

There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

1

Text Mining, Natural Language Processing, and Sentiment Analysis

```
library(tidyverse) #for various data manipulation tasks
library(tidytext) #for text mining specifically, main package in
  ↪ book
library(stringr) #for various text operations
library(gutenbergr) #to access full-text books that are in the
  ↪ public domain
library(scales) # for visualising percentages
library(readtext) # for reading in txt files
library(wordcloud) # for creating wordclouds

library(syuzhet)
```

1.1 CEPEH Qualatative Feedback

The focus group discussions provided a lot of feedback for how the participants experienced their interactions with the chatbots, and how the CEPEH team can improve them, improve the design and development processes, and improve uptake and sharing.

One method of analysing this data is with use of text mining and data manipulation, creating word clouds, sentiment analysis, and using a model which

can distinguish the unique themes in text, and highlights for us what text is used to create these themes.

Therefore, we have created such tools to allow efficient and intelligent analysis of this open/free focus group data.

```
CEPEHQ_raw <- readtext("P1.txt")

CEPEHQ_raw $doc_id <- sub(".txt", "", CEPEHQ_raw $doc_id) # this
↪ gets rid of .txt in the play titles
```

1.2 Tokenising

A Token is “a meaningful unit of text, most often a word, that we are interested in using for further analysis” Meaning, for each word we give it a property that we can call upon later.

The data manipulation for this included removing punctuation, converting to lower-case, and setting word type to word (and not such types as “characters”, “ngrams”, “sentences”, “lines”, “regex”, “paragraphs”)

```
## readtext object consisting of 6 documents and 0 docvars.
## # Description: df [6 x 3]
##   doc_id word      text
##   <fct> <chr>    <chr>
## 1 1      p1      "\"\"\"..."
## 2 1      for     "\"\"\"..."
## 3 1      me      "\"\"\"..."
## 4 1      personally "\"\"\"..."
## 5 1      it      "\"\"\"..."
## 6 1      was     "\"\"\"..."
```

1.2.1 2.2 Removing non-alphanumeric characters

- `str_extract` is used to get rid of non-alphanumeric characters (because we don't want to count *word* separately from word)

```
CEPEHQ_tidy <- CEPEHQ_tidy %>%
  mutate(word = str_extract(word, "[a-z']+"))
```

1.2.2 2.3 Stop words

- Stop words: very common, “meaningless” function words like “the”, “of” and “to” – not usually important in an analysis (i.e. to find out that the most common word in two books you are comparing is “the”)
- tidytext has a built-in df called stop_words for English
- remove these from your dataset with anti_join

We can take a look:

```
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
```

```
CEPEHQ_tidy <- CEPEHQ_tidy %>%
  anti_join(stop_words)
```

```
## Joining, by = "word"
```

```
CEPEHQ_tidy
```

```
## readtext object consisting of 806 documents and 0 docvars.  
## # Description: df [806 x 3]  
##   doc_id word      text  
##   <fct> <chr>      <chr>  
## 1 1      personally "\"\"\"..."  
## 2 1      nice       "\"\"\"..."  
## 3 1      week       "\"\"\"..."  
## 4 1      ive        "\"\"\"..."  
## 5 1      feeling    "\"\"\"..."  
## 6 1      chatbots   "\"\"\"..."  
## # ... with 800 more rows
```

Define other stop words:

```
meaningless_words <- tibble(word = c("found", "chatbot", "chatbots",  
  ↪ "presentations", "NA", "video", "videos", "didnt", "na", "nil",  
  ↪ ""))  
  
CEPEHQ_tidy <- CEPEHQ_tidy %>%  
  anti_join(meaningless_words)
```

```
## Joining, by = "word"
```

Break: Prepare your data with the steps above. 1) Unnest tokens, 2) Remove alpha-numeric characters, 3) Remove stopwords

1.3 3 Analysing frequencies

1.3.1 3.1 Find most frequent words

- Easily find frequent words using `count()`
- Data must be in tidy format (one token per line)
- `sort = TRUE` to show the most frequent words first

