Text, Tweets, and Sentiment

Part 3

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Returning to Trump

```
require(tidyverse)
tweet_words <- readRDS(file="../data/Trump_tweet_words.Rds")
tweet_words <- tweet_words %>% mutate(PostPresident = Tweeting.date >
as.Date('2016-11-06'))
```

Log-Odds

- **Odds**: Probability a word is used pre/post presidency
- **Log**: Useful for removing skew in data!
- Interactive code time!

Odds Step 1

```
(odds1 <- tweet_words %>%
  count(word, PostPresident) %>%
  filter(sum(n) >= 5) %>%
  spread(PostPresident, n, fill = 0) %>%
  ungroup() %>%
  mutate(totFALSE = sum(`FALSE`),
         totTRUE = sum(`TRUE`)))
```

```
## # A tibble: 45,221 × 5
##    word      `FALSE` `TRUE` totFALSE totTRUE
##    <chr>       <dbl>  <dbl>    <dbl>   <dbl>
##  1 a               6     27   189217  257487
##  2 aa              1      2   189217  257487
##  3 aaa            11      1   189217  257487
##  4 aamp            1      0   189217  257487
##  5 aand            0      1   189217  257487
##  6 aaron           2      1   189217  257487
##  7 ab              1      2   189217  257487
##  8 abaco           0      1   189217  257487
##  9 abandon         6      8   189217  257487
## 10 abandoned      13     11   189217  257487
## # ℹ 45,211 more rows
```

Odds Step 2

```r
(odds2 <- odds1 %>%
  mutate(propFALSE = (`FALSE` + 1) / (totFALSE + 1),
         propTRUE = (`TRUE` + 1) / (totTRUE + 1)))
```

```
## # A tibble: 45,221 × 7
##    word   `FALSE` `TRUE` totFALSE totTRUE propFALSE propTRUE
##    <chr>    <dbl>  <dbl>    <dbl>   <dbl>     <dbl>    <dbl>
##  1 a            6     27   189217  257487   3.70e-5  1.09e-4
##  2 aa           1      2   189217  257487   1.06e-5  1.17e-5
##  3 aaa         11      1   189217  257487   6.34e-5  7.77e-6
##  4 aamp         1      0   189217  257487   1.06e-5  3.88e-6
##  5 aand         0      1   189217  257487   5.28e-6  7.77e-6
##  6 aaron        2      1   189217  257487   1.59e-5  7.77e-6
##  7 ab           1      2   189217  257487   1.06e-5  1.17e-5
##  8 abaco        0      1   189217  257487   5.28e-6  7.77e-6
##  9 aband…       6      8   189217  257487   3.70e-5  3.50e-5
## 10 aband…      13     11   189217  257487   7.40e-5  4.66e-5
## # ℹ 45,211 more rows
```

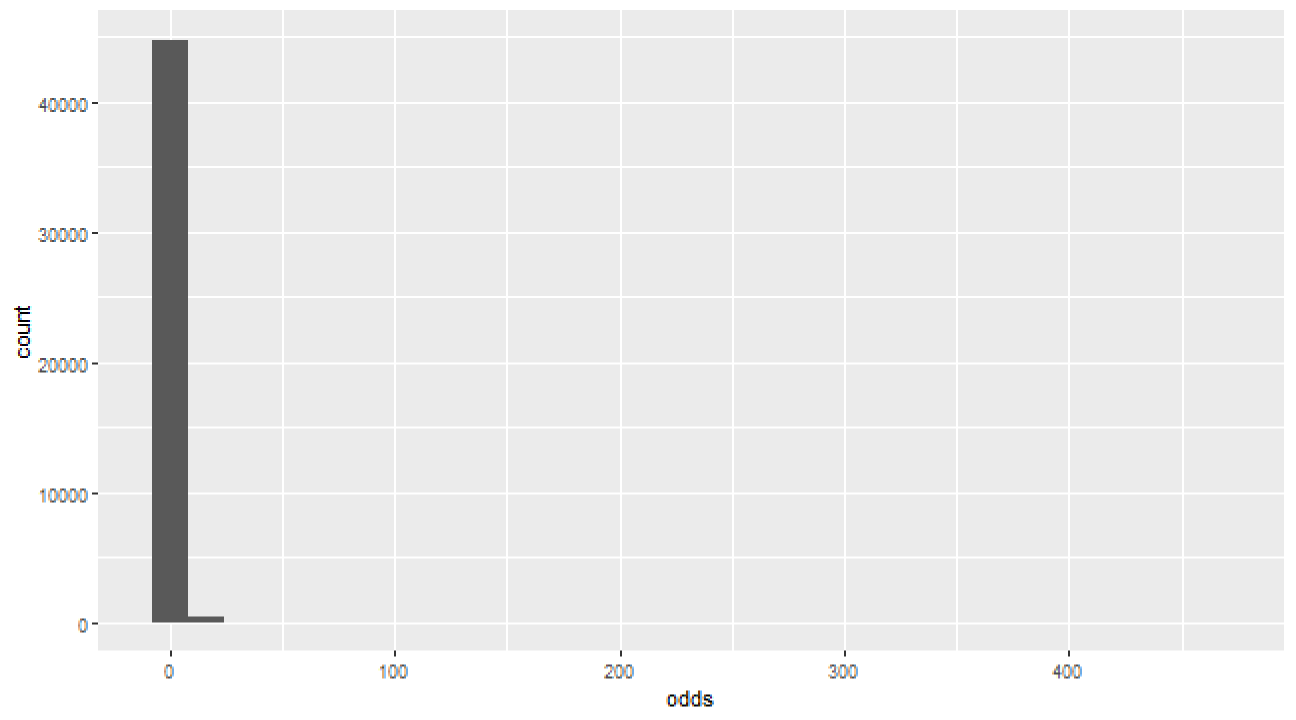
Odds Step 3

```
(odds3 <- odds2 %>%
  mutate(odds = propTRUE / propFALSE))
```

```
## # A tibble: 45,221 × 8
##    word   `FALSE` `TRUE` totFALSE totTRUE propFALSE propTRUE
##    <chr>    <dbl>  <dbl>    <dbl>   <dbl>     <dbl>    <dbl>
##  1 a            6     27   189217  257487   3.70e-5  1.09e-4
##  2 aa           1      2   189217  257487   1.06e-5  1.17e-5
##  3 aaa         11      1   189217  257487   6.34e-5  7.77e-6
##  4 aamp         1      0   189217  257487   1.06e-5  3.88e-6
##  5 aand         0      1   189217  257487   5.28e-6  7.77e-6
##  6 aaron        2      1   189217  257487   1.59e-5  7.77e-6
##  7 ab           1      2   189217  257487   1.06e-5  1.17e-5
##  8 abaco        0      1   189217  257487   5.28e-6  7.77e-6
##  9 aband…       6      8   189217  257487   3.70e-5  3.50e-5
## 10 aband…      13     11   189217  257487   7.40e-5  4.66e-5
## # ℹ 45,211 more rows
## # ℹ 1 more variable: odds <dbl>
```

