Processing Don Quixote

NLP master course 2021-2022

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1 Read text from Internet and selection of text

Use the text of Don Quixote from https://www.gutenberg.org/files/2000/2000-0.txt. Notice that you can load this text in a browser, but typically you can see a maximum number of lines. That is, you cannot see the end of the Quixote.

Delete the header and the tail provided by gutenberg, knowing that both the last line of the header and the first of the tail contain the characters `***`. Compute the number of lines.

```
urlQuijoteGutenber <-  "https://www.gutenberg.org/files/2000/2000-0.txt"
lines <- readLines(urlQuijoteGutenber,
                   encoding = "UTF-8") #It takes a few seconds
grep(pattern = "***", lines, fixed = TRUE) #Warning! Without fixed the regex is "\\*\\*\\*"
```

```
[1]    24 37704 37706
```

```
                                           #Result: 24 37704 37706 lines ids
linesQ <- lines[25:37703]
length(linesQ) #37,679
```

```
[1] 37679
```

However, a simple inspection of the first lines in `linesQ` shows us that there is a prologue. We are interested in the text of Cervantes so, we remove the prologue lines knowing that the Quixote begins with “En un lugar de”.

```
grep(pattern = "En un lugar de",
     linesQ,
     fixed = TRUE) #Lines 1045 and 13513. The good one is the first one
```

```
[1]  1045 13513
```

```
linesQ <- linesQ[-c(1:1044)] #Remove the prologue
length(linesQ) #36,635
```

```
[1] 36635
```

```
linesQ[1:5]
```

```
[1] "En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho"
[2] "tiempo que vivía un hidalgo de los de lanza en astillero, adarga antigua,"
[3] "rocín flaco y galgo corredor. Una olla de algo más vaca que carnero,"
[4] "salpicón las más noches, duelos y quebrantos los sábados, lantejas los"
[5] "viernes, algún palomino de añadidura los domingos, consumían las tres"
```

We can join lines so:

```
paste(linesQ[1:5], collapse = " ")
```

```
[1] "En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho tiempo que vivía un hidal
```

2 Basic checks

It is important to ensure that we selected the right encoding. If you can read the text properly it is a good sign. However, a systematic solution like this would be better:

```r
library(utf8)
#Chack encoding
linesQ[!utf8_valid(linesQ)] #character(0) ==> All lines are made of correct UTF-8 characters
```

```
character(0)
```

```r
#Check character normalization. Specifically, the normalized composed form (NFC)
linesQ_NFC <- utf8_normalize(linesQ)
sum(linesQ_NFC != linesQ) #0 means all right. The text is in NFC.
```

```
[1] 0
```

3 Basic structuration

Obtain a vector (or a list) with the paragraphs in the text, considering paragraph as a **not empty** text block separated from another by two blank lines (three `\n`). Compute the number of paragraphs in Don Quixote.

```r
stringQ <- paste(linesQ, collapse = "\n") #One big string
paragraphs <- unlist(strsplit(stringQ, "\\n\\n\\n"))#Warn! (1)strsplit returns a list,
                                                       #      (2)escape \n and
                                                       #      (3)by default, fixed=FALSE
                                                       #Using fixed=TRUE this should be
                                                       #     "\n\n\n", fixed = TRUE
parEmpty <- which(paragraphs == "") #No empty paragraphs
#paragraphs <- paragraphs[-parEmpty]
length(paragraphs) # 128
```

```
[1] 128
```

We can see the first 200 characteres of the first paragraph with

```r
substring(paragraphs[1], 1, 200)
```

```
[1] "En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho\ntiempo que vivía un hida
```

4 Some cleaning

Although the original text was quite clean, we have adden some `\n` characters. Therefore, we can do some basic cleaning replacing the occurrences of the caracter `\n` by using the base function `gsub()`.
Any sequence of one or more characters `\n` will bw replaced by a unique space " ".

```
#Testing the regex
gsub("[\n]{1,}", " ", c(par1="with one \nbut also\n",
                        par2="with a seq of \n\nlike this"
                      )
    )
```

```
                      par1                       par2 
     "with one  but also " "with a seq of  like this" 
```

```
paragraphswoNL <- gsub("[\n]{1,}", " ", paragraphs) #wo = without
substring(paragraphswoNL[1], 1, 200)
```

```
[1] "En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho tiempo que vivía un hidal
```

