

Introduction to R Markdown

CECL Workshop

Nathan Vandeweerd

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Workshop Materials

All workshop materials (including these slides) are available on GitHub:

https://github.com/nvandeweerd/intro_rmarkdown



Replication and Reproducibility

"The replication of research results is a linchpin of the scientific process." (Nature, 2006)

"To facilitate such replication, researchers would typically be expected to **report the methodology used in some detail**. What can at first appear to be a minor feature hidden away in the "limitations" section of a paper might -- after replicating the study a number of times and in a number of ways -- turn out to be a key factor impacting the outcomes obtained." (Porte, 2012 emphasis added)



Recommendations for replication studies in Applied Linguistics

(Marsden, Morgan-Short, Thompson, and Abugaber, 2018)

- Increase the number of replication studies and the rate at which they are performed and published.
- Make systematic inquiry into the causes of low rates of published replication studies...
- Use more self-labeling with the term replication wherever appropriate.
- Apply a principled, standard nomenclature...
- Reviewers of replications should also read the initial study that is being replicated.
- Provide warrants for replication studies...
- **Increase open availability of materials, including proficiency measures, for L2 research.**
- **Make more research fully transparent and open for replication by making data available.**
- **Encourage more journals to give more and stronger incentives to their authors for systematically making materials and data openly available.**
- Ensure that replication studies are conducted by researchers independently of the initial study's authors...
- Increase multisite collaborative replication efforts.
- Encourage journal editorial boards to consider accepting Registered Reports...
- Encourage publishers to lift word limits or provide online capacity.
- When the initial study is cited, also cite replication studies.
- Increase funding to promote replication.

What is R Markdown?

- Markdown (Gruber, 2004): mark-up language to convert plain text to HTML
- The `knitr` package: a method for embedding R chunks into markdown documents
- The `pandoc` package: enhances Markdown (adds support for tables, footnotes, math expressions etc.)
- The `rmarkdown` package: combines all of the above into a single document format which can be *knit* into various output formats (pdf, HTML, Word, powerpoint etc.)



fsc: French syntactic complexity analyzer

Nathan Vandeweerdt

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This article reports on an open-source R package for the extraction of syntactic units from dependency-parsed French texts. To evaluate the reliability of the package, syntactic units were extracted from a corpus of L2 French and were compared to units extracted manually from the same corpus. The f-score of the extracted units ranged from 0.53-0.97. Although units were not always identical between the two methods, manual and automatically-derived syntactic complexity measures were strongly and significantly correlated ($\rho = 0.62$ - 0.97 , $p < 0.001$), suggesting that this package may be a suitable replacement for manual annotation in some cases where manual annotation is not possible but that care should be used in interpreting the measures based on these units.

Keywords: L2 French, dependency grammar, syntactic complexity, automatic annotation, open-source R package


1

[illegible]

Phrasological sophistication is an important predictor of CEFR level in L2 French.

L2 French.

Applying Phrasological Complexity Measures to L2 French: A Partial Replication Study

Nathan Vandeweyer 
 Alex Houyoux
 Megan Goh

Background

- L2 French: second language of French
- Large focus on lexical and syntactic complexity in L2 research
- Little research focusing on complexity at the phrasal level

Paquot (2019)

- Measured lexical, syntactic or syntactic complexity in L2 French
- Paquot (2019) found that syntactic complexity was more strongly related to CEFR level than lexical complexity
- Paquot (2019) also found that syntactic complexity was more strongly related to CEFR level than lexical complexity
- Paquot (2019) also found that syntactic complexity was more strongly related to CEFR level than lexical complexity

Research Questions

1. How does phrasological complexity relate to CEFR level?
2. To what extent does phrasological complexity predict CEFR level?
3. To what extent does phrasological complexity predict CEFR level?
4. To what extent does phrasological complexity predict CEFR level?