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

```
library(tidytext)
library(tidyverse)
library(tm)
library(tigerstats)
library(tidyselect)

CEPEHQ_freq <- CEPEHQ_tidy %>% group_by(doc_id) %>% count(word,
  ↪ sort=TRUE)

CEPEHQ_freq <- CEPEHQ_freq[-6,]

CEPEHQ_freq
```

```
## # A tibble: 386 x 3
## # Groups:   doc_id [1]
##   doc_id word          n
##   <fct> <chr>        <int>
## 1 1      cybersecurity  11
## 2 1      information   11
## 3 1      presentation   9
## 4 1      helpful        8
## 5 1      understand     8
## 6 1      ideas           7
## 7 1      lot            7
## 8 1      workshop        7
## 9 1      beginning        6
## 10 1     dont           6
## # ... with 376 more rows
```

The preparation of these words has some use in understanding the frequencies, but their emotional valence are not compared. The table above has the word ‘*helpful*’ which has a positive connotation, however there are 386 words, with many having several occurrences.

What is the sentiment of all participants? What is types of emotional words are being used?

```
CEPEHQ_tidy %>%  
  group_by(doc_id) %>%  
  count(word, sort=TRUE) %>%  
  filter(doc_id == "1")
```

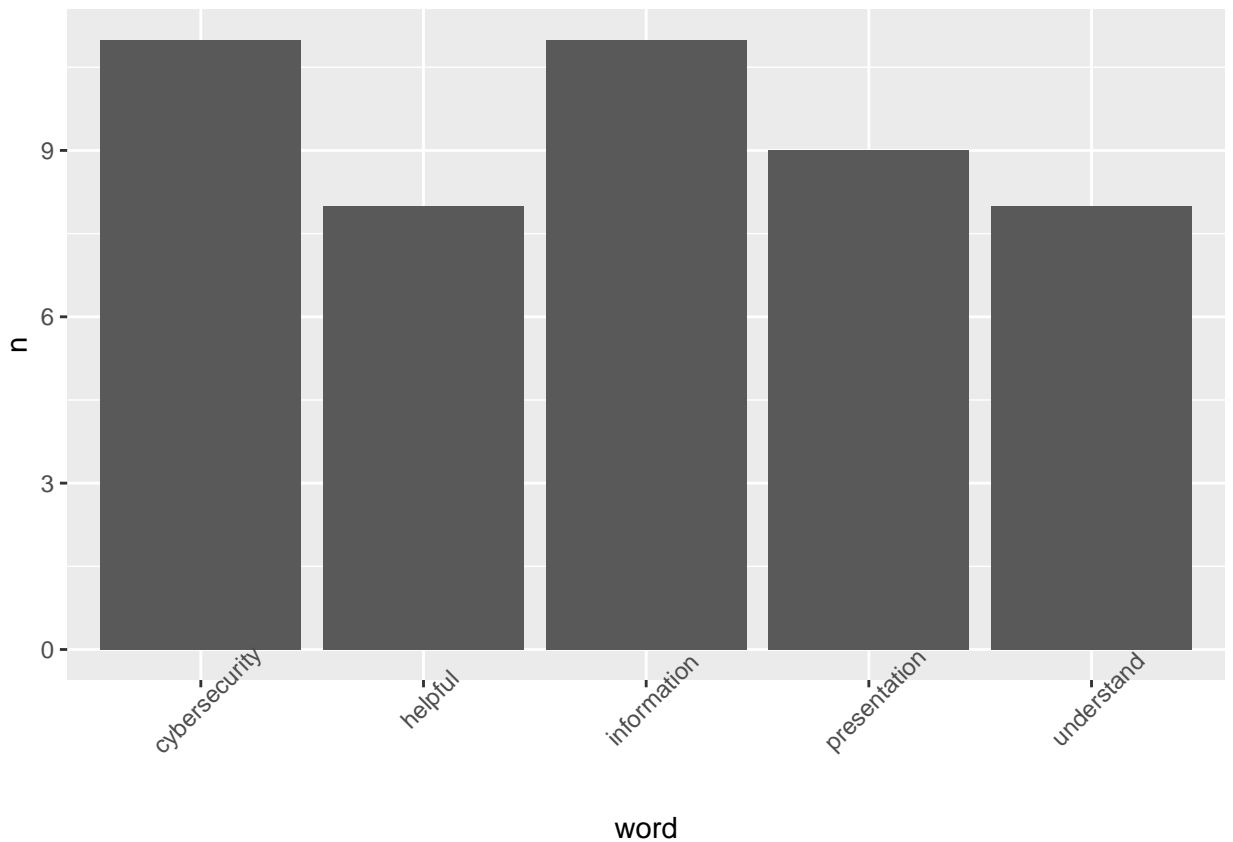
```
## # A tibble: 387 x 3  
## # Groups:   doc_id [1]  
##   doc_id word          n  
##   <fct> <chr>         <int>  
## 1 1      cybersecurity  11  
## 2 1      information    11  
## 3 1      presentation    9  
## 4 1      helpful        8  
## 5 1      understand     8  
## 6 1      idea            7  
## 7 1      ideas            7  
## 8 1      lot             7  
## 9 1      workshop         7  
## 10 1     beginning       6  
## # ... with 377 more rows
```

