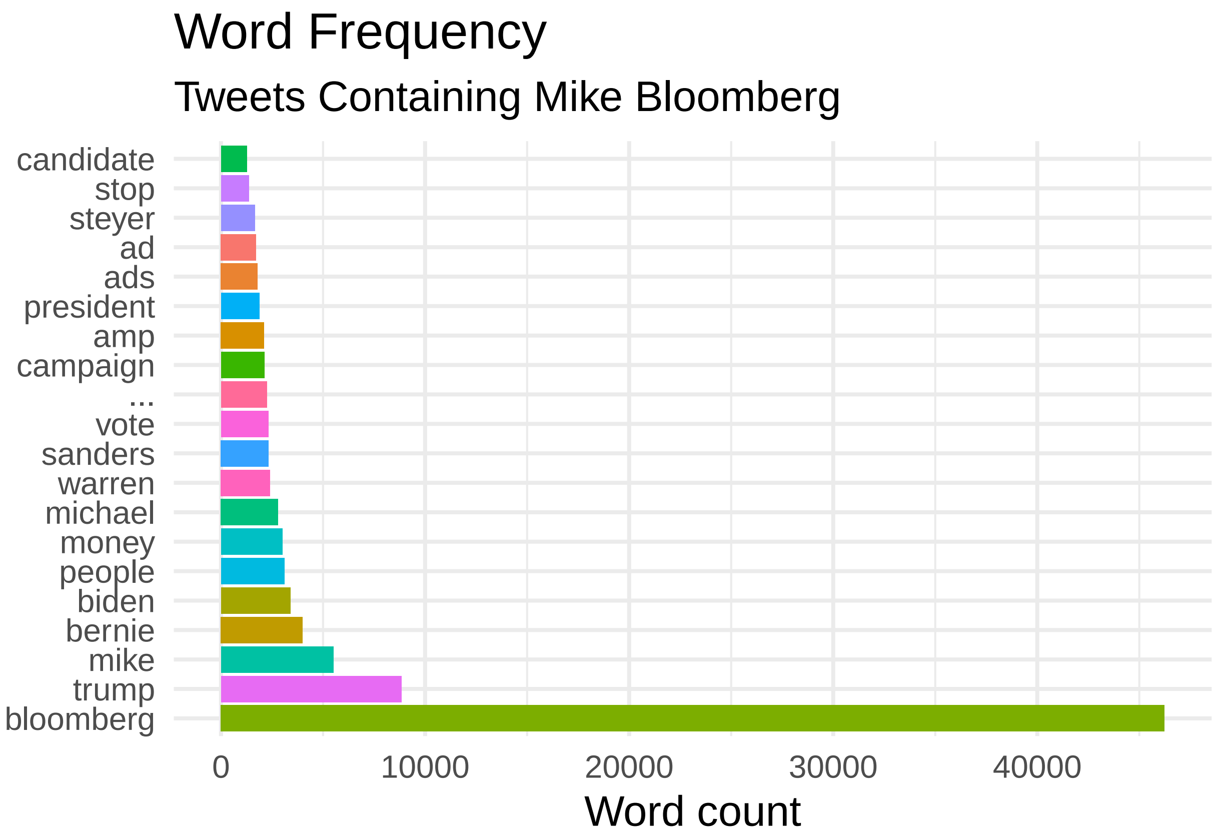
```r
clean_frequency(warren_clean) +
  labs(title = "Word Frequency",
       subtitle = "Tweets Containing Elizabeth Warren",
       x = NULL,
       y = "Word count")
```



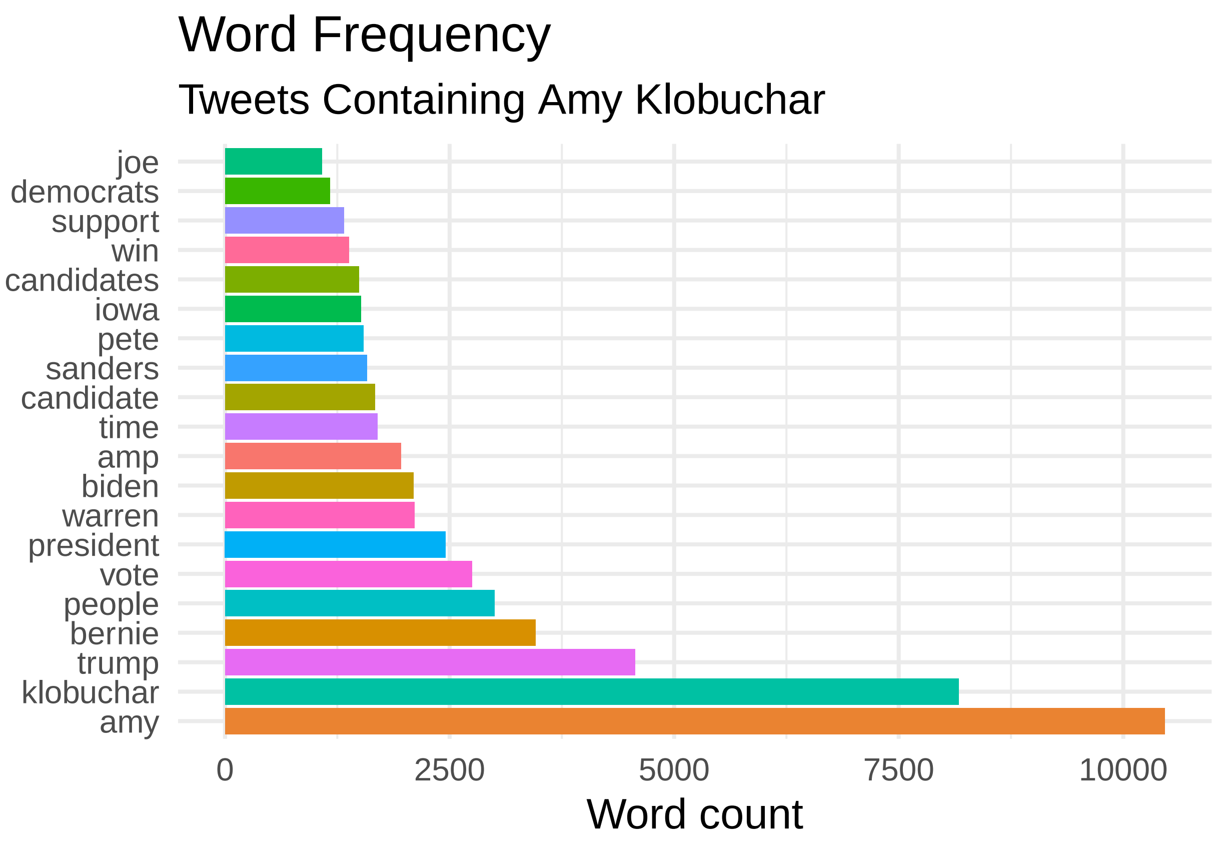
```r
clean_frequency(pete_clean) +
  labs(title = "Word Frequency",
       subtitle = "Tweets Containing Pete Buttigieg",
       x = NULL,
       y = "Word count")
```



```
clean_frequency(bloomberg_clean) +
  labs(title = "Word Frequency",
       subtitle = "Tweets Containing Mike Bloomberg",
       x = NULL,
       y = "Word count")
```

