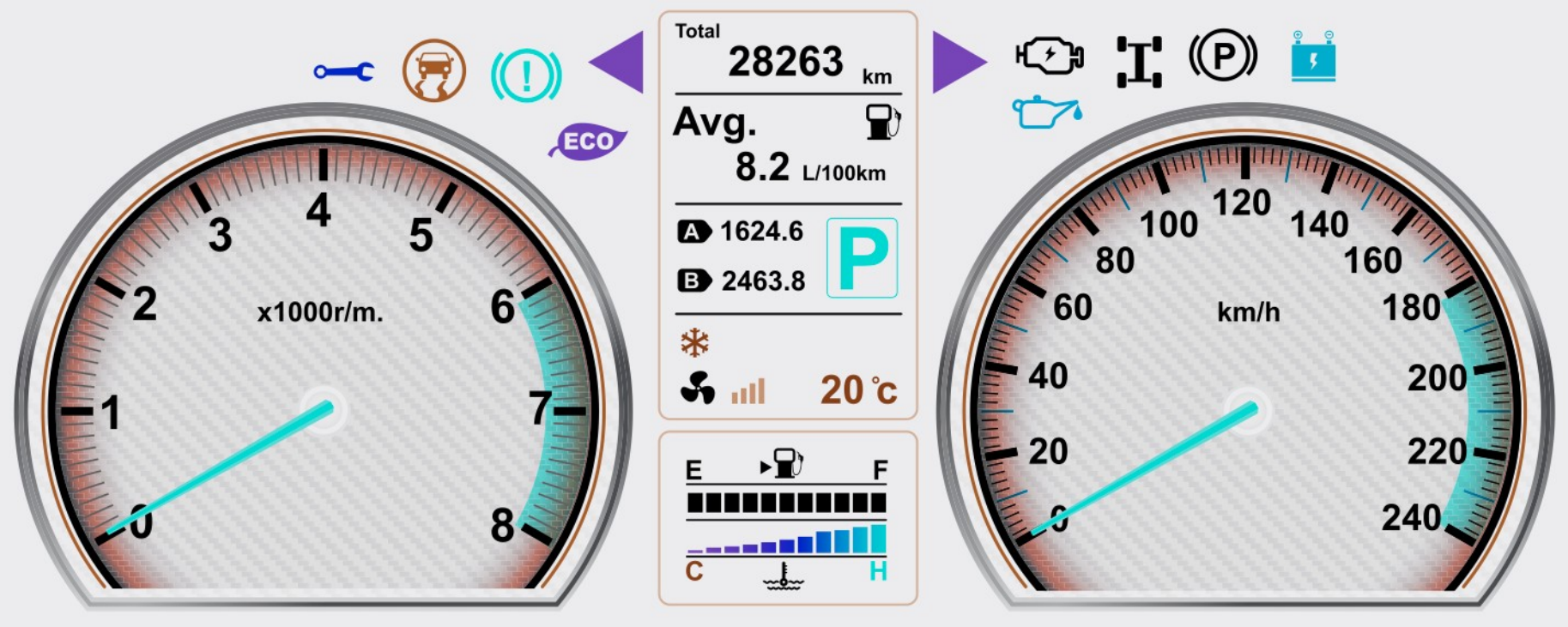
Data Analytics
CS301
Text Analysis:
Sentiment Determination

Week 14
Spring
Oliver BONHAM-CARTER

First, Some Interesting Dashboards



A dashboard provides many points of information

Vaccine Hesitancy by County

IHME | COVID Collaborative

Vaccine hesitancy by county

Sep 17, 2021 - Sep 23, 2021

This map highlights areas of the US that would benefit most from increased vaccination acceptance. This view shows, by county, the % of survey respondents who answered **"Yes, probably" or "No, probably not"** when asked *"If a vaccine to prevent COVID-19 were offered to you today, would you choose to get vaccinated?"*

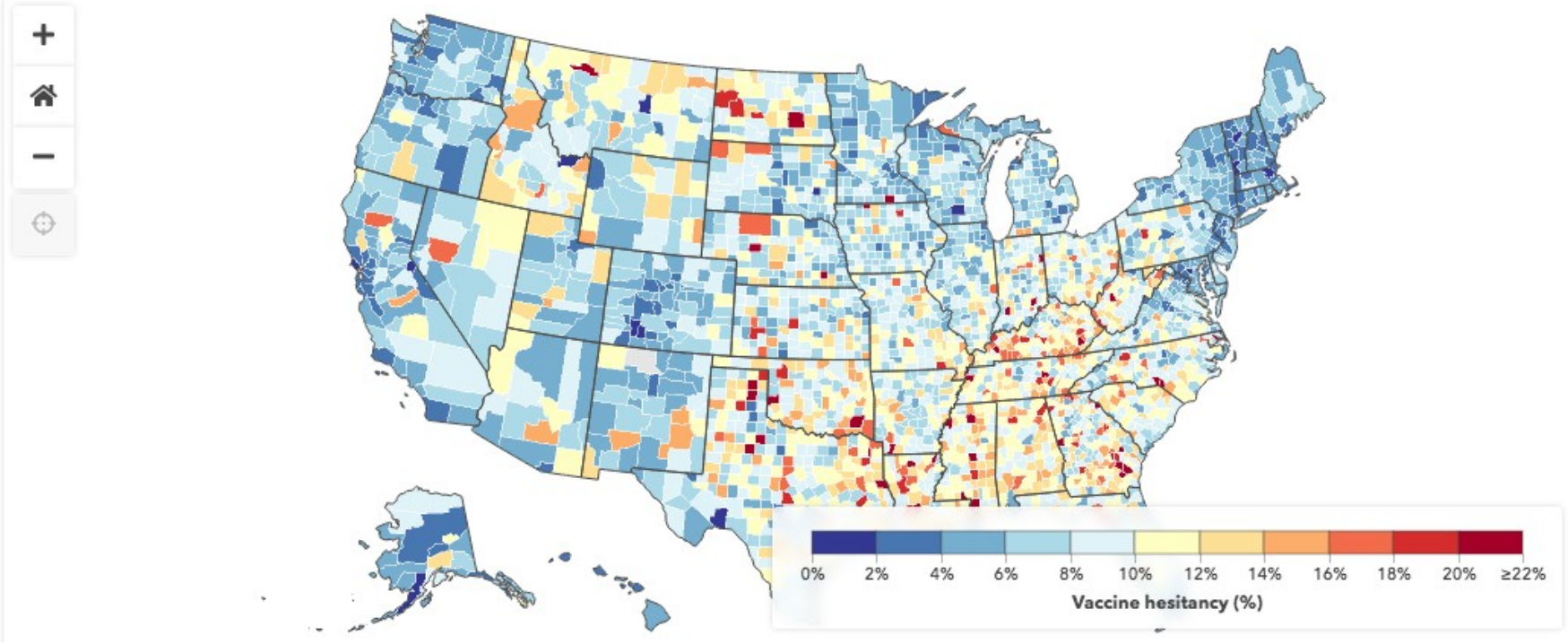
Data source: The Delphi Group at Carnegie Mellon University U.S. COVID-19 Trends and Impact Survey, in partnership with Facebook.