Plotting word frequencies - bar graphs

Bar graph of top words in CEPEHQ.

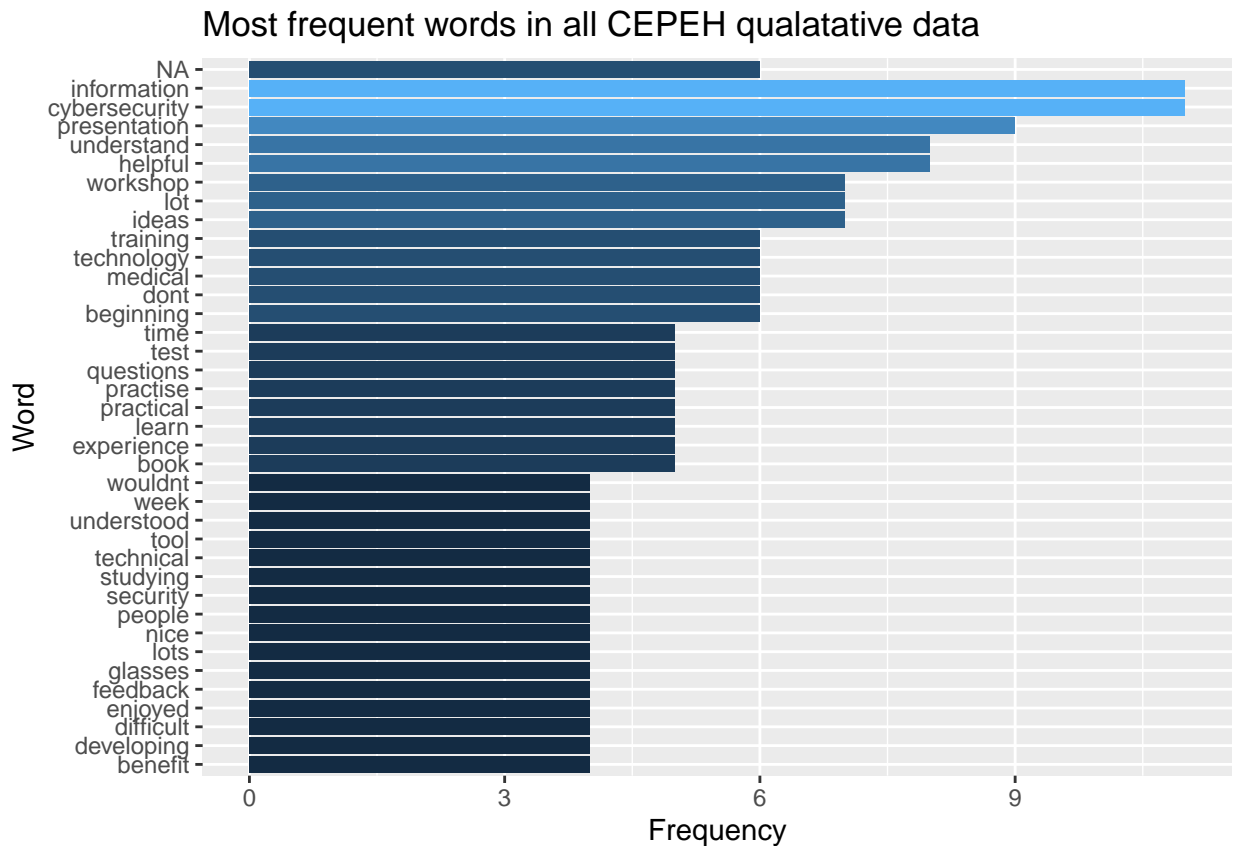
Basic graph:

```
CEPEHQ_freq %>%  
  filter(n>7 & doc_id == "1") %>%  
  ggplot(aes(x=word, y=n)) +  
  geom_col() +  
  theme(axis.text.x = element_text(angle = 45))
```



