

Introduction to RMarkdown

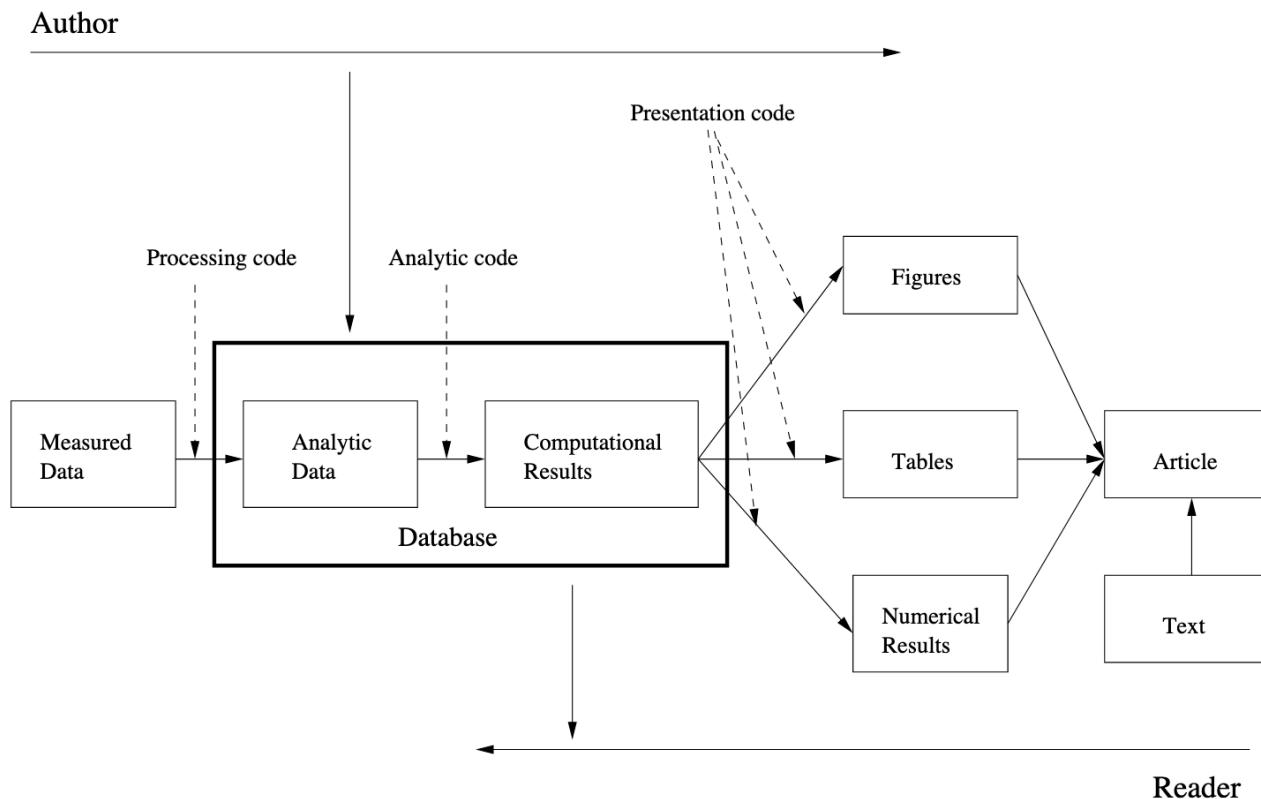
Andrew Zieffler

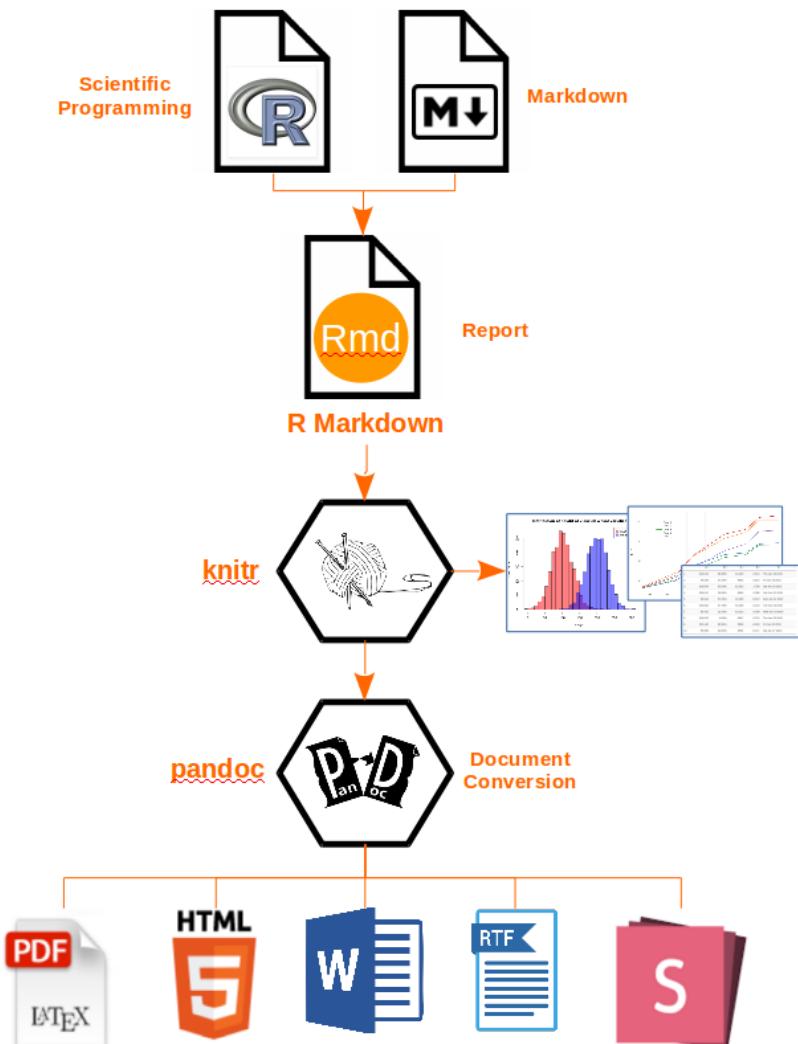


This work is licensed under a
[Creative Commons Attribution
4.0 International License](#).

RMarkdown

R Markdown is a file format for embedding R syntax directly in a text document. Using RMarkdown is one of the first steps to making your research more reproducible. By integrating your R syntax and your text into a single document, it also improves your analytical workflow.





RMarkdown combines **Markdown** (a text-to-HTML conversion tool) and **R syntax** into a compilable report.

The **knitr** package engages the R interpreter to render the R syntax.

The **pandoc** application serves as a document conversion tool and renders text to different output formats (e.g., html, pdf).

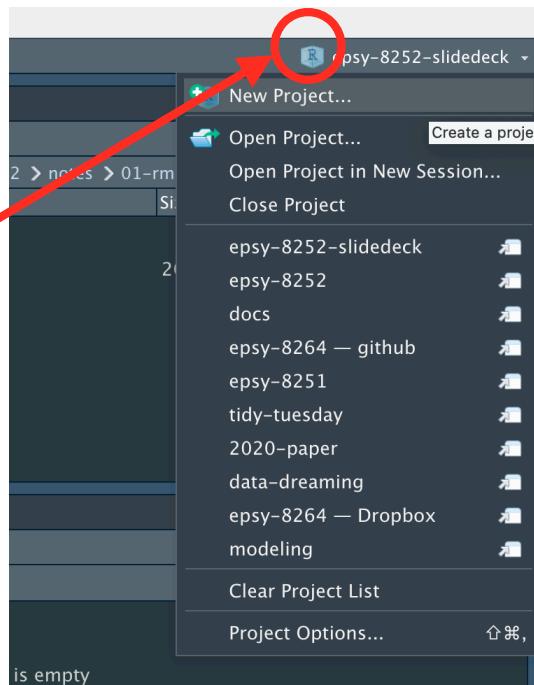
Image credit: Horn, B. (2019). Project reporting with RMarkdown. *Applied R code*.
<http://applied-r.com/project-reporting-template/>

Hello World: Creating an RMarkdown Document to Produce an HTML File

<http://rmarkdown.rstudio.com/>

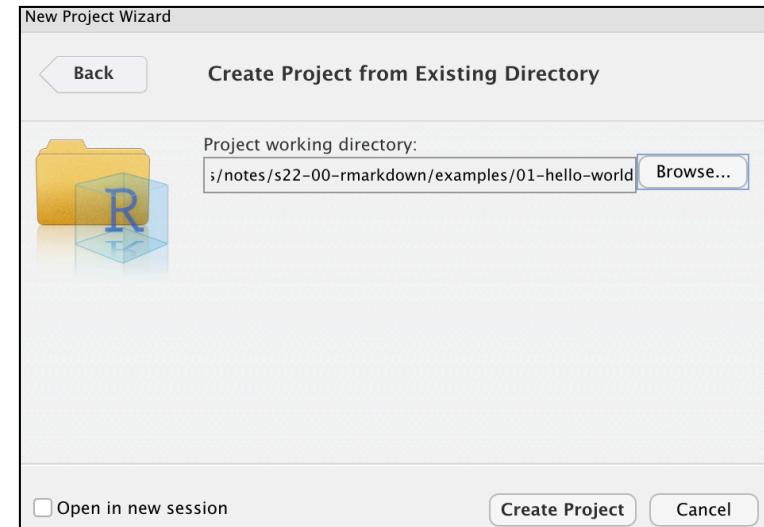
Create an R Project for an Existing Directory

Click the project icon in RStudio (it might say No Project or something like that) and select [New Project...](#)



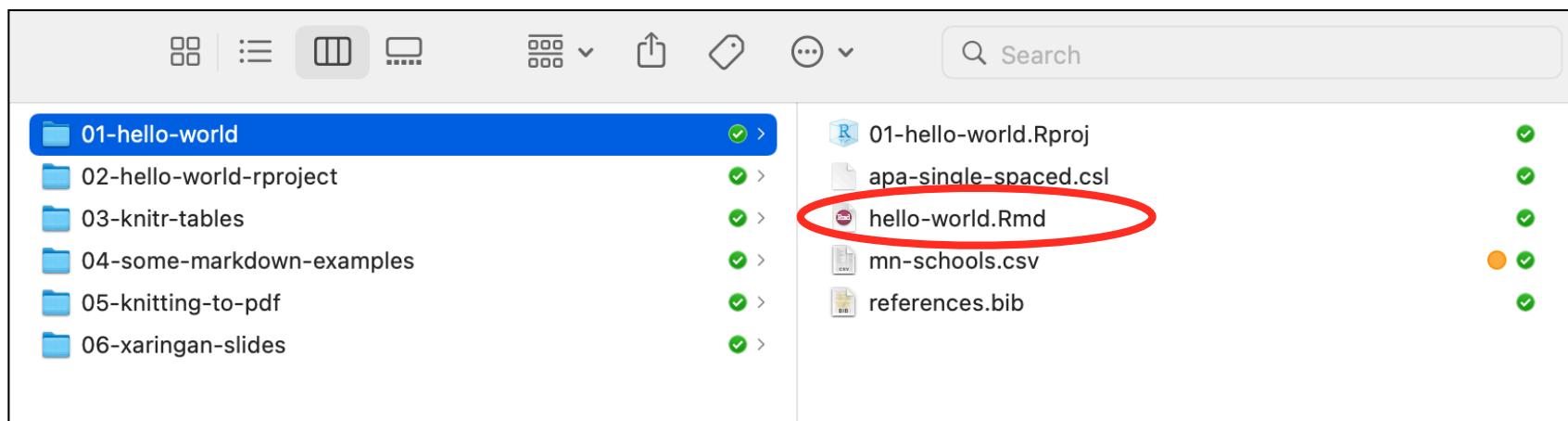
In the project wizard, select:

- [Existing Directory](#),
- Click [Browse](#) and select the [01-hello-world](#) directory in the [examples](#) directory
- Click [Open](#)
- Click [Create Project](#)



The R Project will be created and have the same name as the directory you associated with.

