

# BAE 587

## Introduction to R Markdown and use in Homework #5

BAE587, 10 September 2020

# Download R

- Google: ‘R project’



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[R Project](#)

## The R Project for Statistical Computing

### Getting Started

R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS. To [download R](#), please choose your preferred [CRAN mirror](#).

- <http://archive.linux.duke.edu/cran/>

# Download RStudio

- Google: ‘rstudio download’



Products Resources Pricing Abo

## Choose Your Version of RStudio

RStudio is a set of integrated tools designed to help you be more productive with R. It includes a console, syntax-highlighting editor that supports direct code execution, and a variety of robust tools for plotting, viewing history, debugging and managing your workspace. [Learn More about RStudio features.](#)

| RStudio Desktop<br>Open Source License        | RStudio Desktop<br>Commercial License    | RStudio Server<br>Open Source License         | RStudio Server Pro<br>Commercial License      |
|---|--|---|---|
| <b>FREE</b>                                   | \$995 per year                           | FREE  | \$9,995 per year                              |
| <b>DOWNLOAD</b><br><a href="#">Learn More</a> | <b>BUY</b><br><a href="#">Learn More</a> | <b>DOWNLOAD</b><br><a href="#">Learn More</a> | <b>DOWNLOAD</b><br><a href="#">Learn More</a> |
| Integrated Tools for R                        |  |   |   |
| Priority Support                              |  |   |   |
| Access via                                    |  |   |   |

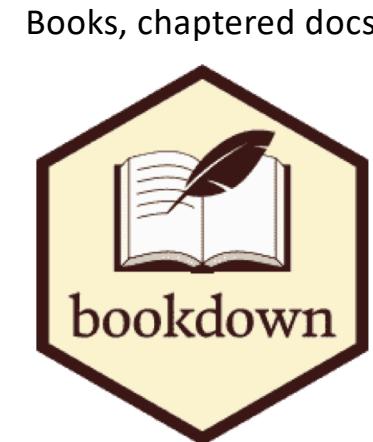
# Using R to make websites, write books and articles



Articles



Websites



Books, chaptered docs

What's this \*\*\***down** business?

- It starts with **Markup** language!

# What is the Markup language?

## What is the Markdown language?

I borrow much of the very good text from [Dr Shalizi](#) from Carnegie Mellon University about Mark-up and Markdown.

Many word processing programs, like Microsoft Word, employ the “what you see is what you get” (WYSIWYG) principle: you want some words to be printed in italics? You select/highlight the words or phrase, do ctrl-I or click Italic, and they’re in italics

- <div id="what-is-the-markdown-language" class="section level2"> <h2>What is the Markdown language?</h2> <p>I borrow ... from <a href="http://www.stat.cmu.edu/~cshalizi/rmarkdown/">Dr Shalizi</a> from ...</p> <p>Many ...that of <em>marking up</em> text. The essential idea in a <strong>mark-up language</strong> is that it consists of ordinary text, <em>plus</em> signs which indicate how to change the formatting or meaning of the text. Some mark-up languages, like HTML (Hyper-Text Markup Language) use very obtrusive markup; others, like the language called <strong>Markdown</strong>, are more subtle.</p> </div>

# Markup, Markdown

- Play on word!
- Markup: a bit on the complicated side (HTML, LaTeX, others)
- Markdown: the idea is to make things simple:
  - <div id="what-is-the-markdown-language" class="section level2"><h2>What is the Markdown language?</h2>
  - Becomes
  - ## What is the Markdown language?

