

University of California
Santa Barbara

Improving the Management of Marine Resources through Economics and Data Science

A dissertation submitted in partial satisfaction
of the requirements for the degree

Doctor of Philosophy

in

Slowly and Painfully Working Out the Surprisingly Obvious

by

Daniel A. Ovando

Committee in charge:

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June 2018

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May 2018

Improving the Management of Marine Resources through Economics and Data Science

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To Hobbes

Acknowledgements

Thanks everyone!

Curriculum Vitæ

Daniel A. Ovando

Education

- 2018 Ph.D. in Environmental Science and Management (Expected), University of California, Santa Barbara.
- 2010 MESM in in Environmental Science and Management, University of California, Santa Barbara.
- 2007 B.S. in Ecosystem Science and Policy and Biology, University of Miami

Publications

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Abstract

Improving the Management of Marine Resources through Economics and Data Science

by

Daniel A. Ovando

The data say ‘meh’

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Chapter 1

UCSB thesis fields

Placeholder

Chapter 2

Introduction

```
getwd()
```

```
[1] "D:/Projects_R/MasterThesis/index"
```

```
test
```

Welcome to the *R Markdown* thesis template. This template is based on (and in many places copied directly from) the UW LaTeX template, but hopefully it will provide a nicer interface for those that have never used TeX or LaTeX before. Using *R Markdown* will also allow you to easily keep track of your analyses in **R** chunks of code, with the resulting plots and output included as well. The hope is this *R Markdown* template gets you in the habit of doing reproducible research, which benefits you long-term as a researcher, but also will greatly help anyone that is trying to reproduce or build onto your results down the road.

Hopefully, you won't have much of a learning period to go through and you will reap the benefits of a nicely formatted thesis. The use of LaTeX in combination with *Markdown* is more consistent than the output of a word processor, much less prone to corruption or

crashing, and the resulting file is smaller than a Word file. While you may have never had problems using Word in the past, your thesis is likely going to be at least twice as large and complex as anything you've written before, taxing Word's capabilities. After working with *Markdown* and **R** together for a few weeks, we are confident this will be your reporting style of choice going forward.

Why use it?

R Markdown creates a simple and straightforward way to interface with the beauty of LaTeX. Packages have been written in **R** to work directly with LaTeX to produce nicely formatting tables and paragraphs. In addition to creating a user friendly interface to LaTeX, *R Markdown* also allows you to read in your data, to analyze it and to visualize it using **R** functions, and also to provide the documentation and commentary on the results of your project. Further, it allows for **R** results to be passed inline to the commentary of your results. You'll see more on this later.

Who should use it?

Anyone who needs to use data analysis, math, tables, a lot of figures, complex cross-references, or who just cares about the final appearance of their document should use *R Markdown*. Of particular use should be anyone in the sciences, but the user-friendly nature of *Markdown* and its ability to keep track of and easily include figures, automatically generate a table of contents, index, references, table of figures, etc. should make it of great benefit to nearly anyone writing a thesis project.

Chapter 3

R Markdown Basics

LISTS

Lists

Line breaks

R chunks

Inline code

Including plots

Loading and exploring data

Additional resources

Chapter 4

Mathematics and Science

Placeholder

Math

Chemistry 101: Symbols

Typesetting reactions

Other examples of reactions

Physics

Biology

Chapter 5

Results

By far the easiest way to present tables in your thesis is to store the contents of the table in a CSV or Excel file, then read that file in to your R Markdown document as a data frame. Then you can style the table with the **kable** function, or functions in the **kableExtra** package.

In addition to the tables that can be automatically generated from a data frame in **R** that you saw in [R Markdown Basics](#) using the **kable** function, you can also create tables using *pandoc*. (More information is available at <http://pandoc.org/README.html#tables>.)

This might be useful if you don't have values specifically stored in **R**, but you'd like to display them in table form. Below is an example. Pay careful attention to the alignment in the table and hyphens to create the rows and columns. Generally I don't recommend this approach of typing the table directly into your R Markdown document.

Table 5.1: Correlation of Inheritance Factors for Parents
and Child

Factors	Correlation between Parents & Child	Inherited
Education	-0.49	Yes
Socio-Economic Status	0.28	Slight
Income	0.08	No
Family Size	0.18	Slight
Occupational Prestige	0.21	Slight

We can also create a link to the table by doing the following: Table 5.1. If you go back to [Loading and exploring data](#) and look at the `kable` table, we can create a reference to this max delays table too: Table ???. The addition of the `(\#tab:inher)` option to the end of the table caption allows us to then make a reference to Table `\@ref(tab:label)`. Note that this reference could appear anywhere throughout the document after the table has appeared.

