# Visualizing Text Data

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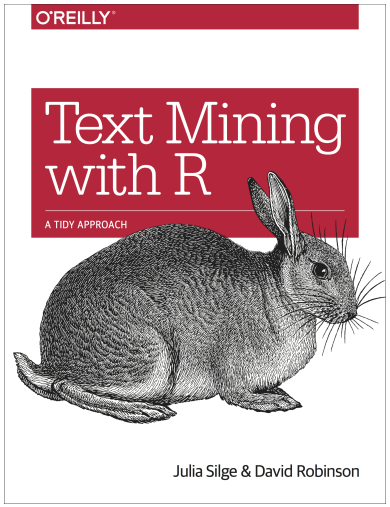
Visualizing Text Data: a Tidy Text Approach

# Tidy text mining

# Tidy data and tidy text format

*"Text Mining with R: A Tidy Approach"* by Julia Silge and David Robinson




Recall that our definition of **tidy data** is:

- Each variable is a column
- Each observation is a row
- Each type of observational unit is a table

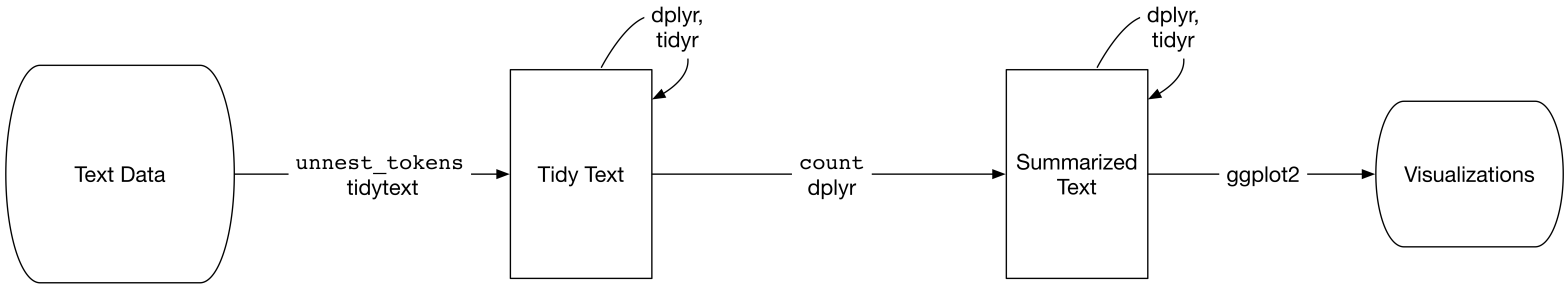
**Tidy text format:** a table with **one-token-per-row**.

*Some core concepts and techniques for working with text data include: tokens, lemmas, parts of speech, sentiment analysis, TF-IDF, topic modeling, and fingerprinting*