# One code, several output formats

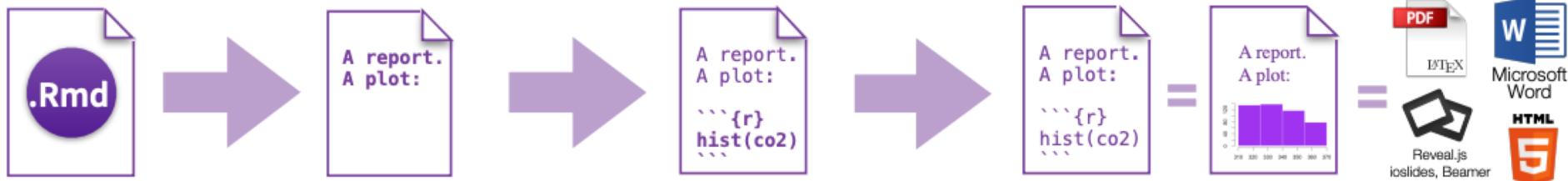
- Markdown .md format recognized by many interpreter codes
- Rmarkdown example outputs:
  - Documents:
    - Html documents
    - Pdf document (via LaTeX)
    - Word document
    - epub
  - Presentations:
    - Ioslides\_presentations
    - Power point presentations
  - Other:
    - Interactive dashboards
    - Github\_documents

- <https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf>

## 1. Workflow

R Markdown is a format for writing reproducible, dynamic reports with R. Use it to embed R code and results into slideshows, pdfs, html documents, Word files and more. To make a report:

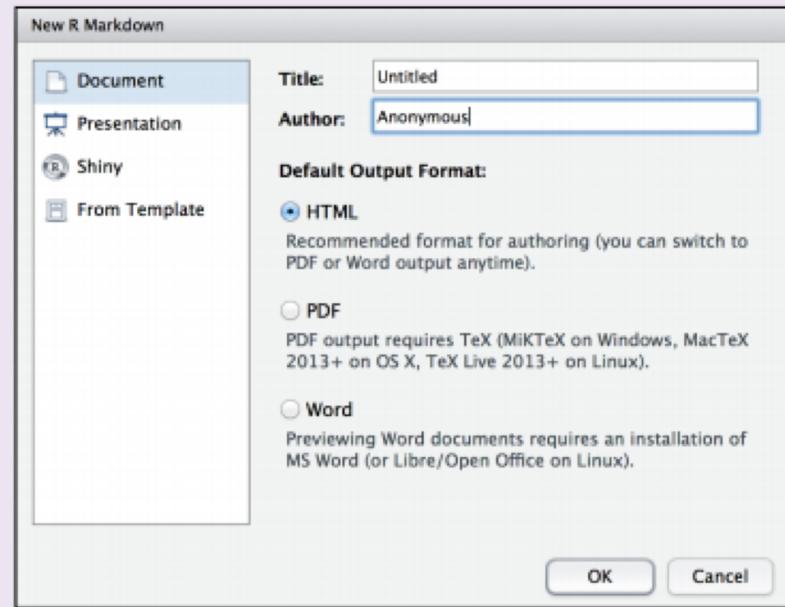
- Open** - Open a file that uses the .Rmd extension.
- Write** - Write content with the easy to use R Markdown syntax
- Embed** - Embed R code that creates output to include in the report
- Render** - Replace R code with its output and transform the report into a slideshow, pdf, html or ms Word file.



## 2. Open File

Start by saving a text file with the extension .Rmd, or open an RStudio Rmd template

- In the menu bar, click **File ▶ New File ▶ R Markdown...**
- A window will open. Select the class of output you would like to make with your .Rmd file
- Select the specific type of output to make with the radio buttons (you can change this later)
- Click OK



### 3. Markdown

Next, write your report in plain text. Use markdown syntax to describe how to format text in the final report.

#### 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  
  
### Header 3  
  
#### Header 4  
  
##### Header 5  
  
##### Header 6
```

#### 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



### Header 3



#### Header 4



##### Header 5



###### Header 6


```

### 3. Markdown

Next, write your report in plain text. Use markdown syntax to describe how to format text in the final report.

