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# Crash Course in R Markdown

## What is R Markdown?

R Markdown is a tool for dynamic, reproducible creation of data-centric documents that include text, code, the results of executed code.

* R Markdown was created by R Studio (<https://www.rstudio.com>) in 2014 (or at least that’s the oldest discussion I can find).
* It is a variant of Markdown, which was created by John Gruber (creator of Daring Fireball (<https://daringfireball.net/>)) and Aaron Swartz (co-creator of Reddit ([https://www.reddit.com/](https://www.reddit.com)) as a lightweight markup language for creating formatted text using a plain-text editor.
* In general, a markdown language is a language that is written in plain-text but that is rendered different based on “markups” in the text.
* Has some capabilities similar to Jupyter (<https://jupyter.org/>) notebooks.

R Markdown is a great way to:

* Create a data analysis notebook that documents how and why you did analysis a certain way.
* Share your work with others in a variety of formats.
* Make your work reproducible.

R Markdown is a very useful tool for the data scientist.

R Studio provides R Markdown (and other) cheatsheets at <https://rstudio.com/resources/cheatsheets/>

### Your turn

The easiest way to create a new R Markdown file is File New File R Markdown. Do this on your computer to see what is produced.

## What’s in an R Markdown document?

An R Markdown document has three components:

1. An optional YAML header.
2. Formatted text.
3. **Chunks** of computer code.

Since the YAML header is optional, we’ll talk about it last.

## Formatting text in R Markdown

### Headings and sections

Headings and sections of different levels are created with #.

* # indicates the first level
* ## being the second level
* etc.

The words after the # will be larger than the regular text.

Note: In R Scripts and the R Console, the # symbol denotes a comment. In R Markdown files (.Rmd or .rmd), a comment is created by placing <!-- and --> to the left and right, respectively, of the text you want to comment.

e.g.,

<!-- comment text -->

would comment the text “comment text”.

The easiest way to comment text in R Markdown documents is to highlight the text and then press Ctrl/Cmd + Shift + c.

### Your turn

Practice commenting some text in R Markdown.

### Font styles and effects

* *Italic text*: \*text\* or \_text\_.
* **Bold text**: \*\*text\*\* or \_\_text\_\_ (two underscores on each side)
* Typewriter (code) text: `text`
* Endash (–), emdash (—): -- and ---.
* superscript and subscript: ^superscript^ and ~subscript~
* ~~strikethrough~~: ~~strikethrough~~
* Escaping special characters \*, \_, $, \, `: \\*, \\_, \$, \\, `` ` ``
* Footnote[[1]](#footnote-33): Footnote^[This is a footnote]

Math is rendered using LaTeX (which is [pronounced](https://www.latex-project.org/about/) “Lah-tech” or “Lay-tech”). So you can use $ and $$ to render inline math and display math like you would in LaTeX.

E.g., Typing “The regression coefficient $\beta$” will produce “The regression coefficient ”.

### Your turn

1. Create a new R Script (Ctrl/Cmd + Shift + n).
2. Replace the file contents with the code below:

---  
title: "Bad jokes"  
output: html\_notebook  
---  
  
# First level  
  
## Second level  
  
### Third level  
  
This document is intended to help you see the effect of markup on a rendered document.  
   
\*This is italic text\*  
  
\*\*This is bold text\*\*  
  
`This looks like computer code`  
  
What's the difference between endash--endash and emdash---emdash?  
  
How can I add a superscript to this? Like this: this^superscript^?  
  
That's a joke if you didn't get the ~subtext~.   
  
Wow, two bad jokes in a row. I'd like to strike ~~that~~ from my memory.  
  
I wish I could \\*escape\\* these bad jokes.  
  
But I guess this will just be an unpleasant footnote^[unpleasant footnote].

1. Save the file (Ctrl/Cmd + s) with the name “bad\_jokes.Rmd”.
2. Click the Preview button and view the results.

## Numbered/ordered and unordered lists

### Numbered/ordered lists

Numbered lists with sub-bullets:

A numbered list with subnumbering.  
  
1. Item 1  
 a. Sub-item 1 # two tabs, not one  
 b. Sub-item 2  
 i. Sub-sub-item 1 # four tabs, not two  
2. Item 2  
 a. Sub-item 1

Result: A numbered list with subnumbering.