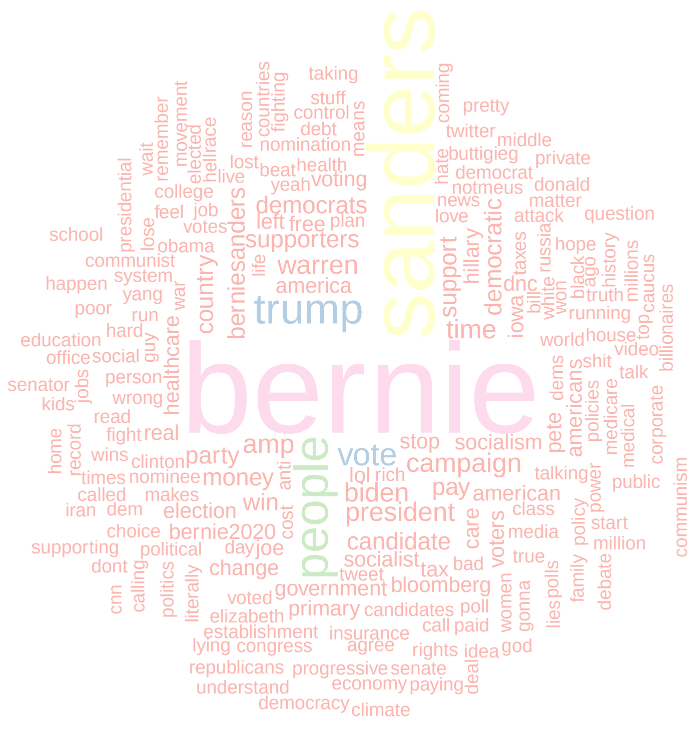


```
clean_frequency(amy_clean) +
  labs(title = "Word Frequency",
       subtitle = "Tweets Containing Amy Klobuchar",
       x = NULL,
       y = "Word count")
```

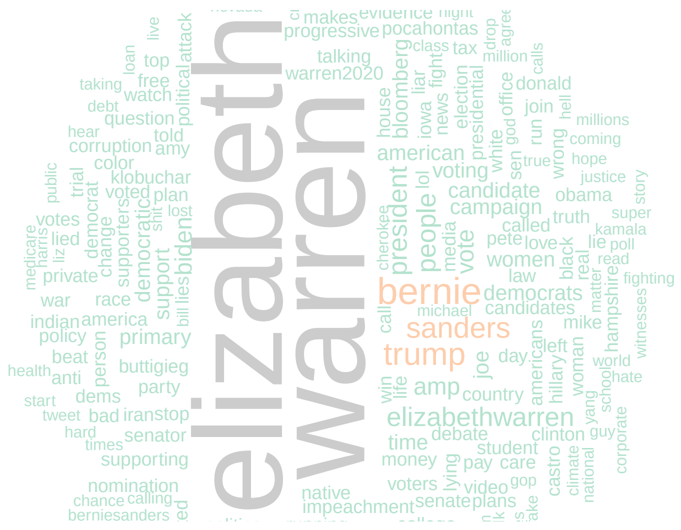


Word Cloud

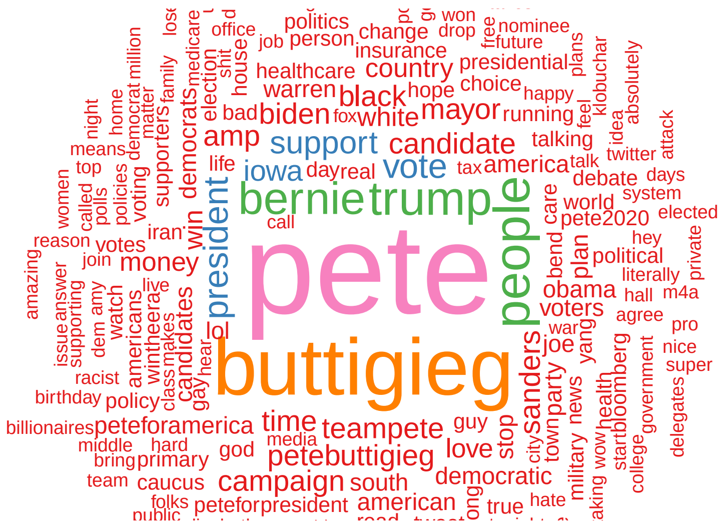
```
set.seed(1234)

wordcloud(words = bernie_clean$text, min.freq = 1,
          max.words = 200, random.order = FALSE, rot.per= 0.35,
          colors = brewer.pal(8, "Pastel1"))
```



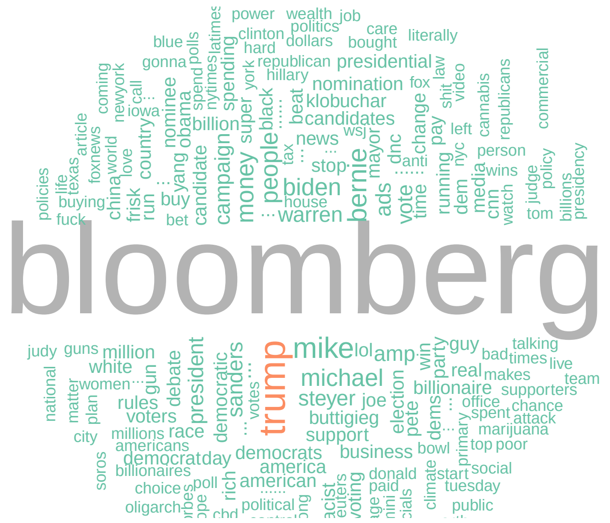
```r
wordcloud(words = warren_clean$text, min.freq = 1,
          max.words = 200, random.order = FALSE, rot.per= 0.35,
          colors = brewer.pal(8, "Pastel2"))
```



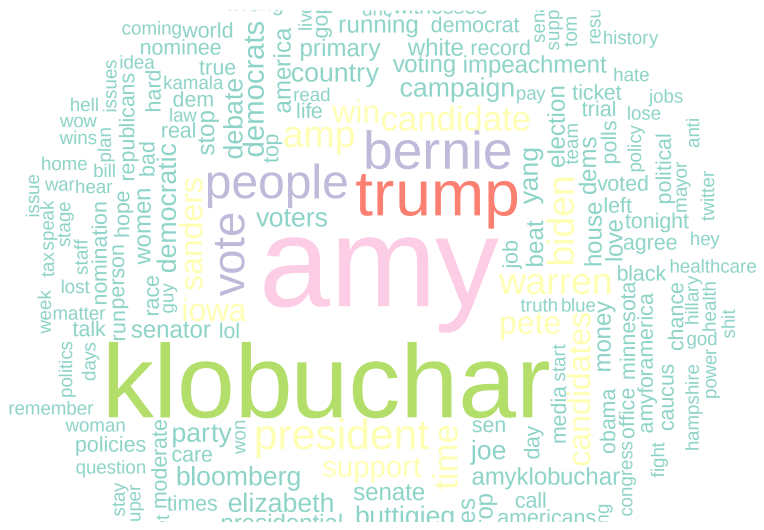
```r
wordcloud(words = pete_clean$text, min.freq = 1,
          max.words = 200, random.order = FALSE, rot.per= 0.35,
          colors = brewer.pal(8, "Set1"))
```



```r
wordcloud(words = bloomberg_clean$text, min.freq = 1,
          max.words = 200, random.order = FALSE, rot.per= 0.35,
          colors = brewer.pal(8, "Set2"))
```



```r
wordcloud(words = amy_clean$text, min.freq = 1,
          max.words = 200, random.order = FALSE, rot.per= 0.35,
          colors = brewer.pal(8, "Set3"))
```