#### syntax

```
endash: --
emdash: ---
ellipsis: ...
inline equation: $A = \pi * r^2$
image: 
```

horizontal rule (or slide break):

\*\*\*

> block quote

#### becomes

```
endash: –
emdash: —
ellipsis: ...
inline equation:  $A = \pi * r^2$ 
image:
```



horizontal rule (or slide break):

---

block quote

### 3. Markdown

Next, write your report in plain text. Use markdown syntax to describe how to format text in the final report.

#### syntax

```
* unordered list
* item 2
  + sub-item 1
  + sub-item 2

1. ordered list
2. item 2
  + sub-item 1
  + sub-item 2
```

| Table Header | Second Header |
|--------------|---------------|
| Table Cell   | Cell 2        |
| Cell 3       | Cell 4        |

#### becomes

```
* unordered list
* item 2
  ○ sub-item 1
  ○ sub-item 2

1. ordered list
2. item 2
  ○ sub-item 1
  ○ sub-item 2
```

| Table Header | Second Header |
|--------------|---------------|
| Table Cell   | Cell 2        |
| Cell 3       | Cell 4        |

## 4. Choose Output

Write a YAML header that explains what type of document to build from your R Markdown file.

### YAML

A YAML header is a set of key:value pairs at the start of your file. Begin and end the header with a line of three dashes (---)

```
---
```

```
title: "Untitled"
author: "Anonymous"
output: html_document
```

```
---
```

This is the start of my report. The above is metadata saved in a YAML header.

The RStudio template writes the YAML header for you

The output value determines which type of file R will build from your .Rmd file (in Step 6)

**output: html\_document** ..... html file (web page)



**output: pdf\_document** ..... pdf document



**output: word\_document** ..... Microsoft Word .docx



**output: beamer\_presentation** ..... beamer slideshow (pdf)



**output: ioslides\_presentation** ..... ioslides slideshow (html)



## 5. Embed Code

Use knitr syntax to embed R code into your report. R will run the code and include the results when you render your report.

### inline code

Surround code with back ticks and r.  
R replaces inline code with its results.

```
Two plus two  
equals `r 2 + 2`.
```

Two plus two  
equals 4.

### code chunks

Start a chunk with ```{r}.

End a chunk with ```

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

Here's some code

```
dim(iris)
```

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

### display options

Use knitr options to style the output of a chunk.  
Place options in brackets above the chunk.

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

Here's some code  

```
dim(iris)
```

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

Here's some code  

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

## 6. Render

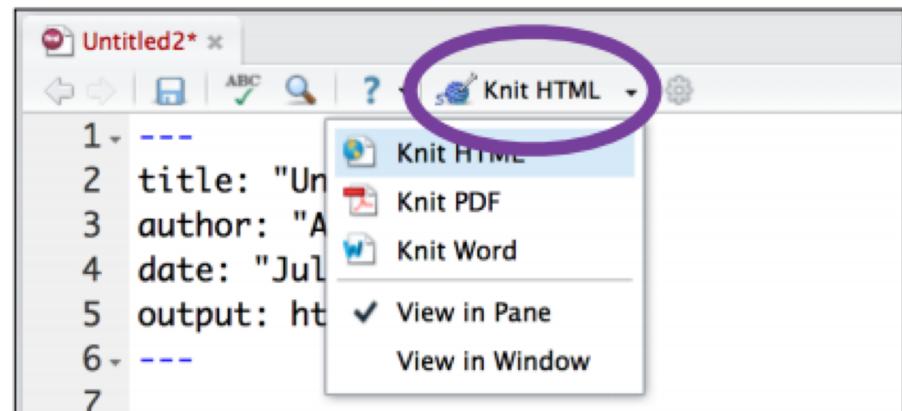
Use your .Rmd file as a blueprint to build a finished report.