Method

Learner data

190 intermediate essays from the International French Competition at three proficiency levels B2, B1 and A2

Phrasological measures

- Lexical diversity: ratio of lexical items to total words
- Syntactic diversity: ratio of syntactic structures to total words
- Mean length of utterance (MLU): ratio of total words to total utterances
- Mean length of phrase (MLP): ratio of total words to total phrases
- Mean length of sentence (MLS): ratio of total words to total sentences
- Mean length of clause (MLC): ratio of total words to total clauses
- Mean length of phrase (MLP): ratio of total words to total phrases
- Mean length of sentence (MLS): ratio of total words to total sentences
- Mean length of clause (MLC): ratio of total words to total clauses

Traditional measures

- Lexical diversity: ratio of lexical items to total words
- Syntactic diversity: ratio of syntactic structures to total words
- Mean length of utterance (MLU): ratio of total words to total utterances
- Mean length of phrase (MLP): ratio of total words to total phrases
- Mean length of sentence (MLS): ratio of total words to total sentences
- Mean length of clause (MLC): ratio of total words to total clauses

Analysis

- 1. Descriptive statistics
- 2. Pearson correlation
- 3. Partial correlation
- 4. Regression analysis
- 5. Mediation analysis
- 6. Path analysis
- 7. Structural equation modeling
- 8. Latent class analysis
- 9. Cluster analysis
- 10. Discriminant analysis
- 11. Factor analysis
- 12. Principal component analysis
- 13. Canonical correlation analysis
- 14. Correspondence analysis
- 15. Multidimensional scaling
- 16. Hierarchical clustering
- 17. K-means clustering
- 18. Fuzzy clustering
- 19. Gaussian mixture models
- 20. Markov chain Monte Carlo
- 21. Variational Bayes
- 22. Expectation-maximization
- 23. Particle filter
- 24. Sequential Monte Carlo
- 25. Approximate Bayesian computation
- 26. Hamiltonian Monte Carlo
- 27. Variational autoencoders
- 28. Generative adversarial networks
- 29. Restricted Boltzmann machines
- 30. Deep Boltzmann machines
- 31. Deep generative models
- 32. Variational generative models
- 33. Generative stochastic networks
- 34. Generative adversarial networks
- 35. Restricted Boltzmann machines
- 36. Deep Boltzmann machines
- 37. Deep generative models
- 38. Variational generative models
- 39. Generative stochastic networks
- 40. Generative adversarial networks
- 41. Restricted Boltzmann machines
- 42. Deep Boltzmann machines
- 43. Deep generative models
- 44. Variational generative models
- 45. Generative stochastic networks
- 46. Generative adversarial networks
- 47. Restricted Boltzmann machines
- 48. Deep Boltzmann machines
- 49. Deep generative models
- 50. Variational generative models

Results

Discussion

Phrasological sophistication (PS), defined as the degree of lexical diversity in L2 French, was found to be a significant predictor of CEFR level, even after controlling for lexical diversity and syntactic complexity.

References

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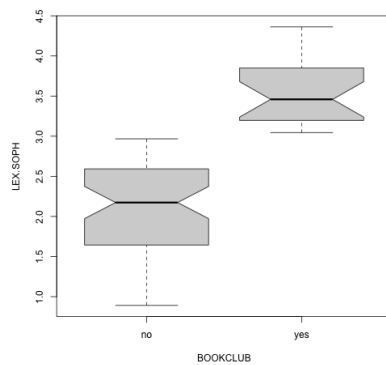
37. Vandeweyer, N., Houyoux, A., & Goh, M

