

# R Markdown and Interactive Dashboards

[education.rstudio.com](https://education.rstudio.com)

Things to do

- Make yourself a name card from card stock (choose your own color)
- Gather up a red and yellow sticky note
- Fill out the getting to know you form at:  
<https://forms.gle/zCtzegZNtvPnbYcz5>
- Wifi network is ""



# R Markdown and Interactive Dashboards

## Carl Howe

## Yihui Xie



**rstudio::conf**  
SAN FRANCISCO // JANUARY 27 - 30, 2020

from RStudio



# Workshop Policies

- Identify the exits closest to you in case of emergency
- Please review the rstudio::conf code of conduct that applies to all workshops. Issues can be addressed three ways:
  - In person: contact any rstudio::conf staff member or the conference registration desk
  - By email: send a message to [conf@rstudio.com](mailto:conf@rstudio.com)
  - By phone: call 844-448-1212
- Please do not photograph people wearing red lanyards
- A chill-out room is available for neurologically diverse attendees on the 4th floor of tower 1



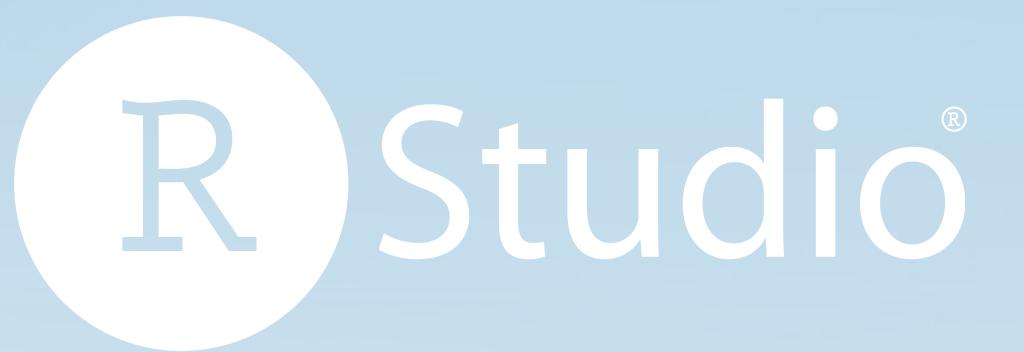
# Introducing your teaching staff

Carl Howe  
Yihui Xie

Hadrien Dykiel  
Melanie Mayer  
Jiena McLellan  
Adi Sarid

The background image is a wide-angle aerial photograph of the San Francisco skyline during sunset. The city is bathed in a warm, golden light from the setting sun, which is visible on the horizon. The skyline features numerous skyscrapers, including the Transamerica Pyramid and the Salesforce Tower. In the foreground, the dense urban landscape of residential and commercial buildings is visible, leading towards the water of the San Francisco Bay. The sky above is a clear, pale blue.

# RStudio's Mission:



Equip everyone, regardless of means,  
to participate in a global economy that  
rewards data literacy

A wide-angle aerial photograph of the San Francisco skyline at sunset. The city is bathed in a warm, golden light from the setting sun, which is visible on the horizon. The Transamerica Pyramid is prominent on the left, and the Golden Gate Bridge is visible in the distance across the water. The city's dense grid of buildings and streets stretches towards the horizon.

RStudio Education's mission:



Train the next million R users

#NextMillionRUsers

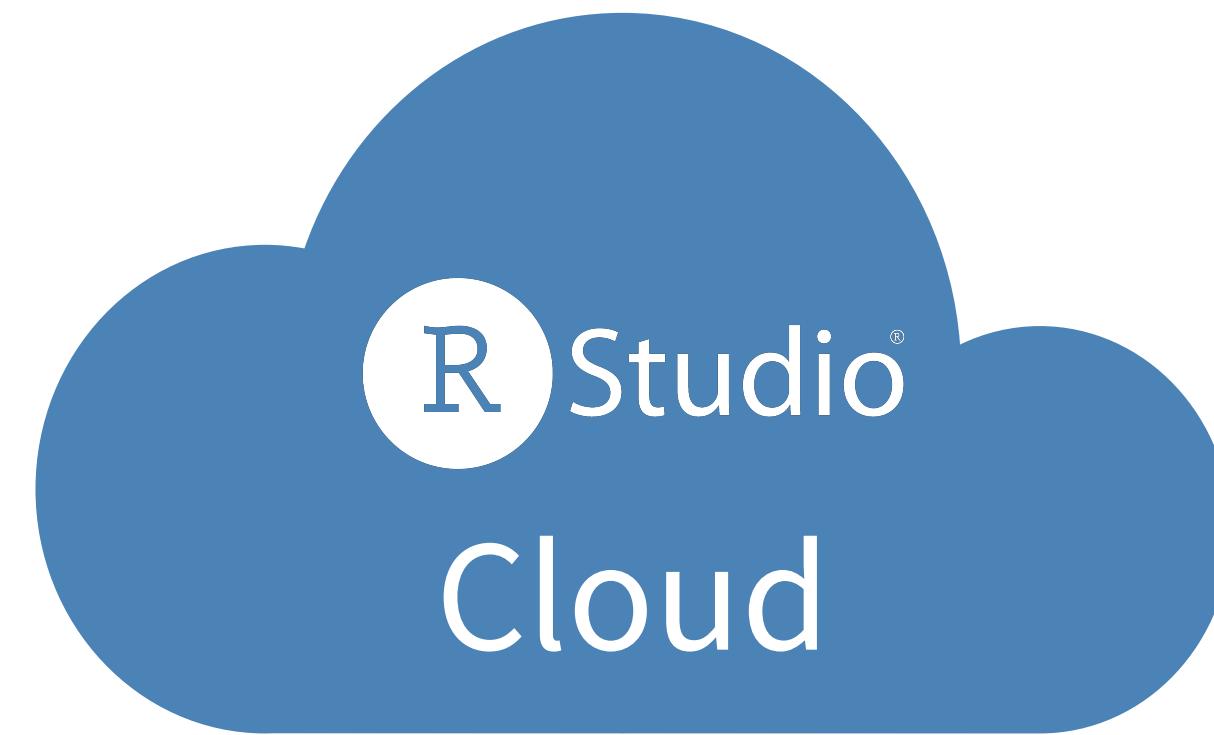
# Getting Set Up

[Github repo: rstd.io/conf20-rmd-dash](#)



# Workshop materials

OPTION 1



log in and sit tight

[Github repo: rstd.io/conf20-rmd-dash](#)

OPTION 2



Clone or download  
[rstd.io/conf20-rmd-dash](#)

A screenshot of a GitHub repository page for "rstudio/rmarkdown-dash". The page includes buttons for "Create new file", "Upload files", "Find File", and a green "Clone or download" button. Below these are links for "Clone with HTTPS" and "Use SSH", with the HTTPS link pointing to "https://github.com/rstudio/rmarkdown-dash". There are also "Open in Desktop" and "Download ZIP" buttons.

[rstudio.cloud workspace: rstd.io/RMAID](#)

# Demo

**Clone or download ▾**

**Clone with HTTPS ⓘ** [Use SSH](#)

Use Git or checkout with SVN using the web URL.

<https://github.com/mine-cetinkaya-rundquist/conf20-rmd-dash> 

---

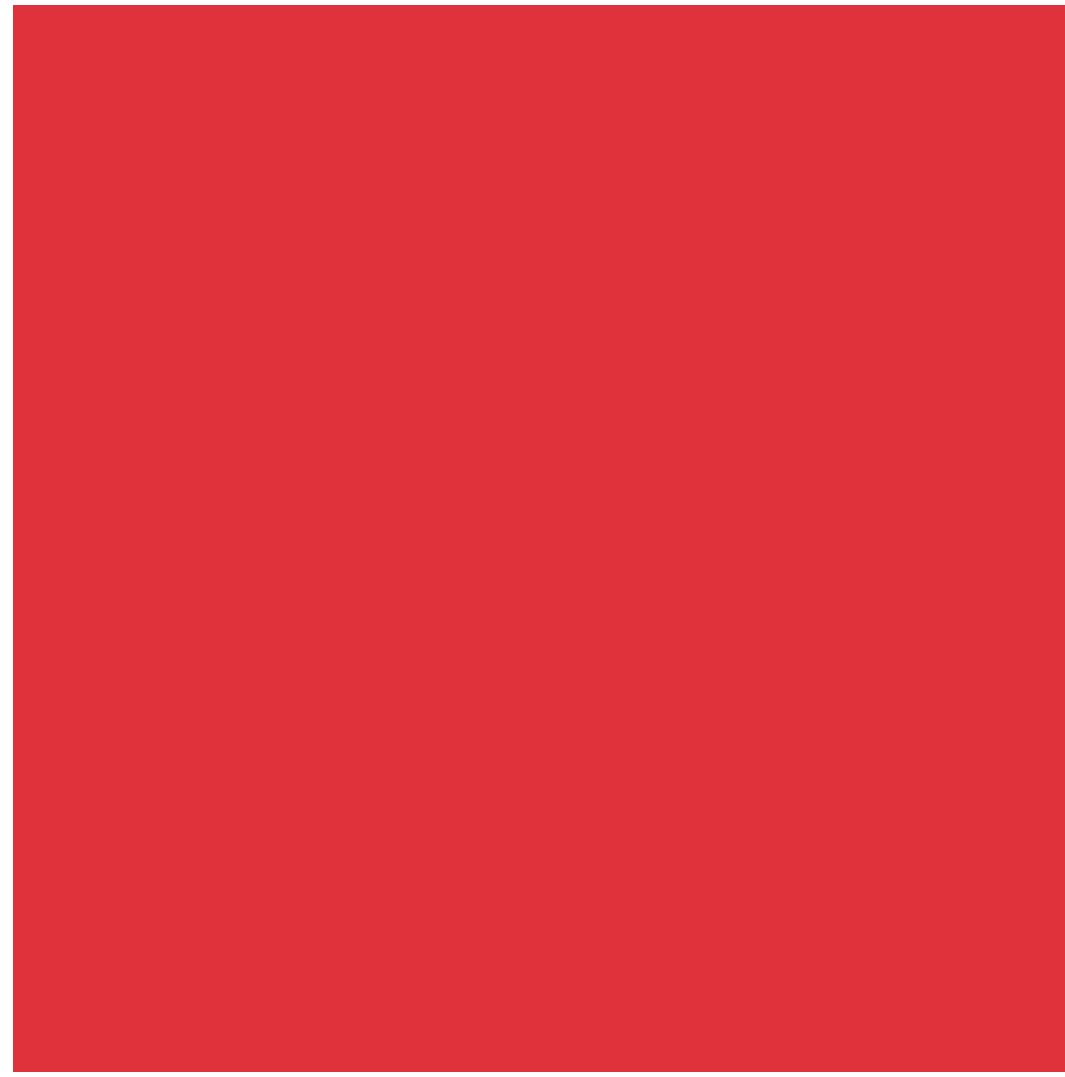
[Open in Desktop](#) [Download ZIP](#)

# If You Run Locally, You Need To Install Packages

The list is in the top level directory as `00-libraries-required.Rmd`. They are also listed here.

- `install.packages("geonames")`
- `install.packages("dplyr")`
- `install.packages("magrittr")`
- `install.packages("rmarkdown")`
- `install.packages("flexdashboard")`
- `install.packages("leaflet")`
- `install.packages("babynames")`
- `install.packages("tufte")`
- `install.packages("rticles")`
- `install.packages("shiny")`
- `install.packages("DT")`
- `install.packages("RCurl")`
- `install.packages("rsconnect")`
- `install.packages("reticulate")`
- `install.packages("revealjs")`
- `install.packages("plotly")`
- `install.packages("crosstalk")`
- `install.packages("knitr")`

# Asking for help



I'm stuck



I'm not stuck, but I need help  
on my computer



I need help  
understanding something  
(which likely means others  
do too)

# Schedule

Time	Day 1	Day 2
09:00-10:30	Introduction and R Markdown Basics	Recap and Shiny Dashboards
10:30-11:00		Break
11:00-12:30	Publishing Outputs	Reactivity
12:30-13:30		Lunch
13:30-15:00	Adding Interactivity	Yihui Xie Master Class: R Markdown Recipes
15:00-15:30		Break
15:30-17:00	Web-based Dashboards	Yihui Xie Answers Your Questions

The rstudio.cloud space for this course is  
[rstd.io/RMAID](https://rstd.io/RMAID)

The github repository for all the materials is at  
[rstd.io/conf-rmd-dash](https://rstd.io/conf-rmd-dash)

# Things you should know

- There are no stupid questions
- Because we have limited time, please write down questions as they occur to you, and then ask them when the instructor pauses for questions
- Don't be afraid to experiment and try things out; you won't blow up anything important if you make a mistake.

# RStudio Technologies We'll Use

- RStudio Integrated Development Environment (the RStudio IDE)
- RStudio.cloud interactive service
- The R language (naturally)
- The R Markdown document language
- The Tidyverse series of R packages
- HTML Widgets
- Shiny interactivity

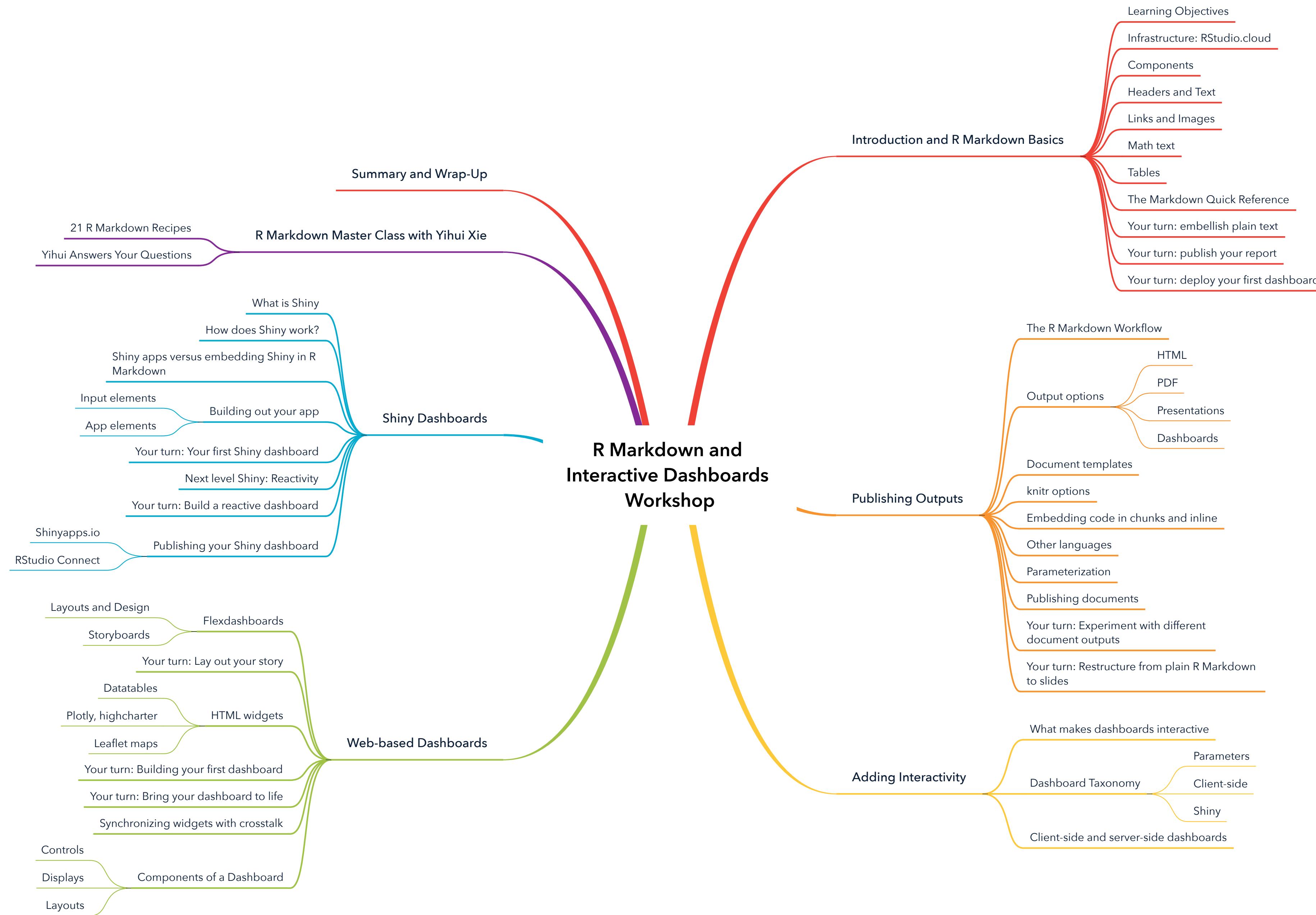
# What You'll Learn In This Workshop

Today you'll learn how to

- Use the RStudio IDE and RStudio.cloud
- Knit an R Markdown document
- Create reports in R Markdown
- Turn static reports into dynamic content
- Apply web browser and Shiny interactivity
- Publish your insights to a larger web audience