Render your report in one of two ways

1. Run `rmarkdown::render("<file path>")`
2. Click the **knit HTML** button at the top of the RStudio scripts pane

When you render, R will

- execute each embedded code chunk and insert the results into your report
- build a new version of your report in the output file type
- open a preview of the output file in the viewer pane
- save the output file in your working directory



## 7. Interactive Docs

Turn your report into an interactive Shiny document in 3 steps

**1** Add `runtime: shiny` to the YAML header

```
---
```

```
title: "Line graph"
```

```
output: html_document
```

```
runtime: shiny
```

```
---
```

**2** In the code chunks, add Shiny `input` functions to embed widgets. Add Shiny `render` functions to embed reactive output

```
---
```

```
title: "Line graph"
```

```
output: html_document
```

```
runtime: shiny
```

```
---
```

```
Choose a time series:
```

```
```{r echo = FALSE}
```

```
selectInput("data", "",
```

```
           c("co2", "lh"))
```

```
```
```

```
See a plot:
```

```
```{r echo = FALSE}
```

```
renderPlot({
```

```
  d <- get(input$data)
```

```
  plot(d)
```

```
})
```

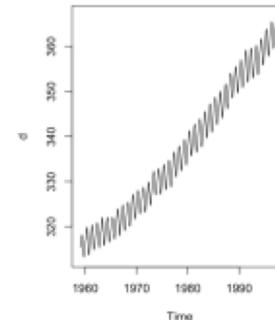
```
```
```

**3** Render with `rmarkdown::run` or click **Run Document** in RStudio

**Line graph**

Choose a time series:

See a plot:



\* Note: your report will be a Shiny app, which means you must choose an html output format, like **html\_document** (for an interactive report) or **ioslides\_presentation** (for an interactive slideshow).

## 9. Learn More

**Documentation and examples - [rmarkdown.rstudio.com](http://rmarkdown.rstudio.com)**

**Further Articles - [shiny.rstudio.com/articles](http://shiny.rstudio.com/articles)**

 - [blog.rstudio.com](http://blog.rstudio.com)

 - @rstudio



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844-448-1212 [rstudio.com](http://rstudio.com)

# The basic structure

- YAML header
  - Defines settings for the document
- Text
  - Headings, alteration, cross-references, etc.
- Code chunks
  - Interprets codes in R, python, C, and fortran
- *Rmarkdown, Bookdown, and blogdown* **KNIT** all pieces together in homogeneous output

# Rmarkdown starter

- Go to <https://github.com/francoisbirgand>
- Go to repositories
- Choose [BAE587-QCHmk](https://github.com/francoisbirgand/BAE587-QCHmk)  
[\(https://github.com/francoisbirgand/BAE587-QCHmk\)](https://github.com/francoisbirgand/BAE587-QCHmk)
- Download ZIP

François Birgand's GitHub profile page. The top navigation bar includes 'Overview', 'Repositories 21' (circled in red), 'Projects', and 'Packages'. Below the navigation is a search bar 'Find a repository...', a type filter 'Type: All', a language filter 'Language: All', and a green 'New' button. A large circular profile picture of François Birgand is on the left. His name 'François Birgand' and GitHub handle 'francoisbirgand' are displayed below the profile picture. An 'Edit profile' button is present. Social metrics show '6 followers', '0 following', and '0 stars'. He is associated with 'NC State University'. A 'Highlights' section shows he is an 'Arctic Code Vault Contributor'. Two repositories are listed: 'BAE587-QCHmk' (circled in red) and 'francoisbirgand.github.io'. Both repositories have a green progress bar indicating activity. A badge notification for 'gaugecam-NR' is shown.