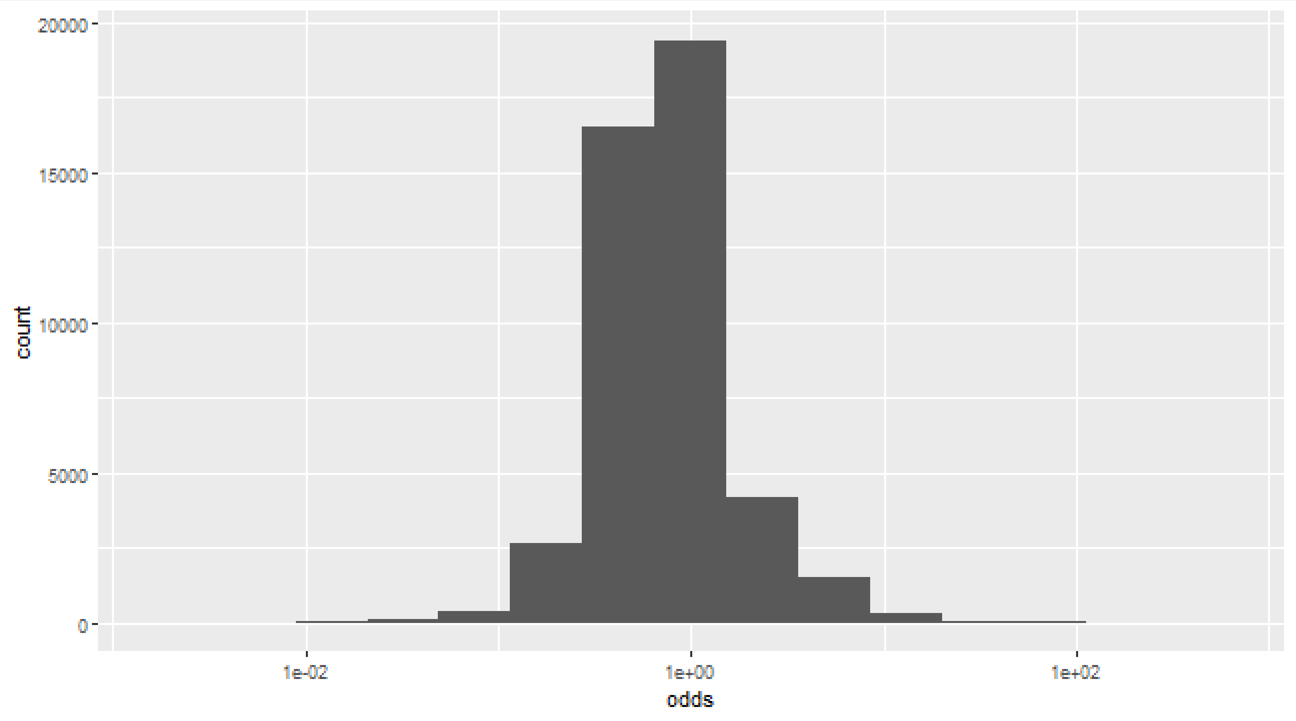
Why log?

```
odds3 %>%
  ggplot(aes(x = odds)) +
  geom_histogram()
```



