EDS 231 - Word Relationships

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```
library(tidyr) #text analysis in R
library(pdftools)
```

```
## Using poppler version 22.02.0
```

```
library(lubridate) #working with date data
```

```
##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.5     v dplyr   1.0.7
## v tibble  3.1.6     v stringr 1.4.0
## v readr   2.1.1     v forcats 0.5.1
## v purrr   0.3.4

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x lubridate::as.difftime() masks base::as.difftime()
## x lubridate::date()        masks base::date()
## x dplyr::filter()          masks stats::filter()
## x lubridate::intersect()   masks base::intersect()
## x dplyr::lag()             masks stats::lag()
## x lubridate::setdiff()     masks base::setdiff()
## x lubridate::union()       masks base::union()
```

```
library(tidytext)
library(readr)
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) #quanteda subpackage for reading pdf
library(quanteda.textstats)
library(quanteda.textplots)
library(ggplot2)
```

```
library(forcats)
library(stringr)
library(quanteda.textplots)
library(widyr)# pairwise correlations
library(igraph) #network plots
```

```
##
## Attaching package: 'igraph'

## The following object is masked from 'package:quanteda.textplots':
##
##     as.igraph

## The following objects are masked from 'package:dplyr':
##
##     as_data_frame, groups, union

## The following objects are masked from 'package:purrr':
##
##     compose, simplify

## The following object is masked from 'package:tibble':
##
##     as_data_frame

## The following objects are masked from 'package:lubridate':
##
##     %--%, union

## The following object is masked from 'package:tidyr':
##
##     crossing

## The following objects are masked from 'package:stats':
##
##     decompose, spectrum

## The following object is masked from 'package:base':
##
##     union
```

```
library(ggraph)
library(patchwork)
```

Import EPA EJ Data

```
setwd('.')
files <- list.files(pattern = "pdf$")

ej_reports <- lapply(files, pdf_text)

ej_pdf <- readtext("*.pdf", docvarsfrom = "filenames",
                    docvarnames = c("type", "subj", "year"),
                    sep = "_")

#creating an initial corpus containing our data
```

```r
epa_corp <- corpus(x = ej_pdf, text_field = "text" )
summary(epa_corp)
```

```
## Corpus consisting of 6 documents, showing 6 documents:
##
##              Text Types Tokens Sentences type subj year
##  EPA_EJ_2015.pdf  2136   8944       263  EPA   EJ 2015
##  EPA_EJ_2016.pdf  1599   7965       176  EPA   EJ 2016
##  EPA_EJ_2017.pdf  2774  16658       447  EPA   EJ 2017
##  EPA_EJ_2018.pdf  3973  30564       653  EPA   EJ 2018
##  EPA_EJ_2019.pdf  3773  22648       672  EPA   EJ 2019
##  EPA_EJ_2020.pdf  4493  30523       987  EPA   EJ 2020
```

```r
#I'm adding some additional, context-specific stop words to stop word lexicon
more_stops <-c("2015","2016", "2017", "2018", "2019", "2020", "www.epa.gov", "https")
add_stops<- tibble(word = c(stop_words$word, more_stops))
stop_vec <- as_vector(add_stops)
```

Now we'll create some different data objects that will set us up for the subsequent analyses

```r
#convert to tidy format and apply my stop words
raw_text <- tidy(epa_corp)

#Distribution of most frequent words across documents
raw_words <- raw_text %>%
  mutate(year = as.factor(year)) %>%
  unnest_tokens(word, text) %>%
  anti_join(add_stops, by = 'word') %>%
  count(year, word, sort = TRUE)

#number of total words by document
total_words <- raw_words %>%
  group_by(year) %>%
  summarize(total = sum(n))

report_words <- left_join(raw_words, total_words)
```

```
## Joining, by = "year"
```

```r
# for the analysis that we want to do at the word level:
par_tokens <- unnest_tokens(raw_text, output = paragraphs, input = text, token = "paragraphs")

par_tokens <- par_tokens %>%
 mutate(par_id = 1:n())

par_words <- unnest_tokens(par_tokens, output = word, input = paragraphs, token = "words")
```