Repositories 21

Find a repository... Type: All Language: All New

BAE587-QCHmk

R Updated 1 minute ago

francoisbirgand.github.io

HTML ★ 1 1 Updated 11 days ago

BAE-587

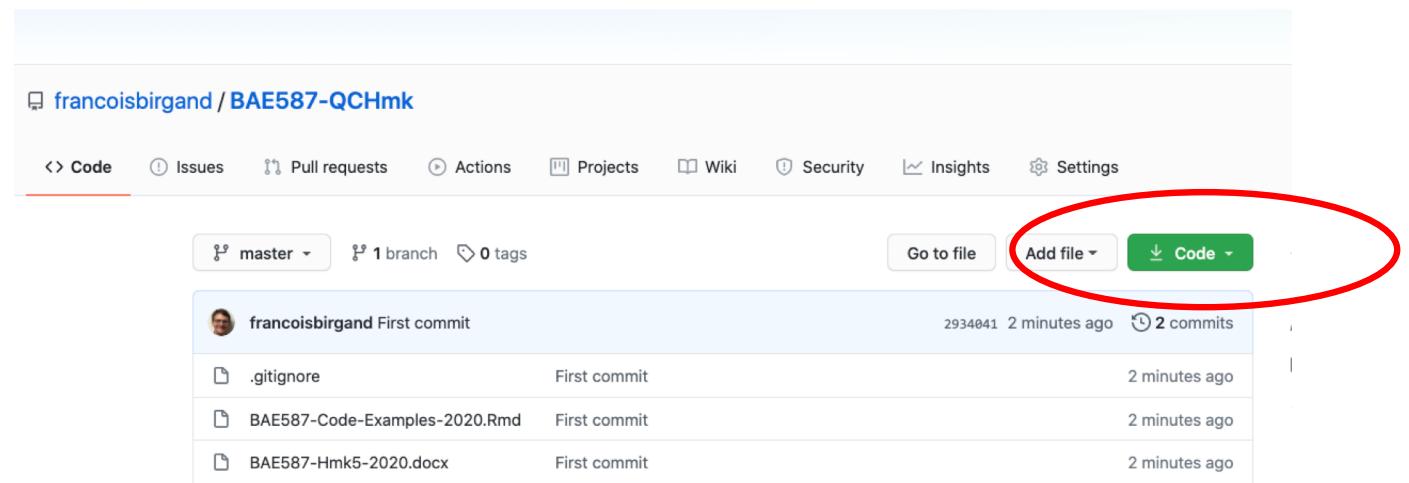
Biogeochemical Processes for Environmental and Ecological Engineering

HTML Creative Commons Zero v1.0 Universal Updated 23 days ago

gaugecam-NR

You have a new badge!

You contributed code to the 2020 GitHub Archive Program and now have a badge for it. Thank you for being part of the program!



The screenshot shows a GitHub repository page for `francoisbirgand / BAE587-QCHmk`. The top navigation bar includes links for Code, Issues, Pull requests, Actions, Projects, Wiki, Security, Insights, and Settings. Below the navigation bar, there are status indicators: master branch (1 branch), 0 tags, Go to file, Add file, and a dropdown menu labeled "Code". A red oval highlights the "Code" dropdown menu. The main content area displays a commit history:

| Author          | Commit Message                | Date                  | Commits       |
|-----------------|-------------------------------|-----------------------|---------------|
| francoisbirgand | First commit                  | 2934041 2 minutes ago | 2 commits     |
|                 | .gitignore                    | First commit          | 2 minutes ago |
|                 | BAE587-Code-Examples-2020.Rmd | First commit          | 2 minutes ago |
|                 | BAE587-Hmk5-2020.docx         | First commit          | 2 minutes ago |

master ▾ 1 branch 0 tags

Go to file

Add file ▾

Code ▾

 francoisbirgand First commit

|  |              |
|--|--------------|
|  .gitignore                       | First commit |
|  BAE587-Code-Examples-2020.Rmd    | First commit |
|  BAE587-Hmk5-2020.docx          | First commit |
|  BAE587-QCHmk.Rproj             | First commit |
|  BAE587-QCHmk5-usingR-2020.pptx | First commit |
|  BAE587_QClab_yourname.Rmd      | First commit |

Clone with HTTPS 

Use SSH

Use Git or checkout with SVN using the web URL.

