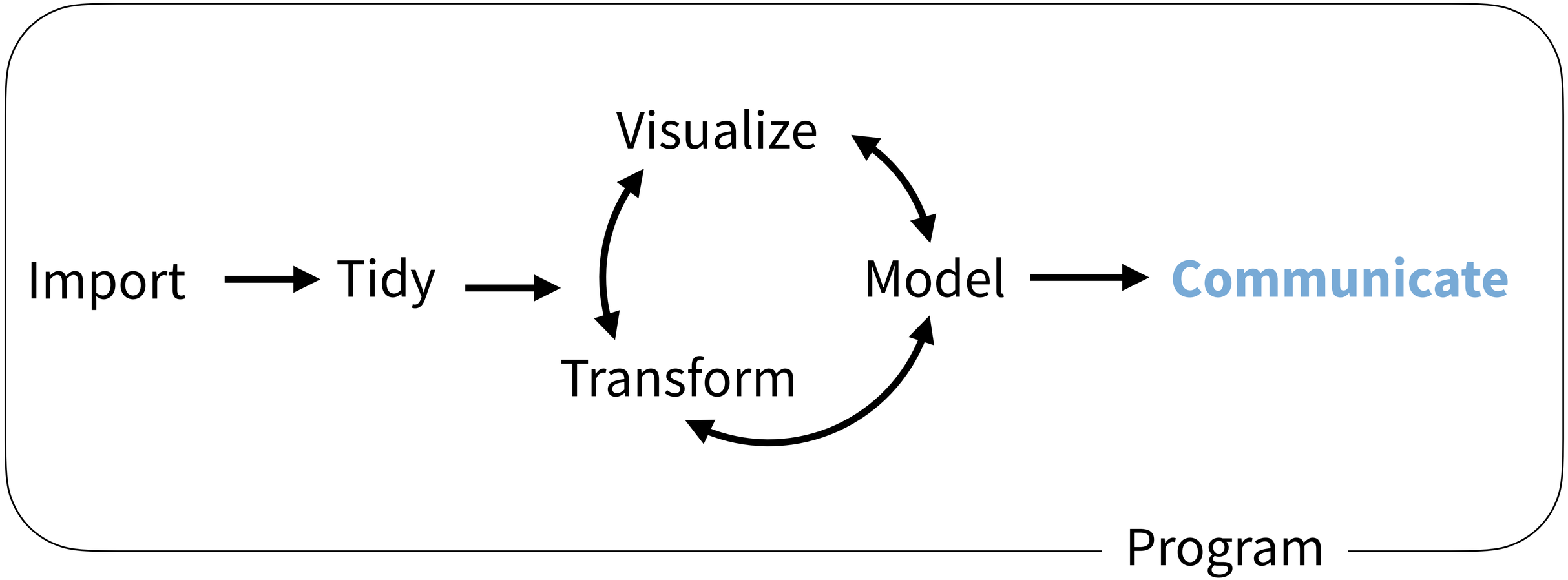
# Report Reproducibly with

Navigate to the main page of the class: **https://astamm.github.io/data-science-with-r/**.

Download **05-Report-Exercises.qmd** and **05-Report-Parameters.qmd** from the outline table and open them.

