R Markdown

STAE04: Data Visualization

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1 R Markdown

This document is written using R Markdown. R Markdown is a syntax for formatting documents that lets you focus on content. You write text (including R code) in a standard text document with the ending `.Rmd` and then R Markdown (plus a handful of very useful packages) turns your text into a neatly formatted document.

This document serves as both a template for your submissions during the data visualization course as well as an introduction into R Markdown.

If you are here for the introduction, simply open this file in R Studio and keep reading.

1.1 Installation

To get started, you are going to need two packages: **rmarkdown** and **knitr**. Run the following line of code to install these now. If you are currently in the R Studio editor when you read this, you can simply highlight the text and hit `Ctrl/Cmd + Enter` or put the cursor inside the code chunk below and hit `Ctrl/Cmd + Shift + Enter` to run the command (and install the packages).

```
install.packages(c("rmarkdown", "knitr"))
```

You will also need a distribution of LaTeX. Installing LaTeX can be installed easily using the **tinytex** package (if you don't already have LaTeX installed). Do so right now by calling the following lines of code.

```
install.packages("tinytex")
tinytex::install_tinytex()
```

After this, we also recommend that you set the options in `Tools > Global Options > Sweave` in R Studio as in Figure 3.

1.2 Knitting

Now that you have LaTeX installed, we can turn this document into a pdf report by **knitting** it. To do so in R Studio, simply hit `Ctrl/Cmd + Shift + k`. Doing so will prompt R to run through all of your code blocks and text and pass this on to LaTeX to render your document into a pdf file, which should open up on your screen. As you keep on reading through this `.Rmd` file, try to keep an eye on the pdf document to see what the output looks like.

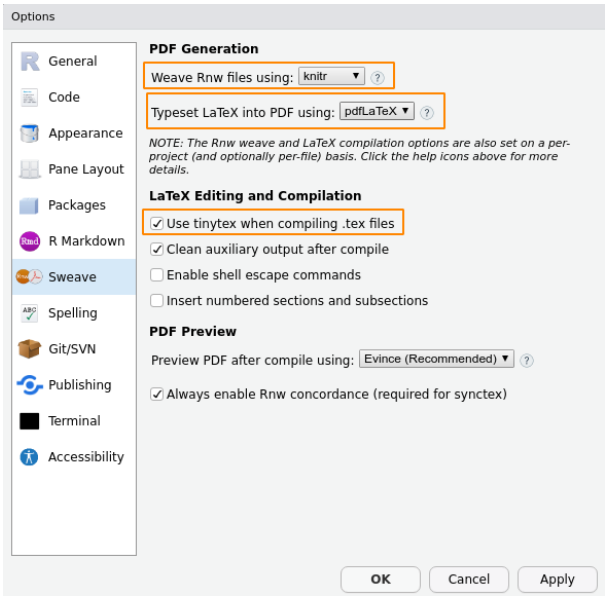


Figure 1: Suggested global options in R Studio.

R Markdown files can be knitted to a wide range of medium, including PDF files, HTML, and word documents. In this course, however, you will always produce PDF files from your R Markdown documents.

1.3 YAML

Each Rmarkdown file starts with a so called YAML block; here is a bare-bones one:

```
---
title: "An Awesome Title"
author: "Fantastic Me"
date: "2020-09-28"
output: pdf_document
---
```

The YAML block contains settings that control the title block (title, author, date) and options for the layout. For this course, please use the YAML block supplied in this template, modifying only the `author`, `date`, `affiliation`, and `title` fields. You should also remove the `references` item in the YAML block unless you need references in your report.

1.4 Formatting

R Markdown is an extension of Pandoc Markdown, which uses a special—but very simple—syntax for formatting text. The following are some ways in which you can format text in R Markdown.

1.4.1 Basic Text Formatting

Start a new paragraph by surrounding text with blank lines.

Single asterisks italicize text, **double asterisks format text in bold**, and `grave accents formats text in monospace` (which is suitable whenever you want to include code).

1.4.2 Lists

To create (unnumbered) lists in markdown, you add a

- dash before each item in the list, and
  - asterisks for sub-items in the list,
- placing each item on its own line, and
- adding blank lines before and after the list.

Numbered lists are

1. created similarly, but
2. using numbers instead of dashes.

1.4.3 Sections

Sections are created by prefacing the section title with a hash tag (`#`):

```
# One Hashtag Creates a Section

## Two Hashtags Creates a Subsection

### Three Hastags Creates a Subsubsection
```

1.4.4 Quotations

R Markdown can even format quotes for you!