<https://github.com/francoisbirgand/BAE>



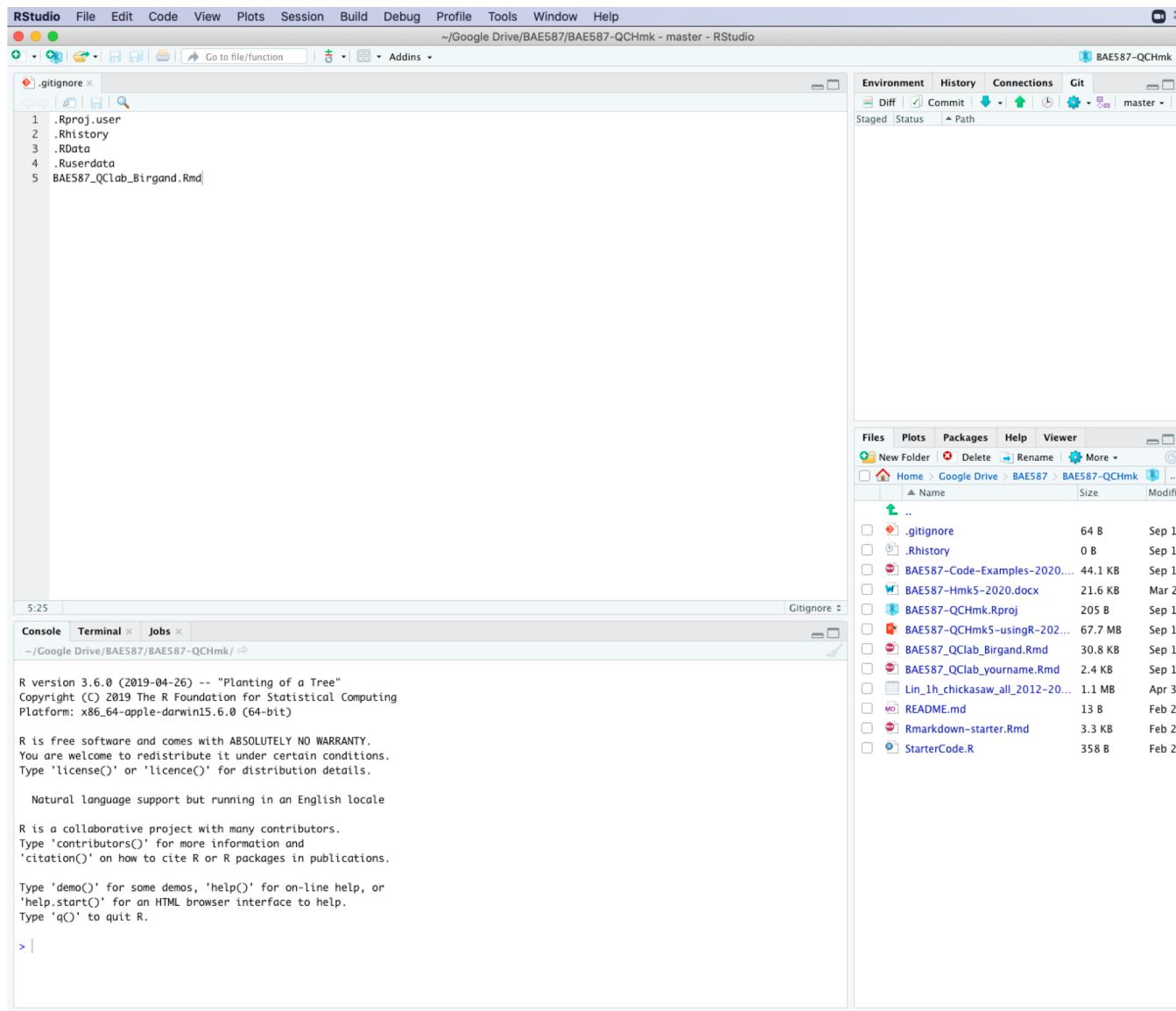
 Open with GitHub Desktop

 Download ZIP

3 minutes ago

3 minutes ago

- Unzip the file into a directory of your choice
- In that directory, open the *BAE587-QCHmk.Rproj* file
- R Studio should open
- Normally, your screen should look like on the next slide