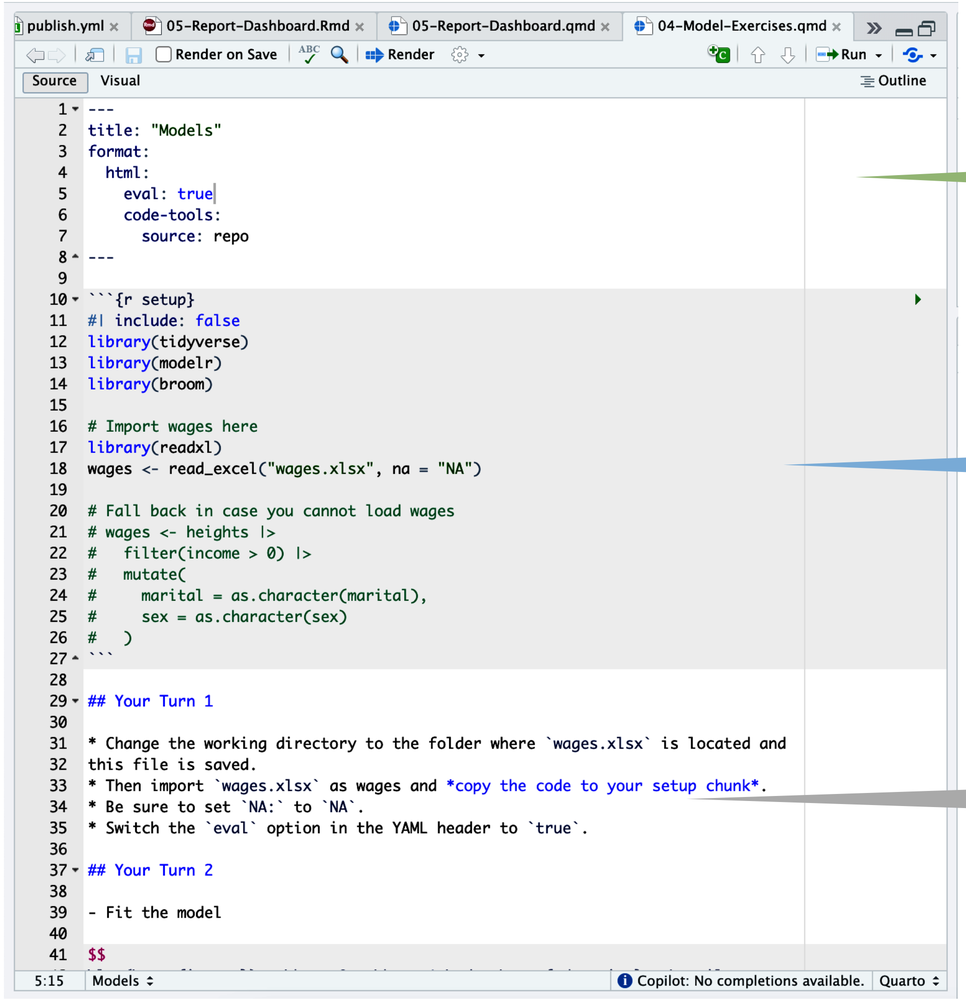
# (Applied) **Data Science**



# Quarto

# Quarto

## Plain text file with 3 types of content:




A YAML header surrounded by

— — —

Code chunks surrounded by

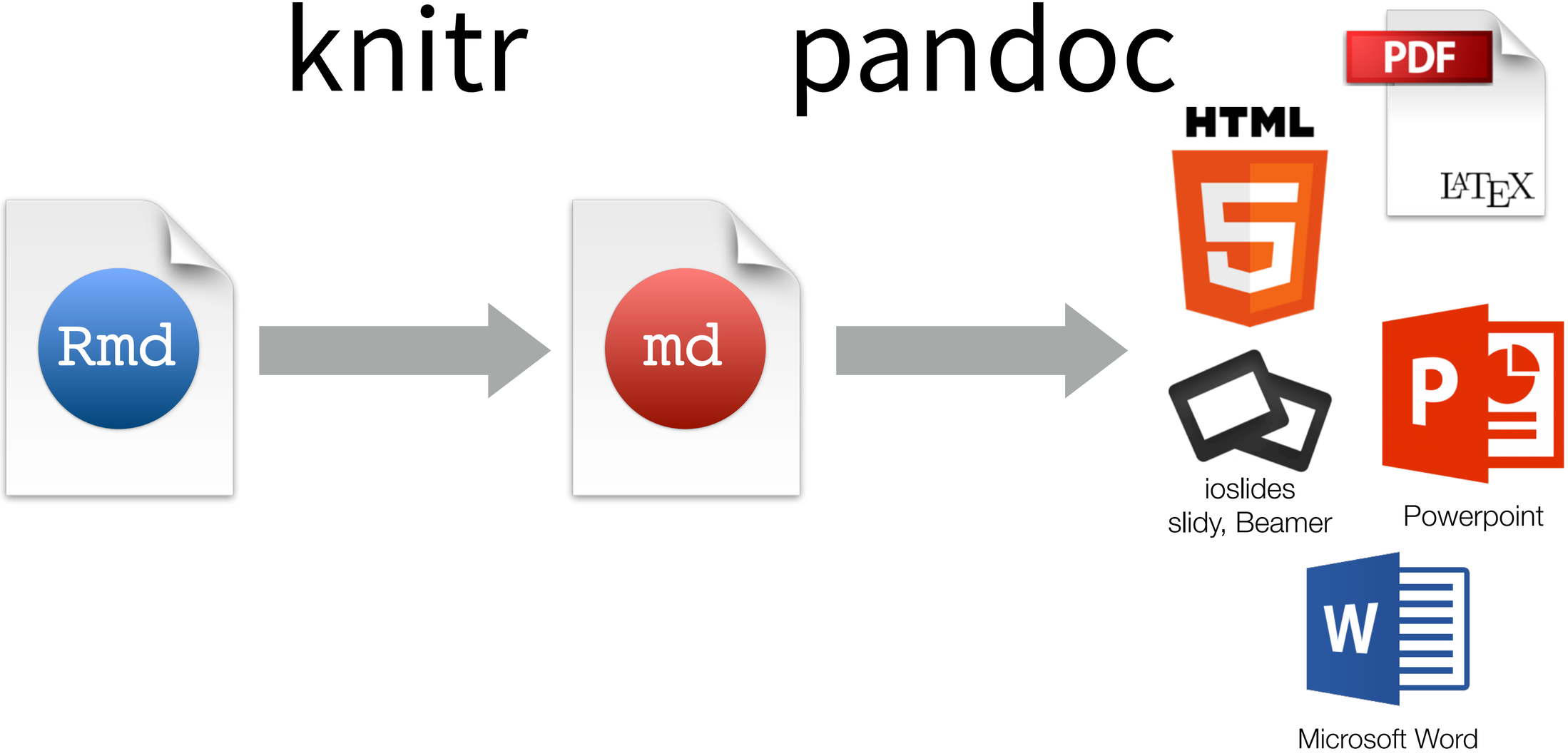
```

Text in markdown

quarto
```

# How it works

# knitr pandoc




quarto

# Logistics

**1** Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

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# Logistics

1. Knitr runs the document in a fresh R session, which means you need to load the libraries that the document uses *in the document*

2. Objects made in one code chunk will be available to code in later code chunks.

quarto

# KNITR IS MULTI-LINGUAL!

SAS

PYTHON

MORE

quarto

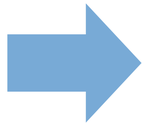
# engine

python

To embed non R code, change the chunk label from r to the language to use.

````
Some python code,

```{python}
x = 'hello, python world!'
print(x)
print(x.split(' '))
```
````



Some python code:

```
x = 'hello, python world!'
print(x)
print(x.split(' '))
```

```
## hello, python world!
## ['hello,', 'python', 'world!']
```

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# Reticulate

ON THIS PAGE



## Combining R and Python with {reticulate} and Quarto

Sometimes you might need to use R. Sometimes you might need to use Python. Sometimes you need to use both at the same time. This blog post shows you how to combine R and Python code using {reticulate} and output the results using Quarto.