Transparent Analysis

```
data <- read.csv("../data/stay-abroad.csv")
data <- data[data$ABROAD == "yes",]
print(head(data))
```

```
##      ID ABROAD BOOKCLUB  PLACEMENT LEX.SOPH ECON.VOCAB VOCAB.TEST
## 2  102    yes      no    erasmus  2.487593   273.6371   85.98986
## 3  103    yes      no   business  0.970495   215.1088   80.58794
## 4  104    yes      no    erasmus  1.717259   324.6748   67.55379
## 6  106    yes      no lang_assist  1.377997   303.7077   50.08712
## 7  107    yes      no   business  1.443990   238.0487   59.67121
## 9  109    yes      no lang_assist  1.066004   229.0751   74.10126
```

```
boxplot(LEX.SOPH ~ BOOKCLUB, data = data, notch = TRUE)
```



```
t.test(data$LEX.SOPH ~ data$BOOKCLUB)
```

```
##
##      Welch Two Sample t-test
##
## data:  data$LEX.SOPH by data$BOOKCLUB
## t = -12.578, df = 56.78, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.733163 -1.257069
## sample estimates:
##  mean in group no mean in group yes
##      2.075463      3.570579
```

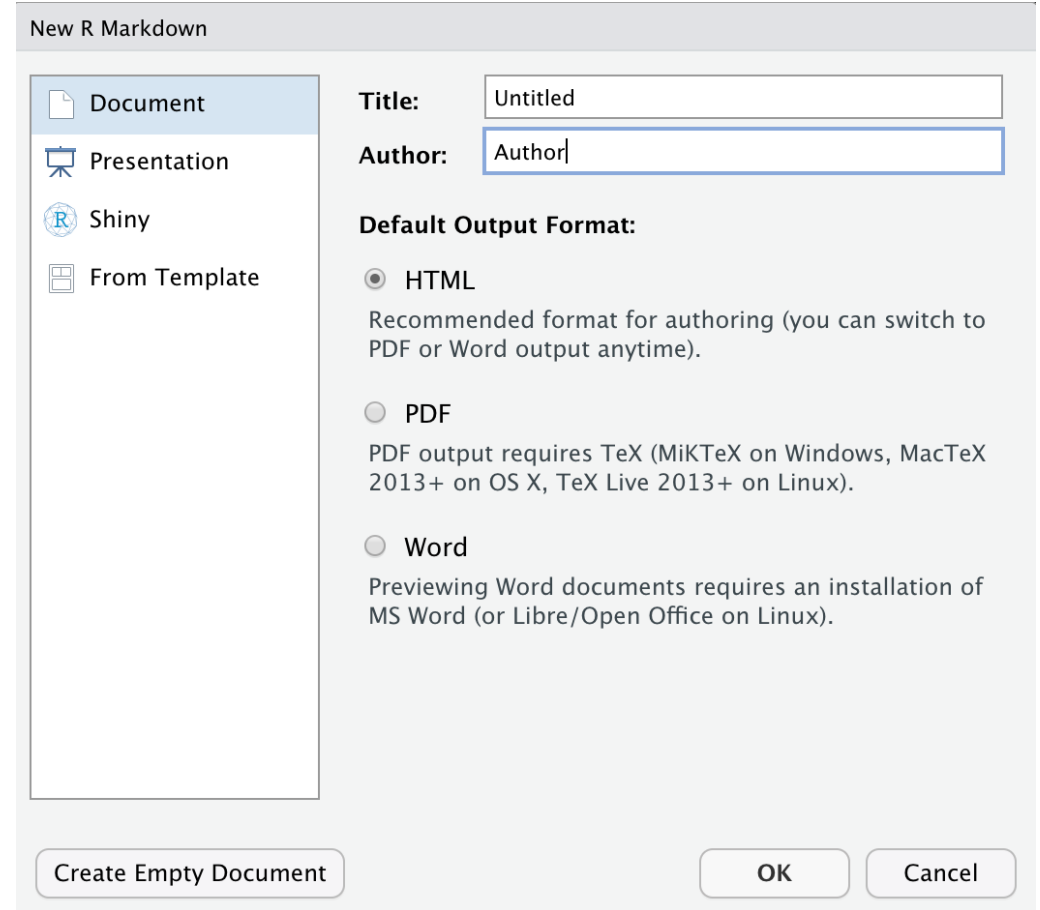
Getting started

```
# Install most recent version
install.packages("rmarkdown")

# Latex engine for PDFs
install.packages("tinytex")
```

In R Studio:

File >> New File >> R Markdown...



