Text Analysis with R for Students of Literature

```
### 1. First Foray

## 1.1. Loading the first text file

library(quanteda)
```

```
Package version: 3.2.1
Unicode version: 13.0
ICU version: 69.1

Parallel computing: 8 of 8 threads used.

See https://quanteda.io for tutorials and examples.
```

```
library(readtext)
```

```
Warning: package 'readtext' was built under R version 4.1.2
```

```
data_macbeth <- texts(readtext("https://www.gutenberg.org/files/1533/1533-0.txt"))
names(data_macbeth) <- "Macbeth"

library(stringi)
stri_sub(data_macbeth, 1, 65)
```

```
[1] "ï»¿The Project Gutenberg eBook of Macbeth, by William Shakespeare"
```

```
## 1.2. Separate content from metadata

# Extract the header information
(start_v <- stri_locate_first_fixed(data_macbeth, "SCENE I. An open Place.")[1])
```

```
[1] 3032
```

```
(end_v <- stri_locate_last_fixed(data_macbeth, "[_Flourish. Exeunt._]")[1])
```

```
[1] 107169
```

```
# Verify that "[_Flourish. Exeunt._]" is the end of the novel
kwic(tokens(data_macbeth), "[_Flourish. Exeunt._]")
```

```
Keyword-in-context with 0 matches.
```

```
stri_count_fixed(data_macbeth, "\n")
```

```
[1] 4528
```

```
stri_sub(data_macbeth, from = start_v, to = end_v) %>%
  stri_count_fixed("\n")
```

```
[1] 4053
```

```
novel_v <- stri_sub(data_macbeth, start_v, end_v)
novel_v = gsub("€", "", novel_v)
novel_v = gsub("", "", novel_v)
length(novel_v)
```

```
[1] 1
```

```
stri_sub(novel_v, 1, 70) %>% cat()
```

```
SCENE I. An open Place.

 Thunder and Lightning. Enter three Witches.
```

```
## 1.3. Reprocessing the content

# Lowercase text
novel_lower_v <- char_tolower(novel_v)

macbeth_word_v <- tokens(novel_lower_v, remove_punct = TRUE) %>% as.character()
(total_length <- length(macbeth_word_v))
```

```
[1] 18190
```

```
macbeth_word_v[1:11]
```

```
 [1] "scene"     "i"         "an"        "open"      "place"     "thunder"
 [7] "and"       "lightning" "enter"     "three"     "witches"
```

```
macbeth_word_v[9999]
```

```
[1] "once"
```

```
macbeth_word_v[c(6,7,8)]
```

```
[1] "thunder"   "and"       "lightning"
```

```r
# Check positions of "love"
which(macbeth_word_v == "love") %>% head()
```

```
[1] 2114 2902 3132 3145 3242 3302
```

```r
## 1.4. Beginning the analysis

length(macbeth_word_v[which(macbeth_word_v == "love")])
```

```
[1] 19
```

```r
# Same thing using kwic()
nrow(kwic(novel_lower_v, pattern = "love"))
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
[1] 19
```

```r
nrow(kwic(novel_lower_v, pattern = "love*")) # Includes words like "whalemen"
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
[1] 25
```

```r
(total_love_hits <- nrow(kwic(novel_lower_v, pattern = "^love{0,1}$", valuetype = "regex")))
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
[1] 19
```

```r
total_love_hits / ntoken(novel_lower_v, remove_punct = TRUE)
```

```
     text1
0.00104453
```

```r
# Total unique words
length(unique(macbeth_word_v))
```

```
[1] 3503
```

```r
ntype(char_tolower(novel_v), remove_punct = TRUE)
```

```
text1
 3503
```

```
# Ten most frequent words
macbeth_dfm <- dfm(novel_lower_v, remove_punct = TRUE)
```

```
Warning: 'dfm.character()' is deprecated. Use 'tokens()' first.
```

```
Warning: '...' should not be used for tokens() arguments; use 'tokens()' first.
```

```
head(macbeth_dfm, nf = 10)
```

```
Warning: nf argument is not used.
```

```
Document-feature matrix of: 1 document, 3,503 features (0.00% sparse) and 0 docvars.
       features
docs    scene   i an open place thunder and lightning enter three
  text1    28 318 32    4    11       6 566         2    72    12
[ reached max_nfeat ... 3,493 more features ]
```

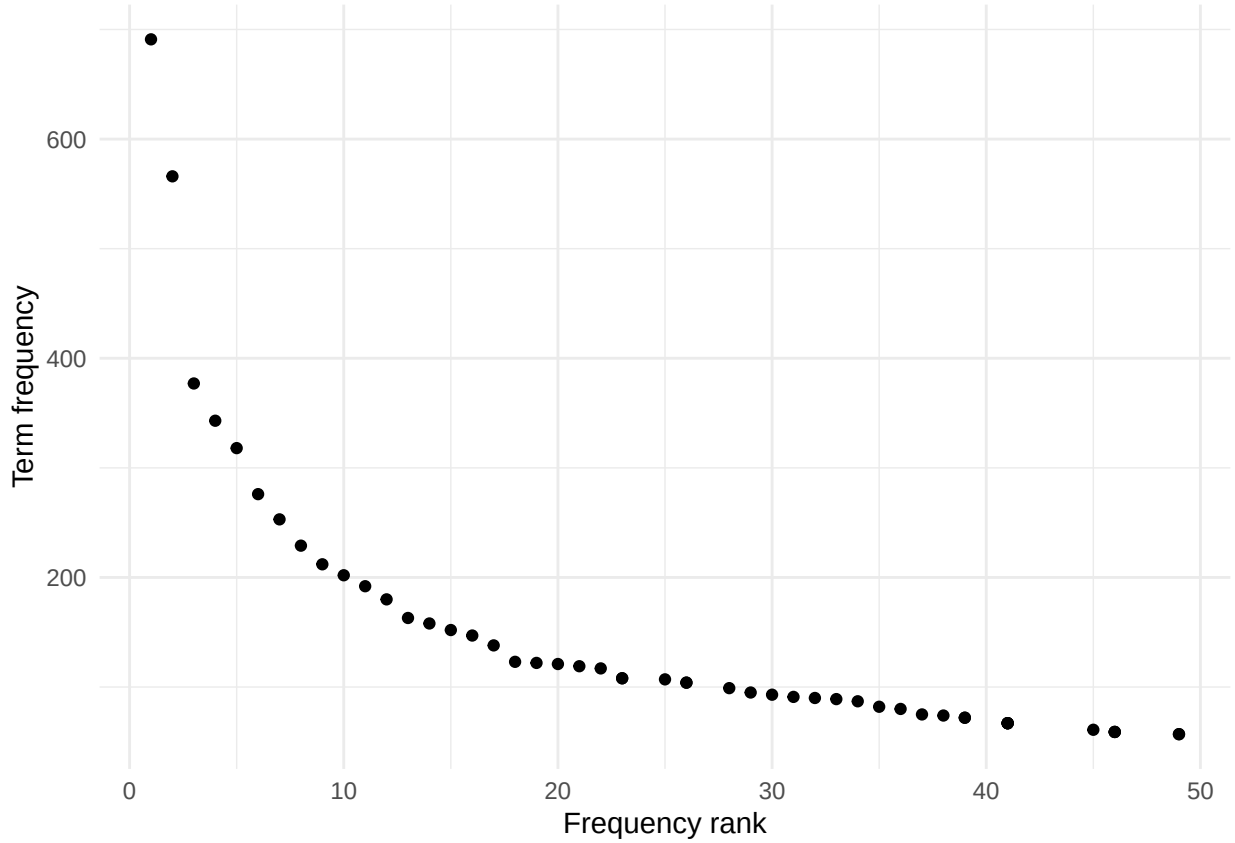
```
library("quanteda.textstats")
```

```
Warning: package 'quanteda.textstats' was built under R version 4.1.2
```

```
textstat_frequency(macbeth_dfm, n = 10)
```

```
   feature frequency rank docfreq group
1      the       691    1       1   all
2      and       566    2       1   all
3       to       377    3       1   all
4       of       343    4       1   all
5        i       318    5       1   all
6  macbeth       276    6       1   all
7        a       253    7       1   all
8     that       229    8       1   all
9       in       212    9       1   all
10     you       202   10       1   all
```

```
# Plot frequency of 50 most frequent terms
library(ggplot2)
theme_set(theme_minimal())
textstat_frequency(macbeth_dfm, n = 50) %>%
  ggplot(aes(x = rank, y = frequency)) +
  geom_point() +
  labs(x = "Frequency rank", y = "Term frequency")
```




```
sorted_macbeth_freqs_t <- topfeatures(macbeth_dfm, n = nfeat(macbeth_dfm))

### 2. Accessing and Comparing Word Frequency Data

## 2.1. Accessing Word Data

# Frequencies of "he" and "she" - these are matrixes, not numerics
sorted_macbeth_freqs_t[c("he", "she", "him", "her")]
```

```
 he she him her
117  19  91  43
```

```
# Another method: indexing the dfm
macbeth_dfm[, c("he", "she", "him", "her")]
```

```
Document-feature matrix of: 1 document, 4 features (0.00% sparse) and 0 docvars.