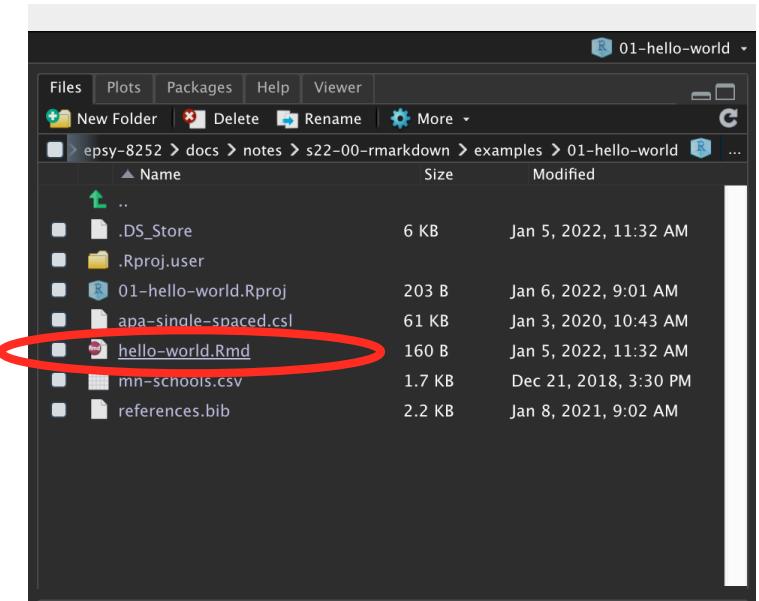
You should now see the R project in the [01-hello-world directory](#). R projects have the file suffix `.Rproj`. You can open a project in RStudio or by double-clicking it.



There are many advantages to using R projects. One big one is that the working directory is set to the project home directory. This means, for example, rather than having to give a long path name for a dataset to import data using the `read_csv()` function, you could just use `read_csv("mn-schools.csv")`—as long as the data set is in the same directory as the `.Rproj` file.

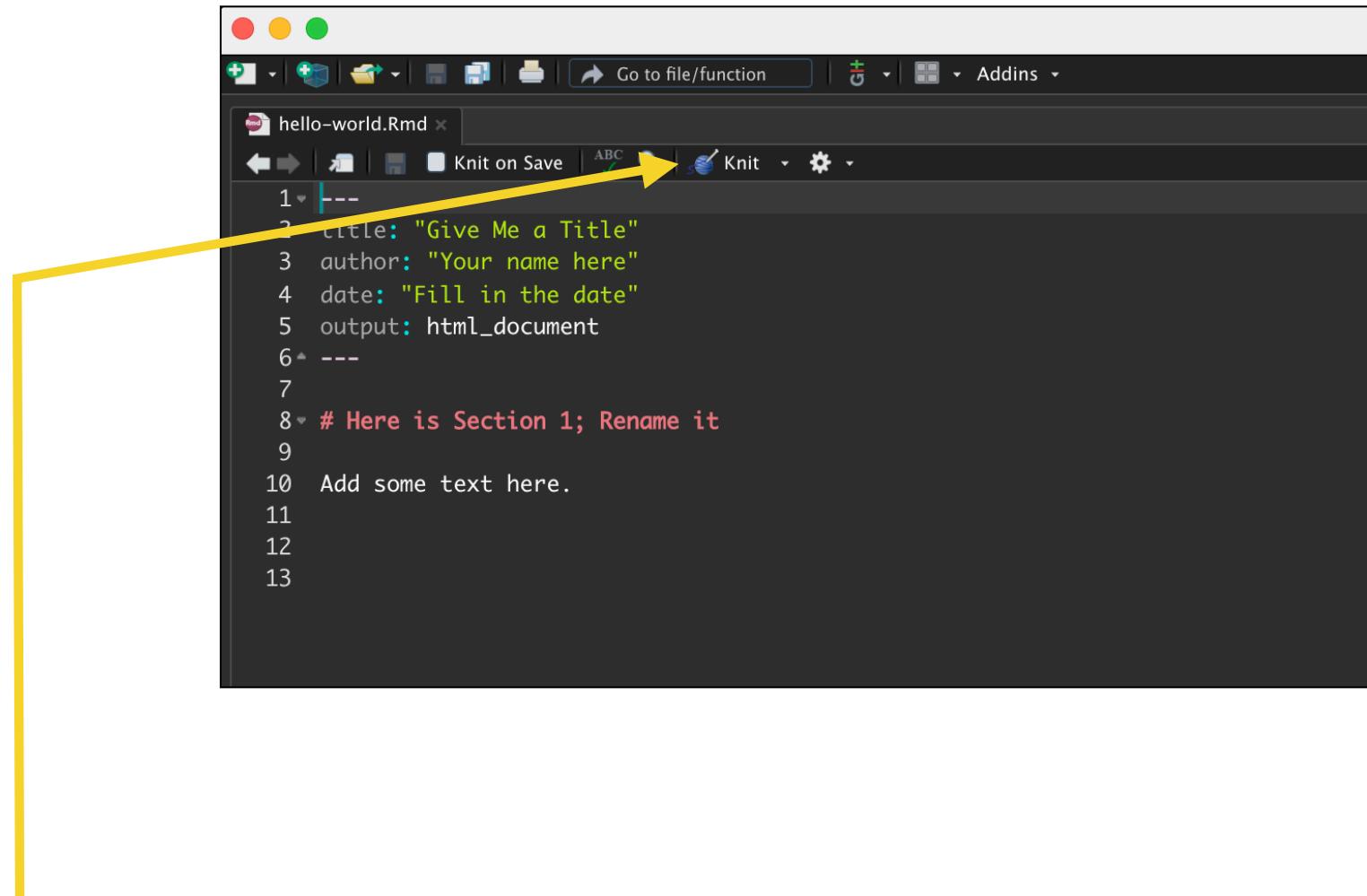
Open the R Markdown Document

- In the [Files](#) pane of your `01-hello-world` R project, select the `hello-world.RMD` file.



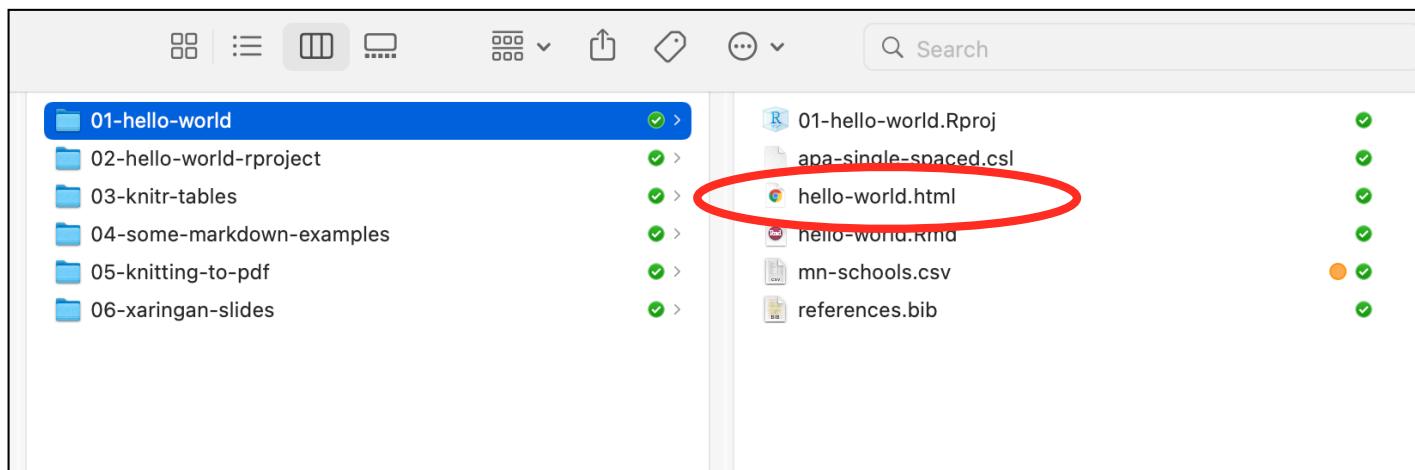
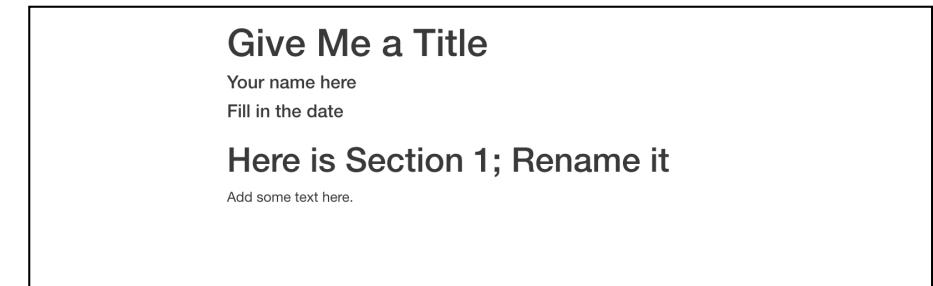
This should open the R Markdown file called `hello-world.Rmd` in the RStudio editor.

When you open the `hello-world.Rmd` file, you will see the following.



Click the **Knit** button.

Knitting compiles the document and formats it according to the markdown you included (or that was pre-included for you).



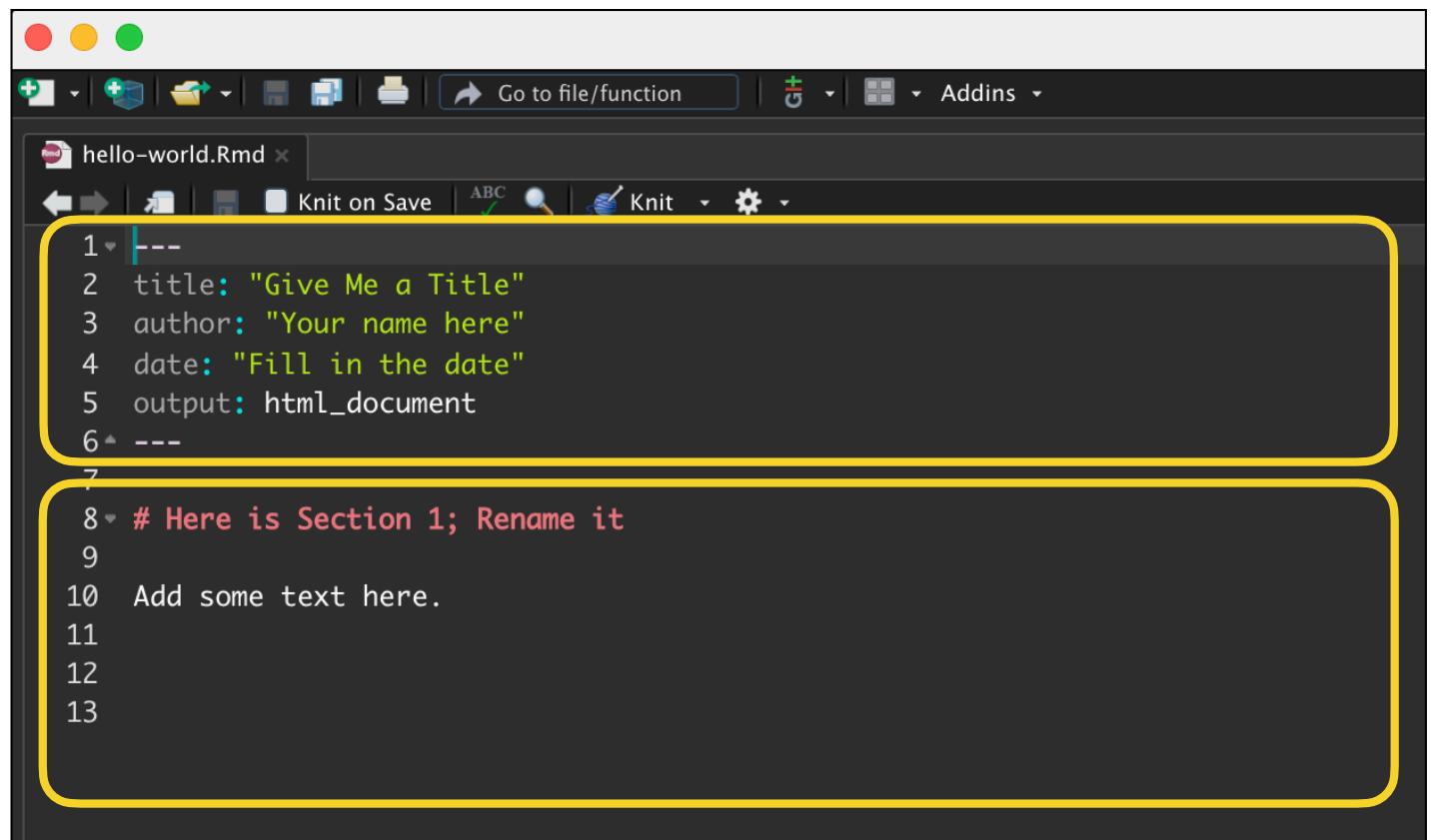
The compiled, formatted document has the extension **.html**. The HTML file can be opened in any browser.

