



Writing dynamic and reproducible documents

An introduction to R Markdown

Olivier Gimenez
November 2020

Credits

- Garrett Grolemund [RStudio webinar](#)



- Ulrik Lyngs [workshop material](#)



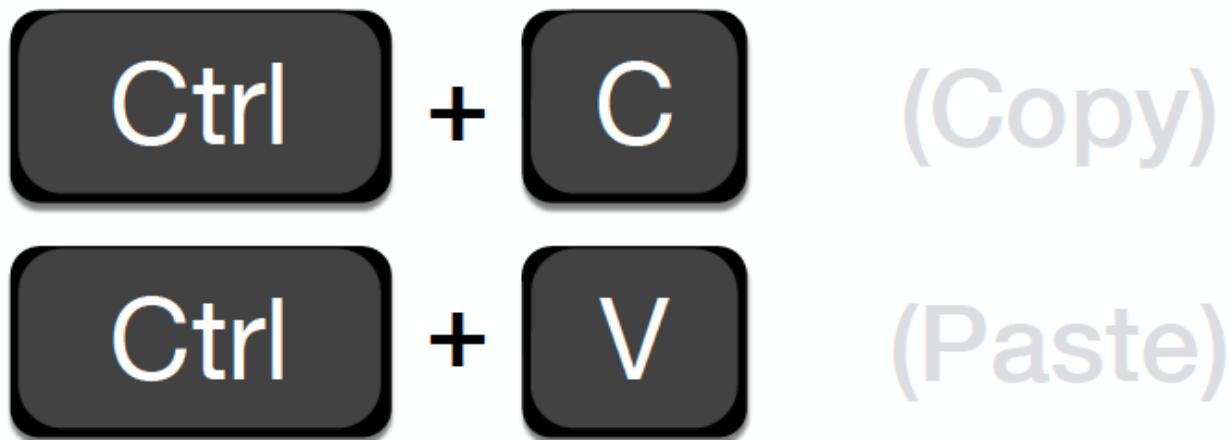
Motivation



#



How can you reproduce results?



What do we need to make research reproducible?

- Something to integrate text, figures and code
 - R, Python, etc
- Something that can be continuously edited and updated
 - Living or dynamic document
- Something that can be easily used in versioning tools
 - Git

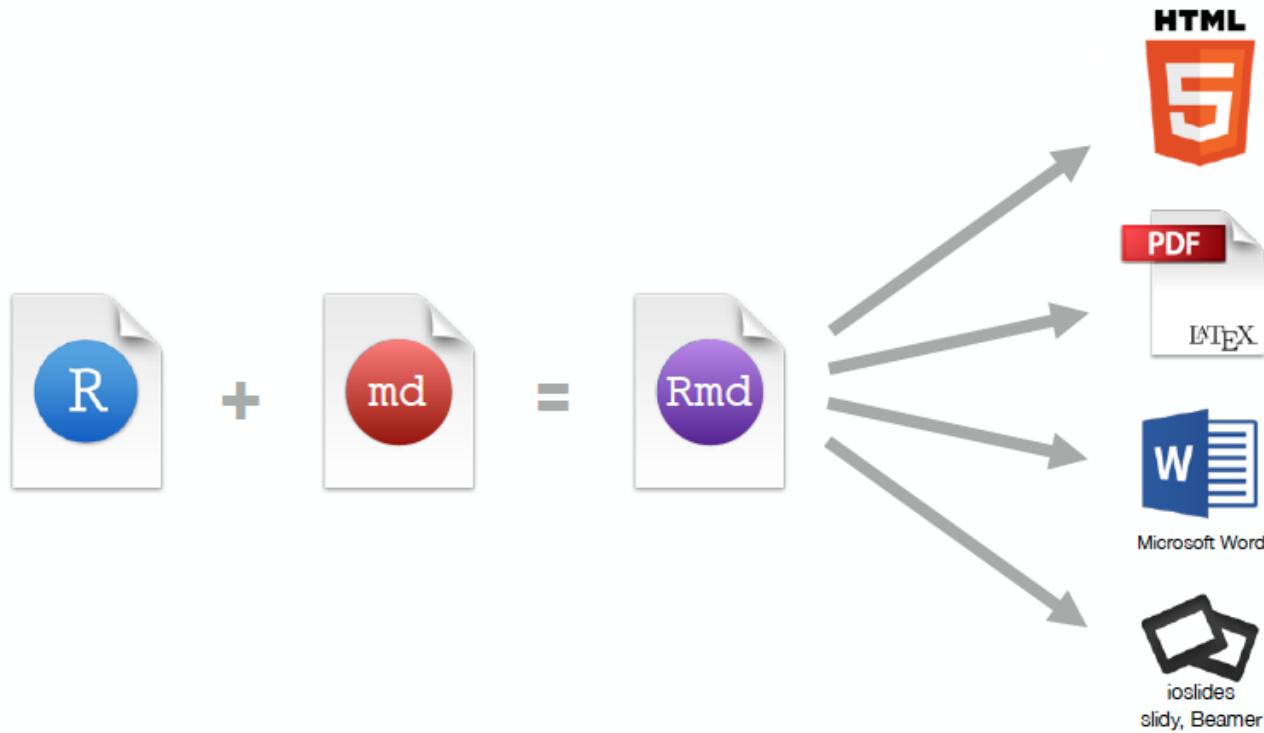
R MARKDOWN

We're getting the BAND BACK TOGETHER.