       features
docs     he she him her
  text1 117  19  91  43
```

```
sorted_macbeth_freqs_t[1]
```

```
the
691
```

```
sorted_macbeth_freqs_t["the"]
```

```
the
691
```

```
# Term frequency ratios
sorted_macbeth_freqs_t["him"] / sorted_macbeth_freqs_t["her"]
```

```
     him
2.116279
```

```
sorted_macbeth_freqs_t["he"] / sorted_macbeth_freqs_t["she"]
```

```
      he
6.157895
```

```
ntoken(macbeth_dfm)
```

```
text1
18190
```

```
sum(sorted_macbeth_freqs_t)
```

```
[1] 18190
```

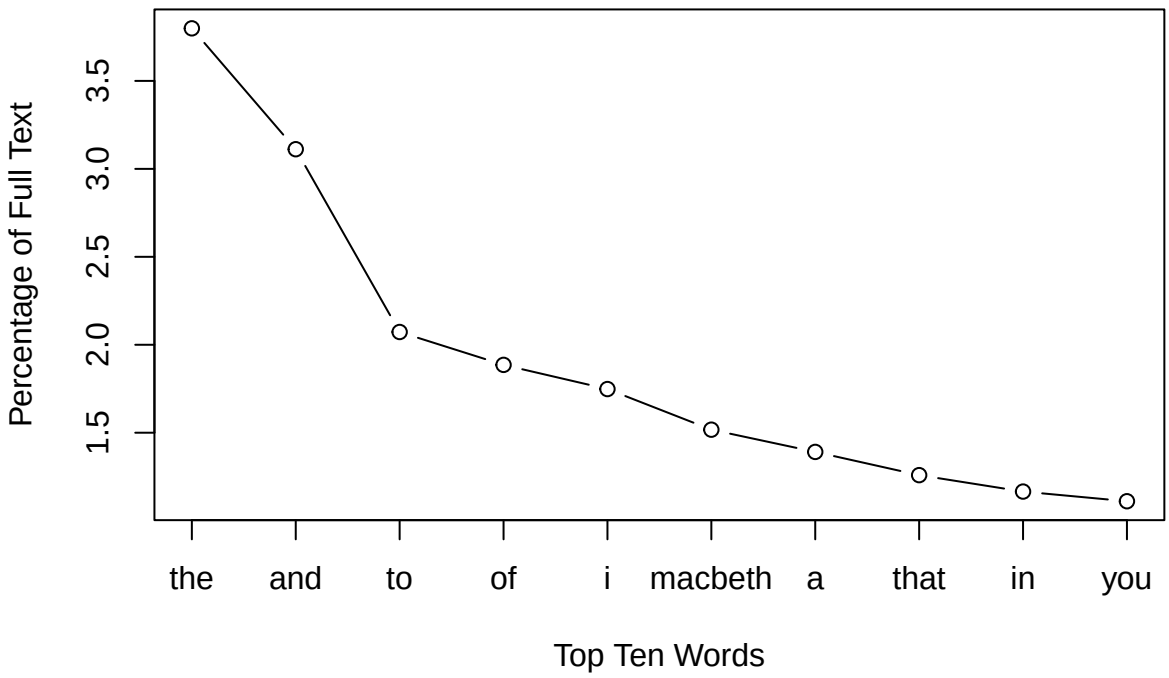
```
## 2.2. Recycling

sorted_macbeth_rel_freqs_t <- sorted_macbeth_freqs_t / sum(sorted_macbeth_freqs_t) * 100
sorted_macbeth_rel_freqs_t["the"]
```

```
     the
3.798791
```

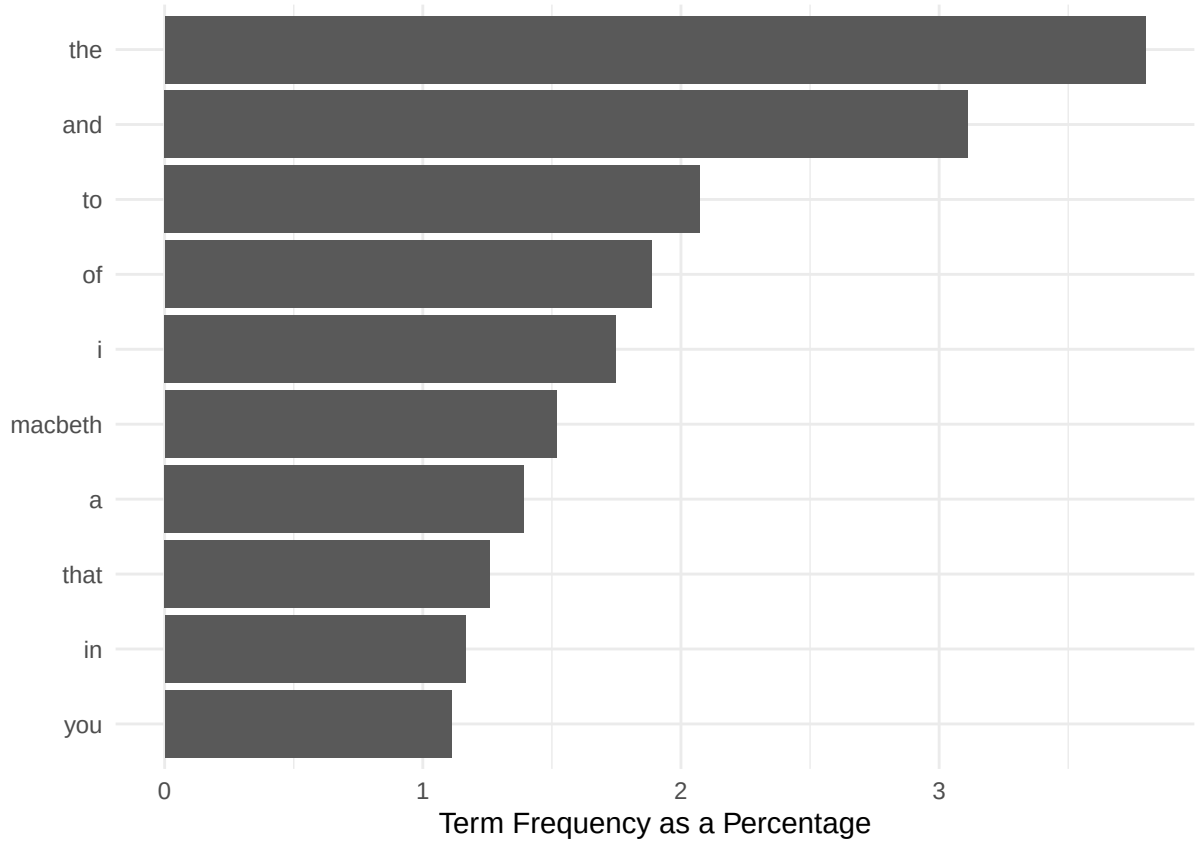
```
# By weighting the dfm directly
macbeth_dfm_pct <- dfm_weight(macbeth_dfm, scheme = "prop") * 100

dfm_select(macbeth_dfm_pct, pattern = "the")
```

```
Document-feature matrix of: 1 document, 1 feature (0.00% sparse) and 0 docvars.
