

Text mining in practice - Bag of Words - corpus creation

Digital Humanities DSC 105 Spring 2023

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README

- Creation of a text source using the `tm` package
- Creation of a volatile corpus from a vector
- Creation of a volatile corpus from a data frame
- Checking metadata and inspecting a corpus
- Building a data frame from scratch

TODO Indexing list structures

- A good way to repeat the `list` structure is this (very short) lesson of the "Introduction to R" DataCamp course.
- Lists can contain any other R object (called *elements*): matrices, vectors, data frames, or other lists.
- A list element is addressed (indexed) with the `[[]]` operator, while values of the list element are addressed with the `[]` operator as usual.
- Example: let's create a list `LIST` of the following elements
 1. a 2 x 2 `matrix m` with four `integer` numbers
 2. a `character` vector `foo` that contains your first names
 3. a vector `bar` with today's date

4. a numeric vector `baz` of the number of characters of `bar`

```
m <- matrix(data=1:4,nrow=2)
foo <- c("Marcus", "Martin", "Bernhard", "Wolfgang", "Heinrich")
bar <- date()
baz <- nchar(bar)
LIST <- list(m,"name"=foo,"date"=bar,baz)
LIST
```

```
[[1]]
      [,1] [,2]
[1,]     1     3
[2,]     2     4
```

```
$name
[1] "Marcus" "Martin" "Bernhard" "Wolfgang" "Heinrich"
```

```
$date
[1] "Thu Jan 26 11:10:01 2023"
```

```
[[4]]
[1] 24
```

- Printing the list shows four elements - two of them are named, two are unnamed. The structure shows this, too:

```
str(LIST)

List of 4
 $      : int [1:2, 1:2] 1 2 3 4
 $ name: chr [1:5] "Marcus" "Martin" "Bernhard" "Wolfgang" ...
 $ date: chr "Thu Jan 26 11:10:01 2023"
 $      : int 24
```

- When extracting elements or values within elements, you can use names if they exist.
- How can you extract the stored date?

```

LIST[[3]] # using the element index
LIST[[3]][1] # pointing at the first value of the 3rd element
LIST$date # this works because the element is named
LIST$date[1] # pointing at the first value of the 'date' element

[1] "Thu Jan 26 11:10:01 2023"
[1] "Thu Jan 26 11:10:01 2023"
[1] "Thu Jan 26 11:10:01 2023"
[1] "Thu Jan 26 11:10:01 2023"

```

- How can you extract the 2nd of the first names, "Martin"?

```

LIST[[2]][2]
LIST$name[2]
LIST[[2]][-c(1,3,4,5)] # remove all the other names

[1] "Martin"
[1] "Martin"
[1] "Martin"

```

TODO The tm text mining package

- The `tm` package for text mining comes with a *vignette* (Feinerer, 2022). Its date reveals that the paper is up to date.
- Load `tm` and check the loaded package list with `search()`:

```

library(tm)
search()

[1] ".GlobalEnv"           "package:tm"
[3] "package:NLP"          "package:stringr"
[5] "package:stringi"      "package:lubridate"
[7] "package:timechange"    "package:qdap"
[9] "package:RColorBrewer" "package:qdapTools"
[11] "package:qdapRegex"    "package:qdapDictionaries"
[13] "ESSR"                 "package:stats"
[15] "package:graphics"     "package:grDevices"
[17] "package:utils"        "package:datasets"
[19] "package:methods"      "Autoloads"
[21] "package:base"