New R Markdown

☒ Document
☐ Presentation
☐ Shiny
☐ From Template

Title:

Author:

Default Output Format:

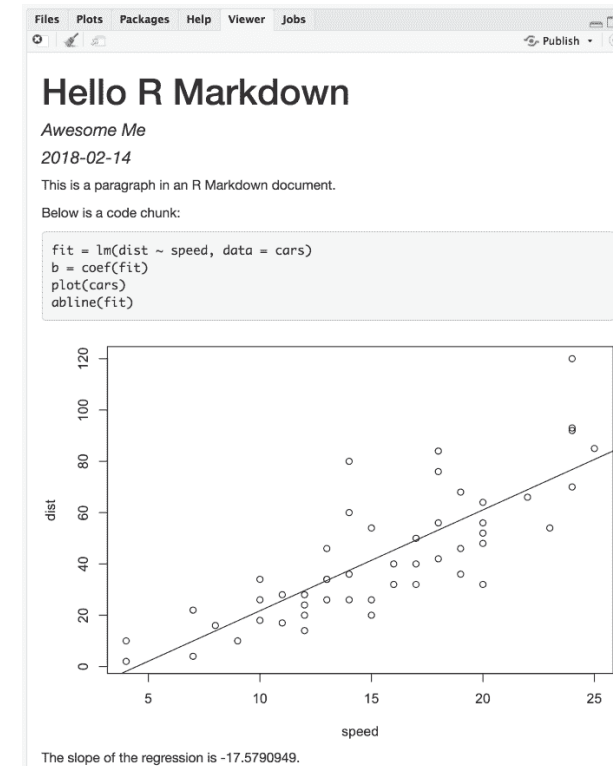
☒ **HTML**
Recommended format for authoring (you can switch to PDF or Word output anytime).

☐ **PDF**
PDF output requires TeX (MiKTeX on Windows, MacTeX 2013+ on OS X, TeX Live 2013+ on Linux).

☐ **Word**
Previewing Word documents requires an installation of MS Word (or Libre/Open Office on Linux).

Anatomy of an R Markdown file

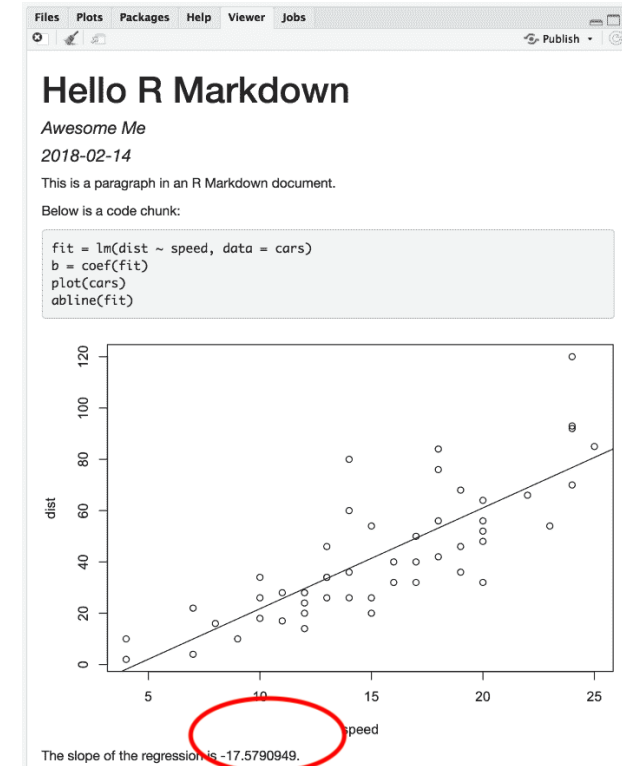
```
1 ---
2 title: "Hello R Markdown"
3 author: "Awesome Me"
4 date: "2018-02-14"
5 output: html_document
6 ---
7
8 This is a paragraph in an R Markdown document.
9
10 Below is a code chunk:
11
12 ```{r}
13 fit = lm(dist ~ speed, data = cars)
14 b = coef(fit)
15 plot(cars)
16 abline(fit)
17 ```
18
19 The slope of the regression is `r b[1]`.
20 |
```