       features
docs          the
  text1 3.798791
```

```
plot(sorted_macbeth_rel_freqs_t[1:10], type = "b",
     xlab = "Top Ten Words", ylab = "Percentage of Full Text", xaxt = "n")
axis(1,1:10, labels = names(sorted_macbeth_rel_freqs_t[1:10]))
```




```
textstat_frequency(macbeth_dfm_pct, n = 10) %>%
  ggplot(aes(x = reorder(feature, -rank), y = frequency)) +
  geom_bar(stat = "identity") + coord_flip() +
  labs(x = "", y = "Term Frequency as a Percentage")
```

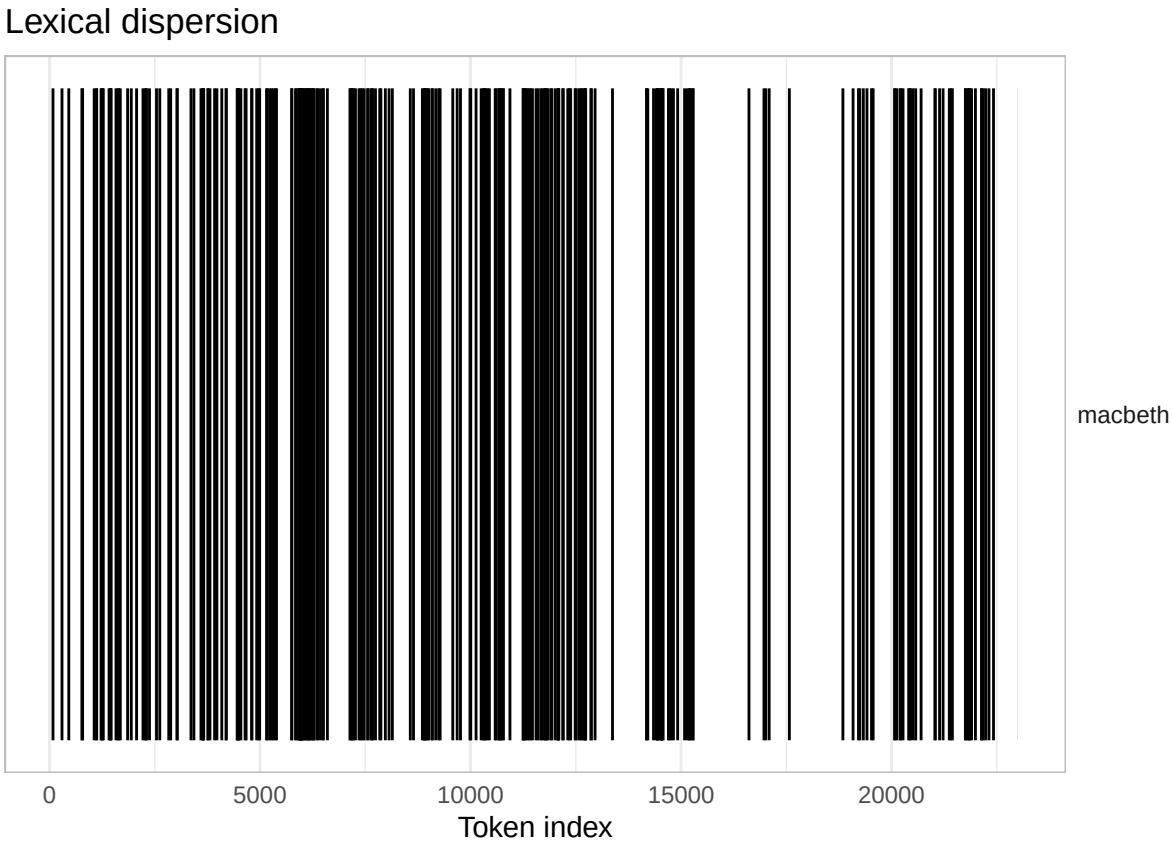



```
### 3. Token Distribution Analysis

## 3.1. Dispersion plots

# Using words from tokenized corpus for dispersion
library("quanteda.textplots")
```

```
Warning: package 'quanteda.textplots' was built under R version 4.1.2
```

```
textplot_xray(kwic(novel_v, pattern = "macbeth")) +
  ggtitle("Lexical dispersion")
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.

Warning: Use of `x$ntokens` is discouraged. Use `ntokens` instead.
```

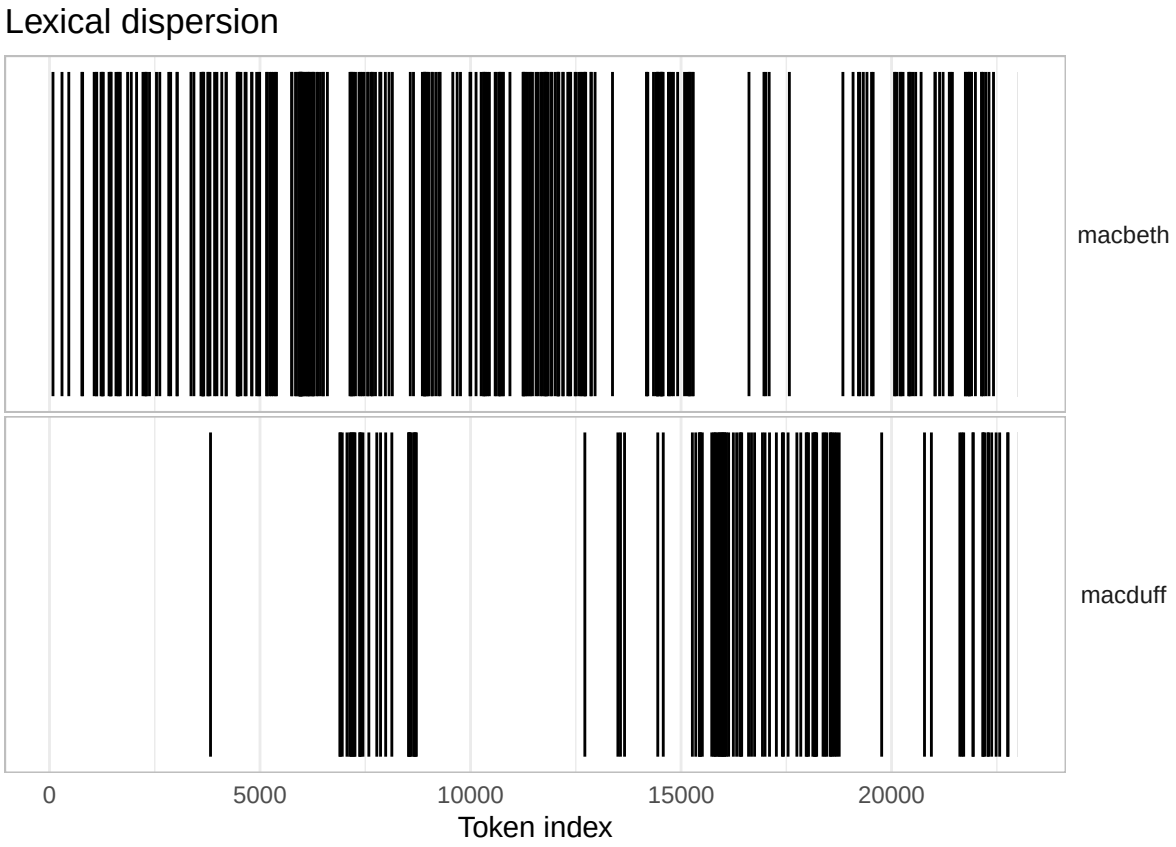



```
textplot_xray(
  kwic(novel_v, pattern = "macbeth"),
  kwic(novel_v, pattern = "macduff")) +
  ggtitle("Lexical dispersion")
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
Warning: Use of `x$ntokens` is discouraged. Use `ntokens` instead.