Sometime we can get sequences of several spaces. We replace any occurrency of more two or more spaces by a unique space doing this:

```
paragraphs <- gsub("[ ]{2,}", " ", paragraphswoNL) #We reassign the varible paragraphs
substring(paragraphs[1], 1, 200)
```

```
[1] "En un lugar de la Mancha, de cuyo nombre no quiero acordarme, no ha mucho tiempo que vivía un hidal
```

5 Some numbers (chars, words, sentences)

We will statrt calculating the number of **non-empty** sentences using `spacy` from the vector of paragraphs.

HINT: The `spacyr` package uses spaCy (a Python library). Before using any functionality in `spacyr` you have to create a *Python environment*. Fortunatelly, the `spacyr` function `spacy_install()` does all this work. Once you have used the Python environment you should call `spacy_finalize()` to free Python resources (more than 1.5GB RAM).

HINT: By default, `spacyr` uses the English model. The Spanish model can be downloaded by using `spacy_download_langmodel('es')`. Currently downloads the `es_core_news_sm model` (`sm` comes from small). If you are insterested in downloading bigger models, follow this link (in Spanish, sorry).

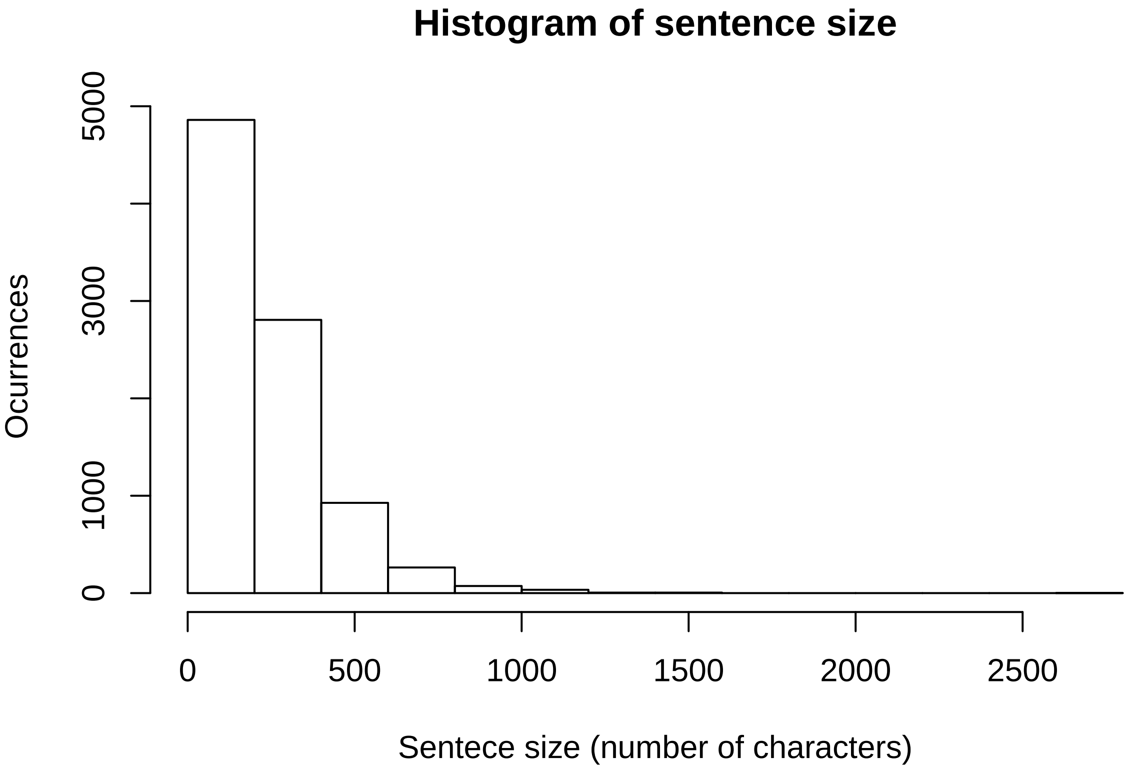
```
library(spacyr)
#Use spacy_install() if you have never used spacyr before. This will install a miniconda environment
#spacy_download_langmodel('es') #This downloads the model es_core_news_sm to disk
spacy_initialize(model = "es_core_news_sm") #Loads the Spanish model fron disk

#Gets sentences from paragraphs
phrases <- spacy_tokenize(paragraphs,     #If you use quanteda you can use
                                          #  corpus_reshape(corpus, to = "sentences"))
                                          #Taks a while.
                                          #Returns a list with 138 elements, each one
                                          #        is a string vector.
                          what="sentence" #By default remove_separators = TRUE
                                          #           (removes trailing spaces)
                         )

v_phrases <- unlist(phrases)
numphrases <- length(v_phrases) #8,975 sentences
sum(v_phrases=="") #1
```

```
[1] 1
```

```
v_phrases <- v_phrases[-which(v_phrases=="")] #8,974 sentences
```