# R Markdown and Interactive Dashboards Workshop





## Introduction and R Markdown Basics

Learning Objectives

Infrastructure: RStudio.cloud

Components

Headers and Text

Links and Images

Math text

Tables

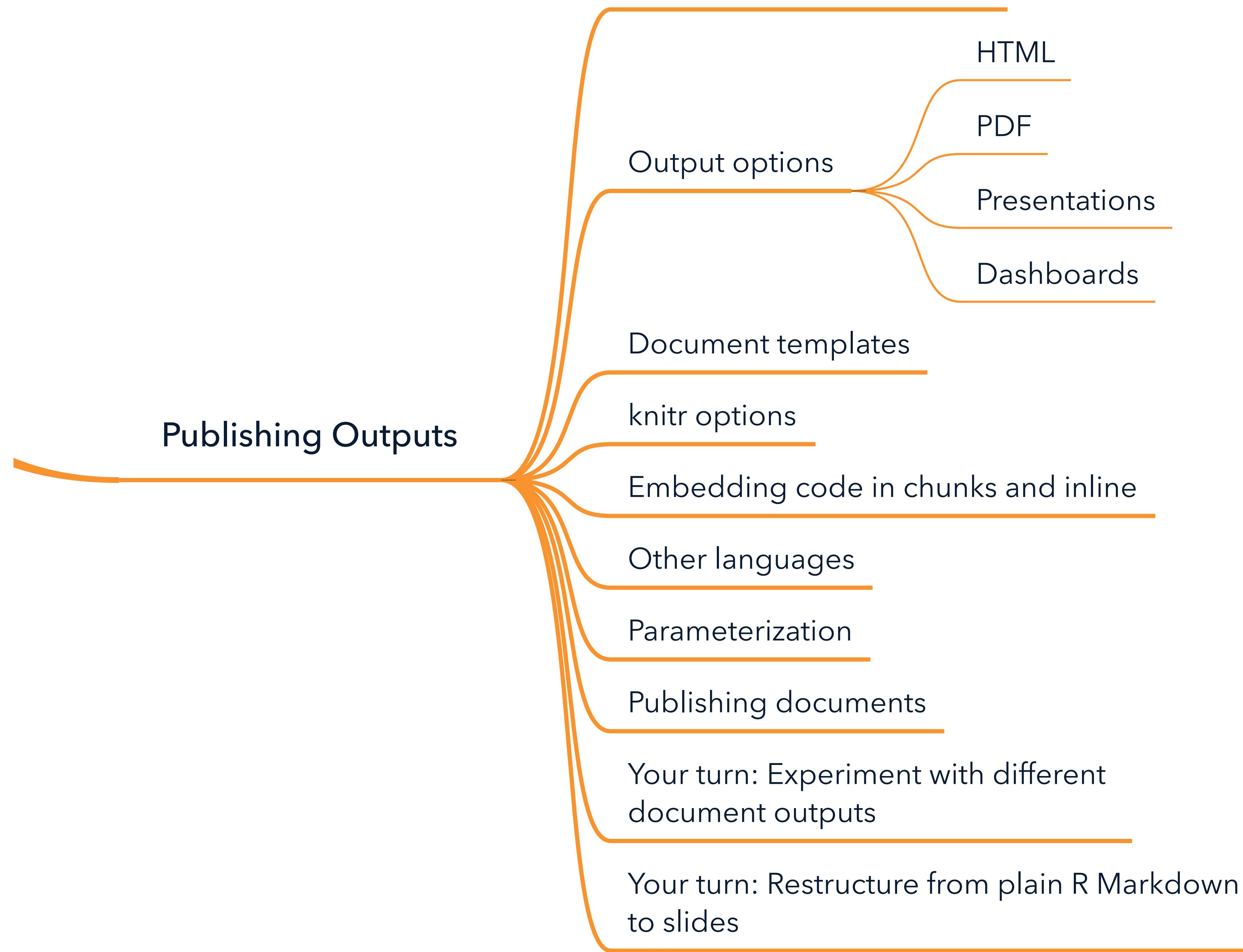
The Markdown Quick Reference

Your turn: embellish plain text

Your turn: publish your report

Your turn: deploy your first dashboard

## The R Markdown Workflow



## Adding Interactivity

What makes dashboards interactive

Dashboard Taxonomy

Parameters

Client-side

Shiny

Client-side and server-side dashboards

## Layouts and Design

Flexdashboards

Storyboards

Your turn: Lay out your story

Datatables

Plotly, highcharter

HTML widgets

Leaflet maps

Your turn: Building your first dashboard

Your turn: Bring your dashboard to life

Synchronizing widgets with crosstalk

Controls

Displays

Layouts

**Web-based Dashboards**

Components of a Dashboard

# Shiny Dashboards

What is Shiny

How does Shiny work?

Shiny apps versus embedding Shiny in R  
Markdown

Input elements

App elements

Building out your app

Your turn: Your first Shiny dashboard

Next level Shiny: Reactivity

Your turn: Build a reactive dashboard

Shinyapps.io

RStudio Connect

Publishing your Shiny dashboard

[21 R Markdown Recipes](#)

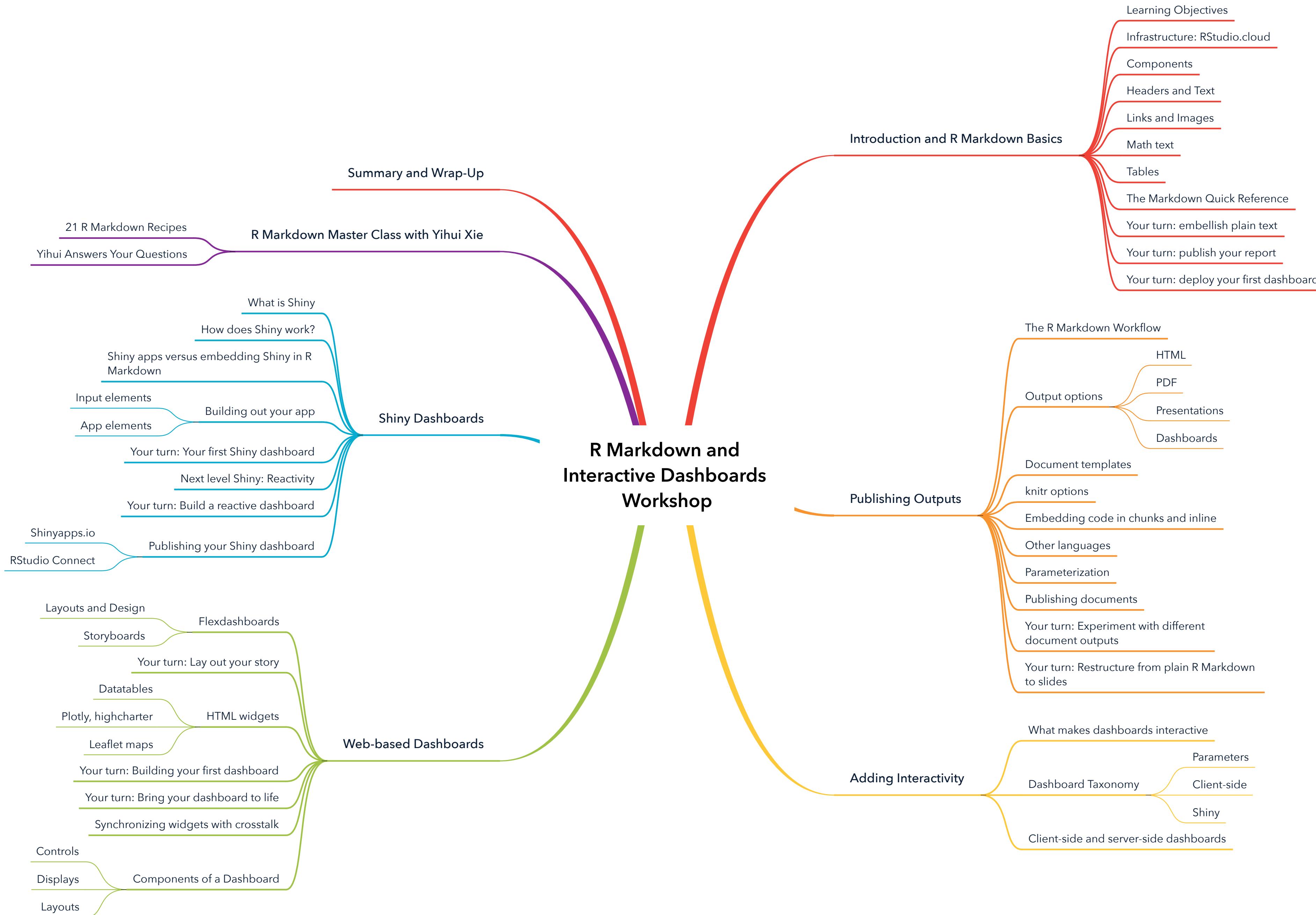
[Yihui Answers Your Questions](#)

## R Markdown Master Class with Yihui Xie

[Summary and Wrap-Up](#)



# R Markdown and Interactive Dashboards Workshop





# Why R Markdown And Interactive Dashboards?

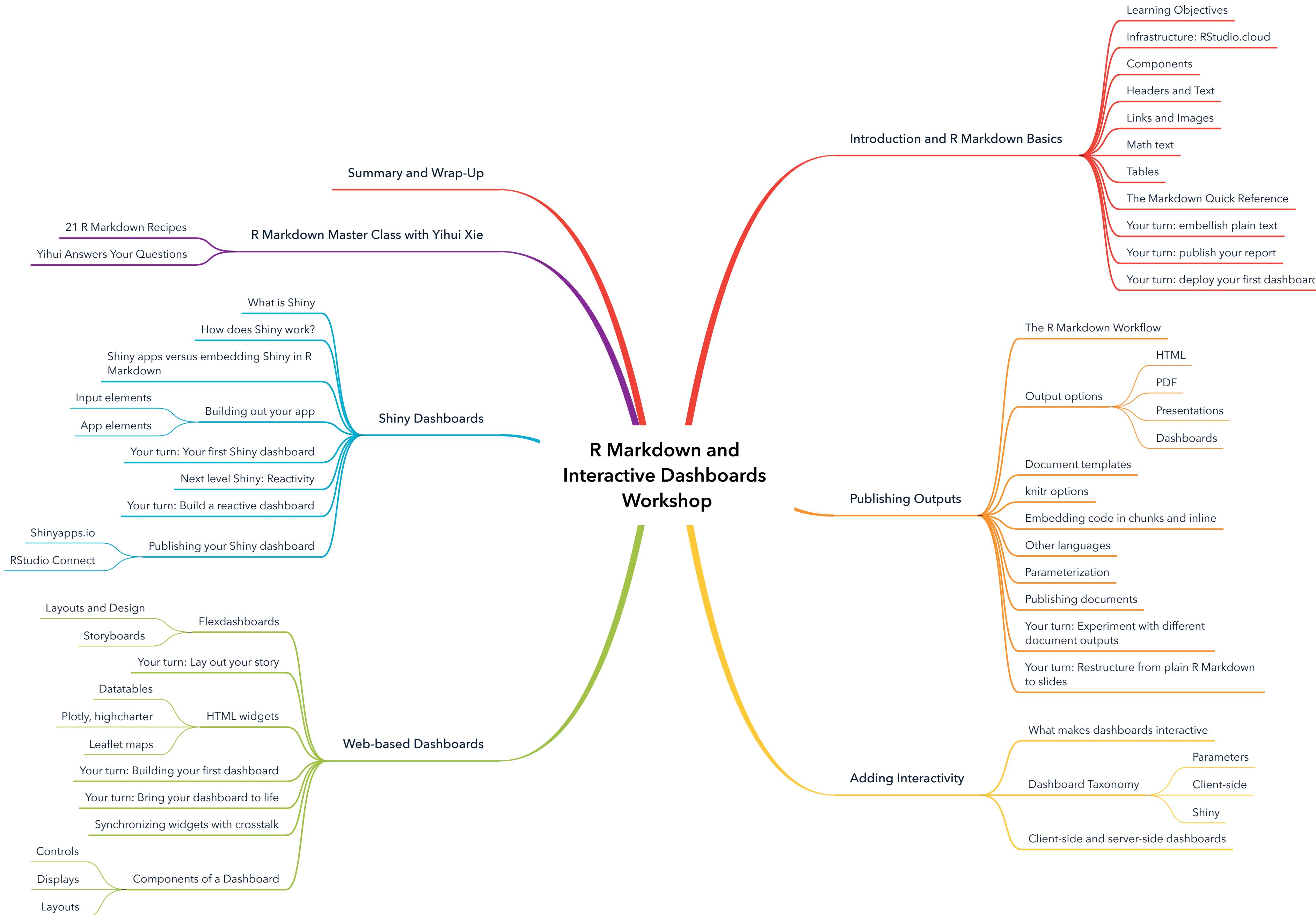
# Your Turn

Form groups of 2-4 people. Introduce yourself to your group members. Tell them:

1. Who you are
2. What you do with data
3. How long you have been using R
4. What do they want to do with R Markdown and Interactive Dashboards?



# R Markdown and Interactive Dashboards Workshop



## Introduction and R Markdown Basics

### Learning Objectives

Infrastructure: RStudio.cloud

Components

Headers and Text

Links and Images

Math text

Tables

The Markdown Quick Reference

Your turn: embellish plain text

Your turn: publish your report

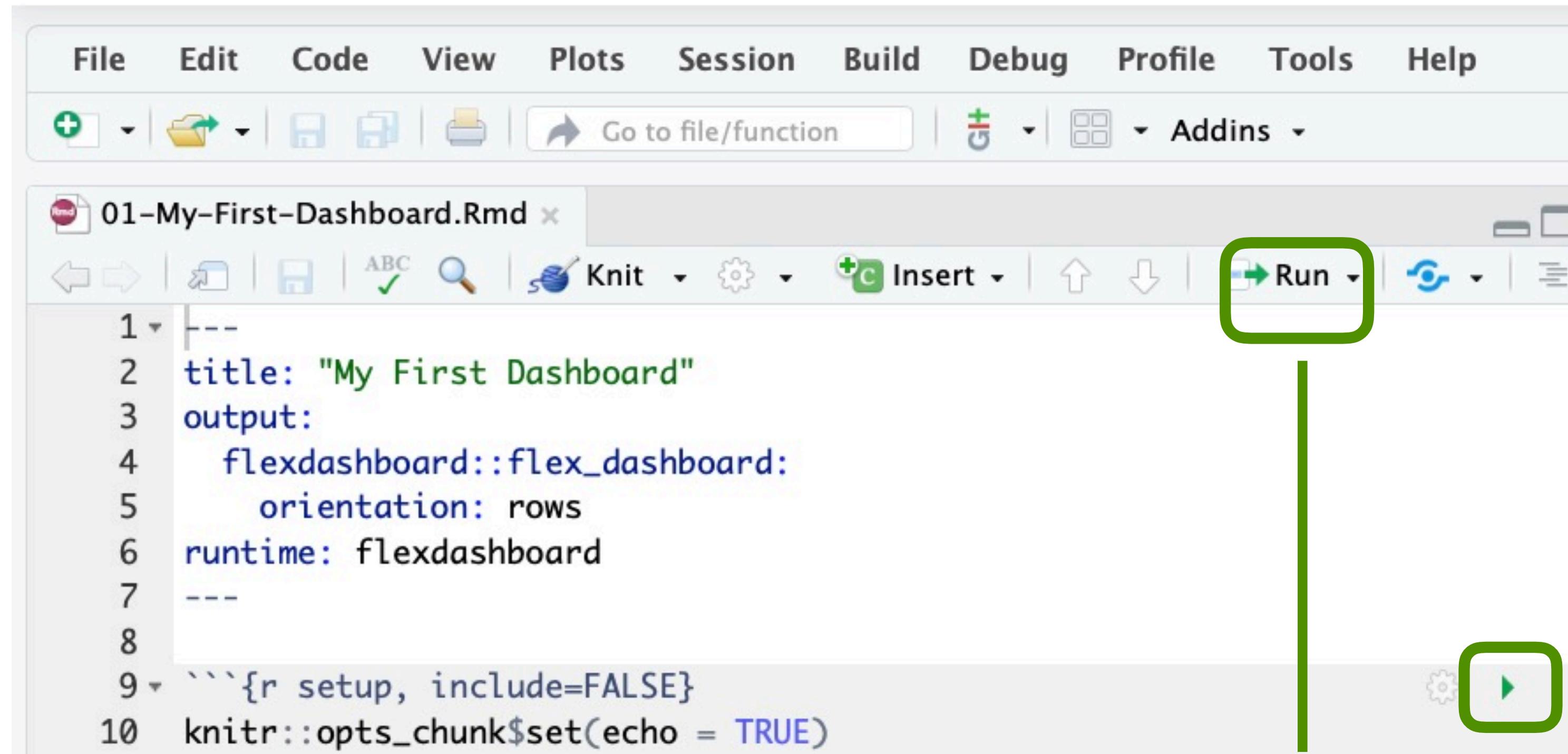
Your turn: deploy your first dashboard



# R Markdown Introduction and Your First Dashboard

# Important Buttons

≡ R Markdown And Interactive Dashboards / 01-Introduction



The screenshot shows the RStudio interface with the following details:

- File Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Includes icons for file operations like Open, Save, Print, and a Go to file/function search bar.
- Document Area:** A file named "01-My-First-Dashboard.Rmd" is open.
- Code Editor:** The code is as follows:

```
1 ---  
2 title: "My First Dashboard"  
3 output:  
4   flexdashboard::flex_dashboard:  
5     orientation: rows  
6 runtime: flexdashboard  
7 ---  
8  
9  ```{r setup, include=FALSE}  
10 knitr::opts_chunk$set(echo = TRUE)
```
- Toolbar Buttons:** Knit, Insert, Run (highlighted with a green box), and other document-related tools.