FIGURES

Figures

Test

In the **R** chunk below, we will load in a picture stored as `uw.png` in our main directory. We then give it the caption of “UW logo”, the label of “uwlogo”, and specify that this is a figure. Make note of the different **R** chunk options that are given in the R Markdown file (not shown in the knitted document).

Here is a reference to the UW logo: Figure `??`. Note the use of the `fig:` code here. By naming the **R** chunk that contains the figure, we can then reference that figure later as done in the first sentence here. We can also specify the caption for the figure via the R chunk option `fig.cap`.

Below we will investigate how to save the output of an **R** plot and label it in a way similar to that done above. Recall the `flights` dataset from Chapter 3. (Note that we've shown a different way to reference a section or chapter here.) We will next explore a bar graph with the mean flight departure delays by airline from Portland for 2014. Note also the use of the `scale` parameter which is discussed on the next page.

```
flights %>% group_by(carrier) %>%
  summarize(mean_dep_delay = mean(dep_delay)) %>%
  ggplot(aes(x = carrier, y = mean_dep_delay)) +
  geom_bar(position = "identity", stat = "identity", fill = "red")

`summarise()` ungrouping output (override with `.groups` argument)
```

Here is a reference to this image: Figure 5.1.

A table linking these carrier codes to airline names is available at <https://github.com/ismayc/pnwflights14/blob/master/data/airlines.csv>.