What about the length of the sentences?

```
#A simple histogram will do fine
hist(nchar(v_phrases),
     main = "Histogram of sentence size",
     xlab = "Sentece size (number of characters)",
     ylab = "Ocurrences"
    )
```



We can compute the number of tokens using `spacy_tokenize`. Notice the number of options of this function. A token is not always just a word.

```
tokens <- spacy_tokenize(paragraphs
                         #Parameters asigned by default:
                           #remove_punct =      FALSE,  punt symbols are tokens
                           #remove_url =        FALSE,  url elements are tokens
                           #remove_numbers =    FALSE,  numbers are tokens
                           #remove_separators = TRUE,   spaces are NOT tokens
                           #remove_symbols =    FALSE,  symbols (like €) are tokens
                        )#Returns a list
v_tokens <- unlist(tokens)
v_tokens[1:10]
```

```
  text11    text12    text13    text14    text15    text16    text17    text18
```

```
    "En"      "un"  "lugar"     "de"      "la" "Mancha"       ","      "de"
  text19  text110
  "cuyo" "nombre"
```

```
length(v_tokens) #442,164 tokens (many repeated)
```

```
[1] 442164
```

```
length(unique(v_tokens)) #24,130 different (unique) tokens.
```

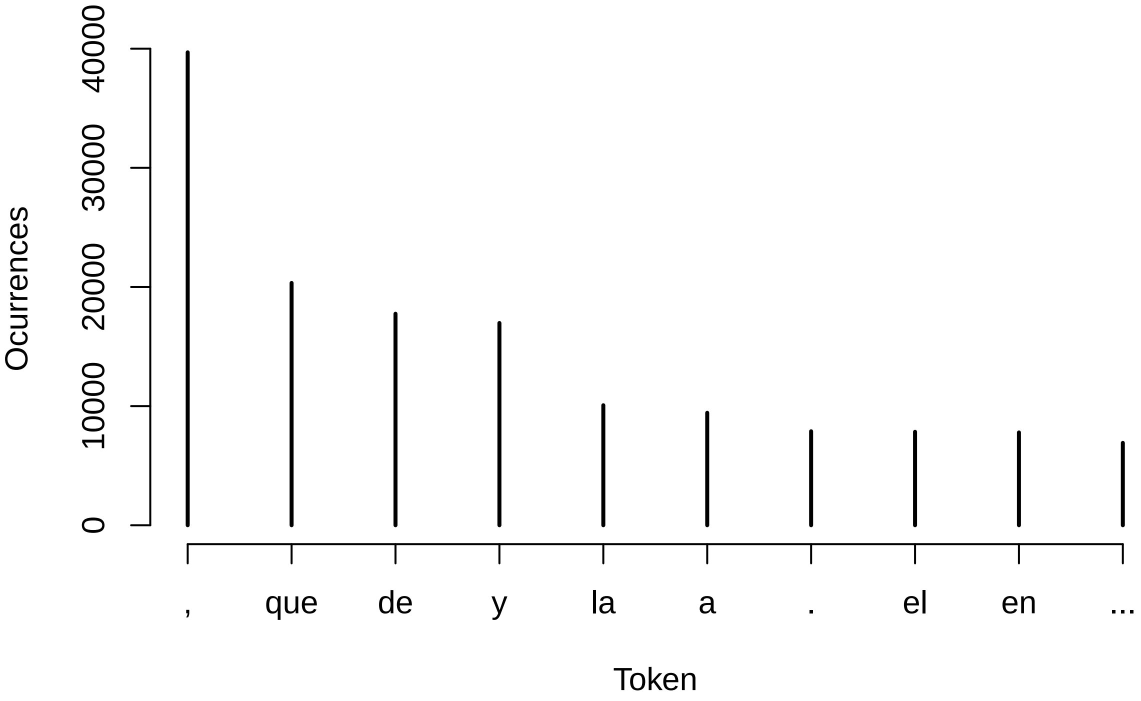
```
[1] 24130
```

Curious about the number of occurrencies of these tokens?

```
#As a list
head(sort(table(v_tokens), decreasing = TRUE), n = 25)
```

```
v_tokens
      ,     que      de       y      la       a       .      el      en       -
  39698   20340   17753   16977   10073    9440    7888    7843    7790    6915
     no       ;      se     los     con     por     las      le      lo      su
   5738    4745    4646    4634    4025    3727    3383    3378    3349    3304
    don     del      me    como Quijote
   2526    2429    2325    2223    2150
```

```
#As a simple plot
plot(head(sort(table(v_tokens), decreasing = TRUE), n = 10),
     xlab = "Token",
     ylab = "Ocurrences"
    )
```



6 Sentence analysis: part of speech and more

The part of speech (pos) is a heavy task that takes a long time to compute. Here we will test the pos functionality with two packages: `spacyr` and `udpipes`.

For this example we will compute the pos of the fist 100 sentences of Don Quixote.

6.1 Using spaCy