Run

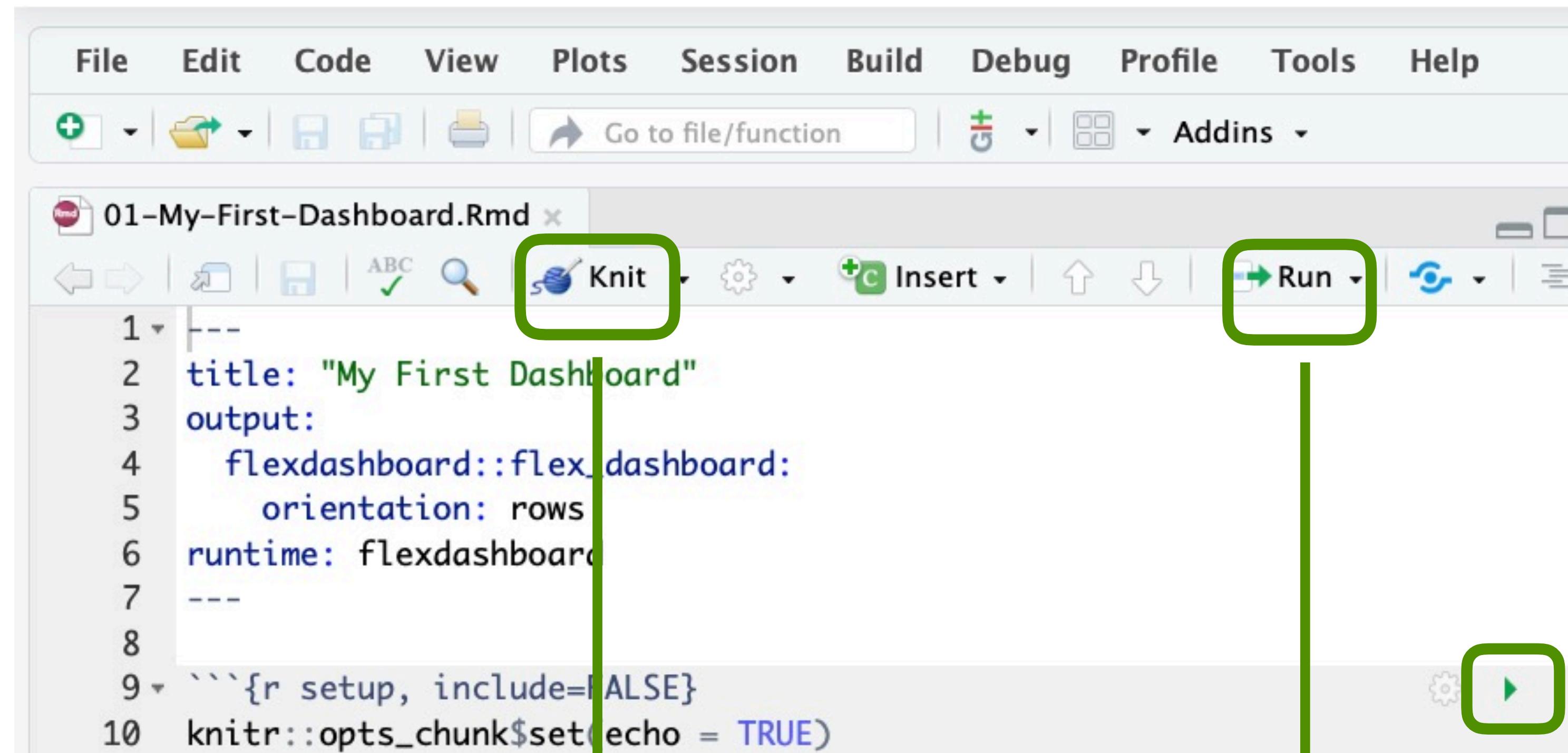
Allows you to run a code chunk or your whole document

Run Chunk

Allows you to run a single code chunk

# Important Buttons

≡ R Markdown And Interactive Dashboards / 01-Introduction



Knit

Knits all your text and code  
into a finished document

Run

Allows you to run a code  
chunk or your whole  
document

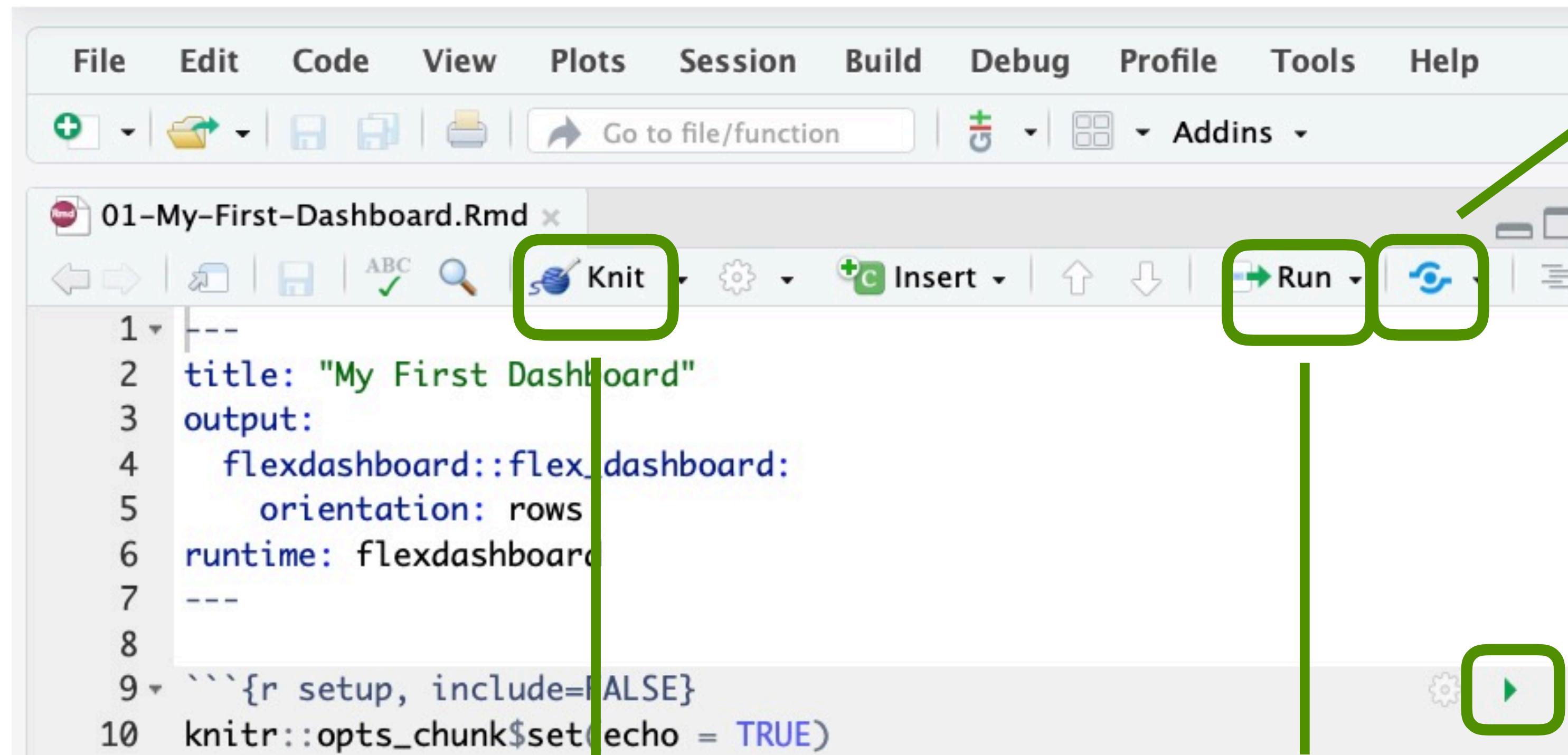


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# Important Buttons

R Markdown And Interactive Dashboards / 01-Introduction



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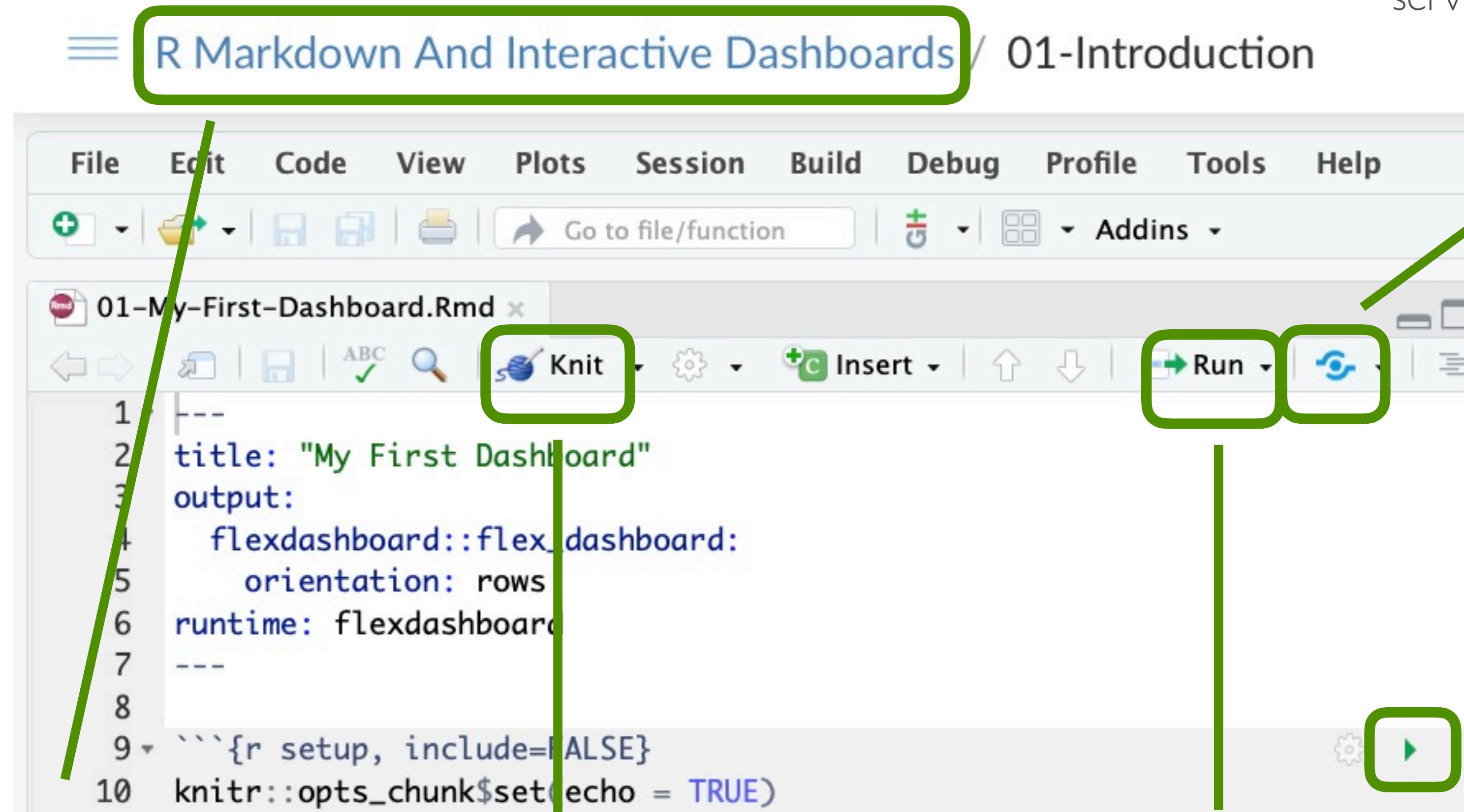
Publish

Publish your document to presentation  
services such as RStudio Connect or  
[shinyapps.io](https://shinyapps.io)

Run Chunk

Allows you to run a single code chunk

# Important Buttons



Return to Project List

Leaves this project  
and returns  
you to the list of projects  
in this space

Knit

Knits all your text and code  
into a finished document

Run

Allows you to run a code  
chunk or your whole  
document

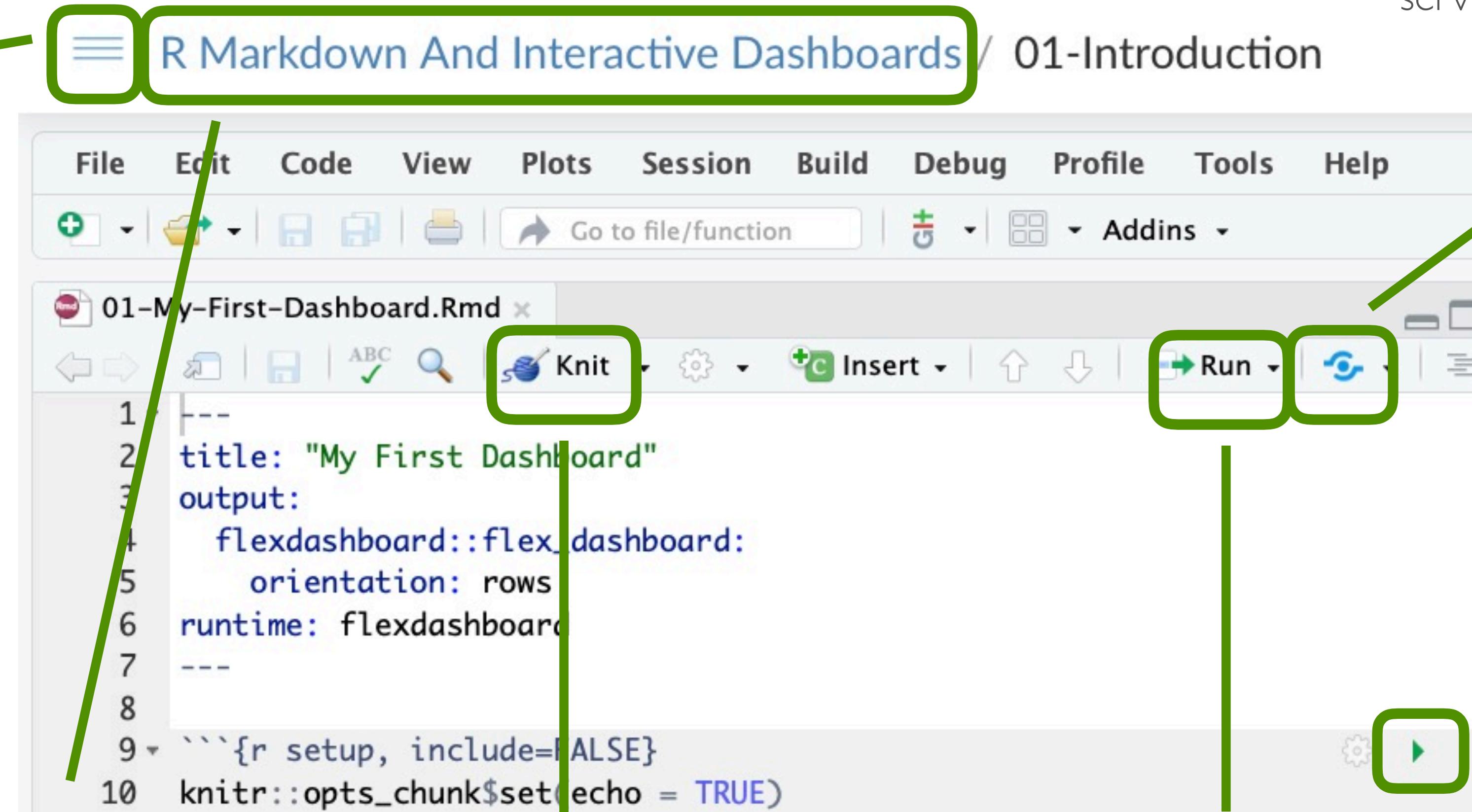
Publish

Publish your document to presentation  
services such as RStudio Connect or  
[shinyapps.io](https://shinyapps.io)

# Important Buttons

Top Menu

Go somewhere  
else in RStudio.cloud



Return to Project List

Leaves this project  
and returns  
you to the list of projects  
in this space

Knit

Knits all your text and code  
into a finished document

Run

Allows you to run a code  
chunk or your whole  
document

Publish

Publish your document to presentation  
services such as RStudio Connect or  
[shinyapps.io](https://shinyapps.io)

Run Chunk

Allows you to run a single code chunk

The screenshot shows the RStudio.cloud dashboard. On the left, there's a sidebar with links like 'Your Workspace', 'MVD', 'R In 90 Minutes' (which is highlighted with a red box), 'R Markdown Tutorial Pages', 'RStudio Portfolio Training Exercises', 'Shiny Essentials - JSM 2018', and 'New Space'. Below that is the 'Learn' section with 'Guide', 'What's New' (highlighted with a red box), 'Primers' (highlighted with a red box), 'DataCamp Courses', 'Cheat Sheets' (highlighted with a red box), and 'Feedback and Questions'. At the bottom is the 'Info' section with 'Terms and Conditions' and 'System Status'. The main area shows 'All Projects' with four listed: '01A Minimal Recipe' (by Carl Howe, created Mar 7, 2019 2:54 PM), '1-Simple-Google-Spreadsheet' (by Carl Howe, created Mar 1, 2019 11:20 AM), '2-Simple-Counting' (by Carl Howe, created Mar 5, 2019 4:42 PM), and 'Untitled Project' (by Carl Howe, created Mar 7, 2019 2:49 PM). Each project entry has a small lock icon.

