

# BAE 587

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

BAE587, 22 September 2022

# Outline of Things to do

1. Download R
2. Download R Studio
3. Read what Markdown is (it is a language)
4. Read what R Markdown does (purple slides)
5. Obtain and follow information for the homework starting on slide 22

# Download R

- Google: ‘R project’



[\[Home\]](#)

[Download](#)

[CRAN](#)

[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 About

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

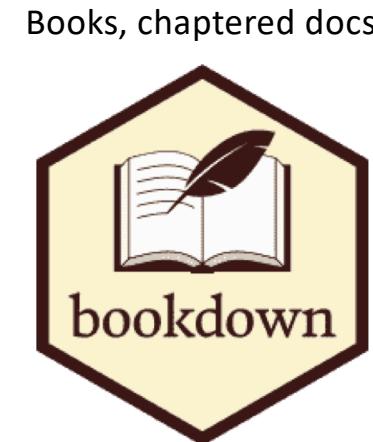
# Using R to make websites, write books and articles



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

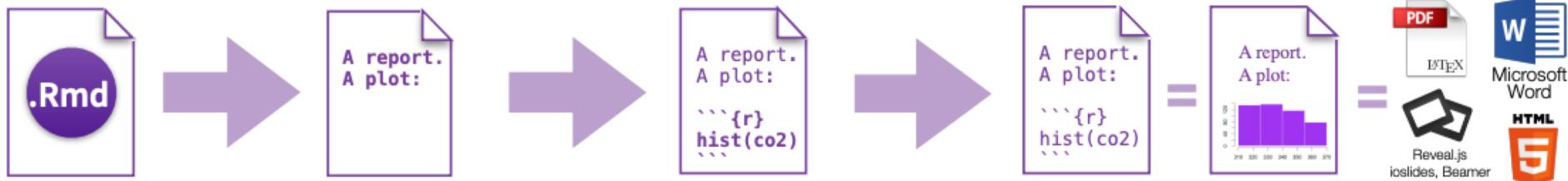
- Markdown .md format recognized by many interpreter codes
- Rmarkdown example outputs:
  - Documents:
    - Html documents
    - Pdf document (via LaTeX)
    - Word document
    - epub
  - Presentations:
    - Ioslides\_presentations
    - Power point presentations
  - Other:
    - Interactive dashboards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

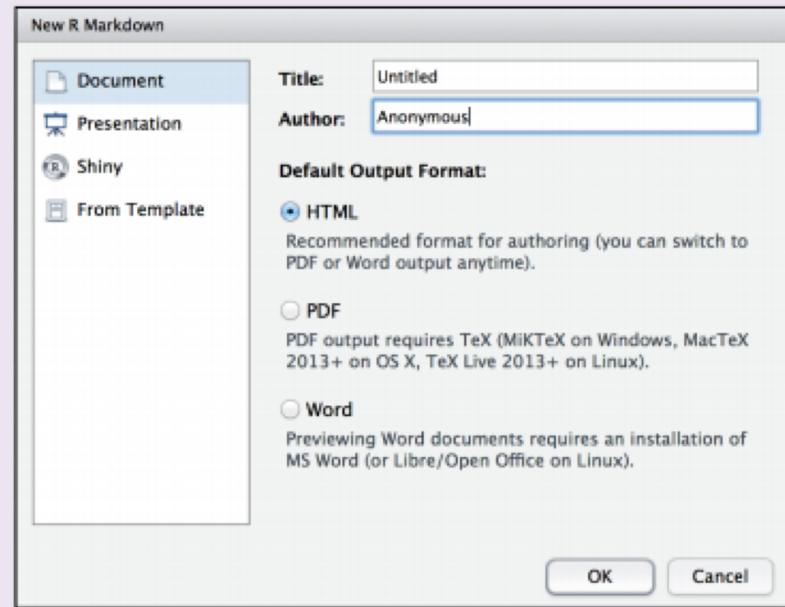
- Open** - Open a file that uses the .Rmd extension.
- Write** - Write content with the easy to use R Markdown syntax
- Embed** - Embed R code that creates output to include in the report
- Render** - Replace R code with its output and transform the report into a slideshow, pdf, html or ms Word file.