The words can be grouped and plotted onto a bar chart, and to show more words this chart is presented with horizontal bars. The most frequent words present in the various focus group discussions after using the 4 CEPEH chatbots are in the Figure below.

```
CEPEHQ_freq %>%
  filter(n>3, doc_id == "1") %>%
  ggplot(aes(x=reorder(word, n), y=n, fill=n)) +
  geom_col(show.legend=FALSE) +
  xlab("Word") +
  ylab("Frequency") +
  ggtitle("Most frequent words in all CEPEH qualitative data") +
  coord_flip()
```



Although the frequency is not high for each word, we are able to get a general picture of the sentiments, intensities, and concerns which would be immediately occurring when plotted.

1.3.2 3.2 Normalised frequency

- when comparing the frequencies of words from different texts, they are commonly normalised
- convention in corpus linguistics: report the frequency per 1 million words
- for shorter texts: per 10,000 or per 100,000 words
- calculation: $\text{raw frequency} \times 1,000,000 / \text{total numbers in text}$

```
# see the total number of words per play (doc_id)
CEPEHQ_freq %>%
  group_by(doc_id) %>%
  mutate(sum(n)) %>%
  distinct(doc_id, sum(n))
```



```
## # A tibble: 1 x 2
## # Groups:   doc_id [1]
##   doc_id `sum(n)`
##   <fct>     <int>
## 1 1          682
```

```
CEPEHQ_freq <- CEPEHQ_freq %>%
  na.omit() %>%
  group_by(doc_id) %>%
  mutate(pmw = n*1000/sum(n)) %>% # creates a new column called pmw
  ungroup() %>%
  anti_join(stop_words) # removing stopwords afterwards
```

```
## Joining, by = "word"
```

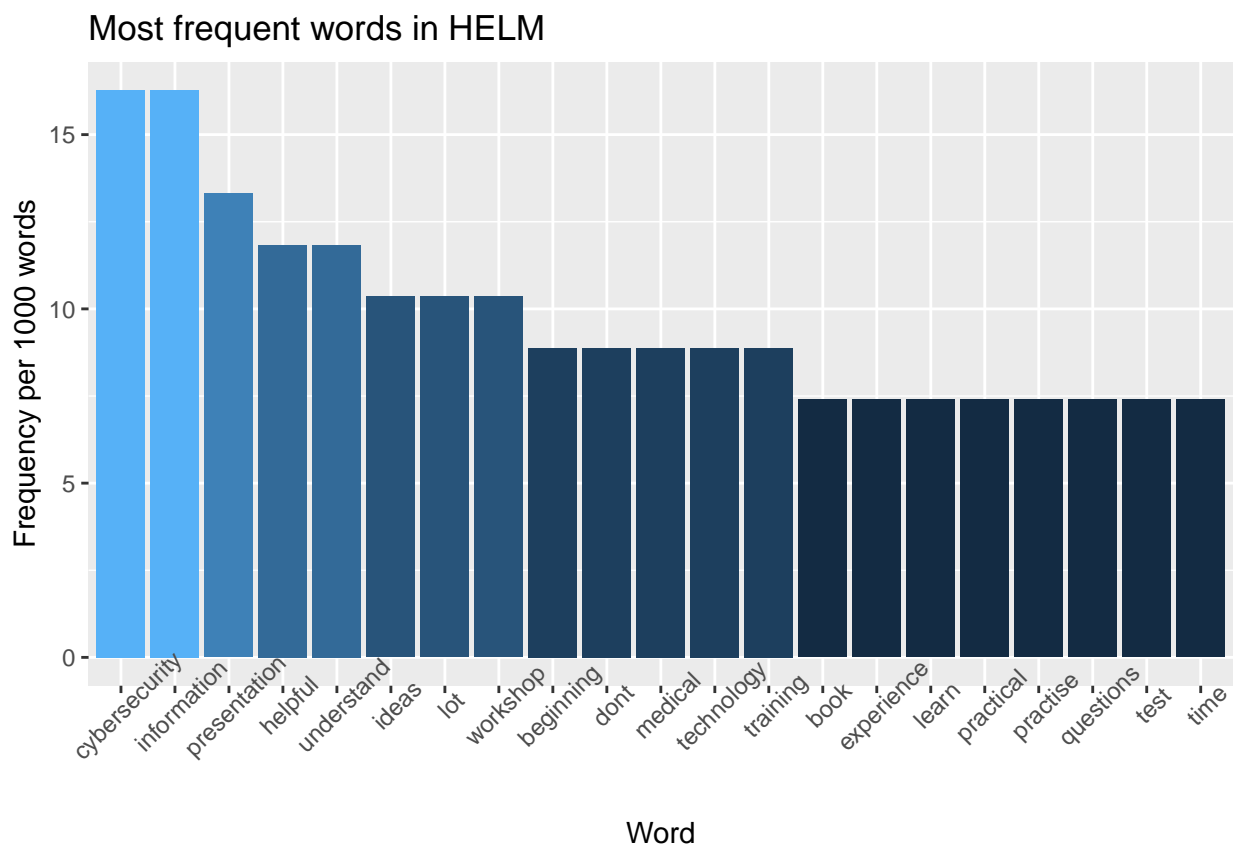
```
CEPEHQ_freq %>% select(word, pmw)
```

```
## # A tibble: 385 x 2
##   word          pmw
##   <chr>        <dbl>
## 1 cybersecurity 16.3
## 2 information   16.3
## 3 presentation 13.3
## 4 helpful      11.8
## 5 understand   11.8
## 6 ideas        10.4
## 7 lot          10.4
## 8 workshop     10.4
## 9 beginning     8.88
## 10 dont         8.88
## # ... with 375 more rows
```