# One-token-per-row

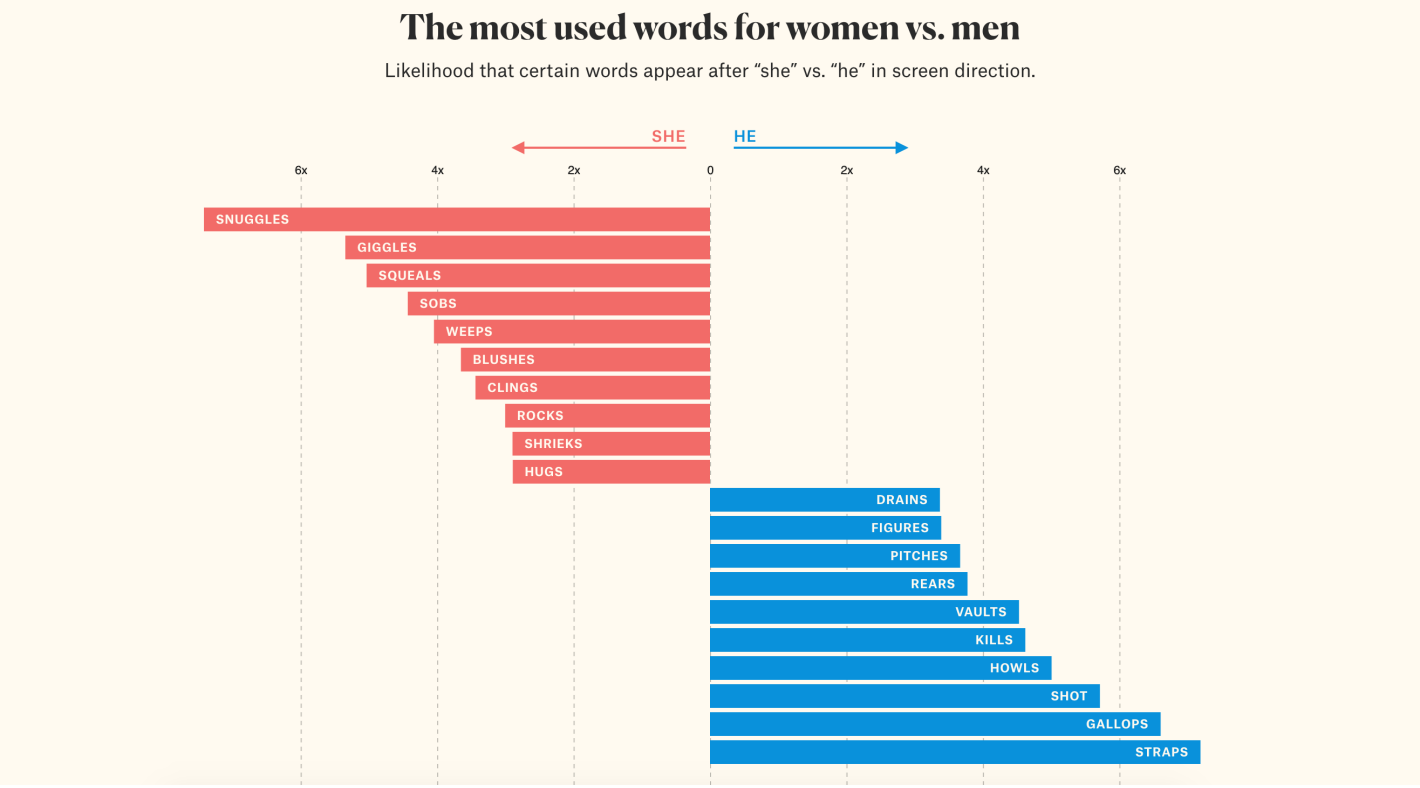
**Tidy text format:** a table with **one-token-per-row**. A **token** is a meaningful unit of text, such as a word, that we are interested in using for analysis, and **tokenization** is the process of splitting text into tokens. The token that is stored in each row is most often a single word, but can also be an n-gram, sentence, or paragraph.

**The `tidytext` package, provides a functionality to tokenize by commonly used units of text and convert to a one-term-per-row format.**



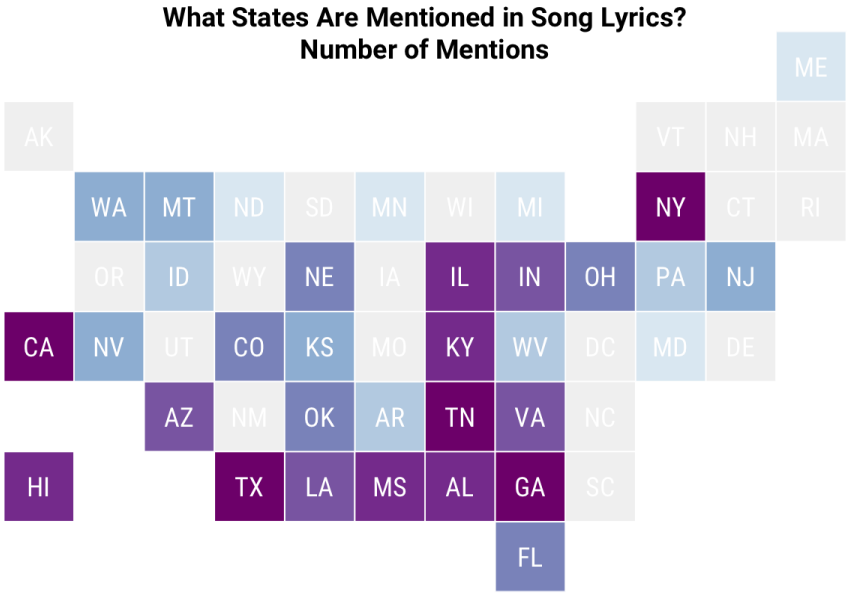

https://www.tidytextmining.com/tidytext.html

# Example from pudding.cool




*"She Giggles, He Gallops:"* Analyzing gender tropes in film with screen direction from 2,000 scripts. By Julia Silge