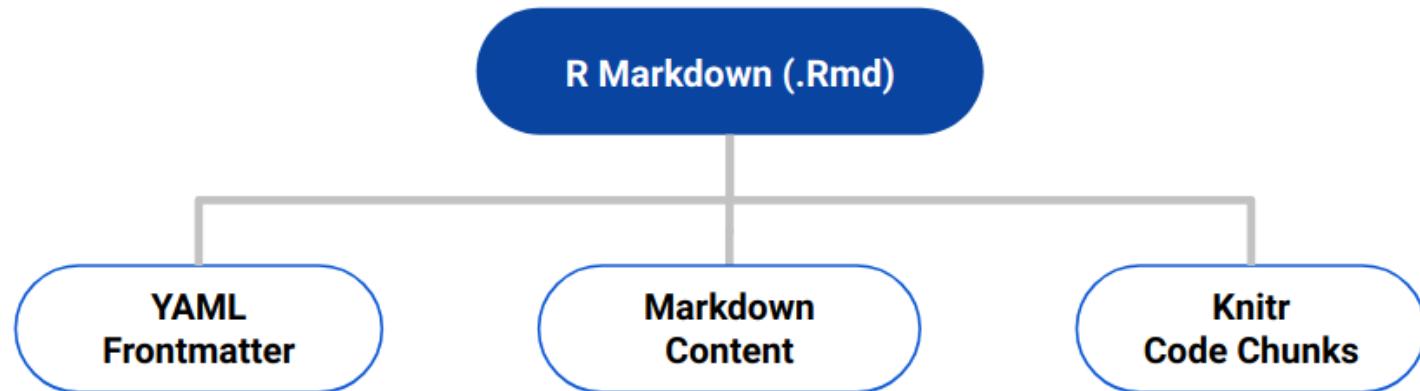


HORST '19

R Markdown workflow



Structure of a R Markdown document



<https://yongfu.name/2019-fju-rmd-talk/slides/#1>

Demo

Open RStudio

Create a new Rmd file

Identify 3 components (frontmatter, content, chunks)

The screenshot shows the RStudio interface with the title bar "Untitled1" and "index.rmd". The main pane displays an R Markdown document with the following content:

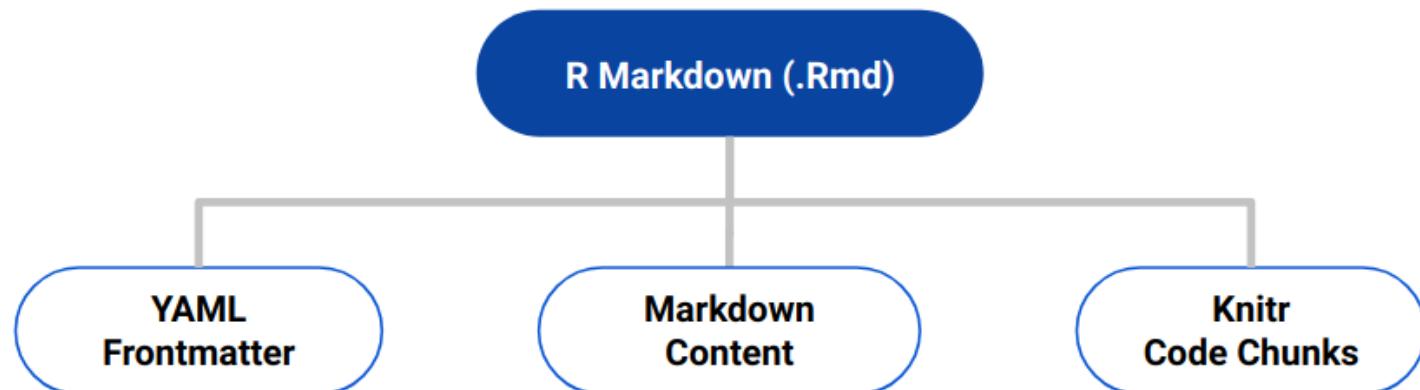
```
1 ---  
2 title: "Untitled"  
3 author: "Olivier Gimenez"  
4 date: "10/24/2020"  
5 output: html_document  
6 ---  
7  
8 ```{r setup, include=FALSE}  
9 knitr::opts_chunk$set(echo = TRUE)  
10 ```  
11  
12 ## R Markdown  
13  
14 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see  
http://rmarkdown.rstudio.com.  
15  
16 When you click the Knit button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:  
17  
18 ```{r cars}  
19 summary(cars)  
20 ```  
21  
22 ## Including Plots  
23  
24 You can also embed plots, for example:  
25  
26 ```{r pressure, echo=FALSE}  
27 plot(pressure)  
28 ```  
29  
30 Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.  
31
```

The screenshot shows an RStudio interface with two tabs: "Untitled1" and "index.rmd". The "index.rmd" tab is active, displaying an R Markdown document. The document is organized into three main sections separated by vertical dashed lines:

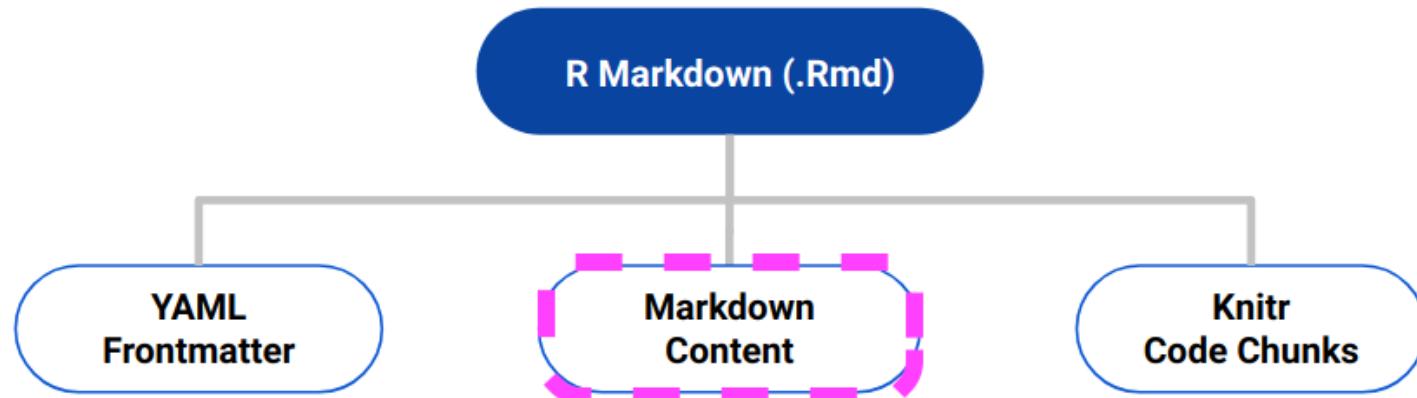
- Front matter**: Lines 1 through 10. Includes code for setting up the document and enabling echo output.
- Chunk**: Lines 11 through 20. A section header followed by an R code chunk that prints the summary of the "cars" dataset.
- Content**: Lines 21 through 31. A section header followed by an R code chunk that generates a plot of pressure data.

```
1 ---  
2 title: "Untitled"  
3 author: "Olivier Gimenez"  
4 date: "10/24/2020"  
5 output: html_document  
6 ---  
7  
8 ```{r setup, include=FALSE}  
9 knitr::opts_chunk$set(echo = TRUE)  
10 ````  
11  
12 ## R Markdown  
13  
14 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see  
http://rmarkdown.rstudio.com.  
15  
16 When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:  
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28 ````  
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30 Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.  
31
```

Structure of a R Markdown document



Structure of a R Markdown document



Format your text with Markdown

What is Markdown?

- A way to write stuff
- Mostly plain words, with some formating

```
# Say Hello  
To my little  
friend, markdown.
```

Markdown is

- * easy to use
- * simple
- * fun?



Say Hello

To my little friend, markdown.
Markdown is

- easy to use
- simple
- fun?

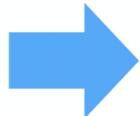
Websites that use Markdown

- GitHub <https://github.com/>
- StackOverflow <https://stackoverflow.com/>
- HackMD <https://hackmd.io>
- Many more

Headers

- Use # to create headers
- Multiple #'s create lower level headers

```
# Header 1  
## Header 2  
### Header 3  
#### Header 4  
##### Header 5  
##### Header 6
```



Header 1
Header 2
Header 3
Header 4
Header 5
Header 6

Text

- Text is rendered as plain text

Add two spaces at
the end of a line to
start a new line

Text
italics
__bold__
'code'



Text
italics
bold
`code`

Lists

- Use asterisks to make bullet points
- Use numbers to make numbered lists
- Use 4 spaces or 1 tab for indentation

Bullets

- * bullet 1
- * bullet 2

Numbered list

1. item 1
2. item 2



Bullets

- bullet 1
- bullet 2

Numbered list

1. item 1
2. item 2

Hyperlinks

- To add a hyperlink, put your text between brackets
- Then place the URL between parentheses

This is a
[link](www.git.com).



This is a link.

Equations

- Write equations with Latex syntax

According to
Einstein,
 $E=mc^2$

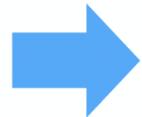


According to
Einstein, $E = mc^2$

Equation blocks

According to Einstein,

$$E=mc^2$$



According to Einstein,

$$E = mc^2$$

Images

- Use a link preceded by an ! to insert an image
- The link text should be
 - a URL if the image is hosted online
 - a file path if the image is saved on your computer

Tables

header A	header B
data	data

Table:title

- A bit of a hassle...
- Use a [generator of Tables for Markdown](#)
- Wait for next section to learn how to generate tables from R

R Markdown Reference Guide

<https://rstudio.com/wp-content/uploads/2015/03/rmarkdown-reference.pdf>



R Markdown Reference Guide

Learn more about R Markdown at rmarkdown.rstudio.com

Learn more about Interactive Docs at shiny.rstudio.com/articles

Contents:

1. **Markdown Syntax**
2. Knitr chunk options
3. Pandoc options

Syntax

```
Plain text  
End a line with two spaces  
to start a new paragraph.  
*italics* and _italics_  
**bold** and bold  
superscript^2^  
strikethrough  
\[link\] (www.rstudio.com)  
# Header 1  
## Header 2
```

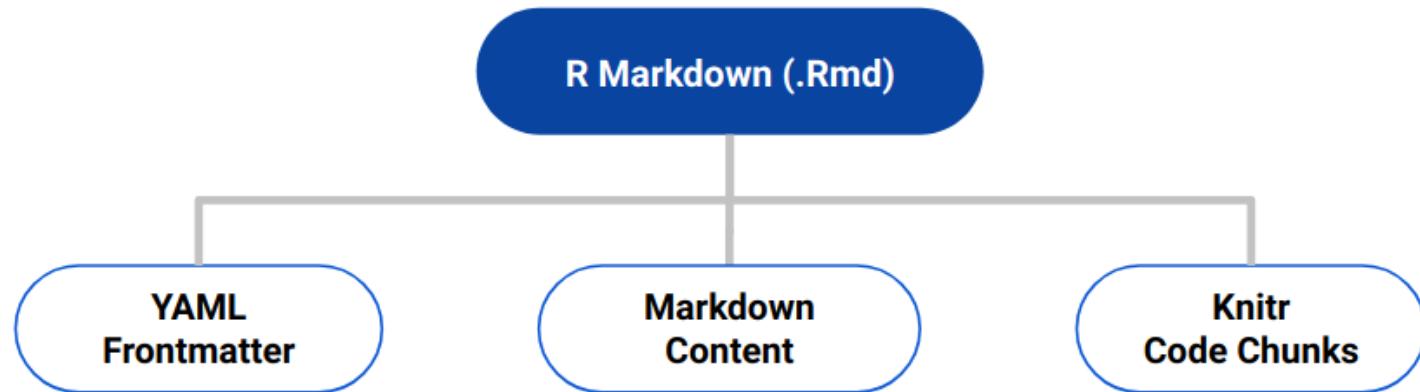
Becomes

```
Plain text  
End a line with two spaces to start a new paragraph.  
italics and italics  
bold and bold  
superscript2  
strikethrough  
link
```