SpaCy is good identifiying sentences in Spanish, better than other packages such as `udpipes` or `quanteda`. Also is good doing Part of Speech (morphosyntactic analysis) and sophisticated tasks such as named entity recognition (NER), noun phrase detection, and dependencies. All this information is located in the `spacy_parse()` function.

For this example we will compute the pos of the fist 100 sentences of Don Quixote.

```r
#begin <- Sys.time()
#spacy_parse() doesn't like duplicated names (and we have sum(duplicated(names(v_phrases))) = 477)
#Therefore we remove the names of the text strings before using spacy_parse().
#names(v_phrases) <- NULL
# res <- spacy_parse(v_phrases, #If you use phrases, spacy will take just 50 secs (in my machine)
#                               #If you use paragraphs, spacy will take just 1.22 mins (in my machine)
#                               # but it will finish in token 441,979 (that is, before the end)
#                               # without any error. spacyr is not very kind :-S
#                                     #Default params
#                                         #pos =        TRUE,
#                                         #tag =        FALSE,   #Nothing extra for Spanish
#                                         #lemma =      TRUE,
#                                         #entity =     TRUE,
#                     dependency = TRUE,  #dependency = FALSE,
#                     nounphrase = TRUE   #nounphrase = FALSE
#                   ) #returns a list of dataframes
# Sys.time()-begin

tic <- Sys.time()
res <- lapply(v_phrases[1:100],
              spacy_parse, #This is the function to apply to every element in v_phrases
              dependency = TRUE, nounphrase = TRUE #These are the arguments of the function
             )
df <- res[[1]] #A data frame with the first resuls
for (i in 2:length(res)){ #Attention! The loop starts from 2
  df <- rbind(df, res[[i]])
}
Sys.time()-tic
```

```
Time difference of 12.41932 secs
```

```r
#As this takes a while, I save the result
saveRDS(df, file="spacy_parse_Quixote.rds")

#Shows the first 20 tokens.
library(kableExtra) #Styling the kable output to show very width data frames
kable_styling(kable(df[1:20, c(3:ncol(df))]),  #The first 2 cols UNSHOWN are doc_id and sentence_id
                    font_size = 7
                   )
```