# Song lyrics across the United




*"Song Lyrics Across the United States"* by Julia Silge

# Working with tidy text data

# The `unnest_tokens()` function

```
queen <- c(
  "Buddy, you are a boy, make a big noise",
  "Playing in the street, gonna be a big man someday",
  "You got mud on your face, you big disgrace",
  "Kicking your can all over the place, singing"
)
```

This is a typical character vector that we might want to analyze. In order to turn it into a tidy text dataset, we first need to put it into a data frame.

```
library(tidyverse)
text_df <- tibble(line = 1:4, text = q
```

```
## # A tibble: 4 x 2
##    line text
##   <int> <chr>
## 1     1 Buddy, you are a boy, make a big noise
## 2     2 Playing in the street, gonna be a big ma
## 3     3 You got mud on your face, you big disgra
## 4     4 Kicking your can all over the place, sin
```

(a *tibble* has a convenient print method, will not convert strings to factors, and does not use row names)

# The `unnest_tokens()` function

```
library(tidytext)
text_df %>%
  unnest_tokens(output = word,
                input = text)
```

```
## # A tibble: 36 x 2
##     line word
##    <int> <chr>
##  1     1 buddy
##  2     1 you
##  3     1 are
##  4     1 a
##  5     1 boy
##  6     1 make
##  7     1 a
##  8     1 big
##  9     1 noise
## 10     2 playing
## # … with 26 more rows
```

The two basic arguments to `unnest_tokens()` used here are column names. First we have the *output column* name that will be created as the text is unnested into it (`word`, in this case), and then the *input column* that the text comes from (`text`, in this case).

Remember that `text_df` above has a column called `text` that contains the data of interest.

# Sample tidy text data

**One row for each text element: it can be chapter, page, verse, etc.**

```
hp <- read_csv("https://github.com/reisanar/datasets/raw/master/hp.csv")
hp <- hp %>% mutate(
  book = factor(book, levels = c("Philosopher's Stone",
                                 "Chamber of Secrets", "Prisoner of Azkaban", "Go
                                 "Order of the Phoenix", "Half-Blood Prince","Dea
head(hp, 6) # sample with text column per chapter
```

```
## # A tibble: 6 x 3
##   book              text                                                chapter
##   <fct>             <chr>                                                 <dbl>
## 1 Philosopher's … "THE BOY WHO LIVED   Mr. and Mrs. Dursley, of numb…       1
## 2 Philosopher's … "THE VANISHING GLASS   Nearly ten years had passed…       2
## 3 Philosopher's … "THE LETTERS FROM NO ONE   The escape of the Brazi…       3
## 4 Philosopher's … "THE KEEPER OF THE KEYS   BOOM. They knocked again…       4
## 5 Philosopher's … "DIAGON ALLEY   Harry woke early the next morning.…       5
## 6 Philosopher's … "THE JOURNEY FROM PLATFORM NINE AND THREE-QUARTER…       6
```

Dataset obtained from https://github.com/bradleyboehmke/harrypotter

# Sample tidy text data (cont.)

**One row for each text element: it can be chapter, page, verse, etc.**

```
hp1_data <- read_csv("https://github.com/reisanar/datasets/raw/master/hp1_data.cs
head(hp1_data, 8) # sample with text column with
```

```
## # A tibble: 8 x 3
##   chapter book                        text
##     <dbl> <chr>                       <chr>
## 1       1 Harry Potter and the Ph… "THE BOY WHO LIVED   Mr. and Mrs. Dursley…
## 2       2 Harry Potter and the Ph… "THE VANISHING GLASS   Nearly ten years h…
## 3       3 Harry Potter and the Ph… "THE LETTERS FROM NO ONE   The escape of …
## 4       4 Harry Potter and the Ph… "THE KEEPER OF THE KEYS   BOOM. They knoc…
## 5       5 Harry Potter and the Ph… "DIAGON ALLEY   Harry woke early the next…
## 6       6 Harry Potter and the Ph… "THE JOURNEY FROM PLATFORM NINE AND THRE…
## 7       7 Harry Potter and the Ph… "THE SORTING HAT   The door swung open at…
## 8       8 Harry Potter and the Ph… "THE POTIONS MASTER   There, look.\"   \"W…
```