# Don't Panic!

RStudio.cloud also has Primers for helping you learn more of the details of the language once this class is done.

RStudio.cloud also has Cheat Sheets for the IDE functions and for all the packages we are using!

# Account Setup for geonames.org

- This process allows us to use real-time weather and earthquake data
- Please set up an account for yourself at <https://www.geonames.org/login>
- Only a user name, email account, and password are required; no other information is gathered

# EXERCISE 1

rstudio::conf

## Knit Your First Document

1. Click on **01-My-First-Dashboard.Rmd** in the files pane to open that file
2. Change the **geonames\_account** parameter to the account name you created a few moments ago.
3. Click **Knit** above the source pane
4. Admire the result.

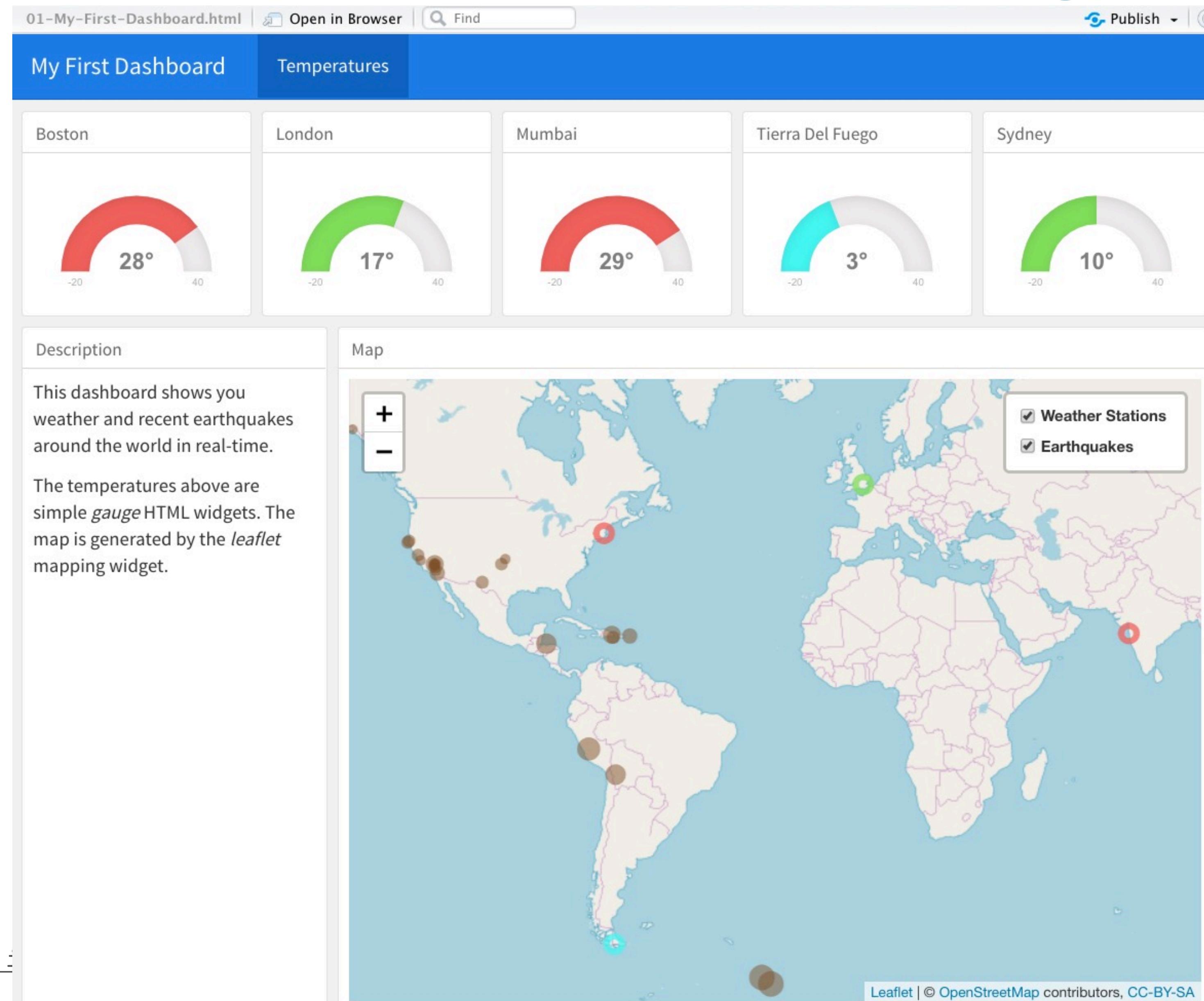
WARNING: you may need to disable your browser pop-up blocker to see the result

3m 00s

The screenshot shows the RStudio interface with the following components:

- Source Pane:** Displays the R Markdown file `01-My-First-Dashboard.Rmd`. A specific line of code, `geonames_account: "rstudio_dashboard"`, is highlighted with a green rectangle.
- Console Pane:** Shows the output of the knitting process. It includes R code like `label: anc_gauges (with options)` and progress messages like "73%" and "80%".
- Files Pane:** Shows the project structure. The file `01-My-First-Dashboard.Rmd` is selected and highlighted with a green rectangle.
- Top Bar:** Includes tabs for Environment, History, Connections, and Git, along with standard RStudio icons.

# You Should See Something Like This



# EXERCISE 2

rstudio::conf

## Edit Your Dashboard To Use A Different City

1. Find the lines following the word **params:**
2. Change the value **San Francisco** to the name of another city.
3. Change the value **KSFO** to the ICAO airport code for an airport in that city (you can look up the ICAO code for any major airport using Google)
4. Knit your dashboard again and see the new city temperature gauge and map location.

5m 00s

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```
File Edit Code View Plots Session Build Debug Profile Tools Help
+ Go to file/function Addins
01-My-First-Dashboard.Rmd x ABC Knit Insert Run
1 ---  
2 title: "My First Dashboard"  
3 output:  
4   flexdashboard::flex_dashboard:  
5     orientation: rows  
6 runtime: flexdashboard  
7 params:  
8   my_city: "San Francisco"  
9   my_airport: "KSFO"  
10  
11  
12```{r setup, include=FALSE}  
13 knitr::opts_chunk$set(echo = TRUE)  
14 library(geonames)  
15 library(dplyr)  
16 library(magrittr)  
17 library(flexdashboard)  
12:1 (Top Level) >  
Console Terminal Jobs  
/cloud/project/materials/exercises/01-Introduction/  
You are welcome to redistribute it under certain conditions.  
Type 'license()' or 'licence()' for distribution details.  
R is a collaborative project with many contributors.  
Type 'contributors()' for more information and  
'citation()' on how to cite R or R packages in publications.  
Type 'demo()' for some demos, 'help()' for on-line help, or  
'help.start()' for an HTML browser interface to help.  
Type 'q()' to quit R.  
> library(geonames)  
> |
```

Environment History  
Files Plots Packages  
R: ICAO weather station  
GNweatherIcao (geonames)  
ICAO weather station  
Description  
weather record from ICAO  
Usage  
GNweatherIcao (geonames)  
Arguments  
ICAO ICAO code  
Details

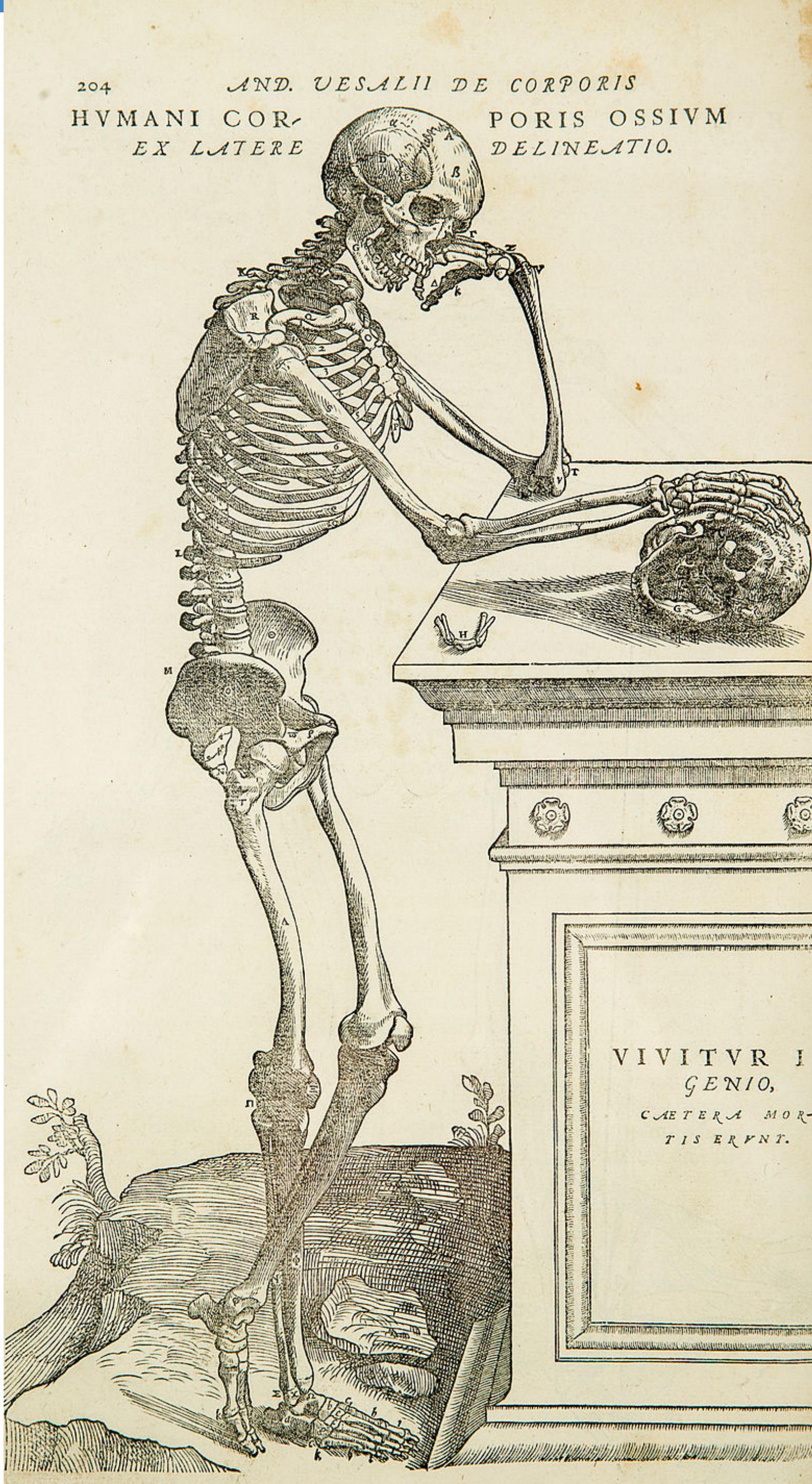
Congratulations! You have created your first dashboard!



# What You've Learned

You've already learned how to

- Launch a project in rstudio.cloud
- Edit a file
- Knit a file into a result



# The Anatomy Of An R Markdown Document

You'll learn

- What R Markdown is
- How to create your own R Markdown document
- The components of an R Markdown document
- How to customize the content R Markdown documents

# R Markdown is a language for creating *computational* *documents\**

Donald Knuth's name for computational documents was *Literate Programming*, which he defined in a book of the same name. I prefer computation documents because it is more intuitively descriptive.

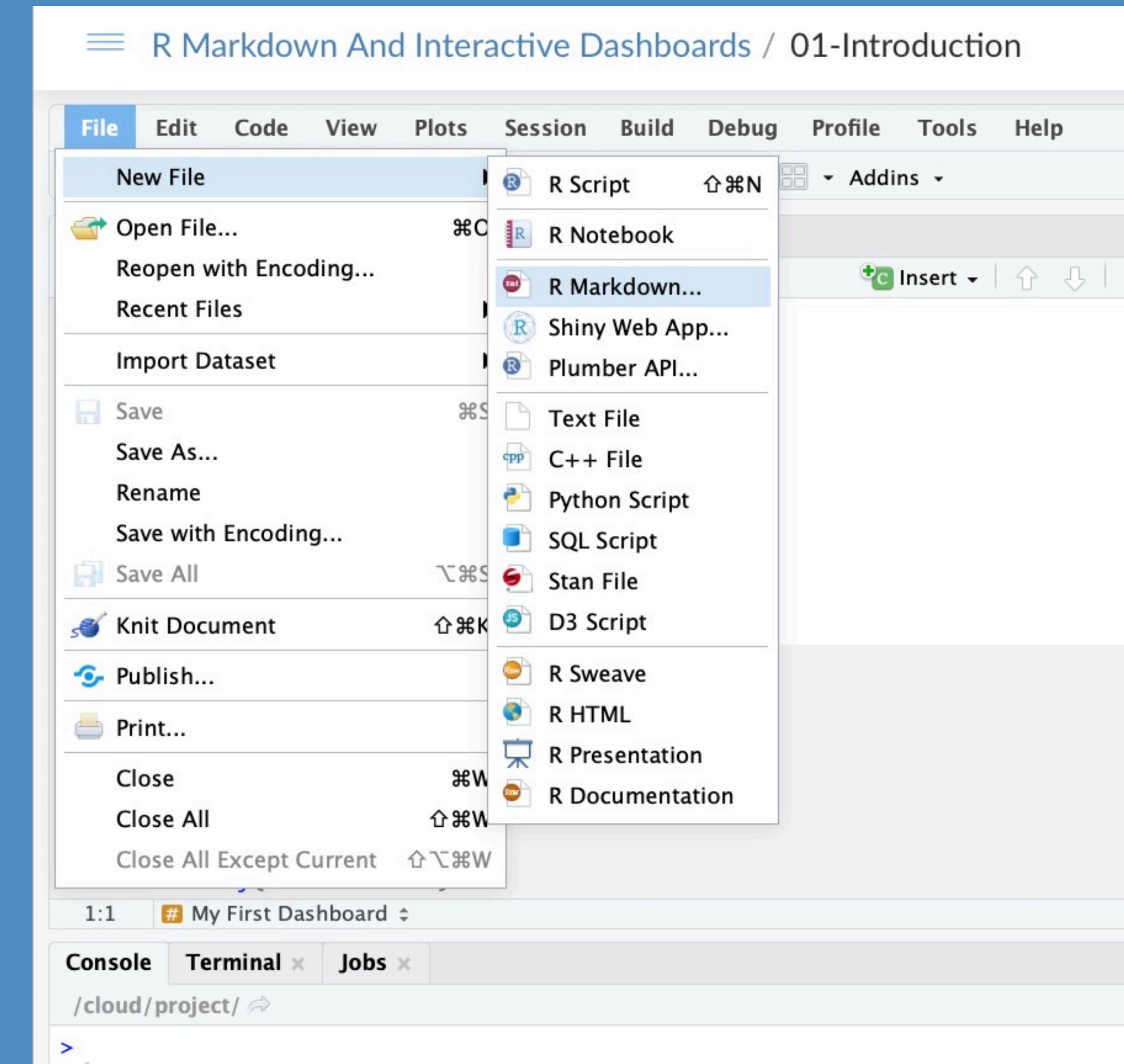
# EXERCISE 3

rstudio::conf

## Create Your Own R Markdown Document

1. Choose *New File* from the *File* Menu
2. Pick *Document*, select *HTML* as your output type, and title it *My First R Markdown Document*
3. Select *Knit* to render your document

5m 00s



# This Is OK: Click Trv Again

R Markdown And Interactive Dashboards / 01-Introduction

The screenshot shows the RStudio interface with the following details:

- File Menu:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help.
- Toolbar:** Includes icons for file operations like Open, Save, Print, and Go to file/function, along with Addins.
- Document Area:** Displays an R Markdown document titled "01-My-First-Dashboard.Rmd". The code includes R Markdown metadata, a chunk setup, and several code chunks. One chunk uses `knitr::opts\_chunk\$set(echo = TRUE)`.
- Message Box:** A "Popup Blocked" dialog box is centered over the document area. It contains a red circular "X" icon and the text: "We attempted to open an external browser window, but the action was prevented by your popup blocker. You can attempt to open the window again by pressing the "Try Again" button below." Below this, a note says: "NOTE: To prevent seeing this message in the future, you should configure your browser to allow popup windows for carl-howe.rstudio.cloud." It has "Try Again" and "Cancel" buttons.
- Environment Tab:** Shows the Global Environment pane with various objects listed.
- Plots Tab:** Shows a preview of a plot titled "My First R Markdown Document".
- Console Tab:** Shows the R Markdown workspace with commands like `library(knitr)` and `knitr::include\_graphics`.
- Terminal Tab:** Shows the command `/cloud/project/`.
- Jobs Tab:** Shows a list of jobs.
- Right Sidebar:** Shows the project structure under "Cloud > project".

# You Should See Something Like This

## My First R Markdown Document

Carl Howe, RStudio

8/26/2019

### 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:

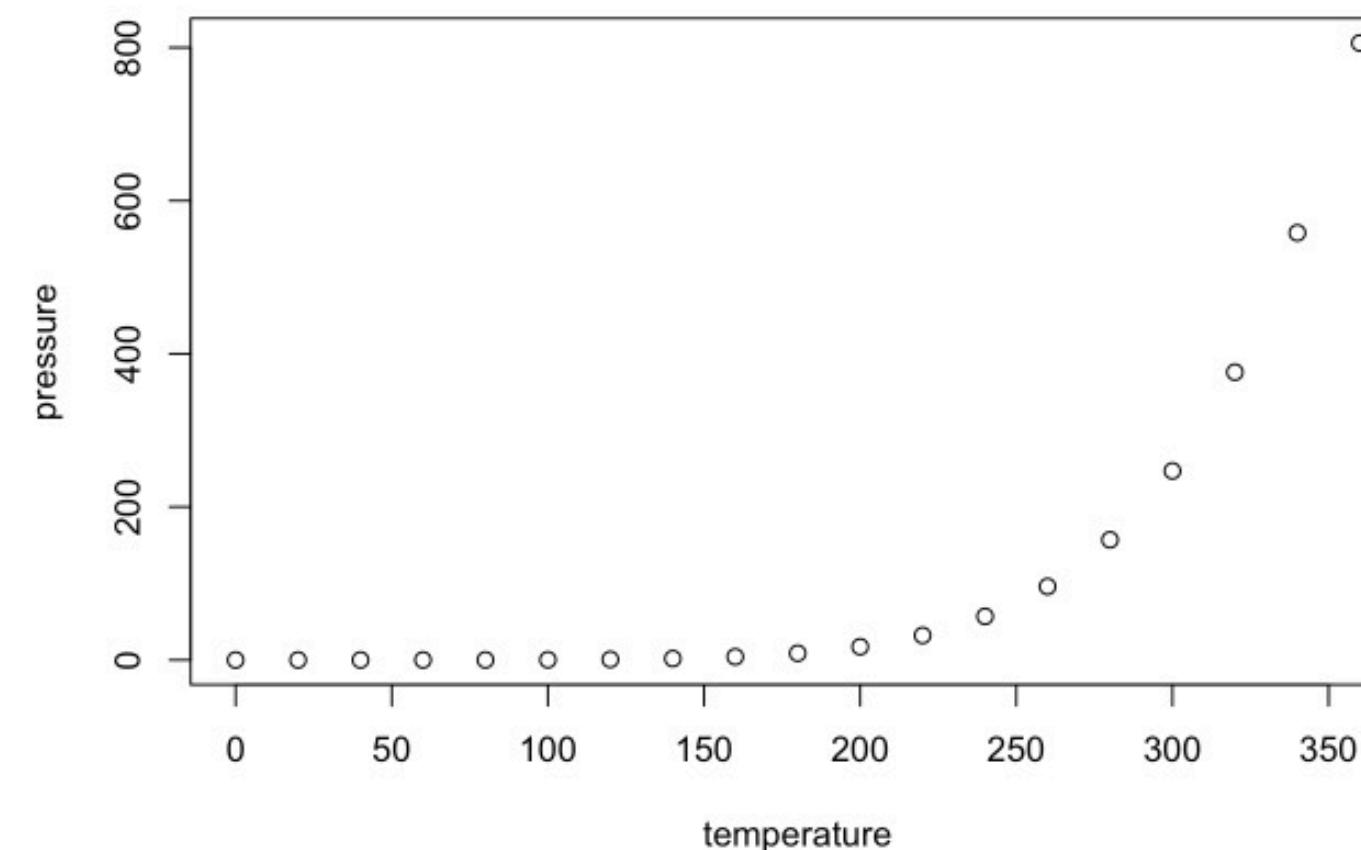
```
summary(cars)
```

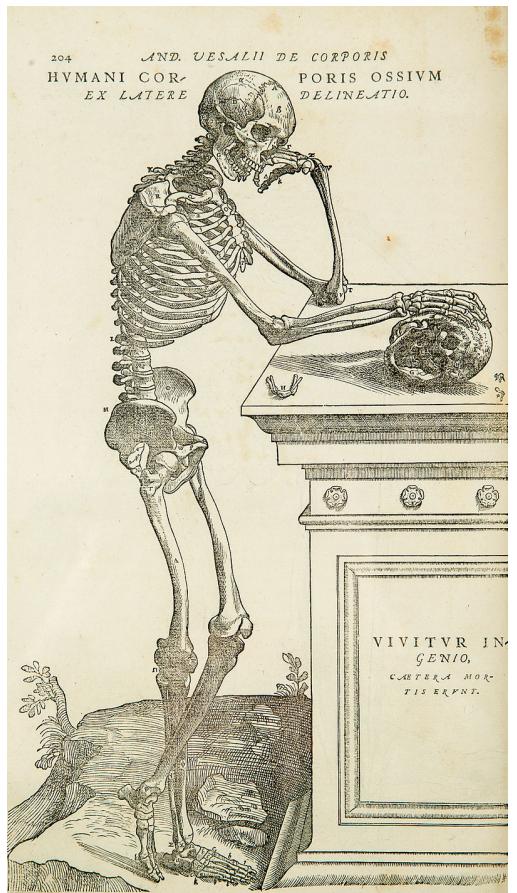
  