Detail: County | Zip code

Hesitancy: Somewhat | All

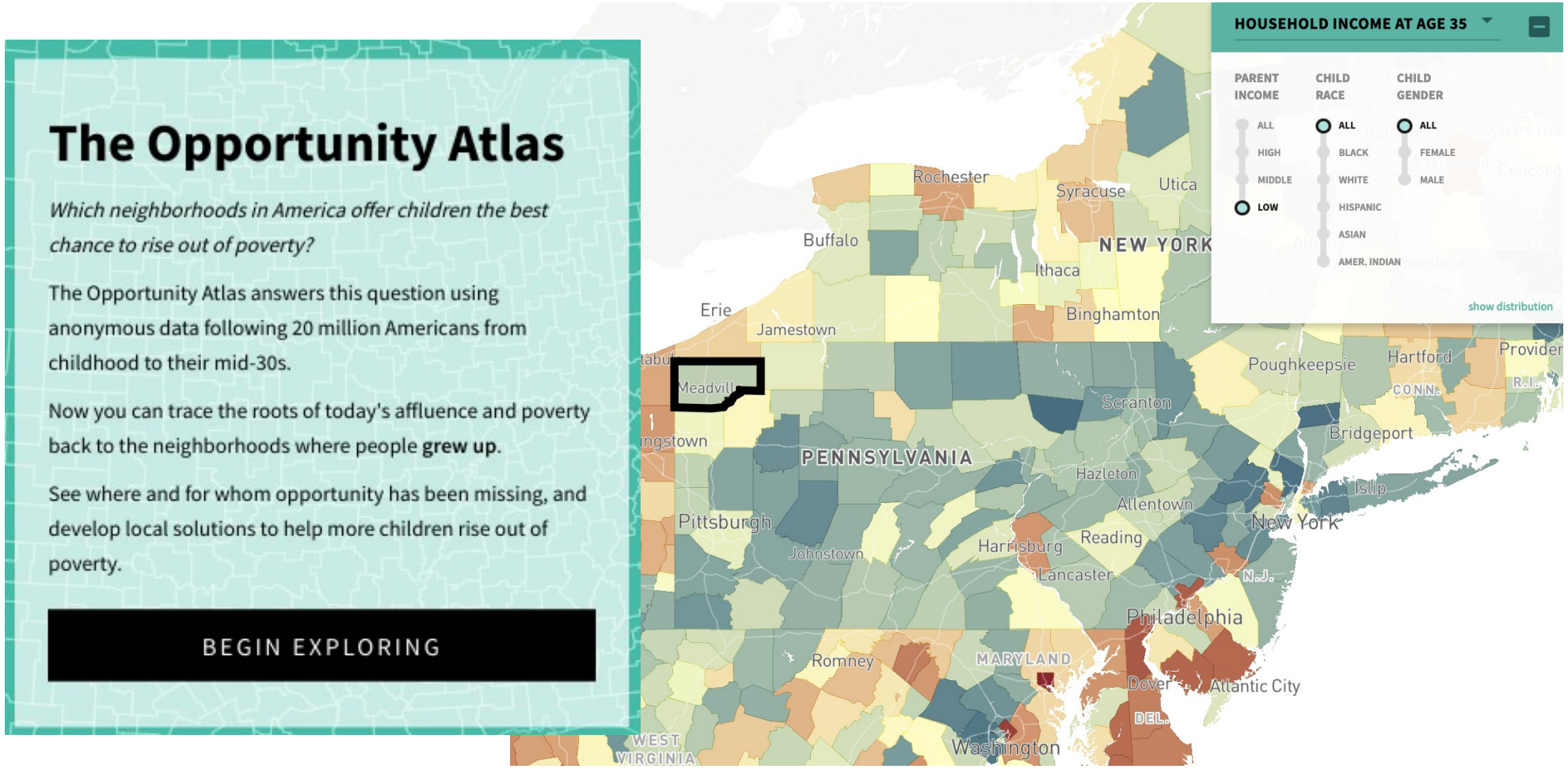
Show change

Highlight: Select county(ies) or click on map



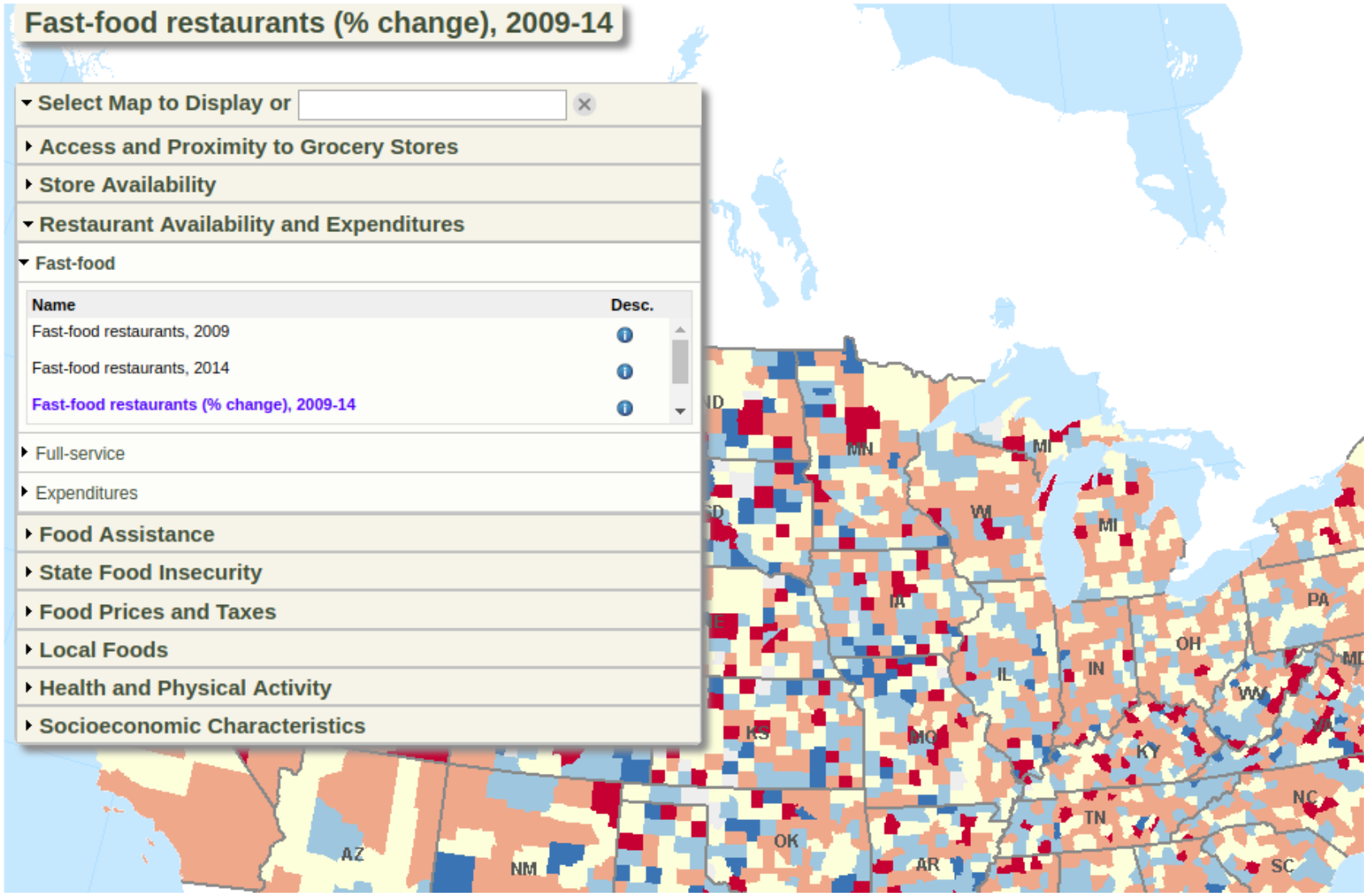
https://vaccine-hesitancy.healthdata.org/

The Opportunity Atlas



https://www.opportunityatlas.org/

The US Dept of Agriculture

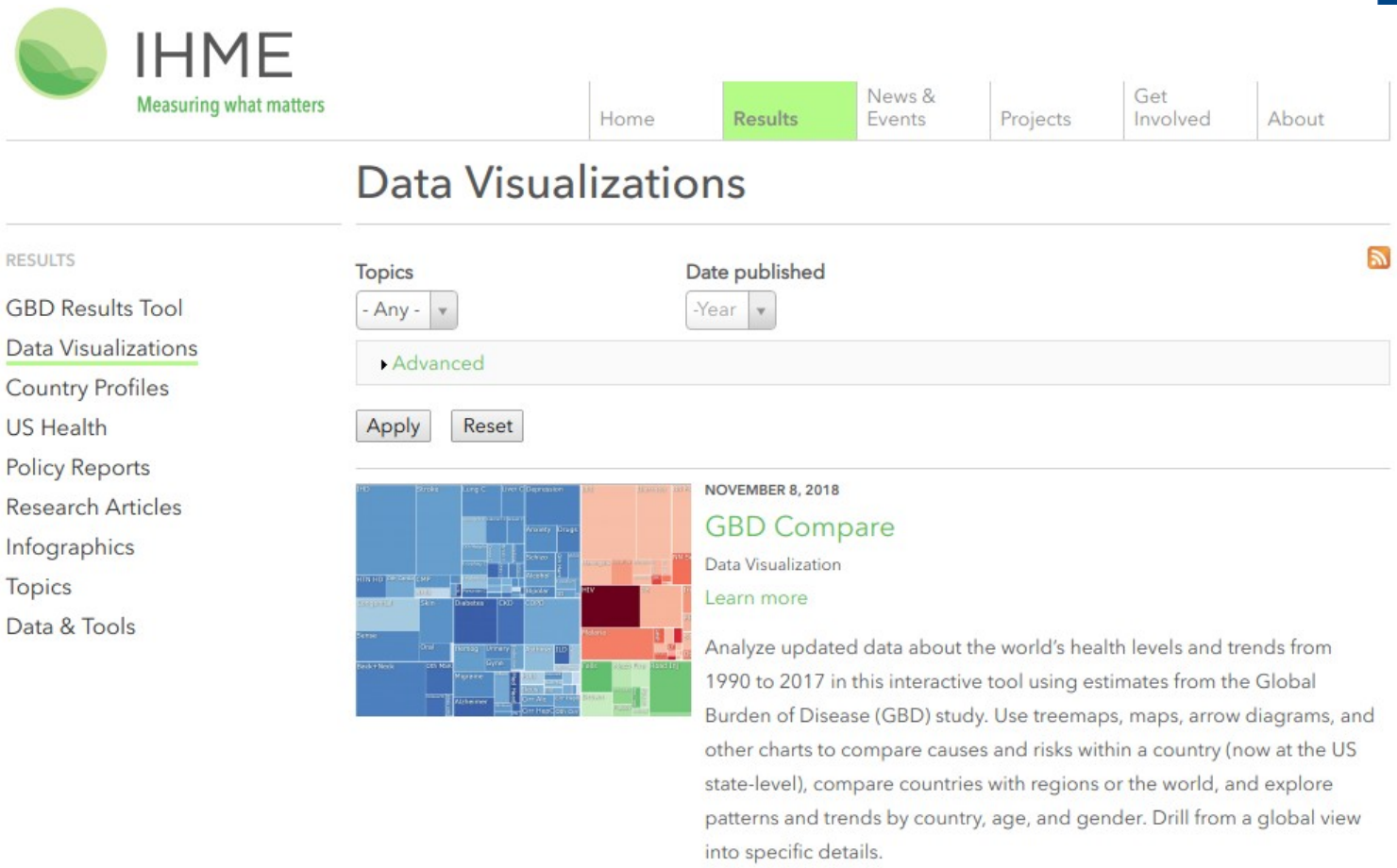


https://www.ers.usda.gov/data-products/food-environment-atlas/go-to-the-atlas/

Online Tool: The Institute for Health Metrics and Evaluation

- Health-Policies
  - http://www.healthdata.org/
- Visualization dashboard
  - https://vizhub.healthdata.org/epi/