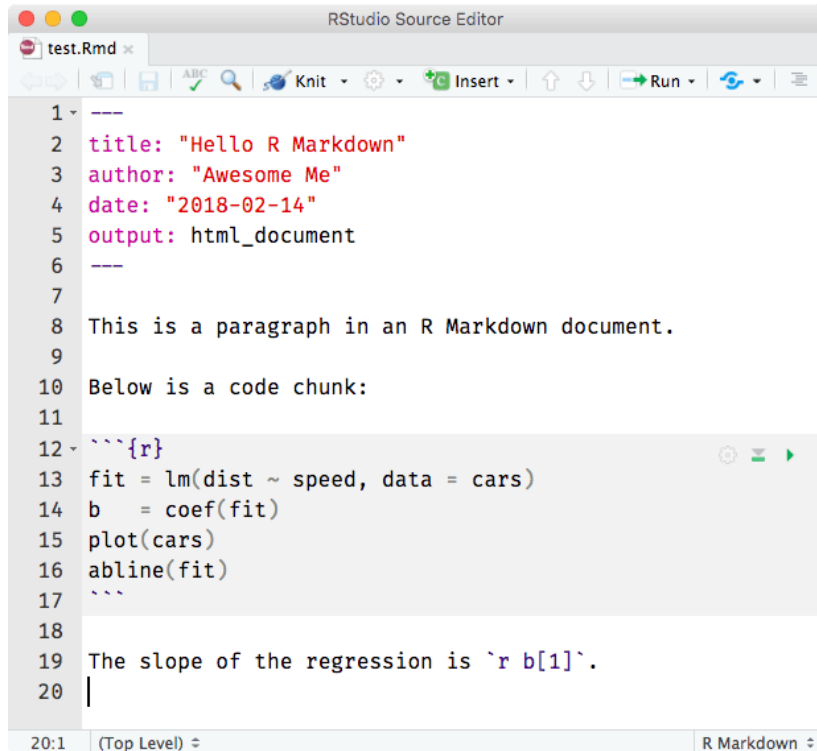
Did you spot the error?

Accountability

```
1 ---
2 title: "Hello R Markdown"
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5 output: html_document
6 ---
7
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Anatomy of an R Markdown file



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17 ```
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19 The slope of the regression is `r b[1]`.
20 |
```

YAML Header

- "YAML Ain't Markup Language"
- Generated automatically when you use wizard
- Contains:
 - file metadata
 - output format
 - instructions for **knitting** the document

Markdown formatted text

Code chunks

- Three backticks followed by the language (R) in curly brackets

Inline code

- A single backtick followed by the language (without curly brackets)

YAML Header

- file metadata:
 - title, subtitle, author, date, abstract
- output file:
 - "html_document"
 - "pdf_document" (requires Tex)
 - "word_document"
- instructions for knitting:
 - styling information (page numbers, table of contents, font size)
 - path to a template document (handy for working with Microsoft Word)
 - path to a citation file (and citation format file)

Markdown formatted text

```
# Header Level 1
## Header Level 2
### Header Level 3
Text surrounded by a single asterisks is *italic*
Text surrounded by two asterisks **bold**
- Single dash renders as bullet points
  - item
  - item
- Numbered lists
  1. thing
  2. thing

hyperlinks: [R Markdown Cheatsheet](https://www.rstudio.org/links/r
>block quotes
```

Note: You must put two spaces at the end of a line if you want a line break.