# Downloading all necessary packages

- In the right bottom window, you can see all the files in your working directory.
- You can see several types of files:
  - \*.Rmd: Rmarkdown files, where all your code and text are stored
  - \*.yml: files that define the settings for the book and for the output
  - \*.csv: files where I have data to draw tables
  - \*.bib: files in which the info for cited references is stored
  - .gitignore: a file in which info of all the files and file types you do NOT want uploaded on Github are stored
  - \*.css: files that define the html output formats
  - pictures directory: a directory where all the pictures are stored
  - docs directory: a directory where the all the rendered files are stored and ready for upload in Github
  - \*.R script

# Downloading all necessary packages

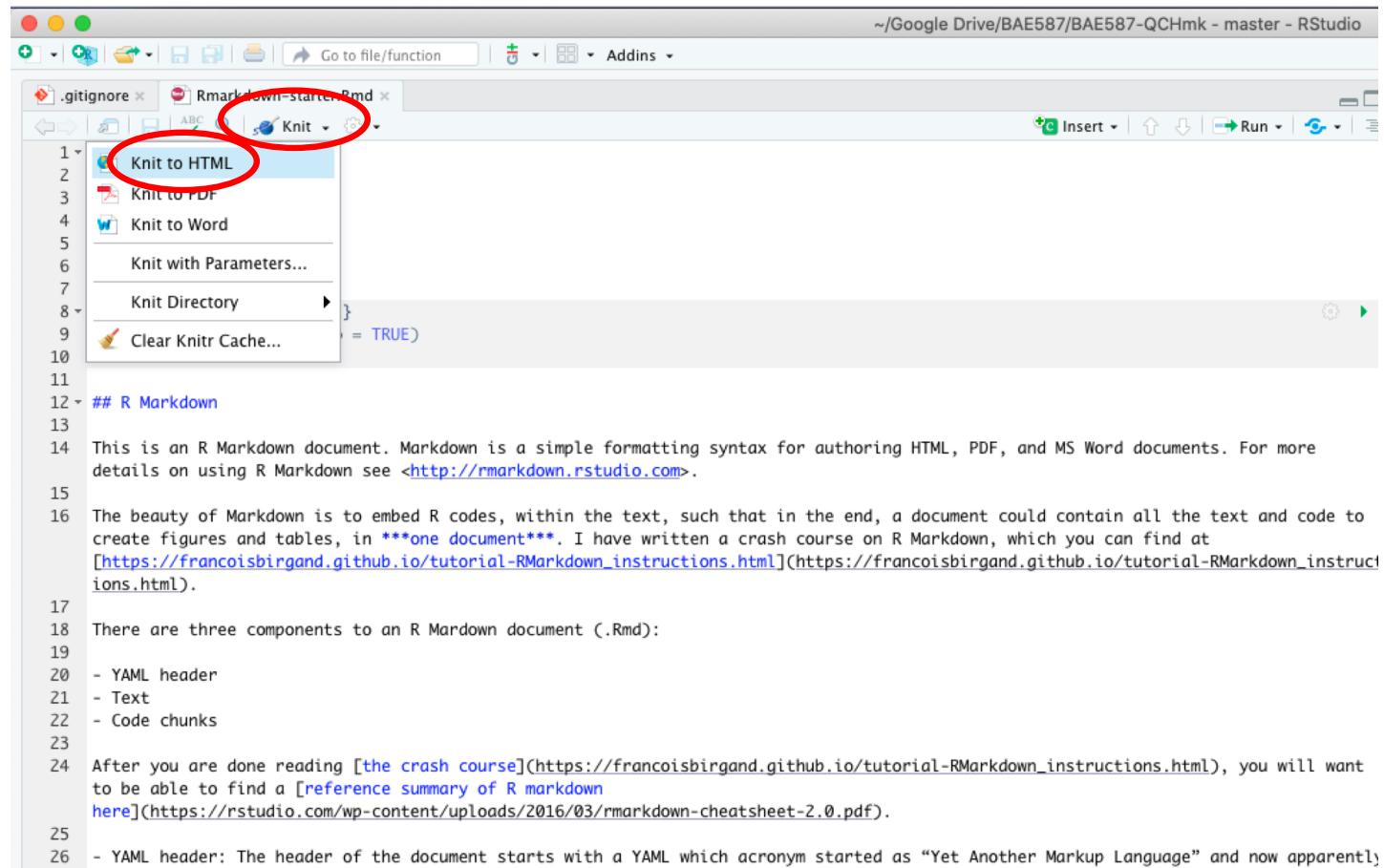
- Find in that window the StarterCode.R code, click on it
- The left panel on the general view is now separated with a console at the bottom, and the file you just opened is at the top
- Select all the text and click run



```
1 _build.sh x 2 StarterCode.R x
  ↻ ⇢ ⌂ Source on Save | ⚔ 🔍 ⚡
  1 ipak <- function(pkg){
  2   new.pkg <- pkg[!(pkg %in% installed.packages(), "Package")]
  3   if (length(new.pkg))
  4     install.packages(new.pkg, dependencies = TRUE)
  5   sapply(pkg, library, character.only = TRUE)
  6 }
  7 # usage
  8 packages <- c("knitr", "captioner", "stringr", "devtools", "bookdown","kableExtra", "rmarkdown","blogdown","pander","kable"
  9 ipak(packages)
10
11
```