Get sentiment scores

```r
# function to calculate the sentiment score
sentiment_score <- function(df) {
  df %>%
    unnest %>%
    get_sentences() %>%
    # get sentiment score for each tweet
    sentiment() %>%
    mutate(characters = nchar(stripWhitespace(text))) %>%
    filter(characters > 1)
    # same number of obs, hence no error
}

# get sentiment scores for all our data frames
bernie_sent <- sentiment_score(bernie_clean)
warren_sent <- sentiment_score(warren_clean)
pete_sent <- sentiment_score(pete_clean)
bloomberg_sent <- sentiment_score(bloomberg_clean)
amy_sent <- sentiment_score(amy_clean)

# quick summary of the result
skim(bernie_sent$sentiment)
```

Table 1: Data summary

Name	bernie_sent$sentiment
Number of rows	51567
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.35	-2.3	-0.22	0	0.17	2.87	

```r
skim(warren_sent$sentiment)
```

Table 3: Data summary

Name	warren_sent$sentiment
Number of rows	52736
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.34	-2.76	-0.22	0	0.18	1.88	

```r
skim(pete_sent$sentiment)
```

Table 5: Data summary

Name	pete_sent$sentiment
Number of rows	50601
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	0.01	0.36	-2.65	-0.15	0	0.21	1.96	

```r
skim(bloomberg_sent$sentiment)
```

Table 7: Data summary

Name	bloomberg_sent$sentiment
Number of rows	55134
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.31	-1.92	-0.19	0	0.13	1.53	

```r
skim(amy_sent$sentiment)
```

Table 9: Data summary

Name	amy_sent$sentiment
Number of rows	51568
Number of columns	1
Column type frequency:	

Table 9: Data summary

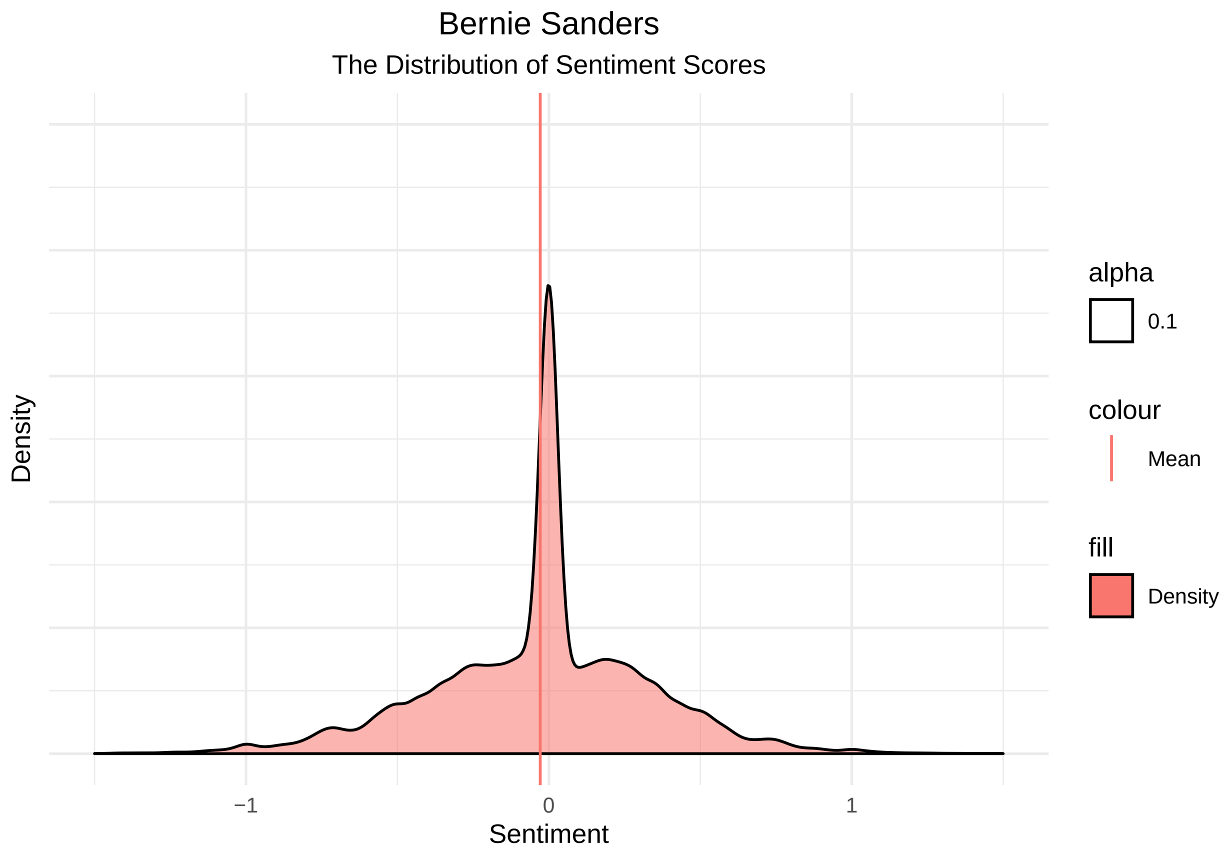
numeric	1
Group variables	None

Variable type: numeric

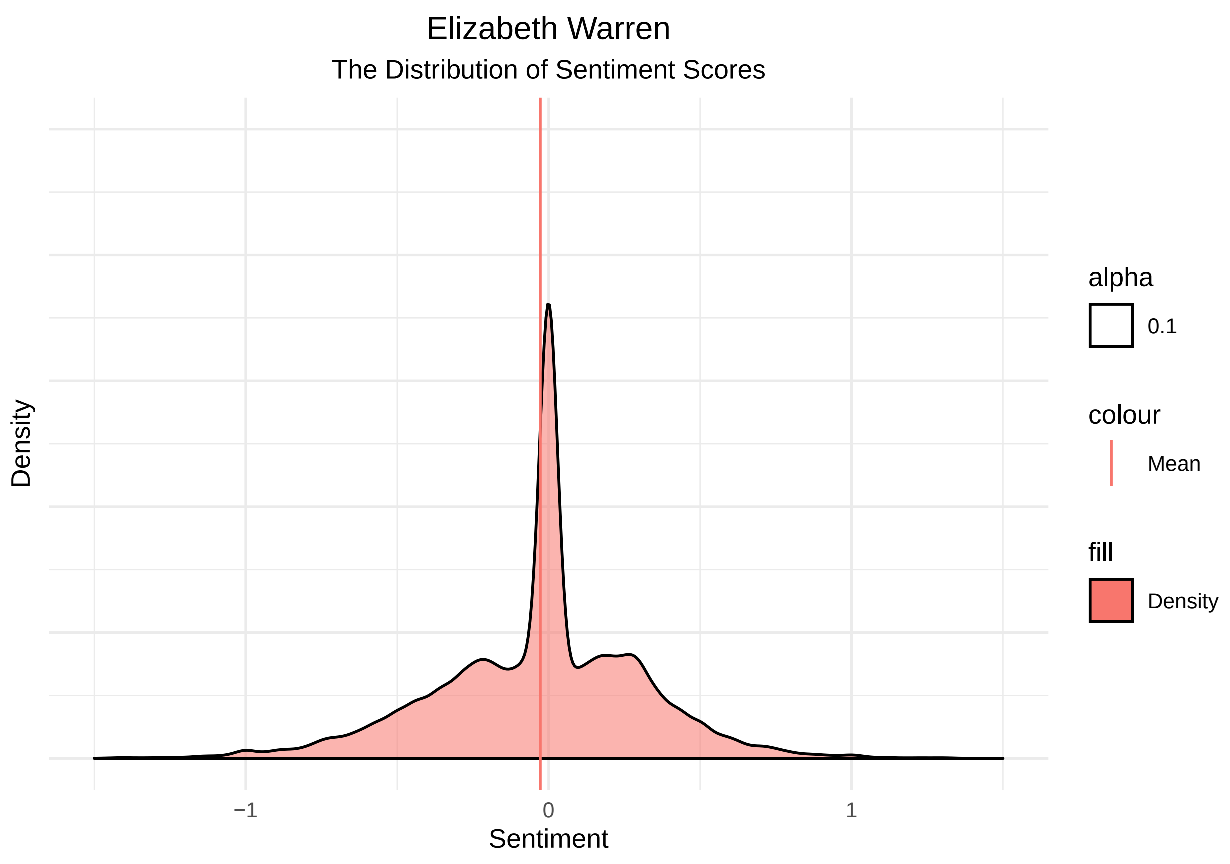
skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	0.02	0.35	-2.3	-0.14	0	0.21	2.06	