Online Tool: The Institute for Health Metrics and Evaluation

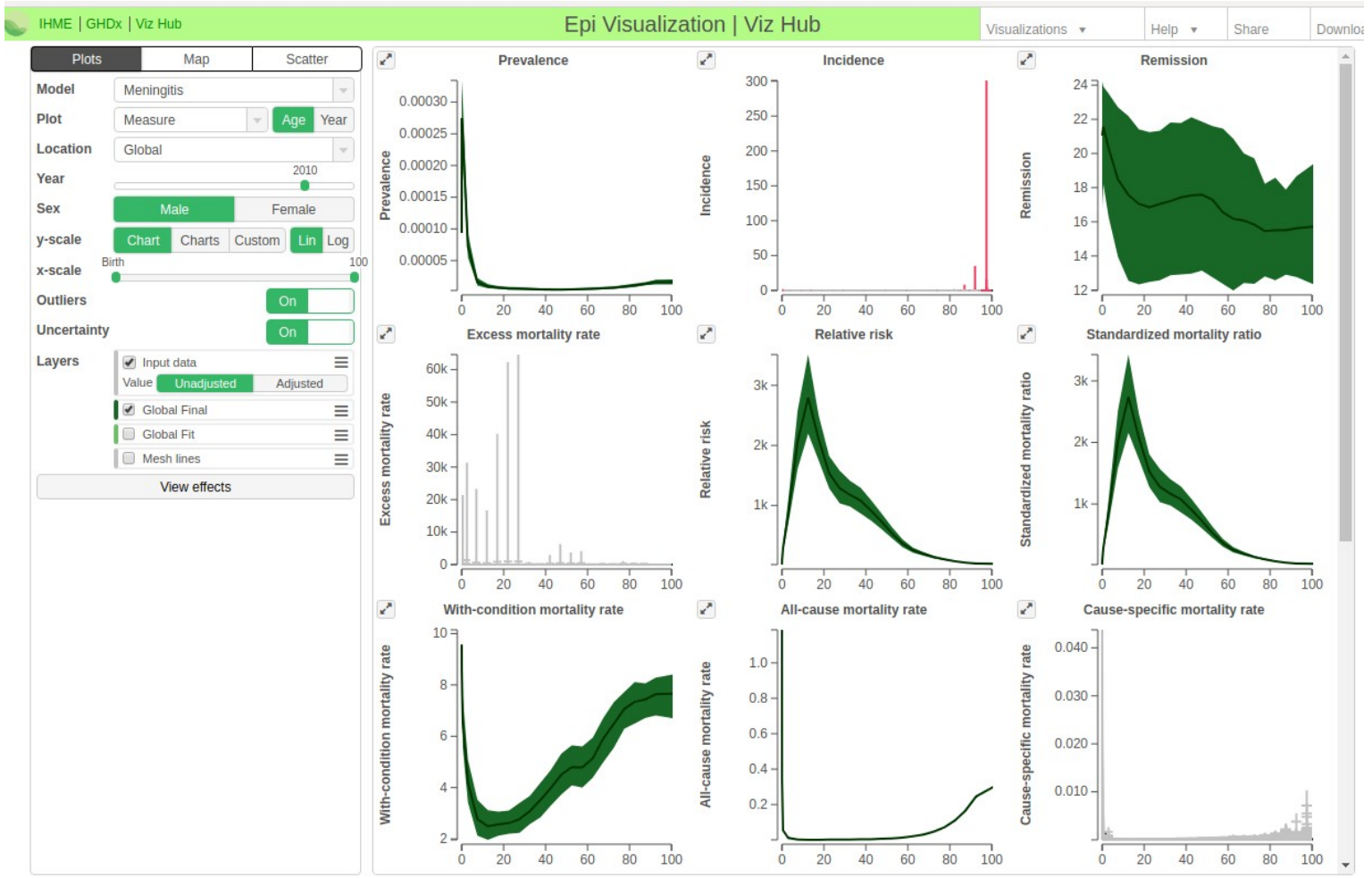


Visualize data on seemingly any topic of health

http://www.healthdata.org/

https://vizhub.healthdata.org/epi/

Online Tool: The Institute for Health Metrics and Evaluation

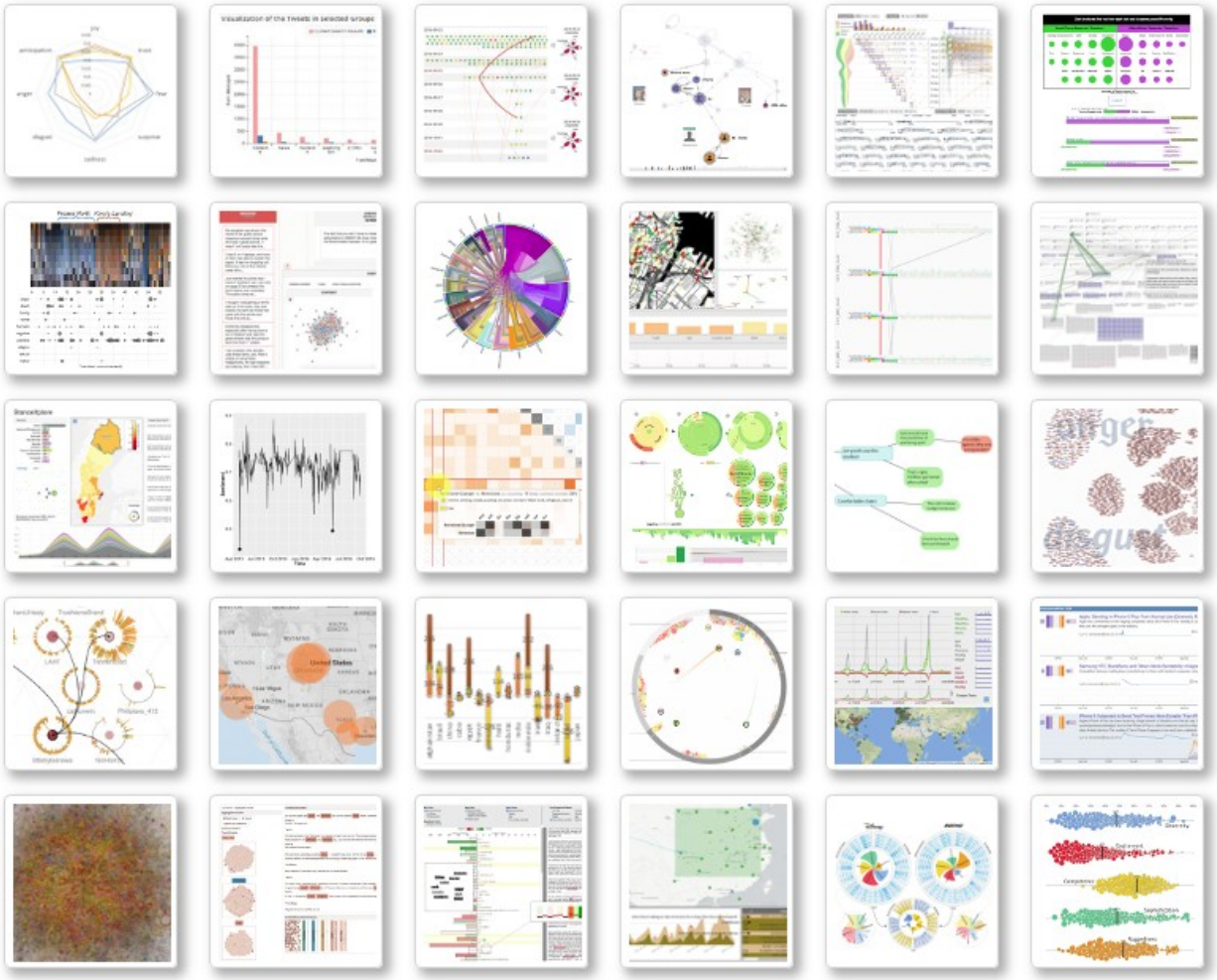


https://vizhub.healthdata.org/epi/

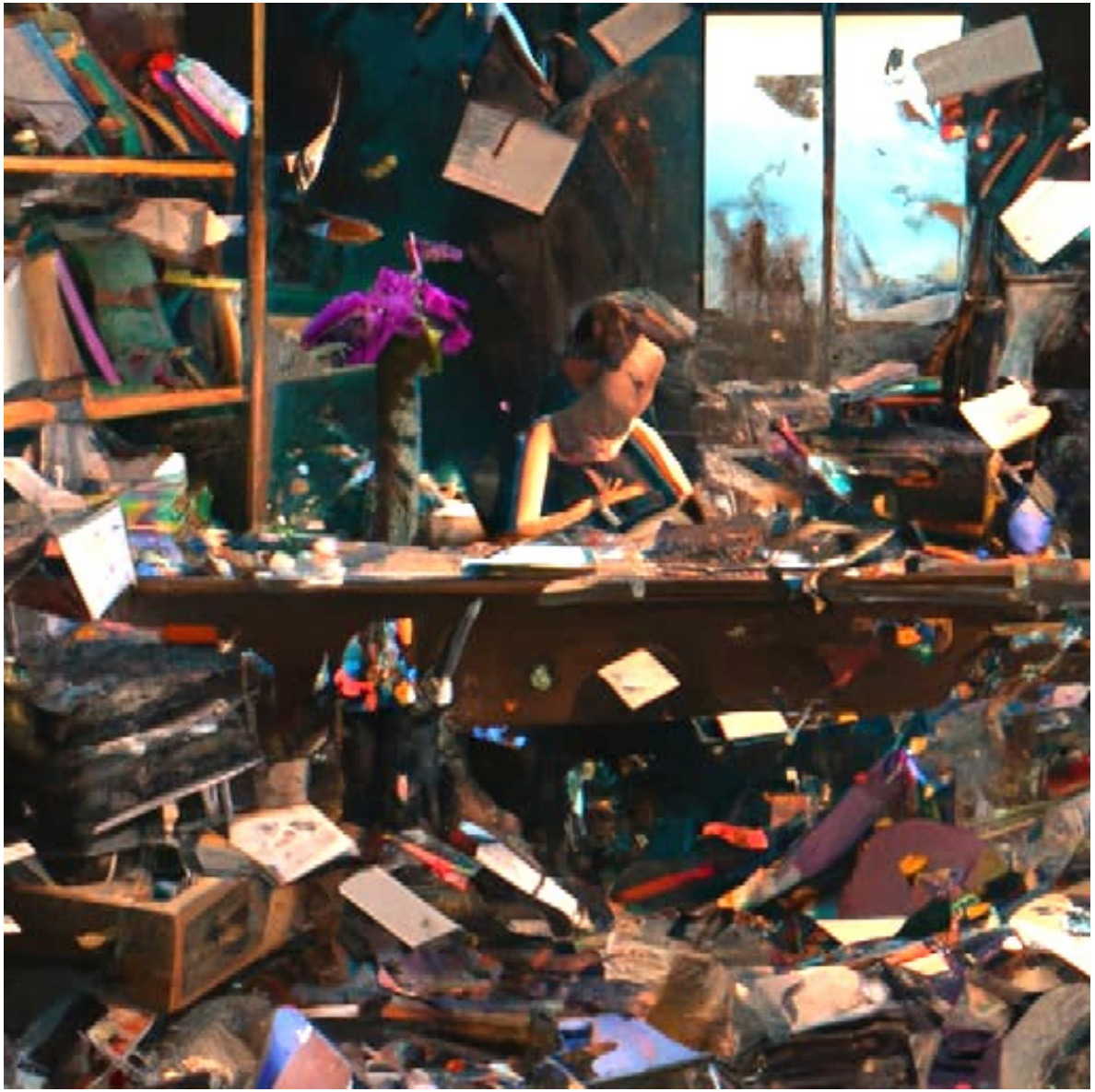
Visualizing Schemes are still being developed

- To find out about new work in visualizing analytics, check out the **SentimentVis Browser** at http://sentimentvis.lnu.se/

A Visual Survey of Sentiment Visualization Techniques: Have a look at all the different ways to determine sentiment in text!