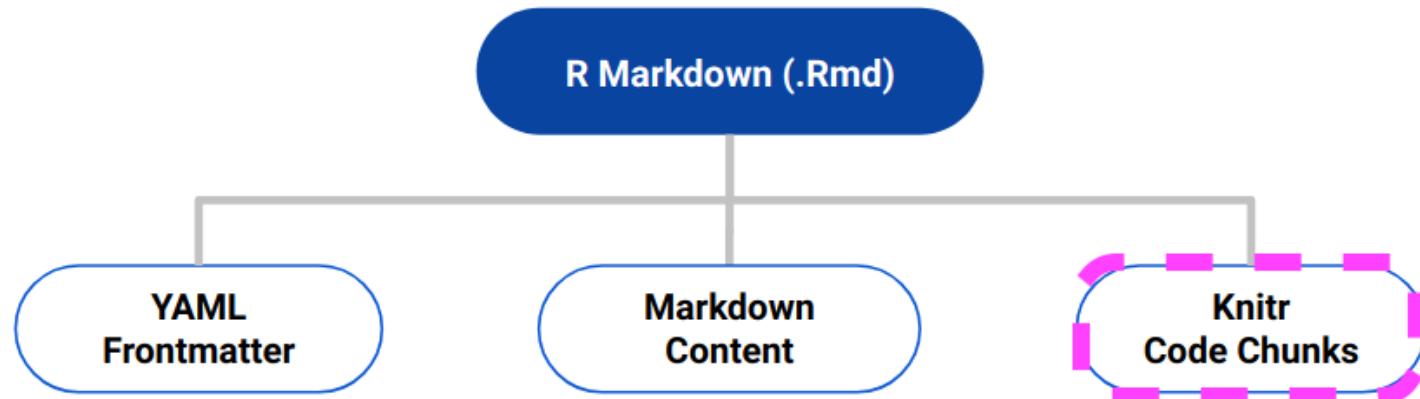
Header 1

Header 2

Structure of a R Markdown document



Structure of a R Markdown document



Code, figures and tables

Embed code

- Insert chunk of R code
- R Markdown runs code and includes results.

```
```{r}
some code
```

```
```
```

Inline code

- Place code in a sentence with
- R Markdown replaces code with results

Today is
`r Sys.Date()`.



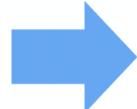
Today is 2015-04-16.

.

Chunk options

- By default, R markdown includes both code and results

```
Here's some code  
```{r}  
dim(iris)
```
```

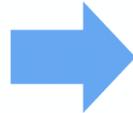


```
Here's some code  
dim(iris)  
## [1] 150      5
```

echo

- Add options between brackets after r.
- echo = FALSE hides code.

```
Here's some code  
```{r echo=FALSE}  
dim(iris)
```
```



Here's some code

```
## [1] 150 5
```

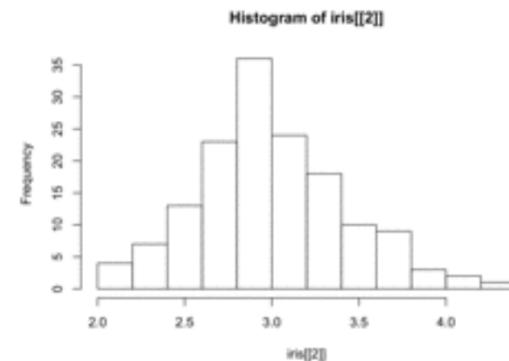
echo

- Add options between brackets after r.
- echo = FALSE hides code.

```
Here's a plot  
```{r echo=FALSE}  
hist(iris[[2]])
```
```



Here's a plot



eval

- eval = FALSE prevents code from being run
- No results is displayed, only code

```
Here's some code  
```{r eval=FALSE}  
dim(iris)
```
```



```
Here's some code  
dim(iris)
```

fig.height, fig.width

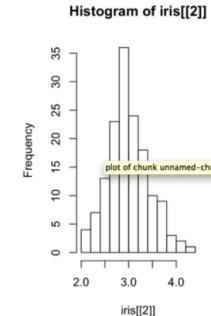
- Specify dimension of plots (in inches) with `fig.width` and `fig.height`
- Separate multiple arguments with commas.

Here's a plot

```
```{r echo=FALSE, fig.width=3, fig.height=5}
hist(iris[[2]])
````
```



Here's a plot



message

- `message = FALSE` prevents messages from appearing in output

```
Here's some code  
```{r message=FALSE}  
library(forecast)
```
```



```
Here's some code  
library(forecast)
```

Default chunk options

- Repeating chunk options can be painful
- If you have echo = FALSE in every single chunk, how to set the default chunk option to echo = FALSE ?
- Use knitr::opts_chunk\$set(echo = FALSE)
- You may overwrite the default for each chunk
- For chunk options, check out <https://yihui.name/knitr/options/>

Including tables

```
# cars is a built-in-to-R data set of cars
# and their stopping distances
cars %>%
  head(5) %>%
  knitr::kable(format = "html", caption = "A kable table")
```

| A kable table | |
|---------------|------|
| speed | dist |
| 4 | 2 |
| 4 | 10 |
| 7 | 4 |
| 7 | 22 |
| 8 | 16 |