```

- There is no separate data package. Check which functions `tm` contains:

```
ls("package:tm")

[1] "as.DocumentTermMatrix"  "as.TermDocumentMatrix"
[3] "as.VCorpus"             "Boost_tokenizer"
[5] "content_transformer"    "Corpus"
[7] "DataframeSource"        "DirSource"
[9] "Docs"                   "DocumentTermMatrix"
[11] "DublinCore"             "DublinCore<-"
[13] "eoi"                    "findAssocs"
[15] "findFreqTerms"          "findMostFreqTerms"
[17] "FunctionGenerator"      "getElem"
[19] "getMeta"                "getReaders"
[21] "getSources"             "getTokenizers"
[23] "getTransformations"     "Heaps_plot"
[25] "inspect"                "MC_tokenizer"
[27] "nDocs"                  "nTerms"
[29] "PCorpus"                "pGetElem"
[31] "PlainTextDocument"      "read_dtm_Blei_et_al"
[33] "read_dtm_MC"            "readDataframe"
[35] "readDOC"                "reader"
[37] "readPDF"                "readPlain"
[39] "readRCV1"               "readRCV1asPlain"
[41] "readReut21578XML"       "readReut21578XMLasPlain"
[43] "readTagged"             "readXML"
[45] "removeNumbers"          "removePunctuation"
[47] "removeSparseTerms"      "removeWords"
[49] "scan_tokenizer"         "SimpleCorpus"
[51] "SimpleSource"           "stemCompletion"
[53] "stemDocument"           "stepNext"
[55] "stopwords"              "stripWhitespace"
[57] "TermDocumentMatrix"     "termFreq"
[59] "Terms"                  "tm_filter"
[61] "tm_index"               "tm_map"
[63] "tm_parLapply"           "tm_parLapply_engine"
[65] "tm_reduce"              "tm_term_score"
[67] "URISource"              "VCorpus"
[69] "VectorSource"           "weightBin"
[71] "WeightFunction"         "weightSMART"
```

```
[73] "weightTf"           "weightTfIdf"
[75] "writeCorpus"        "XMLSource"
[77] "XMLTextDocument"    "Zipf_plot"
[79] "ZipSource"
```

- Texts are processed at different levels:
 1. Strings like "Hello world"
 2. Documents like a text of many strings stored as vector, dataframe
 3. Corpora as collections of documents
- We'll get back to this paper when we learn to clean text data
- Use `VectorSource` to create a *source* from a *character* vector:

```
doc <- c("This is a text.", "This is another one.")
doc_source <- VectorSource(doc)
doc_source

$encoding
[1] ""

$length
[1] 2

$position
[1] 0

$reader
function (elem, language, id)
{
  if (!is.null(elem$uri))
    id <- basename(elem$uri)
  PlainTextDocument(elem$content, id = id, language = language)
}
<bytecode: 0x000001c24c3ced70>
<environment: namespace:tm>

$content
[1] "This is a text."      "This is another one."
```

```
attr("class")
[1] "VectorSource" "SimpleSource" "Source"
```

- The source `doc_source` is a `list` of five elements and an attribute:
 1. `encoding` says that the content is encoded with apostrophs.
 2. `length = 2` is the length of the input vector
 3. `position = 0` means that there is no other document in the corpus
 4. `reader` is the function used to process the vector
 5. `content` is the content of the corpus - two strings
 6. `attr` is a vector that says what type of source this is

```
typeof(doc_source)
```

```
[1] "list"
```

- To turn the `VectorSource` into a volatile (in-memory) corpus, use `VCorpus` (also a `list`):

```
doc_corpus <- VCorpus(VectorSource(doc))
doc_corpus
typeof(doc_corpus)
```

```
<<VCorpus>>
```

```
Metadata: corpus specific: 0, document level (indexed): 0
```

```
Content: documents: 2
```

```
[1] "list"
```

- A corpus can have metadata - this only has two "documents", i.e. the two strings. A corpus can have thousands of documents.
- You can inspect the corpus with `inspect`. This provides information about each of the documents -

```
inspect(doc_corpus)
```

```
<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 0
Content: documents: 2
```

```
[[1]]
<<PlainTextDocument>>
Metadata: 7
Content: chars: 15
```

```
[[2]]
<<PlainTextDocument>>
Metadata: 7
Content: chars: 20
```

- Individual documents can be accessed with the `[[` operator or via their name:

```
meta(doc_corpus[[2]]) # metadata for document no. 2 (list index)
meta(doc_corpus[[2]], "language") # metadata for document language
```

```
author      : character(0)
datetimestamp: 2023-01-26 17:10:01
description  : character(0)
heading      : character(0)
id           : 2
language     : en
origin       : character(0)
[1] "en"
```

- Accessing the corpus document content with `content`:

```
content(doc_corpus[[2]])

[1] "This is another one."
```

TODO Getting the coffee.csv data (again)

- Dataframes and vectors created during a session are deleted once the session is ended unless the session is stored (then they can be found in an `.RData` file) - so we need to re-import the data.