```




```
## 3.2. Searching with regular expression

# Identify the chapter break locations
chap_positions_v <- kwic(novel_v, phrase(c("SCENE")), valuetype = "regex")$from
```

```
Warning: 'kwic.character()' is deprecated. Use 'tokens()' first.
```

```
head(chap_positions_v)
```

```
[1]    1  128  796 2391 3015 3797
```

```
chap_positions_v
```

```
 [1]     1   128   796  2391  3015  3797  4162  5036  5745  6635  8301  8774
[13] 10295 10898 11231 12904 13253 13773 15422 16408 18882 19721 20061 20756
[25] 21016 21598 21738 22125
```

```
## 3.3. Identifying chapter breaks

chapters_corp <-
  corpus(novel_v) %>%
  corpus_segment(pattern = "SCENE\\s*.*\\n", valuetype = "regex")
summary(chapters_corp, 10)
```

```
Corpus consisting of 28 documents, showing 10 documents:

     Text Types Tokens Sentences
  text1.1    67    120        25
  text1.2   361    660        52
  text1.3   591   1589       145
  text1.4   316    613        45
  text1.5   373    771        54
  text1.6   203    355        26
  text1.7   416    862        53
  text1.8   339    699        52
  text1.9   367    884       103
 text1.10   618   1660       163
                                        pattern
                      SCENE I. An open Place.\n
                  SCENE II. A Camp near Forres.\n
                             SCENE III. A heath.\n
         SCENE IV. Forres. A Room in the Palace.\n
 SCENE V. Inverness. A Room in Macbethâs Castle.\n
          SCENE VI. The same. Before the Castle.\n
     SCENE VII. The same. A Lobby in the Castle.\n
    SCENE I. Inverness. Court within the Castle.\n
                             SCENE II. The same.\n
                            SCENE III. The same.\n
```

```
docvars(chapters_corp, "pattern") <- stringi::stri_trim_right(docvars(chapters_corp, "pattern"))
summary(chapters_corp, n = 3)
```

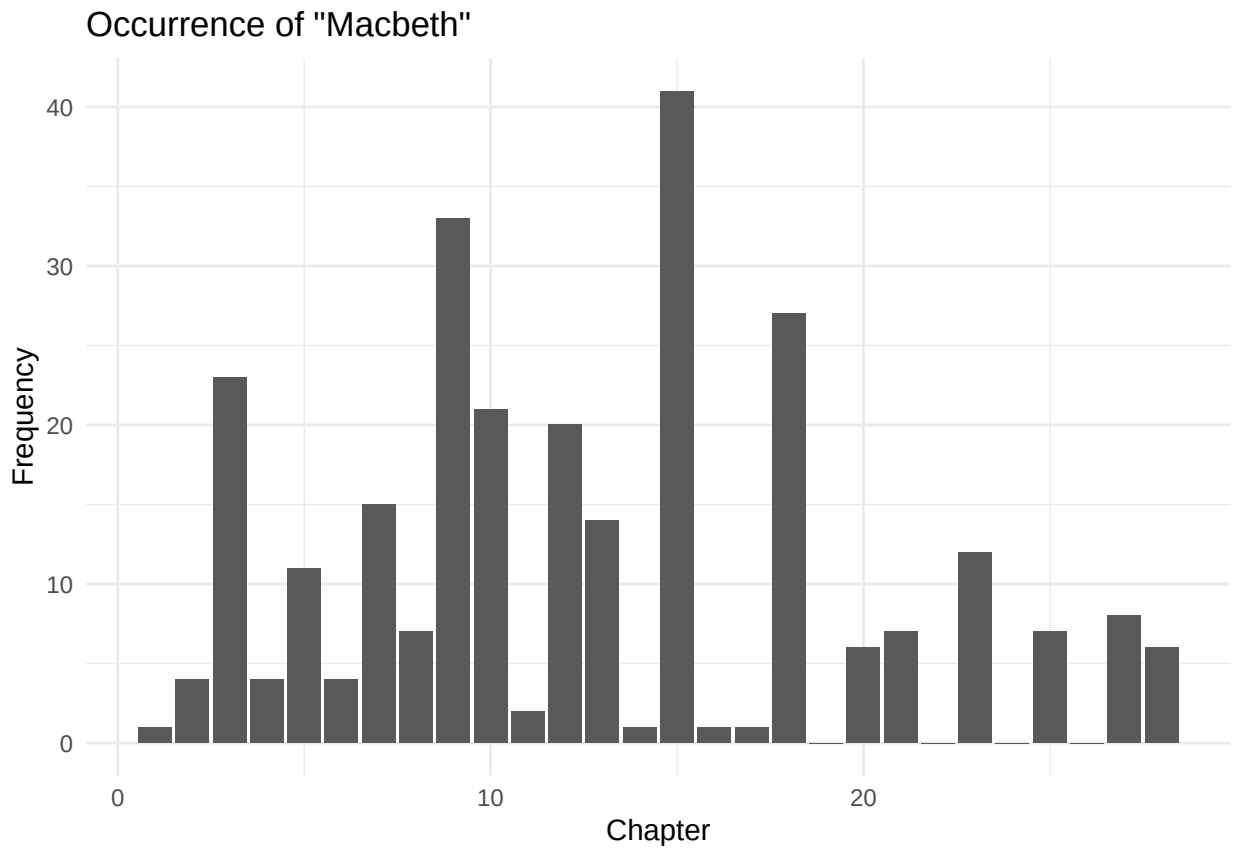
```
Corpus consisting of 28 documents, showing 3 documents:

    Text Types Tokens Sentences                       pattern
 text1.1    67    120        25       SCENE I. An open Place.
 text1.2   361    660        52 SCENE II. A Camp near Forres.
 text1.3   591   1589       145           SCENE III. A heath.