Why log?

```
odds3 %>%
  ggplot(aes(x = odds)) +
  geom_histogram(bins = 15) +
  scale_x_log10()
```



Odds Step 4

```
(prepost_logodds <- odds3 %>%
  mutate(logodds = log(odds)))
```

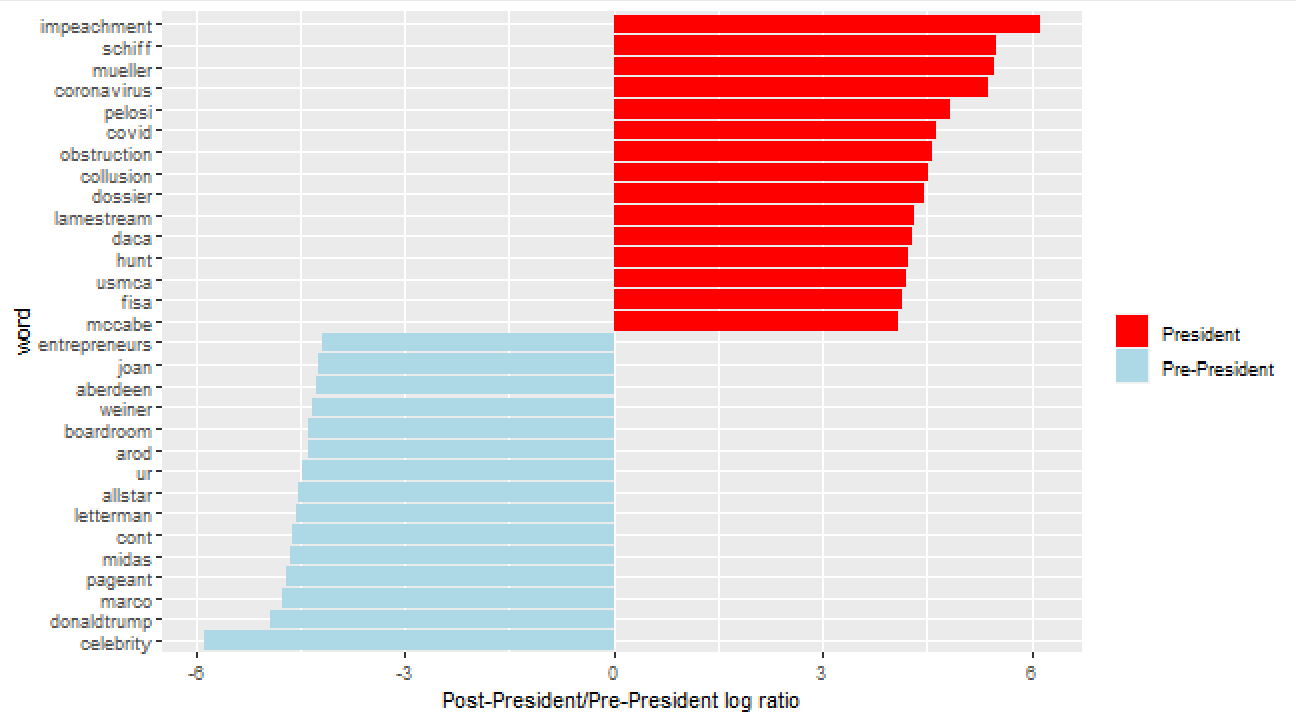
```
## # A tibble: 45,221 × 9
##    word   `FALSE` `TRUE` totFALSE totTRUE propFALSE propTRUE
##    <chr>    <dbl>  <dbl>    <dbl>   <dbl>     <dbl>    <dbl>
##  1 a            6     27   189217  257487   3.70e-5  1.09e-4
##  2 aa           1      2   189217  257487   1.06e-5  1.17e-5
##  3 aaa         11      1   189217  257487   6.34e-5  7.77e-6
##  4 aamp         1      0   189217  257487   1.06e-5  3.88e-6
##  5 aand         0      1   189217  257487   5.28e-6  7.77e-6
##  6 aaron        2      1   189217  257487   1.59e-5  7.77e-6
##  7 ab           1      2   189217  257487   1.06e-5  1.17e-5
##  8 abaco        0      1   189217  257487   5.28e-6  7.77e-6
##  9 aband…       6      8   189217  257487   3.70e-5  3.50e-5
## 10 aband…      13     11   189217  257487   7.40e-5  4.66e-5
## # ℹ 45,211 more rows
## # ℹ 2 more variables: odds <dbl>, logodds <dbl>
```

Effect of becoming president

```
p <- prepost_logodds %>%
  group_by(logodds > 0) %>%
  top_n(15, abs(logodds)) %>%
  ungroup() %>%
  mutate(word = reorder(word, logodds)) %>%
  ggplot(aes(word, logodds, fill = logodds < 0)) +
  geom_bar(stat = "identity") +
  coord_flip() +
  ylab("Post-President/Pre-President log ratio") +
  scale_fill_manual(name = "", labels = c("President", "Pre-
President"),
                    values = c("red", "lightblue"))
```