## 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

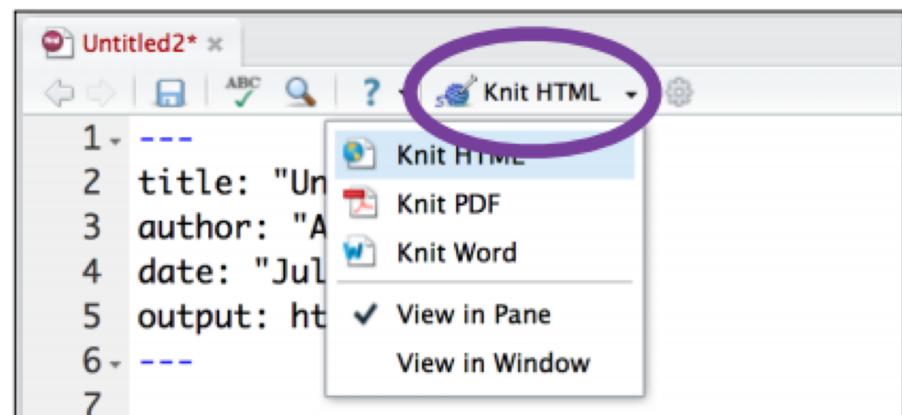
Use your .Rmd file as a blueprint to build a finished report.

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)
```

```
})
```

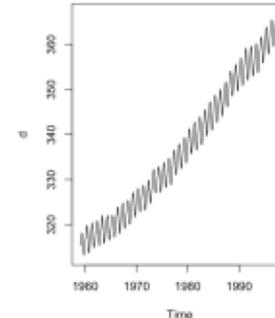
```
```
```

**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)

# Summaries of what R Markdown is

- A nice summary of what R markdown is with available details:
  - <https://rmarkdown.rstudio.com/lesson-1.html>
- I wrote this one and there are lots of good details in it:
  - [https://francoisbirgand.github.io/tutorial-RMarkdown\\_instructions.html](https://francoisbirgand.github.io/tutorial-RMarkdown_instructions.html)

# The basic structure of an R Markdown document

- 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

And now some practice

# Rmarkdown starter

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



François Birgand  
francoisbirgand

[Edit profile](#)

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NC State University

Overview

**Repositories** 22

Projects

Packages

Stars

Find a repository...