token_id	token	lemma	pos	head_token_id	dep_rel	entity	nounphrase	whitespace
1	En	en	ADP	3	case			TRUE
2	un	uno	DET	3	det		beg	TRUE
3	lugar	lugar	NOUN	18	obl		end_root	TRUE
4	de	de	ADP	6	case			TRUE
5	la	el	DET	6	det	LOC_B	beg	TRUE
6	Mancha	Mancha	PROPN	3	nmod	LOC_I	end_root	FALSE
7	,	,	PUNCT	12	punct			TRUE
8	de	de	ADP	10	case			TRUE
9	cuyo	cuyo	PRON	10	nmod		beg_root	TRUE
10	nombre	nombre	NOUN	12	obj		beg_root	TRUE
11	no	no	ADV	12	advmod			TRUE
12	quiero	querer	VERB	6	acl			TRUE
13	acordarme	acordar yo	VERB	12	xcomp			FALSE
14	,	,	PUNCT	12	punct			TRUE
15	no	no	ADV	18	advmod			TRUE
16	ha	haber	AUX	18	cop			TRUE
17	mucho	mucho	DET	18	det		beg	TRUE
18	tiempo	tiempo	NOUN	18	ROOT		end_root	TRUE
19	que	que	SCONJ	20	mark			TRUE
20	vivía	vivir	VERB	18	acl			TRUE

6.2 Using udpipes

The package udpipes has most functionalities of spacyr (for different languages, Spanish included) with the exception of name entity recognition. However, spacyr y around 6 times faster than udpipes. You can see the comparation here. Specifically udpipes can do from raw text: tokenization, parts of speech tagging, lemmatization and dependency parsing. Also has usefull functions like: collocations, token co-occurrence, document term matrix handling, term frequency inverse document frequency calculations, handling of multi-word expressions, noun phrase extraction, handling of syntactical patterns, among other.

Another usefull funcionality in udpipes is that it can save/load the annotations in coNLL format, a very popular annotation format.

```r
library(udpipe)
model_file <- 'spanish-ancora-ud-2.5-191206.udpipe'
if(!file.exists(model_file)){
  model <- udpipe_download_model(language = "spanish-ancora") #Another alternative: "spanish-gsd"
  udmodel_es <- udpipe_load_model(file = model$file_model)
}else{
  udmodel_es <- udpipe_load_model(file = model_file)
}

tic <- Sys.time()
anno <- udpipe_annotate(udmodel_es,
                        x = v_phrases[1:100],
                        parallel.cores = 10 #Check your system!!
                       )
df <- as.data.frame(anno)
Sys.time()-tic
```

```
Time difference of 7.436565 secs
```

```
## Pay attention
#anno is a list containing 3 things (last 2 where lost converting to data frame):
# 1) x: the character vector with text.
# 2) conllu: annnotation in CONLL-U format
# 3) error: A vector with the same length of x containing possible errors when annotating x

#Write the result as a coNLL file
cat(anno$conllu, file = "udpipes_es_Quixote.conllu")
#You can read this file with udpipe_read_conllu()

#Show the annotations of the first 20 tokens
#As df has 14 columns, we show them in two tables
library(kableExtra) #Styling the kable output to show very width data frames
kable_styling(kable(df[1:20, c(5:9)]),  #The first 4 cols UNSHOWN are
                                        #doc_id, paragraph_id, sentence_id and sentence
              font_size = 7
             )
```

token_id	token	lemma	upos	xpos
1	En	en	ADP	ADP
2	un	uno	DET	DET
3	lugar	lugar	NOUN	NOUN
4	de	de	ADP	ADP
5	la	el	DET	DET
6	Mancha	Mancha	PROPN	PROPN
7	,	,	PUNCT	PUNCT
8	de	de	ADP	ADP
9	cuyo	cuyo	PRON	PRON
10	nombre	nombre	NOUN	NOUN
11	no	no	ADV	ADV
12	quiero	querer	VERB	VERB
13-14	acordarme	NA	NA	NA
13	acordar	acordar	VERB	VERB
14	me	yo	PRON	PRON
15	,	,	PUNCT	PUNCT
16	no	no	ADV	ADV
17	ha	haber	AUX	AUX
18	mucho	mucho	DET	DET
19	tiempo	tiempo	NOUN	NOUN

```
kable_styling(kable(df[1:20, c(10:14)]),  #Remaining cols
              font_size = 7
             )
```