Working with RMarkdown

There are two major parts to your RMD document.

The first part, called YAML, is set between two sets of three hyphens. This constitutes meta-data for your document.

The second part is the main text and uses Markdown to format the rendered document.

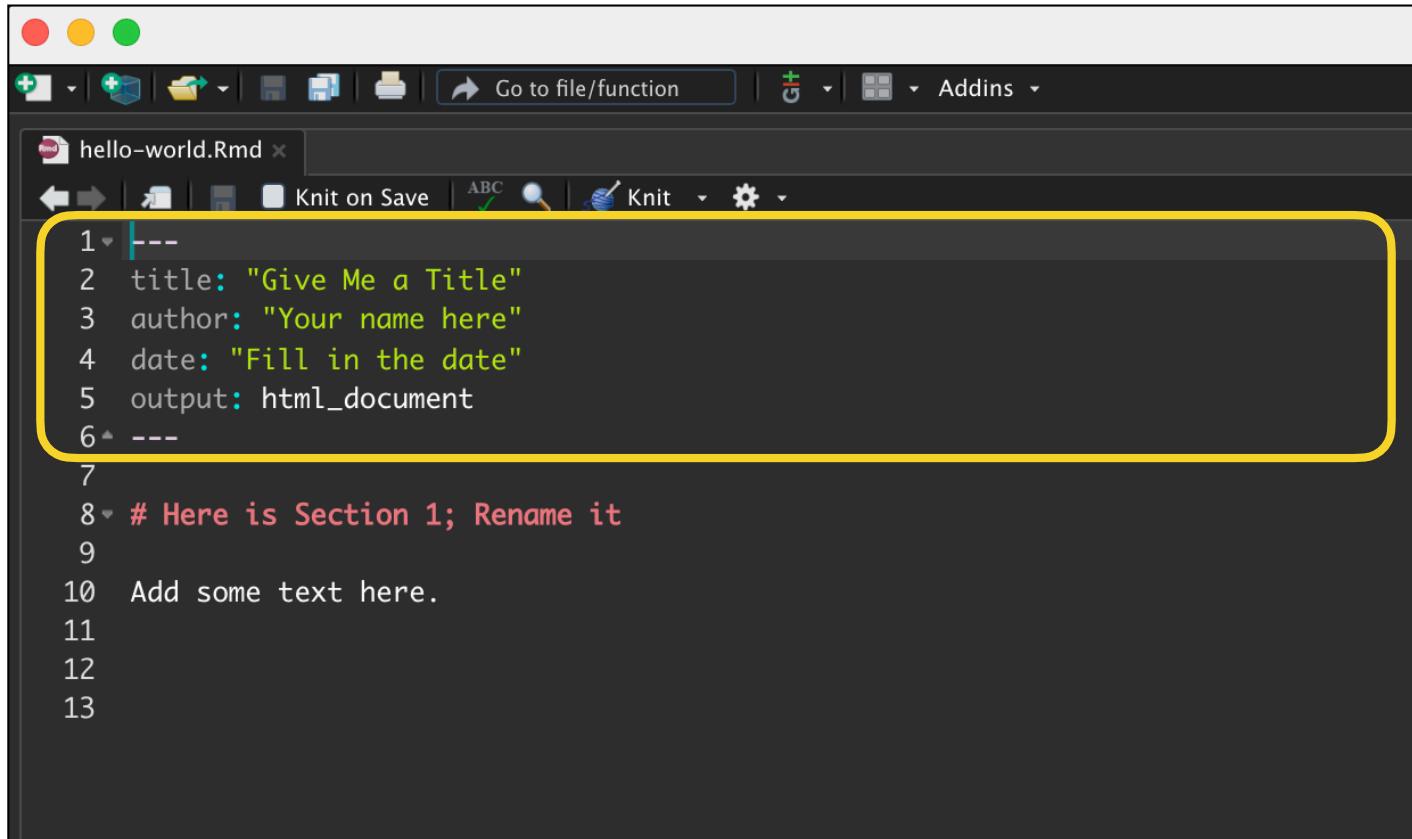


A screenshot of the RStudio interface showing an RMD file named "hello-world.Rmd". The file contains the following content:

```
1 ---  
2 title: "Give Me a Title"  
3 author: "Your name here"  
4 date: "Fill in the date"  
5 output: html_document  
6 ---  
7  
8 # Here is Section 1; Rename it  
9  
10 Add some text here.  
11  
12  
13
```

The first section (lines 1-6) is highlighted with a yellow rounded rectangle, representing the YAML front matter. The second section (lines 7-13) is also highlighted with a yellow rounded rectangle, representing the main Markdown content.

Edit the YAML



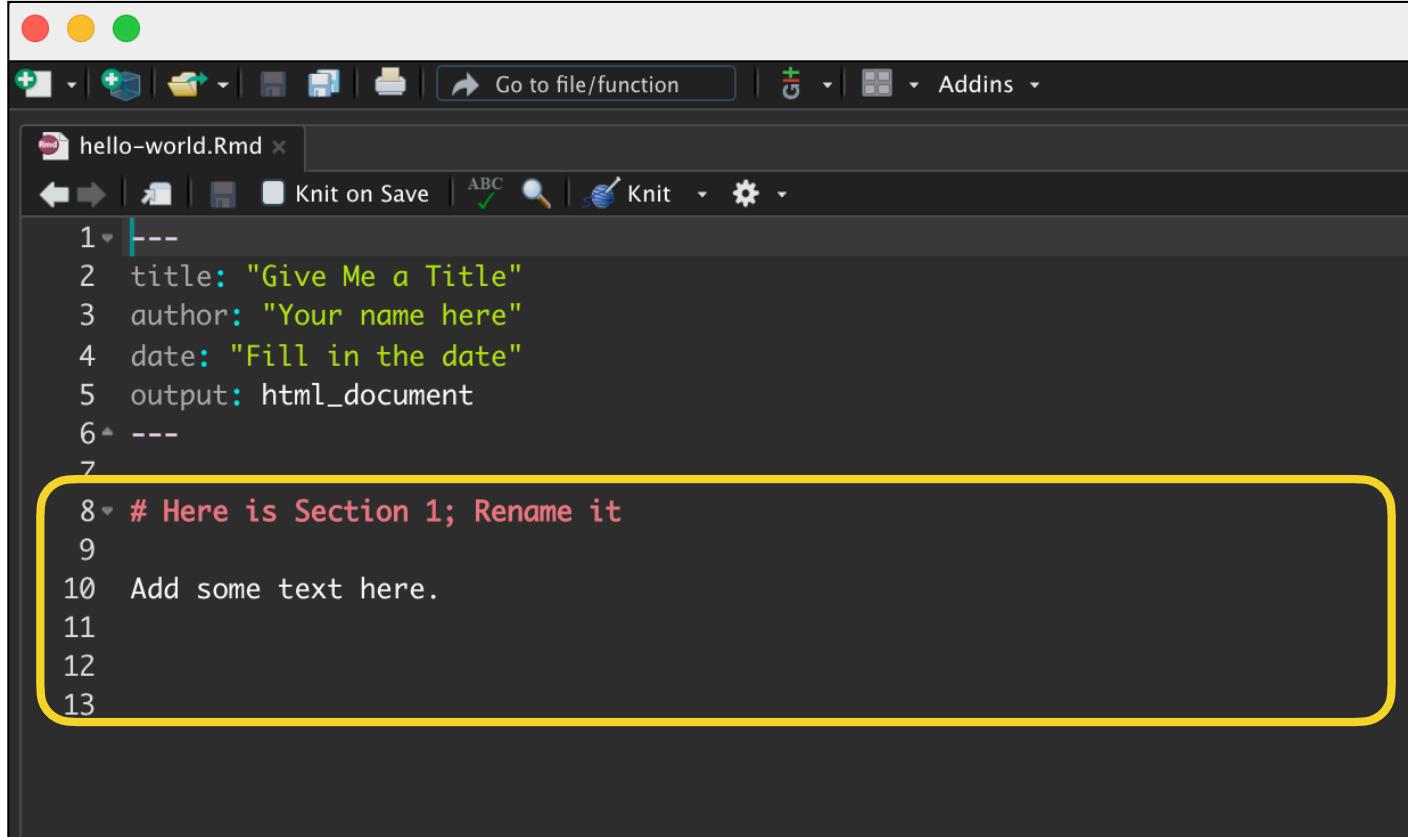
The screenshot shows the RStudio interface with a dark theme. A file named "hello-world.Rmd" is open. The code editor displays the following YAML header:

```
1 ---  
2 title: "Give Me a Title"  
3 author: "Your name here"  
4 date: "Fill in the date"  
5 output: html_document  
6 ---  
7  
8 # Here is Section 1; Rename it  
9  
10 Add some text here.  
11  
12  
13
```

A yellow rectangular box highlights the first six lines of the YAML header (lines 1 through 6). The "Knit" button in the toolbar is also highlighted.

Edit the YAML by giving your document a title, putting your name as the author, and adding the date. (Make sure you keep the quotation marks. Do not change the `output:` line. Then click the **knit** button.

Edit the Main Part of the Document

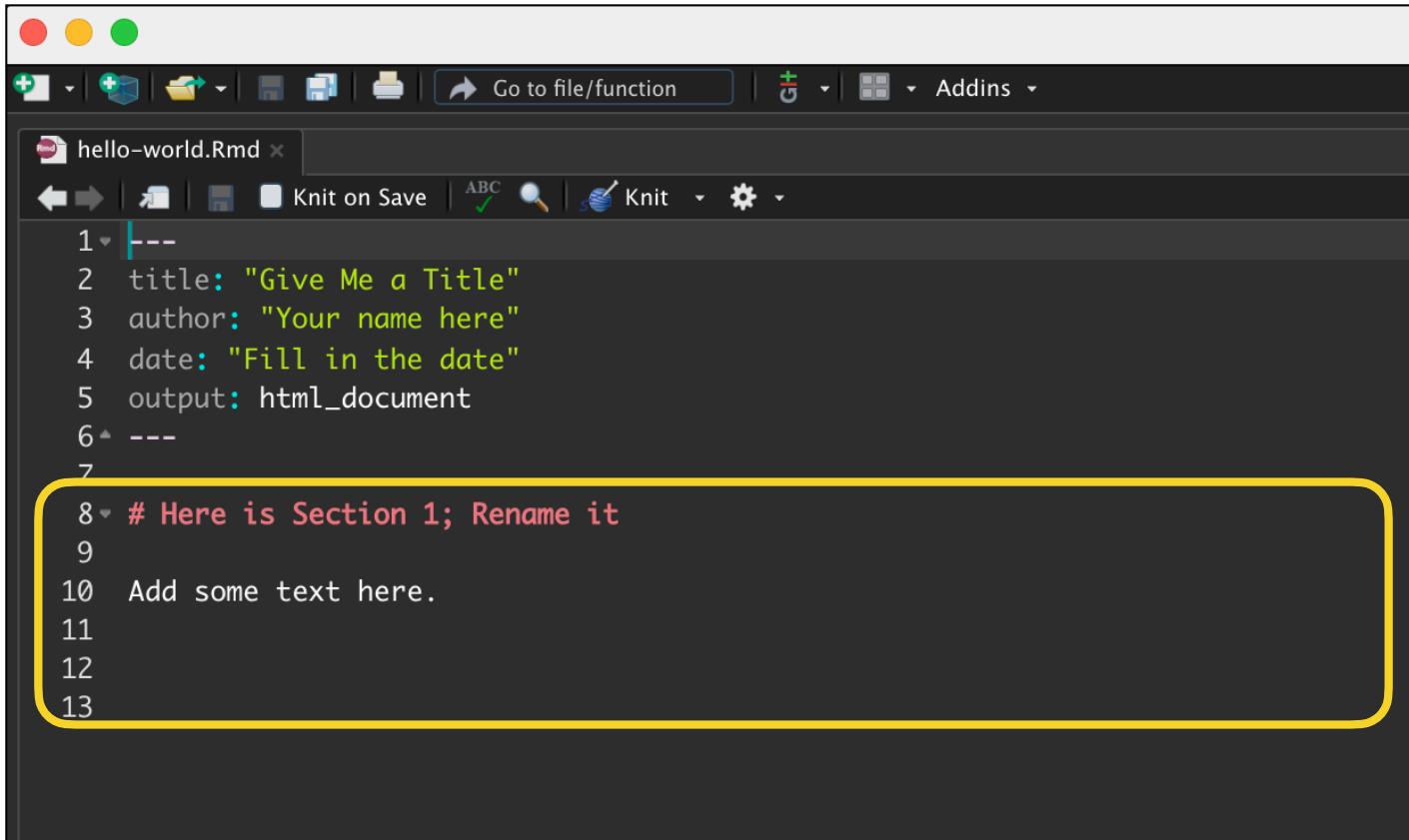


```
1 ---  
2 title: "Give Me a Title"  
3 author: "Your name here"  
4 date: "Fill in the date"  
5 output: html_document  
6 ---  
7  
8 # Here is Section 1; Rename it  
9  
10 Add some text here.  
11  
12  
13
```

Edit the main part of the document by giving changing the Section name (the text after the hashtag on Line 8). Also add some text to this section by replacing the text that is on Line 10. (Add as much or as little as you want.) Then click the **knit** button.