Effect of becoming president

```
p
```



Meaning

- Thus far, everything is **topic**-related
    - How often he talks about things
- But what does he **mean** when he talks about Mueller?
    - We can probably guess
- But we want a more systematic method
    - **Sentiment**: the *feeling* behind words

Meaning

- **Sentiment** analysis is based on **dictionaries**
  - Just like **stop words** from last week!
  - Prepared lists of words, but tagged according to **emotion**
- Good dictionary included in `tidytext` package

```
require(tidytext)
```

```
## Loading required package: tidytext
```

```
nrc <- get_sentiments("nrc")
# If this doesn't work on your computer, just load it with read_rds()
nrc <-
read_rds('https://github.com/jbisbee1/DS1000_F2023/blob/main/Lectures/8
raw=true')
```

Meaning

```
nrc
```

```
## # A tibble: 13,901 × 2
##    word        sentiment
##    <chr>       <chr>
##  1 abacus      trust
##  2 abandon     fear
##  3 abandon     negative
##  4 abandon     sadness
##  5 abandoned   anger
##  6 abandoned   fear
##  7 abandoned   negative
##  8 abandoned   sadness
##  9 abandonment anger
## 10 abandonment fear
## # ℹ 13,891 more rows
```

Sentiment by Pre/Post Presidency

- Measure sentiment by proportion of words
- Divide by pre/post presidency

```
word_freq <- tweet_words %>%
  group_by(PostPresident) %>%
  count(word) %>%
  filter(sum(n) >= 5) %>%
   mutate(prop = prop.table(n)) # Faster way of calculating
proportions!
```

Sentiment by Pre/Post Presidency

- Attaching sentiment from `nrc`
  - `inner_join()`: only keeps words that appear in `nrc`

```
word_freq_sentiment <- word_freq %>%
    inner_join(nrc, by = "word")
```

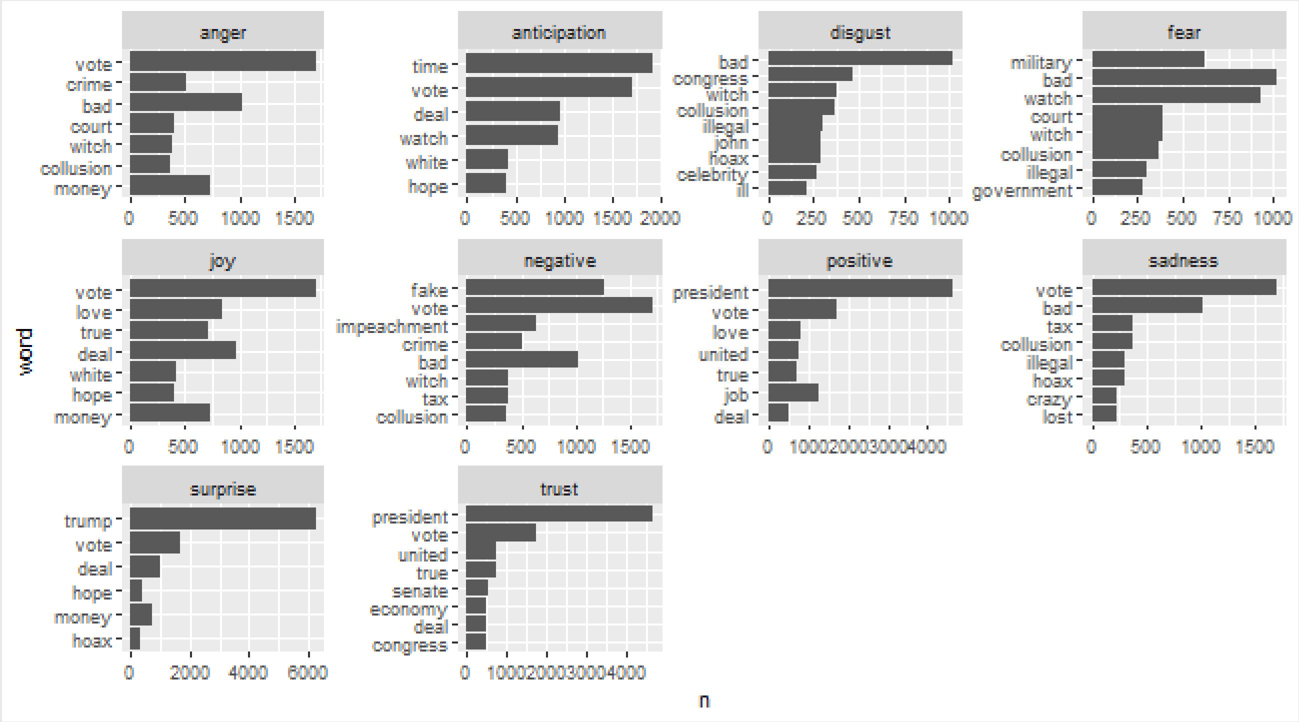
```
## Warning in inner_join(., nrc, by = "word"): Detected an unexpected
many-to-many relationship between
## `x` and `y`.
## ℹ Row 7 of `x` matches multiple rows in `y`.
## ℹ Row 2 of `y` matches multiple rows in `x`.
## ℹ If a many-to-many relationship is expected, set
##   `relationship = "many-to-many"` to silence this warning.
```