```

```
docnames(chapters_corp) <- docvars(chapters_corp, "pattern")

## 3.4. Barplots of Macbeth and Macduff

# Create a dfm
chap_dfm <- dfm(chapters_corp)
```

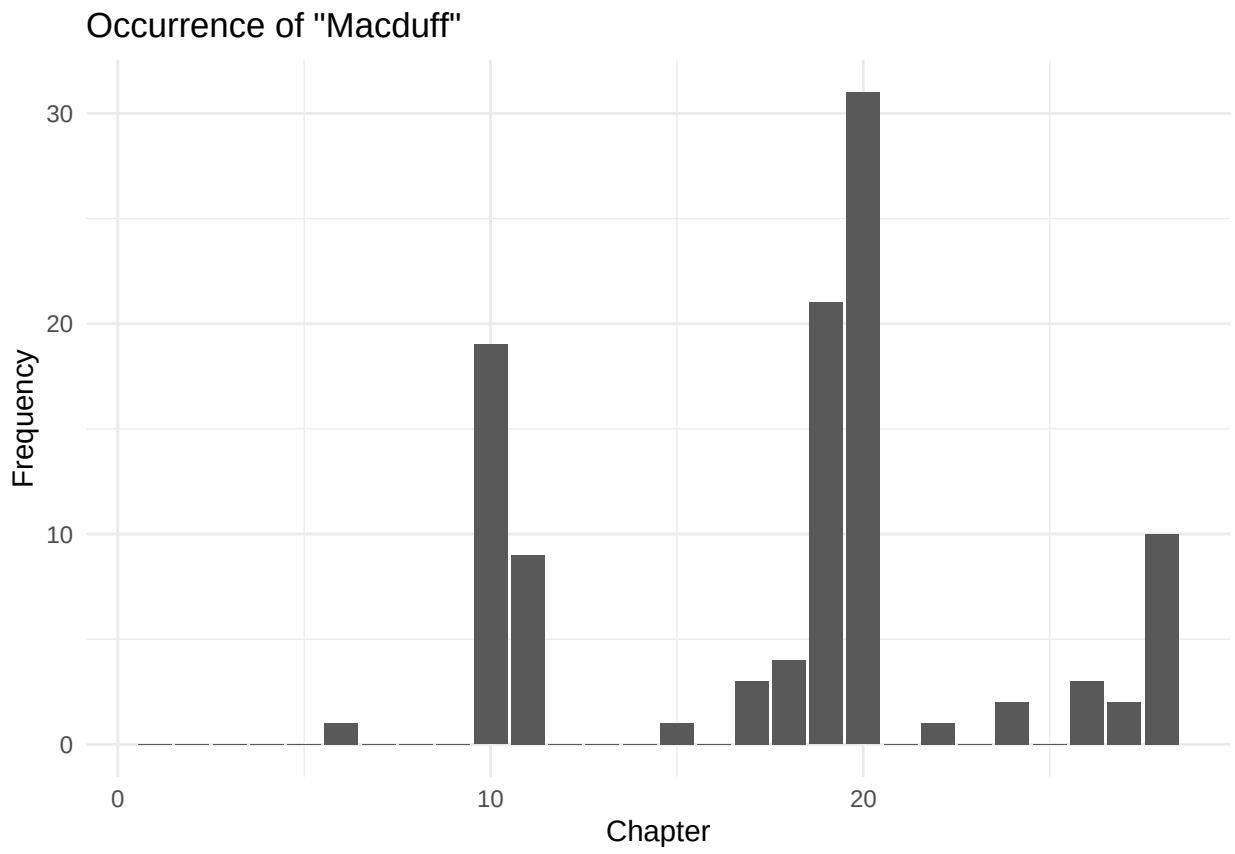
```
Warning: 'dfm.corpus()' is deprecated. Use 'tokens()' first.
```

```
# Extract row with count for "whale"/"ahab" in each chapter and convert to data frame for plotting
macbeth_macduff_df <- chap_dfm %>%
  dfm_keep(pattern = c("macbeth", "macduff")) %>%
  convert(to = "data.frame")

macbeth_macduff_df$chapter <- 1:nrow(macbeth_macduff_df)

ggplot(data = macbeth_macduff_df, aes(x = chapter, y = macbeth)) +
```

```
  geom_bar(stat = "identity") +
  labs(x = "Chapter",
       y = "Frequency",
       title = 'Occurrence of "Macbeth"')
```




```
ggplot(data = macbeth_macduff_df, aes(x = chapter, y = macduff)) +
  geom_bar(stat = "identity") +
  labs(x = "Chapter",
       y = "Frequency",
       title = 'Occurrence of "Macduff"')
```

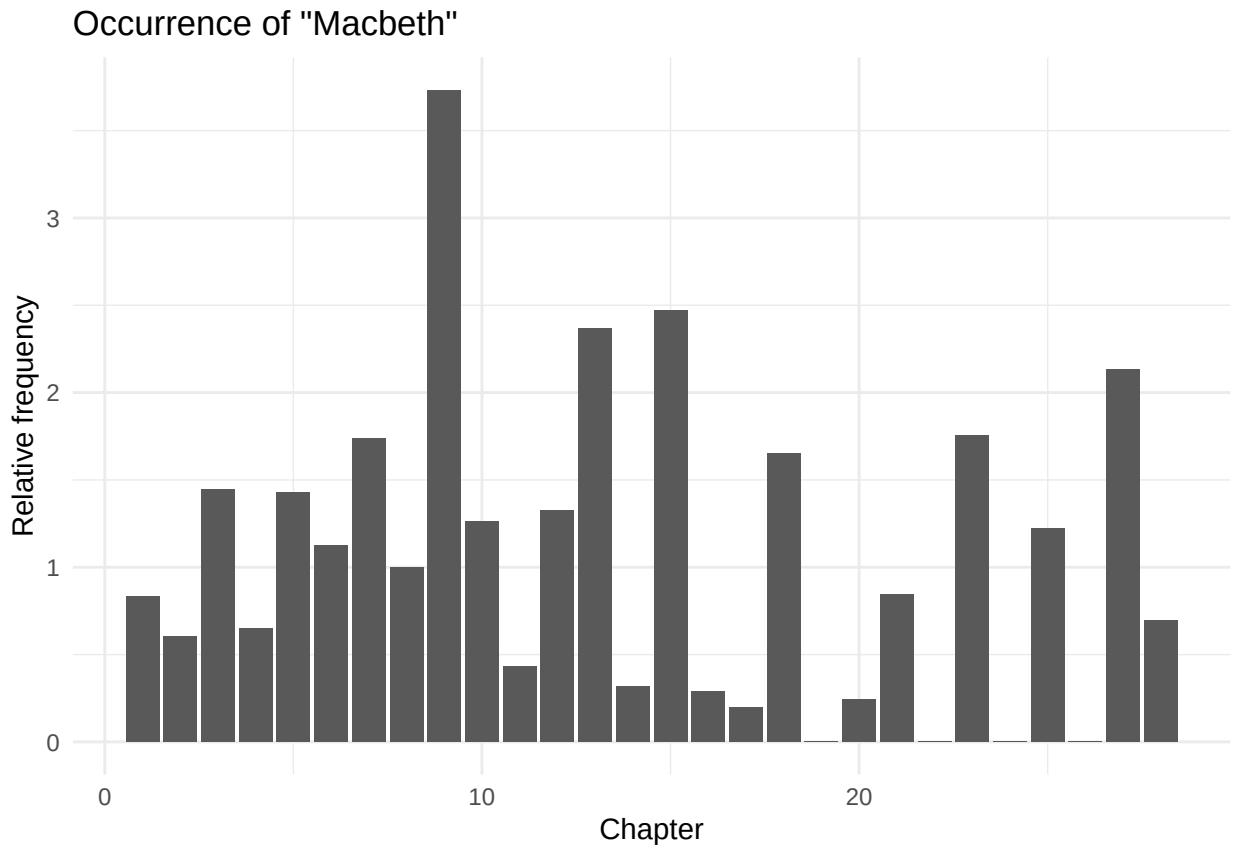



```
rel_dfm <- dfm_weight(chap_dfm, scheme = "prop") * 100
head(rel_dfm)
```

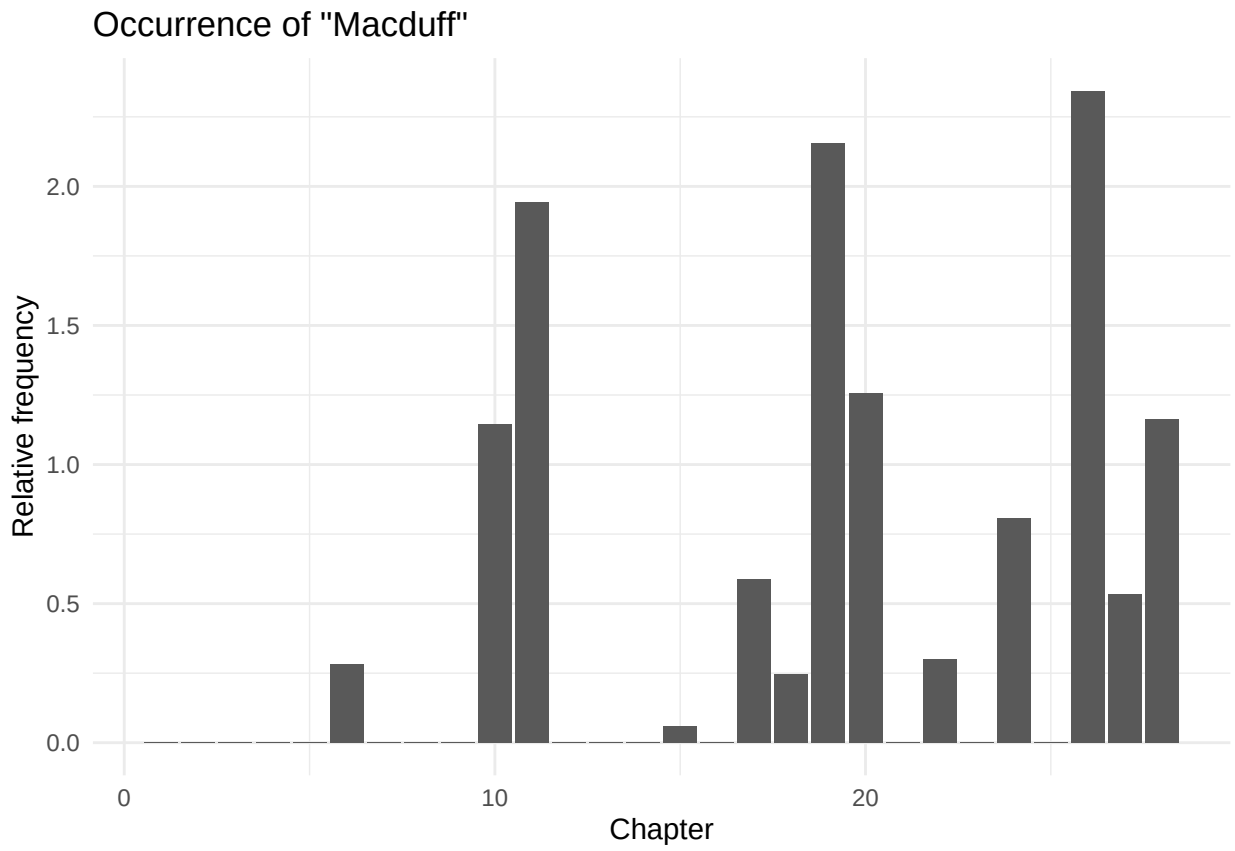
```
Document-feature matrix of: 6 documents, 3,500 features (91.86% sparse) and 1 docvar.
                                                 features
docs                                                 thunder      and lightning
  SCENE I. An open Place.                          1.66666667 3.333333  1.666667
  SCENE II. A Camp near Forres.                    0          1.818182  0
  SCENE III. A heath.                              0.06293266 2.769037  0
  SCENE IV. Forres. A Room in the Palace.          0          2.610114  0
  SCENE V. Inverness. A Room in Macbethâs Castle. 0          2.464332  0
  SCENE VI. The same. Before the Castle.           0          3.943662  0
                                                 features
docs                                                      .     enter
  SCENE I. An open Place.                          16.666667 0.8333333
  SCENE II. A Camp near Forres.                     6.363636 0.3030303
  SCENE III. A heath.                               7.614852 0.1887980