```r
tokens <- tokens(epa_corp, remove_punct = TRUE) # create token obj
toks1<- tokens_select(tokens, min_nchar = 3)
toks1 <- tokens_tolower(toks1)
toks1 <- tokens_remove(toks1, pattern = (stop_vec)) # remove stop words
dfm <- dfm(toks1) # has docs in 1 col, the rows refer to num of occurrences for each word in the corpus
# fundamental obj for text analysis in quanteda

#first the basic frequency stat
tstat_freq <- textstat_frequency(dfm, n = 5, groups = year)
```

```r
head(tstat_freq, 10)
```

```
##          feature frequency rank docfreq group
## 1  environmental       127    1       1  2015
## 2    communities        99    2       1  2015
## 3            epa        92    3       1  2015
## 4        justice        84    4       1  2015
## 5      community        47    5       1  2015
## 6  environmental       109    1       1  2016
## 7    communities        85    2       1  2016
## 8        justice        71    3       1  2016
## 9            epa        48    4       1  2016
## 10       federal        31    5       1  2016
```

1. What are the most frequent trigrams in the dataset? How does this compare to the most frequent bigrams? Which n-gram seems more informative here, and why?

Start by looking at bigrams:

```r
toks2 <- tokens_ngrams(toks1, n=2) # bigram, tokenize, it goes thru the text with a 2 word window and c
dfm2 <- dfm(toks2)
dfm2 <- dfm_remove(dfm2, pattern = c(stop_vec))
freq_words2 <- textstat_frequency(dfm2, n=20)
freq_words2$token <- rep("bigram", 20)
#tokens1 <- tokens_select(tokens1,pattern = stopwords("en"), selection = "remove")

head(freq_words2)
```

```
##                 feature frequency rank docfreq group  token
## 1 environmental_justice       556    1       6   all bigram
## 2  technical_assistance       139    2       6   all bigram
## 3        drinking_water       133    3       6   all bigram
## 4         public_health       123    4       6   all bigram
## 5       progress_report       108    5       6   all bigram
## 6           air_quality        73    6       6   all bigram
```

The top 5 most frequent bigrams are:
1. environmental_justice
2. technical_assistance
3. drinking_water
4. public_health
5. progress_report

```r
toks2 <- tokens_ngrams(toks1, n = 3) # trigram, tokenize, it goes thru the text with a 3 word window an
dfm2 <- dfm(toks2)
dfm2 <- dfm_remove(dfm2, pattern = c(stop_vec))
freq_words2 <- textstat_frequency(dfm2, n=20)
freq_words2$token <- rep("trigram", 20)

head(freq_words2)
```

```
##                            feature frequency rank docfreq group   token
## 1        justice_fy2017_progress        51    1       1   all trigram
## 2         fy2017_progress_report        51    1       1   all trigram
```

```
## 3    environmental_public_health        50    3        6    all trigram
## 4   environmental_justice_fy2017        50    3        1    all trigram
## 5 national_environmental_justice        37    5        6    all trigram
## 6   office_environmental_justice        32    6        6    all trigram
```

The top 5 most frequent trigrams are:
1. justice_fy2017_progress
2. fy2017_progress_report
3. environmental_public_health
4. environmental_justice_fy2017
5. national_environmental_justice

The trigrams show more repetitive words such as justice, progress, fy2017, and environmental, and appear to be words that do not form a sensical, stand-alone phrase when read together, while the bigrams are more diverse and the words make sense when read together in sequence. Therefore I think that bigrams are more informative here.

2. Choose a new focal term to replace "justice" and recreate the correlation table and network (see corr_paragraphs and corr_network chunks). Explore some of the plotting parameters in the cor_network chunk to see if you can improve the clarity or amount of information your plot conveys. Make sure to use a different color for the ties!