Header Level 1

Header Level 2

Header Level 3

Text surrounded by a single asterisks is *italic*

Text surrounded by two asterisks is **bold**

- Single dash renders as bullet points
 - item
 - item
 - Numbered lists
 1. thing
 2. thing
- hyperlinks: R Markdown Cheatsheet

block quotes

Code chunks

- Need to specify the language (r)
- Options can be specified after the language
 - **echo**: should the code be printed? (default = TRUE)
 - **eval**: should the code be run? (default = TRUE)

```
```{r, echo = TRUE, eval = TRUE}  
mean(data$LEX.SOPH)
```
```

What will this produce in the output document?

```
mean(data$LEX.SOPH)
```

```
## [1] 2.497163
```

What about this?

```
```{r, echo = TRUE, eval = FALSE}  
mean(data$LEX.SOPH)
```
```

```
mean(data$LEX.SOPH)
```

Code chunks

- Need to specify the language (r)
- Options can be specified after the language
 - **echo**: should the code be printed? (default = TRUE)
 - **eval**: should the code be run? (default = TRUE)

What about this?

```
```{r, echo = FALSE, eval = TRUE, comment = '(:):)'}  
mean(data$LEX.SOPH)
```
```

```
(:):) [1] 2.497163
```



Inserting graphics

```
```{r}  
knitr::include_graphics('cecl.png')
```
```



Inserting graphics

```
```{r, out.width='10%', fig.cap = 'Figure 1. CECL logo', fig.align='center'}  
knitr::include_graphics('cecl.png')
```
```



Figure 1. CECL logo

Options:

- out.width: changes the size of the image
- fig.cap: adds a caption below the image
- fig.align: alignment of the image

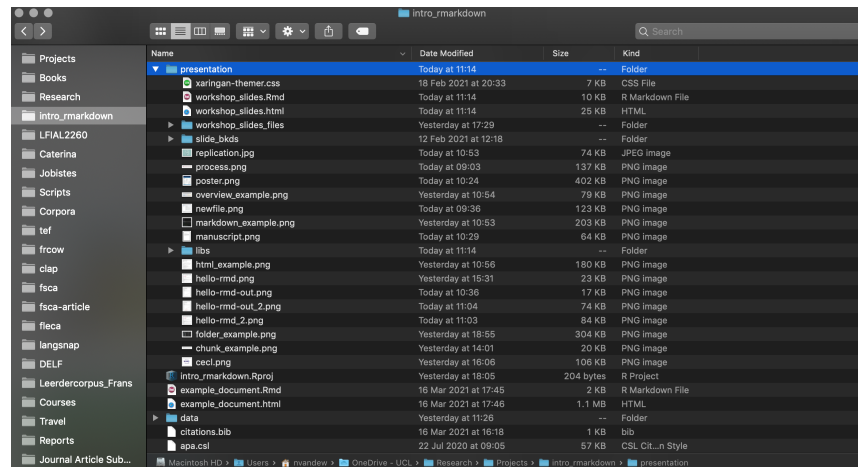


A note about file management

- By default the "working directory" of an R Markdown file is the folder where it is located
- File paths (e.g. for images, data) must be specified *relative* to the working directory
- Easiest to include all necessary files in the same folder as the R Markdown folder
- Also useful to work in "projects" (the [here](#) package is very useful for this)

Note: An R Markdown document also uses its own "environment" so packages need to be loaded using `library()` in a code chunk **or** explicitly called using double colons

```
knitr::include_graphics("folder_example.png")
```



Tables

How can we turn the raw data frame into a nicely formatted table?

```
text.lengths <- read.csv("../data/lsnp.info.csv")  
print(text.lengths)
```

```
##           TASK min median   mean  max  
## 1    lgbt_essay 110  213.0 212.72 306  
## 2    drugs_essay 143  209.5 208.00 279  
## 3    food_essay 155  212.0 209.91 298  
## 4     cat_story 130  335.0 349.72 842  
## 5 sisters_story 211  402.5 410.27 916  
## 6 brothers_story 123  265.0 297.17 778  
## 7     interview 282 1021.0 1231.45 4158
```



Tables

The `kable()` function from the **knitr** package can be used to convert raw data frames to markdown format

```
```{r}
text.lengths <- read.csv('../data/lsnp.info.csv')
knitr::kable(text.lengths, booktabs = TRUE, caption = 'Text lengths by task')
```
```