Sentiment overall

```
p <- word_freq_sentiment %>%
  group_by(sentiment) %>%
  top_n(10, n) %>%
  ungroup() %>%
  mutate(word = reorder(word, n)) %>%
  ggplot(aes(y = word, x = n)) +
  facet_wrap(~ sentiment, scales = "free", nrow = 3) +
  geom_bar(stat = "identity")
```

Sentiment Overall

```
p
```



Sentiment overall

- Could also just calculate positive sentiments - negative sentiments
    - Want to do this at the tweet level

```
tweet_sentiment <- tweet_words %>%
    inner_join(nrc, by = "word")
```

```
## Warning in inner_join(., nrc, by = "word"): Detected an unexpected
many-to-many relationship between
## `x` and `y`.
## ℹ Row 2 of `x` matches multiple rows in `y`.
## ℹ Row 12751 of `y` matches multiple rows in `x`.
## ℹ If a many-to-many relationship is expected, set
##   `relationship = "many-to-many"` to silence this warning.
```

```
tweet_sentiment_summary <- tweet_sentiment %>%
  group_by(PostPresident, sentiment) %>%
  count(document,sentiment) %>%
  pivot_wider(names_from = sentiment,
              values_from = n,
              values_fill = 0) %>% # same as spread()!
```

Sentiment overall

```
tweet_sentiment_summary
```

```
## # A tibble: 45,592 × 13
## # Groups:   PostPresident [2]
##    PostPresident   document anger anticipation disgust  fear
##    <lgl>              <dbl> <int>        <int>   <int> <int>
##  1 FALSE         1701461182     1            3       1     0
##  2 FALSE         1741160716     1            1       1     0
##  3 FALSE         1924074459     1            1       0     0
##  4 FALSE         2045871770     1            0       0     0
##  5 FALSE         2317112756     1            0       0     1
##  6 FALSE         2346367430     2            1       1     2
##  7 FALSE         2403435685     1            2       1     2
##  8 FALSE         3688564134     1            0       1     1
##  9 FALSE         7677152231     1            1       1     0
## 10 FALSE         8083871612     1            1       1     0
## # ℹ 45,582 more rows
## # ℹ 7 more variables: joy <int>, negative <int>,
## #   positive <int>, sadness <int>, surprise <int>,
## #   trust <int>, sentiment <int>
```

Sentiment by presidency

- Calculate total number of tweets by sentiment

```r
tweet_sentiment_summary  %>%
  group_by(PostPresident) %>%
  mutate(ntweet = 1) %>%
  summarize(across(-document, sum))
```

```
## # A tibble: 2 × 13
##   PostPresident anger anticipation disgust  fear   joy
##   <lgl>         <int>        <int>   <int> <int> <int>
## 1 FALSE          8138        13333    5356  7999 12440
## 2 TRUE          13892        14095    8933 14051 10973
## # ℹ 7 more variables: negative <int>, positive <int>,
## #   sadness <int>, surprise <int>, trust <int>,
## #   sentiment <int>, ntweet <dbl>
```