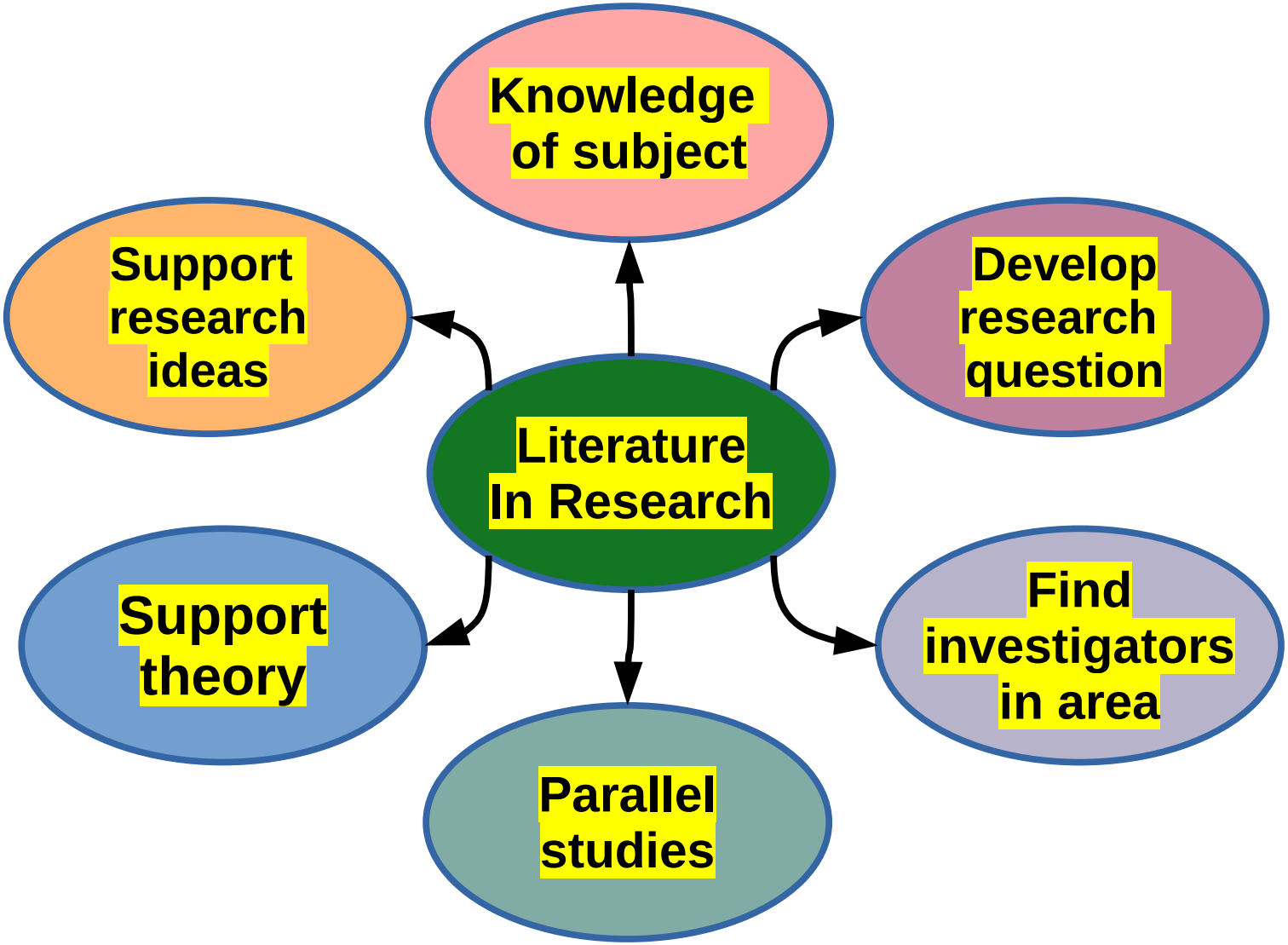


New Chapter: Text Analysis

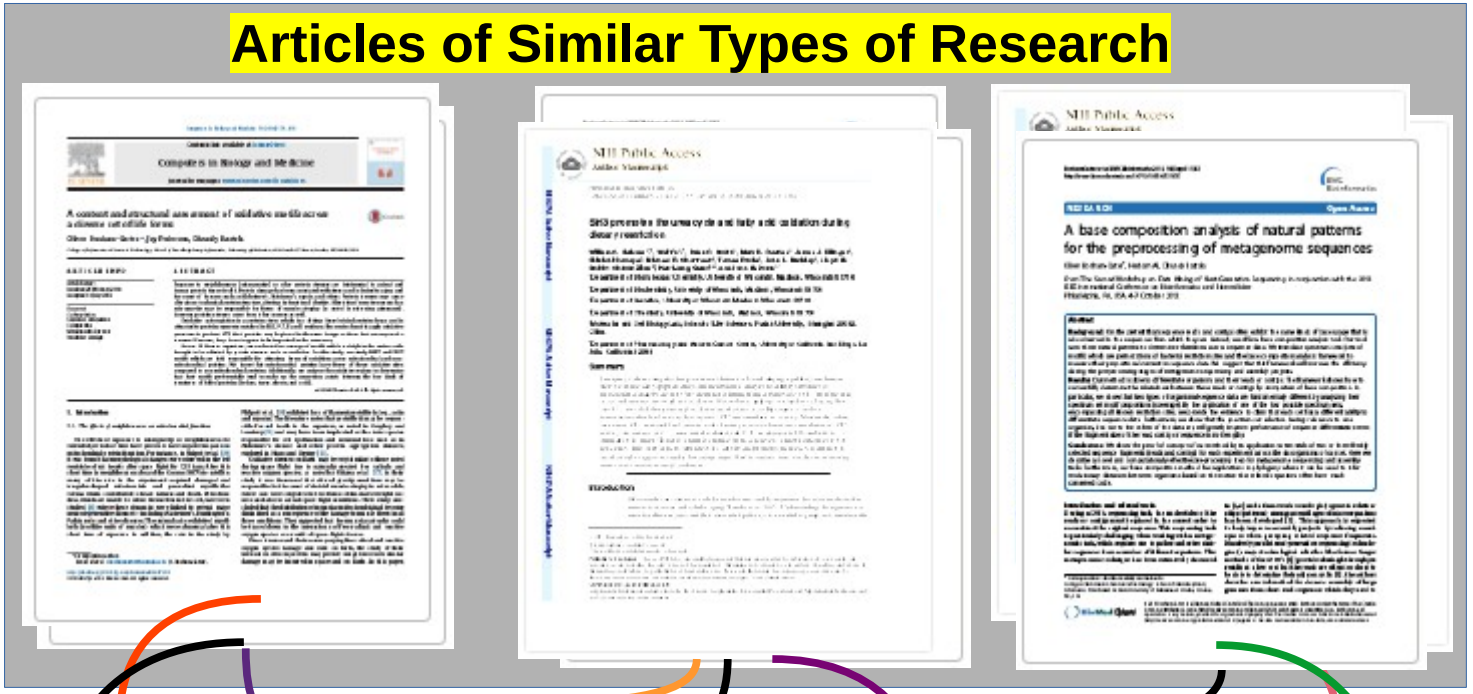


How to find meaningful information in large bodies of textual Data!?

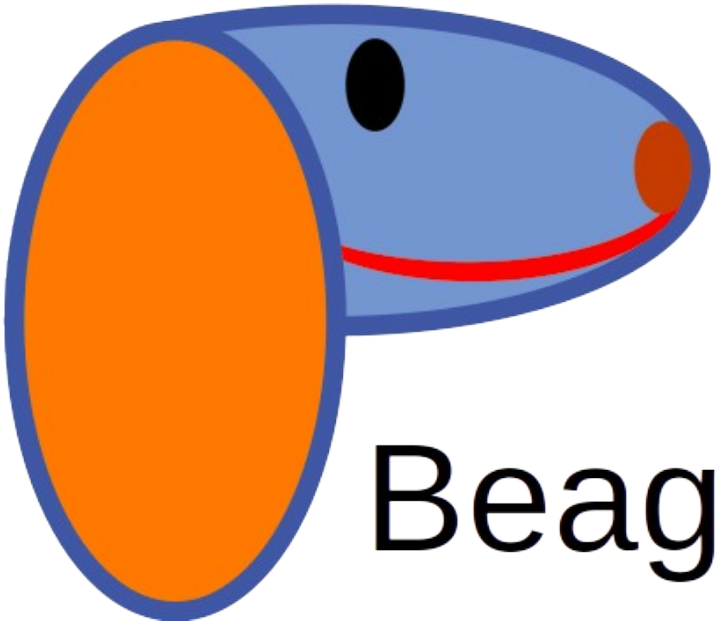
Wait, What's in the Literature?



Common Ideas, But Different Names!



Find Relationships in the Literature

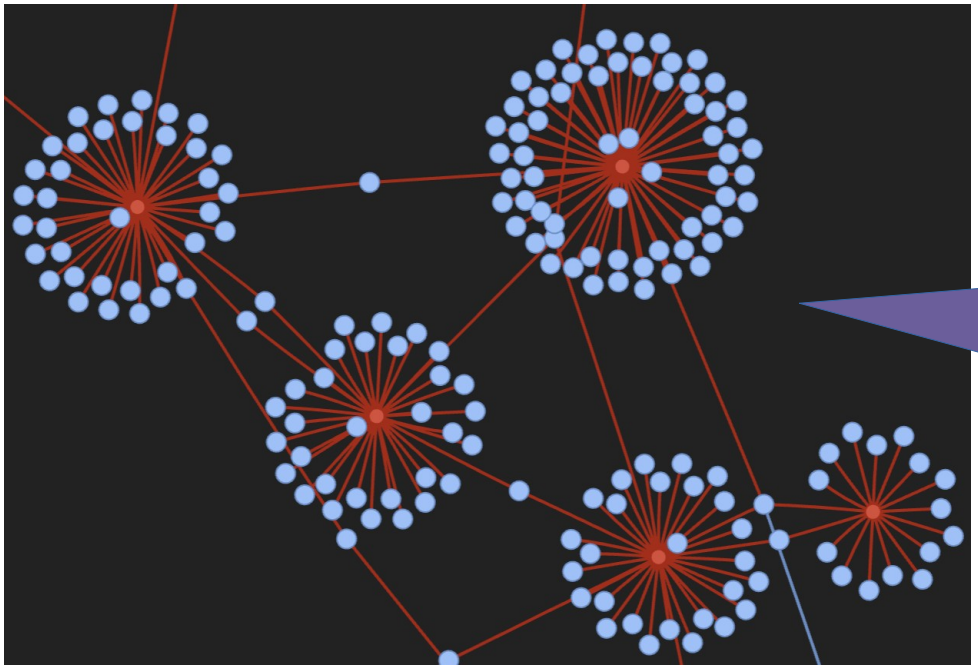


BeagleTM

A text mining tool for developing visual and interactive relationship networks from a corpus created from PubMed articles.

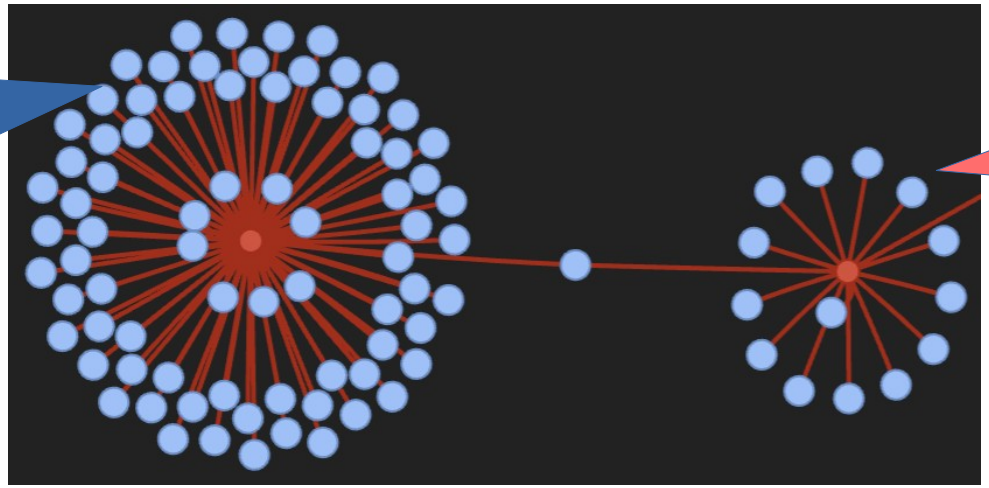
Yet even more information:
https://www.oliverbonhamcarter.com/portfolio/sample-project/index_beagletm/

Find Relationships in the Literature



Visualization of a literature review!

Blue nodes: Reference articles

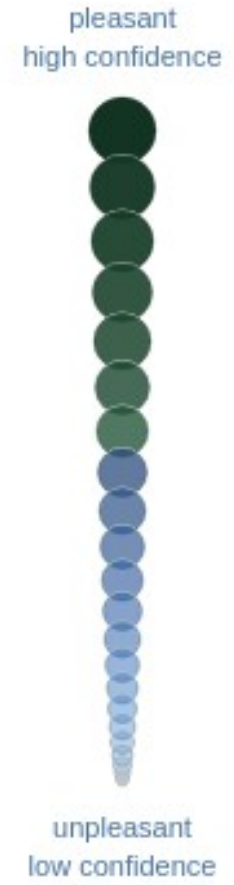


Red nodes: Central articles to literature review

Text Analysis: *Sentiment* of Content

- The determination of a text's "message" or "mood" based on the actual individual *words*.
- How good, how bad is the writer feeling about some topic?
- Is a body of text describing some idea where many of the words are emotionally charged with some type of feeling?
- Sentiment analysis is able to determine what the general feeling is behind some written work.

Tweet Text Analysis



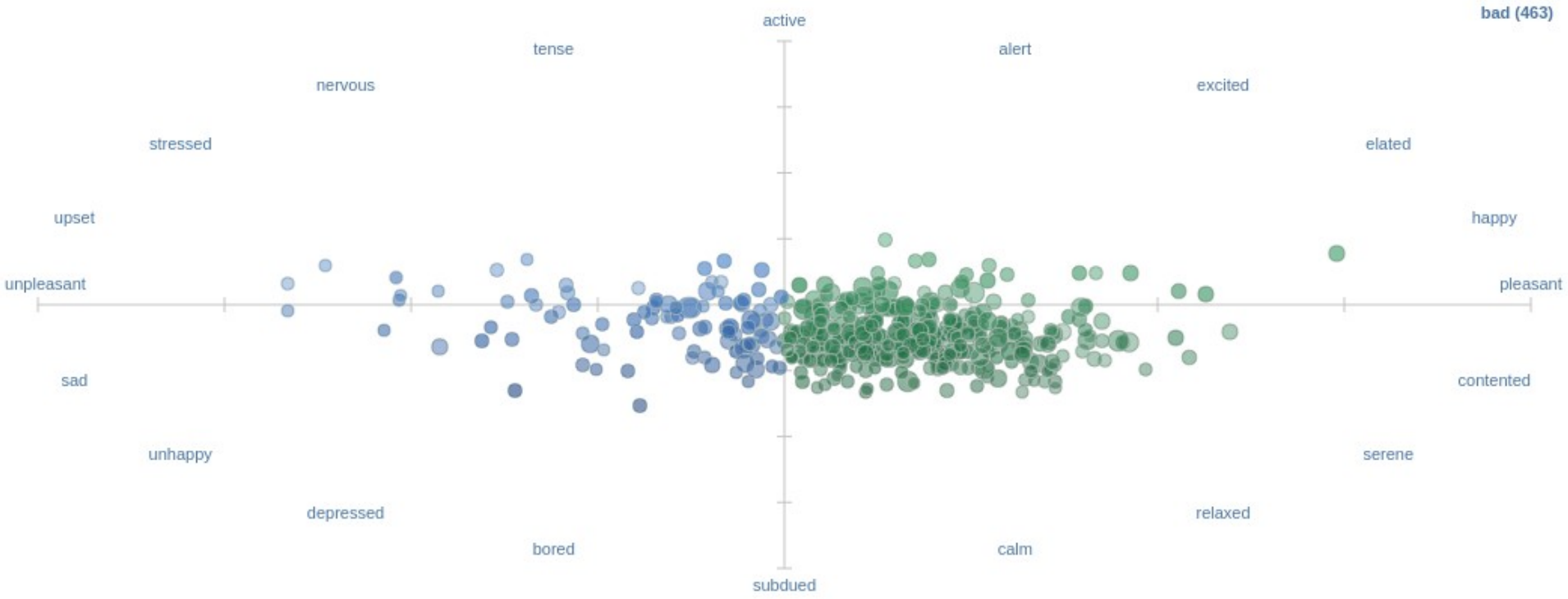
https://www.csc2.ncsu.edu/faculty/healey/tweet_viz/tweet_app/

What Is This Tool?

