

Creating Reproducible Reports using R Markdown

**Symposium: Using RStudio for Visualization and Analysis
of Weed Science Experiments**

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Outline

- What is literate programming?
- Why is it useful?
- How to use R Markdown to create reproducible reports
 - Text formatting
 - Code chunks
 - Output formats

Literate programming

human readable **text**

+

machine readable **code**

=

Reproducible **document**

Programs as works of literature

- Developed by Donald Knuth, Stanford University
- **Traditional**: telling a computer what to do
- **Novel**: telling a human what you want the computer to do
- Improves documentation and the programs themselves

Literate programming in research

- Tailor reports to an audience
- Repeatable and assures reproducibility
- Works well with version control
- Works well with languages used in research:



R Markdown

- Weave narrative text and code
 - R
 - Python
 - Stata
 - SAS
- Produce documents in many formats
- Reproducible

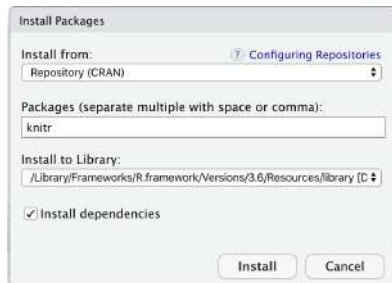


Setup

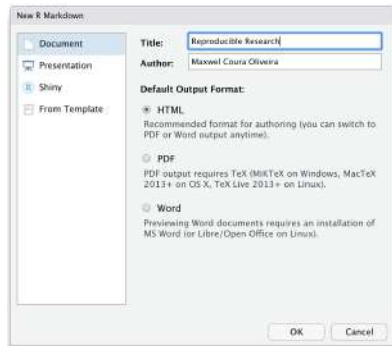
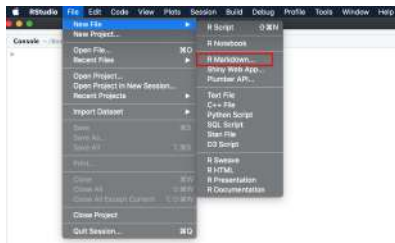
- Tools > install packages

```
install.packages("markdown")
```

- Install TeX if you want create PDFs
- Open **R** project



Open/Create a markdown document



Sections of R Markdown

```
---
title: "Reproducible Research"
author: "Maxwel Coura Oliveira"
date: "10/31/2019"
output: html_document
---
```

YAML metadata **Header**

```
```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```
```

Code chunk

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>.

Human-readable text

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:

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

Code chunk

Including Plots

You can also embed plots, for example:

```
```{r pressure, echo=FALSE}
plot(pressure)
```
```

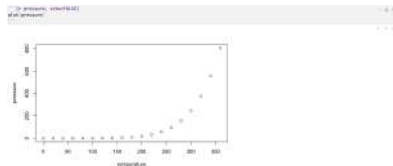
Code chunk

Note that the `echo = FALSE` parameter was added to the code chunk to prevent rendering the plot.

Human-readable text

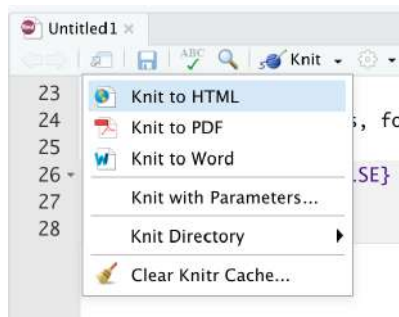
Notebook interface

- Press **green triangle** on a code chunk to run the code and show the output



Knit: from text to document

`render(input = "name.Rmd",
output = "html_document")`
OR



Reproducible Research

Maxwell Coura Oliveira
10/21/2018

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for creating 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:

```
## knitr plot ##  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot  
## Mtcars ~> plot ~> plot
```

Including Plots

You can also embed plots, for example:



How it works

- knitr package converts the **R Markdown** document to markdown
- Pandoc converts the markdown document to the final



Human readable text

- Outline first, code
- Use markdown rich formatting syntax to
- Cheat sheet: [Link](#)

| 3. Markdown | Next, write your report in plain text. | Use markdown syntax to describe how to format text in the final report. |
|-------------|--|---|
| | <p>syntax</p> <pre>Plain text End a line with two spaces to start a new paragraph. <italics> and <bold> <u> --strike through-- [Link](www.rstudio.com) # Header 1 ## Header 2 ### Header 3 #### Header 4 ##### Header 5 ##### Header 6 endash: --- enddash: --- all pipes: inline equation: SA = \pi r^2 (2\pi) image: [](path/to/smallerb.png) Horizontal rule (or slide break): --- = Block quote + unordered list - item 1 + sub-item 1 + sub-item 2</pre> | <p>becomes</p> <p>Plain text
End a line with two spaces to start a new paragraph.
<i>italics</i> and bold
<u></u>
--strike through--
Link</p> <h1>Header 1</h1> <h2>Header 2</h2> <h3>Header 3</h3> <h4>Header 4</h4> <h5>Header 5</h5> <h6>Header 6</h6> <p>— endash —
— endash —
 all pipes
inline equation: $SA = \pi r^2 (2\pi)$
image: </p> <hr/> <p>Horizontal rule (or slide break)</p> <p>= Block quote</p> <ul style="list-style-type: none"> + unordered list - item 1 + sub-item 1 + sub-item 2 |

Adding code chunks

- Chunk delimiters
 - beginning: “`{r name}`”
- end: “
- Shortkey: Ctrl+Alt+i
- Editor toolbar



Setup code block