Type ▾

Language ▾

Sort ▾

New

**BAE587-QCHmk** Public

HTML Updated 1 minute ago

Star ▾

**francoisbirgand.github.io** Public

HTML 1 1 Updated 27 days ago

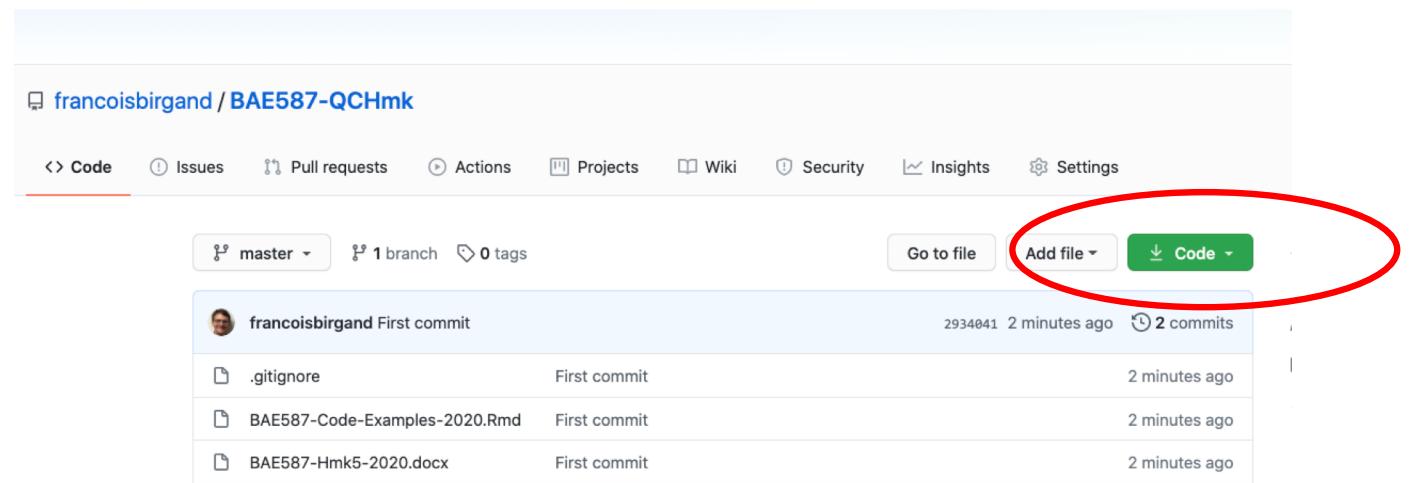
Star ▾

**BAE-587** Public

Biogeochemical Processes for Environmental and Ecological Engineering

HTML Creative Commons Zero v1.0 Universal Updated on Aug 23

Star ▾



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 green Code dropdown menu. A red oval highlights the 'Code' dropdown. 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 |

## francoisbirgand / BAE587-QCHmk Public

[Code](#) [Issues](#) [Pull requests](#) [Actions](#) [Projects](#) [Wiki](#) [Security](#) [Insights](#) [Settings](#)

master ▼

1 branch ▼

0 tags

Go to file

Add file ▼

Code ▼

 francoisbirgand 2022 updates on BAE 587 QClab

|  |                               |
|--|-------------------------------|
|  .gitignore                       | 2022 updates on BAE 587 QClab |
|  BAE587-Code-Examples-2022.Rmd    | 2022 updates on BAE 587 QClab |
|  BAE587-Hmk5-2022.docx            | 2022 updates on BAE 587 QClab |
|  BAE587-QCHmk.Rproj               | 2022 updates on BAE 587 QClab |
|  BAE587-QCHmk5-usingR-2022.pptx | 2022 updates on BAE 587 QClab |
|  BAE587_QClab_Birgand.html      | 2022 updates on BAE 587 QClab |
|  BAE587_QClab_yourname.Rmd      | 2022 updates on BAE 587 QClab |
|  BAE587_QClab_yourname.docx     | 2022 updates on BAE 587 QClab |
|  BAE587_QClab_yourname.html     | 2022 updates on BAE 587 QClab |

 Clone

[HTTPS](#) [SSH](#) [GitHub CLI](#)

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

Use Git or checkout with SVN using the web URL.

 Open with GitHub Desktop

 Download ZIP

- 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

BAE587-QCHmk - master - RStudio

.gitignore x

1 .Rproj.user  
2 .Rhistory  
3 .RData  
4 .Ruserdata  
5 BAE587\_QClab\_Birgand.Rmd  
6 BAE587\_QClab\_Tate.Rmd

6:22 Gitignore

Console Terminal x Render x Background Jobs x

R 3.6.0 · /Volumes/GoogleDrive-112706825753006847985/My Drive/BAE587/BAE587-QCHmk/

```
R version 3.6.0 (2019-04-26) -- "Planting of a Tree"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin15.6.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

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
```

Environment History Connections Git

Import Dataset 81 MiB List C

R Global Environment

Environment is empty

Files Plots Packages Help Viewer Presentation

Folder Blank File Delete Rename ...