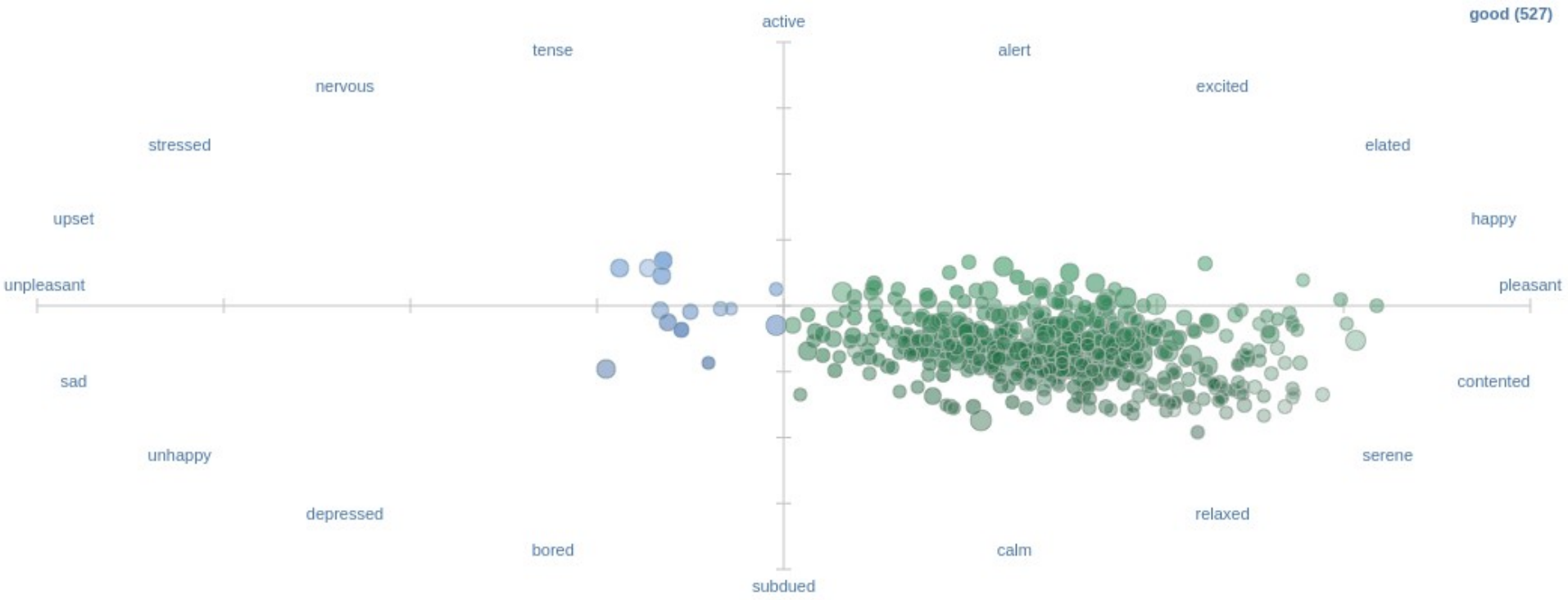
- User-entered keywords are parsed in the tweets of the day.
- The sentiment tab visualizes where tweets lie in an emotional scatter plot with pleasure and arousal on its horizontal and vertical axes.
- The spatial distribution of the tweets summarizes their overall sentiment.
- The number of queries per minute is limited...

https://www.csc2.ncsu.edu/faculty/healey/tweet_viz/tweet_app/

The word, “Bad”


bad (463)
active
tense
alert
nervous
excited
stressed
elated
upset
happy
unpleasant
pleasant
sad
contented
unhappy
serene
depressed
relaxed
bored
calm
subdued

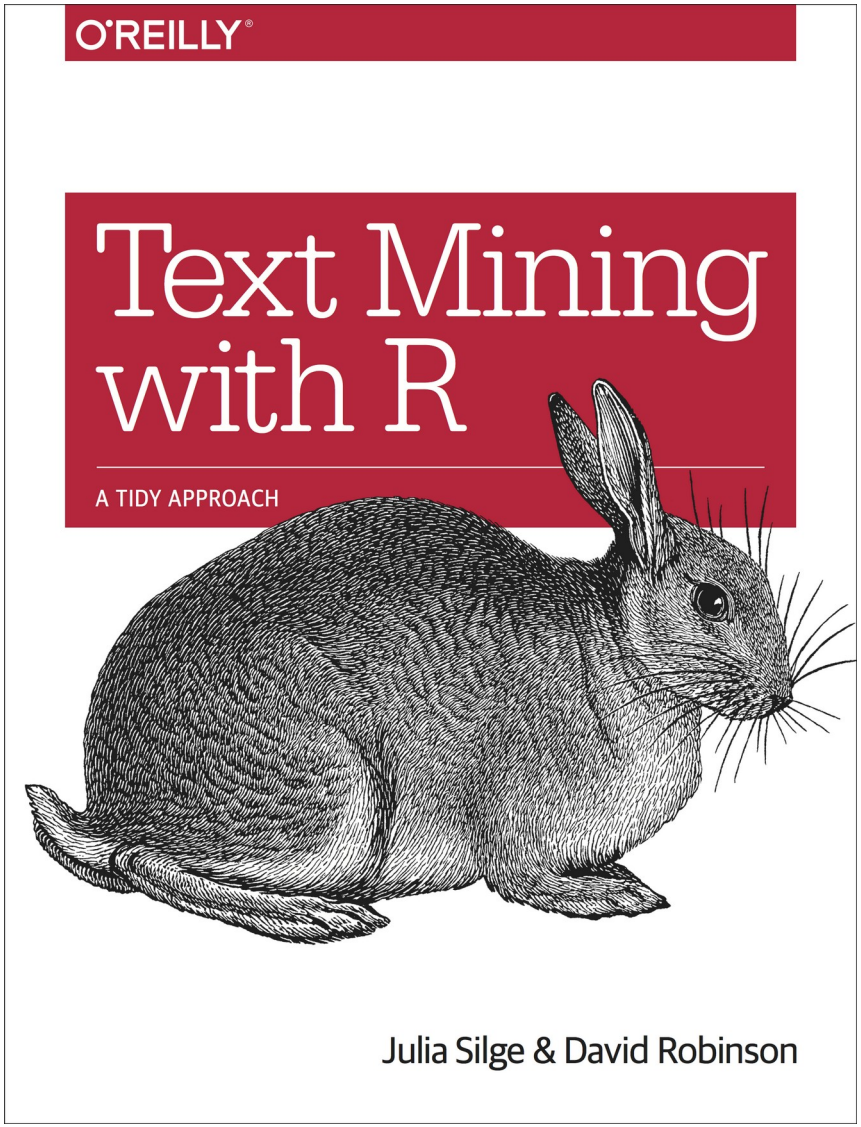
The word, “Good”



Click around on the web site to discover new ways of viewing data.

Analysis with R...

In The Textbook



This slide material below has been taken from Silge *et al*.

Chapter: 2
Sentiment analysis with tidy data

https://www.tidytextmining.com/sentiment.html

Packages and Libraries

```
# install.packages("janeaustenr")
# install.packages("stringr")
rm(list = ls())
library(janeaustenr)
library(dplyr)
library(stringr)
library(tidyverse)
```

All following code is provided in:
sandbox/textAnalysis.r

Data: Jane Austen's Text

- Jane Austen's 6 completed, published novels from the *janeaustenr* package.
  - Sense & Sensibility
  - Pride & Prejudice
  - Mansfield Park
  - Emma
  - Northanger Abbey
  - Persuasion

Research Question

- Jane Austen's written work:

  How many *Bad (pessimistic)* words did she use?

  How many *Good* (optimistic) words did she use?

The *Sentiments* dataset

```
#install.packages("tidytext")
library(tidytext)
sentiments
```

```
## # A tibble: 27,314 × 4
##           word sentiment lexicon score
##          <chr>     <chr>   <chr> <int>
## 1       abacus     trust     nrc    NA
## 2      abandon      fear     nrc    NA
## 3      abandon  negative     nrc    NA
## 4      abandon   sadness     nrc    NA
## 5    abandoned     anger     nrc    NA
## 6    abandoned      fear     nrc    NA
## 7    abandoned  negative     nrc    NA
```

Three general-purpose lexicons

- ***AFINN*** from Finn Årup Nielsen,
  - assigns words with a score that runs between -5 and 5, with negative scores indicating negative sentiment and positive scores indicating positive sentiment
- ***bing*** from Bing Liu and collaborators,
  - categorizes words in a binary fashion into positive and negative categories
- ***nrc*** from Saif Mohammad and Peter Turney
  - categorizes words in a binary fashion ("yes"/"no") into categories of positive, negative, anger, anticipation, disgust, fear, joy, sadness, surprise, and trust.

- Used to determine the general mood of words.
- Lexicons are based on unigrams, (i.e., single words).
- Words are assigned scores for positive/negative sentiment,
- Emotions: joy, anger, sadness and etc.

Sentiments: afinn

```
# install.packages("textdata")
get_sentiments("afinn")
```

You might need to install another package.

```
> get_sentiments("afinn")
# A tibble: 2,476 x 2
          word score
         <chr> <int>
 1     abandon    -2
 2   abandoned    -2
 3    abandons    -2
 4    abducted    -2
 5   abduction    -2
 6  abductions    -2
 7       abhor    -3
 8    abhorred    -3
 9   abhorrent    -3
10       abhors    -3
# ... with 2,466 more rows
```

Returns a score for each word [-5, 5] (Bad to Good)

Sentiments: nrc

```
# install.packages("textdata")
get_sentiments("nrc")
```

```
> get_sentiments("nrc")
# A tibble: 13,901 x 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
# ... with 13,891 more rows
```

You might need to install another package.

Returns a *synonym* for each word

Sentiments: bing

```
# install.packages("textdata")
get_sentiments("bing")
```

```
> get_sentiments("bing")
# A tibble: 6,788 x 2
           word sentiment
          <chr>     <chr>
 1     2-faced  negative
 2     2-faces  negative
 3          a+  positive
 4    abnormal  negative
 5     abolish  negative
 6  abominable  negative
 7  abominably  negative
 8   abominate  negative
 9 abomination  negative
10       abort  negative
# ... with 6,778 more rows
```

You might need to install another package.