Plot the result

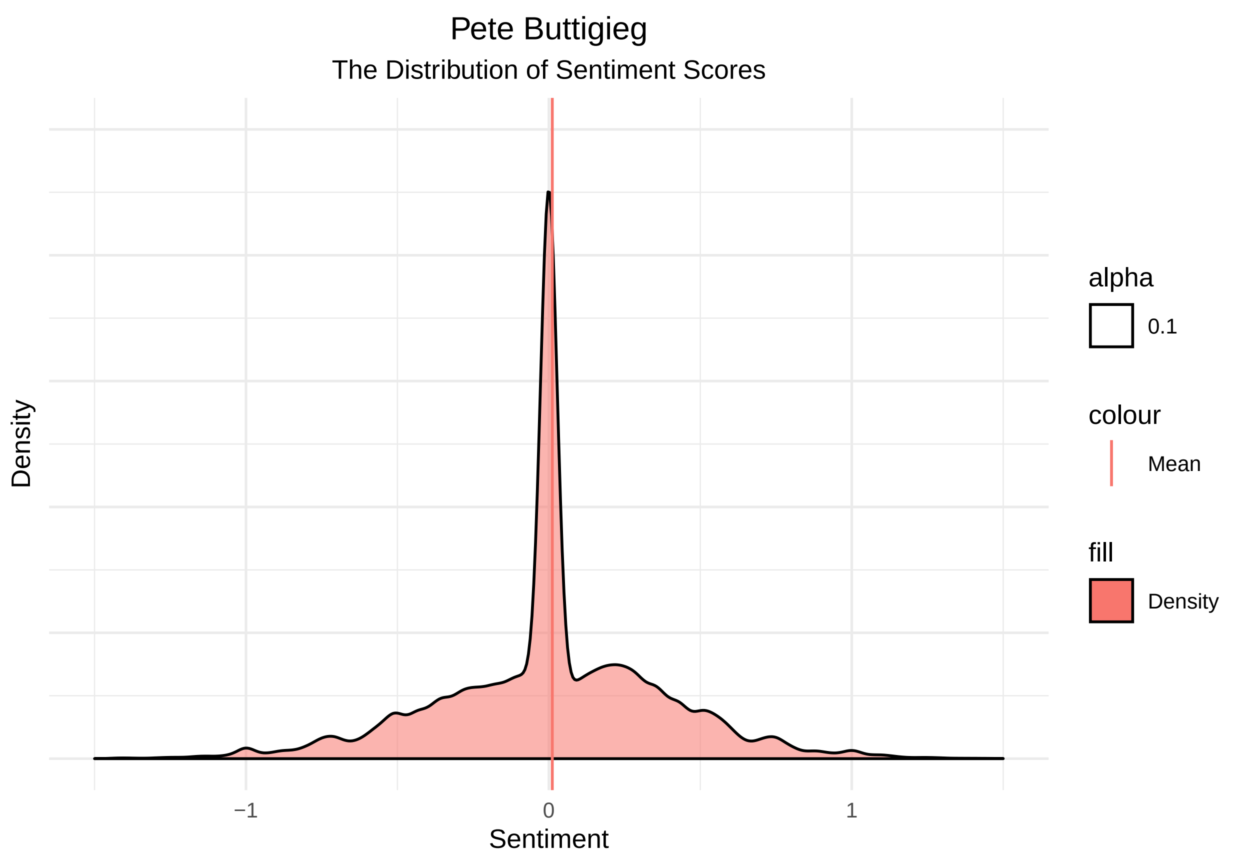
```r
# function to plot the distribution of sentiment scores
sentiment_plot <- function(df){
  ggplot(df, aes(sentiment)) +
    geom_density(aes(fill = "Density", alpha = 0.1)) +
    scale_y_continuous(limits = c(0, 5)) +
    scale_x_continuous(limits = c(-1.5, 1.5)) +
    theme_minimal(base_size = 10) +
    geom_vline(aes(xintercept = mean(sentiment), color = "Mean"))
}

# customizing the labels
bernie_plot <- sentiment_plot(bernie_sent) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Bernie Sanders",
       subtitle = "The Distribution of Sentiment Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

bernie_plot
```



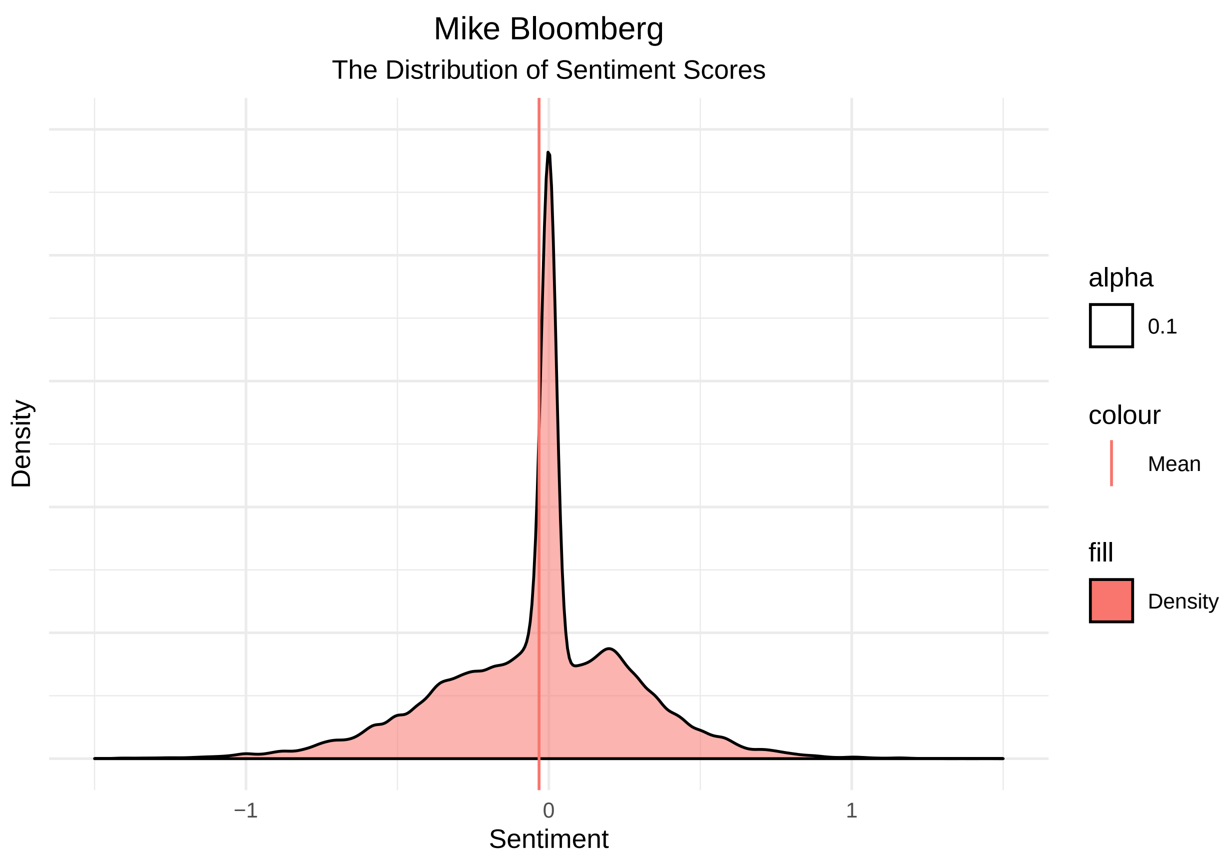
```r
warren_plot <- sentiment_plot(warren_sent) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Elizabeth Warren",
       subtitle = "The Distribution of Sentiment Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

warren_plot
```