```
word_cors <- par_words %>%
  add_count(par_id) %>%
  filter(n >= 50) %>%
  select(-n) %>%
  pairwise_cor(word, par_id, sort = TRUE) # generates correlation coefficients rather than just the num
# cols = item1 and item2 and correlation

wildlife_cors <- word_cors %>%
  filter(item1 == "wildlife")

word_cors %>%
  filter(item1 %in% c("wildlife", "environmental", "equity", "income")) %>%
  group_by(item1) %>%
  top_n(6) %>%
  #slice_max(item1, n = 6) %>%
  ungroup() %>%
  mutate(item1 = as.factor(item1),
  name = reorder_within(item2, correlation, item1)) %>%
  ggplot(aes(y = name, x = correlation, fill = item1)) +
  geom_col(show.legend = FALSE) +
  facet_wrap(~item1, ncol = 2, scales = "free")+
  scale_y_reordered() +
  labs(y = NULL,
         x = NULL,
         title = "Correlations with key words",
         subtitle = "EPA EJ Reports")
```

```
## Selecting by correlation
```

```
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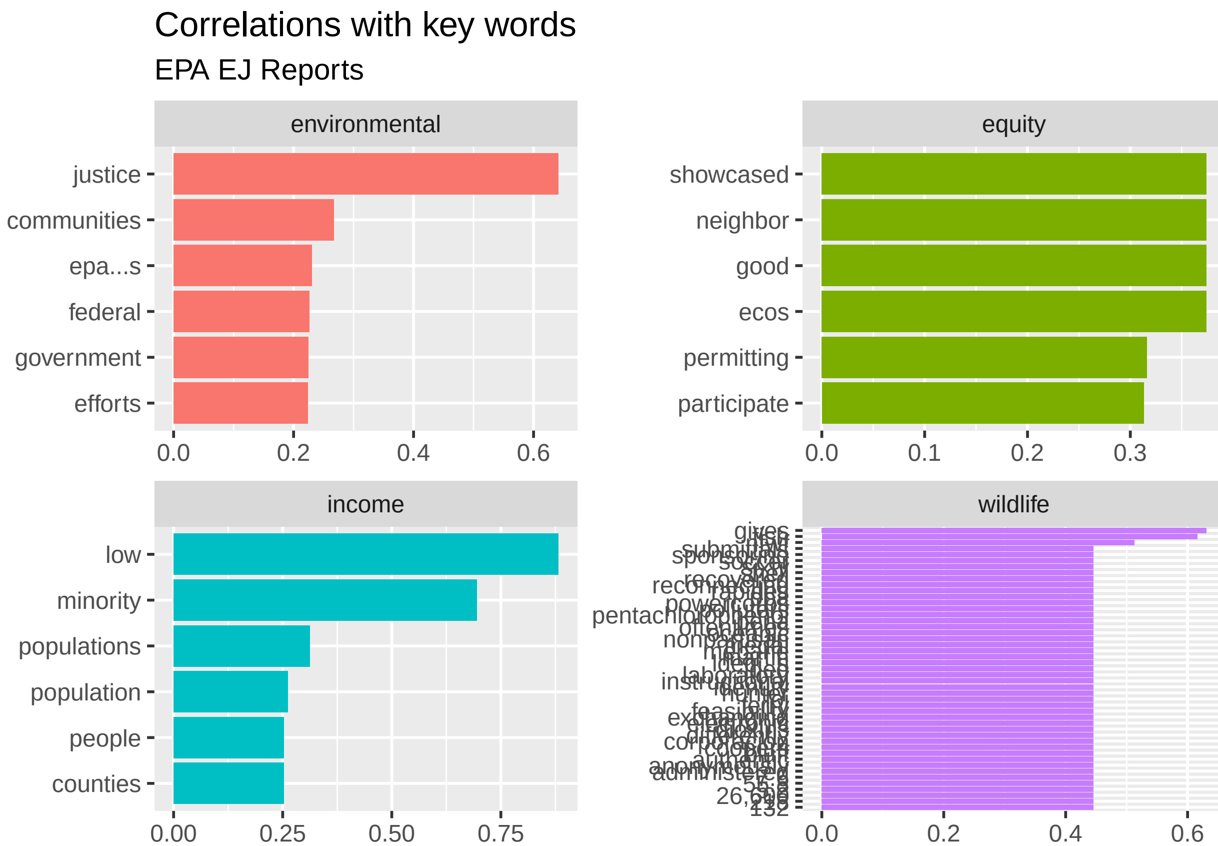


```
#let's zoom in on just one of our key terms
wildlife_cors <- word_cors %>%
  filter(item1 == "wildlife") %>%
  mutate(n = 1:n())

head(wildlife_cors)
```

```
## # A tibble: 6 x 4
##   item1    item2 correlation     n
##   <chr>    <chr>       <dbl> <int>
## 1 wildlife gives       0.631     1
## 2 wildlife fish        0.616     2
## 3 wildlife nfwf        0.513     3
## 4 wildlife 218         0.446     4
## 5 wildlife 132         0.446     5
## 6 wildlife 55.8        0.446     6
```