Returns "Positive" or "Negative" for words

Wrangling Book Data

```
original_books <- austen_books() %>% group_by(book) %>%
 mutate(
linenumber = row_number(),
chapter = cumsum(str_detect(text,
    regex("^chapter [\\divxlc]", ignore_case = TRUE)))) %>%
  ungroup()

# words from all novels
View(original_books)
```

Chapter Words

- The words in the order that they appear in the text.
- Note the first line is the title of the book.

```
## # A tibble: 73,422 x 4
##    text                  book                linenumber chapter
##    <chr>                 <fctr>                   <int>   <int>
##  1 SENSE AND SENSIBILITY Sense & Sensibility          1       0
##  2 ""                    Sense & Sensibility          2       0
##  3 by Jane Austen        Sense & Sensibility          3       0
##  4 ""                    Sense & Sensibility          4       0
##  5 (1811)                Sense & Sensibility          5       0
##  6 ""                    Sense & Sensibility          6       0
##  7 ""                    Sense & Sensibility          7       0
##  8 ""                    Sense & Sensibility          8       0
##  9 ""                    Sense & Sensibility          9       0
## 10 CHAPTER 1             Sense & Sensibility         10       1
## # ... with 73,412 more rows
```

Un-nesting Book Words

We need the words separated and in a set to work with them.

```
tidy_books <- original_books %>%
#make a set of words from the paragraphs
  unnest_tokens(word, text)
View(tidy_books)
```

Un-nested Words

```
## # A tibble: 725,055 x 4
##    book                linenumber chapter word
##    <fctr>                   <int>   <int> <chr>
##  1 Sense & Sensibility          1       0 sense
##  2 Sense & Sensibility          1       0 and
##  3 Sense & Sensibility          1       0 sensibility
##  4 Sense & Sensibility          3       0 by
##  5 Sense & Sensibility          3       0 jane
##  6 Sense & Sensibility          3       0 austen
##  7 Sense & Sensibility          5       0 1811
##  8 Sense & Sensibility         10       1 chapter
##  9 Sense & Sensibility         10       1 1
## 10 Sense & Sensibility         13       1 the
## # ... with 725,045 more rows
```

When words are in one-word-per-row format, manipulation with tidy tools like *dplyr* is possible

Stop Words

- Remove *stop words:* words which do not add any distinguishing information to a body of text.
  - Contractions: hasn’t, didn’t won’t
  - Middle words: been, is, had, having

```
data("stop_words")

View(stop_words)

cleaned_books <- tidy_books %>% anti_join(stop_words)

# anti_join() Note: anti_join() return all rows from x without a match in y.
```

Counting Common Words Across All Books

```
cleaned_books %>%
  count(word, sort = TRUE)
```

```
## # A tibble: 13,914 x 2
##    word       n
##    <chr>  <int>
##  1 miss    1855
##  2 time    1337
##  3 fanny    862
##  4 dear     822
##  5 lady     817
##  6 sir      806
##  7 day      797
##  8 emma     787
##  9 sister   727
## 10 house    699
## # ... with 13,904 more rows
```

“Joy” in Emma

- We will consider the common words having scores indicating that they are of the same sentiment as “Joy”, according to the *nrc* lexicon in the novel, Emma.

```
#install.packages("textdata")
library(textdata)
# Note: enter '1', if prompted
nrcjoy <- get_sentiments("nrc") %>%
  filter(sentiment == "joy")
tidy_books %>%
  filter(book == "Emma") %>%
  semi_join(nrcjoy) %>%
  count(word, sort = TRUE)
```

Counting All Words in Set ...

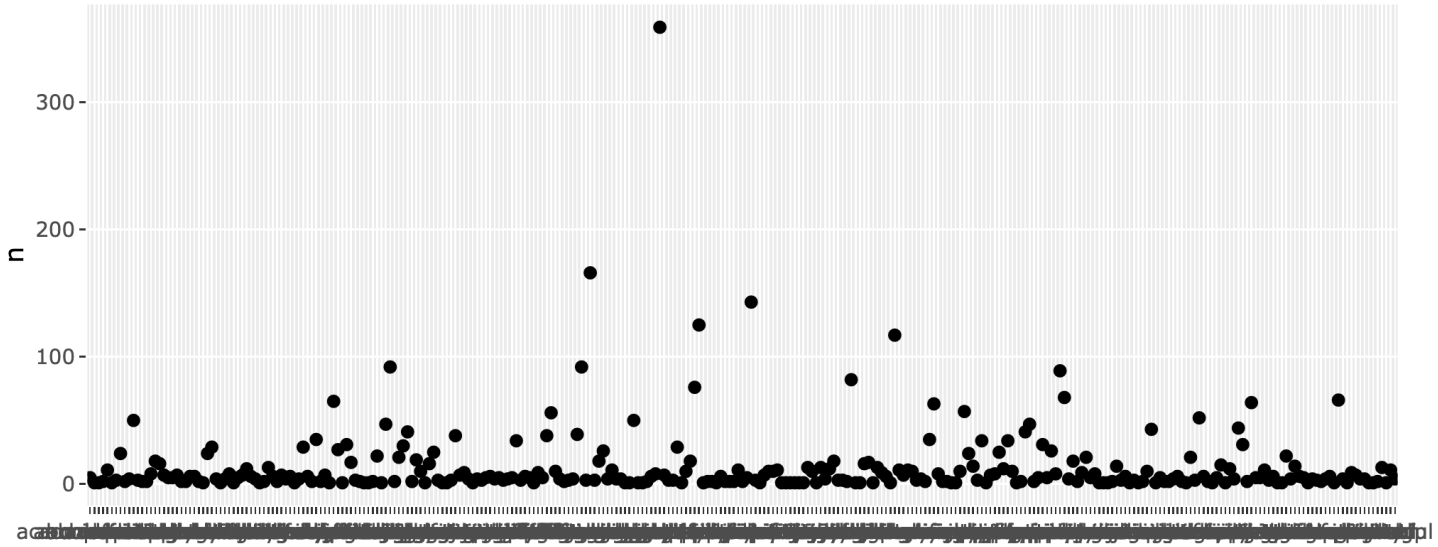
```
tidy_books %>%
  filter(book == "Emma") %>%
  semi_join(nrcjoy) %>%
  count(word, sort = TRUE)
```

We count optimistic words in the novel, Emma

```
## # A tibble: 303 x 2
##    word          n
##    <chr>     <int>
##  1 good        359
##  2 young       192
##  3 friend      166
##  4 hope        143
##  5 happy       125
##  6 love        117
##  7 deal         92
##  8 found        92
##  9 present      89
## 10 kind         82
## # ... with 293 more rows
```

Quick Plot of Words in Set ...

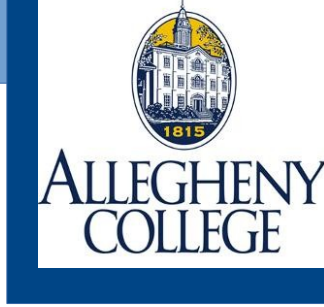
```
tidy_book_counts <- tidy_books %>%
  filter(book == "Emma") %>%
  semi_join(nrcjoy) %>%
  count(word, sort = TRUE)

library(plotly)
p <- ggplot(tidy_book_counts, aes(x = word, y = n ))
p <- p + geom_point()
p <- ggplotly(p)
p
```



How Does Sentiment Change? (In each novel?)

```
library(tidyr)

bing <- get_sentiments("bing")

# move line by line of book, find difference in
sentiments to "score" each line

janeaustensentiment <- tidy_books %>%

  inner_join(bing) %>%

  count(book, index = linenumber %/% 80, sentiment)
      %>% spread(sentiment, n, fill = 0) %>%
    mutate(sentiment = positive - negative)
```

What Most Common Positive and Negative Words?



Count the common positive words across the books.

```
bing_word_counts <- tidy_books %>%
  inner_join(bing) %>%
  count(word, sentiment, sort = TRUE) %>%
  ungroup()

View(bing_word_counts)
```

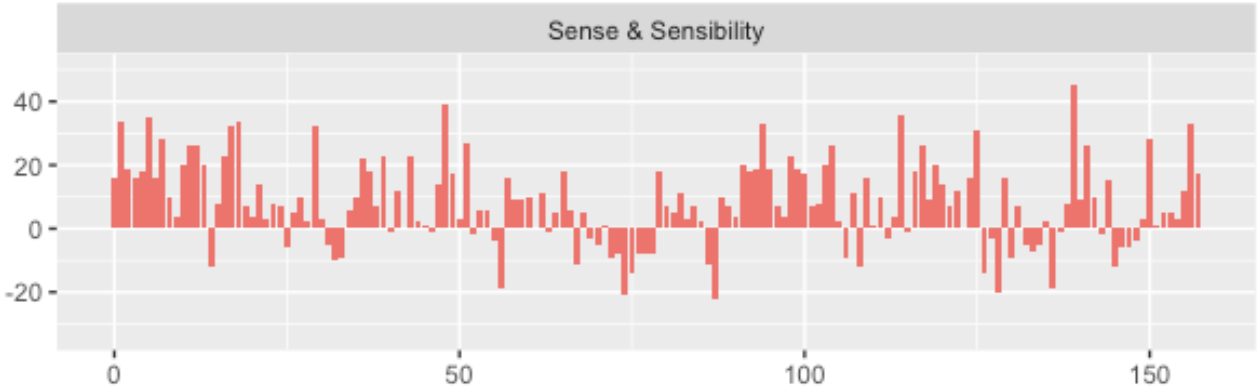
Such Positivity ...

View(bing_word_counts)

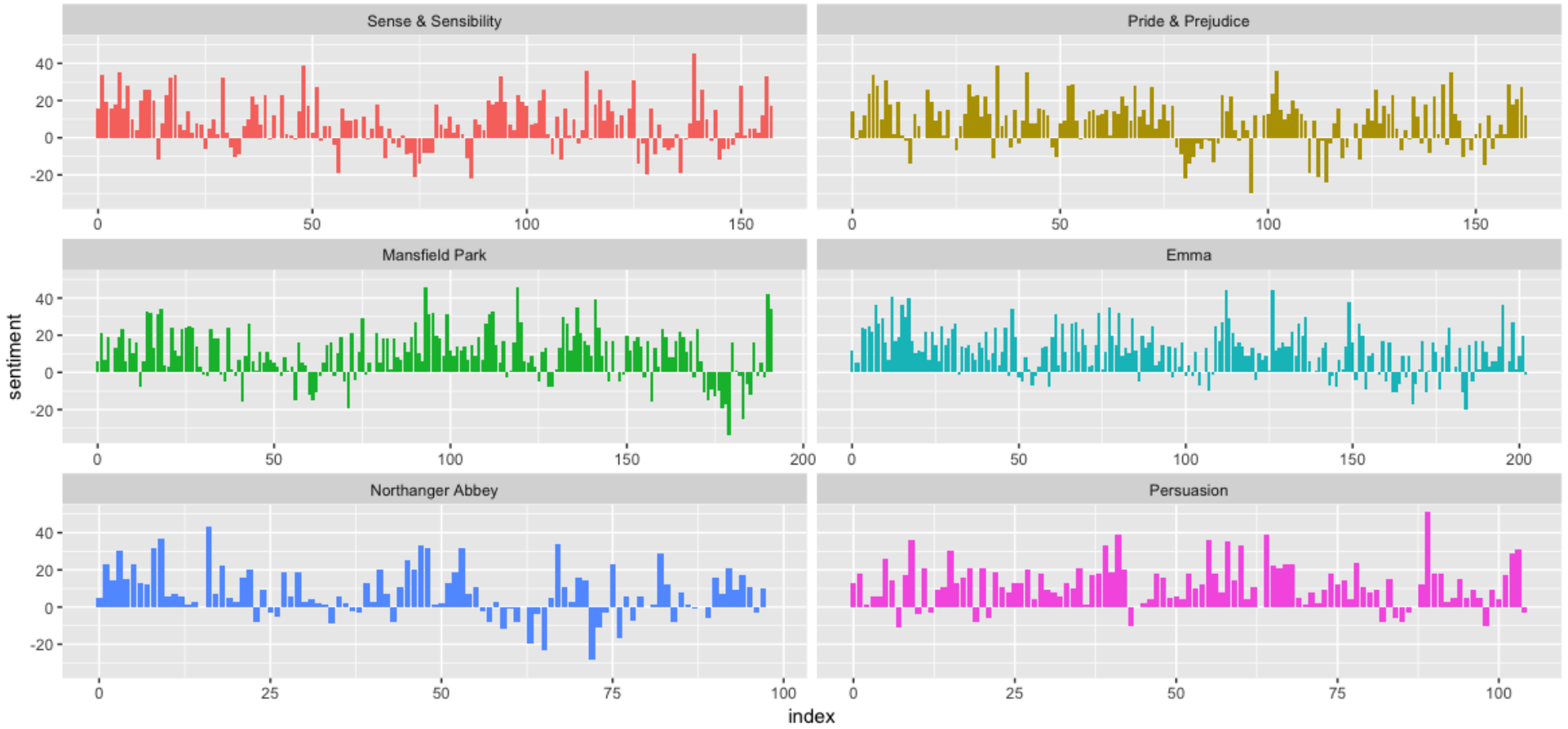
```
## # A tibble: 2,585 x 3
##    word      sentiment      n
##    <chr>     <chr>      <int>
##  1 miss      negative    1855
##  2 well      positive    1523
##  3 good      positive    1380
##  4 great     positive     981
##  5 like      positive     725
##  6 better    positive     639
##  7 enough    positive     613
##  8 happy     positive     534
##  9 love      positive     495
## 10 pleasure  positive     462
## # ... with 2,575 more rows
```