Edit the Main Part of the Document

After the YAML (but before the text you just entered), put in a heading. To do this start the line with a single hashtag (#), then one space, then the text you want to use as a heading. For example:



```
1 ---  
2 title: "Give Me a Title"  
3 author: "Your name here"  
4 date: "Fill in the date"  
5 output: html_document  
6 ---  
7  
8 # Here is Section 1; Rename it  
9  
10 Add some text here.  
11  
12  
13
```

Add Sections and Subsections

The section heading you created is called a **Level-1 heading**. There are six different heading sizes. Level-1 is the largest. To create a Level-2 heading (subsection) use two hashtags rather than one. Etc.

- Add a subsection to your document. Also add some text in this subsection.
- Add another section (Level-1) and some text in that section as well.
- Then click the **knit** button.

#important: New headings need to have a blank line before and after them in the RMD document.

YAML: Changing Document-Level Metadata

YAML: The Header

YAML is a human-friendly standard for describing the structure of data and embedded this structure within the data being described.

```
---
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output: html_document
---
```

All YAML metadata are **key-value combinations**, given as

key: value

YAML: Add a Table of Contents

```
---
```

```
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output:
  html_document:
    toc: true
```

Here `html_document` is nested in `output`,
and `toc` is nested in `html_document`

```
---
```

Remember, in YAML, spaces at the beginning of lines are used to indicate nesting.
Correctly structured YAML needs to be indented **exactly two spaces**.

Adding a TOC will only work when you are rendering to an HTML document.
--

```
---
```

```
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output:
  html_document:
    toc: true
    toc_float: true
---
```

Here both `toc` and `toc_float` are nested in `html_document` since they are at the same level of indentation.

The screenshot shows a R Markdown document with the following structure:

- Header:** Level-1 Heading (highlighted in blue), Level-2 Heading
- Title:** Untitled
- Author:** Andrew Zieffler
- Date:** 1/5/2018
- Section:** Level-1 Heading
- Text:** A long paragraph of placeholder text (Lorem ipsum).
- Data:** A code block containing statistical summary data:

	speed	dist	
## Min.	4.0	Min.	2.00
## 1st Qu.	12.0	1st Qu.	26.00
## Median	15.0	Median	36.00
## Mean	15.4	Mean	42.98
## 3rd Qu.	19.0	3rd Qu.	56.00
## Max.	25.0	Max.	120.00

```
---
```

```
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output:
  html_document:
    toc: true
    toc_float:
      collapsed: false
      smooth_scroll: false
  theme: united
  highlight: tango
```

Which YAML fields are nested in which other YAML fields in this example?

The screenshot shows a R Markdown document with the following structure:

```
Level-1 Heading
Level-2 Heading
```

Level-2 Heading

In non metus elementum, tincidunt purus vel, pharetra magna. Nullam tellus ipsum, euismod ac mauris ac, posuere ultricies massa. Curabitur vehicula mollis eros ac aliquam. Cras a dolor ultrices, pretium dui eu, hendrerit sapien. Suspendisse cursus diam id tortor fermentum sollicitudin. Aenean bibendum, magna id vestibulum faucibus, ligula est pellentesque turpis, eu dictum tortor nulla eget quam. Praesent sit amet aliquet lectus. Nullam vitae vehicula urna. Quisque sit amet dignissim est. Suspendisse id arcu a augue suscipit dictum a sit amet ante. Nam congue sollicitudin justo, a pellentesque arcu mattis a. Suspendisse potenti. Nulla ut mauris ac urna tincidunt venenatis id at velit. Curabitur ullamcorper mauris sit amet magna sodales, non ullamcorper dui efficitur. Vivamus molestie pharetra tincidunt.

```
plot(cars)
```

See many more YAML options at:
http://rmarkdown.rstudio.com/html_document_format.html

Content and Formatting in the Main Part of the Document

Italic and Bold Text

To set any of your text in *italics* surround the text with either a single asterisk or underscore. For **bold** text, use two asterisks or underscores.

```
*italic*    **bold**  
_italic_    __bold__
```

Try making some text both bold and italics.

Writing Equations in RMarkdown Documents

There are two different manners in which equations/mathematics is included in a document.

- **Display equations** are typeset on a separate line from the body text and are centered on the page.
- **Inline equations** are typeset directly within the body text.

Display Equation

There are two different types of equations that are typically typeset in a document. Display equations are printed on a separate line from the body text and are centered on the page. Here is a display equation.

$$Y_i = \beta_0 + \beta_1(X_i) + \epsilon_i$$

Another type of equation is the inline equation which is typeset in the body text. For example, in the text we can write the regression equation as $Y_i = \beta_0 + \beta_1(X_i) + \epsilon_i$. This is set directly in the body text.

Inline Equation

Display Equations

Display equations are included by placing the mathematical expression inside of two sets of two dollar signs.

Markdown
syntax:

```
$$  
\hat{Y}_{ij} = \beta_0 + \beta_1(X_1) + \epsilon_{ij}  
$$
```

Output:

$$\hat{Y}_{ij} = \beta_0 + \beta_1(X_1) + \epsilon_{ij}$$

There is no equation numbering support in simple RMarkdown documents....although it has already been added as a feature request. You can also look into [bookdown](#).

Inline Equations

Markdown
syntax:

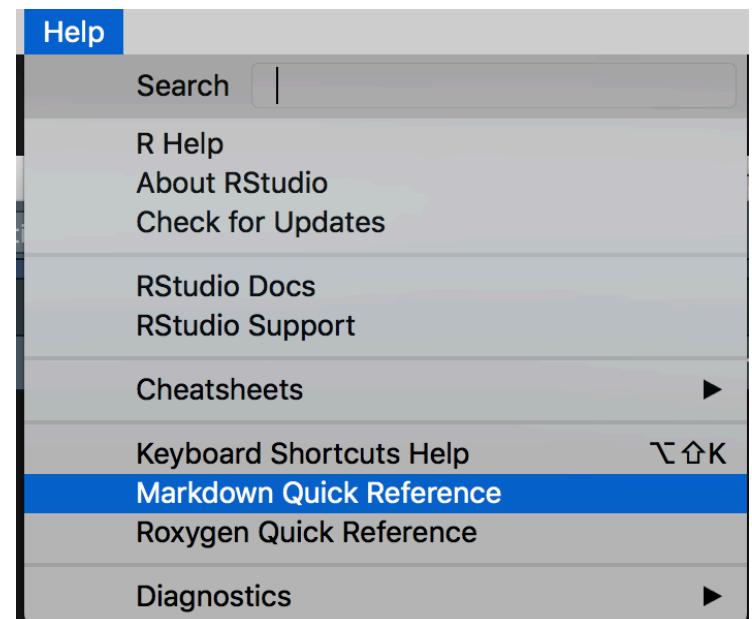
The hat notation (e.g., \hat{Y}_{ij}) is used to indicate an estimate.

Output:

The hat notation (e.g., \hat{Y}_{ij}) is used to indicate an estimate.

What else can be added to your document?

- Headers: *Six sizes*
- Text Emphasis: *Bold and italics*
- Lists: *Ordered or unordered; also nesting*
- Blockquotes
- Code: *Inline and block code*
- Fenced Code Blocks (non-indented blocks)
- Horizontal Rules
- Images
- Links and Email
- Footnotes
- Strikethrough
- Tables
- Anchors
- Equations: *Inline and block equations*

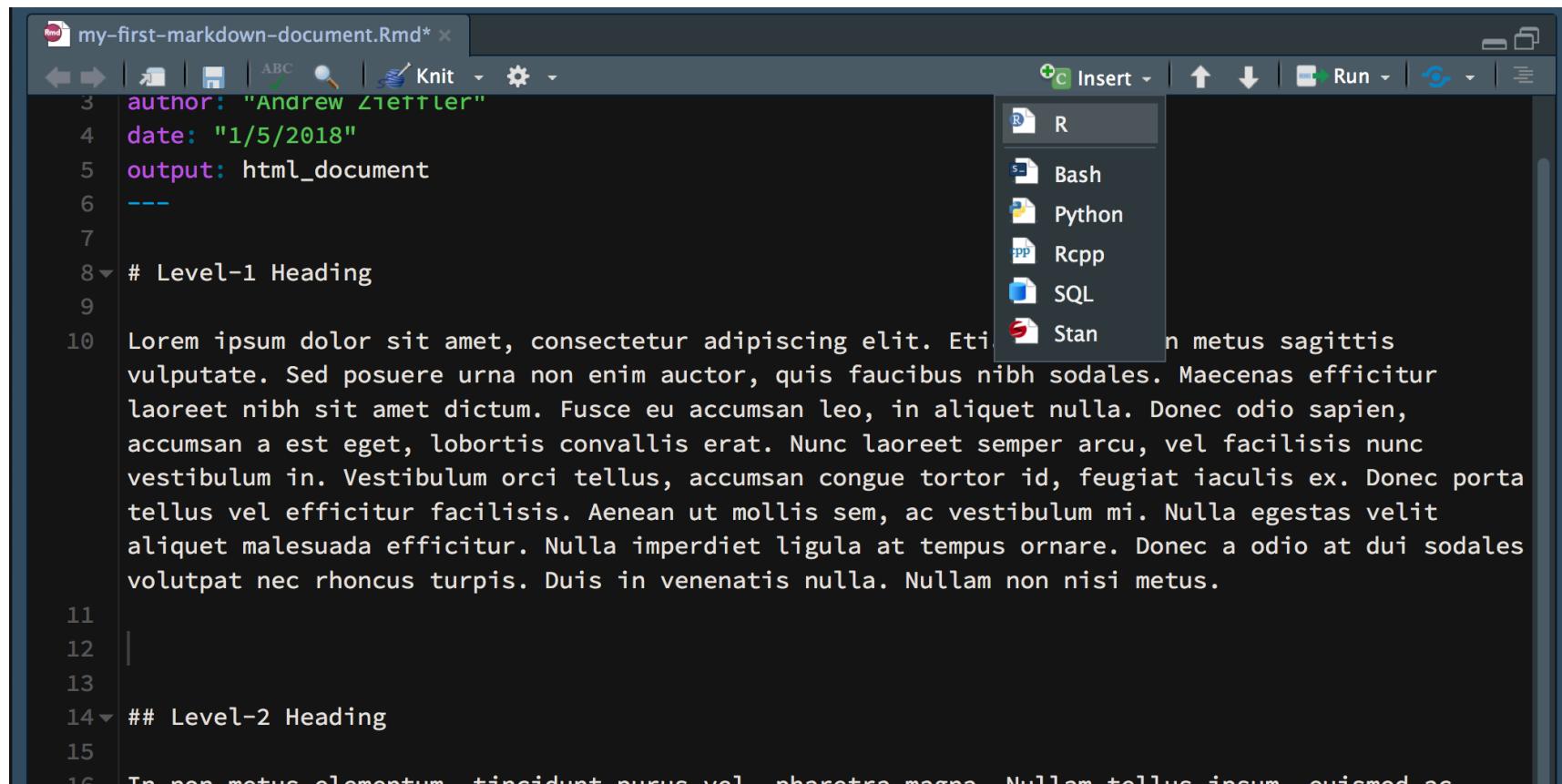


Code Chunks: Including R Syntax

Inserting a Code Chunk

RMarkdown allows us to embed and run R syntax directly in a markdown document.