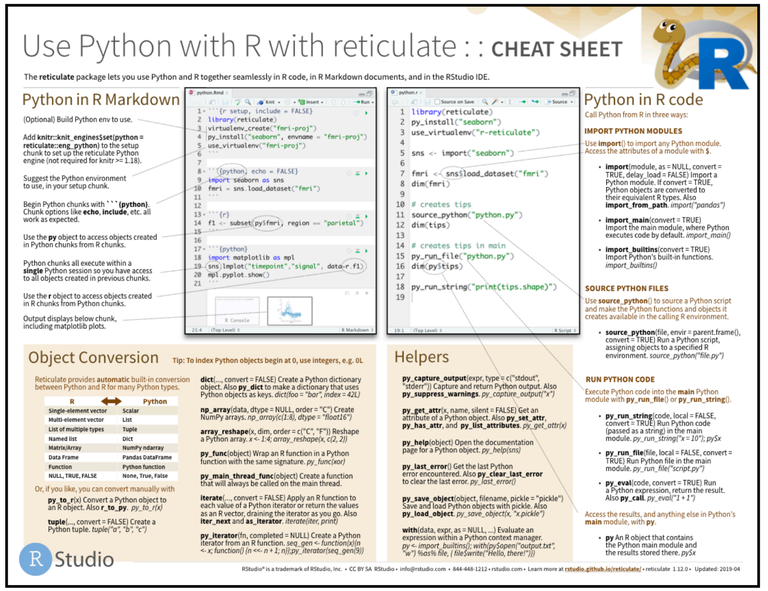
JANUARY 6, 2023

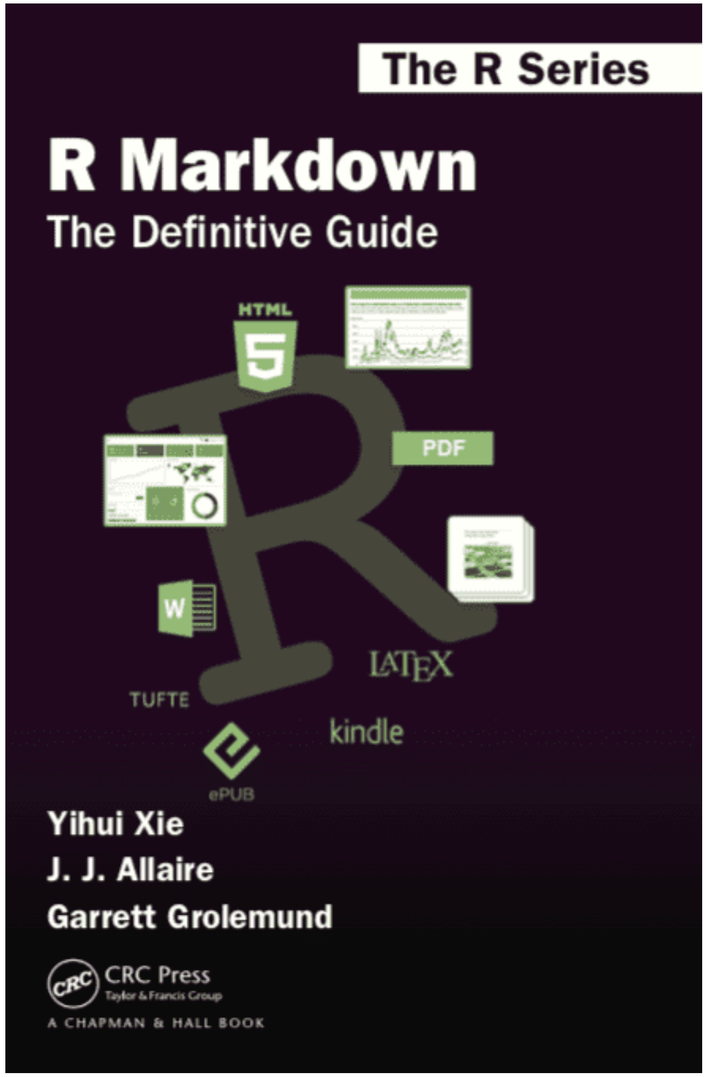
The R versus Python debate has been going on for as long as both languages have existed. I'm not one to takes sides - I think you need to use the best tool for the job. Sometimes R will be better. Sometimes Python will be better. But what happens if you need both languages in the same workflow? Do you need to choose? No, is the simple answer. You can use both. This blog post will show you how you can combine R and Python code in the same analysis using {reticulate} and output the results using Quarto.

### What is Quarto?

Quarto is an open-source scientific and technical publishing system that lets you combine narrative text with code to create reproducible and elegantly formatted output. If you're familiar with R Markdown, Quarto might sound somewhat similar - you can think of Quarto as next generation of R Markdown. The great thing about Quarto is that it doesn't just support code written in R - it supports other languages, including Python!

Quarto documents have two main sections: (i) the YAML header, where we specify document-wide properties such as the output format, and (ii) the content, which can include text, images, code, and more. For the example in this blog post, I'm going to output the code and results from the analysis to revealjs slides so my YAML header looks like this:








# Guide

Comprehensive guide to using Quarto. If you are just starting out, you may want to explore the tutorials to learn the basics.