# Knit a document

- Open Rmarkdown-starter.Rmd
- Knit the document



The screenshot shows the RStudio interface with the 'Rmarkdown-starter.Rmd' file open. The 'Knit' dropdown menu is displayed, with the 'Knit to HTML' option highlighted and circled in red. The code editor below shows the R Markdown document content, which includes a YAML header, text, and code chunks.

```
## 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>.
The beauty of Markdown is to embed R codes, within the text, such that in the end, a document could contain all the text and code to create figures and tables, in ***one document***. I have written a crash course on R Markdown, which you can find at [https://francoisbirgand.github.io/tutorial-RMarkdown\_instructions.html](https://francoisbirgand.github.io/tutorial-RMarkdown\_instructions.html).
There are three components to an R Markdown document (.Rmd):
- YAML header
- Text
- Code chunks
After you are done reading [the crash course](https://francoisbirgand.github.io/tutorial-RMarkdown\_instructions.html), you will want to be able to find a [reference summary of R markdown here](https://rstudio.com/wp-content/uploads/2016/03/rmarkdown-cheatsheet-2.0.pdf).
- YAML header: The header of the document starts with a YAML which acronym started as "Yet Another Markup Language" and now apparently
```

# You should obtain

The screenshot shows a web browser window displaying an R Markdown document. The title bar reads "Rmarkdown-starter.html" and "Open in Browser". The page header includes the URL "~/Google Drive/BAE587/BAE587-QCHmk/Rmarkdown-starter.html", a search bar, and a "Publish" button. The main content is titled "Rmarkdown-starter" by François Birgand, dated 2/27/2020. It features a section titled "R Markdown" with a brief introduction. Below this, there's a list of components for an R Markdown document (.Rmd):

- YAML header
- Text
- Code chunks

Following this, there's a note about spell checking and a section on "Code Chunks" where actual R code is shown:

```
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
```

# Open BAE587-Code-Examples-2020.Rmd

- Knit it to see what you get
- Use this document to mine code as needed

Rename BAE587\_QClab\_yourname.Rmd

- Rename BAE587\_QClab\_yourname.Rmd
- Use this document to do the homework
- Submit your \*.Rmd and \*.html rendered document