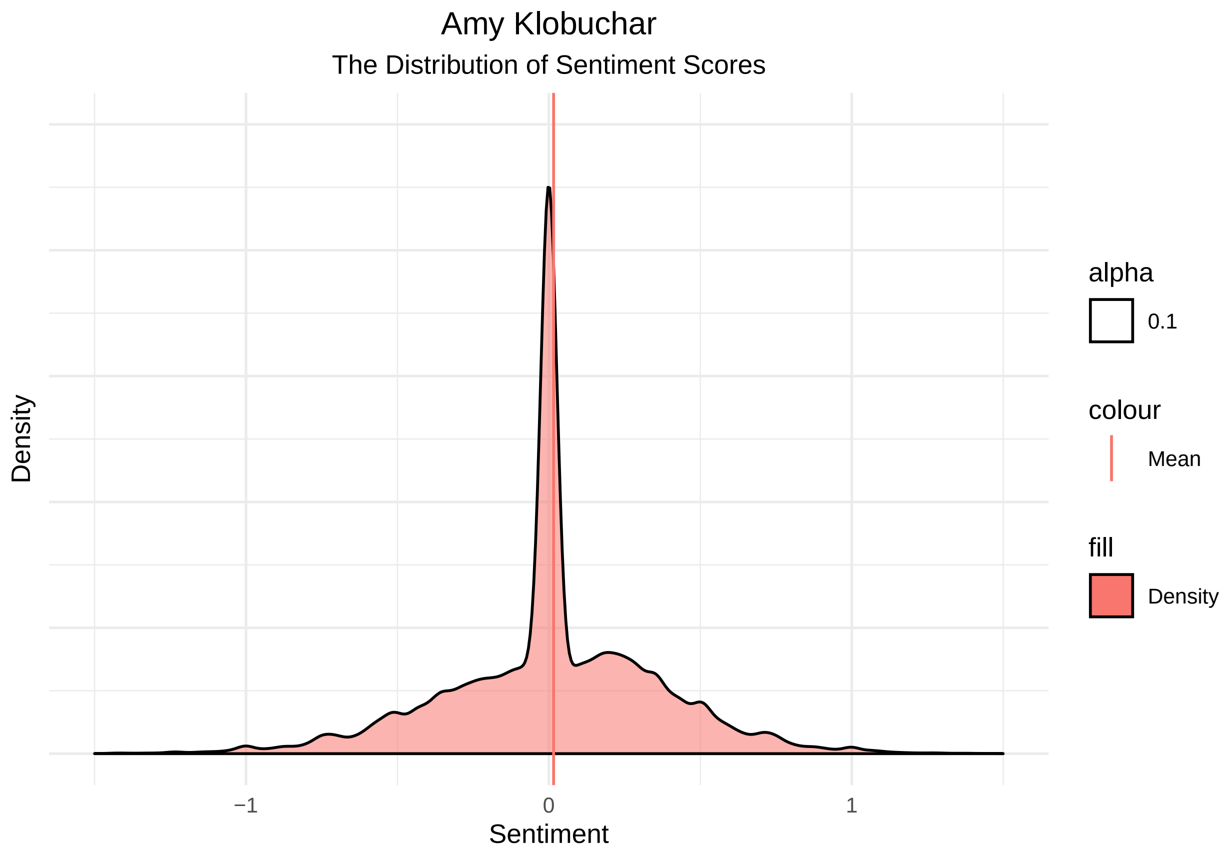
```r
pete_plot <- sentiment_plot(pete_sent) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Pete Buttigieg",
       subtitle = "The Distribution of Sentiment Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

pete_plot
```



```r
bloomberg_plot <- sentiment_plot(bloomberg_sent) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Mike Bloomberg",
       subtitle = "The Distribution of Sentiment Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

bloomberg_plot
```



```r
amy_plot <- sentiment_plot(amy_sent) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Amy Klobuchar",
       subtitle = "The Distribution of Sentiment Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

amy_plot
```



Polarity score: weighted sentiment scores

```r
# function to calculate the sentiment score
polarity_score <- function(df) {
  df %>%
    unnest %>%
    get_sentences() %>%
    # get sentiment score for each tweet
    sentiment(polarity_dt = lexicon::hash_sentiment_jockers_rinker) %>%
    mutate(characters = nchar(stripWhitespace(text))) %>%
    filter(characters > 1)
    # same number of obs, hence no error
}

# get sentiment scores for all our data frames
bernie_polar <- polarity_score(bernie_clean)
warren_polar <- polarity_score(warren_clean)
pete_polar <- polarity_score(pete_clean)
bloomberg_polar <- polarity_score(bloomberg_clean)
amy_polar <- polarity_score(amy_clean)

# quick summary of the result
skim(bernie_polar$sentiment)
```

Table 11: Data summary

Name	bernie_polar$sentiment
Number of rows	51567
Number of columns	1

Column type frequency:

Table 11: Data summary

numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.35	-2.3	-0.22	0	0.17	2.87	

```r
skim(warren_polar$sentiment)
```

Table 13: Data summary

Name	warren_polar$sentiment
Number of rows	52736
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.34	-2.76	-0.22	0	0.18	1.88	

```r
skim(pete_polar$sentiment)
```

Table 15: Data summary

Name	pete_polar$sentiment
Number of rows	50601
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	0.01	0.36	-2.65	-0.15	0	0.21	1.96	

```r
skim(bloomberg_polar$sentiment)
```

Table 17: Data summary

Name	bloomberg_polar$sentiment
Number of rows	55134
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	-0.03	0.31	-1.92	-0.19	0	0.13	1.53	

```r
skim(amy_polar$sentiment)
```