  SCENE IV. Forres. A Room in the Palace.           6.035889 0.3262643
  SCENE V. Inverness. A Room in Macbethâs Castle.  5.577173 0.3891051
  SCENE VI. The same. Before the Castle.            6.760563 0.5633803
                                                 features
docs                                                   three    witches
  SCENE I. An open Place.                          1.66666667 0.83333333
  SCENE II. A Camp near Forres.                    0          0
  SCENE III. A heath.                              0.06293266 0.06293266
```

```
  SCENE IV. Forres. A Room in the Palace.         0          0
  SCENE V. Inverness. A Room in Macbethâs Castle. 0          0
  SCENE VI. The same. Before the Castle.          0          0
                                                features
docs                                                first    witch      when
  SCENE I. An open Place.                        2.500000 7.500000 2.5000000
  SCENE II. A Camp near Forres.                  0        0        0
  SCENE III. A heath.                            0.566394 1.384519 0.1258653
  SCENE IV. Forres. A Room in the Palace.        0        0        0.1631321
  SCENE V. Inverness. A Room in Macbethâs Castle. 0        0        0.2594034
  SCENE VI. The same. Before the Castle.         0        0        0
[ reached max_nfeat ... 3,490 more features ]
```

```
# Subset dfm and convert to data.frame object
rel_chap_freq <- rel_dfm %>%
  dfm_keep(pattern = c("macbeth", "macduff")) %>%
  convert(to = "data.frame")

rel_chap_freq$chapter <- 1:nrow(rel_chap_freq)
ggplot(data = rel_chap_freq, aes(x = chapter, y = macbeth)) +
  geom_bar(stat = "identity") +
  labs(x = "Chapter", y = "Relative frequency",
       title = 'Occurrence of "Macbeth"')
```



```
ggplot(data = rel_chap_freq, aes(x = chapter, y = macduff)) +
  geom_bar(stat = "identity") +
  labs(x = "Chapter", y = "Relative frequency",
       title = 'Occurrence of "Macduff"')
```



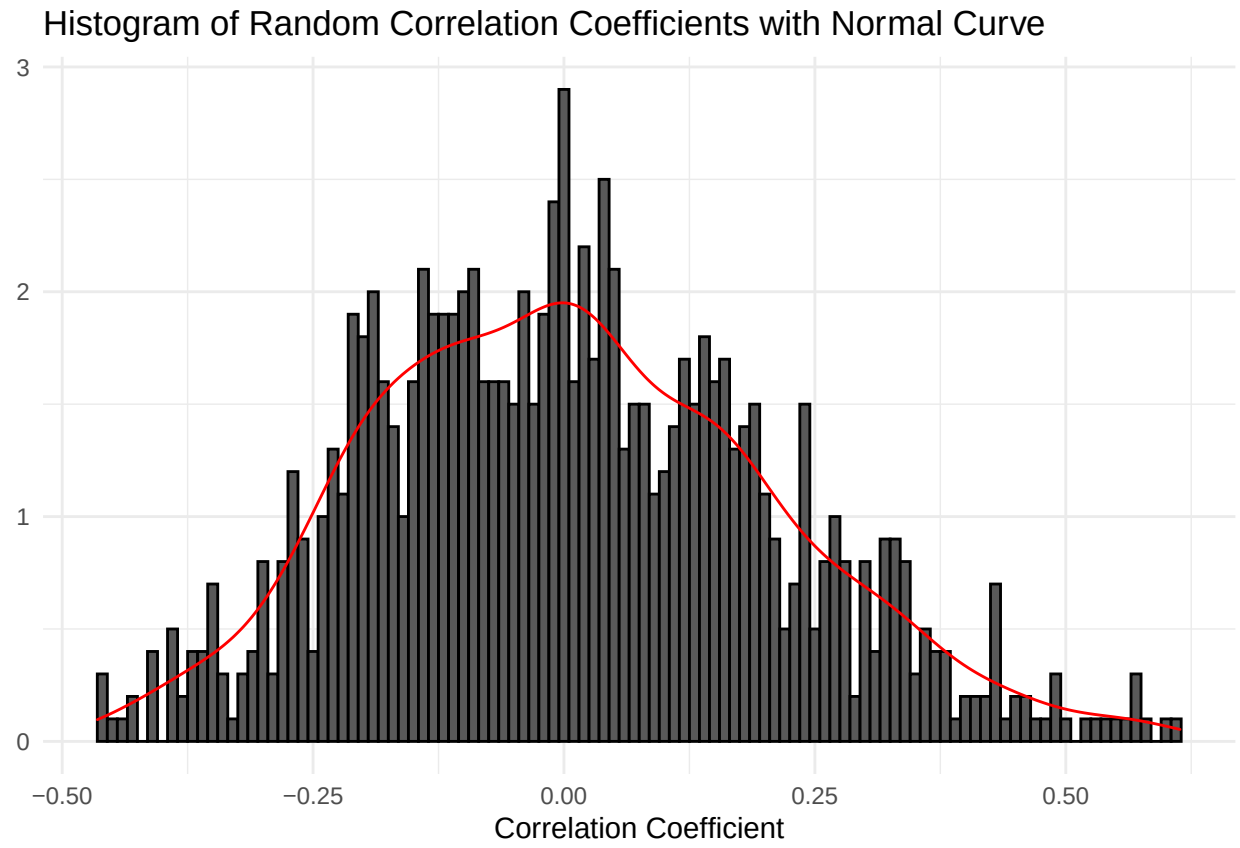

```
### 4. Correlation

## 4.1. Correlation Analysis

dfm_weight(chap_dfm, scheme = "prop") %>%