### Authoring
Create content with markdown

Markdown Basics
Figures
Tables
Diagrams
Citations
Cross References
Article Layout
Shortcodes

### Computations
Execute code and display its output

Using Python
Using R
Using Julia
Using Observable
Execution Options
Parameters

### Tools
Use your favorite tools with Quarto

JupyterLab
RStudio IDE
VS Code
Neovim
Text Editors
Visual Editor

### Documents
Generate output in many formats

HTML
PDF
MS Word
Typst
Markdown
All Formats

### Presentations
Present code and technical content

Presentation Basics
Revealjs (HTML)
PowerPoint (Office)
Beamer (PDF)

### Dashboards
Publish data with dashboards

Dashboard Basics
Layout
Data Display
Interactivity
Deployment

### Websites
Create websites and blogs

Creating a Website
Website Navigation
Creating a Blog
Website Search
Website Listings

### Books
Create books and manuscripts

Creating a Book
Book Structure
Book Crossrefs
Customizing Output

### Manuscripts
Write and publish

### Interactivity
Engage readers with

### Publishing
Publishing documents

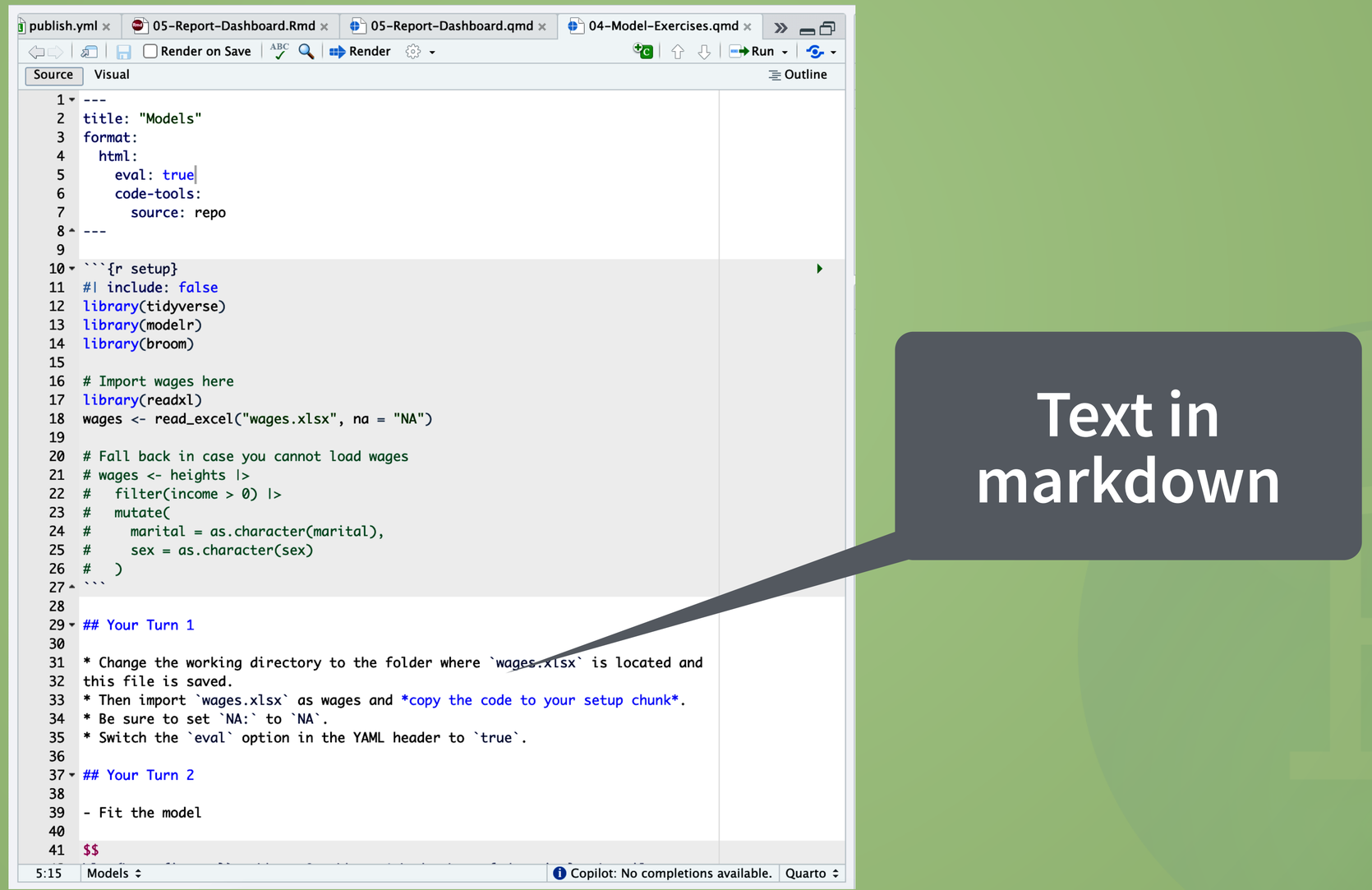
### Projects
Scale up your work with

bookdown.org/yihui/rmarkdown/

ONLINE, FREE

quarto

# Markdown

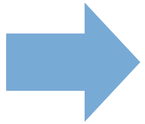


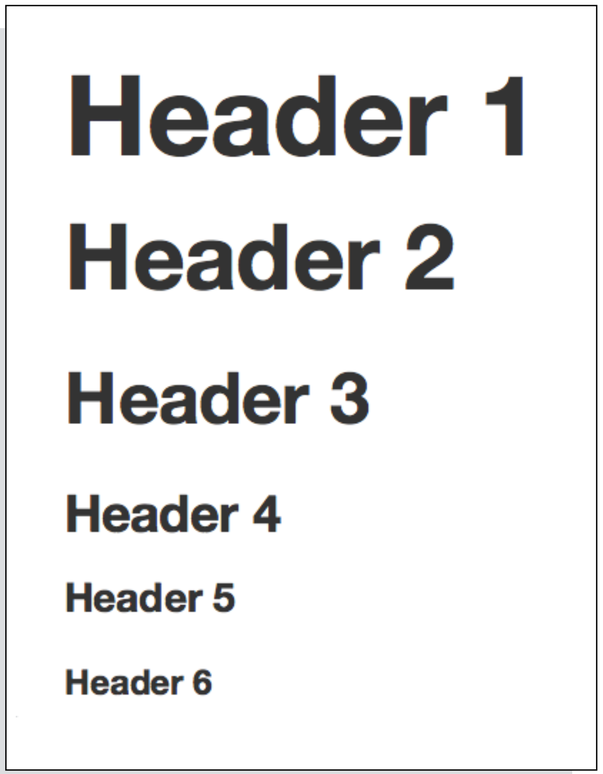

Text in markdown