Not surprisingly, the correlation between "environmental" and "justice" is by far the highest, which makes sense given the nature of these reports. How might we visualize these correlations to develop of sense of the context in which justice is discussed here?

```
wildlife_cors  %>%
  filter(n <= 50) %>%
  graph_from_data_frame() %>%
  ggraph(layout = "fr") +
  geom_edge_link(aes(edge_alpha = correlation, edge_width = correlation), edge_colour = "firebrick") +
  geom_node_point(size = 5) +
  geom_node_text(aes(label = name), repel = TRUE,
```

```
                 point.padding = unit(0.2, "lines")) +
  theme_void()
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
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## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
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## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
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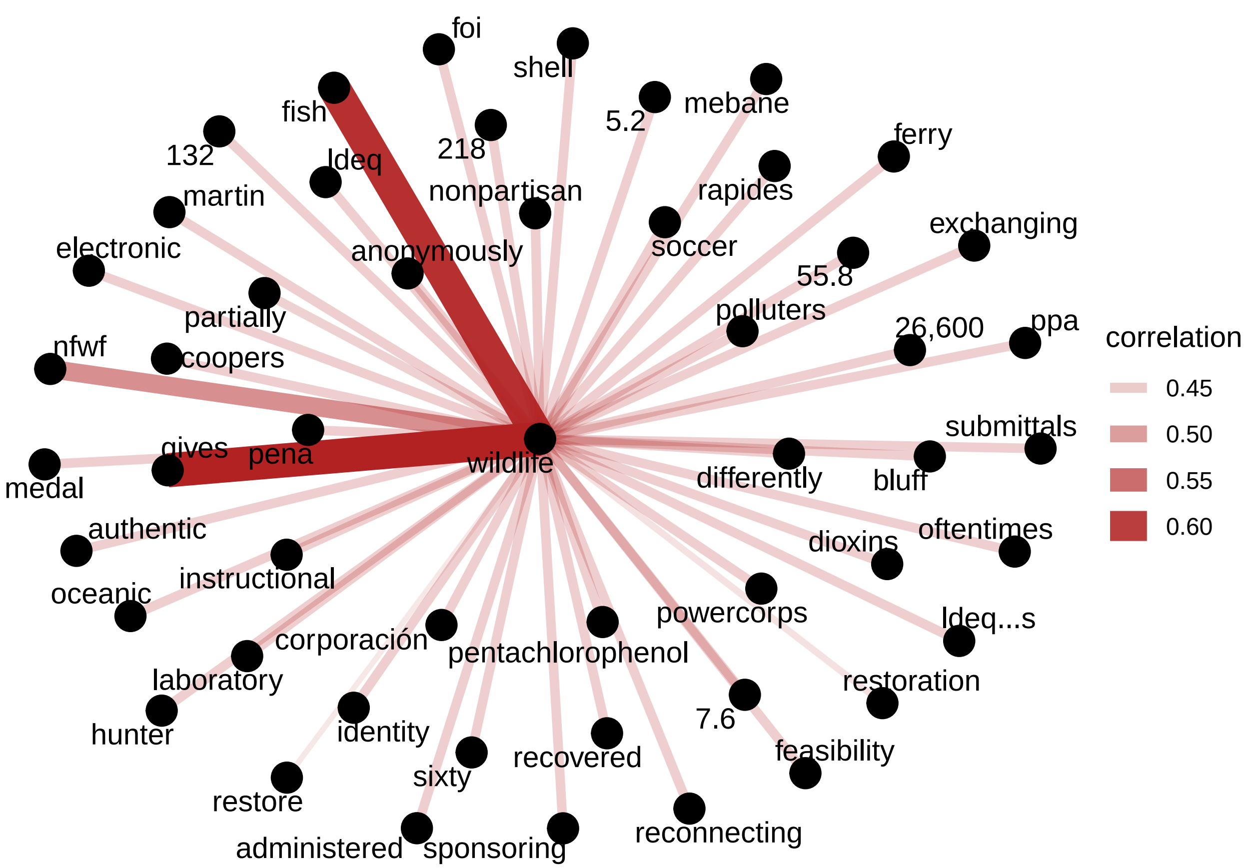
```