```
#load the libraries we need
library(tidyverse)
library(knitr)
library(lattice) #this is for the barley dataset
data <- barley
```

Code chunk options

- `include = FALSE`
 - Hide code and results from document
 - results can still be used later
- `echo = FALSE`
 - hides code, keeps result
- `message = FALSE`
 - hides messages
- `warning = FALSE`
 - hides warnings
- `fig.cap = " "`
 - adds figure captions

Setting options for all code chunks

- Set default options for all code chunks
- `knitr::opts_chunk$set()` function
- Put it in your first codeblock
- Must be after you load the rmarkdown package

Tables

- Tables look like console output by default
- `kable()` function makes it pretty

```
nd <- barley %>%  
  group_by(site, year) %>%  
  summarize(mean = mean(yield))
```

```
kable(nd, digits=1)
```

| site | year | mean |
|-----------------|------|------|
| Grand Rapids | 1932 | 20.8 |
| Grand Rapids | 1931 | 29.1 |
| Duluth | 1932 | 25.7 |
| Duluth | 1931 | 30.3 |
| University Farm | 1932 | 29.5 |
| University Farm | 1931 | 35.8 |
| Morris | 1932 | 41.5 |
| Morris | 1931 | 29.3 |
| Crookston | 1932 | 31.2 |
| Crookston | 1931 | 43.7 |
| Waseca | 1932 | 41.9 |
| Waseca | 1931 | 54.3 |

Inline code

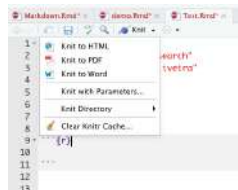
- Syntax `r`
- Include in test for responsive text
- Allows you to write one report and run it over changing datasets
- Example: mean

```
460  
461 The overall yield mean is `r mean(data$yield)`  
462  
463
```

The overall yield mean is 34.4205553

Change output formats

- select output from knit menu
- Specify output in header
- with render



```
---  
title: "Demo"  
author: "Maxwel Coura Oliveira"  
date: "11/1/2019"  
output: html_document  
---
```

```
## {r}  
library(rmarkdown)  
render("demo.Rmd", output_format="html_document")  
## }
```

Manuscripts

```
library(rarticles)
```

Package ‘rarticles’

November 12, 2019

Type Package

Title Article Formats for R Markdown

Version 0.12

Description A suite of custom R Markdown formats and templates for authoring journal articles and conference submissions.

License GPL-3

Imports utils, rmarkdown, knitr, yaml, tinytex, xfun

SystemRequirements GNU make

URL <https://github.com/rstudio/rarticles>

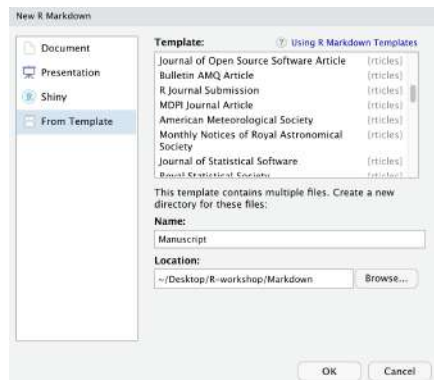
Opening a template

- File > New File > R Markdown > From Template > **Template:**

- Choose *PLOS Journal Article*

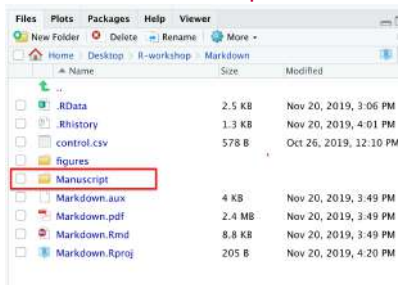


- Change name to **Manuscript**

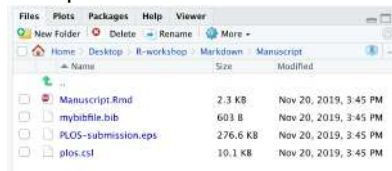


New folders

- It creates a new folder name **Manuscript**



- **Manuscript** > Rmd, bib, PLOS-submission.eps and plos.csl



PloS one template

■ Rmarkdown template: the manuscript