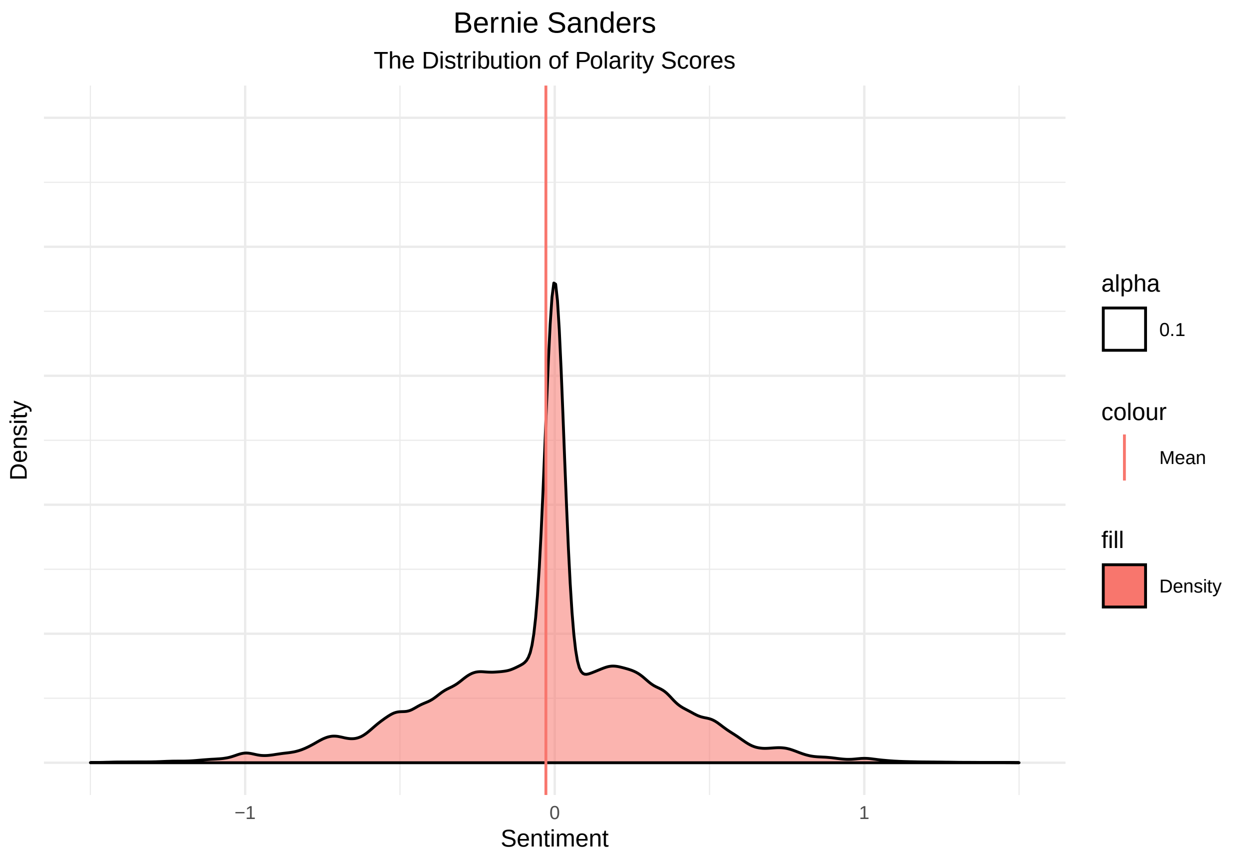
Table 19: Data summary

Name	amy_polar$sentiment
Number of rows	51568
Number of columns	1
Column type frequency:	
numeric	1
Group variables	None

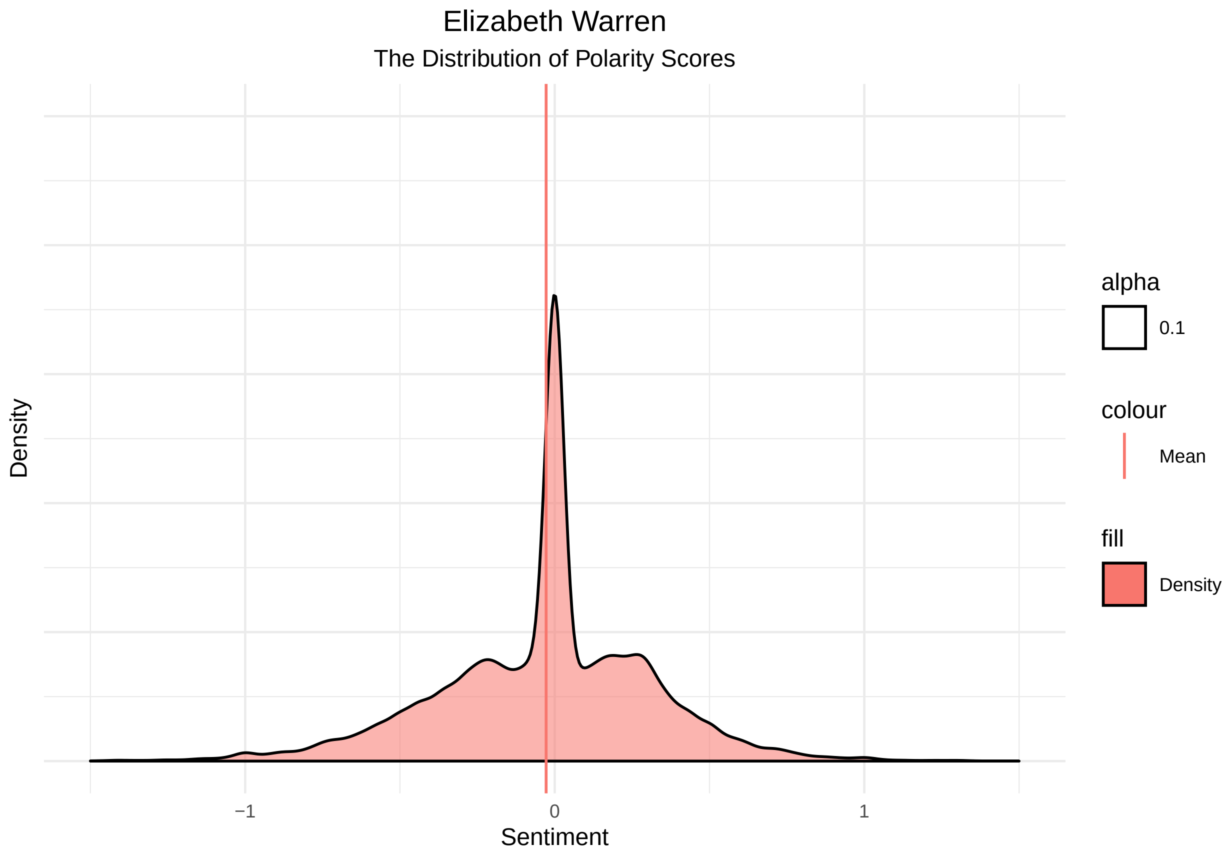
Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	0.02	0.35	-2.3	-0.14	0	0.21	2.06	