- The coffee tweets still sit in the CSV file. We import them into a data frame `tweets` and check that the file is okay with `str`:

```
tweets <- read.csv(file="../data/coffee.csv")
str(tweets)
```

```
Error in file(file, "rt") : cannot open the connection
```

```
In addition: Warning message:
```

```
In file(file, "rt") :
```

```
cannot open file '../data/coffee.csv': No such file or directory
```

```
'data.frame': 1000 obs. of 15 variables:
```

```
$ num      : int  1 2 3 4 5 6 7 8 9 10 ...
```

```
$ text      : chr  "@ayyytylerb that is so true drink lots of coffee" "RT @bryz
```

```
$ favorited : logi  FALSE FALSE FALSE FALSE FALSE FALSE ...
```

```
$ replyToSN : chr  "ayyytylerb" NA NA NA ...
```

```
$ created   : chr  "8/9/2013 2:43" "8/9/2013 2:43" "8/9/2013 2:43" "8/9/2013 2
```

```
$ truncated : logi  FALSE FALSE FALSE FALSE FALSE FALSE ...
```

```
$ replyToSID : num  3.66e+17 NA NA NA NA ...
```

```
$ id         : num  3.66e+17 3.66e+17 3.66e+17 3.66e+17 3.66e+17 ...
```

```
$ replyToUID : int  1637123977 NA NA NA NA NA NA 1316942208 NA NA ...
```

```
$ statusSource: chr  "<a href=\"http://twitter.com/download/iphone\" rel=\"nofollow
```

```
$ screenName : chr  "thejennagibson" "carolynicosia" "janeCkay" "Alexandria00TD
```

```
$ retweetCount: int  0 1 0 0 2 0 0 0 1 2 ...
```

```
$ retweeted   : logi  FALSE FALSE FALSE FALSE FALSE FALSE ...
```

```
$ longitude    : logi  NA NA NA NA NA NA ...
```

```
$ latitude     : logi  NA NA NA NA NA NA ...
```

- Be mindful that this only works if the computer can find the file: in my code example, I stored it in the `data` directory, which is at the same level as the directory this Org-mode file is in, `org`:
- This Org-mode file `3_corpus.org` expects to find the R console in the buffer `*R*`. If the current working directory, which you can get with `getwd()` is not `org`, it will produce a connection error:
- Find the current working directory for your R session with `getwd`:

```
getwd()
```

```
[1] "C:/Users/birkenkrahe/Documents/GitHub/grades"
```



```

data<tm>
c:/Users/birkenkrahe/Documents/GitHub/tm:
total used in directory 83 available 277.8 GiB
drwxrwxrwx 1 Birkenkrahe None 8192 01-11 00:07 ..
drwxrwxrwx 1 Birkenkrahe None 4096 01-06 09:53 .
drwxrwxrwx 1 Birkenkrahe None 4096 01-19 12:21 data
drwxrwxrwx 1 Birkenkrahe None 4096 01-25 14:33 .git
-rw-rw-rw- 1 Birkenkrahe None 66 2022-05-04 .gitattributes
-rw-rw-rw- 1 Birkenkrahe None 216 2022-05-04 .gitignore
drwxrwxrwx 1 Birkenkrahe None 16384 01-24 21:43 img
-rw-rw-rw- 1 Birkenkrahe None 35129 2022-05-04 LICENSE
drwxrwxrwx 1 Birkenkrahe None 4096 01-25 14:36 org
drwxrwxrwx 1 Birkenkrahe None 4096 01-25 11:43 pdf
-rw-rw-rw- 1 Birkenkrahe None 3592 11-26 17:04 README.org

2 U\%%- tm All (8,0) (Dired by name)
c:/Users/birkenkrahe/Documents/GitHub/tm/data:
total used in directory 2148 available 277.8 GiB
drwxrwxrwx 1 Birkenkrahe None 4096 01-06 09:53 ..
drwxrwxrwx 1 Birkenkrahe None 4096 01-19 12:21 .
-rw-rw-rw- 1 Birkenkrahe None 419306 01-07 10:06 airline_tweets.rds
-rw-rw-rw- 1 Birkenkrahe None 250392 01-19 12:09 coffee.csv
-rw-rw-rw- 1 Birkenkrahe None 157815 01-07 20:56 oct_delta.csv
-rw-rw-rw- 1 Birkenkrahe None 1363721 01-07 08:28 Roomba_reviews.csv

3 U\%%- data<tm> All (6,63) (Dired by name)