# Tokens

**Split the text into even smaller parts: paragraph, line, verse, sentence, n-gram, word, letter, etc.**

```
hp1_words <- hp1_data %>%
  unnest_tokens(word, text) %>%
  mutate(
    book = str_trunc(book,
                     width = 15)) %>%
  select(word, chapter, book) %>%
  head()
```

```
# A tibble: 6 x 3
  word  chapter book
  <chr>   <dbl> <chr>
1 the         1 Harry Potter...
2 boy         1 Harry Potter...
3 who         1 Harry Potter...
4 lived       1 Harry Potter...
5 mr          1 Harry Potter...
6 and         1 Harry Potter...
```

# Tokens (cont.)

**Split the text into even smaller parts: paragraph, line, verse, sentence, n-gram, word, letter, etc.**

```
hp1_bigrams <- hp1_data %>%
  unnest_tokens(bigram, text,
                token = "ngrams", n =
  mutate(
    book = str_trunc(book,
                     width = 15)) %>%
  select(bigram, chapter, book) %>%
  head()
```

```
## # A tibble: 6 x 3
##   bigram    chapter book
##   <chr>       <dbl> <chr>
## 1 the boy         1 Harry Potter..
## 2 boy who         1 Harry Potter..
## 3 who lived       1 Harry Potter..
## 4 lived mr        1 Harry Potter..
## 5 mr and          1 Harry Potter..
## 6 and mrs         1 Harry Potter..
```

# Stop words

**Common words that we can generally ignore**

```
stop_words
```

```
# A tibble: 1,149 x 2
   word        lexicon
   <chr>       <chr>
 1 a           SMART
 2 a's         SMART
 3 able        SMART
 4 about       SMART
 5 above       SMART
 6 according   SMART
 7 accordingly SMART
 8 across      SMART
 9 actually    SMART
10 after       SMART
# … with 1,139 more rows
```

Use the `stopwords()` function to find a list of common stop-words in different languages

```
stopwords::stopwords(language = "engl
  sample(6)
```

```
## [1] "she's"  "that's" "few"    "why
```

```
# another sample
stopwords::stopwords(language = "span
  sample(6)
```