Table: Text lengths by task

| TASK | min | median | mean | max |
|----------------|-----|--------|---------|------|
| lgbt_essay | 110 | 213.0 | 212.72 | 306 |
| drugs_essay | 143 | 209.5 | 208.00 | 279 |
| food_essay | 155 | 212.0 | 209.91 | 298 |
| cat_story | 130 | 335.0 | 349.72 | 842 |
| sisters_story | 211 | 402.5 | 410.27 | 916 |
| brothers_story | 123 | 265.0 | 297.17 | 778 |
| interview | 282 | 1021.0 | 1231.45 | 4158 |

Tables

For more flexibility (and for non HTML documents), try the `flextable` package

```
```{r}
library(flextable)
library(magrittr)
text.lengths <- read.csv('../data/lsnp.info.csv')
flextable(text.lengths) %>%
 bold(part = 'header') %>%
 bg(i = ~ median > 300, bg = 'wheat') %>%
 set_caption('Table 1. Text lengths by task')
```
```

Table 1. Text lengths by task

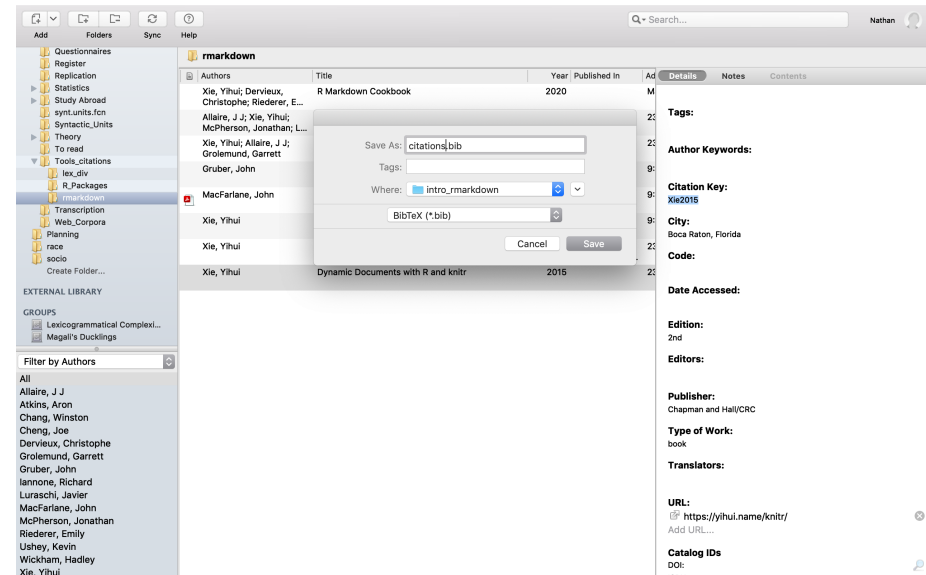
| TASK | min | median | mean | max |
|----------------|-----|---------|---------|-------|
| lgbt_essay | 110 | 213.0 | 212.7 | 306 |
| drugs_essay | 143 | 209.5 | 208.0 | 279 |
| food_essay | 155 | 212.0 | 209.9 | 298 |
| cat_story | 130 | 335.0 | 349.7 | 842 |
| sisters_story | 211 | 402.5 | 410.3 | 916 |
| brothers_story | 123 | 265.0 | 297.2 | 778 |
| interview | 282 | 1,021.0 | 1,231.5 | 4,158 |

Citations

In order to include citations, you first need to add two lines to the YAML header:

- a path to a **.bib** file containing citations in Bibtex format (can be exported from Mendeley or Zotero)
- a path to a **.csl** file containing citation formatting style guidelines (can be downloaded from the [Zotero Style Repository](#))
- easiest if you store both of these in the same folder as the R Markdown file

```
---  
title: "Introduction to R Markdown"  
author: "Nathan Vandeweerd"  
date: "`r Sys.Date()`"  
output: html_document  
bibliography: citations.bib  
csl: apa.csl  
---
```