We do this by inserting an **R code chunk**. Click in the text where you want to insert the code chunk (for me it is at Line 12) then select `Insert > R`



The screenshot shows the RStudio interface with a dark theme. The top bar includes standard file operations like Open, Save, and Print, along with ABC, Knit, and Settings icons. The main editor window displays an RMarkdown file named "my-first-markdown-document.Rmd". The code includes YAML front matter (author: "Andrew Ziettler", date: "1/5/2018", output: html_document), a Level-1 Heading, and a large block of Latin placeholder text (Lorem ipsum). A vertical line marks the insertion point at Line 12, which contains a blank line. A context menu is open at this position, with the "Insert" option expanded. The "R" icon is highlighted, indicating it is the selected choice for inserting a new code chunk.

```
my-first-markdown-document.Rmd*
author: "Andrew Ziettler"
date: "1/5/2018"
output: html_document
---
# Level-1 Heading
#
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam metus sagittis
vulputate. Sed posuere urna non enim auctor, quis faucibus nibh sodales. Maecenas efficitur
laoreet nibh sit amet dictum. Fusce eu accumsan leo, in aliquet nulla. Donec odio sapien,
accumsan a est eget, lobortis convallis erat. Nunc laoreet semper arcu, vel facilisis nunc
vestibulum in. Vestibulum orci tellus, accumsan congue tortor id, feugiat iaculis ex. Donec porta
tellus vel efficitur facilisis. Aenean ut mollis sem, ac vestibulum mi. Nulla egestas velit
aliquet malesuada efficitur. Nulla imperdiet ligula at tempus ornare. Donec a odio at dui sodales
volutpat nec rhoncus turpis. Duis in venenatis nulla. Nullam non nisi metus.

## Level-2 Heading
#
To non netus elementum tincidunt purus vel pharetra magna. Nullam tellus ipsum quismodoc.
```

Code Chunks

```
```{r}  
Your R syntax goes here
```
```

Write the following R syntax in your code chunk:

```
summary(cars)
```

R is case sensitive, so upper and lowercase matter! This is all lowercase.

Code chunk:

```
```{r}  
summary(cars)
```
```

Re-knit your document

Knitting not only formats your Markdown, it also executes any R syntax embedded in a code chunk.

Untitled

Andrew Zieffler

1/5/2018

Level-1 Heading

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam non sem in metus sagittis vulputate. Sed posuere urna non enim auctor, quis faucibus nibh sodales. Maecenas efficitur laoreet nibh sit amet dictum. Fusce eu accumsan leo, in aliquet nulla. Donec odio sapien, accumsan a est eget, lobortis convallis erat. Nunc laoreet semper arcu, vel facilisis nunc vestibulum in. Vestibulum orci tellus, accumsan congue tortor id, feugiat iaculis ex. Donec porta tellus vel efficitur facilisis. Aenean ut mollis sem, ac vestibulum mi. Nulla egestas velit aliquet malesuada efficitur. Nulla imperdiet ligula at tempus ornare. Donec a odio at dui sodales volutpat nec rhoncus turpis. Duis in venenatis nulla. Nullam non nisi metus.

```
summary(cars)
```

```
##      speed         dist
## Min.   :4.0   Min.   : 2.00
## 1st Qu.:12.0  1st Qu.:26.00
## Median :15.0  Median :36.00
## Mean   :15.4  Mean   :42.98
## 3rd Qu.:19.0  3rd Qu.:56.00
## Max.   :25.0  Max.   :120.0

## Level-2 Heading



In non metus elementum, tincidunt purus vel, pharetra magna. Nullam tellus ipsum, euismod ac mauris ac, posuere ultricies massa. Curabitur vehicula mollis eros ac aliquam. Cras a dolor ultrices, pretium dui eu, hendrerit sapien. Suspendisse cursus diam id tortor fermentum sollicitudin. Aenean bibendum, magna id vestibulum faucibus, ligula est pellentesque turpis, eu dictum tortor nulla eget quam. Praesent sit amet aliquet lectus. Nullam vitae vehicula urna. Quisque sit amet dignissim est. Suspendisse id arcu a augue suscipit dictum a sit amet ante. Nam congue sollicitudin justo, a pellentesque arcu mattis a. Suspendisse potenti. Nulla ut mauris ac urna tincidunt venenatis id at velit. Curabitur ullamcorper mauris sit amet magna sodales, non ullamcorper dui efficitur. Vivamus molestie pharetra tincidunt.



Pellentesque rhoncus mauris id enim blandit, ut viverra lectus lacinia. Donec at justo ante. Pellentesque elementum, magna sed cursus convallis, nisi ex ultricies magna, dignissim elementum lacinia tellus at justo. Integer posuere fringilla lobortis. Nam aliquet odio orci, in cursus nulla fermentum nec. Sed congue enim ac odio luctus, in mollis ex feugiat. Nam pretium nulla quam, vitae molestie ipsum vulputate at. Mauris ante nulla viverra egestas commodo sit amet lobortis ac nibh. Vivamus blandit purus nec quam sodales, egestas dignissim


```

Code Chunk Options

```
```{r chunk_name, option1, option2, ...}  
Your R syntax goes here
```
```

The **chunk name** (no spaces allowed in the name) goes in-between the curly braces after the r.

Code chunk **options** are then added and separated by commas.

Code chunk:

```
```{r my_summary, echo=FALSE}  
summary(cars)
```
```

Re-knit your document

The option echo=FALSE hides the actual syntax, but still prints the output of the syntax.

A screenshot of a web browser window displaying a Markdown document titled "Untitled". The document includes author information ("Andrew Zieffler" and "1/5/2018"), a level-1 heading ("Level-1 Heading"), and a level-2 heading ("Level-2 Heading"). A red box highlights a block of R code output within the level-2 heading section. The code provides statistical summary statistics for the variables "speed" and "dist".

```
##      speed          dist
## Min.   : 4.0   Min.   : 2.00
## 1st Qu.:12.0  1st Qu.: 26.00
## Median :15.0  Median : 36.00
## Mean   :15.4  Mean   : 42.98
## 3rd Qu.:19.0  3rd Qu.: 56.00
## Max.   :25.0  Max.   :120.00
```

Untitled

Andrew Zieffler

1/5/2018

Level-1 Heading

Level-2 Heading

speed dist
Min. : 4.0 Min. : 2.00
1st Qu.:12.0 1st Qu.: 26.00
Median :15.0 Median : 36.00
Mean :15.4 Mean : 42.98
3rd Qu.:19.0 3rd Qu.: 56.00
Max. :25.0 Max. :120.00

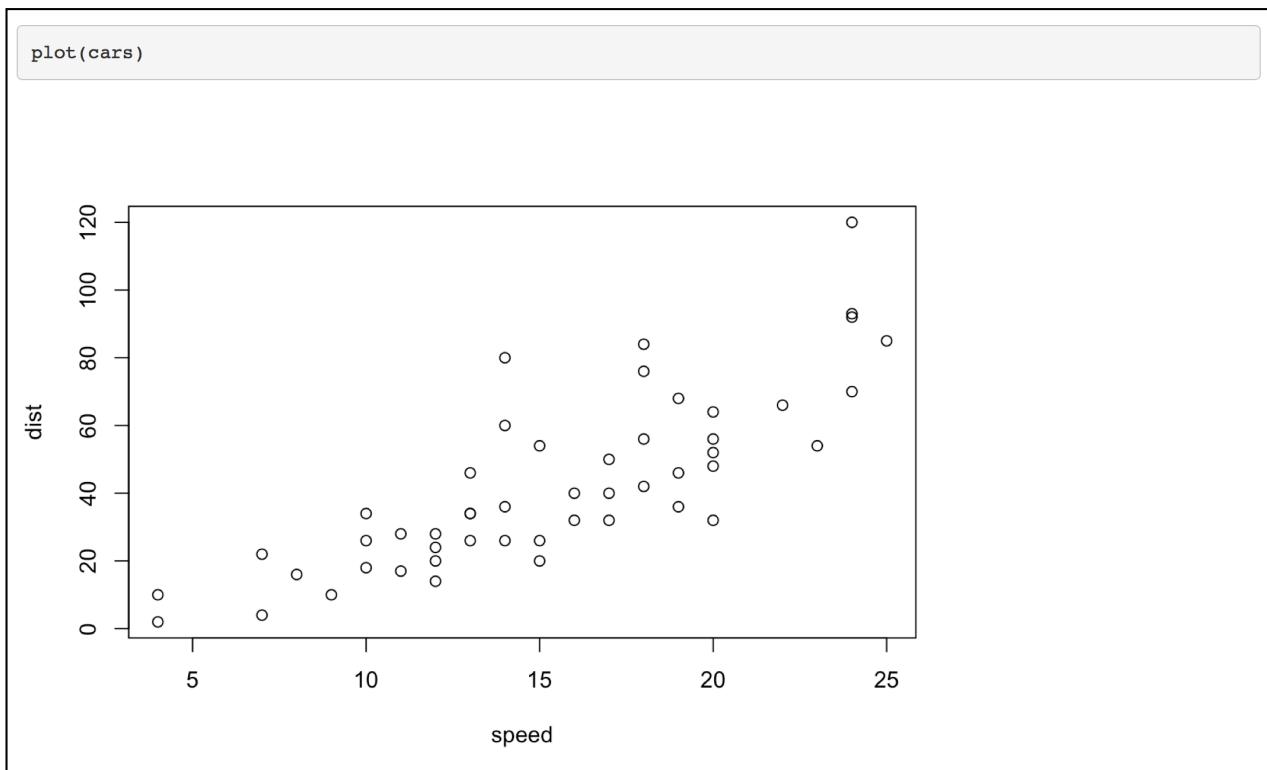
In non metus elementum, tincidunt purus vel, pharetra magna. Nullam tellus ipsum, euismod ac mauris ac, posuere ultricies massa. Curabitur vehicula mollis eros ac aliquam. Cras a dolor ultrices, pretium dui eu, hendrerit sapien. Suspendisse cursus diam id tortor fermentum sollicitudin. Aenean bibendum, magna id vestibulum faucibus, ligula est pellentesque turpis, eu dictum tortor nulla eget quam. Praesent sit amet aliquet lectus. Nullam vitae vehicula urna. Quisque sit amet dignissim est. Suspendisse id arcu a augue suscipit dictum a sit amet ante. Nam congue sollicitudin justo, a pellentesque arcu mattis a. Suspendisse potenti. Nulla ut mauris ac urna tincidunt venenatis id at velit. Curabitur ullamcorper mauris sit amet magna sodales, non ullamcorper dui efficitur. Vivamus molestie pharetra tincidunt.