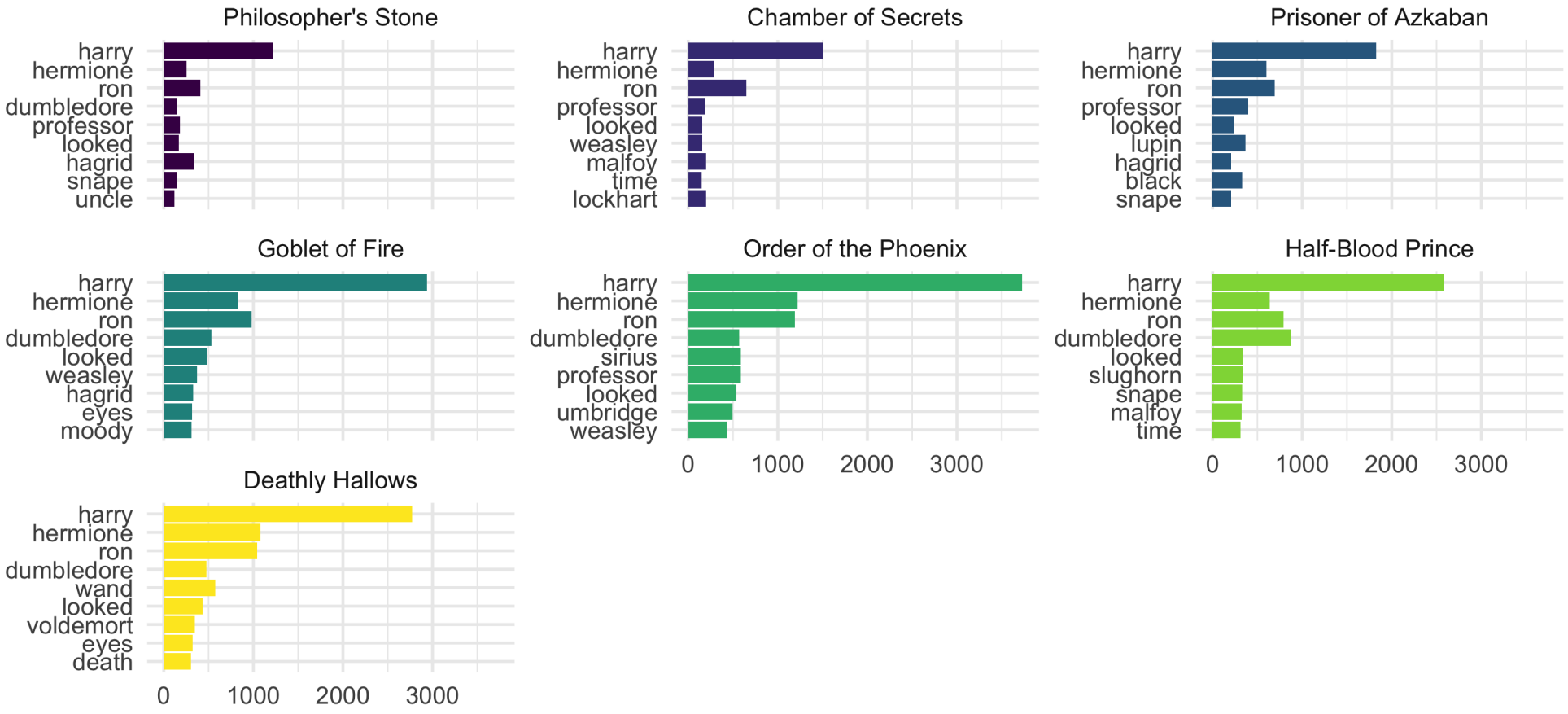
```
## [1] "ella"     "habríais" "esto"
```

# Counting words

```
hp_tokens <- hp %>%
  unnest_tokens(word, text) %>%
  anti_join(stop_words, by = "word") %>% # remove stopwords
  group_by(book) %>%
  count(word, sort = TRUE) %>%
  top_n(9, n) %>%
  ungroup() %>%
  mutate(word = fct_inorder(word))

# create a bar plot showing the token frequency
ggplot(hp_tokens, aes(x = n, y = fct_rev(word), fill = book)) +
  geom_col() +
  guides(fill = FALSE) +
  labs(x = NULL, y = NULL) +
  scale_fill_viridis_d() +
  facet_wrap(vars(book), scales = "free_y") +
  theme_minimal()
```