```
##      speed         dist
## Min.   : 4.0   Min.   : 2.00
## 1st Qu.:12.0   1st Qu.:26.00
## Median :15.0   Median :36.00
## Mean   :15.4   Mean   :42.98
## 3rd Qu.:19.0   3rd Qu.:56.00
## Max.   :25.0   Max.   :120.00
```

### Including Plots

You can also embed plots, for example:





```
---
```

```
title: "My First R Markdown Document"
author: "Carl Howe, RStudio"
date: "8/26/2019"
output: html_document
```

```
---
```

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

## ## 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:

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

## ## Including Plots

You can also embed plots, for example:

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

# YAML\* Header Data About Your Document (Metadata)

\*YAML: Yet Another Markup Language

Everything between --- and --- is read as key value pairs

Metadata for an R Markdown  
document is written at the  
top of the document in YAML

# Things To Know About YAML

- **output** selects what type of file your R Markdown will generate
- If you indent YAML lines, they must be indented 2 spaces and those lines will become sub-parameters (we'll get to this later)
- If you omit or modify one or both --- lines, you may get strange output and very unhelpful errors

R Markdown flags structural  
elements of our text for  
special treatment



# Text Headers

```
---
```

```
title: "My First R Markdown Document"
author: "Carl Howe, RStudio"
date: "8/26/2019"
output: html_document
```

```
---
```

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

## ## R Markdown

This is an R Markdown document. Markdown is a simple text-to-markup language that you can use to write Word documents. For more details on using R Markdown, see the [R Markdown documentation](#).

When you click the **Knit** button a document will be generated from the output of any embedded R code chunks within the document.

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

## ## Including Plots

You can also embed plots, for example:

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

The # signs indicate that this is a heading line

# = Level 1 heading

## = Level 2 heading

### = Level 3 heading

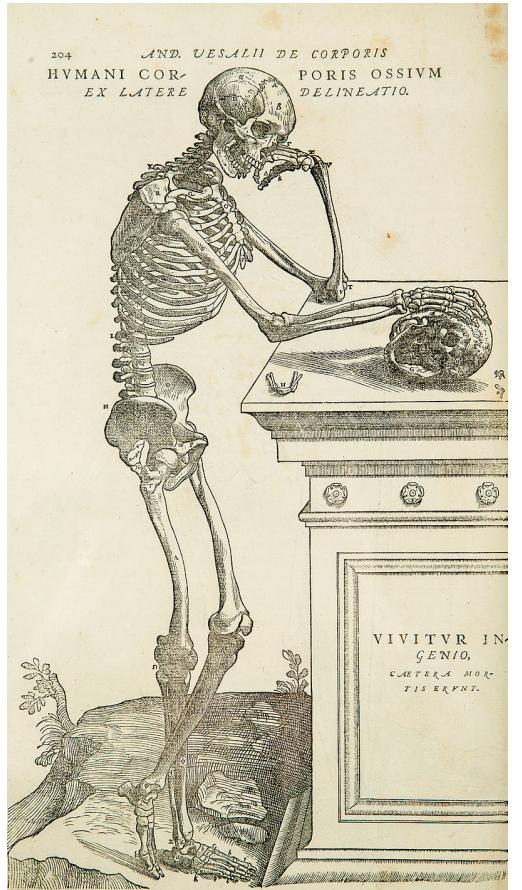
When we get to dashboards, you'll find that these headings are interpreted differently according to what kind of dashboard layout you are using:

# = New dashboard page

## = New column or row on this dashboard page

### = New tab on this column or row

This will make more sense when we discuss layouts.



```
---
```

```
title: "My First R Markdown Document"
author: "Carl Howe, RStudio"
date: "8/26/2019"
output: html_document
```

```
--
```

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

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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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```

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plot(pressure)
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```

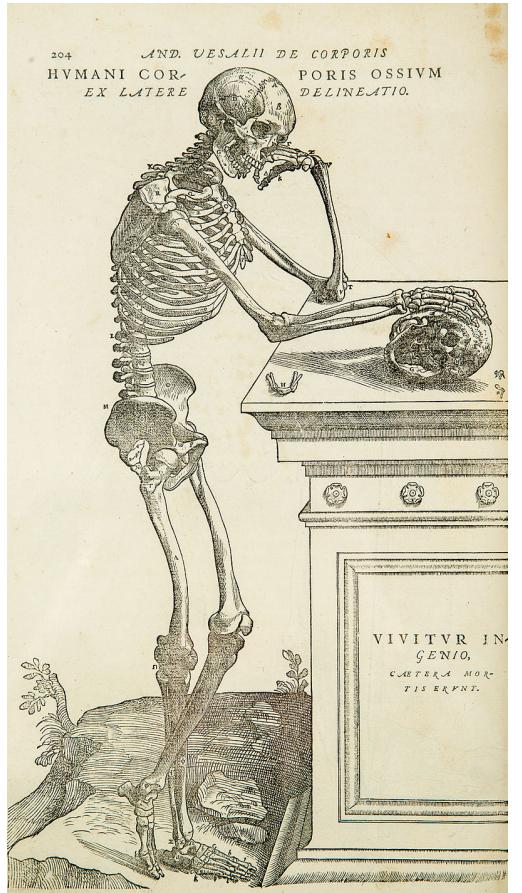
## Ordinary Text

Any text you type will flow into the resulting report unchanged, although lines may be wrapped.  
Use **\*text\*** for italics, or **\*\*text\*\*** for bold.

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Code chunks delimited by  
``` glyphs allow us to add  
computation to our  
document.





```
---
```

```
title: "My First R Markdown Document"
author: "Carl Howe, RStudio"
date: "8/26/2019"
output: html_document
```

```
---
```

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

## ## R Markdown

This is an R Markdown document. Markdown is a simple way to write documents in a format that's easy to read, and easy to convert into HTML, PDF, and many other formats. Unlike HTML, Markdown uses a plain text syntax instead of tags, so it's easier to read, write, and format content.

When you click the **Knit** button a document will be generated that contains both the output of any embedded R code chunks with

## Code Chunks

R Code should start with ````{r chunk_name}```` and end with `````. Any output generated by the code will be inserted into your knit document.

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

## ## Including Plots

You can also embed plots, for example:

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

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

# Recap

```
---  
title: "My First R Markdown Document"  
author: "Carl Howe, RStudio"  
date: "8/26/2019"  
output: html_document  
---
```

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

## ## 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:

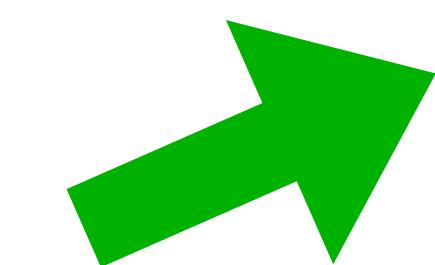
```
```{r cars}  
summary(cars)  
```
```

## ## Including Plots

You can also embed plots, for example:

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

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.



## My First R Markdown Document

Carl Howe, RStudio

8/26/2019

### 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>.

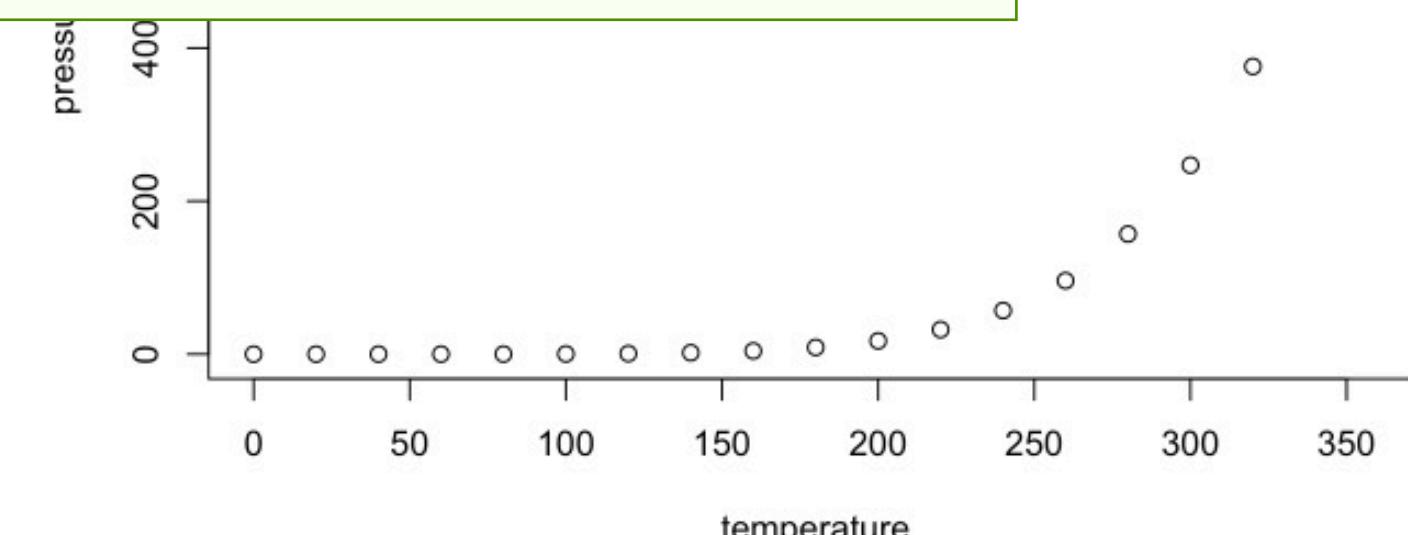
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed         dist  
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 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
```

## Text Gets Reformatted

- Headers get formatted
- Ordinary text flows through



# Recap: R Markdown Generates This Output