> If you want to quote something, adding a `>` before the text creates a block quote —Johan Larsson

1.4.5 Tables

There are many ways to format tables in markdown, but the simplest one is two simply create columns of text with dashes (`---`) separating the title of each column from the cells of the table.

Table 1: A caption for the table can be added like this.

Header 1	Header 2
Cell 1	Cell 2
Cell 3	Cell 4

1.4.6 Links

To add a link in Markdown, you can either simply surround the URL with brackets (as in this link to a R Markdown cheatsheet): https://rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf or you can use brackets and parentheses to provide your own text for the link.

1.4.7 Images

Images can be added with syntax similar to the one for links, with the text inside brackets indicating the caption for the figure. Let's first download an image to our working directory.

```
download.file(
  "https://imgs.xkcd.com/comics/scientific_paper_graph_quality.png",
  "xkcd.png",
  mode = "wb"
)
```

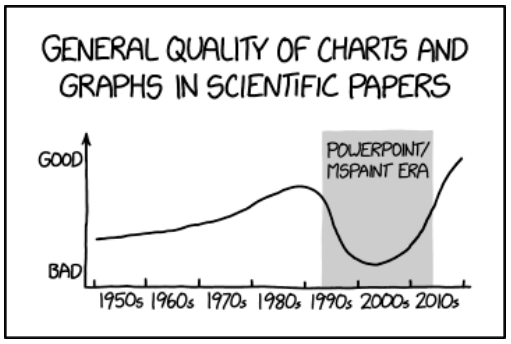


Figure 2: Including the image is then simply a matter of using square brackets and parentheses (https://xkcd.com/1945/).

1.4.8 Footnotes

Footnotes can be useful to provide additional information[1]. For a longer footnote, it might be better to refer to it with a number[2].

1.4.9 Citations

It is possible to add citations in R Markdown but this is somewhat complicated if you are not familiar with Markdown and Pandoc. You will not be needing a lot of references in this course, so it's perfectly alright to write your references and citations manually; in this case, you can skip the next paragraph.

To cite in R Markdown, you will need either 1) a `.bib` file (with bibtex-formatted references) somewhere in your working directory or 2) a `references` field in the YAML block; in this document we use the latter but only to keep this document self-contained. Using a `.bib` file is recommended. Find the key of the reference you are looking for and preface it with an `@`, like the following reference to Wickham (2010), which creates a text reference. If you surround the key with brackets, you instead get a non-text citation (Wickham 2010). If you've done everything right, the final document will get a bibliography at the end (as in this one).

1.5 Code Chunks

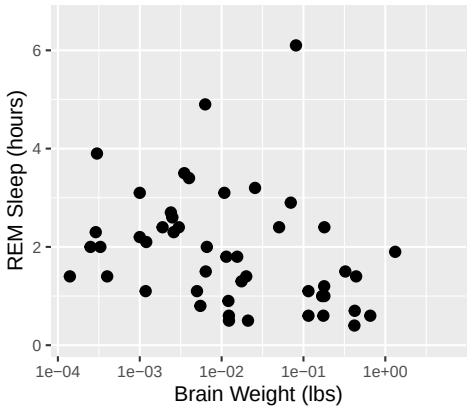
So far we've only really talked about features that are made possible by pandoc and its flavor of Markdown. But what makes R Markdown special is that is allows us to

[1] If the footnote is short, it is often best to write it in-line, like this.
[2] Then you can add your text separately in the document.

write seamlessly include chunks of R code in our texts. This is a code chunk that plots a simple plot using ggplot2:

```r
library(tidyverse)

ggplot(msleep, aes(brainwt, sleep_rem)) +
  geom_point() +
  scale_x_log10() +
  labs(x = "Brain Weight (lbs)", y = "REM Sleep (hours)")
```



As you can see, we've started the code chunk with ```` ```{r} ```` and ended it with ```` ``` ````. Everything in between will be treated as R code, just as if you would have written in in an R script of the R terminal. When you compile this document all this code will be run and if it produces any output (text, plot, tables) then that output will make it into the final document.