FIGURES

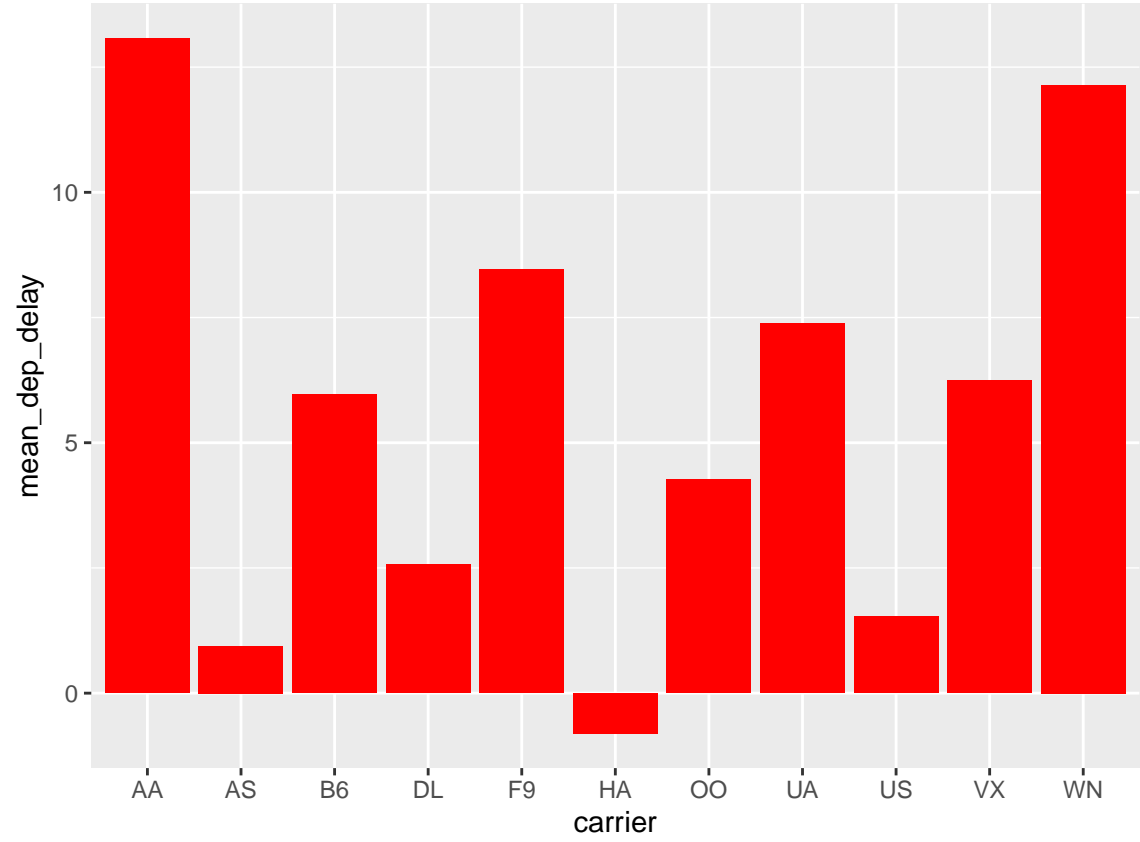


Figure 5.1: Mean Delays by Airline

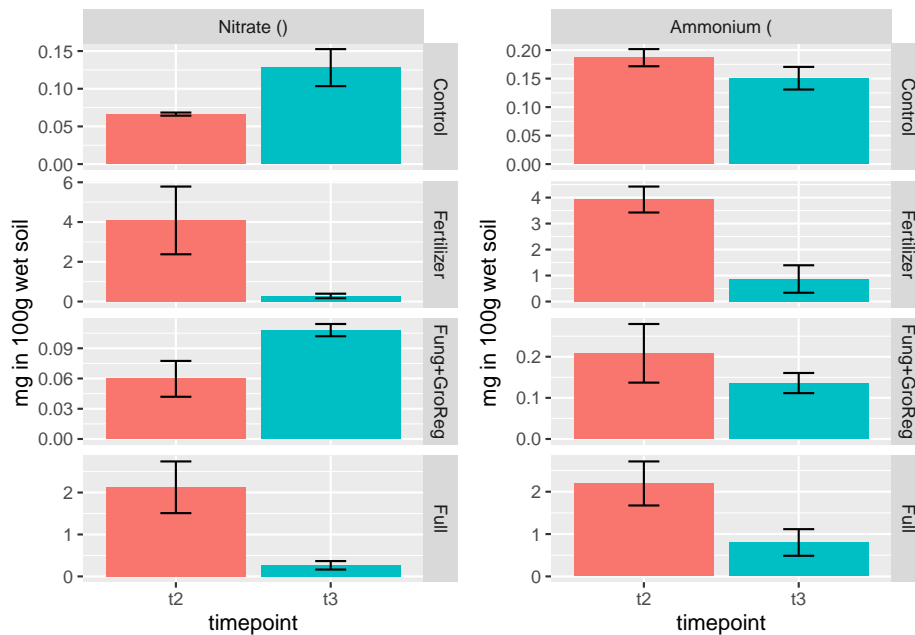


Figure 5.2: Subdiv. graph

Next, we will explore the use of the `out.extra` chunk option, which can be used to shrink or expand an image loaded from a file by specifying `"scale= "`. Here we use the mathematical graph stored in the “subdivision.pdf” file.

Here is a reference to this image: Figure 5.2. Note that `echo=FALSE` is specified so that the **R** code is hidden in the document.

Knit Child

Footnotes and Endnotes

You might want to footnote something.¹ The footnote will be in a smaller font and placed appropriately. Endnotes work in much the same way.

¹footnote text

Bibliographies

Of course you will need to cite things, and you will probably accumulate an armful of sources. There are a variety of tools available for creating a bibliography database (stored with the .bib extension). In addition to BibTeX suggested below, you may want to consider using the free and easy-to-use tool called Zotero. Some Zotero documentation is at <http://libguides.reed.edu/citation/zotero>. In addition, a tutorial is available from Middlebury College at <http://sites.middlebury.edu/zoteromiddlebury/>.

R Markdown uses *pandoc* (<http://pandoc.org/>) to build its bibliographies. One nice caveat of this is that you won't have to do a second compile to load in references as standard LaTeX requires. To cite references in your thesis (after creating your bibliography database), place the reference name inside square brackets and precede it by the “at” symbol. For example, here's a reference to a book about worrying: [1]. This Molina1994 entry appears in a file called `thesis.bib` in the `bib` folder. This bibliography database file was created by a program called BibTeX. You can call this file something else if you like (look at the YAML header in the main .Rmd file) and, by default, is to placed in the `bib` folder.