Plotting normalised frequency

Now we can plot, for example, the 20 most frequent words (by pmw).

```
CEPEHQ_freq %>%
  filter(doc_id == "1") %>%
  top_n(20, pmw) %>%
  ggplot(aes(x=reorder(word, -pmw), y=pmw, fill=pmw)) +
  geom_col(show.legend=FALSE) +
  theme(axis.text.x = element_text(angle = 45)) +
  xlab("Word") +
  ylab("Frequency per 1000 words") +
  ggtitle("Most frequent words in HELM")
```



1.3.3 3.3 Word clouds

Let's visualise the most frequent words in a word cloud. Here, the size indicates the frequency, with words that occur more often being displayed in a larger font size, but this can also be used to visualise e.g. normalised frequency (pmw) or length or anything else you pass to the `freq =` part of the command.

```
wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n,  
          min.freq = 4, max.words=2000, random.order=FALSE,  
          ↪ rot.per=0.35,  
          colors=brewer.pal(8, "Dark2"))
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : presentation could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : understand could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : experience could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : developing could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : security could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : studying could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : technical could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : understood could not be fit on page. It will not be plotted.
```

```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : week could not be fit on page. It will not be plotted.
```

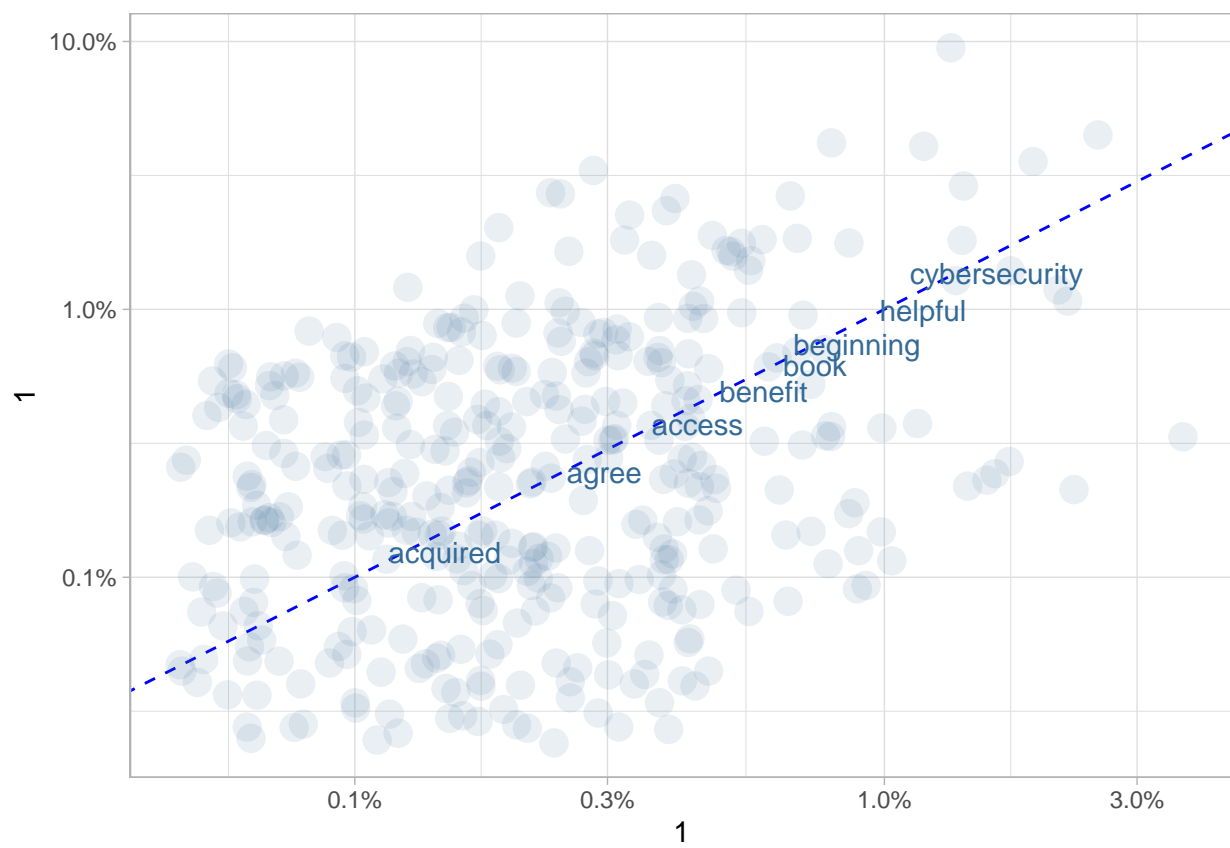
```
## Warning in wordcloud(words = CEPEHQ_freq$word, freq = CEPEHQ_freq$n, min.freq =  
## 4, : wouldnt could not be fit on page. It will not be plotted.
```



1.4 The vocabulary of Texts

Here is a graph that has plotted the words in places depending on the word frequencies. Additionally, colour coding shows how different the frequencies are - darker items are more similar in terms of their frequencies, lighter-coloured ones more frequent in one text compared to the other.