feats	head_token_id	dep_rel	deps	misc
AdpType=Prep	3	case	NA	NA
Definite=Ind|Gender=Masc|Number=Sing|PronType=Art	3	det	NA	NA
Gender=Masc|Number=Sing	17	obl	NA	NA
AdpType=Prep	6	case	NA	NA
Definite=Def|Gender=Fem|Number=Sing|PronType=Art	6	det	NA	NA
NA	3	nmod	NA	SpaceAfter=No
PunctType=Comm	12	punct	NA	NA
AdpType=Prep	10	case	NA	NA
Gender=Masc|Number=Sing|Poss=Yes|PronType=Int,Rel	10	nmod	NA	NA
Gender=Masc|Number=Sing	12	obl	NA	NA
Polarity=Neg	12	advmod	NA	NA
Mood=Ind|Number=Sing|Person=1|Tense=Pres|VerbForm=Fin	6	acl	NA	NA
NA	NA	NA	NA	SpaceAfter=No
VerbForm=Inf	12	xcomp	NA	NA
Case=Acc,Dat|Number=Sing|Person=1|PrepCase=Npr|PronType=Prs	13	obj	NA	NA
PunctType=Comm	12	punct	NA	NA
Polarity=Neg	17	advmod	NA	NA
Mood=Ind|Number=Sing|Person=3|Tense=Pres|VerbForm=Fin	0	root	NA	NA
Gender=Masc|Number=Sing|NumType=Card|PronType=Ind	19	det	NA	NA
Gender=Masc|Number=Sing	17	obj	NA	NA

7 Relations beyond sentence level

If you want to detect relations beyond sentence level, you have to use **coreferences**. For example, in the sentence "he did [...]", the token "he" refers to a previous entity. This relation is a coreference. The package `coreNLP` (a wrapper around the Java library created by Stanford University) allows you to compute coreferences.

8 Finishing

Do not forget to free Python resources used by `spacyr`.

```r
spacy_finalize() #Do not forget this
```

In order to reproduce these results here is the session info:

```r
sessionInfo()
```

```
R version 3.6.3 (2020-02-29)
Platform: x86_64-pc-linux-gnu (64-bit)
Running under: Ubuntu 16.04.7 LTS

Matrix products: default
BLAS:   /usr/lib/libblas/libblas.so.3.6.0
LAPACK: /usr/lib/lapack/liblapack.so.3.6.0

locale:
 [1] LC_CTYPE=en_US.UTF-8       LC_NUMERIC=C
 [3] LC_TIME=en_US.UTF-8        LC_COLLATE=en_US.UTF-8
 [5] LC_MONETARY=en_US.UTF-8    LC_MESSAGES=en_US.UTF-8
 [7] LC_PAPER=en_US.UTF-8       LC_NAME=C
 [9] LC_ADDRESS=C               LC_TELEPHONE=C
[11] LC_MEASUREMENT=en_US.UTF-8 LC_IDENTIFICATION=C
```

```
attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

other attached packages:
[1] udpipe_0.8.8     kableExtra_1.1.0 spacyr_1.2.1     utf8_1.1.4

loaded via a namespace (and not attached):
 [1] Rcpp_1.0.7        compiler_3.6.3    pillar_1.6.4      tools_3.6.3
 [5] digest_0.6.27     viridisLite_0.3.0 jsonlite_1.6.1    evaluate_0.14
 [9] tibble_3.0.1      lifecycle_1.0.1   lattice_0.20-41   pkgconfig_2.0.3
[13] rlang_0.4.11      Matrix_1.3-4      rstudioapi_0.11   yaml_2.2.1
[17] xfun_0.13         xml2_1.3.2        httr_1.4.1        stringr_1.4.0
[21] knitr_1.28        vctrs_0.3.8       rappdirs_0.3.1    hms_0.5.3
[25] webshot_0.5.1     grid_3.6.3        reticulate_1.15   glue_1.4.2
[29] data.table_1.12.8 R6_2.4.1          fansi_0.4.1       rmarkdown_2.1
[33] readr_1.3.1       magrittr_2.0.1    scales_1.0.0      htmltools_0.4.0
[37] ellipsis_0.3.2    rvest_0.3.5       colorspace_1.4-1  stringi_1.7.5
[41] munsell_0.5.0     crayon_1.3.4
```