# Counting words (cont.)

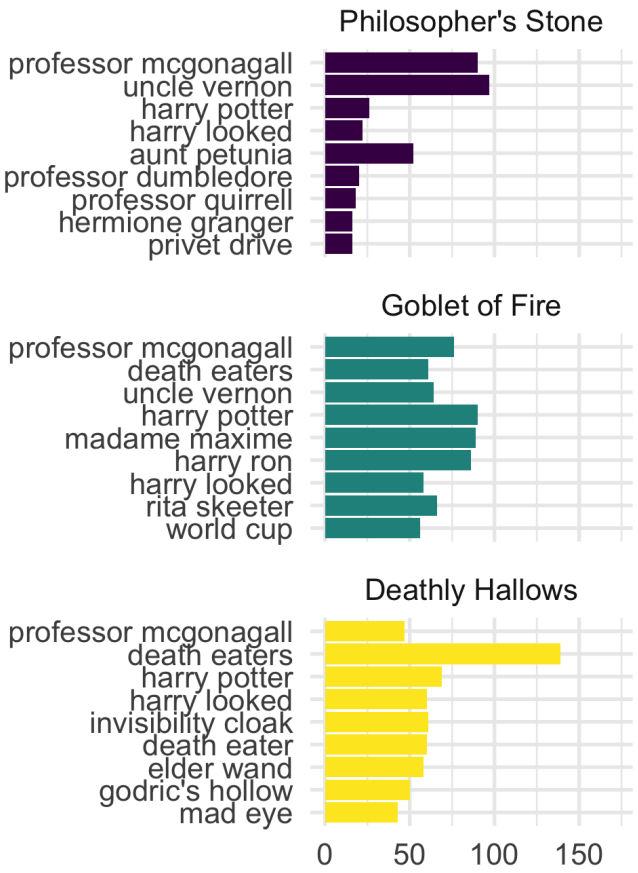


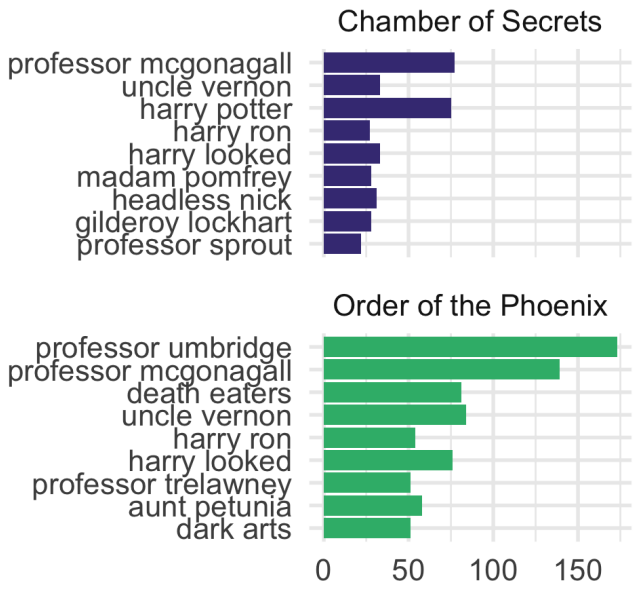
# Token frequency: n-grams

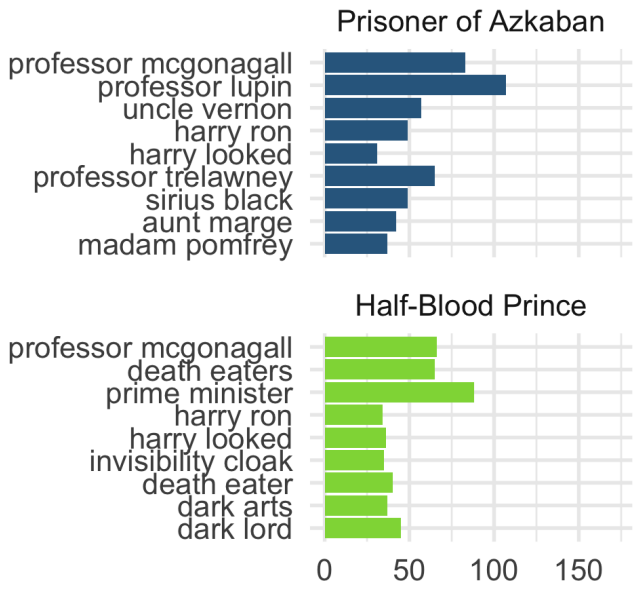
```
hp_bigrams <- hp %>%
  unnest_tokens(bigram, text, token = "ngrams", n = 2) %>%
  separate(bigram, c("word1", "word2"), sep = " ") %>%
  filter(!word1 %in% stop_words$word) %>% # remove stopwords
  filter(!word2 %in% stop_words$word) %>% # remove stopwords
  unite(bigram, word1, word2, sep = " ") %>%
  group_by(book) %>%
  count(bigram, sort = TRUE) %>%
  top_n(9, n) %>%
  ungroup() %>%
  mutate(bigram = fct_inorder(bigram))

# create a bar plot showing the token frequency (bigrams)
ggplot(hp_bigrams, aes(x = n, y = fct_rev(bigram), fill = book)) +
  geom_col() +
  guides(fill = FALSE) +
  labs(x = NULL, y = NULL) +
  scale_fill_viridis_d() +
  facet_wrap(vars(book), scales = "free_y") +
  theme_minimal()
```

# Token frequency: n-grams (cont.)



# Sentiment Analysis

# Sentiment analysis

- **Sentiment analysis** can be thought of as the exercise of taking a sentence, paragraph, document, or any piece of natural language, and **determining whether that text's emotional tone is positive, negative or neutral**.
- One way to analyze the sentiment of a text is to consider the text as a *combination of its individual words* and the sentiment content of the whole text as the **sum of the sentiment content of the individual words**.
- When human readers approach a text, we use our understanding of the *emotional intent* of words to infer whether a section of text is positive or negative, or perhaps characterized by some other more nuanced emotion like surprise or disgust.