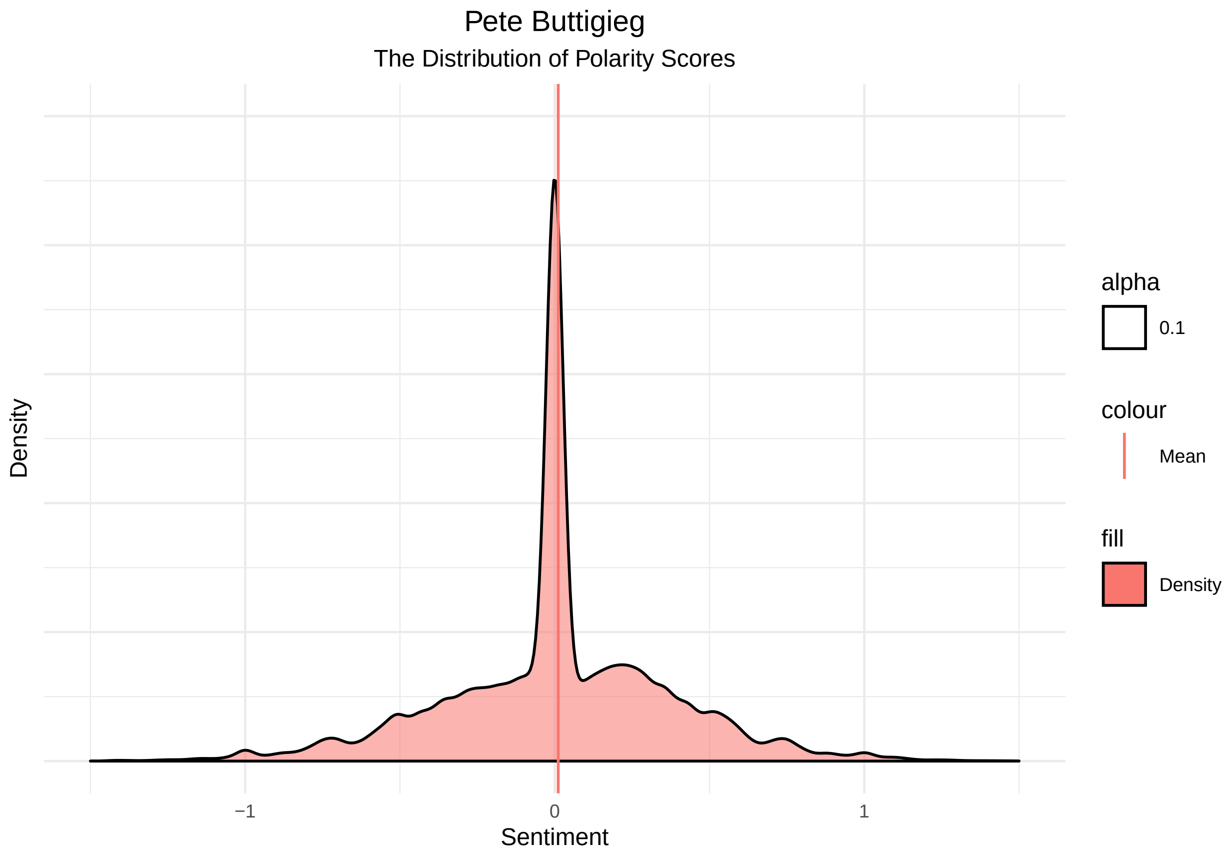
```r
# function to plot the distribution of sentiment scores
polarity_plot <- function(df){
  ggplot(df, aes(sentiment)) +
    geom_density(aes(fill = "Density", alpha = 0.1)) +
    scale_y_continuous(limits = c(0, 5)) +
    scale_x_continuous(limits = c(-1.5, 1.5)) +
    theme_minimal(base_size = 9) +
    geom_vline(aes(xintercept = mean(sentiment), color = "Mean"))
}

# customizing the labels
bernie_plot_polar <- polarity_plot(bernie_polar) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Bernie Sanders",
       subtitle = "The Distribution of Polarity Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

bernie_plot_polar
```



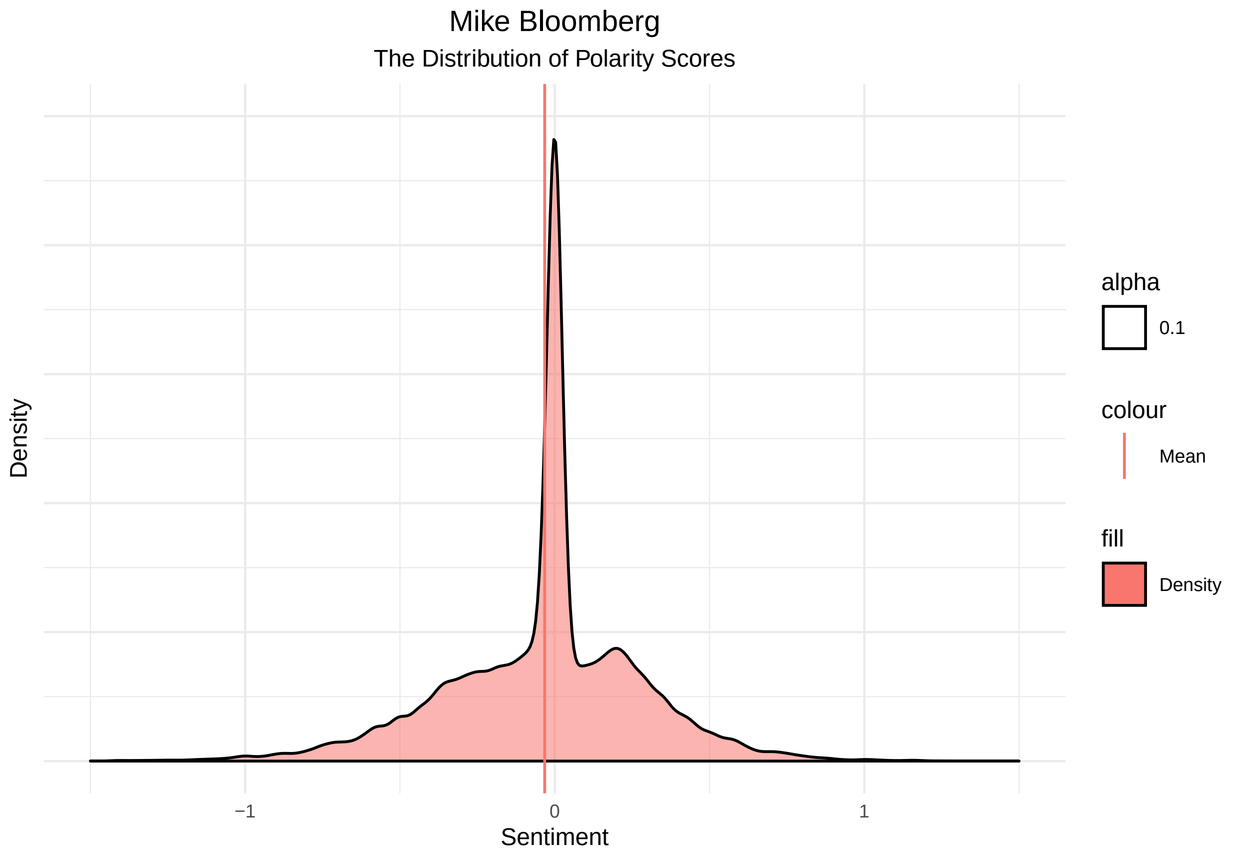
```
warren_plot_polar <- polarity_plot(warren_polar) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Elizabeth Warren",
       subtitle = "The Distribution of Polarity Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

warren_plot_polar
```