1.5.1 Chunk Settings

You can control many settings via the header of the code chunk (the content between `{` and `}` in the first line of the code chunk). In the following chunk we've changed the width and height of the figure as well as added a caption to the figure. These are settings that will be **incredibly** useful to you during the course.

```r
ggplot(msleep, aes(brainwt, sleep_rem)) +
  geom_point() +
  scale_x_log10() +
  labs(x = "Brain Weight (kg)", y = "REM Sleep (hours)")
```

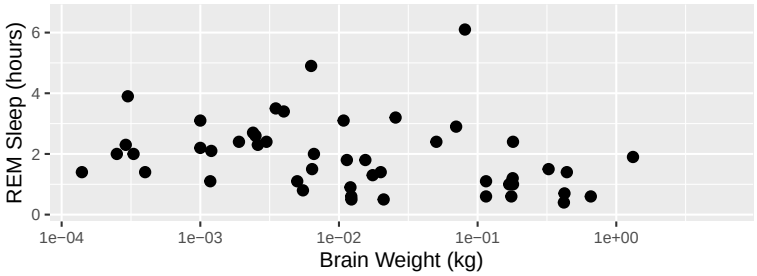


Figure 3: Brain weight and REM sleep duration for mammals.

There are a few other settings that will also come in handy: `include`, `eval`, `results`, `fig.show`, and `echo`.

`echo` Setting `echo = TRUE` means that the code in your code chunk will be included in the output (your pdf report). In this template, `echo` is set to `TRUE` by default (seethe first code hunk header "setup" in this document), but sometimes you onlywant the output of your code and not the code itself, which is often the case when you create figures.

`eval` Setting `eval = FALSE` means that the code in your code chunk will not be evaluated at all. This is often useful when you want to show how something is done (like installing a package) but don't want to do this every time you knit your document.

`results` and `fig.show` Setting either of these to `"hide"` means that the results generated from the code won't make it into the output (your pdf report); uses `results = "hide"` if you want to suppress code results and `fig.show = "hide"` if you want to suppress plots. This is sometimes useful if you want to run code interactively but not have it end up in your output. It can also be useful if the code you run produces output as a side-effect.

`include` Setting `include = FALSE` mean that the code will be evaluated but neither the output not the code will be included. This is equivalent to setting `echo = FALSE`, `eval = TRUE`, and `results = "hide"`.

Here are a couple of examples of these arguments (note that `echo = TRUE`, `include = TRUE`, `eval = TRUE`, and `results = "show"` are the defaults):

```
## [1]  1.9517 -0.3632 -0.8334 -0.0672 -0.1706
```

```
# this code block will show in the output,
# but the results of `rnorm(50)` will not
rnorm(5)
```

```
# this code will not be evaluated at all
rnorm(5)
```

1.5.2 Global Chunk Settings

The chunk settings for an R Markdown document can be modified globally. To do so, you need to call the `knitr::opts_chunk$set()` function at the top of your document. Inside the function, you set defaults for the various chunk arguments. The following is the global settings for this document, which you'll also find in the first chunk the `setup` chunk, in this document.

1.6 Reproducibility and Automation

Authoring your documents using R Markdown facilitates reproducibility. Because you need to supply all the code used to produce your paper in the `.Rmd` file, this makes it much easier for other people to re-run your analysis and use your code. It also means that your paper is now automated. Should you need to update or modify your data, for instance, you will typically be able to generate your final document simply by re-knitting it after having made your changes.

2 Learning More About R Markdown

If you want to learn more about R Markdown, we recommend the R Markdown Cookbook. If you run into any issues with R Markdown, please use the course's discussion board on Canvas or search stack overflow with the `[r-markdown]` or `[knitr]` tag.

3 Troubleshooting

3.1 Error: `'"pdflatex"' not found`

If you receive an error when knitting such as

```
Error: Failed to compile Test.tex.
In addition: Warning message:
In system2(..., stdout = FALSE, stderr = FALSE) : '"pdflatex"' not found
Execution halted
```

then please try running `tinytex:::install_prebuilt()`.

If this doesn't help, take a look at https://github.com/yihui/tinytex/issues/103 to see if any of the suggested solutions there may help.

3.2 I still cannot knit to `.pdf`!

As a last resort, you can change the output from pdf to Word document instead. (But then you need to convert it to pdf before submitting.)

In this case, change the output section in the YAML front matter to the following:

```
output:
  word_document:
    number_sections: true
```

References

Wickham, Hadley. 2010. "A Layered Grammar of Graphics." *Journal of Computational and Graphical Statistics* 19 (1): 3–28. https://doi.org/10.1198/jcgs.2009.07098.