```
ggplot(comp_2,
  aes(x = `1`, y = `1`,
    color = abs(`1` - `1`))) +
  geom_abline(color = "blue1", lty = 2) +
  geom_jitter(alpha = 0.1, size = 4.5, width = 0.5, height = 0.8) +
  geom_text(aes(label = word), check_overlap = TRUE, vjust = 1.5) +
  scale_x_log10(labels = percent_format()) +
  scale_y_log10(labels = percent_format()) +
  theme_light() +
  theme(legend.position="none") +
  labs(y = "1", x = "1")
```



2

Sentiment analysis

```
## # A tibble: 6 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

## readtext object consisting of 6 documents and 1 docvar.
## # Description: df [6 x 4]
##   doc_id word      sentiment text
##   <fct> <chr>      <chr>    <chr>
## 1 1      nice      positive  "\"\"..."
## 2 1      invaluable positive  "\"\"..."
## 3 1      facilitate positive  "\"\"..."
## 4 1      difficult negative  "\"\"..."
## 5 1      benefits   positive  "\"\"..."
```

```

## 6 1      easier      positive "\"\"..."
## readtext object consisting of 2 documents and 0 docvars.
## # Description: df [2 x 3]
##   sentiment      n text
##   <chr>         <int> <chr>
## 1 negative      24 "\"\"..."
## 2 positive      62 "\"\"..."

## readtext object consisting of 6 documents and 1 docvar.
## # Description: df [6 x 4]
##   word      sentiment      n text
##   <chr>      <chr>         <int> <chr>
## 1 helpful    positive       8 "\"\"..."
## 2 benefit    positive       4 "\"\"..."
## 3 difficult  negative       4 "\"\"..."
## 4 enjoyed    positive       4 "\"\"..."
## 5 nice       positive       4 "\"\"..."
## 6 easy       positive       3 "\"\"..."

## readtext object consisting of 2 documents and 1 docvar.
## # Description: df [2 x 4]
##   doc_id sentiment      n text
##   * <fct> <chr>         <int> <chr>
## 1 1      negative      24 "\"\"..."
## 2 1      positive      62 "\"\"..."

## readtext object consisting of 2 documents and 0 docvars.
## # Description: df [2 x 3]
##   sentiment      n text
##   <chr>         <int> <chr>
## 1 negative      24 "\"\"..."
## 2 positive      62 "\"\"..."