1. Item 1
   1. Sub-item 1
   2. Sub-item 2
      1. Sub-sub-item 1
2. Item 2
   1. Sub-item 1

Note: There must be a line between any text and the number 1.

### Unordered lists

Unordered lists with sub-bullets:

Some text with bullets.  
  
\* Item 1  
 \* Sub-item 1  
 \* Sub-item 2  
 \* Sub-sub-item 1  
\* Item 2  
 \* Sub-item 1

Result: Some text with bullets.

* Item 1
  + Sub-item 1
  + Sub-item 2
    - Sub-sub-item 1
* Item 2
  + Sub-item 1

Notes:

* There must be a line between any text and the \*.
* You can use + or - instead of \* when creating unordered lists with the same result.

### Your turn

Create an example of a numbered list with 4 levels and an unordered list with 3 levels.

## Code chunks

Chunks of code can be added in an R Markdown by placing the relevant code between ```{r} and ```. e.g.,

```{r, label = chunk\_name}  
1 + 1  
```

You can generate a code chunk template using Ctrl/Cmd + Alt + i.

The chunk\_name is optional but allows you give give chunks names labels that you can refer back to. This is useful for complicated documents and reports. (See [Verbatim Code Chunks](https://bookdown.org/yihui/rmarkdown-cookbook/verbatim-code-chunks.html) for how to get the above code to render.)

Note: each label should be unique within the document. I don’t recommend adding chunk labels unless you actually need them, otherwise you are likely to reuse a chunk label and make a headache for yourself!

### Chunk options

Code chunks have many options that can be used to customize the code. We will cover many important ones below. I will specify the default option in parentheses, (), after the option. So this is what will be used by default if you don’t specify anything.

Yuhui Xie, creator of **knitr**, provides a complete list (<https://yihui.org/knitr/options/>) of chunk options on his website (<https://yihui.org/>).

### Code evaluation

* eval: (TRUE) A logical value indicating whether the chunk should be evaluated in the Console.
  + You can also evaluate **selected lines** if you provide a numeric vector. e.g., eval = 1:3 would evaluate lines 1 through 3.

### Text output

* echo: (TRUE). A logical value indicating whether the source code should be displayed.
  + You can also echo **selected lines** if you provide a numeric vector. e.g., echo = 1:3 would echolines 1 through 3
* results: ('markup'). Determines hwo the results are displayed.
  + Other options are 'asis', 'hold', 'hide'.
* collapse: (FALSE). A logical value indicating whether the source and output should be collapsed into a single block.
* include: (TRUE) A logical value indicating whether to include the chunk output.
  + Set to FALSE when you want something to run but not be shown.

Other options: warning, error, messages (TRUE) determine whether warnings, errors, and messages will be displayed, respectively.

### Code styling

* highlight: (TRUE) A logical value indicating whether the source code syntax should be highlighted with different colors.
* comment: (##) The text that will be shown prior to evaluated code in the output block.
  + Use ## or #> to make the code blocks easier to copy and paste into the Console. #> is closer to what the Console output actually looks like.
* tidy: (FALSE) A logical value indicating whether the source code be automatically reformatted.
* tidy.opts: (NULL) A list of options that can be used to customize the tidy option above.
  + e.g., tidy.opts = list(width.cutoff = 60) controls the length of the code and tries to cut the code lines at 60 characters.

### Plots

* fig.show: ('asis'). Instructions for displaying plots.
  + 'asis': Show plots in the order and places they would be if executed in the Console.
  + 'hold': Output all plots at the end of the chunk.
  + 'hide': Hide all plots.
  + 'animate': Combine and animate the plots
* fig.align: ('default'). A character vector specifying how to align the figures.
  + Allowable values are: 'default', 'left', 'right', and 'center'.
* fig.width, fig.height: (7). A numeric value indicating the width and height of the result figures.
* fig.cap: (NULL). A caption for the figure.

### Your turn

Copy and paste the code at <https://github.com/jfrench/DataWrangleViz/blob/master/rmd-chunks-viz.Rmd> into an R Markdown document and then Knit the file to see visual examples of the options described above.