# Headers

Use # to create headers.
Multiple #’s create lower level headers.

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





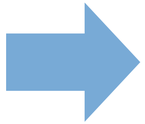

quarto

# Text

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

Text is rendered as plain text. Surround text with _, **, or ` to format it.

```
Text
_italics_
**bold**
`code`
```



Text

*italics*

**bold**

`code`

quarto

# Lists

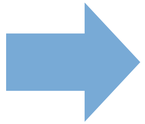
Use asterisks to make bullet points.
Use numbers to make numbered lists.

```
Bullets

* bullet 1
* bullet 2

Numbered list

1. item 1
2. item 2
```



Bullets

- bullet 1
- bullet 2

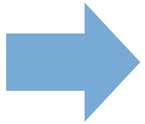
Numbered list

1. item 1
2. item 2

# Hyperlinks

Use brackets to denote a link.
Place the URL in parentheses.

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



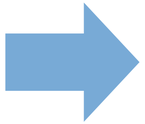

quarto

# Images

Use a link preceded by an ! to insert an image.

*The link text should be a URL (if the image is hosted online), or a file path (if the image is saved as a file)*

```
![](images/1.png)
The RStudio logo.
```

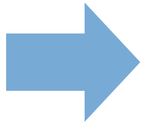



quarto

# Equations

Write equations with latex math commands and surround them in $'s.

```
According to
Einstein,
$E=mc^{2}$
```