For more information about BibTeX and bibliographies, see (<http://web.reed.edu/cis/help/latex/index.html>)². There are three pages on this topic: *bibtex* (which talks about using BibTeX, at <http://web.reed.edu/cis/help/latex/bibtex.html>), *bibtexstyles* (about how to find and use the bibliography style that best suits your needs, at <http://web.reed.edu/cis/help/latex/bibtexstyles.html>) and *bibman* (which covers how to make and maintain a bibliography by hand, without BibTeX, at <http://web.reed.edu/cis/help/latex/bibman.html>). The last page will not be useful un-

²[2](#)

less you have only a few sources.

If you look at the YAML header at the top of the main .Rmd file you can see that we can specify the style of the bibliography by referencing the appropriate csl file. You can download a variety of different style files at <https://www.zotero.org/styles>. Make sure to download the file into the csl folder.

Tips for Bibliographies

- Like with thesis formatting, the sooner you start compiling your bibliography for something as large as thesis, the better.
- The cite key (a citation’s label) needs to be unique from the other entries.
- When you have more than one author or editor, you need to separate each author’s name by the word “and” e.g. `Author = {Noble, Sam and Youngberg, Jessica},.`
- Bibliographies made using BibTeX (whether manually or using a manager) accept LaTeX markup, so you can italicize and add symbols as necessary.
- To force capitalization in an article title or where all lowercase is generally used, bracket the capital letter in curly braces.

Anything else?

If you’d like to see examples of other things in this template, please [contact us](#) (email bmarwick@uw.edu) with your suggestions. We love to see people using *R Markdown* for their theses, and are happy to help.

Conclusion

If we don't want Conclusion to have a chapter number next to it, we can add the `{-}` attribute.

More info

And here's some other random info: the first paragraph after a chapter title or section head *shouldn't be* indented, because indents are to tell the reader that you're starting a new paragraph. Since that's obvious after a chapter or section title, proper typesetting doesn't add an indent there.

Appendix A

The First Appendix

This first appendix includes all of the R chunks of code that were hidden throughout the document (using the `include = FALSE` chunk tag) to help with readability and/or setup.

In the main Rmd file

In Chapter 5:

```
# This chunk ensures that the huskydown package is  
# installed and loaded. This huskydown package includes  
# the template files for the thesis and also two functions  
# used for labeling and referencing  
if(!require(devtools))  
  install.packages("devtools", repos = "http://cran.rstudio.com")  
if(!require(dplyr))  
  install.packages("dplyr", repos = "http://cran.rstudio.com")  
if(!require(ggplot2))  
  install.packages("ggplot2", repos = "http://cran.rstudio.com")
```

```
if(!require(ggplot2))  
  install.packages("bookdown", repos = "http://cran.rstudio.com")  
if(!require(gauchodown)){  
  library(devtools)  
  devtools::install_github("benmarwick/gauchodown")  
}  
library(gauchodown)  
flights <- read.csv("data/flights.csv")
```

Appendix B

The Second Appendix, for Fun

Colophon

This document is set in [EB Garamond](#), [Source Code Pro](#) and [Lato](#). The body text is set at 11pt with *lmr*.

It was written in R Markdown and \LaTeX , and rendered into PDF using [gauchodown](#) and [bookdown](#).

This document was typeset using the XeTeX typesetting system, and the [University of Washington Thesis class](#) class created by Jim Fox. Under the hood, the [University of Washington Thesis LaTeX template](#) is used to ensure that documents conform precisely to submission standards. Other elements of the document formatting source code have been taken from the [Latex](#), [Knitr](#), and [RMarkdown templates for UC Berkeley's graduate thesis](#), and [Dissertate: a LaTeX dissertation template to support the production and typesetting of a PhD dissertation at Harvard, Princeton, and NYU](#)

The source files for this thesis, along with all the data files, have been organised into an R package, `xxx`, which is available at <https://github.com/xxx/xxx>. A hard copy of the thesis can be found in the University of Washington library.