```

Figure 1: Directories tm and tm/data with coffee.csv

```

#+RESULTS:
: Error in file(file, "rt") : cannot open the connection
: In addition: Warning message:
: In file(file, "rt") :
: cannot open file '../data/coffee.csv': No such file or directory

```

Figure 2: Directories tm and tm/data with coffee.csv

- This should be the same directory that this buffer is currently in:

```
(symbol-value 'default-directory)
```

- Reset the current working directory with `setwd`, e.g. to Downloads:

```
setwd("~/Downloads")
```

TODO Making a VectorSource from tweets

- Now we have the data frame and extract the `text` from it. To be sure, we print the first three tweets.

```
coffee_tweets <- tweets$text
head(coffee_tweets, n=3)
```

```
[1] "@ayyytylerb that is so true drink lots of coffee"
[2] "RT @bryzy_brib: Senior March tmw morning at 7:25 A.M. in the SENIOR lot. Get
[3] "If you believe in #gunsense tomorrow would be a very good day to have your c
```

- Now we have a vector with text. The steps to get a source are:

1. load the `tm` package (re-loading does no harm)
2. make a source from the vector using `VectorSource`
3. display structure of the source

```
library(tm)
coffee_source <- VectorSource(coffee_tweets)
str(coffee_source)
```

```
Classes 'VectorSource', 'SimpleSource', 'Source'  hidden list of 5
 $ encoding: chr ""
 $ length  : int 1000
 $ position: num 0
 $ reader   :function (elem, language, id)
 $ content  : chr [1:1000] "@ayyytylerb that is so true drink lots of coffee" "RT C
```

- We recognize the familiar list elements from the general explanation of the `tm` package.

- Print the first 2 tweets in `coffee_source`

```
head(coffee_source,n=2)
```

```
[1] "@ayyytylerb that is so true drink lots of coffee"
[2] "RT @bryzy_brib: Senior March tmw morning at 7:25 A.M. in the SENIOR lot. Get
```

- Print the 999th tweet in `coffee_source`

```
coffee_source$content[999] # with the list element and the index
coffee_source[[999]] # list element only
coffee_source[999] # index only
```

```
[1] "First morning coffee after Ramadan http://t.co/ZEu6cl9qGY"
[1] "First morning coffee after Ramadan http://t.co/ZEu6cl9qGY"
[1] "First morning coffee after Ramadan http://t.co/ZEu6cl9qGY"
```

TODO Making a VCorpus from a vector of tweets

- Use `VCorpus`, to create a corpus `coffee_corpus` from `coffee_source`, then print `coffee_corpus`:

```
coffee_corpus <- VCorpus(coffee_source)
coffee_corpus
```

```
<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 0
Content: documents: 1000
```

- The corpus is a *container*, hence the content is not printed, only indicated.