  textstat_simil(selection = c("macbeth", "macduff"), method = "correlation", margin = "features") %>%
  as.matrix() %>%
  head(2)
```

```
Warning: 'selection' is deprecated. Use 'y' instead.
```

```
            macbeth    macduff
thunder -0.06668006 -0.1554300
and     -0.34230943  0.2220466
```

```
## 4.2. Testing Correlation with Randomization+

cor_data_df <- dfm_weight(chap_dfm, scheme = "prop") %>%
  dfm_keep(pattern = c("macbeth", "macduff")) %>%
```

```
  convert(to = "data.frame")

# Sample 1000 replicates and create data frame
n <- 1000
samples <- data.frame(
  cor_sample = replicate(n, cor(sample(cor_data_df$macbeth), cor_data_df$macduff)),
  id_sample = 1:n
)

# Plot distribution of resampled correlations
ggplot(data = samples, aes(x = cor_sample, y = ..density..)) +
  geom_histogram(colour = "black", binwidth = 0.01) +
  geom_density(colour = "red") +
  labs(x = "Correlation Coefficient", y = NULL,
       title = "Histogram of Random Correlation Coefficients with Normal Curve")
```




```
### 5. Measures of Lexical Variety

## 5.1. Mean word frequency

# Length of the book in chapters
ndoc(chapters_corp)
```

```
[1] 28
```

```
# Chapter names
docnames(chapters_corp) %>% head()
```

```
[1] "SCENE I. An open Place."
[2] "SCENE II. A Camp near Forres."
[3] "SCENE III. A heath."
[4] "SCENE IV. Forres. A Room in the Palace."
[5] "SCENE V. Inverness. A Room in Macbethâs Castle."
[6] "SCENE VI. The same. Before the Castle."
```

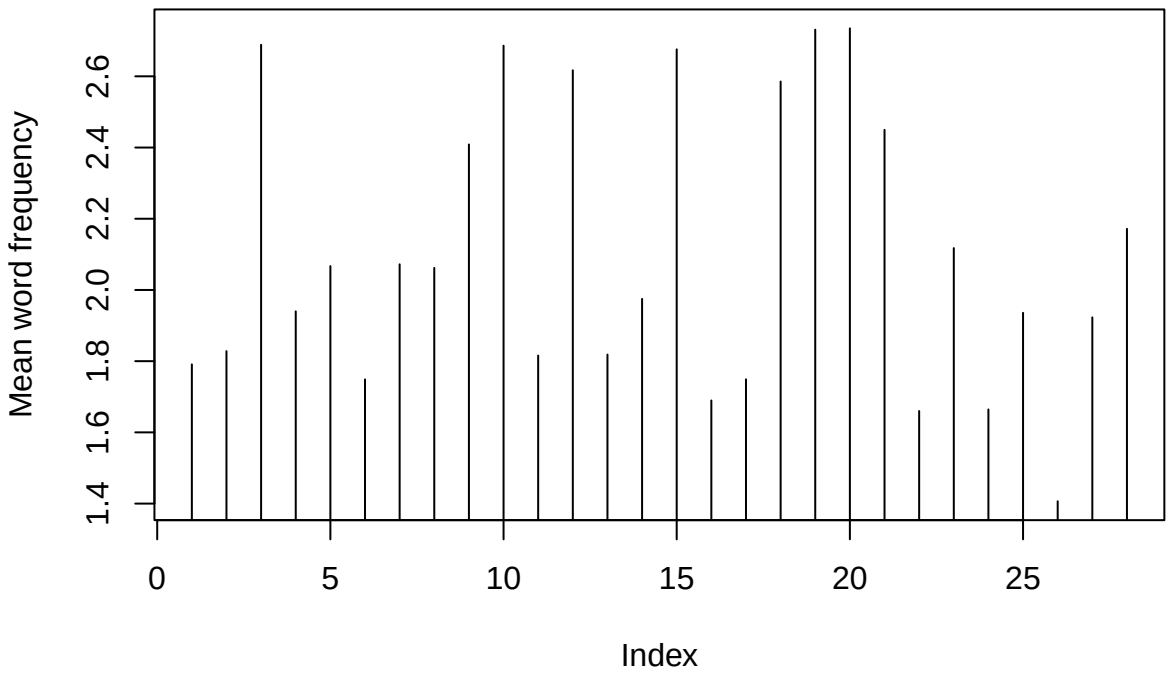
```
# For first few chapters
ntoken(chapters_corp) %>% head()
```

```
                      SCENE I. An open Place.
                                          120
                 SCENE II. A Camp near Forres.
                                          660
                            SCENE III. A heath.
                                         1589
       SCENE IV. Forres. A Room in the Palace.
                                          613
SCENE V. Inverness. A Room in Macbethâs Castle.
                                          771
        SCENE VI. The same. Before the Castle.