Citations

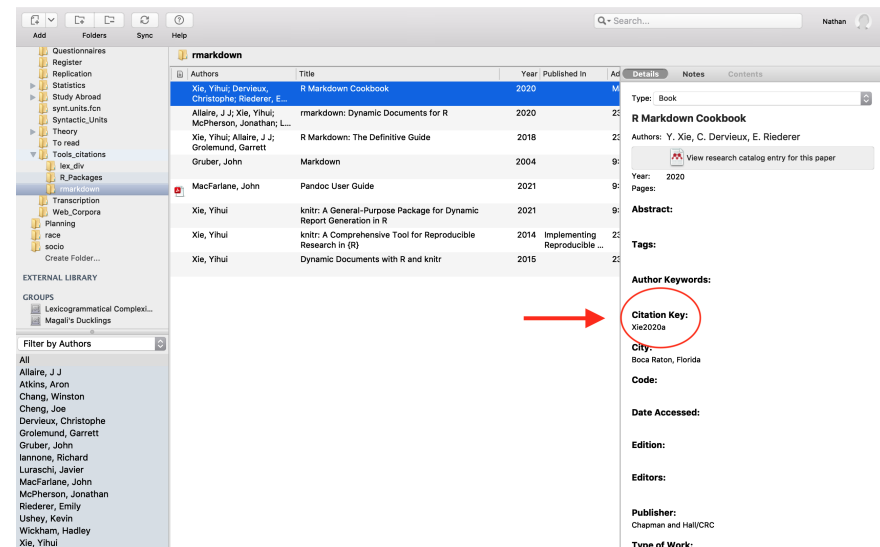
Once you have linked to a **.bib** file and a **.csi** file, you can include in-text citations using the format below:

- Multiple citations can be separated with a semi-colon
- A minus sign (-) means that only the year will be included

[@CitationKey]; @CitationKey2] --> (Author, 2005; Author, 2006)
[-@CitationKey1] --> (2005)

The Citation Key is **generated automatically** by reference tools such as Mendeley and Zotero (though you may need to change the settings to make it visible).

A bibliography will automatically be included at the end of the document which contains all of the cited references. To turn this off, simply add the following line to the YAML header:
suppress-bibliography: true



Useful packages

Some other useful packages:

- `knitr` (included with `rmarkdown` package): working with code chunks, inserting graphics, rendering basic tables
- `officer` and `officetools`: for working with Microsoft Office
- `xaringan`: for HTML presentations (like this one)
- `flextable`: more customizable tables
- `bookdown`: for long documents (i.e. dissertations)

Q & Eh?



Practice

Download the following files from GitHub (remember to save them all in the same folder):

- `example_document.Rmd`
- `apa.csl`
- `citations.bib`
- `cecl.png`
- `lsnp.info.csv`

To do:

1. make section headers:
 - abstract (first level)
 - topics covered (second level)
2. make bullet points for the topics covered
3. add a code chunk that calculates 1+1 (show both the code and the result)
4. add inline code that calculates 1+1
5. add the CECL Logo (in a reasonable size)
6. add a table showing the lengths of the langsnap texts by task (`lsnp.info.csv`)
7. add a barplot (`barplot()`) of the same data
8. add a hyperlink to the R Markdown webpage
9. make the second paragraph a block quote
10. add the citations for the R Markdown package

References

Gruber, J. (2004). *Markdown*. URL: <https://daringfireball.net/projects/markdown/>.

Marsden, E., K. Morgan-Short, et al. (2018). "Replication in Second Language Research: Narrative and Systematic Reviews and Recommendations for the Field". In: *Language Learning* 68.2, pp. 321-391.

Nature (2006). "Let's Replicate". In: *Nature* 442.7101, p. 330.

Porte, G. (2012). *Replication research in applied linguistics*. Cambridge: Cambridge University Press.