| Name                            | Size     | Modified               |
|---------------------------------|----------|------------------------|
| ..                              |          |                        |
| .gitignore                      | 86 B     | Sep 16, 2020, 10:14 PM |
| .Rhistory                       | 0 B      | Sep 22, 2022, 5:41 PM  |
| BAE587_QClab_Birgand.html       | 2.8 MB   | Sep 14, 2020, 5:14 PM  |
| BAE587_QClab_Birgand.Rmd        | 30.8 KB  | Sep 11, 2020, 6:37 PM  |
| BAE587_QClab_yourname.Rmd       | 7 KB     | Sep 27, 2022, 10:36 AM |
| BAE587-Code-Examples-2022....   | 44 KB    | Sep 27, 2022, 10:11 AM |
| BAE587-Hmk5-2022.docx           | 22.9 KB  | Sep 11, 2020, 7:16 PM  |
| BAE587-QCHmk.Rproj              | 205 B    | Sep 27, 2022, 8:49 AM  |
| BAE587-QCHmk5-usingR-202...     | 6.9 MB   | Sep 22, 2022, 5:36 PM  |
| Lin_1h_chickasaw_all_2012-20... | 1.1 MB   | Apr 3, 2020, 4:22 PM   |
| Lin_1h_cuyahoga_all_2008-200... | 1.1 MB   | Mar 24, 2020, 9:56 PM  |
| README.md                       | 14 B     | Sep 22, 2022, 5:36 PM  |
| Rmarkdown-starter.html          | 715.6 KB | Sep 27, 2022, 8:50 AM  |
| Rmarkdown-starter.Rmd           | 3.4 KB   | Sep 27, 2022, 9:06 AM  |
| sample_1hr_QC_data.csv          | 273.3 KB | Apr 1, 2021, 12:17 PM  |
| StarterCode.R                   | 358 B    | Feb 27, 2020, 10:41 AM |
| ~\$E587-Hmk5-2022.docx          | 162 B    | Sep 27, 2022, 9:09 AM  |
| BAE587_QClab_yourname.html      | 757.8 KB | Sep 27, 2022, 10:36 AM |
| BAE587_QClab_yourname.docx      | 38.2 KB  | Sep 27, 2022, 10:36 AM |
| BAE587_QClab_yourname.pdf       | 210.9 KB | Sep 27, 2022, 10:36 AM |
| ~\$BAE587-QCHmk5-usingR-2...    | 165 B    | Sep 27, 2022, 10:37 AM |