- The `kable` package is often used with the `kableExtra` package
- A number of other packages are available for making pretty tables, see rmarkdown.rstudio.com

R Markdown Reference Guide

<https://rstudio.com/wp-content/uploads/2015/03/rmarkdown-reference.pdf>



R Markdown Reference Guide

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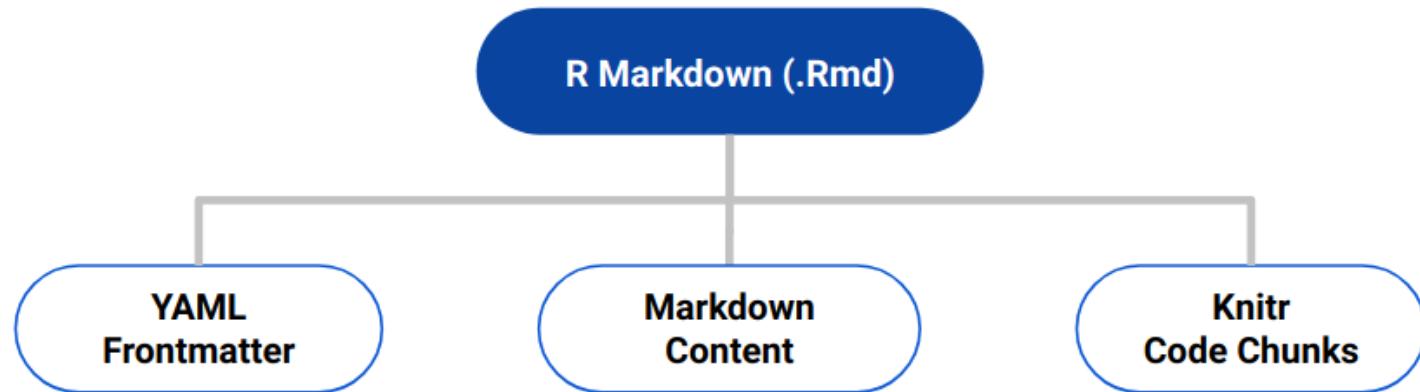
Learn more about Interactive Docs at shiny.rstudio.com/articles

Contents:

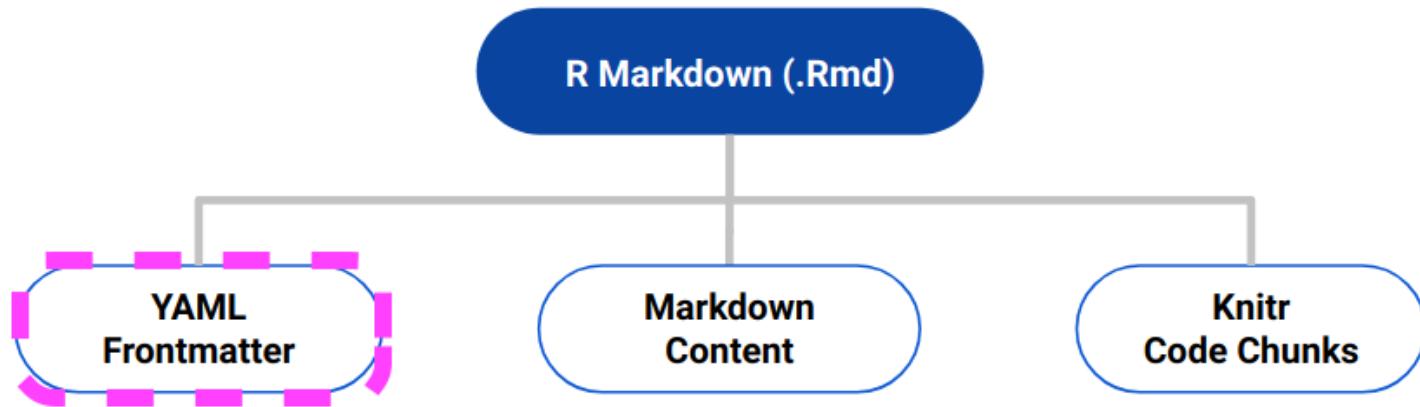
1. Markdown Syntax
- 2. Knitr chunk options**
3. Pandoc options

| Syntax | Becomes |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Make a code chunk with three back ticks followed by an r in braces. End the chunk with three back ticks:</p> <pre>```{r} paste("Hello", "World!") ```</pre> | <p>Make a code chunk with three back ticks followed by an r in braces. End the chunk with three back ticks:</p> <div style="border: 1px solid #ccc; padding: 5px;"><pre>paste("Hello", "World!")</pre></div> <div style="border: 1px solid #ccc; padding: 5px; margin-top: 10px;"><pre>## [1] "Hello World!"</pre></div> |
| <p>Place code inline with a single back ticks. The first back tick must be followed by an R, like this `r paste("Hello", "World!")`.</p> | <p>Place code inline with a single back ticks. The first back tick must be followed by an R, like this Hello World!.</p> |
| <p>Add chunk options within braces. For example, `echo=FALSE` will prevent source code from being displayed:</p> <pre>```{r eval=TRUE, echo=FALSE} paste("Hello", "World!") ```</pre> | <p>Add chunk options within braces. For example, <code>echo=FALSE</code> will prevent source code from being displayed:</p> <div style="border: 1px solid #ccc; padding: 5px;"><pre>## [1] "Hello World!"</pre></div> |