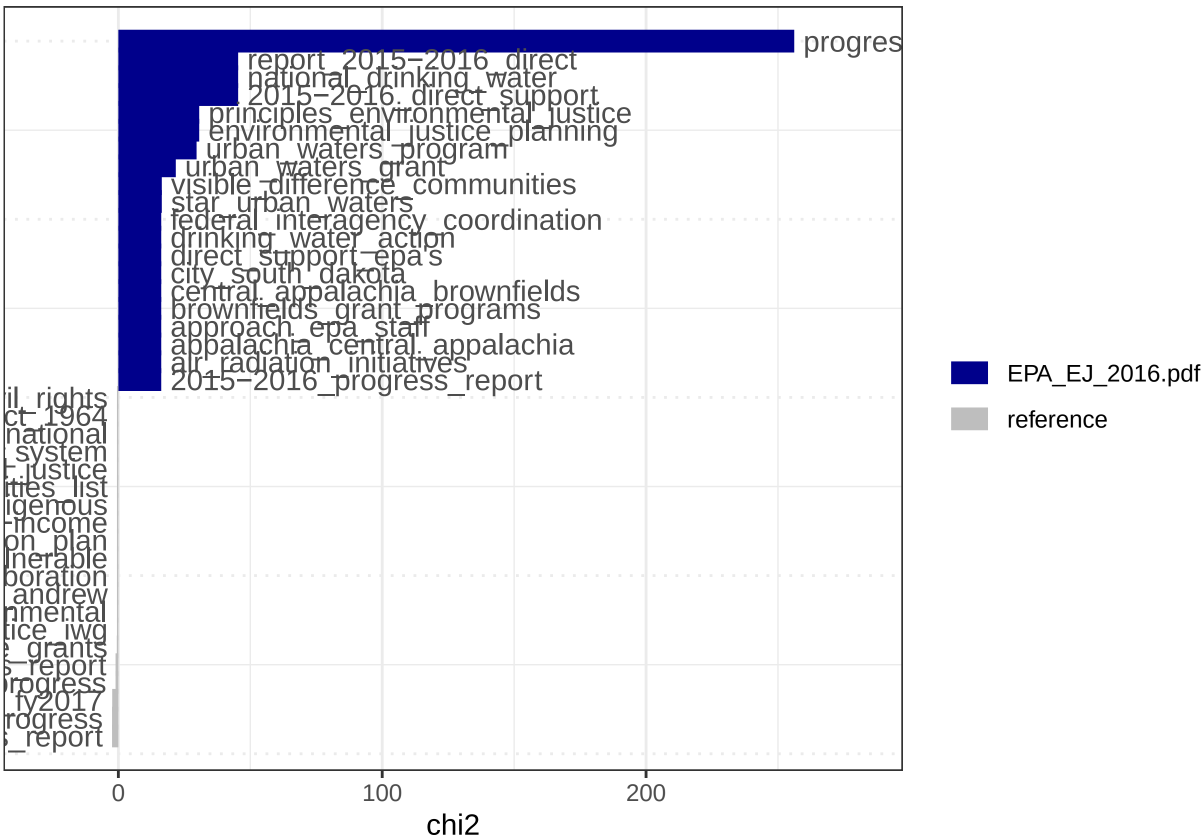


3. Write a function that allows you to conduct a keyness analysis to compare two individual EPA reports (hint: that means target and reference need to both be individual reports). Run the function on 3 pairs of reports, generating 3 keyness plots.

Use all of the frequencies for each word in each document and calculate a chi-square to see which words occur significantly more or less within a particular target document.