See also:
https://www.reisanar.com/slides/sentiment-analysis#1

https://www.reisanar.com/slides/n-grams#1

# Lexicons

The `tidytext` package contains `sentiments` dataset. Three general-purpose lexicons are included:

- `AFINN` from Finn Arup Nielsen: scores a word with a number, which may range from -5 to +5.
- `bing` from Bing Liu and collaborators: scores a word as either positive or negative.
- `nrc` from Saif Mohammad and Peter Turney: categorizes a word under sentiment type categories such as positive, negative, anger, anticipation, disgust, fear, joy, sadness, surprise, and trust.

These sentiment lexicons, based on unigrams (i.e. single words) are derived from a single English word and are assigned different scores of positive/negative sentiments.

# Lexicons (cont.)

```
get_sentiments("bing")
```

```
# A tibble: 6,786 x 2
   word        sentiment
   <chr>       <chr>
 1 2-faces     negative
 2 abnormal    negative
 3 abolish     negative
 4 abominable  negative
 5 abominably  negative
 6 abominate   negative
 7 abomination negative
 8 abort       negative
 9 aborted     negative
10 aborts      negative
# … with 6,776 more rows
```

```
get_sentiments("afinn")
```

```
# A tibble: 2,477 x 2
   word       value
   <chr>      <dbl>
 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 2,467 more rows
```

```
get_sentiments("nrc")
```

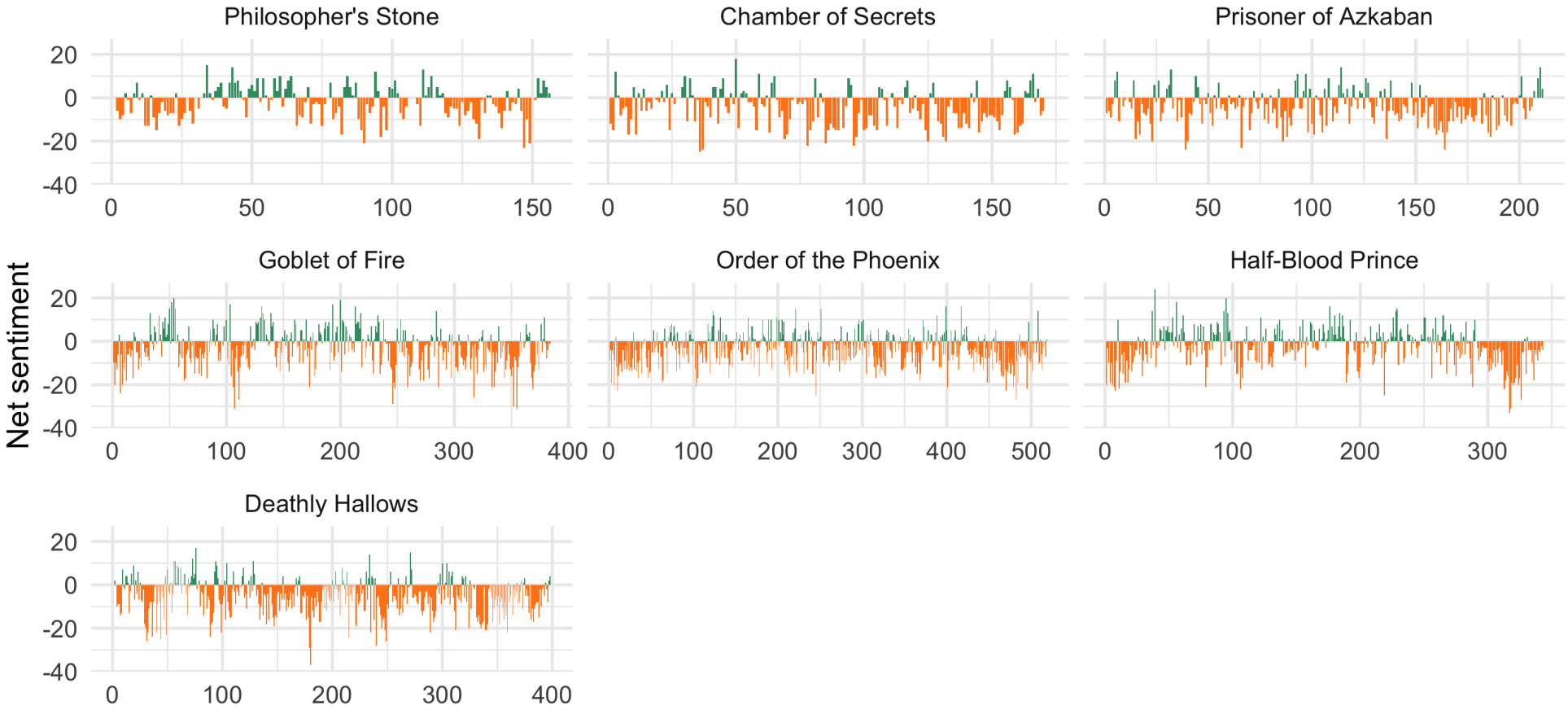
```
# A tibble: 13,901 x 2
   word        sentiment
   <chr>       <chr>
 1 abacus      trust
 2 abandon     fear
 3 abandon     negative
 4 abandon     sadness
 5 abandoned   anger
 6 abandoned   fear
 7 abandoned   negative
 8 abandoned   sadness
 9 abandonment anger
10 abandonment fear
# … with 13,891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

# Sentiment analysis from books