Structure of a R Markdown document



Structure of a R Markdown document

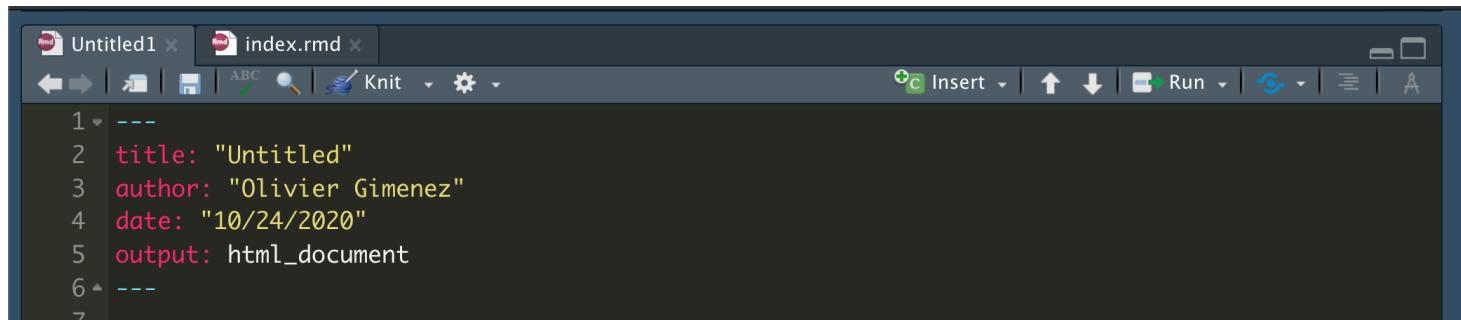


YAML Yet Another Markup Language

YAML in brief

- Contains the metadata of the document
- Starts and ends by three dashes
- Comes first in the document

Simplest example



The screenshot shows the RStudio interface with two tabs open: "Untitled1" and "index.rmd". The "index.rmd" tab is active, displaying the following R Markdown code:

```
1 ---  
2 title: "Untitled"  
3 author: "Olivier Gimenez"  
4 date: "10/24/2020"  
5 output: html_document  
6 ---  
7
```

The code consists of a YAML front matter block with five key-value pairs: title, author, date, output, and a blank line at the end.

Output formats

Untitled

Oliver Gimenez
10/25/2020

R Markdown

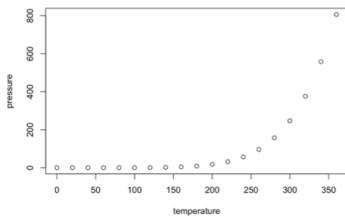
This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##   speed      dist
## Min. : 4.0  Min. :  2.00
## 1st Qu.:12.0  1st Qu.: 24.00
## Median :15.4  Median : 46.98
## Mean   :15.4  Mean   : 42.98
## 3rd Qu.:19.0  3rd Qu.: 56.00
## Max. :25.0   Max. :120.00
```

Including Plots



html

Untitled

Oliver Gimenez
10/25/2020

R Markdown

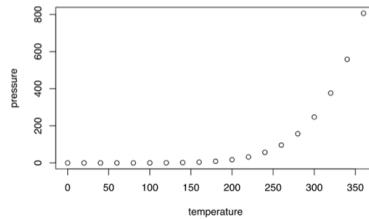
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## 1st Qu.:12.0  1st Qu.: 24.00
## Median :15.0  Median : 36.00
## Mean   :15.4  Mean   : 42.98
## 3rd Qu.:19.0  3rd Qu.: 56.00
## Max. :25.0   Max. :120.00
```

Including Plots



pdf

Untitled

Oliver Gimenez
10/25/2020

R Markdown

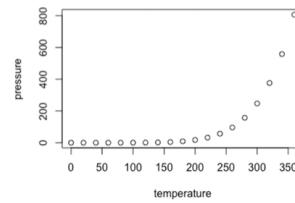
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## Median :15.0  Median : 36.00
## Mean   :15.4  Mean   : 42.98
## 3rd Qu.:19.0  3rd Qu.: 56.00
## Max. :25.0   Max. :120.00
```

Including Plots



docx

Knit



Output formats

Appearance and style

- In HTML output, you can use theme or a custom **.css** style sheet
- theme options (bootswatch.com) : “cerulean”, “journal”, “flatly”, “darkly”, “readable”, “spacelab”, “united”, “cosmo”, “lumen”, “paper”, “sandstone”, “simplex”, “yeti”
- You may also use LaTeX templates with R Markdown, and write **reproducible scientific paper**
- You can also **use Word templates in R Markdown** (see also [this short video](#))

Managing bibliography

1. Put references in a plain text file with the extension **.bib**, in **BibTex** format (my advice: use **Zotero**)

```
@article{Shea2014,
  author = {Shea, Nicholas and Boldt, Annika},
  journal = {Trends in Cognitive Sciences},
  pages = {186--193},
  title = {{Supra-personal cognitive control}},
  volume = {18},
  year = {2014},
  doi = {10.1016/j.tics.2014.01.006},
}
```

2. Reference this file in your YAML header