Example from class:

```r
keyness <- textstat_keyness(dfm2, target = 2)
textplot_keyness(keyness)
```

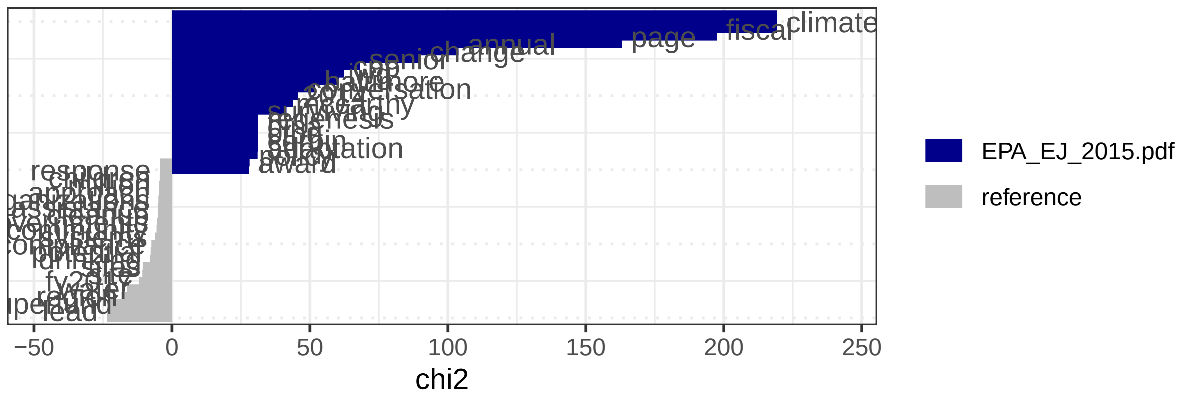


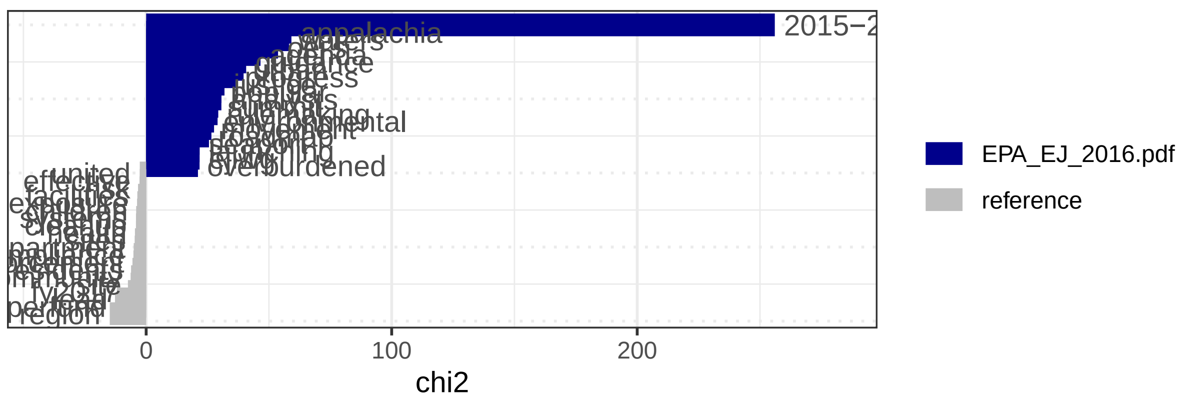
Create function:

```r
keyness_analysis <- function(data, target1, target2) {
  keyness1 <- textstat_keyness(data, target = target1)
  keyness2 <- textstat_keyness(data, target = target2)
  plot1 <- textplot_keyness(keyness1)
  plot2 <- textplot_keyness(keyness2)
  plot <- plot1 / plot2
  return(plot)
}
```

Test Function:

```r
keyness_analysis(data = dfm, target1 = 1, target2 = 2)
```





Select a word or multi-word term of interest and identify words related to it using windowing and keyness comparison. To do this you will create to objects: one containing all words occurring within a 10-word window of your term of interest, and the second object containing all other words. Then run a keyness comparison on these objects. Which one is the target, and which the reference? Hint