Creating Plots in a Code Chunk

Code chunk:

```
20  
21 -> ````{r figure_01}  
22 plot(cars)  
23 ````  
24
```

Output:



Some Figure Code Chunk Options

- `fig.cap = 'caption'` (put in quotes)
- `fig.align = 'center'` (put in quotes; 'left', 'right', 'center')

Set aspect ratio of figure

- `fig.width = 7` (numeric; in inches)
- `fig.height = 7` (numeric; in inches)

Set size of figure to appear in document

- `out.width = '600px'` (put in quotes; in pixels)
- `out.height = '600px'` (put in quotes; in pixels)



Find all code chunk options
and their descriptions at:
<https://yihui.name/knitr/>

```
20
21 ````{r figure_01, fig.align='center', fig.cap='Hello. This is my figure.'}
22 plot(cars)
23 ````
```

Inline Code Chunks

```
`r Your R syntax goes here`
```

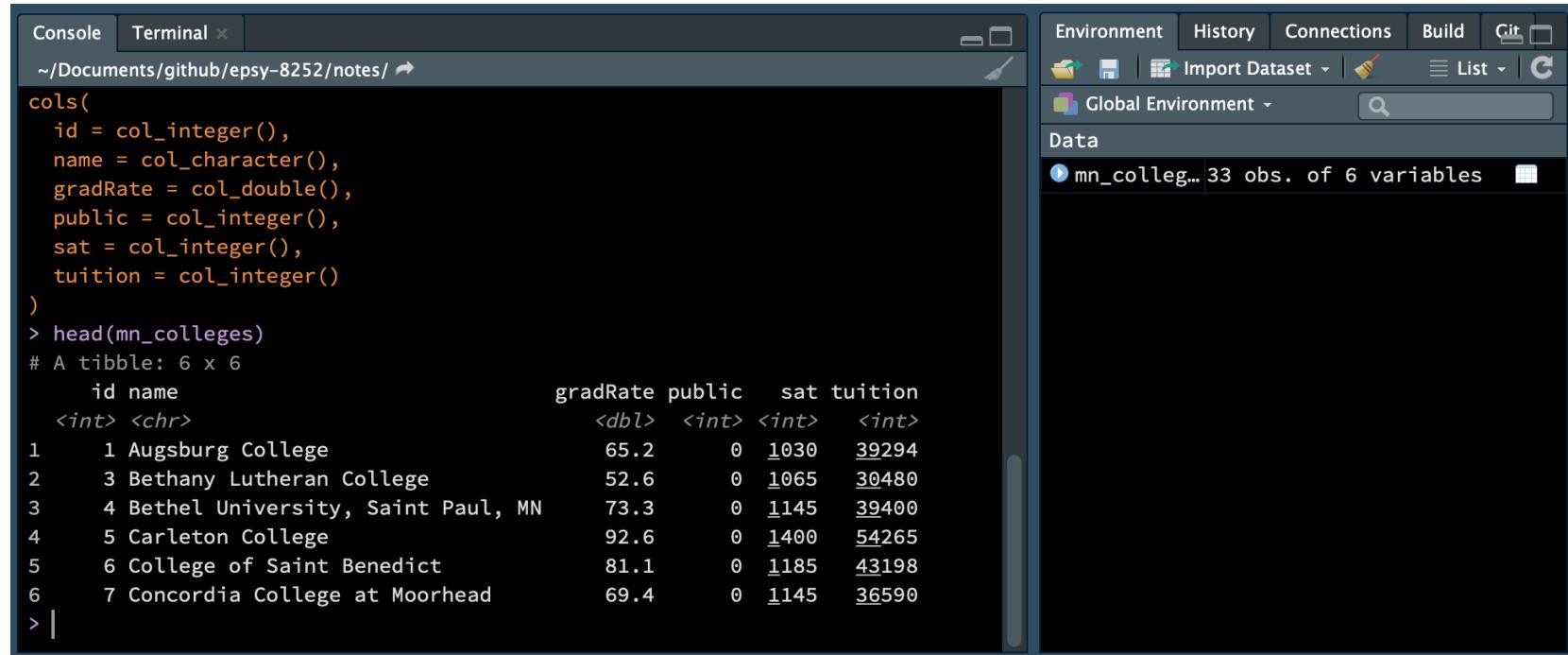
Code chunk:

```
Here is an example of an inline code chunk. The mean  
speed is `r mean(cars$speed)`.
```

Output:

```
Here is an example of an inline code chunk. The mean speed is 15.4.
```

Environment and Markdown Document Independence

A screenshot of the RStudio interface. On the left, the 'Console' tab is active, showing R code and its output. The code defines a function 'cols' and then uses it to print the first six rows of a dataset named 'mn_colleges'. The output shows the data as a tibble with columns: id, name, gradRate, public, sat, and tuition. The 'Environment' tab is selected on the right, showing the 'Global Environment' pane which lists the 'mn_colleges' object as a tibble with 33 observations and 6 variables.

```
Console Terminal ✘ ~ /Documents/github/epsy-8252/notes/ ↵ cols( id = col_integer(), name = col_character(), gradRate = col_double(), public = col_integer(), sat = col_integer(), tuition = col_integer() ) > head(mn_colleges) # A tibble: 6 x 6 id name gradRate public sat tuition <int> <chr> <dbl> <int> <int> <int> 1 1 Augsburg College 65.2 0 1030 39294 2 3 Bethany Lutheran College 52.6 0 1065 30480 3 4 Bethel University, Saint Paul, MN 73.3 0 1145 39400 4 5 Carleton College 92.6 0 1400 54265 5 6 College of Saint Benedict 81.1 0 1185 43198 6 7 Concordia College at Moorhead 69.4 0 1145 36590 > |
```

| | | gradRate | public | sat | tuition |
|---|-------------------------------------|----------|--------|-------|---------|
| | | <dbl> | <int> | <int> | <int> |
| 1 | 1 Augsburg College | 65.2 | 0 | 1030 | 39294 |
| 2 | 3 Bethany Lutheran College | 52.6 | 0 | 1065 | 30480 |
| 3 | 4 Bethel University, Saint Paul, MN | 73.3 | 0 | 1145 | 39400 |
| 4 | 5 Carleton College | 92.6 | 0 | 1400 | 54265 |
| 5 | 6 College of Saint Benedict | 81.1 | 0 | 1185 | 43198 |
| 6 | 7 Concordia College at Moorhead | 69.4 | 0 | 1145 | 36590 |

When we create objects, they are stored in the R environment and we can operate on those objects. For example, here we read in some data and assigned it to `mn_colleges`. We then used the `head()` function on `mn_colleges` to display the data.

The screenshot shows the RStudio interface. The top panel displays an R Markdown file titled "Untitled.Rmd" with the following content:

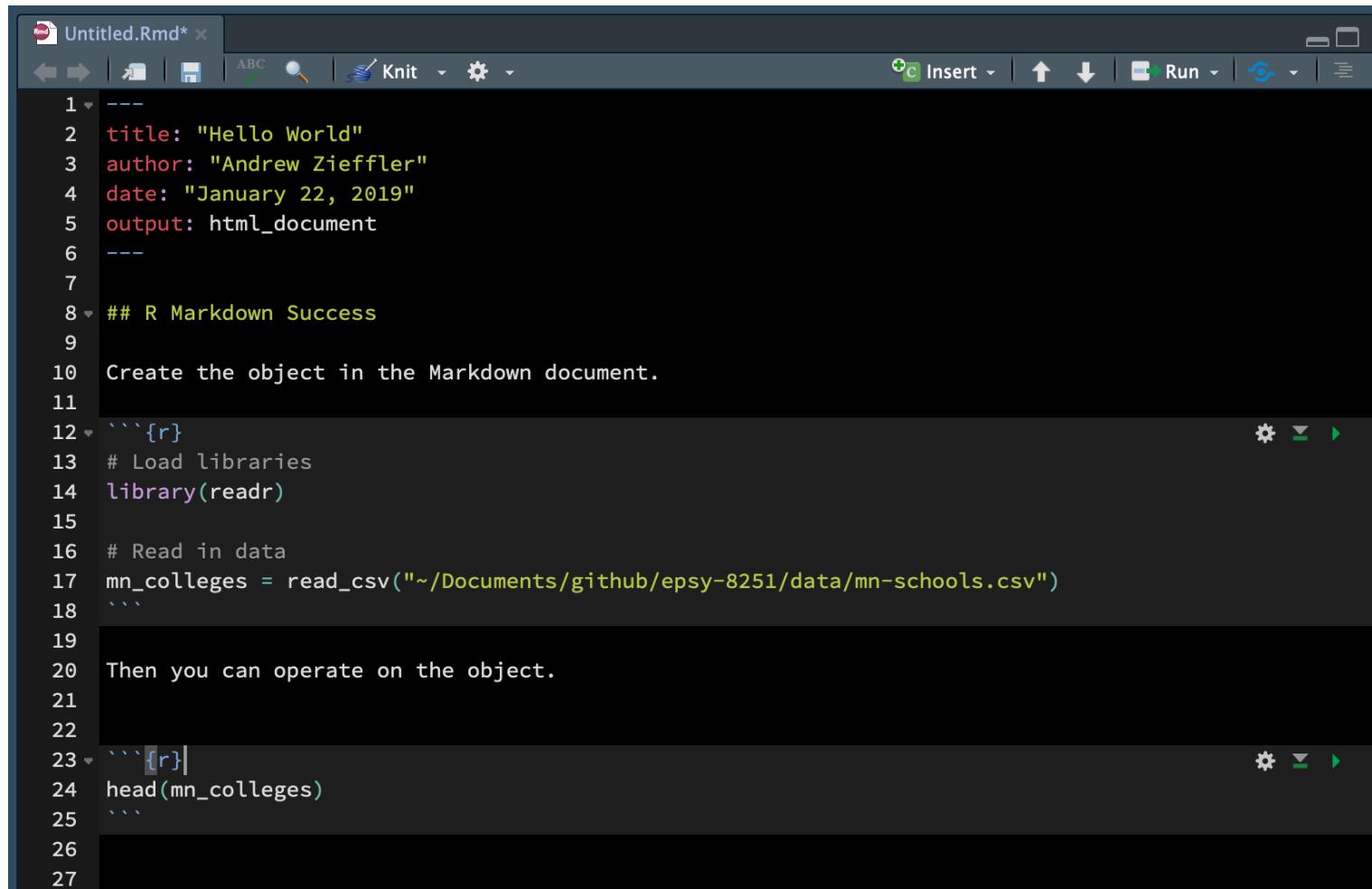
```
1 ---  
2 title: "Hello World"  
3 author: "Andrew Zieffler"  
4 date: "January 22, 2019"  
5 output: html_document  
6 ---  
7  
8 ## R Markdown Fail  
9  
10 Trying to operate on an object that we created in the R environment, but do not create in our  
document will lead to an error.  
11  
12 `r`  
13 head(mn_colleges)  
14  
15  
16
```

The bottom panel shows the R Markdown tab selected in the tab bar, with the status bar indicating "8:1" and "R Markdown". The console tab is active, showing the command ".../my-first-markdown/Untitled.Rmd" and an error message:

✖ Line 13 Error in head(mn_colleges) : object 'mn_colleges' not found Calls: <Anonymous> ...
withCallingHandlers -> withVisible -> eval -> eval -> head Execution halted

Trying to operate on an object that we created in the R environment, but do not create in our RMarkdown document will lead to an error.

If you want to operate on an object you have to create the object in the R Markdown document.



The screenshot shows an RStudio interface with an R Markdown file titled "Untitled.Rmd". The code in the editor is as follows:

```
1 ---  
2 title: "Hello World"  
3 author: "Andrew Zieffler"  
4 date: "January 22, 2019"  
5 output: html_document  
---  
7  
8 ## R Markdown Success  
9  
10 Create the object in the Markdown document.  
11  
12 ```{r}  
13 # Load libraries  
14 library(readr)  
15  
16 # Read in data  
17 mn_colleges = read_csv("~/Documents/github/epsy-8251/data/mn-schools.csv")  
18 ```  
19  
20 Then you can operate on the object.  
21  
22  
23 ```{r}  
24 head(mn_colleges)  
25  
26  
27
```

The code uses R Markdown syntax, including code blocks (```{r}```) and a code chunk header (```{r}```). The `head` function is used to print the first few rows of the `mn_colleges` dataset.

You will need to import datasets using syntax. You will not be able to use the Import Dataset button to import the data.

This is also true of loading libraries/packages. They need to be loaded in the R Markdown document in order to be used in the R Markdown document.

#protip

Use the first code chunk in your R Markdown document to load all the packages and datasets used in the document. Name this chunk *setup*. This has the added advantage that others can immediately see what packages and datasets are needed to run the document. Naming it setup also runs that chunk when you try to run other chunks, so your code works!