```
---
title: "Citation test"
bibliography: example.bib
output: html_document
---
```

Citations

3. In your text, citations go inside brackets and separated by semicolons

This...

Blah blah [@Shea2014;
@Lottridge2012].

turns into this...

Blah blah (Shea et al. 2014;
Lottridge et al. 2012).

Citations

3. In your text, citations go inside brackets and separated by semicolons

This...

Blah blah [@Shea2014;
@Lottridge2012].

@Shea2014 says blah.

Blah blah [see @Shea2014, pp. 33-
35; also @Wu2016, ch. 1].

turns into this...

Blah blah (Shea et al. 2014;
Lottridge et al. 2012).

Shea et al. (2014) says blah.

Blah blah (see Shea et al. 2014,
33–35; also Wu 2016, ch. 1).

Citations

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This...

Blah blah [@Shea2014;
@Lottridge2012].

@Shea2014 says blah.

Blah blah [see @Shea2014, pp. 33-
35; also @Wu2016, ch. 1].

turns into this...

Blah blah (Shea et al. 2014;
Lottridge et al. 2012).

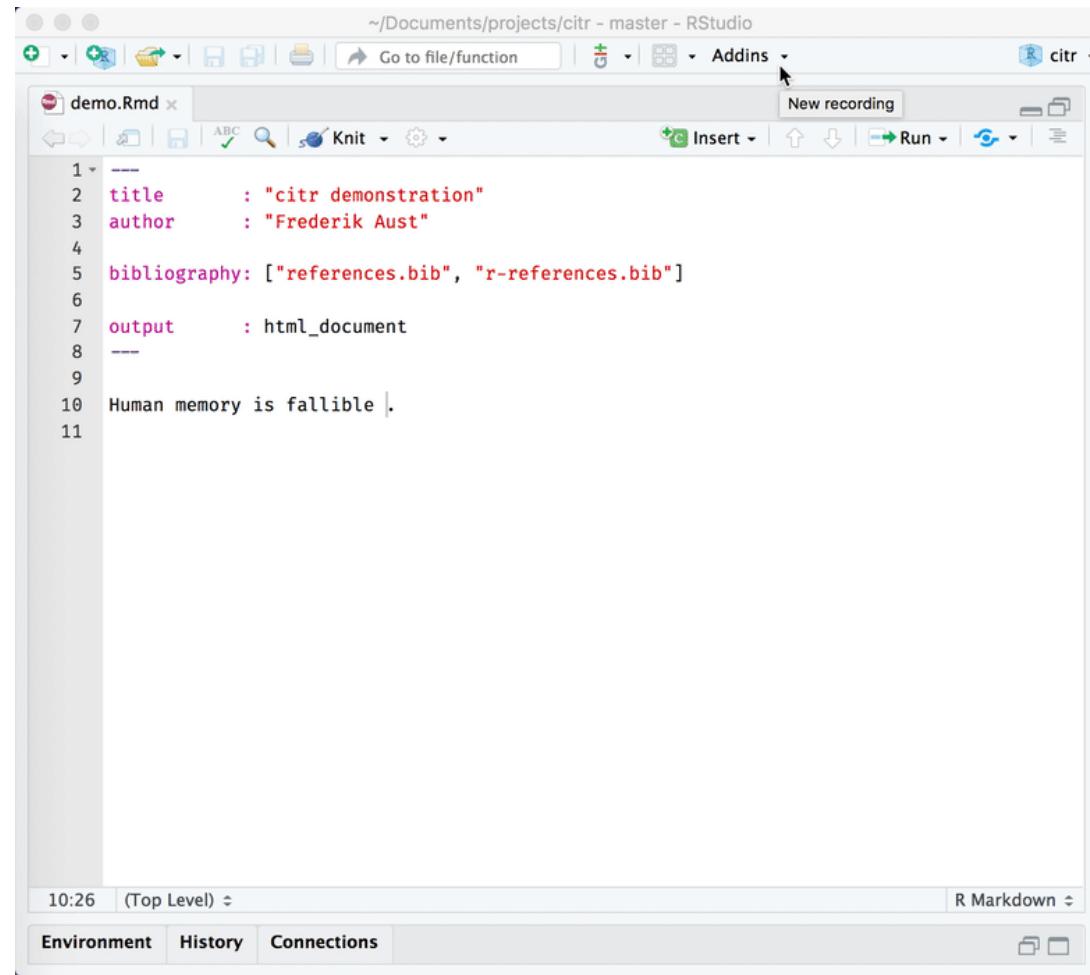
Shea et al. (2014) says blah.

Blah blah (see Shea et al. 2014,
33–35; also Wu 2016, ch. 1).

- Add e.g `csl: my-style.csl` in the YAML header to change to other formats
- Browse through and download styles at zotero.org/styles

Citations

For an easy way to insert citations, try the `citr` RStudio add-in.



The screenshot shows the RStudio interface with the following details:

- Title Bar:** ~/Documents/projects/citr - master - RStudio
- Addins Menu:** A dropdown menu labeled "citr" is open, showing options like "New recording".
- Toolbar:** Includes standard RStudio icons for file operations, search, and knit.
- Code Editor:** The file "demo.Rmd" is open, displaying the following R Markdown code:

```
1 ---  
2 title      : "citr demonstration"  
3 author     : "Frederik Aust"  
4  
5 bibliography: ["references.bib", "r-references.bib"]  
6  
7 output      : html_document  
8 ---  
9  
10 Human memory is fallible |.  
11
```
- Status Bar:** Shows the time (10:26), project level (Top Level), and mode (R Markdown).
- Bottom Navigation:** Environment, History, Connections tabs.

R Markdown Reference Guide

<https://rstudio.com/wp-content/uploads/2015/03/rmarkdown-reference.pdf>



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Contents:

1. Markdown Syntax
2. Knitr chunk options
- 3. Pandoc options**

| Templates | Basic YAML | Template options | Latex options | Interactive Docs |
|-----------------------|----------------------------|----------------------------------|-----------------------------|----------------------------|
| html_document | --- | --- | --- | --- |
| pdf_document | title: "A Web Doc" | title: "Chapters" | title: "My PDF" | title: "Slides" |
| word_document | author: "John Doe" | output:
html_document: | output: pdf_document | output: |
| md_document | date: "May 1, 2015" | toc: true | fontsize: 11pt | slidy_presentation: |
| ioslides_presentation | output: md_document | toc_depth: 2 | geometry: margin=1in | incremental: true |
| slidy_presentation | --- | --- | --- | runtime: shiny |
| beamer_presentation | --- | --- | --- | --- |

Rmarkdown

TEXT. CODE. OUTPUT.
(GET IT TOGETHER, PEOPLE.)



What else can we reproduce with R Markdown?

Let's have a tour

R Markdown from R Studio

Ge

Gallery

Check out the range of outputs and formats you can create using R Markdown.

Documents

With R Markdown, you write a single .Rmd file and then use it to render finished output in a variety of forms.

Great NYT Interactive -- Now Reusable with rCharts

Chauhan and Atkinson

Introducing the new **2016 Curriculum**, which includes one of the most comprehensive systems available for supporting the program. A system that includes every tool, the right input, and output. Please understand, it is highly-recommended you use the 2016 Curriculum resources.

Another Photo by Jason Dettman

нормальном режиме, т.е. вакуумная магнитная ВЧ-система функционирует. Важно это знать на начальном этапе, чтобы избежать ошибок в работе с ВЧ-системой.



A Pandoc Markdown Article Starter and Template

Section V: Metrics → Conclusions

This document provides an introduction to R Markdown, allows for its benefits, and presents a simple non-interactive template intended for its academic audience. I will use basic syntax in R Markdown and a minimal working example of how the `analysis.Rmd` file can be rendered within R within the `knitr` package.

• Introduction

Acknowledgments, acknowledgments, acknowledgments, as it was approached. The American Journal of Pathology (January 1980) acknowledged a prior "unpublished" manuscript by simply adding "and colleagues" to the list of authors. The *Journal of Clinical Investigation* (February 1980) published a paper by the same author team, but did not acknowledge the source of the prior work. The *Journal of Neuroscience Research* (March 1980) acknowledged the source of the prior work, but did not cite the source. The *Journal of Neuroscience* (April 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience Research* (May 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (June 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (July 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (August 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (September 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (October 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (November 1980) cited the source, but did not acknowledge the source. The *Journal of Neuroscience* (December 1980) cited the source, but did not acknowledge the source.

Elite anti-socialite negotiations to the Laffer committee as well. Political culture, the insurance-future, and struggle with the excess of the late 1990s by Michael Ettner

R Mackay

This is an [OpenMark workspace](#).
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Including Plots

R Markdown gallery <https://rmarkdown.rstudio.com/gallery.html>

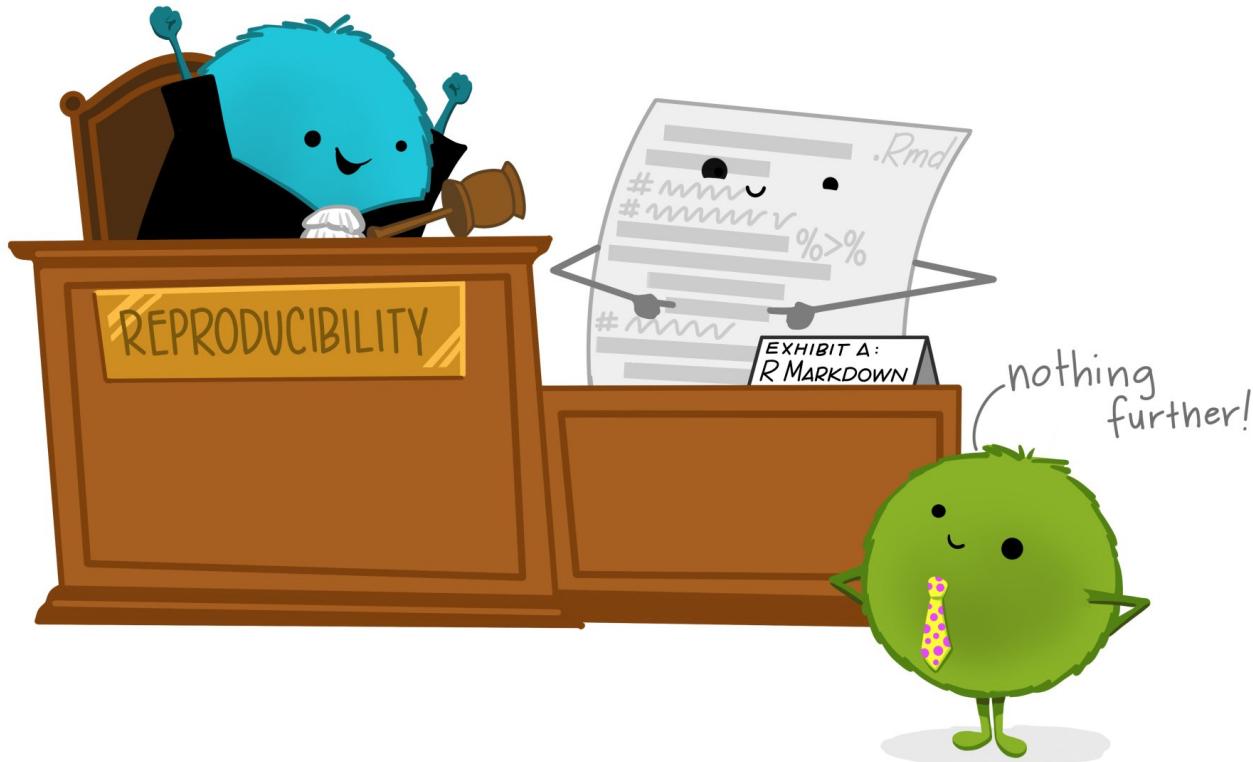
Websites

- Use package blogdown <https://bookdown.org/yihui/blogdown/>
- Customize with Hugo <https://themes.gohugo.io/>
- Deploy via GitHub pages or Netlify

Live demo

Build your own website in a few minutes

#



@allison_horst

To go further

Books

Thanks!

I created these slides with **xaringan** and **R Markdown** using the **rutgers** **css** that I slightly modified.

Credit: I borrowed slides from **Garrett Grolemund** and **Ulrik Lyngs**. I also used the beautiful illustrations shared by **Allison Horst**.



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<https://oliviergimenez.github.io/>



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