```
1 |---
2 title: Title of submission to PLoS journal
3 author:
4   - name: Alice Anonymous
5     email: alice@example.com
6     affiliation: Some Institute of Technology
7     corresponding: alice@example.com
8   - name: Bob Security
9     email: bob@example.com
10    affiliation: Another University
11 address:
12   - code: Some Institute of Technology
13     address: Department, Street, City, State, Zip
14   - code: Another University
15     address: Department, Street, City, State, Zip
16 abstract: |
17   Lorem ipsum dolor sit amet, consectetur adipiscing elit. Curabitur eget porta erat. Morbi consectetur est vel gravida pretium. Suspendisse ut dui eu ante
18   cursus gravida non sed sem. Nullam sapien tellus, conmodo id velit id, eleifend volutpat quam. Phasellus mauris velit, dapibus finibus elementum vel, pulvinar
19   non tellus. Nunc pellentesque pretium diam, quis maximus dolor faucibus id. Nunc convallis sodales ante, ut ullamcorper est egestas vitae. Nam sit amet enim
20   ultrices, ultrices elit pulvinar, volutpat risus.
21
22 author_summary: |
23   Lorem ipsum dolor sit amet, consectetur adipiscing elit. Curabitur eget porta erat. Morbi consectetur est vel gravida pretium. Suspendisse ut dui eu ante
24   cursus gravida non sed sem. Nullam sapien tellus, conmodo id velit id, eleifend volutpat quam. Phasellus mauris velit, dapibus finibus elementum vel, pulvinar
25   non tellus. Nunc pellentesque pretium diam, quis maximus dolor faucibus id. Nunc convallis sodales ante, ut ullamcorper est egestas vitae. Nam sit amet enim
26   ultrices, ultrices elit pulvinar, volutpat risus.
27
28 bibliography: mybibfile.bib
29 output: rtticles::plos_article
30 csl: plos.csl
31 ---
32
33 _Text based on plos sample manuscript, see http://journals.plos.org/ploscompbiol/s/latex(http://journals.plos.org/ploscompbiol/s/latex)_
34
35 # End of document
```

YAML metadata

Bibliography

- The word **BibTeX** stands for a tool and a file format which are used to describe and process lists of references, mostly in conjunction with LaTeX documents.
- Zotero is a free, easy-to-use tool to help you collect, organize, [cite](#), and share research.

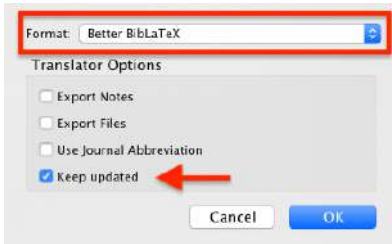


- Right click in your citation folder

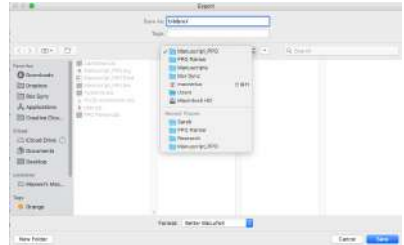


Saving the bibliography

- Save as Better BibLaTeX

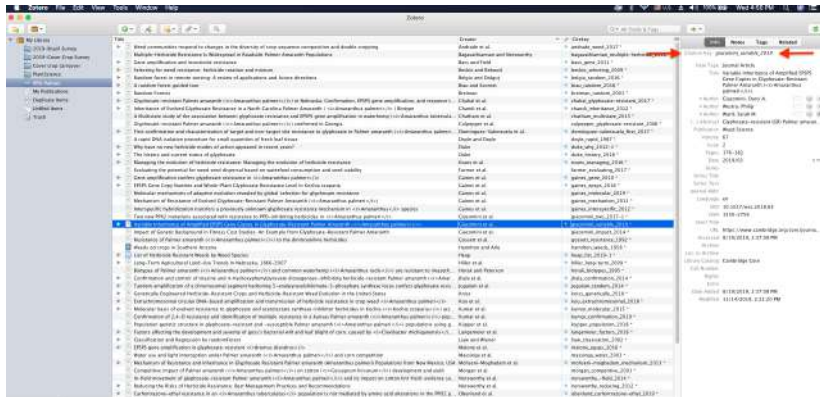


- Save your bib file in the same folder of your manuscript



Citation key

- Copy and paste citation key as: `[@giacomini_variable_2019]`



Summary

- Literate programming makes reproducible research more machine readable
- R markdown documents facilitate literate programming in RStudio
- R markdown has 3 sections
 - **Header**: determines output and adds parameters
 - **Markdown Text**: can include inline code
 - **Code chunks**: can be customized to mute code or output
- Manuscript templates

Need help?

- Email: max.oliveira@wisc.edu
- R markdown cheatsheet: [Link](#)
- R markdown tutorial: [Link](#)
- Table generator: [Link](#)