TODO Accessing the corpus list with index or content

- Look at its structure to see how to get to the content - but not the structure of the whole thing since the metadata are overwhelming - instead only at the structure of the first list item.

```
str(coffee_corpus[[1]])
```

```
List of 2
 $ content: chr "@ayyytylerb that is so true drink lots of coffee"
 $ meta    :List of 7
 ..$ author      : chr(0)
 ..$ timestamp: POSIXlt[1:1], format: "2023-01-26 17:10:01"
 ..$ description : chr(0)
 ..$ heading     : chr(0)
 ..$ id          : chr "1"
 ..$ language    : chr "en"
 ..$ origin      : chr(0)
 ..- attr(*, "class")= chr "TextDocumentMeta"
 - attr(*, "class")= chr [1:2] "PlainTextDocument" "TextDocument"
```

- Inspect the data - select the 15th tweet from the corpus:

```
inspect(coffee_corpus[[15]])
```

```
<<PlainTextDocument>>
Metadata:  7
Content:   chars: 111
```

```
@HeatherWhaley I was about 2 joke it takes 2 hands to hold hot coffee...then I re
```

- To extract the content of the 15th tweet in this volatile corpus, you can either use your list indexing powers, or use `content`:

```
coffee_corpus[[15]][1] # select list element by index and entry
coffee_corpus[[15]]["content"] # select by index and name
coffee_corpus[[15]]$content # select by name
content(coffee_corpus[[15]]) # select with content function
```

```
$content
[1] "@HeatherWhaley I was about 2 joke it takes 2 hands to hold hot coffee...then
$content
[1] "@HeatherWhaley I was about 2 joke it takes 2 hands to hold hot coffee...then
[1] "@HeatherWhaley I was about 2 joke it takes 2 hands to hold hot coffee...then
[1] "@HeatherWhaley I was about 2 joke it takes 2 hands to hold hot coffee...then
```

- How many characters does the 15th tweet have? (You already know this value from the `inspect` above):

```
nchar(coffee_corpus[[15]]$content)
```

```
[1] 111
```

TODO Making a DataSource from tweets

- Often, larger amounts of data are in dataframes (i.e. tables of vectors) rather than individual vectors.
- To demonstrate, turn the vector `coffee_tweets` into a dataframe with the function `data.frame`, and show its structure:

```
coffee_tweets.df <- data.frame(coffee_tweets)
str(coffee_tweets.df)
```

```
'data.frame': 1000 obs. of  1 variable:
```

```
 $ coffee_tweets: chr  "@ayyytylerb that is so true drink lots of coffee" "RT @bry"
```

- This dataframe has one feature (`coffee_tweets.df$coffee_tweets`) and 1000 records or lines.
- However, to turn a dataframe into a source, the dataframe must have a very specific structure:
 1. Column 1 must be called `doc_id` with a unique string for each row.
 2. Column 2 must be called `text` with standard "UTF-8" encoding.
 3. Columns 3+ are metadata and will be retained as such
- `coffee_tweets.df` does **not** fulfil these conditions - the first column is called `coffee_tweets`. But we can reformat it:
 1. add a column 1 that is called `doc_id` and contains a record ID
 2. change the column name to `text`

```
df <- data.frame(
  "doc_id" = 1:1000,
  "text" = coffee_tweets.df$coffee_tweets)
str(df)
```

```
'data.frame': 1000 obs. of 2 variables:
 $ doc_id: int 1 2 3 4 5 6 7 8 9 10 ...
 $ text : chr "@ayyytylerb that is so true drink lots of coffee" "RT @bryzy_bril
```

- Now we're good to go for DataframeSource:

```
df_source <- DataframeSource(df)
str(df_source)
```

```
Classes 'DataframeSource', 'SimpleSource', 'Source' hidden list of 5
 $ encoding: chr ""
 $ length : int 1000
 $ position: num 0
 $ reader :function (elem, language, id)
 $ content : 'data.frame': 1000 obs. of 2 variables:
 ..$ doc_id: int [1:1000] 1 2 3 4 5 6 7 8 9 10 ...
 ..$ text : chr [1:1000] "@ayyytylerb that is so true drink lots of coffee" "RT
```

- The source looks similar to the output of VectorSource, of course, except that the content is a 1000 x 2 table, not a 1000 element vector.