```

```
## readtext object consisting of 6 documents and 1 docvar.
## # Description: df [6 x 4]
##   word      sentiment      n text
##   <chr>     <chr>      <int> <chr>
## 1 helpful   positive     8 "\"\"\"..."
## 2 benefit   positive     4 "\"\"\"..."
## 3 difficult negative     4 "\"\"\"..."
## 4 enjoyed   positive     4 "\"\"\"..."
## 5 nice       positive     4 "\"\"\"..."
## 6 easy       positive     3 "\"\"\"..."
##   max(total_score) min(total_score)
## 1                  38                38
```




```
```r
```

```
knitr::include_graphics("figures/sample-content/pdf_embed_example/Lyngs2020_FB.pdf")
```

```
install.packages(pdftools)
split PDF into pages stored in
↪ figures/sample-content/pdf_embed_example/split/
#
↪ pdftools::pdf_split("figures/sample-content/pdf_embed_example/Lyngs2020_FB.pdf",
output =
↪ "figures/sample-content/pdf_embed_example/split/")

grab the pages
pages <-
↪ list.files("figures/sample-content/pdf_embed_example/split",
↪ full.names = TRUE)

set how wide you want the inserted PDFs to be:
1.0 is 100 per cent of the oxforddown PDF page width;
you may want to make it a bit bigger
pdf_width <- 1.2