Sentiment by presidency

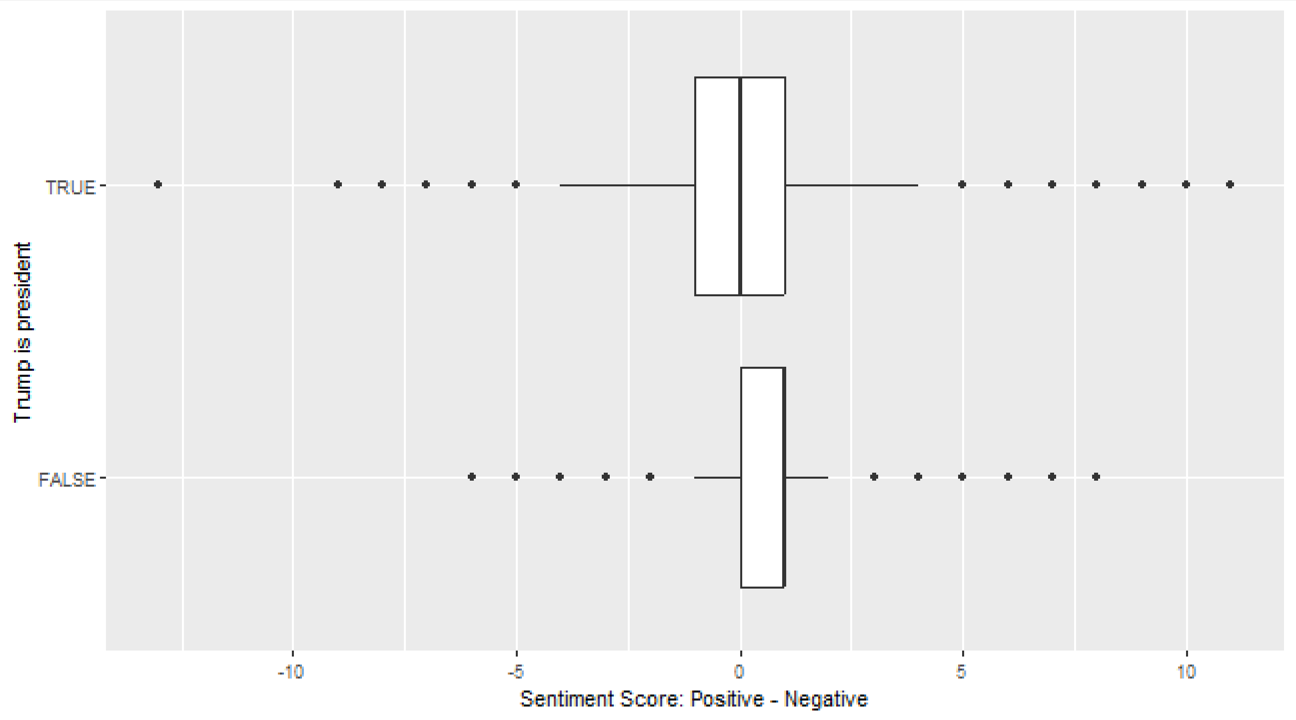
- Univariate distributions!

```
p <- tweet_sentiment_summary %>%
  ggplot(aes(x = sentiment, y = PostPresident)) +
  geom_boxplot() +
  labs(y= "Trump is president", x = "Sentiment Score: Positive -
Negative")
```

Sentiment by presidency

- Univariate distributions!

```
p
```



Sentiment by hour

- Univariate distributions
    - Comparing sentiment by hour

```
p <- tweet_sentiment %>%
  group_by(PostPresident,Tweeting.hour,sentiment) %>%
  count(document,sentiment) %>%
  pivot_wider(names_from = sentiment, values_from = n, values_fill =
0) %>%
  mutate(sentiment = positive - negative) %>%
  summarize(AvgSentiment = mean(sentiment)) %>%
  ggplot(aes(y = AvgSentiment, x= Tweeting.hour,
color=PostPresident)) +
  geom_point(size = 4) +
  geom_hline(yintercept = 0,linetype = 'dashed') +
  labs(x = "Tweeting Hour (EST)", y = "Average Tweet Sentiment:
Positive - Negative", color = "Is President?")
```