```
# See : https://rstudio-pubs-static.s3.amazonaws.com/300624_8260952d1f0346969e65
hp_sentiment <- hp %>%
  unnest_tokens(word, text) %>%
  group_by(book) %>%
  mutate(word_count = 1:n(),
         index = word_count %/% 500 + 1) %>%
  inner_join(get_sentiments("bing")) %>%
  count(book, index = index, sentiment) %>%
  pivot_wider(names_from = sentiment, values_from = n) %>%
  mutate(net_sentiment = positive - negative)

ggplot(hp_sentiment,
       aes(x = index, y = net_sentiment, fill = net_sentiment > 0)) +
  geom_col() +
  guides(fill = FALSE) +
  labs(x = NULL, y = "Net sentiment") +
  scale_fill_manual(name = "", labels = c("Positive", "Negative"),
                    values = c("#FF851B", "#3D9970")) +
  facet_wrap(vars(book), scales = "free_x") +
  theme_minimal()
```

# Sentiment analysis from books



# TF-IDF

For a given document $d$ and term $t$, the **term frequency** is the number of times term $t$ appears in document $d$ :

$$TF(d,t) = \#\text{ times } t \text{ appears in document } d$$

To account for terms that appear frequently in the domain of interest, we compute the **Inverse Document Frequency** of term $t$, calculated over the entire corpus and defined as

$$IDF(t) = \ln\left(\frac{\text{total number of documents}}{\#\text{ documents containing term } t}\right)$$

TF-IDF is high where a rare term is present or frequent in a document TF-IDF is near zero where a term is absent from a document, or abundant across all documents

# TF-IDF (cont.)

$$TF - IDF(t, d) = TF(t, d) \times IDF(t) = TF(t, d) \times \ln\left( \frac{n_{\text{docs}}}{n_{\text{docs}} \text{ containin}} \right.$$

- If term $t$ appears in few documents then $IDF(t, d)$ increases

**TF-IDF measures how *important* is a word in a collection of documents**

- TF-IDF is large when a rare terms is frequent in a document.
- TF-IDF is close to zero when term is absent from documents, or term is abundant across all documents.

# TF-IDF example

```
# Get a list of words in all the books
hp_words <- hp %>%
  unnest_tokens(word, text) %>%
  count(book, word, sort = TRUE) %>%
  ungroup()

# Add the tf-idf for these words
hp_tf_idf <- hp_words %>%
  bind_tf_idf(word, book, n) %>%
  arrange(desc(tf_idf))

# Get the top 8 uniquest words
hp_tf_idf_plot <- hp_tf_idf %>%
  group_by(book) %>%
  top_n(8) %>%
  ungroup() %>%
  mutate(word = fct_inorder(word))

ggplot(hp_tf_idf_plot, aes(y = fct_rev(word), x = tf_idf, fill = book)) +
  geom_col() +
  guides(fill = FALSE) +
  labs(y = "tf-idf", x = NULL) +
  facet_wrap(~ book, scales = "free") +
  theme_minimal()
```

# TF-IDF example (cont.)