Including Citations

Citations

To add citations, we need to:

- Create a BIB file that holds the metadata for our references.
- Save the BIB file to the same folder as our RMD file
- Include the `bibliography`: key in the YAML of our RMD document

```
---
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output:
  html_document:
    toc: true
    toc_float: true
bibliography: "references.bib"
---
```

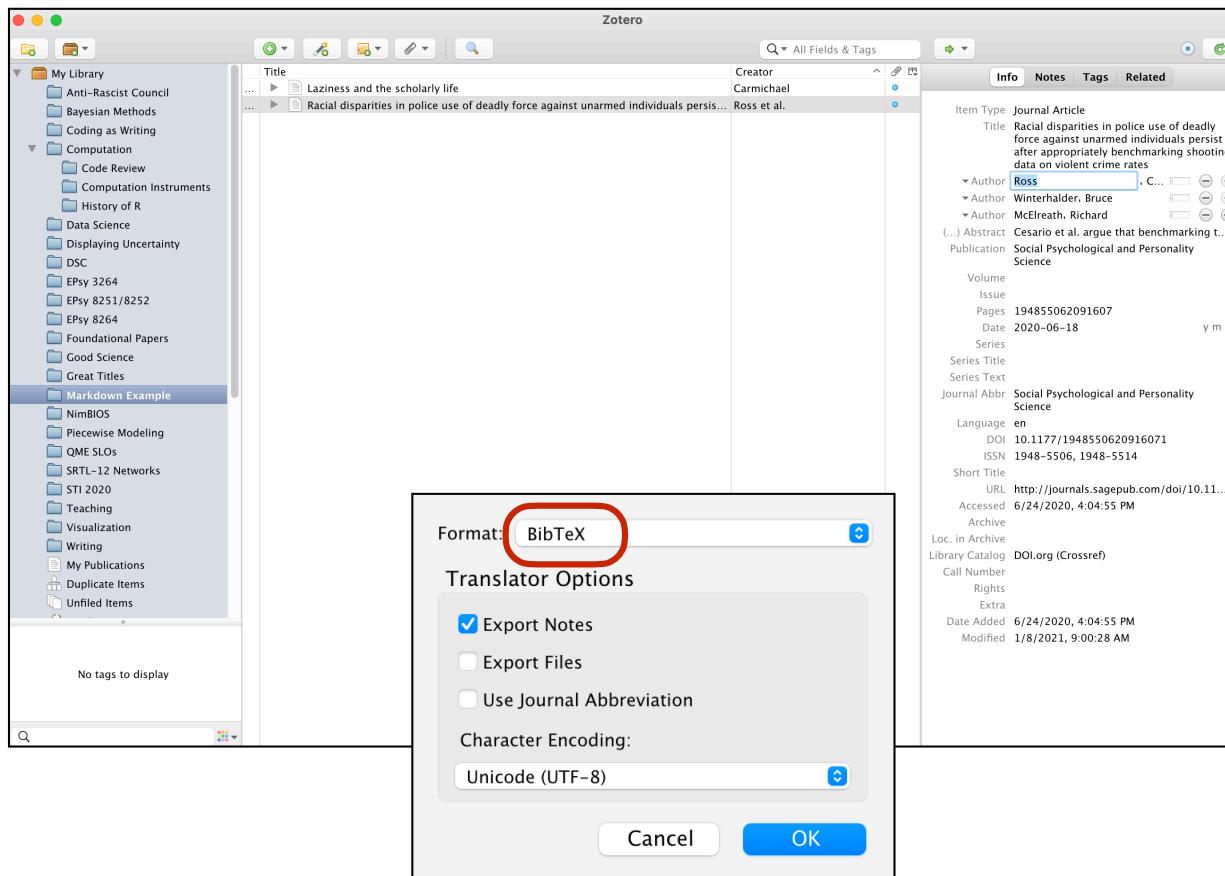
BibTeX (.bib) Files

BibTeX files are essentially databases that store bibliographic information in a plain-text (style-independent) file. The database includes a set of references and their metadata.

```
@article{carmichael_laziness_1954,
  title = {Laziness and the scholarly life},
  volume = {78},
  number = {4},
  journal = {The Scientific Monthly},
  author = {Carmichael, Leonard},
  year = {1954},
  pages = {208--213},
  file = {Carmichael - 1954 - Laziness and the scholarly life.pdf:/Users/zief0002/Zotero/storage/GB9LT73E/Carmichael - 1954 - Laziness and the scholarly life.pdf:application/pdf}
}
```

Creating .bib Files using Zotero

Most reference managers (e.g., Papers, Zotero, Mendelay) can produce BibTeX files. Here I will illustrate the process using Zotero.

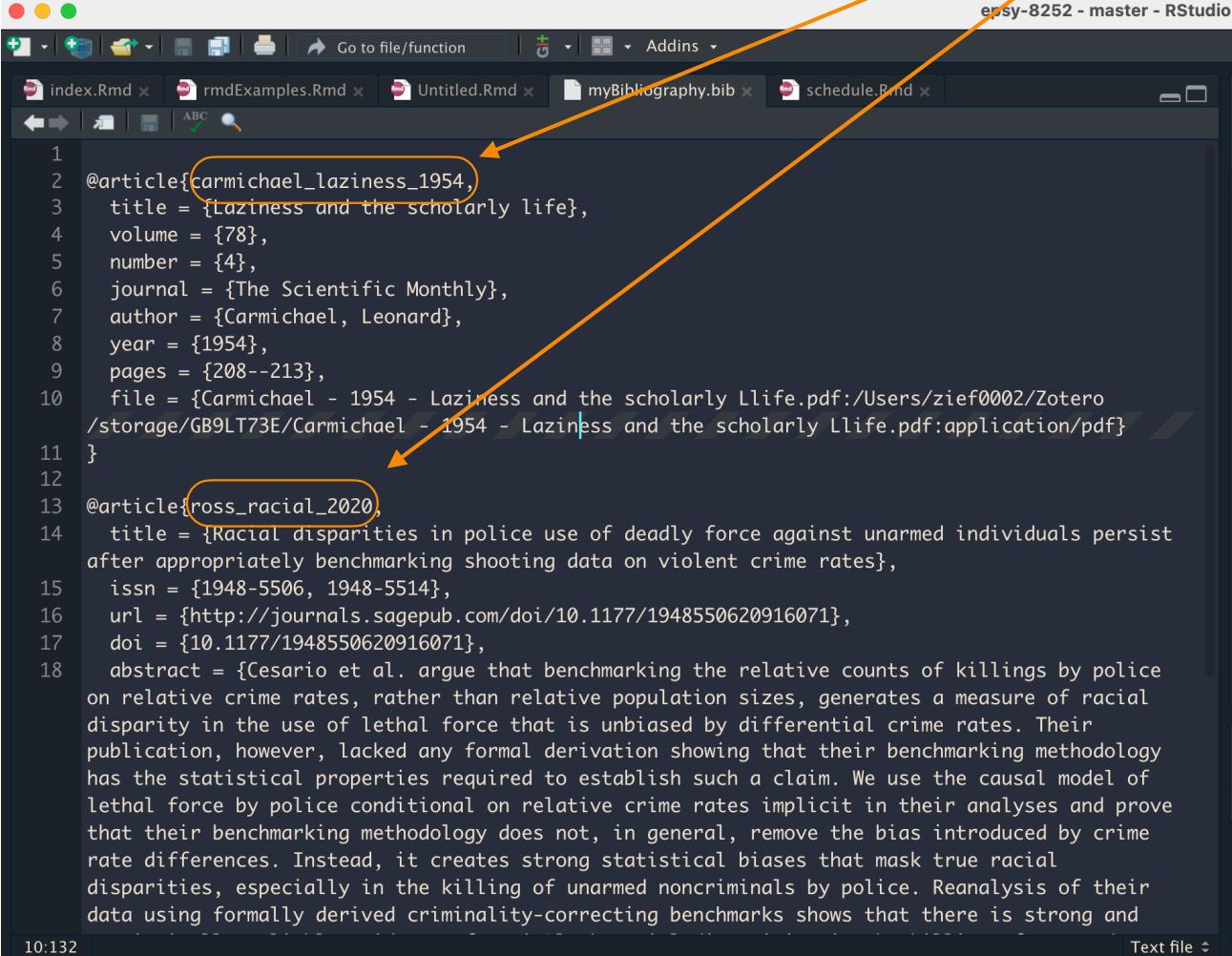


- Create a New Collection.
- Drag the references you want in your BibTeX database into this collection.
- Right-click the collection and select Export Collection.
- In the pop-up window, change the format of the exported collection to BibTeX.
- Click OK.

Name the BibTeX file (here we will use [my_bibliography.bib](#)) and save it in **the same folder** as your RMD document.

The name of your BibTeX file should also match the value given in the `bibliography:` key in the YAML of our RMD document.

Open the file using RStudio. (Do this by using Open File... within RStudio; double-clicking on the BibTeX file will likely open it in a different application.) Find the citation identifiers—they are located immediately after the first curly brace. This is how we will refer to the citations.



The screenshot shows the RStudio interface with a dark theme. The top bar displays the project name "easy-8252 - master - RStudio". Below the bar, several files are listed in the tabs: index.Rmd, rmdExamples.Rmd, Untitled.Rmd, myBibliography.bib (which is the active tab), and schedule.Rmd. The main code editor area contains a BibTeX file with two entries. The first entry is for Carmichael's 1954 article, and the second is for Ross' 2020 article. Both entries have their citation identifiers circled in red. A large orange arrow points from the text "they are located immediately after the first curly brace. This is how we will refer to the citations." to the circled identifiers in the code.

```
1
2 @article{carmichael_laziness_1954,
3   title = {Laziness and the scholarly life},
4   volume = {78},
5   number = {4},
6   journal = {The Scientific Monthly},
7   author = {Carmichael, Leonard},
8   year = {1954},
9   pages = {208--213},
10  file = {Carmichael - 1954 - Laziness and the scholarly life.pdf:/Users/zief0002/Zotero
11 /storage/GB9LT73E/Carmichael - 1954 - Laziness and the scholarly life.pdf:application/pdf}
12 }
13 @article{ross_racial_2020,
14   title = {Racial disparities in police use of deadly force against unarmed individuals persist
15   after appropriately benchmarking shooting data on violent crime rates},
16   issn = {1948-5506, 1948-5514},
17   url = {http://journals.sagepub.com/doi/10.1177/1948550620916071},
18   doi = {10.1177/1948550620916071},
19   abstract = {Cesario et al. argue that benchmarking the relative counts of killings by police
20   on relative crime rates, rather than relative population sizes, generates a measure of racial
21   disparity in the use of lethal force that is unbiased by differential crime rates. Their
22   publication, however, lacked any formal derivation showing that their benchmarking methodology
23   has the statistical properties required to establish such a claim. We use the causal model of
24   lethal force by police conditional on relative crime rates implicit in their analyses and prove
25   that their benchmarking methodology does not, in general, remove the bias introduced by crime
26   rate differences. Instead, it creates strong statistical biases that mask true racial
27   disparities, especially in the killing of unarmed noncriminals by police. Reanalysis of their
28   data using formally derived criminality-correcting benchmarks shows that there is strong and
```

The citation identifiers here are [carmichael_laziness_1954](#) and [ross_racial_2020](#).

Including Citations in Your Markdown Document

Citations go inside square brackets and are separated by semicolons. Each citation must have a key, composed of '@' + the citation identifier from the database (no spaces between them).

```
Here is some text and a citation [@carmichael_laziness_1954].
```

This will create a citation where you included it in the text and also add the reference at the end of the document. If you want a section header for your references, include a level-1 heading called "References" at the end of your document.

```
14  
15 Here is some text and a citation [@carmichael_laziness_1954].  
16  
17  
18 # References
```

The knitted document now includes a citation and the associated reference.

Here is some text and a citation (Carmichael 1954).

References

Carmichael, Leonard. 1954. "Laziness and the Scholarly Life." *The Scientific Monthly* 78 (4): 208–13.

Citations may also include additional text before and after the citation.

16

17 In this example, we have prefixed the citation with the word "see" and added a page number after the citation by including "p. 208". The identifier and the text following the identifier are separated by a comma. [see @carmichael_laziness_1954, p. 208].

18

In this example, we have prefixed the citation with the word "see" and added a page number after the citation by including "p. 208." The identifier and the text following the identifier are separated by a comma. (see Carmichael 1954, 208).