for each PDF page, insert it nicely and
end with a page break
cat(stringr::str_c("\\newpage \\begin{center}
↪ \\makebox[\\linewidth][c]{\\includegraphics[width=", pdf_width,
↪ "\\linewidth]{", pages, "}} \\end{center}"))
```

# ‘I Just Want to Hack Myself to Not Get Distracted’: Evaluating Design Interventions for Self-Control on Facebook

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## ABSTRACT

Beyond being the world’s largest social network, Facebook is for many also one of its greatest sources of digital distraction. For students, problematic use has been associated with negative effects on academic achievement and general wellbeing. To understand what strategies could help users regain control, we investigated how simple interventions to the Facebook UI affect behaviour and perceived control. We assigned 58 university students to one of three interventions: goal reminders, removed newsfeed, or white background (control). We logged use for 6 weeks, applied interventions in the middle weeks, and administered fortnightly surveys. Both goal reminders and removed newsfeed helped participants stay on task and avoid distraction. However, goal reminders were often annoying, and removing the newsfeed made some fear missing out on information. Our findings point to future interventions such as controls for adjusting types and amount of available information, and flexible blocking which matches individual definitions of ‘distraction’.

## Author Keywords

Facebook; problematic use; self-control; distraction; ICT non-use; addiction; focus; interruptions

## CCS Concepts

•Human-centered computing → Empirical studies in HCI;

## INTRODUCTION

Research on ‘Problematic Facebook Use’ (PFU) has investigated correlations between Facebook use and negative effects on outcomes such as level of academic achievement [35] and subjective wellbeing [58, 57]. A cross-cutting finding is that negative outcomes are associated with difficulty at exerting self-control over use, as well as specific use patterns including viewing friends’ wide-audience broadcasts rather than receiving targeted communication from strong ties [13, 58].

Much of this work has focused on self-control over Facebook use in student populations [2, 44, 46], with media multitasking research finding that students often give in to use which provides short-term ‘guilty pleasures’ over important, but aversive academic tasks [76, 88, 60]. In the present paper, we present a mixed-methods study exploring how two interventions to Facebook — goal reminders and removing the newsfeed — affect university students’ patterns of use and perceived control over Facebook use. To triangulate self-report with objective measurement, our study combined usage logging with fortnightly surveys and post-study interviews.

We found that both interventions helped participants stay on task and use Facebook more in line with their intentions. In terms of use patterns, goal reminders led to less scrolling, fewer and shorter visits, and less time on site, whereas removing the newsfeed led to less scrolling, shorter visits, and less content ‘liked’. However, goal reminders were often experienced as annoying, and removing the newsfeed made some participants fear missing out on information. After the study, participants suggested a range of design solutions to mitigate self-control struggles on Facebook, including controls for filtering or removing the newsfeed, reminders of time spent and of use goals, and removing features that drive engagement. As an exploratory study, this work should be followed by confirmatory studies to assess whether our findings replicate, and how they may generalise beyond a student population.

## RELATED WORK

### Struggles with Facebook use

Whereas many uses of Facebook offer important benefits, such as social support, rapid spread of information, or facilitation of real-world interactions [78], a substantial amount of research has focused on negative aspects [58]. For example, studies have reported correlations between patterns of Facebook use and lower academic achievement [77, 86], low self-esteem, depression and anxiety [51], feelings of isolation and loneliness [2], and general psychological distress [15]. Such ‘Problematic Facebook Use’ (PFU) has been studied under various names (including ‘Facebook dependence’ [87] and ‘Facebook addiction’ [5]), but a recent review summarised a common definition as ‘problematic behaviour characterised by addictive-like symptoms and/or self-regulation difficulties related to Facebook use leading to negative consequences in personal and social life’ [58].

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<p>Title of your Thesis</p> <p>John Doe</p>	<p><b>Thesis committee</b></p> <p><b>Promotor:</b> Prof.dr. J. Smith Professor of Geo-information Science and Remote Sensing Wageningen University</p> <p><b>Co-promotors:</b> Dr. Name of co-promotor Assistant Professor, Laboratory of Geo-information Science and Remote Sensing Wageningen University</p> <p><b>Other members:</b> Prof.dr. Jury member 1, Wageningen University Prof.dr. Jury member 2, Affiliation Prof.dr. Jury member 3, Affiliation Prof.dr. Jury member 4, Affiliation</p> <p>This research was conducted under the auspices of the C.T. de Wit Graduate School of Production Ecology &amp; Resource Conservation (PERC)</p>	<p>Title of your thesis</p> <p>John Doe</p> <p><b>Thesis</b> submitted in fulfillment of the requirements for the degree of doctor at Wageningen University by the authority of the Rector Magnificus Prof. Dr A.P.J. Mol, in the presence of the Thesis Committee appointed by the Academic Board to be defended in public on Date of your defense at 4 p.m. in the Aula</p>
<p>John Doe Title of your thesis 77 pages PhD thesis, Wageningen University, Wageningen, NL (2015) With references, with summary in English ISBN XXX-YYY</p>	<p>For Yihai Xie</p>	<p>Acknowledgements</p> <p>This is where you will normally thank your advisor, colleagues, family and friends, as well as funding and institutional support. In our case, we will give our thanks to the people who developed the ideas and tools that allow us to push open science a little step forward by writing plain-text, transparent, and reproducible theses in R Markdown.</p> <p>We must be grateful to John Gruber for inventing the original version of Markdown, to John MacFarlane for creating Pandoc (<a href="http://pandoc.org">http://pandoc.org</a>) which converts Markdown to a large number of output formats, and to Yihai Xie for creating knitr which introduced R Markdown as a way of embedding code in Markdown documents, and bookdown which added tools for technical and longer-form writing.</p> <p>Special thanks to Chetani Ismay, who created the <i>thesisdown</i> package that helped many a PhD student write their theses in R Markdown. And a very special thanks to John MacFarlane, whose adoption of Stan Evans' adaptation of Keith Gilmer's original <i>marble</i> template for writing an Oxford University DPhil thesis in L<sup>A</sup>T<sub>E</sub>X provided the template that I in turn adapted for R Markdown.</p> <p>Finally, profuse thanks to JJ Allaire, the founder and CEO of RStudio, and Hadley Wickham, the mastermind of the tidyverse without whom we'd all just given up and done data science in Python instead. Thanks for making data science easier, more accessible, and more fun for us all.</p> <p>Ulrik Lengen Linacre College, Oxford 2 December 2018</p>