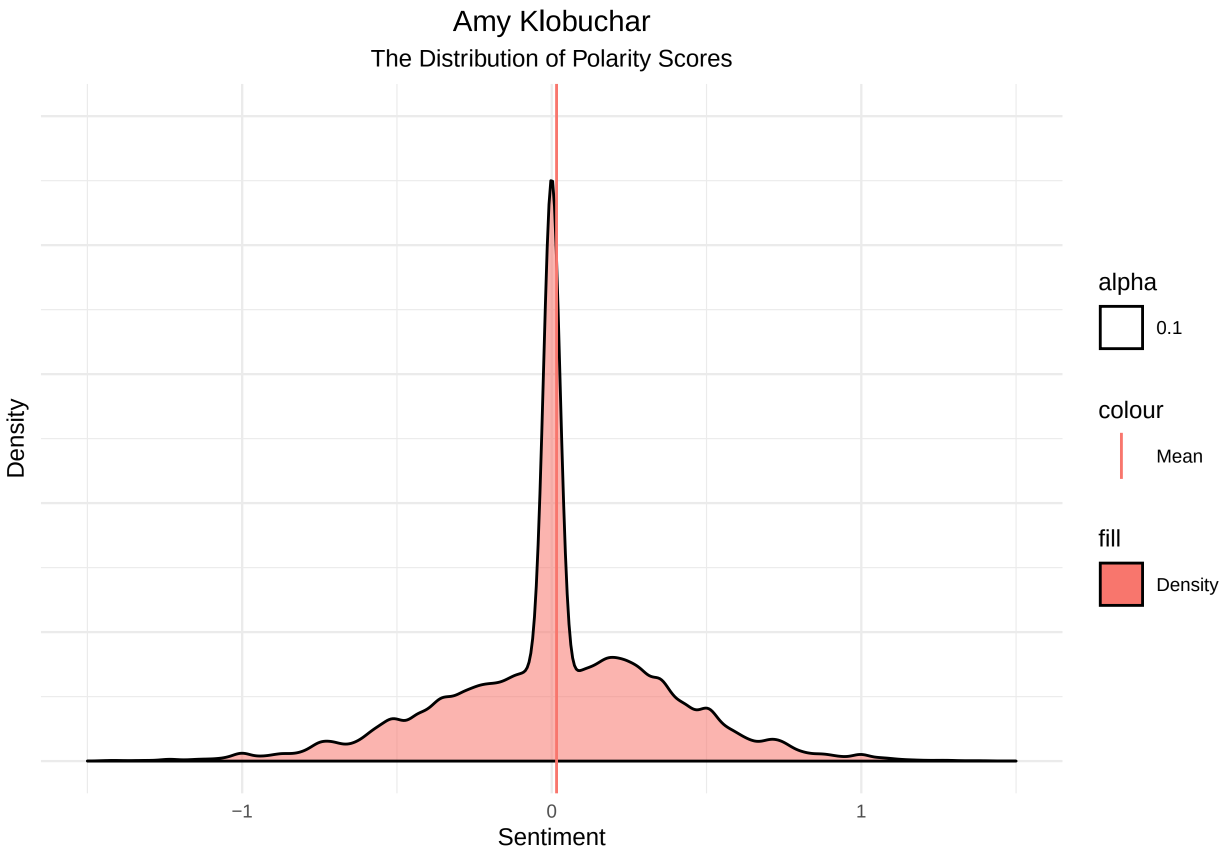
```r
pete_plot_polar <- polarity_plot(pete_polar) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Pete Buttigieg",
       subtitle = "The Distribution of Polarity Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

pete_plot_polar
```



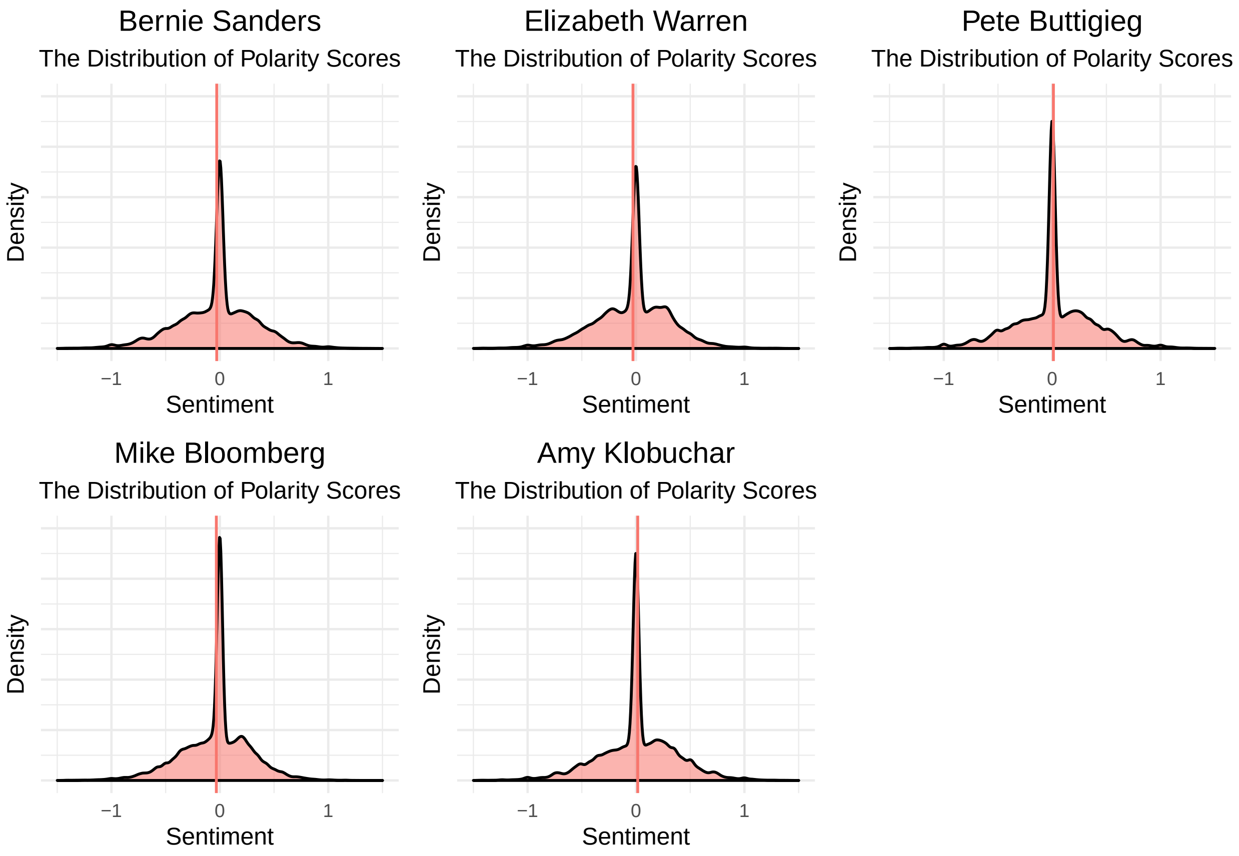
```
bloomberg_plot_polar <- polarity_plot(bloomberg_polar) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Mike Bloomberg",
       subtitle = "The Distribution of Polarity Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

bloomberg_plot_polar
```



```r
amy_plot_polar <- polarity_plot(amy_polar) +
  labs(x = "Sentiment",
       y = "Density",
       title = "Amy Klobuchar",
       subtitle = "The Distribution of Polarity Scores") +
  theme(plot.title = element_text(hjust = 0.5),
        plot.subtitle = element_text(hjust = 0.5),
        axis.text.y=element_blank())

amy_plot_polar
```



```r
ggarrange(bernie_plot_polar, warren_plot_polar, pete_plot_polar, bloomberg_plot_polar, amy_plot_polar, leg
```



Resampling and Bootstrapping