# 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

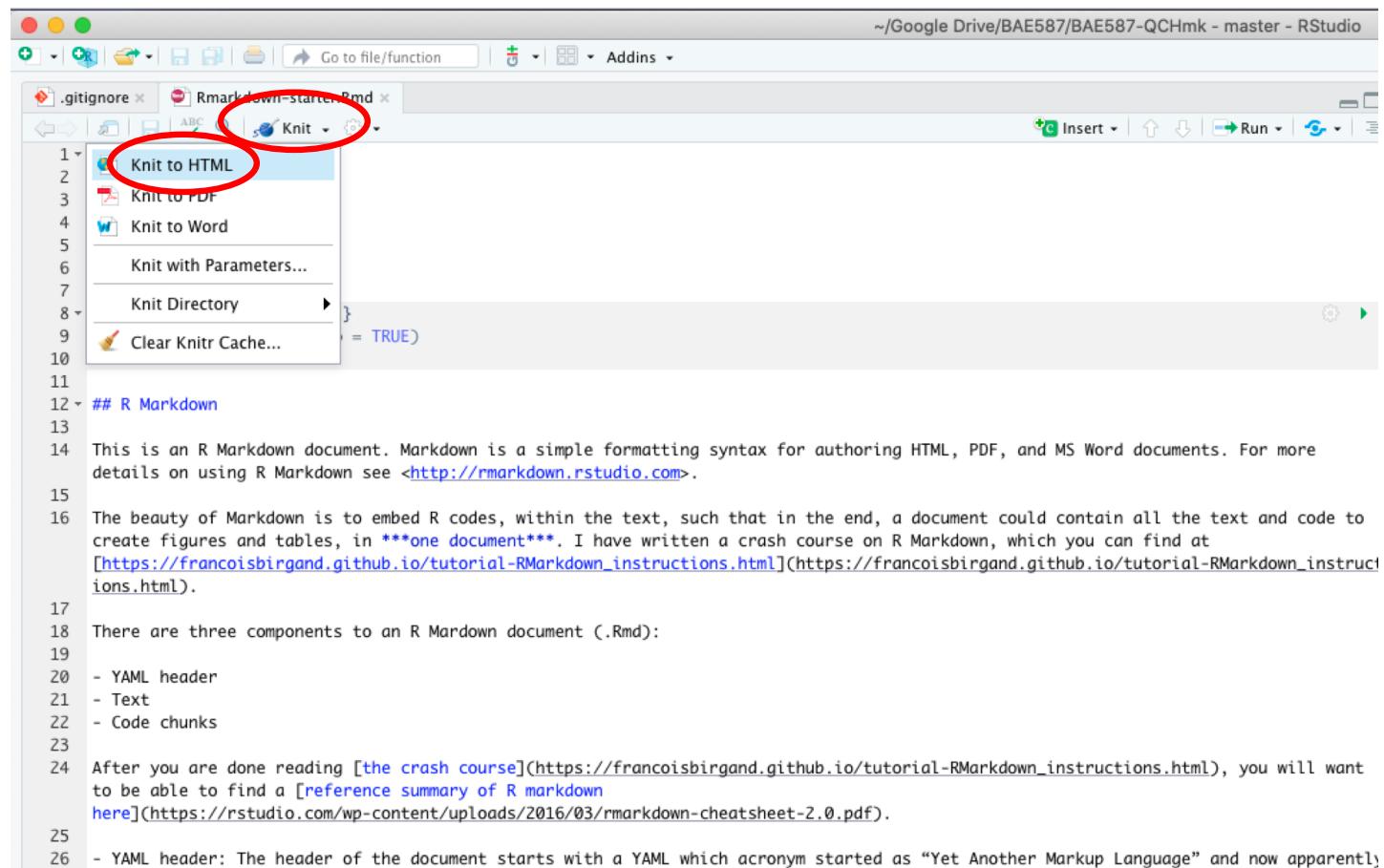


```
_build.sh x StarterCode.R x
Source on Save | Run | Source | E

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 file 'Rmarkdown-starter.Rmd' open. The 'Knit' dropdown menu is displayed, with the option 'Knit to HTML' highlighted and circled in red. The code editor below shows an R Markdown document with several lines of text and code chunks.

```
1 Knit to HTML
2 Knit to PDF
3 Knit to Word
4 Knit with Parameters...
5 Knit Directory
6 = TRUE)
7
8
9
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 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).
17
18 There are three components to an R Markdown document (.Rmd):
19
20 - YAML header
21 - Text
22 - Code chunks
23
24 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).
25
26 - 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



## Rmarkdown-starter

François Birgand

2022-09-27

### 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).

### The three components of an R markdown document

There are three components to an R Mardown document (.Rmd):

- YAML header
- Text
- Code chunks

After you are done reading [the crash course](#), you will want to be able to find a [reference summary of R markdown here](#).

- YAML header: The header of the document starts with a YAML which acronym started as "Yet Another Markup Language" and now apparently stands for "YAML Ain't Markup Language"... The YAML Header specifies how the document will be formatted.
- Text: most of your writing will be done using plain text, very much like you have been doing with Word, with mark-up alterations. Many details on mark-up are in [the crash course](#). Spell check can be done using
  - A spell check button to the right of the save button (with "ABC" and a check mark).
  - Edit > Check Spelling...
  - The F7 key
- Code Chunks: This is where you will add the actual R code that will create tables and figures.

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
```

# Open BAE587-Code-Examples-2022.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 a rendered document (\*.html , \*.pdf, or \*.docx)