### Some general options not discussed

* Caching: This has to do with saving previous code that has been evaluated. This is important for documents with lots of code that is time consuming to run.
* Animation: You can add plot animations if you have the FFMpeg program installed <https://ffmpeg.org/>.

### Inline code

You can run code in the middle of text using something like `r mean(1:3)`.

For example, `r 1 + 1` will produce 2.

### Tables

By default, R will print tables (like data frames) exactly like you would see them in the Console output.

For example:

```{r}  
head(cars)  
```

head(cars)

## speed dist  
## 1 4 2  
## 2 4 10  
## 3 7 4  
## 4 7 22  
## 5 8 16  
## 6 9 10

The formatting can be improved with the kable function in the **knitr** package.

```{r}  
knitr::kable(cars[1:6,], caption = "Kable table")  
```

knitr::kable(cars[1:6,], caption = "Kable table")

Kable table

|  |  |
| --- | --- |
| speed | dist |
| 4 | 2 |
| 4 | 10 |
| 7 | 4 |
| 7 | 22 |
| 8 | 16 |
| 9 | 10 |

## YAML header

The YAML (Yet Another Markdown Language) header controls many aspects of the R Markdown document. Unless you’re using R Markdown for advanced purposes (books, blogs, websites, running the same file with multiple input parameters) then you probably don’t need to know a lot about the YAML header at this stage.

And if you do need to know about the YAML header in detail, then you probably need a more advanced introduction to R Markdown!

### References

You can add a bibliography to your document using the YAML header.

You need to add something like the following to the header:

bibliography: filename.filetype

Many bibliography types are supported. A list of supported file types is currently available at <https://rmarkdown.rstudio.com/authoring_bibliographies_and_citations.html>

Citations must be placed in square brackets.

* Multiple citations should be separated by semicolons.

A citation will have a key associated with it in the bibliography file, and you must use @key to cite the relevant reference.

Here are some examples from the R Studio website:

Blah blah [see @doe99, pp. 33-35; also @smith04, ch. 1].  
  
Blah blah [@doe99, pp. 33-35, 38-39 and \*passim\*].  
  
Blah blah [@smith04; @doe99].

Many for details about bibliographies with R Markdown are available on the R Studio website, and are currently found at <https://rmarkdown.rstudio.com/authoring_bibliographies_and_citations.html>

### Producing different document types

One of the incredible features of R Markdown is that you can easily produce multiple file types with a single click of the “Knit” button.

Adding the following code in the YAML header will produce a pdf document, an html notebook, an html document, and a Microsoft Word document, all with one click of the Knit button!

output:  
 pdf\_document: default  
 html\_notebook: default  
 html\_document:  
 df\_print: paged  
 word\_document: default

* pdf\_document: Excellent for distributing a static (unchanging) document. Also great for submitting homework solutions to your instructor!
* html\_document: Excellent for sharing interactive files. Can be viewed in a web browser.
* html\_notebook: The excellent “R notebook”.
  + It’s like an html\_document but the source code can be downloaded by toggling the “Code” button in the upper right hand corner of the file.
  + Great to share with collaborators because they can update the document, add analysis, etc.
  + Make sure to “Run All Code” using Ctrl/Cmd + Alt + r prior to “Previewing” the document or the code chunk output will not be included.
* word\_document: If you have to have Microsoft Word editing capabilities, for some reason.

### Your turn

* Execute the command download.file("https://raw.githubusercontent.com/jfrench/DataWrangleViz/master/02-crash-course-in-rmd.nb.html", destfile = "02-crash-course-in-rmd.nb.html") in the Console.
* Close R Studio.
* Find the downloaded file.
* Toggle the “Code” button in the right hand corner of the file to download the original source code.

### Other things you can create in R Markdown:

* Presentations: Use the ioslides\_presentation or the slidy\_presentation output type (there are others) to create a presentation.
  + Use # to start a new slide with a title.
  + Use \*\*\* to start a new slide without a title.
  + Use ## for a second level header.
* Shiny apps: This is essentially an interactive web app created using R Markdown.
* Websites
* Books (**bookdown**)
* Blogs (**blogdown**)
* Dashboards (**flexdashboard**)
* html\_widgets (various packages)

1. This is a footnote [↑](#footnote-ref-33)