TODO Making a VCorpus from the dataframe source

- Let's turn this monster frame into a corpus and access some tweets:

```
df_corpus <- VCorpus(df_source)
df_corpus
```

```
<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 0
Content: documents: 1000
```

- Compare this with coffee_corpus that we derived from a vector:

```
coffee_corpus # got this from VCorpus(coffee_source)

<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 0
Content: documents: 1000
```

TODO Checking metadata with meta

- The metadata for our examples, `coffee_corpus` and `df_corpus` are minimal, because we extracted the text only from the dataframe `tweets`:

```
meta(coffee_corpus)
meta(df_corpus)
```

```
data frame with 0 columns and 1000 rows
data frame with 0 columns and 1000 rows
```

- Let's construct an example dataframe with some metadata to illustrate the use of `meta`. This is the table we wish to construct - it already fulfils the conditions to build a source from a dataframe:

	doc_id	text	author	date
1	1	Text mining is a great time.	Author1	1514953399
2	2	Text analysis provides insights	Author2	1514866998
3	3	qdap and tm are used in text mining	Author3	1514780598

- We use the `data.frame` function to build this table from scratch:

```
example <-
  data.frame( "doc_id"=c(1,2,3),
    "text"=c("Text mining is a great time.",
      "Text analysis provides insights",
      "qdap and tm are used in text mining"),
    "author"=c("Author1","Author2","Author3"),
    "date"=c("1514953399","1514866998","1514780598"))
example
```

	doc_id	text	author	date
1	1	Text mining is a great time.	Author1	1514953399
2	2	Text analysis provides insights	Author2	1514866998
3	3	qdap and tm are used in text mining	Author3	1514780598

- Success! Now the usual steps to build our corpus:

1. build source list with `DataframeSource`
2. build volatile corpus list with `VCorpus`

```
example_source <- DataframeSource(example)
example_corpus <- VCorpus(example_source)
example_corpus
```

```
<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 2
Content: documents: 3
```

- Inspect the corpus with `inspect`:

```
inspect(example_corpus)
```

```
<<VCorpus>>
Metadata: corpus specific: 0, document level (indexed): 2
Content: documents: 3
```

```
[[1]]
<<PlainTextDocument>>
Metadata: 7
Content: chars: 28
```

```
[[2]]
<<PlainTextDocument>>
Metadata: 7
Content: chars: 31
```

```
[[3]]
<<PlainTextDocument>>
Metadata: 7
Content: chars: 35
```

- Finally, extraction of the metadata with `meta`:

```
meta(example_corpus)
```

```
      author      date
1 Author1 1514953399
2 Author2 1514866998
3 Author3 1514780598
```


TODO TM Glossary - concepts and code

TERM	MEANING
<code>tm</code>	Text mining package
<code>[[</code>	List element index
<code>[</code>	Vector element index
<code>List[[2]][5]</code>	Extracts 5th value of 2nd element of <code>List</code>
<code>x[-n]</code>	Removes nth element of vector <code>x</code>
Vignette	Documentation for an R package (paper)
<code>ls()</code>	List all objects in current session
<code>ls('package:tm')</code>	List all objects in package <code>tm</code>
<code>tm::VectorSource</code>	Build source <code>list</code> from vector
<code>tm::VCorpus</code>	Build corpus <code>list</code> from source
<code>tm::DataframeSource</code>	BUild source <code>list</code> from dataframe
<code>data.frame</code>	Create data frame
<code>typeof</code>	Return R data type or data structure
<code>tm::inspect</code>	Get information about each corpus element
<code>tm::meta</code>	Extract metadata from corpus
<code>tm::content</code>	Extract <code>content</code> element from corpus <code>list</code>