We can also change the format of the citation. For example, here we use a format common to starting a sentence with a citation.

18

19

20

21

@carmichael_laziness_1954 suggest that something is true.|

Carmichael (1954) suggest that something is true.

You can also include multiple citations.

21
22 Add multiple references by including multiple citation identifiers separated by a semicolon
[e.g., @ross_racial_2020; @carmichael_laziness_1954]
23

Add multiple references by including multiple citation identifiers separated by a semicolon (e.g., Ross, Winterhalder, and McElreath 2020; Carmichael 1954)

References

- Carmichael, Leonard. 1954. "Laziness and the Scholarly Life." *The Scientific Monthly* 78 (4): 208–13.
Ross, Cody T., Bruce Winterhalder, and Richard McElreath. 2020. "Racial Disparities in Police Use of Deadly Force Against Unarmed Individuals Persist After Appropriately Benchmarking Shooting Data on Violent Crime Rates." *Social Psychological and Personality Science*, June, 194855062091607. <https://doi.org/10.1177/1948550620916071>.

Notice that the order of the citations matters in the citation itself (the Ross et al. article is listed prior to the Carmichael article because we included the Ross citation identifier before the Carmichael citation identifier). However, the actual references are ordered correctly at the end of the document.

Use APA Formatted Citations and References

By default, citations and references are formatted using the Chicago style. To use another style, you will need to:

- Download the appropriate [citation style language](#) (CSL) file. (Find many at <https://zotero.org/styles>)
- Place the CSL file in the same folder as the RMD file.
- Specify the name of the CSL style file in the `csl:` key in the RMd file's YAML.

```
---
title: "Hello World"
author: "Andrew Zieffler"
date: "January 22, 2019"
output:
  html_document:
    toc: true
    toc_float: true
bibliography: "references.bib"
csl: "apa-single-spaced.csl"
---
```

Add multiple references by including multiple citation identifiers separated by a semicolon (Carmichael, 1954; e.g., Ross et al., 2020)

References

- Carmichael, L. (1954). Laziness and the scholarly life. *The Scientific Monthly*, 78(4), 208–213.
- Ross, C. T., Winterhalder, B., & McElreath, R. (2020). Racial disparities in police use of deadly force against unarmed individuals persist after appropriately benchmarking shooting data on violent crime rates. *Social Psychological and Personality Science*, 194855062091607.
<https://doi.org/10.1177/1948550620916071>

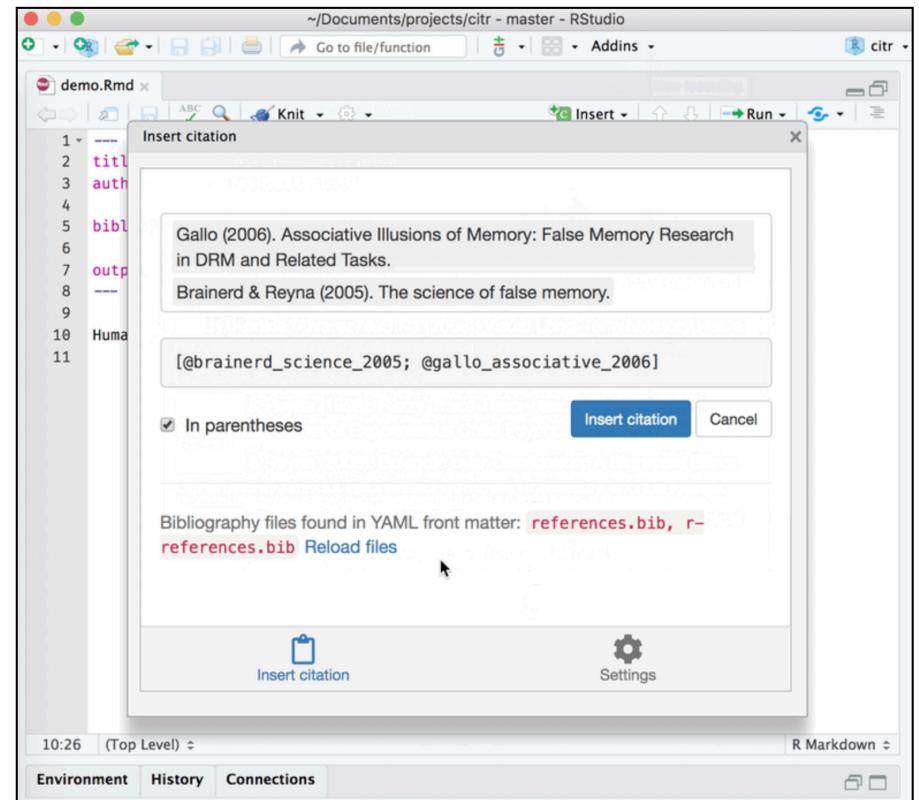
Use of the APA CSL file not only formats the references according to APA format, but it also fixed the order of the citations in the text itself!

Citation Extras



For Mac users, [BibDesk](#) is an application that can be used to edit and manage your bibliography. Although I use it at times, I have found that Zotero works just fine for this.

[citr](#) is an R package that provides functionality and an RStudio Add-In to search a BibTeX-file to create and insert formatted Markdown citations into an RMD document.



Markdown Extras

Markdown Templates

Overview

The `rticles` package provides a suite of custom R Markdown LaTeX formats and templates for various formats, including:

- JSS articles
- R Journal articles
- CTeX documents
- ACM articles
- ACS articles
- AMS articles
- PeerJ articles
- Elsevier journal submissions
- AEA journal submissions
- IEEE Transaction journal submissions
- Statistics in Medicine journal submissions
- Royal Society Open Science journal submissions
- Bulletin de l'AMQ journal submissions
- MDPI journal submissions

<https://github.com/hrbrmstr/markdowntemplates>

<https://github.com/rstudio/rticles>

The screenshot shows a LaTeX editor interface with a dark theme. At the top right, there is a "Save" button and a "NAVTITLE" dropdown menu. The main content area has a placeholder text "INSERT_TITLE_HERE". Below it, there is a line of text "AUTHOR • 2016-02-04". The main body of the document contains a block of dialogue text from the Star Trek: Deep Space Nine episode "The Way of the Phoenix". The text reads:

Captain John Sheridan: You know, I just had a thought. You've been back and forth to your world so many times since you got here. How do I know you're the same Vorlon? Inside that encounter suit you could be anyone. Kosh Naranek: I have always been here. Captain John Sheridan: Oh, yeah? You said that about me too. Kosh Naranek: Yes. [starts to walk away] Captain John Sheridan: I really hate it when you do that. Kosh Naranek: [turns around] Good! Delenn: I am Grey. I stand between the candle and the star. We are Grey. We stand between the darkness and the light. Lt. Corwin: Do we trust no-one then? Cmdr. Susan Ivanova: No, trust Ivanova, trust yourself, anybody else, shoot'em. Ta'Lor: Congratulations citizen G'Kar. You are now a religious icon. Susan Ivanova: So the next time we find out where the Shadows plan to strike, we can mine the area, and as soon as they come out of hyperspace... Citizen G'Kar: Then, as you so concisely say, Boom!

Section Title

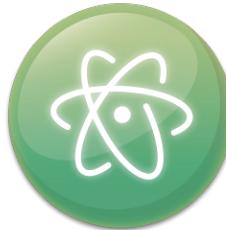
G'Kar: It is said that the future is always born in pain. The history of war is the history of pain. If we are wise, what is born of that pain matures into the promise of a better world, because we learn that we can no longer afford the mistakes of the past. Dr. Stephen Franklin: Doesn't anyone listen to one damn word I say? Captain John Sheridan: No surrender, no retreat. [Opening narration, season 4] Lennier: It was the year of fire, Zack Allan: The year of destruction, Citizen G'Kar: The year we took back what was ours. Lyta Alexander: It was the year of rebirth, Ambassador Vir Cotto: The year of great sadness, Marcus Cole: The year of pain, Delenn: And a year of joy. Ambassador Londo Mollari: It was a new age. Dr. Stephen Franklin: It was the end of history. Susan Ivanova: It was the year everything changed. Michael Garibaldi: The year is 2261. Captain John Sheridan: The place, Babylon 5. Sinclair: They say God works in mysterious ways. Michael Garibaldi: Maybe so, but He's a con-man compared to the Vorlon.

Figures

Other Markdown Editors



MacDown



Atom



Marked 2



StackEdit
(online editor)



Sublime Text



Scrivener



Mou



Dillinger
(online editor)

<https://github.com/mundimark/awesome-markdown-editors>

Notes App

There are several notes apps in which you can use Markdown for quick, easy formatting (e.g., Evernote, Joplin).



Joplin: <https://joplinapp.org/>

The screenshot shows the Joplin desktop application interface. On the left, there's a sidebar with 'NOTEBOOKS' and 'TAGS'. Under 'NOTEBOOKS', 'Bloomington 1' is selected, showing sub-notebooks like 'Books', 'House', 'Projects/Grants', and 'UMN 20'. Under 'UMN 20', 'zief0002's notebook' is listed. Under 'TAGS', 'Conflicts' is shown. The main area displays a note titled 'EPsy 8252' with the following content:

```
# For 2022
- Focus on model evaluation rather than coefficient evaluation (Wald test, R2, LRT, Model Evidence)
- Switch from stargazer to texreg
- Dump Assignment 2
  - Change #1 to remove heading
  - Be specific about using the .lft and .right classes to create the columns
  - Change #6 to compute using the estimate and se
- **Working with Probability Distributions Notes**
  - [ ] Add `lower.tail=FALSE` argument
  - [ ] Adios `rnorm()` ?
  - [ ] Adapt the probability distributions to only deal with the density?
- **Logistic Models**
  - [ ] Add two-way tables
  - 2 denominators depending on proportion
  - `group_by()` order matters
- **Longitudinal models**
  - [ ] Start with linear growth; only b0j
  - [ ] linear growth; b0j and bij
  - [ ] Log-linear; b0j and bij
  - [ ] Add predictors; between-subject and within-subjects

# For 2021
- **RMarkdown Notes:**
```

At the bottom of the note, there's a link to 'Click to add tags...'.

Markdown in Email!

Use Markdown in your email messages for quick, easy formatting.



Markdown Here: <https://markdown-here.com/>

New Message

Goldy Gopher (██████████)

Subject

| Name | Lunch order | Spicy | Owes |
|-------|-------------|--------|------|
| Joan | saag paneer | medium | \$11 |
| Sally | vindaloo | mild | \$14 |
| Erin | lamb madras | HOT | \$5 |

There are **multiple syntax highlighting themes** to choose from. Here's one of them:

```
```javascript
// All the code you will ever need
var hw = "Hello World!"
alert(hw);
```
--
```

Andrew Zieffler, Ph.D.
Educational Psychology
University of Minnesota

New Message

Goldy Gopher (██████████)

Subject

| Name | Lunch order | Spicy | Owes |
|-------|-------------|--------|------|
| Joan | saag paneer | medium | \$11 |
| Sally | vindaloo | mild | \$14 |
| Erin | lamb madras | HOT | \$5 |

There are **multiple syntax highlighting themes** to choose from. Here's one of them:

```
// All the code you will ever need
var hw = "Hello World!"
alert(hw);
--
```

Andrew Zieffler, Ph.D.
Educational Psychology
University of Minnesota

Learning More

OFFICIAL DOCUMENTATION

- **Markdown Syntax:** <http://daringfireball.net/projects/markdown/syntax>
- **R Markdown:** <http://rmarkdown.rstudio.com/>
- **Knitr:** <http://yihui.name/knitr/>

BOOKS/TUTORIALS

- **R Markdown: The Definitive Guide:** Electronic version of Yihui Xie, J. J. Allaire, and Garrett Grolemund's book published by Chapman & Hall/CRC.
- **Pimp my Rmd:** Blog post providing a few tips to improve the appearance of output documents.
- **Getting Started with RMarkdown:** Tutorial from Coding Club
- **Rmarkdown (and friends) Tutorial:** Tutorial

CHEAT SHEETS/EXAMPLES

- **R Markdown cheatsheet:** One-page (front/back) cheatsheet illustrating the essential R Markdown syntax
- **R Markdown Gallery:** Gallery showing the range of outputs and formats you can create using R Markdown