This version of the thesis was generated on 2021-01-11 16:32:36. The repository is currently at this commit:

The computational environment that was used to generate this version is as follows:

APPENDIX B. THE SECOND APPENDIX, FOR FUN

```
- Session info -----
setting  value
version  R version 4.0.3 (2020-10-10)
os       Windows 10 x64
system   x86_64, mingw32
ui       RTerm
language (EN)
collate   English_United States.1252
ctype     English_United States.1252
tz        Europe/Berlin
date      2021-01-11

- Packages -----
package      * version date      lib source
abind         1.4-5   2016-07-21 [1] CRAN (R 4.0.3)
assertthat    0.2.1   2019-03-21 [1] CRAN (R 4.0.3)
backports     1.2.0   2020-11-02 [1] CRAN (R 4.0.3)
bookdown      0.21.6  2021-01-11 [1] Github (rstudio/bookdown@92c59d3)
broom         0.7.3   2020-12-16 [1] CRAN (R 4.0.3)
callr         3.5.1   2020-10-13 [1] CRAN (R 4.0.3)
car           3.0-10  2020-09-29 [1] CRAN (R 4.0.3)
carData       3.0-4   2020-05-22 [1] CRAN (R 4.0.3)
cellranger    1.1.0   2016-07-27 [1] CRAN (R 4.0.3)
cli           2.2.0   2020-11-20 [1] CRAN (R 4.0.3)
colorspace    2.0-0   2020-11-11 [1] CRAN (R 4.0.3)
cowplot       1.1.1   2020-12-30 [1] CRAN (R 4.0.3)
```


crayon	1.3.4	2017-09-16	[1]	CRAN	(R 4.0.3)
curl	4.3	2019-12-02	[1]	CRAN	(R 4.0.3)
data.table	1.13.4	2020-12-08	[1]	CRAN	(R 4.0.3)
DBI	1.1.0	2019-12-15	[1]	CRAN	(R 4.0.3)
dbplyr	2.0.0	2020-11-03	[1]	CRAN	(R 4.0.3)
desc	1.2.0	2018-05-01	[1]	CRAN	(R 4.0.3)
devtools	* 2.3.2	2020-09-18	[1]	CRAN	(R 4.0.3)
digest	0.6.27	2020-10-24	[1]	CRAN	(R 4.0.3)
dplyr	* 1.0.2	2020-08-18	[1]	CRAN	(R 4.0.3)
ellipsis	0.3.1	2020-05-15	[1]	CRAN	(R 4.0.3)
evaluate	0.14	2019-05-28	[1]	CRAN	(R 4.0.3)
fansi	0.4.1	2020-01-08	[1]	CRAN	(R 4.0.3)
farver	2.0.3	2020-01-16	[1]	CRAN	(R 4.0.3)
forcats	* 0.5.0	2020-03-01	[1]	CRAN	(R 4.0.3)
foreign	0.8-80	2020-05-24	[2]	CRAN	(R 4.0.3)
fs	1.5.0	2020-07-31	[1]	CRAN	(R 4.0.3)
gauchodown	* 1.0	2021-01-07	[1]	Github	(danovando/gauchodown@d9a19b8)
generics	0.1.0	2020-10-31	[1]	CRAN	(R 4.0.3)
ggplot2	* 3.3.3	2020-12-30	[1]	CRAN	(R 4.0.3)
ggpubr	* 0.4.0	2020-06-27	[1]	CRAN	(R 4.0.3)
ggsignif	0.6.0	2019-08-08	[1]	CRAN	(R 4.0.3)
git2r	0.27.1	2020-05-03	[1]	CRAN	(R 4.0.3)
glue	1.4.2	2020-08-27	[1]	CRAN	(R 4.0.3)
gtable	0.3.0	2019-03-25	[1]	CRAN	(R 4.0.3)
haven	2.3.1	2020-06-01	[1]	CRAN	(R 4.0.3)
highr	0.8	2019-03-20	[1]	CRAN	(R 4.0.3)