Sentiment by hour

- Comparing sentiment by hour

```
p
```

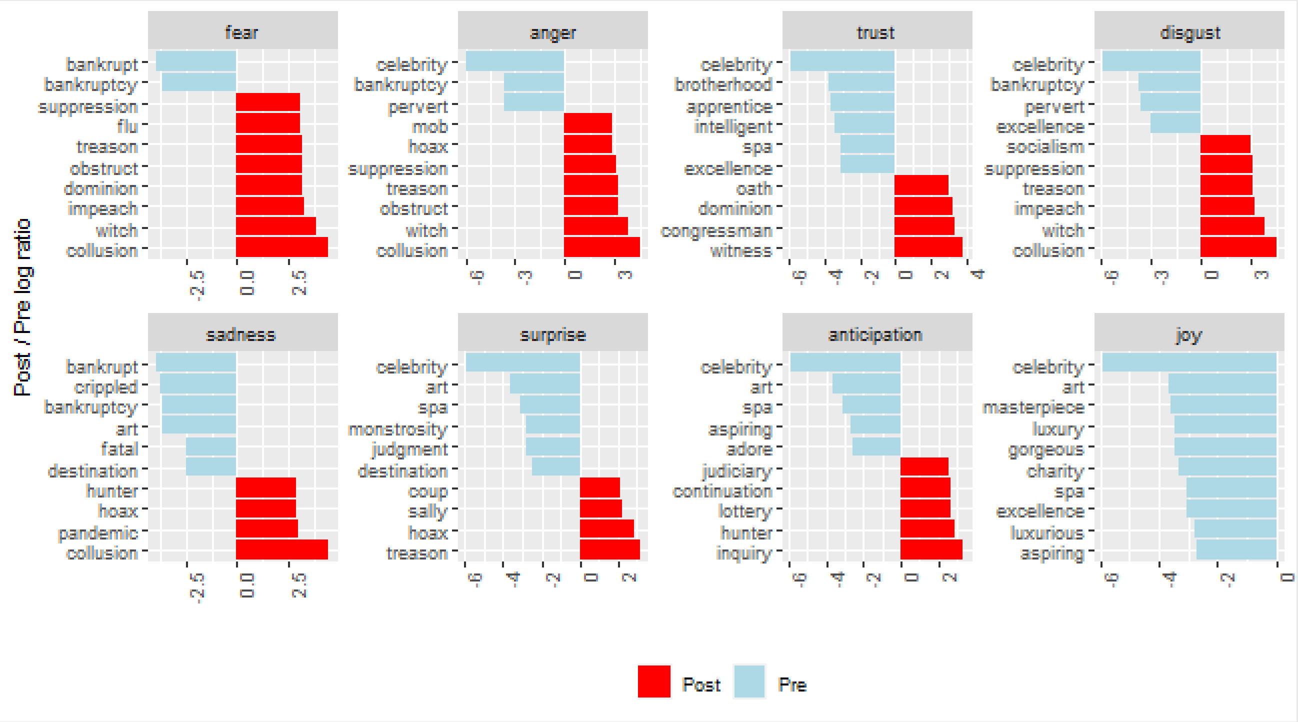
Understanding Trump

- When Trump is coded as "positive" or "negative", what is he saying?
- Look at log-odds ratio words, matched to sentiment!

```
p <- prepost_logodds %>%
  inner_join(nrc, by = "word") %>%
  filter(!sentiment %in% c("positive", "negative")) %>%
  mutate(sentiment = reorder(sentiment, -logodds),
         word = reorder(word, -logodds)) %>%
  group_by(sentiment) %>%
  top_n(10, abs(logodds)) %>%
  ungroup() %>%
  ggplot(aes(y = word, x = logodds, fill = logodds < 0)) +
  facet_wrap(~ sentiment, scales = "free", nrow = 2) +
  geom_bar(stat = "identity") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
  labs(x = "", y = "Post / Pre log ratio") +
  scale_fill_manual(name = "", labels = c("Post", "Pre"),
                    values = c("red", "lightblue")) +
  theme(legend.position = 'bottom')
```

Understanding Trump

p



Text as predictors

- Let's say we didn't know when each tweet was written
- Could we predict whether it was written during his presidency or not?
    - Logit model using **text** as predictors

Text as Data

- Predict tweets by average of words' log-odds!

```
toanal <- tweet_words %>%
  select(document,word,PostPresident) %>%
  left_join(prepost_logodds %>% select(word,logodds)) %>% # Link data with log-odds
  group_by(document,PostPresident) %>%
  summarise(logodds = mean(logodds)) %>% # Calculate average log-odds by document
  ungroup()

m <- glm(PostPresident ~ logodds,toanal,family = binomial) # logit regression
```

Text as Data

- Evaluate the performance

```
require(tidymodels)
```

```
## Warning: package 'broom' was built under R version 4.2.3
```

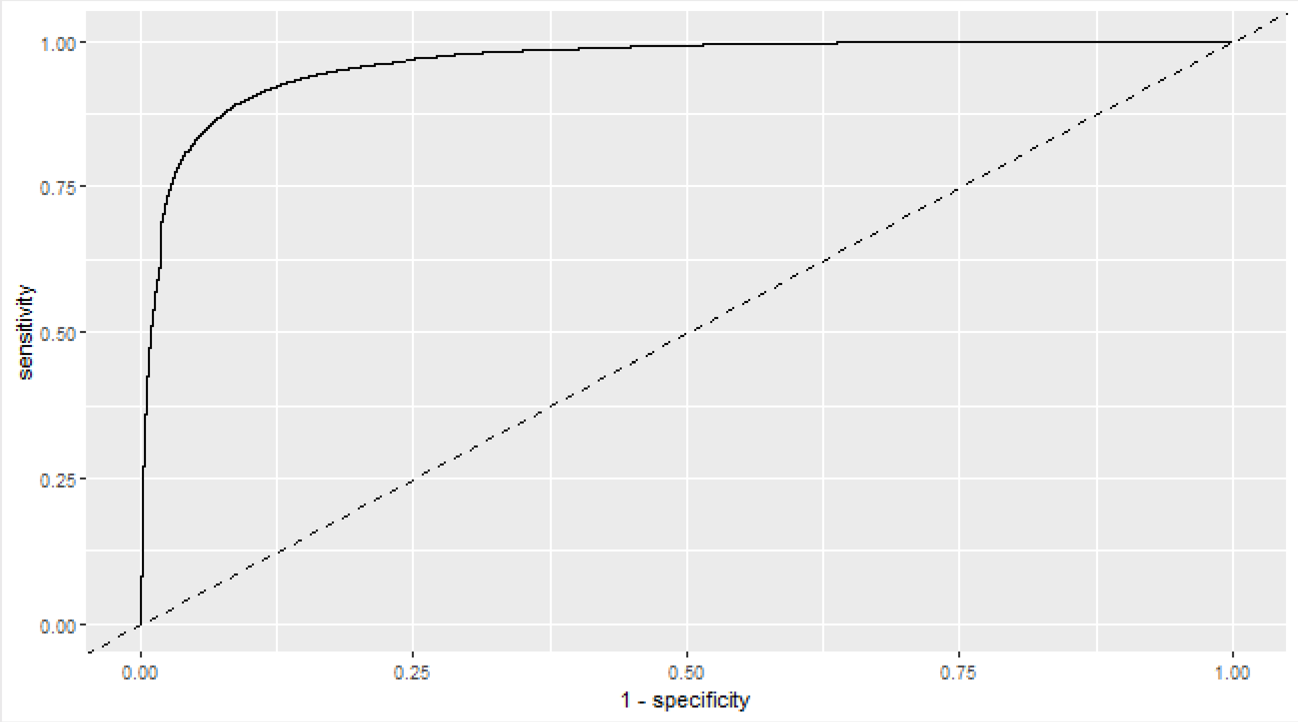
```
forAUC <- toanal %>% # Evaluate model performance
  mutate(preds = predict(m,type = 'response'),
         truth = factor(PostPresident,levels = c('TRUE','FALSE')))

roc_auc(forAUC,'truth','preds')
```

```
## # A tibble: 1 × 3
##   .metric .estimator .estimate
##   <chr>   <chr>          <dbl>
## 1 roc_auc binary         0.962
```

```
p <- roc_curve(forAUC,'truth','preds') %>%
  ggplot(aes(x = 1-specificity,y = sensitivity)) +
  geom_line() +
  geom_abline(intercept = 0,slope = 1,linetype = 'dashed')
```