```
---  
title: "My First R Markdown Document"  
author: "Carl Howe, RStudio"  
date: "8/26/2019"  
output: html_document  
---
```

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

## ## 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:

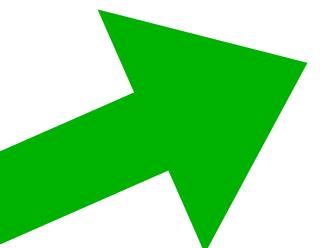
```
```{r cars}  
summary(cars)  
```
```

## ## Including Plots

You can also embed plots, for example:

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

Note that the `echo = FALSE` parameter was added to the code that generated the plot.



## My First R Markdown Document

Carl Howe, RStudio

8/26/2019

## 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>.

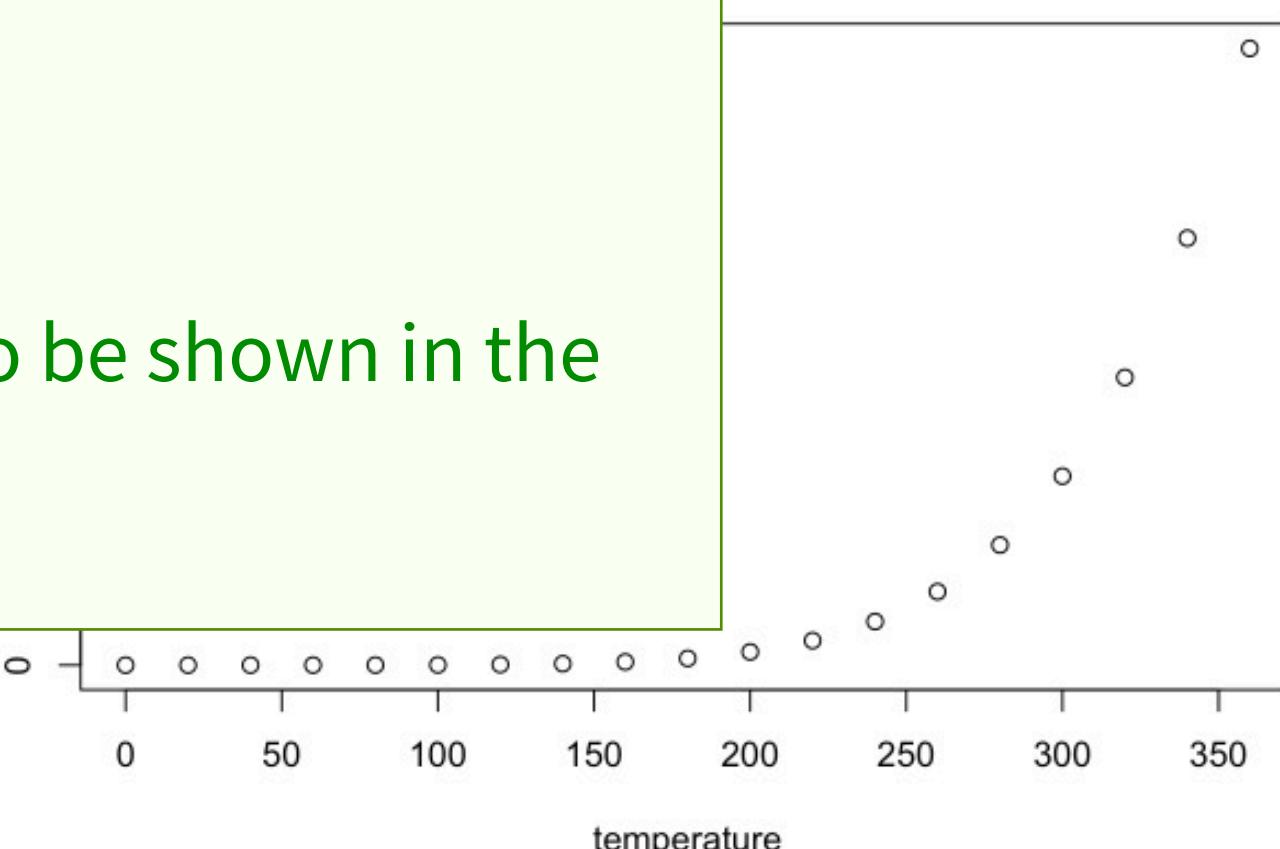
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##   speed      dist  
## Min.   : 4.0   Min.   :  2.00  
## 1st Qu.:12.0   1st Qu.: 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
```

## Including Plots

You can also embed plots, for example:



## Code Chunks Get Run

- Output gets put into the document.
- If the echo option is true, the code run will also be shown in the document

# Recap: R Markdown Generates This Output

```
---
```

```
title: "My First R Markdown Document"
author: "Carl Howe, RStudio"
date: "8/26/2019"
output: html_document
```

```
---
```

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

```

## ## 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

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

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

```

## ## Including Plots

You can also embed plots, for example:

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

```

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.



## My First R Markdown Document

Carl Howe, RStudio

8/26/2019

## R Markdown

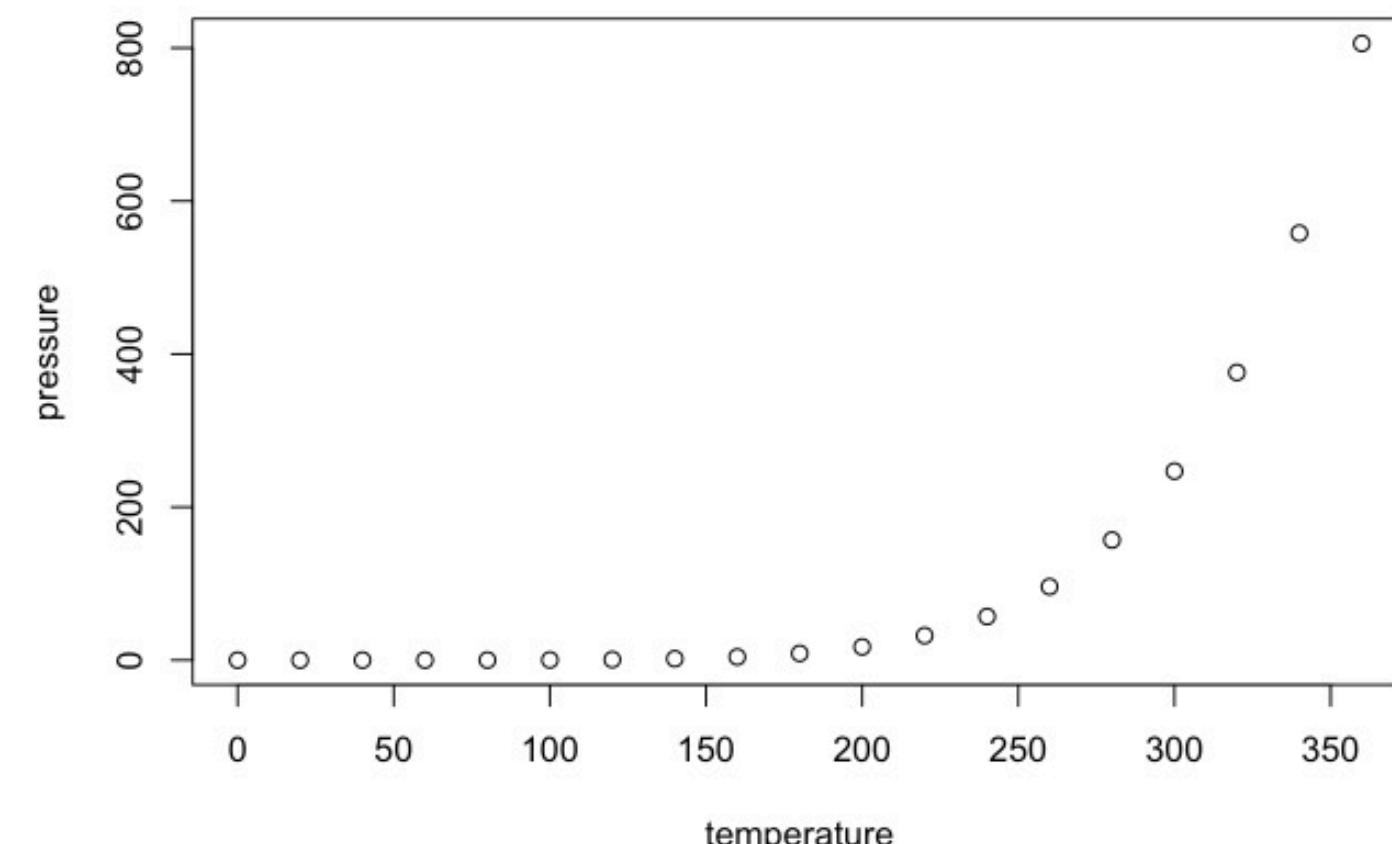
This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

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:

```
dist
Min. : 2.00
1st Qu.: 26.00
Median : 36.00
Mean   : 42.98
3rd Qu.: 56.00
Max.   :120.00
```

## Plots

For example:



Github repo: [rstudio.github.io/conf20-rmd-dash](https://rstudio.github.io/conf20-rmd-dash)

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

# EXERCISE 4

rstudio::conf

## Modify Your R Markdown Document

1. Add the text `library(ggplot2)` to the setup code chunk
2. Add a new section with a header, text, and a code chunk at the bottom.
3. In the code section, add code to create a ggplot graphic of the pressure data set. The following is code you can copy if you don't know ggplot:

```
ggplot(pressure, aes(temperature, pressure)) + geom_point()
```

4. Test your ggplot code chunk using the green arrow.
5. When you're happy with your ggplot, knit the final document.
6. Save your file as the file name `my-first-rmarkdown.Rmd`

5m 00s

# Your Turn

In your group, discuss the following questions:

1. Why are chunks scattered through the R Markdown document? Why not put all the code in one chunk?
2. Did you notice anything special about the **setup** R chunk when you ran just your **ggplot** chunk?



# Discussion Takeaways

- Allowing text and code in the same document allows us to create what Donald Knuth called *literate programming*, a type of holistic programmable document
- The setup chunk is special. When you run any code chunk in your document, the setup chunk is guaranteed to have been run previously. It's a great place to put global parameter settings and library statements.



# References and Resources

# You've Knit The Doc, Now Get the Cheat Sheet!

## R Markdown :: CHEAT SHEET

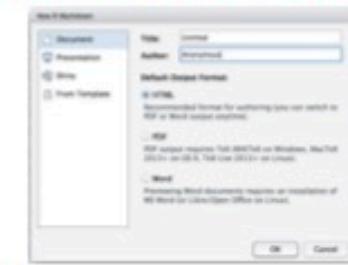
### What is R Markdown?

**.Rmd files** • An R Markdown (.Rmd) file is a record of your research. It contains the code that a scientist needs to reproduce your work along with the narration that a reader needs to understand your work.

**Reproducible Research** • At the click of a button, or the type of a command, you can rerun the code in an R Markdown file to reproduce your work and export the results as a finished report.

**Dynamic Documents** • You can choose to export the finished report in a variety of formats, including html, pdf, MS Word, or RTF documents; html or pdf based slides, Notebooks, and more.

### Workflow



① Open a new .Rmd file at File ► New File ► R Markdown. Use the wizard that opens to pre-populate the file with a template

② Write document by editing template

③ Knit document to create report; use knit button or render() to knit

④ Preview Output in IDE window

⑤ Publish (optional) to web server

⑥ Examine build log in R Markdown console

⑦ Use output file that is saved along side .Rmd

The screenshot illustrates the RStudio interface for R Markdown. The top pane shows the R Markdown editor with code like `summary(cars)` and various buttons for interacting with the code chunks. The bottom pane shows the rendered HTML output, which includes a summary of the 'cars' dataset:

```
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.   :120.00
```

### render

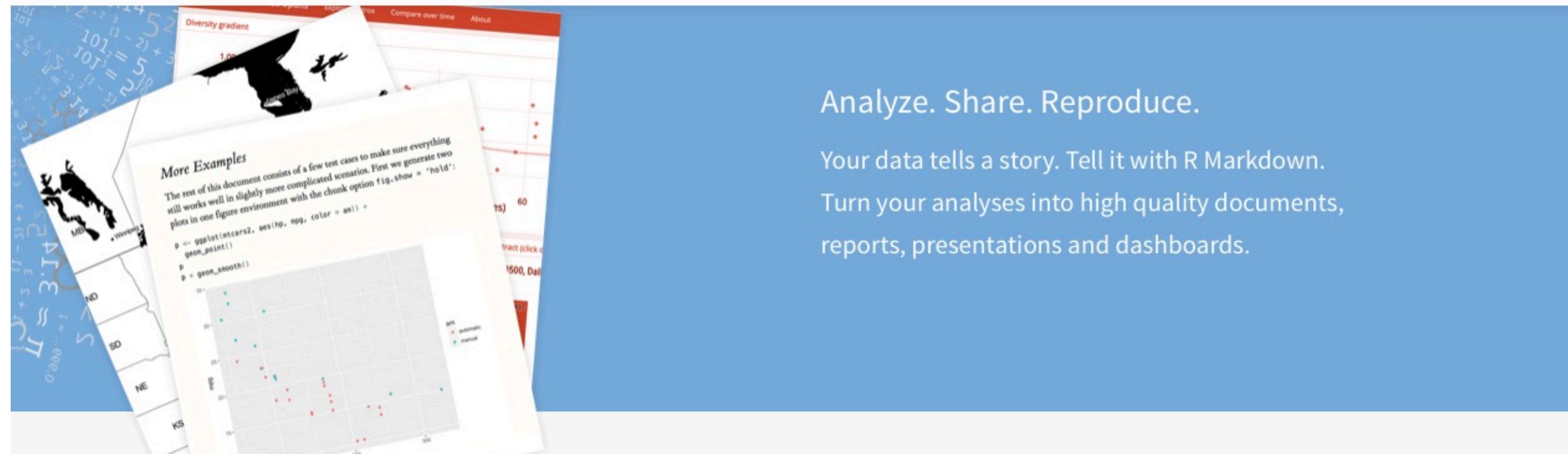
Use rmarkdown::render() to render/knit at cmd line. Important args:

|                               |                                     |                    |                                       |                                                       |                                 |
|-------------------------------|-------------------------------------|--------------------|---------------------------------------|-------------------------------------------------------|---------------------------------|
| <b>input</b> - file to render | <b>output_options</b> -             | <b>output_file</b> | <b>params</b> - list of params to use | <b>envir</b> - environment to evaluate code chunks in | <b>encoding</b> - of input file |
| <b>output_format</b>          | List of render options (as in YAML) | <b>output_dir</b>  |                                       |                                                       |                                 |

# R Markdown

from R Studio

Get Started    Gallery    Formats    Articles    Book    References



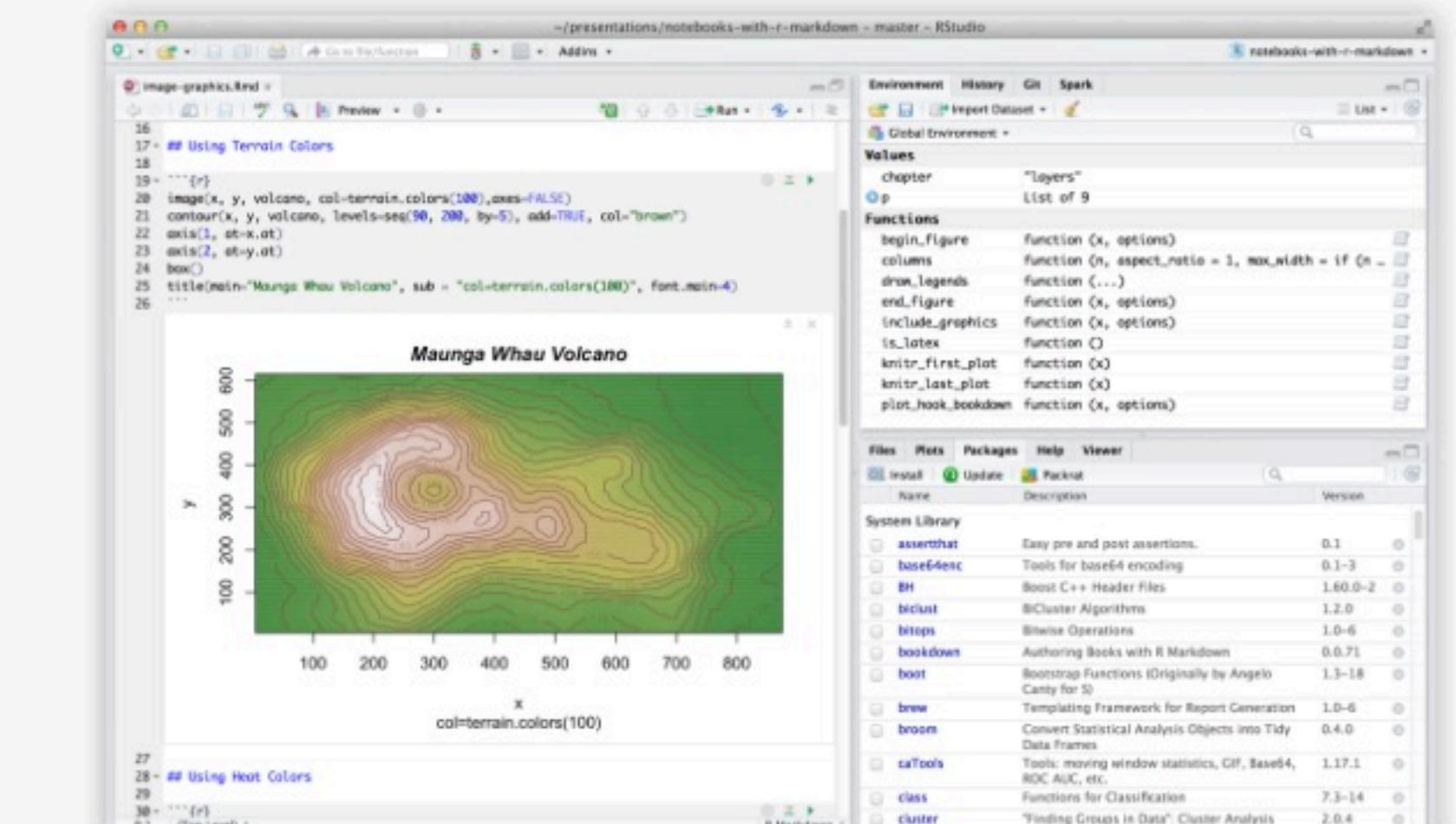
## Analyze. Share. Reproduce.

Your data tells a story. Tell it with R Markdown.

Turn your analyses into high quality documents, reports, presentations and dashboards.

R Markdown documents are fully reproducible.

Use a productive [notebook interface](#) to weave together narrative text and code to produce elegantly formatted output. Use [multiple languages](#) including R, Python, and SQL.



<https://rmarkdown.rstudio.com>

Github repo: [rstd.io/conf20-rmd-dash](https://github.com/rstd-io/conf20-rmd-dash)

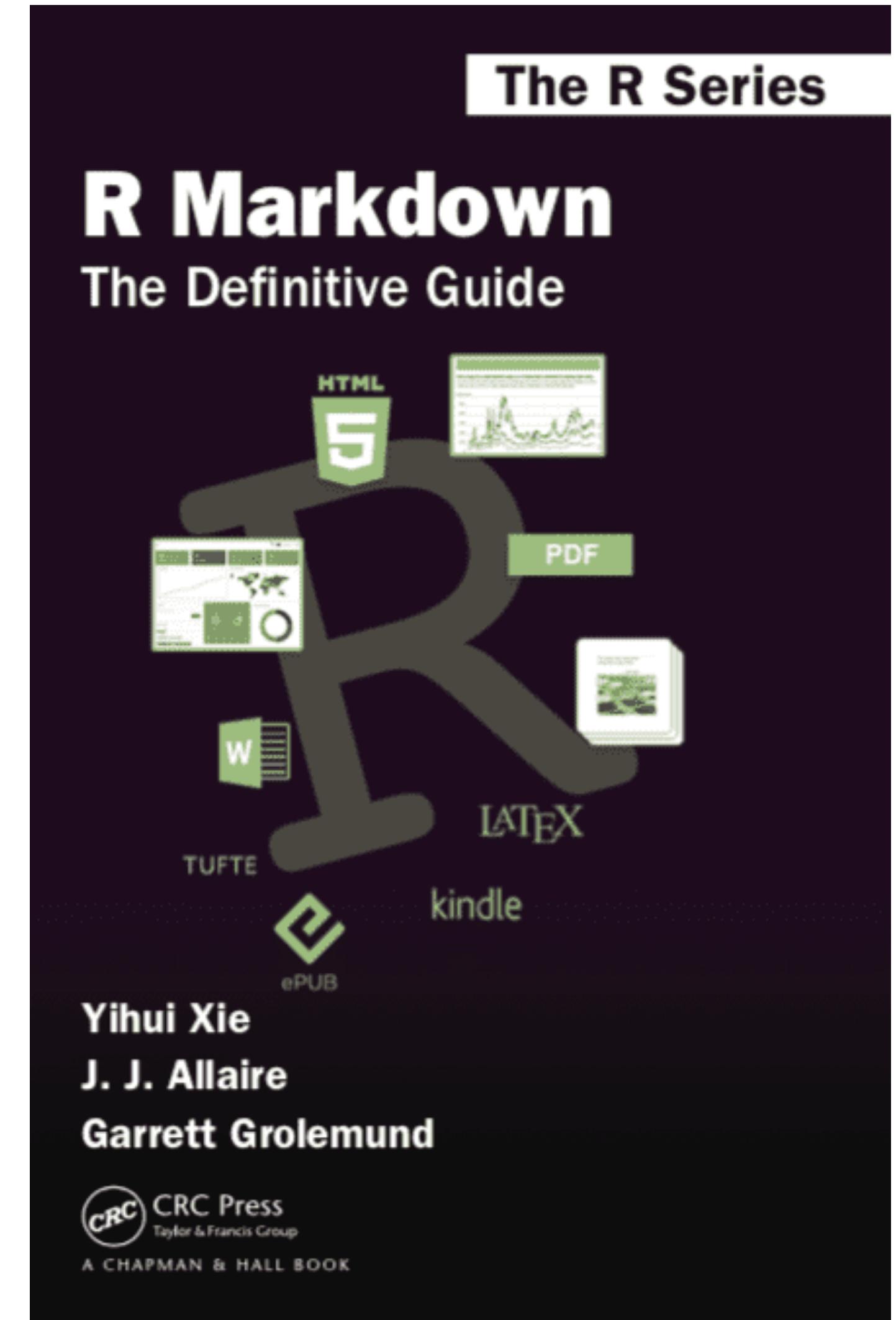
rstudio.cloud workspace: [rstd.io/RMAID](https://rstudio.cloud/workspace/rstd.io/RMAID)

# R Markdown: The Definitive Guide

Free!

<https://bookdown.org/yihui/rmarkdown/>

Also available from CRC Press, Amazon, Apple Books





# More Formatting Types

# Text and Headers

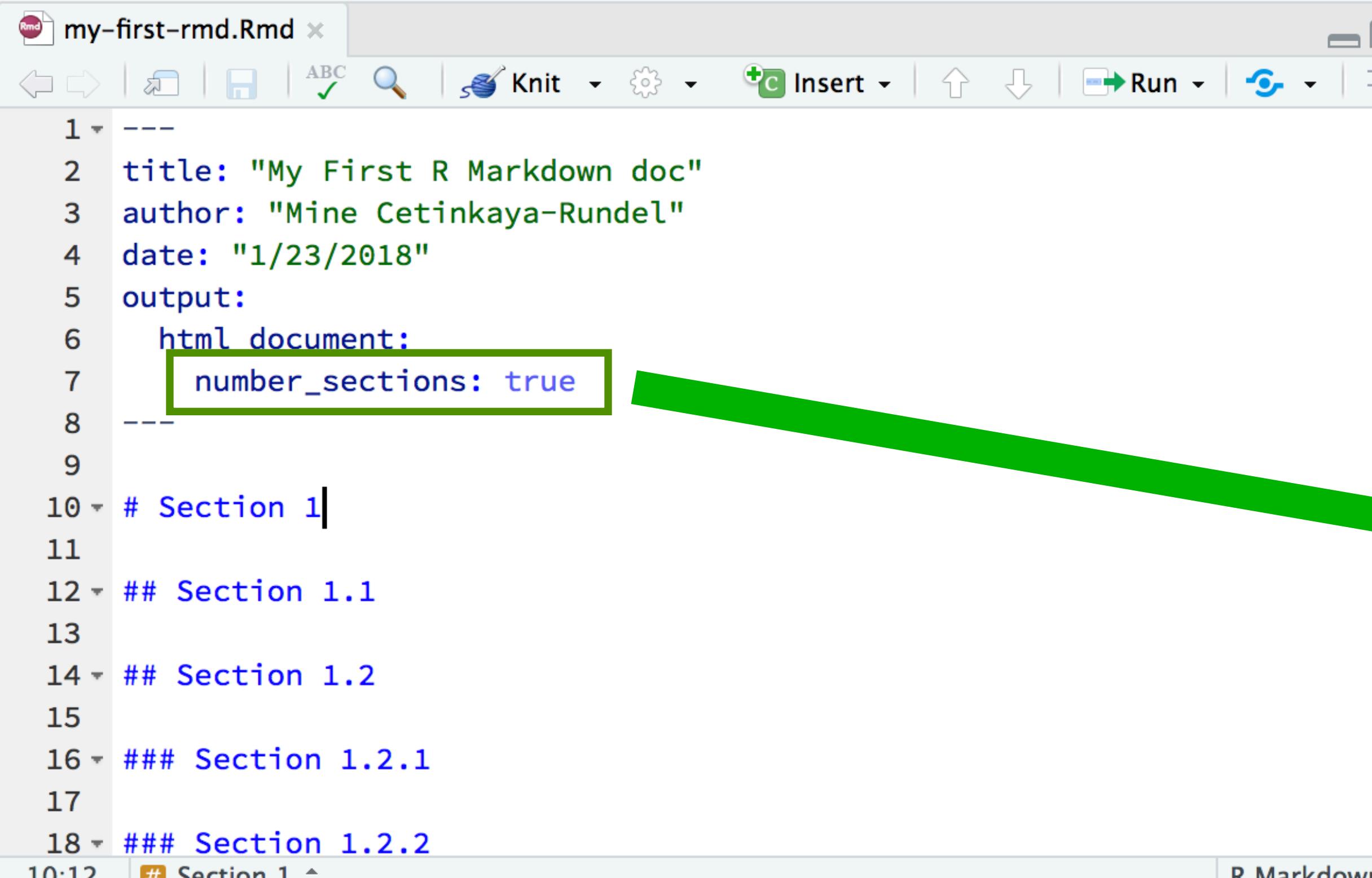
- Text can be plain text or decorated as **\*italic\*** or **\*\*bold\*\***
- Headers use #s

# Header 1

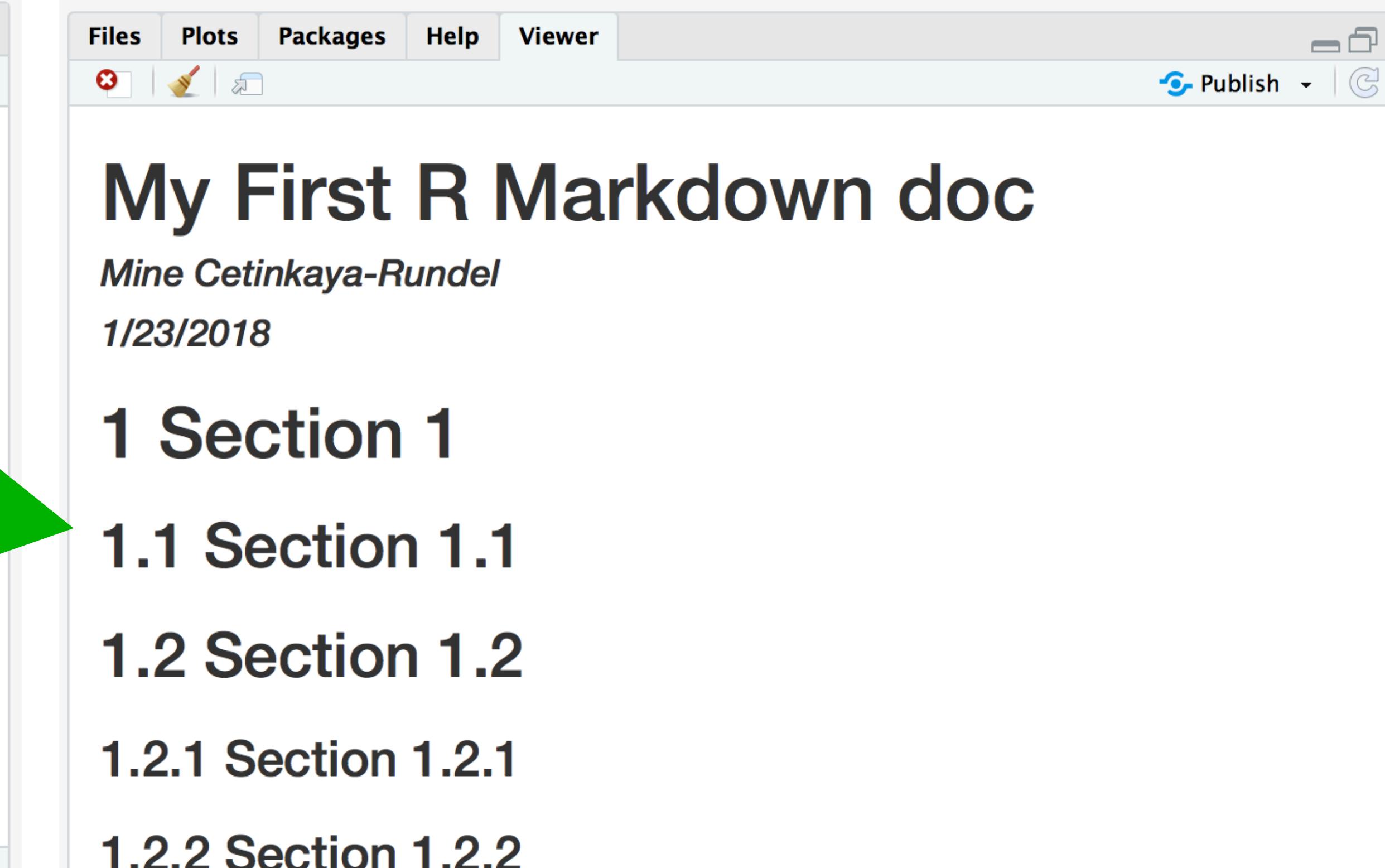
## Header 2

### Header 3

# Numbered sections



```
my-first-rmd.Rmd x
1 ---  
2 title: "My First R Markdown doc"  
3 author: "Mine Cetinkaya-Rundel"  
4 date: "1/23/2018"  
5 output:  
6   html_document:  
7     number_sections: true  
8 ---  
9  
10 # Section 1|  
11  
12 ## Section 1.1  
13  
14 ## Section 1.2  
15  
16 ### Section 1.2.1  
17  
18 ### Section 1.2.2  
10:12 # Section 1
```



My First R Markdown doc  
*Mine Cetinkaya-Rundel*  
1/23/2018

# 1 Section 1

## 1.1 Section 1.1

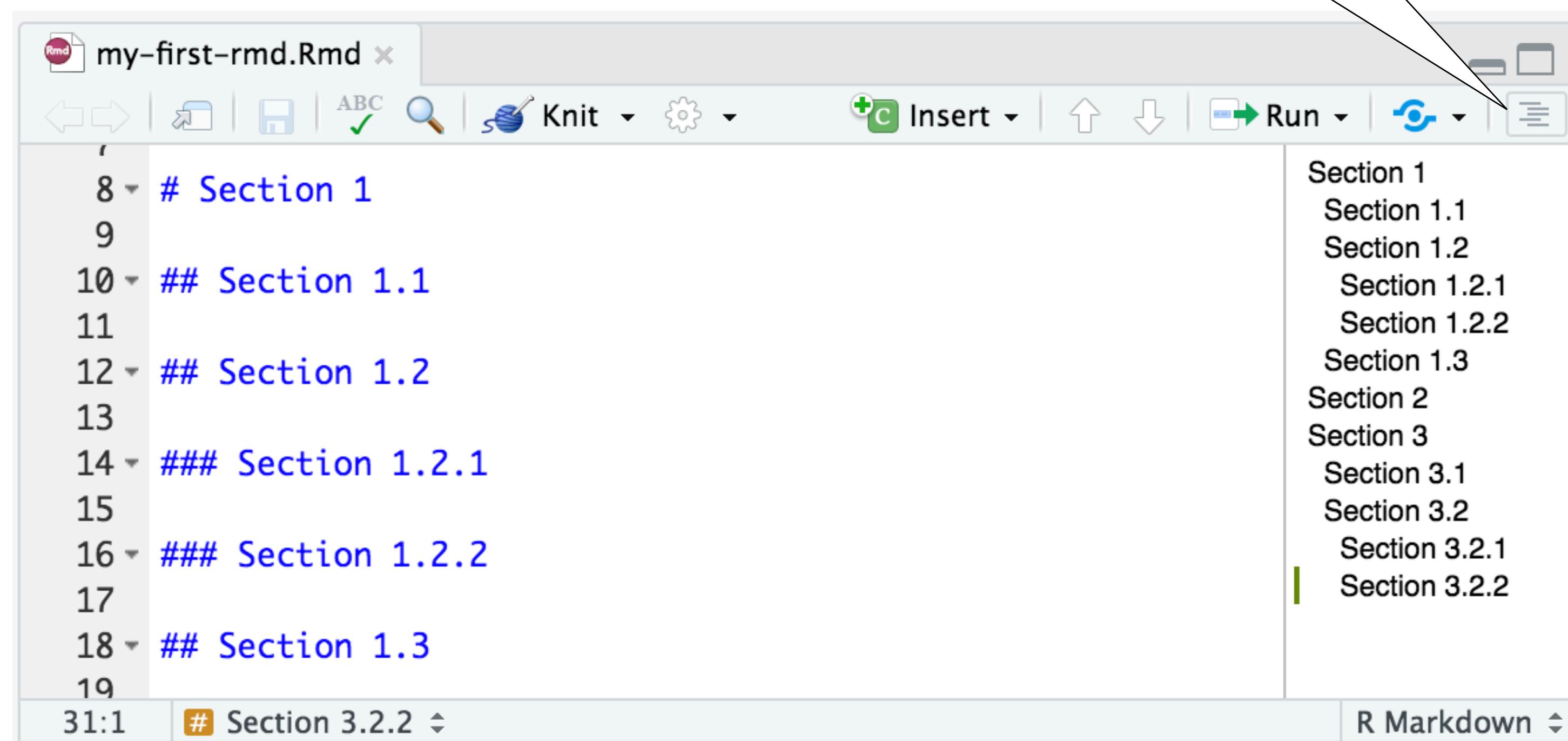
## 1.2 Section 1.2

### 1.2.1 Section 1.2.1

### 1.2.2 Section 1.2.2

# Tips

Show / hide  
document  
outline

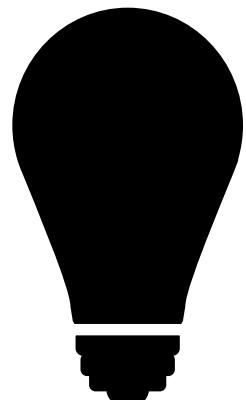


The screenshot shows the RStudio interface with a document titled "my-first-rmd.Rmd". The code editor pane contains the following R Markdown code:

```
8 # Section 1
9
10 ## Section 1.1
11
12 ## Section 1.2
13
14 ### Section 1.2.1
15
16 ### Section 1.2.2
17
18 ## Section 1.3
19
```

The right pane displays the document outline, which includes:

- Section 1
  - Section 1.1
  - Section 1.2
    - Section 1.2.1
    - Section 1.2.2
  - Section 1.3
- Section 2
- Section 3
  - Section 3.1
  - Section 3.2
    - Section 3.2.1
    - Section 3.2.2



# Lists

- Lists can be ordered
  1. Item 1
  2. Item 2
    - + Item 2a
    - + Item 2b
- And lists can be unordered
  - \* Item 1
  - \* Item 2
    - + Item 2a
    - + Item 2b

*Hint: you don't have to keep track of the numbers in an ordered list. You can just put 1. at the front of each item, and R Markdown will supply the proper item numbers.*

# Links

- Links can be plain http address or they can add a link to a phrase:
  - <http://rmarkdown.rstudio.com/>
  - [R Markdown website] (<http://rmarkdown.rstudio.com/>)

# Images

- Including an image is very similar to hyperlinking

- Images can be on the web:

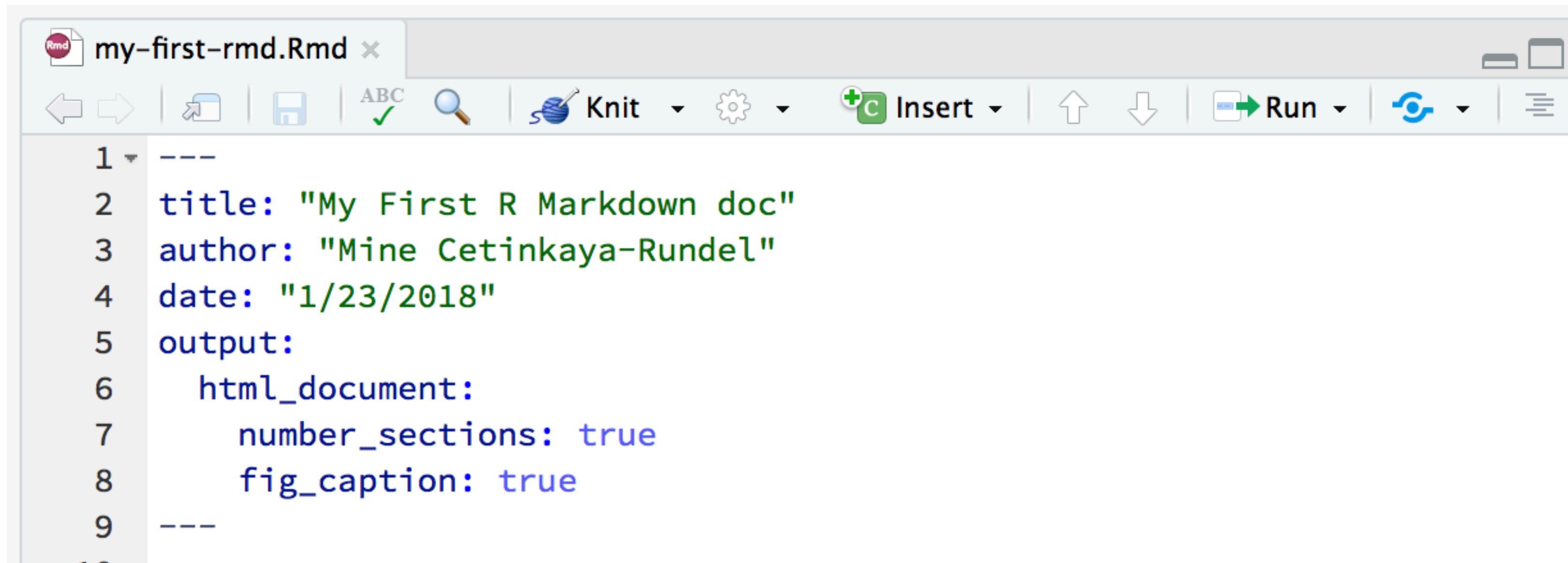
```
![RStudio logo](https://www.rstudio.com/wp-content/uploads/2014/04/rmarkdown.png)
```

- Or they can be locally stored:

```
![RStudio logo](img/rmarkdown.png)
```

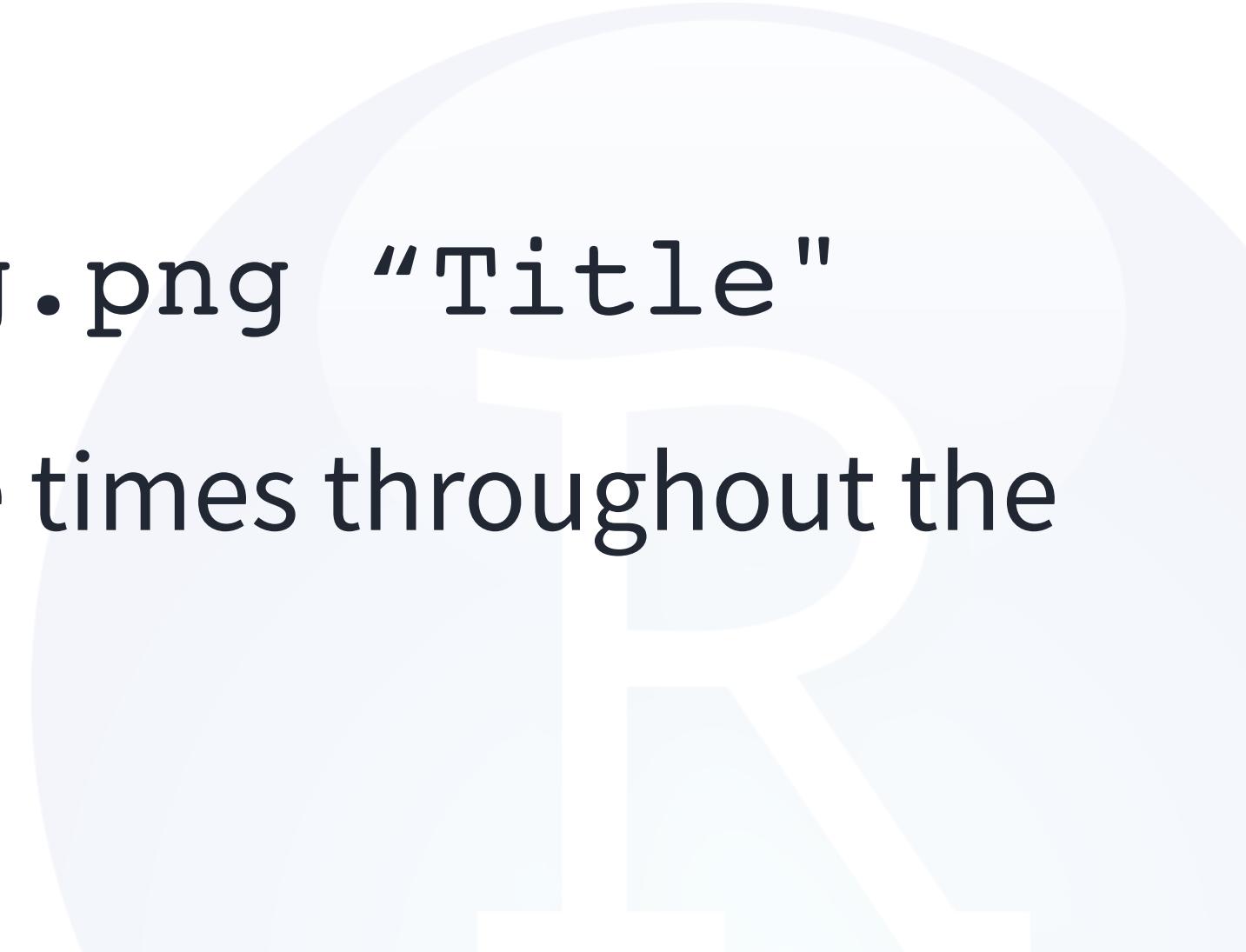
# Tips

- To improve the accessibility of your document, always add alt text to your images (e.g., `! [Alt text] (img/rmarkdown.png)`)
- To print the alt text underneath the image as a caption, use `fig_caption: true` in the YAML, and make sure there is a line break before the figure call.



```
my-first-rmd.Rmd x
[File] [New] [Open] [Save] ABC [Knit] [Insert] [Run] [Help]
1 ---  
2 title: "My First R Markdown doc"  
3 author: "Mine Cetinkaya-Rundel"  
4 date: "1/23/2018"  
5 output:  
6   html_document:  
7     number_sections: true  
8     fig_caption: true  
9 ---
```

# Reference style links and images

- Links
  - A [linked phrase][id]
  - At the bottom of the document: [id]: [http://example.com/ "Title"](http://example.com/)
- Images
  - ! [alt text][id]
  - At the bottom of the document: [id]: figures/img.png "Title"
- Useful if you'll be linking to the same target/image multiple times throughout the document

# Math text

- If you already know some LaTeX, you're good to go
- Equations can be inline:

```
$\bar{x} \sim N(\mu, \frac{\sigma}{\sqrt{n}})$
```

- Equations can be inline:  $\bar{x} \sim N\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$
- And equations can be centered in a new line:

```
$$ \bar{x} \sim N(\mu, \frac{\sigma}{\sqrt{n}}) $$
```

- And equations can be centered in a new line:

$$\bar{x} \sim N\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$$

# Math text (Continued)

- If your LaTeX is rusty or non-existent, you can try out equations in the RStudio IDE using an equations code chunk, and RStudio will show you how it will render.
- The equation code chunk starts and ends with \$\$

```
38 $$  
39 \bar{x} \sim N(\mu, \frac{\sigma}{\sqrt{n}})  
40 $$
```

$$\bar{x} \sim N\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$$

# EXERCISE 5

rstudio::conf

## Add An Equation to Your R Markdown Document

1. Still using `my-first-rmarkdown.Rmd`, add the following text after your last chunk:

```
$$  
E = mc^{\{2\}}  
$$
```

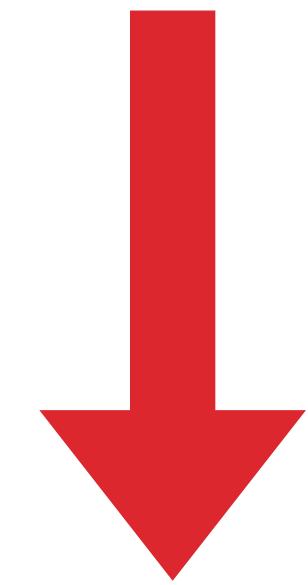
3m 00s

You should see Einstein's equation appear below the code chunk. Don't forget the curly braces around the 2. If you have time, try some other simple equations.

# Tables

- Two components let you define tables:
  - A header row that starts and ends with a vertical bar
  - A separator row starting and ending with a vertical bar containing hyphens and optionally colons
- Hyphens separate the header row from content cells, and vertical bars separate the columns

| Column A | Column B | Column C |
|----------|----------|----------|
| Value 1A | Value 1B | Value 1C |
| Value 2A | Value 2B | Value 2C |



| Column A | Column B | Column C |
|----------|----------|----------|
| Value 1A | Value 1B | Value 1C |
| Value 2A | Value 2B | Value 2C |

# Table Alignment

| Left-Aligned | Right Aligned | Centered |
|--------------|---------------|----------|
| Value 1A     | Value 1B      | Value 1C |
| Left         | Right         | Centered |

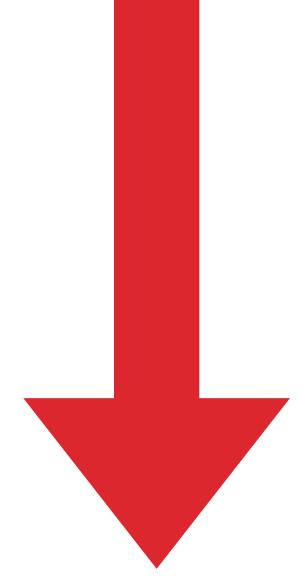
Colons in the row that separates the header from the values let you left-align, right-align, and center your columns

| Left-Aligned | Right Aligned | Centered |
|--------------|---------------|----------|
| Value 1A     | Value 1B      | Value 1C |
| Left         | Right         | Centered |

# Table Input Formatting Doesn't Matter

| Left-Aligned | Right Aligned | Centered |
|--------------|---------------|----------|
| :- :- :-     |               |          |
| Value 1A     | Value 1B      | Value 1C |
| Left         | Right         | Centered |

Note that you don't have to format your input so that things line up -- the vertical bars and hyphens are all you need



| Left-Aligned | Right Aligned | Centered |
|--------------|---------------|----------|
| Value 1A     | Value 1B      | Value 1C |
| Left         | Right         | Centered |

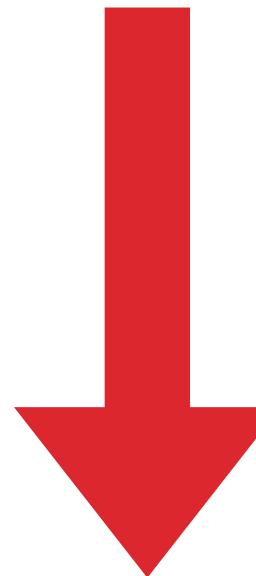
# Table Font Directives (HTML Only)

You can modify some font attributes using html directives of the form:

```
<font color="red"  
size="10pt"  
face="times">text  
</font>
```

Only do this for small local changes. for document wide changes, you would want to use a custom CSS file.

|                                                                                                             |               |          |
|-------------------------------------------------------------------------------------------------------------|---------------|----------|
| Left-Aligned                                                                                                | Right Aligned | Centered |
| :- :- :-:                                                                                                   |               |          |
| Left Right Centered                                                                                         |               |          |
| <font color="red">Red</font> <font size="10pt">Big</font> <font face="times" color="blue">Times Blue</font> |               |          |



| Left-Aligned | Right Aligned | Centered   |
|--------------|---------------|------------|
| Left         | Right         | Centered   |
| Red          | Big           | Times Blue |

# Markdown Quick Reference

In RStudio: Help ➔ Markdown Quick Reference

## Markdown Quick Reference

R Markdown is an easy-to-write plain text format for creating dynamic documents and reports.  
See [Using R Markdown](#) to learn more.

### Emphasis

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

### Headers

```
# Header 1  
## Header 2  
### Header 3
```

### Lists

#### Unordered List

```
* Item 1  
* Item 2  
  + Item 2a  
  + Item 2b
```

# Add A Table to Your R Markdown Document

1. Still using `my-first-rmarkdown.Rmd`, add a table to the bottom of your document that recreates the table to the right.

Don't forget **Help → Markdown Quick Reference**

| Roses | Violets | Markdown | R Markdown |
|-------|---------|----------|------------|
| are   | are     | is       | is         |
| Red   | Blue    | sweet    | too        |

5m 00s

# Tips

- Keep your text to max ~80 characters across, especially if you use a version control system (like git)
- Starting a list? Leave an empty line before the first item on your list
- Need to test out bits of markdown code without knitting the entire document? Start another document with bits and pieces of code to test them out

# EXERCISE 7

Turn Plain Text Into A Report

1. Open 07-Open-Share-Repro.Rmd
2. Add R Markdown notation to make it render as shown at right
3. You can view a file showing you are trying to produce in answers/07-Open-Share-Repro-solution.html

You'll have to view that in a browser.

Don't forget **Help ➔ Markdown Quick Reference**

10m 00s

## Analyze. Share. Reproduce. and do it all with R Markdown

Your data tells a **joke** story. Tell it with R Markdown. Turn your analyses into **high quality** documents, reports, presentations and dashboards – and don't forget to drink some H<sub>2</sub>O while you do that.<sup>1</sup>

R Markdown documents are fully reproducible. Use a productive [notebook interface](#)<sup>2</sup> to weave together narrative text and code to produce *elegantly formatted* output. Use multiple languages including

- R
- Python

and

- SQL

Do you need still need convincing to use R Markdown? See what a friend once said:

I used to use Sweave, and get terrible headaches. Now I use R Markdown, and life is much more pleasant.

1. Or coffee, whatever floats your boat. ↵
2. This link should point to [http://rmarkdown.rstudio.com/r\\_notebooks.html](http://rmarkdown.rstudio.com/r_notebooks.html). ↵

# What Have We Forgotten? Code Chunks

- Up until this point, we've focused our efforts on R Markdown text.
- But the essence of a computational document is code.
- We put our code in *code chunks*
- Code chunks look like this:

```
```{r chunk_name parameter1=value, param2=value}
print("My R code goes here")
```
```

R Markdown code chunks  
support many languages.



# Code Chunks Support Many Languages

- R and Python are the most common in R Markdown documents
- However, R Markdown also supports
  - SQL
  - Bash
  - Rcpp
  - Stan
  - JavaScript
  - CSS

## Observe R Markdown's Multi-Language Support

1. Open `08-code-chunks.Rmd` by clicking on it in the File menu
2. Read and either run or knit the code
3. Where does the value `py$python_string` come from?

3m 00s

# Summary

- R Markdown is a language for creating computational documents.
- Metadata for an R Markdown document is written at the top of the document in \_\_\_\_\_
- R Markdown documents can include a variety of formatting elements
  - Headers
  - Plain text
  - Code chunks in several languages
  - Links
  - Tables
  - Images
  - More

# Break