Plot the Good and Bad Words Across Each Book

```
# plot the sentiments from each book

ggplot(janeaustensentiment, aes(index, sentiment, fill = book)) + geom_bar(stat = "identity", show.legend = FALSE) + facet_wrap(~book, ncol = 2, scales = "free_x")
```



Plot the Good and Bad Words Across Each Book

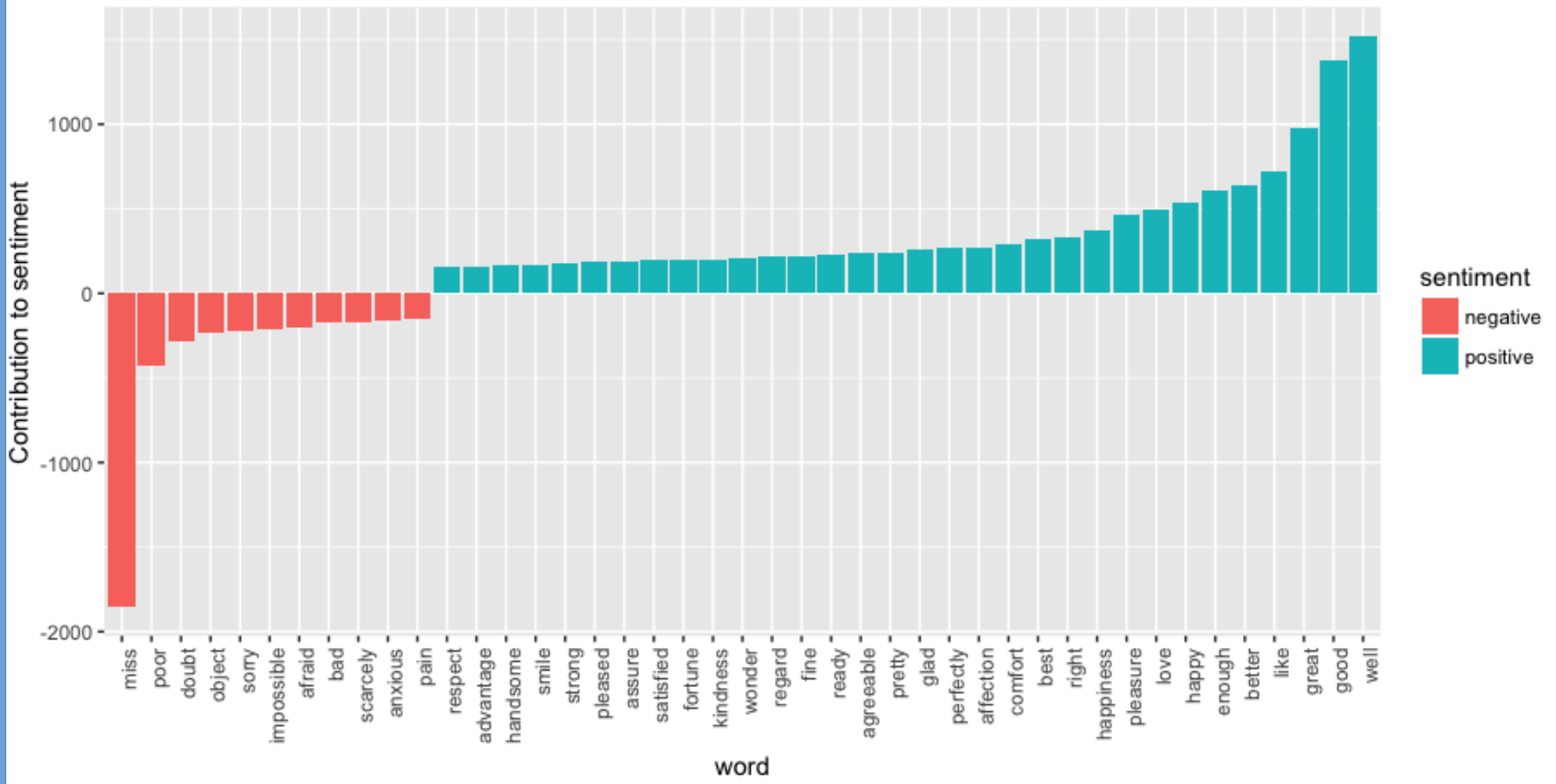


An optimistic writer: there appears to be a similar pattern of optimistic / pessimistic word usage across all her books!

Plot of The Common Positive and Negative Words

```
# Plot the common positive words across the books.


bing_word_counts %>%
  filter(n > 150) %>%
  mutate(n = ifelse(sentiment == "negative", -n, n)) %>%
  mutate(word = reorder(word, n)) %>%
  ggplot(aes(word, n, fill = sentiment)) +
  geom_bar(stat = "identity") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
 ylab("Contribution to sentiment")
```

Plot of Positive and Negative Sentiment Words



And Now. Back to the Research Question!

- Jane Austen's written work:

  How many *Bad (pessimistic)* words did she use?

  How many *Good* (optimistic) words did she use?

Get list of Positive and Negative Sentiments

```
bing_word_counts <- tidy_books %>%
  inner_join(get_sentiments("bing")) %>
%
  count(word, sentiment, sort = TRUE)
%>%
  ungroup()

bing_word_counts
```

```
> bing_word_counts
# A tibble: 2,585 x 3
   word      sentiment      n
   <chr>     <chr>      <int>
 1 miss      negative    1855
 2 well      positive    1523
 3 good      positive    1380
 4 great     positive     981
 5 like      positive     725
 6 better    positive     639
 7 enough    positive     613
 8 happy     positive     534
 9 love      positive     495
10 pleasure  positive     462
# … with 2,575 more rows
```

What are the Sentiments of Words?

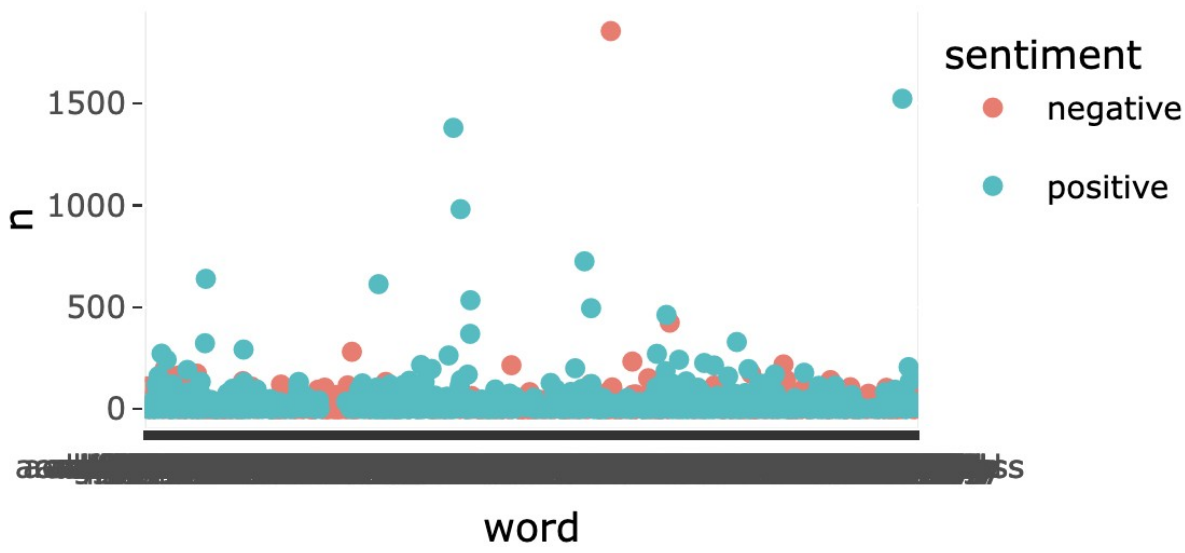
```
bing_word_counts <- tidy_books %>%
  inner_join(get_sentiments("bing")) %>%
%
  count(word, sentiment, sort = TRUE) %>%
  ungroup()

bing_word_counts
```

```
> bing_word_counts
# A tibble: 2,585 x 3
   word     sentiment     n
   <chr>    <chr>     <int>
 1 miss     negative   1855
 2 well     positive   1523
 3 good     positive   1380
 4 great    positive    981
 5 like     positive    725
 6 better   positive    639
 7 enough   positive    613
 8 happy    positive    534
 9 love     positive    495
10 pleasure positive    462
# … with 2,575 more rows
```

Each word has an associated sentiment. Here we note the number of words that may be associated to each of the sentiments.

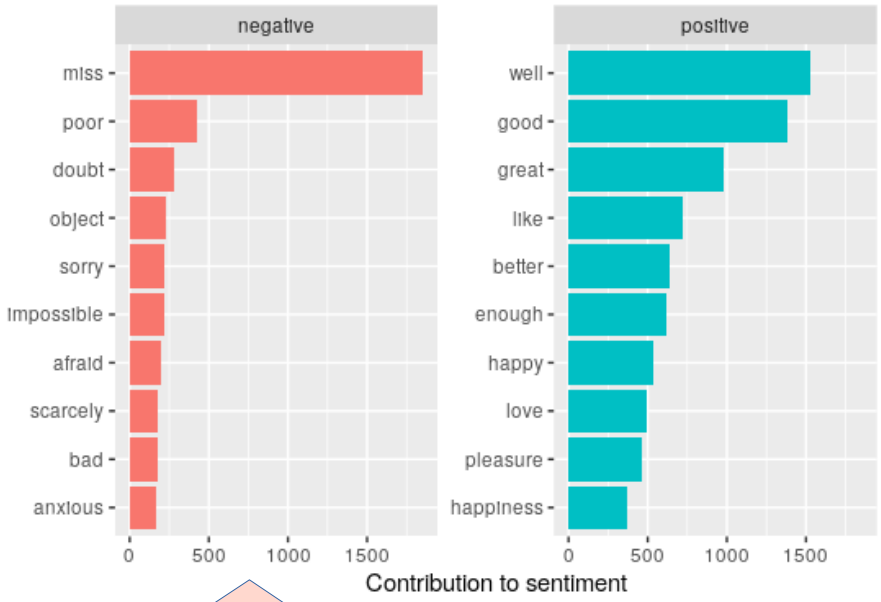
Get Plot of Sentiments

```
# Takes less time
ggplot(bing_word_counts, aes(x = word, y = n, col = sentiment )) +
geom_point()

# Takes a long time to plot ... :-(
p <- ggplot(bing_word_counts, aes(x = word, y = n, col = sentiment ))
p <- p + geom_point()
p <- ggplotly(p)
p
```