APPENDIX B. THE SECOND APPENDIX, FOR FUN

hms	0.5.3	2020-01-08	[1]	CRAN	(R 4.0.3)
htmltools	0.5.0	2020-06-16	[1]	CRAN	(R 4.0.3)
httr	1.4.2	2020-07-20	[1]	CRAN	(R 4.0.3)
jsonlite	1.7.2	2020-12-09	[1]	CRAN	(R 4.0.3)
knitr	1.30	2020-09-22	[1]	CRAN	(R 4.0.3)
labeling	0.4.2	2020-10-20	[1]	CRAN	(R 4.0.3)
lifecycle	0.2.0	2020-03-06	[1]	CRAN	(R 4.0.3)
lubridate	1.7.9.2	2020-11-13	[1]	CRAN	(R 4.0.3)
magrittr	2.0.1	2020-11-17	[1]	CRAN	(R 4.0.3)
memoise	1.1.0	2017-04-21	[1]	CRAN	(R 4.0.3)
modelr	0.1.8	2020-05-19	[1]	CRAN	(R 4.0.3)
munsell	0.5.0	2018-06-12	[1]	CRAN	(R 4.0.3)
openxlsx	4.2.3	2020-10-27	[1]	CRAN	(R 4.0.3)
pillar	1.4.7	2020-11-20	[1]	CRAN	(R 4.0.3)
pkgbuild	1.2.0	2020-12-15	[1]	CRAN	(R 4.0.3)
pkgconfig	2.0.3	2019-09-22	[1]	CRAN	(R 4.0.3)
pkgload	1.1.0	2020-05-29	[1]	CRAN	(R 4.0.3)
prettyunits	1.1.1	2020-01-24	[1]	CRAN	(R 4.0.3)
processx	3.4.5	2020-11-30	[1]	CRAN	(R 4.0.3)
ps	1.5.0	2020-12-05	[1]	CRAN	(R 4.0.3)
purrr	* 0.3.4	2020-04-17	[1]	CRAN	(R 4.0.3)
R6	2.5.0	2020-10-28	[1]	CRAN	(R 4.0.3)
Rcpp	1.0.5	2020-07-06	[1]	CRAN	(R 4.0.3)
readr	* 1.4.0	2020-10-05	[1]	CRAN	(R 4.0.3)
readxl	1.3.1	2019-03-13	[1]	CRAN	(R 4.0.3)
remotes	2.2.0	2020-07-21	[1]	CRAN	(R 4.0.3)

reprex	0.3.0	2019-05-16	[1]	CRAN	(R 4.0.3)
rio	0.5.16	2018-11-26	[1]	CRAN	(R 4.0.3)
rlang	0.4.10	2020-12-30	[1]	CRAN	(R 4.0.3)
rmarkdown	2.6.4	2021-01-11	[1]	Github	(rstudio/rmarkdown@2e8572e)
rprojroot	2.0.2	2020-11-15	[1]	CRAN	(R 4.0.3)
rstatix	0.6.0	2020-06-18	[1]	CRAN	(R 4.0.3)
rstudioapi	0.13	2020-11-12	[1]	CRAN	(R 4.0.3)
rvest	0.3.6	2020-07-25	[1]	CRAN	(R 4.0.3)
scales	1.1.1	2020-05-11	[1]	CRAN	(R 4.0.3)
sessioninfo	1.1.1	2018-11-05	[1]	CRAN	(R 4.0.3)
stringi	1.5.3	2020-09-09	[1]	CRAN	(R 4.0.3)
stringr	* 1.4.0	2019-02-10	[1]	CRAN	(R 4.0.3)
testthat	3.0.1	2020-12-17	[1]	CRAN	(R 4.0.3)
tibble	* 3.0.4	2020-10-12	[1]	CRAN	(R 4.0.3)
tidyr	* 1.1.2	2020-08-27	[1]	CRAN	(R 4.0.3)
tidyselect	1.1.0	2020-05-11	[1]	CRAN	(R 4.0.3)
tidyverse	* 1.3.0	2019-11-21	[1]	CRAN	(R 4.0.3)
usethis	* 2.0.0	2020-12-10	[1]	CRAN	(R 4.0.3)
vctrs	0.3.6	2020-12-17	[1]	CRAN	(R 4.0.3)
withr	2.3.0	2020-09-22	[1]	CRAN	(R 4.0.3)
xfun	0.20	2021-01-06	[1]	CRAN	(R 4.0.3)
xml2	1.3.2	2020-04-23	[1]	CRAN	(R 4.0.3)
yaml	2.2.1	2020-02-01	[1]	CRAN	(R 4.0.3)
zip	2.1.1	2020-08-27	[1]	CRAN	(R 4.0.3)

[1] D:/rlib

APPENDIX B. THE SECOND APPENDIX, FOR FUN

[2] D:/Program Files/R/R-4.0.3/library

References

Placeholder

- [1] S. T. Molina and T. D. Borkovec, “The Penn State worry questionnaire: Psychometric properties and associated characteristics,” in *Worrying: Perspectives on theory, assessment and treatment*, G. C. L. Davey and F. Tallis, Eds. New York: Wiley, 1994, pp. 265–283.
- [2] Reed College, “LaTeX your document.” 2007 [Online]. Available: <http://web.reed.edu/cis/help/LaTeX/index.html>