                                          355
```

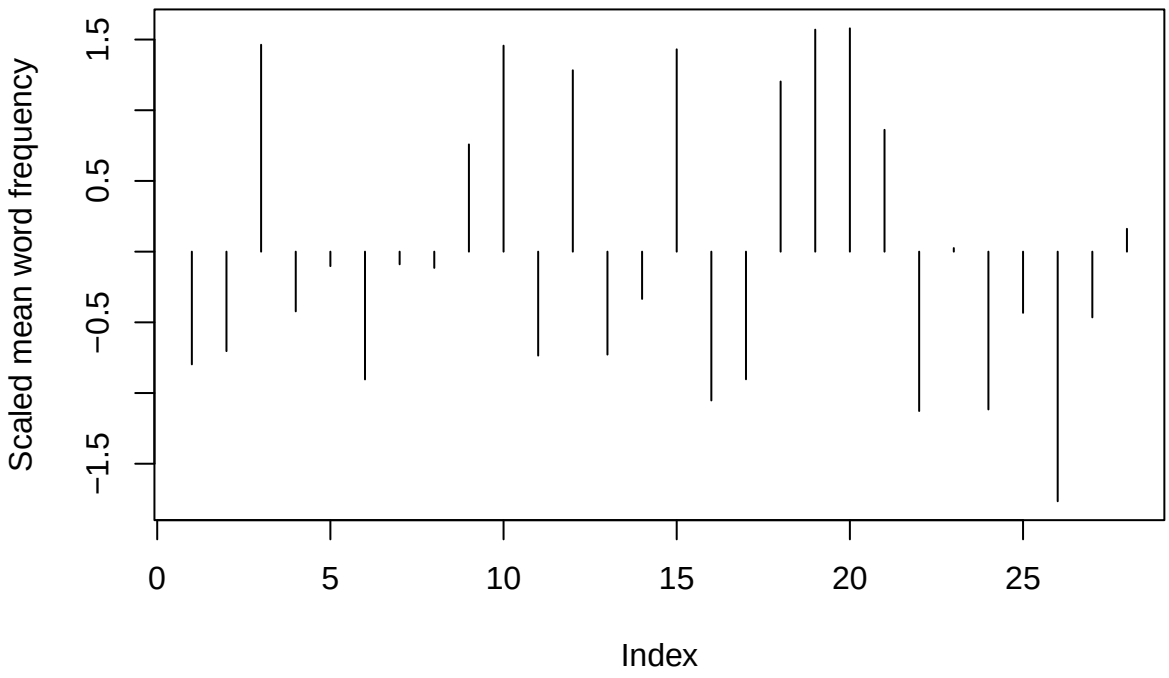
```
# Average
(ntoken(chapters_corp) / ntype(chapters_corp)) %>% head()
```

```
                      SCENE I. An open Place.
                                    1.791045
                 SCENE II. A Camp near Forres.
                                    1.828255
                            SCENE III. A heath.
                                    2.688663
       SCENE IV. Forres. A Room in the Palace.
                                    1.939873
SCENE V. Inverness. A Room in Macbethâs Castle.
                                    2.067024
        SCENE VI. The same. Before the Castle.
                                    1.748768
```

```
## 5.2. Extracting Word Usage Means

(ntoken(chapters_corp) / ntype(chapters_corp)) %>%
  plot(type = "h", ylab = "Mean word frequency")
```




```
(ntoken(chapters_corp) / ntype(chapters_corp)) %>%
  scale() %>%
  plot(type = "h", ylab = "Scaled mean word frequency")
```




```
## 5.3. Ranking the values

mean_word_use_m <- (ntoken(chapters_corp) / ntype(chapters_corp))
sort(mean_word_use_m, decreasing = TRUE) %>% head()
```

```
     SCENE III. England. Before the Kingâs Palace.
                                          2.734739
       SCENE II. Fife. A Room in Macduffâs Castle.
                                          2.731092
                               SCENE III. A heath.
                                          2.688663
                             SCENE III. The same.
                                          2.686084
SCENE IV. The same. A Room of state in the Palace.
                                          2.675806
            SCENE I. Forres. A Room in the Palace.
                                          2.616984
```

```
## 5.4. Calculating the TTR

dfm(chapters_corp) %>%
  textstat_lexdiv(measure = "TTR") %>%
  head(n = 10)
```

```
Warning: 'dfm.corpus()' is deprecated. Use 'tokens()' first.
```

```
                                       document       TTR
1                         SCENE I. An open Place. 0.6321839
2                    SCENE II. A Camp near Forres. 0.6057143
3                              SCENE III. A heath. 0.4022436
4           SCENE IV. Forres. A Room in the Palace. 0.5472837
5  SCENE V. Inverness. A Room in Macbethâs Castle. 0.5078616
6            SCENE VI. The same. Before the Castle. 0.6289753
7       SCENE VII. The same. A Lobby in the Castle. 0.4945205
8     SCENE I. Inverness. Court within the Castle. 0.5222816
9                              SCENE II. The same. 0.4580925
10                            SCENE III. The same. 0.4247439
```

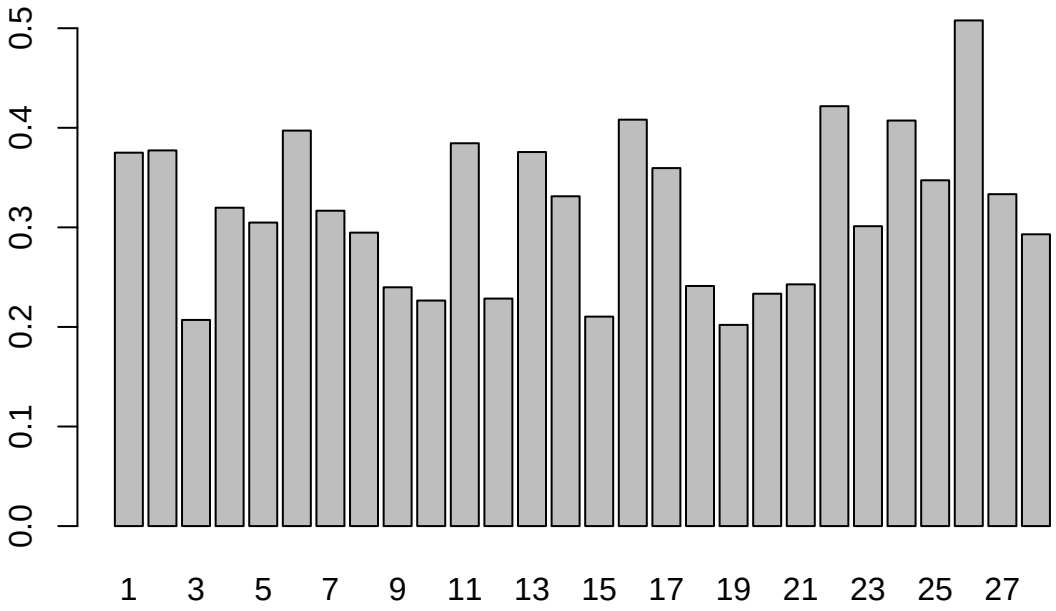
```
### 6. Hapax Richness

# Hapaxes per document
rowSums(chap_dfm == 1) %>% head()
```

```
                         SCENE I. An open Place.
                                              45
                    SCENE II. A Camp near Forres.
                                             249
                               SCENE III. A heath.
                                             329
          SCENE IV. Forres. A Room in the Palace.
                                             196
SCENE V. Inverness. A Room in Macbethâs Castle.
                                             235
           SCENE VI. The same. Before the Castle.
                                             141
```

```
# As a proportion
hapax_proportion <- rowSums(chap_dfm == 1) / ntoken(chap_dfm)
head(hapax_proportion)
```

```
                         SCENE I. An open Place.
                                       0.3750000
                    SCENE II. A Camp near Forres.
                                       0.3772727
                               SCENE III. A heath.
                                       0.2070485
          SCENE IV. Forres. A Room in the Palace.
                                       0.3197390
SCENE V. Inverness. A Room in Macbethâs Castle.
                                       0.3047990
           SCENE VI. The same. Before the Castle.
                                       0.3971831
```

```
barplot(hapax_proportion, beside = TRUE, col = "grey", names.arg = seq_len(ndoc(chap_dfm)))
```


0.0
0.1
0.2
0.3
0.4
0.5
1
3
5
7
9
11
13
15
17
19
21
23
25
27