Evaluate performance

```
p
```



Evaluate on some sample tweets

```
raw_tweets <- read_rds('../data/Trumptweets.Rds')
set.seed(20)
toCheck <- raw_tweets %>% slice(sample(1:nrow(.),size = 10))

toCheck %>%
  select(content)
```

```
## # A tibble: 10 × 1
##    content
##    <chr>
##  1 "RT @ShannonBream: BREAKING:  POTUS commutes Roger Stone…
##  2 "Congratulations to a future STAR of the Republican Part…
##  3 "@Seanelmi  Thanks Sean."
##  4 "\"\"\"@007lLisav: @CNN @realDonaldTrump @CNNPolitics ca…
##  5 "RT @thejtlewis: @realDonaldTrump https://t.co/W7L9kCZK3…
##  6 "RT @TrumpWarRoom: WATCH: @KatrinaPierson explains Joe B…
##  7 "The State Department's 'shadow government' #DrainTheSwa…
##  8 "Sexual pervert Anthony Weiner has zero business holding…
##  9 "TO MY FAVORITE PEOPLE IN THE WORLD! https://t.co/38DbQt…
## 10 "Small businesses will have an ally in the White House w…
```

Evaluate on some sample tweets

```r
toTest <- toCheck %>% left_join(toanal,by = c('id' = 'document')) # Merge the raw text with the log-odds

toTest %>%
  mutate(preds = predict(m,newdata = toTest,type = 'response')) %>%
  select(content,PostPresident,preds) %>%
  mutate(pred_binary = preds > .5) %>%
  filter(PostPresident != pred_binary)
```

```
## # A tibble: 3 × 4
##   content                        PostPresident preds pred_binary
##   <chr>                          <lgl>         <dbl> <lgl>
## 1 @Seanelmi  Thanks Sean.        FALSE         0.985 TRUE
## 2 The State Department's 's…     FALSE         0.731 TRUE
## 3 TO MY FAVORITE PEOPLE IN …     TRUE          0.316 FALSE
```

```r
# We only make 1 mistake! And it is on a tough tweet
```

Can we do better if we add sentiment?

```
toanal <- toanal %>%
  left_join(tweet_sentiment_summary) %>%
  drop_na()
```

```
## Joining with `by = join_by(document, PostPresident)`
```

```
m1 <- glm(PostPresident ~ logodds,toanal,family = binomial)
m2 <- glm(PostPresident ~ logodds + sentiment,toanal,family =
binomial)
m3 <- glm(PostPresident ~ logodds + anger + anticipation + disgust +
fear + joy + sadness + surprise + trust,toanal,family = binomial)

forAUC <- toanal %>%
  mutate(preds1 = predict(m1,type = 'response'),
         preds2 = predict(m2,type = 'response'),
         preds3 = predict(m3,type = 'response'),
         truth = factor(PostPresident,levels = c('TRUE','FALSE')))
```

Can we do better if we add sentiment?

```
roc_auc(forAUC,'truth','preds1') %>% mutate(model = 'logodds') %>%
  bind_rows(roc_auc(forAUC,'truth','preds2') %>% mutate(model =
'logodds & net sentiment')) %>%
  bind_rows(roc_auc(forAUC,'truth','preds3') %>% mutate(model =
'logodds & detailed sentiment'))
```

```
## # A tibble: 3 × 4
##   .metric .estimator .estimate model
##   <chr>   <chr>          <dbl> <chr>
## 1 roc_auc binary         0.966 logodds
## 2 roc_auc binary         0.967 logodds & net sentiment
## 3 roc_auc binary         0.968 logodds & detailed sentiment
```

- Not really

Conclusion

- Sentiment can...
  - ...help us describe the data (i.e., infer what someone meant)
  - ...help us predict the data (RQ: do positive tweets get more likes?)