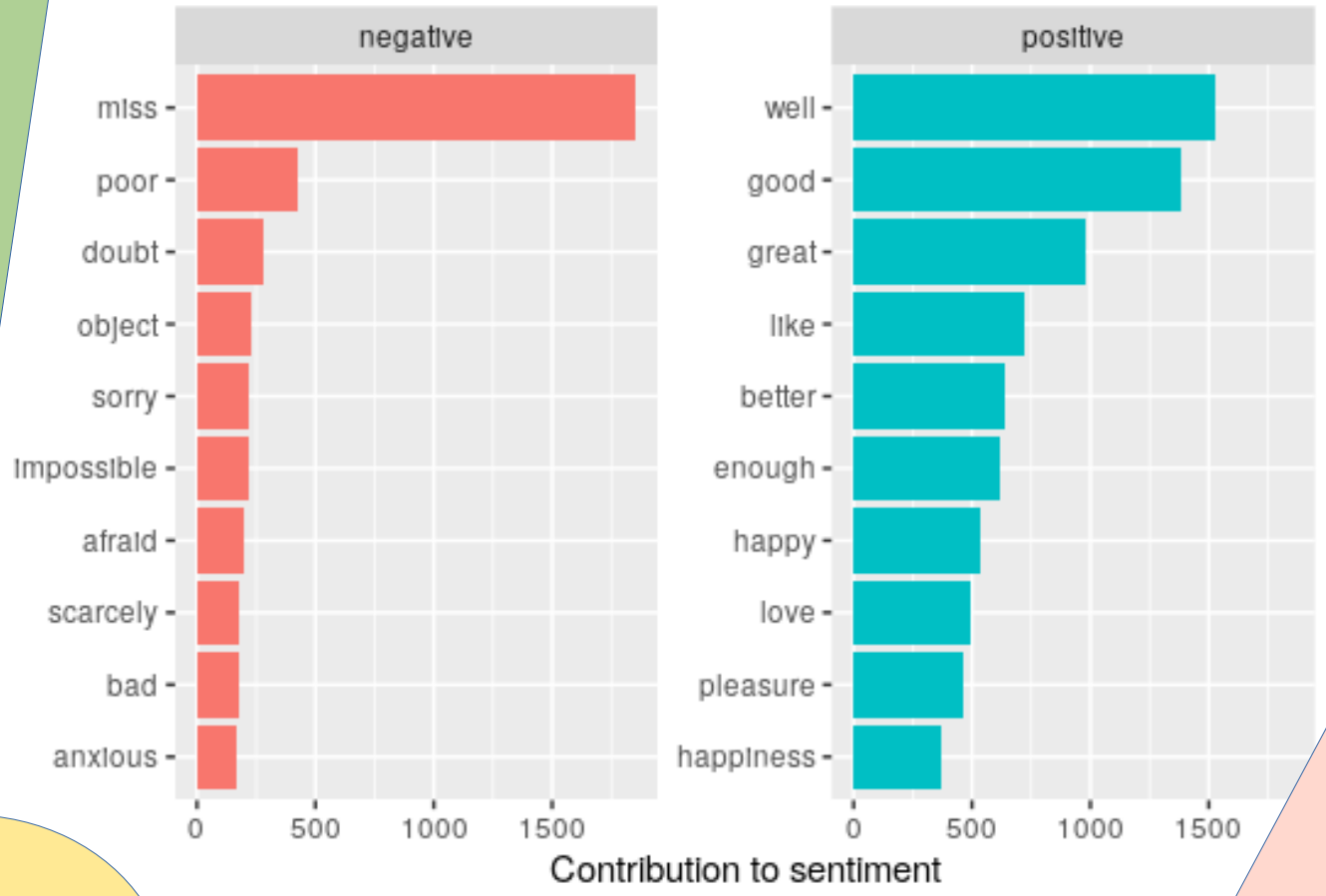
Visually Shown, The Sentiment Words

```
bing_word_counts %>%
  group_by(sentiment) %>%
  top_n(10) %>%
  ungroup() %>%
  mutate(word = reorder(word, n)) %>%
  ggplot(aes(word, n, fill = sentiment)) +
  geom_col(show.legend = FALSE) +
  facet_wrap(~sentiment, scales = "free_y") +
  labs(y = "Contribution to sentiment",
       x = NULL) +
  coord_flip()
```



Gimme the top ten, and then show me how many lexicon words are associated to that sentiment.

Many more words associated to “miss” (pessimistic maximum) than “well” (optimistic maximum)



“Miss”: a girl’s title?

Could “well” also have other types of optimistic uses? And “***Good”***? Why not more occurrences of “***Great”...?***

Topic Modeling:

Latent Dirichlet allocation (LDA)

- Document are a mixture of topics, and each topic as a mixture of words.
- Word usage can be used to describe something “telling” about the topic of the document.
- Example: cooking books contain words about cooking, computer science books use terms about computers …
- More about this at link: https://www.tidytextmining.com/topicmodeling.html

Topic Modeling:
Latent Dirichlet allocation (LDA)

Algorithm, programming, Python, Java, ...

Baking, bread, pastry, mixing, chocolate, vanilla, ...

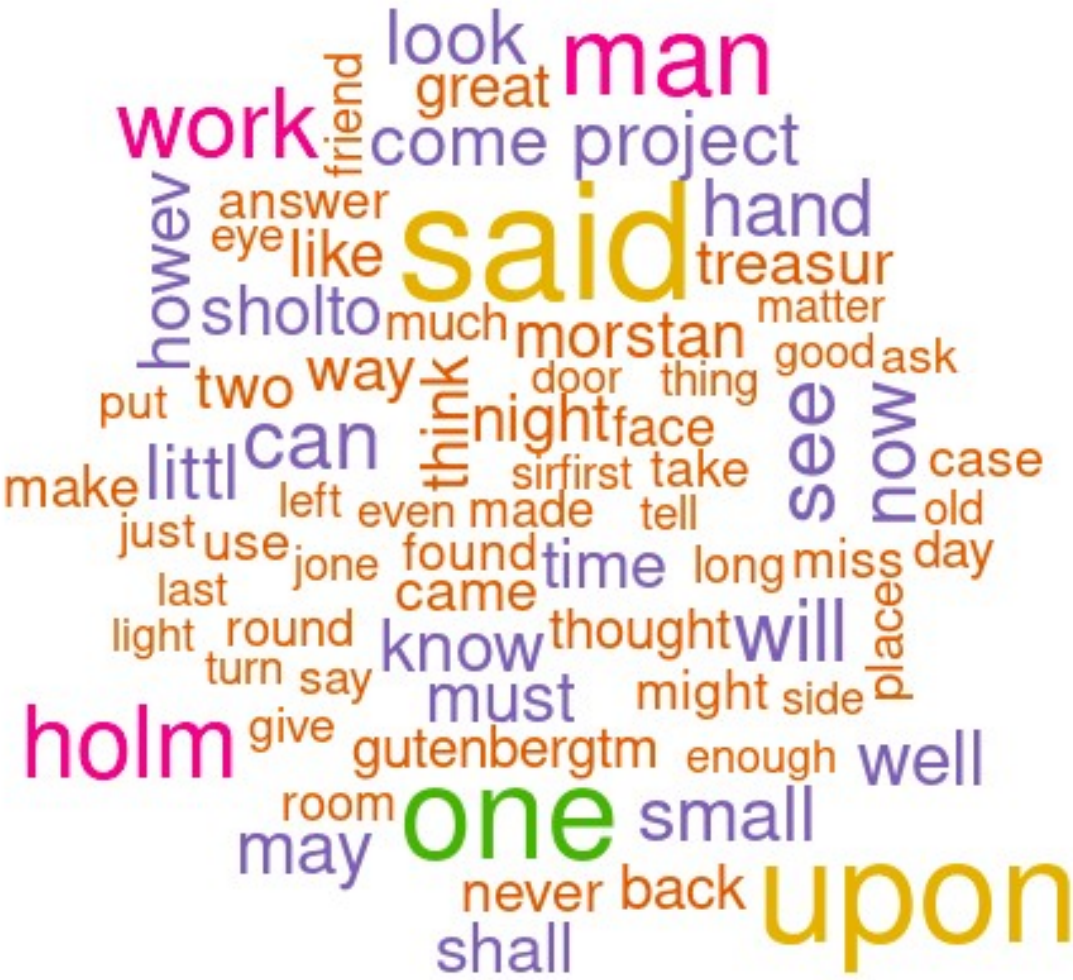
Lye, oil, temperature, kaolin, essential oils, ...

Studying, scholarship, teaching, class planning

- We can determine the topic of a book by the most commonly used words

Topic Modeling:

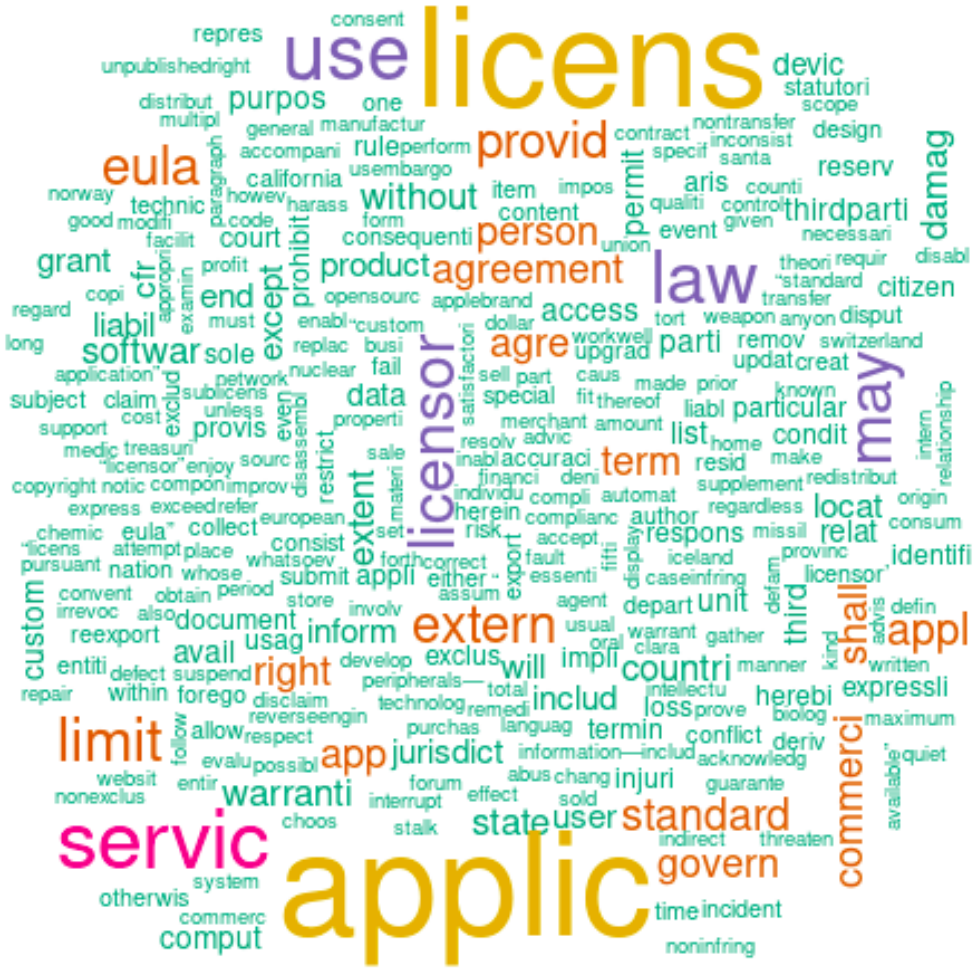
The Sign of the Four, by Arthur Conan Doyle



Make your own word clouds: sandbox/wordCloudDemo.r

Topic Modeling:

Software license agreement (ula)



Make your own word clouds: sandbox/wordCloudDemo.r

Topic Modeling:
WikiPage about Volcanoes

Make your own word clouds: sandbox/wordCloudDemo.r