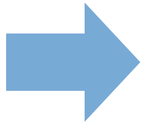
According to Einstein, $E = mc^2$

# Equation blocks

Use two $'s to make centered equation blocks.

```
According to Einstein,

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

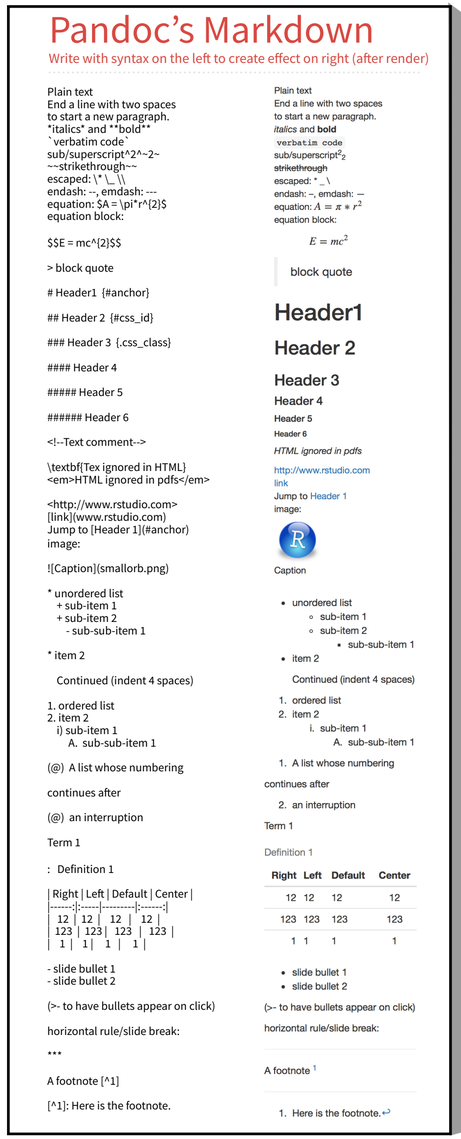


According to Einstein,

$$E = mc^2$$

# Markdown

## Dictionary of formatting cues.



Pandoc's Markdown

Write with syntax on the left to create effect on right (after render)

Plain text
End a line with two spaces
to start a new paragraph.
*italics* and **bold**
`verbatim code`
sub/superscript^2^~2~
~~strikethrough~~
escaped: * _ \\
endash: --, emdash: ---
equation: $A = \pi*r^{2}$
equation block:

$$E = mc^{2}$$

> block quote

# Header1 {#anchor}

## Header 2 {#css_id}

### Header 3 {.css_class}

#### Header 4

##### Header 5

###### Header 6

<!--Text comment-->

\textbf{Tex ignored in HTML}
HTML ignored in pdfs

<http://www.rstudio.com>
[link](www.rstudio.com)
Jump to [Header 1](#anchor)
image:

![Caption](smallorb.png)

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

* item 2

  Continued (indent 4 spaces)

1. ordered list
2. item 2
   i) sub-item 1
      A. sub-sub-item 1

(@) A list whose numbering

continues after

(@) an interruption

Term 1

: Definition 1

| Right | Left | Default | Center |
|------:|:-----|---------|:------:|
| 12 | 12 | 12 | 12 |
| 123 | 123 | 123 | 123 |
| 1 | 1 | 1 | 1 |

- slide bullet 1
- slide bullet 2

(>- to have bullets appear on click)

horizontal rule/slide break:

***

A footnote [^1]

[^1]: Here is the footnote.

Plain text
End a line with two spaces
to start a new paragraph.
*italics* and **bold**
`verbatim code`
sub/superscript$^2$~2~
~~strikethrough~~
escaped: * _ \
endash: --, emdash: —
equation: $A = \pi * r^2$
equation block:

$$E = mc^2$$

> block quote

# Header1

## Header 2

### Header 3

#### Header 4

##### Header 5

###### Header 6

*HTML ignored in pdfs*

http://www.rstudio.com
link
Jump to Header 1
image:

Caption

- unordered list
  - sub-item 1
  - sub-item 2
    - sub-sub-item 1
- item 2

  Continued (indent 4 spaces)

1. ordered list
2. item 2
   i. sub-item 1
      A. sub-sub-item 1

1. A list whose numbering

continues after

2. an interruption

Term 1

Definition 1

| Right | Left | Default | Center |
|---:|:---|---|:---:|
| 12 | 12 | 12 | 12 |
| 123 | 123 | 123 | 123 |
| 1 | 1 | 1 | 1 |

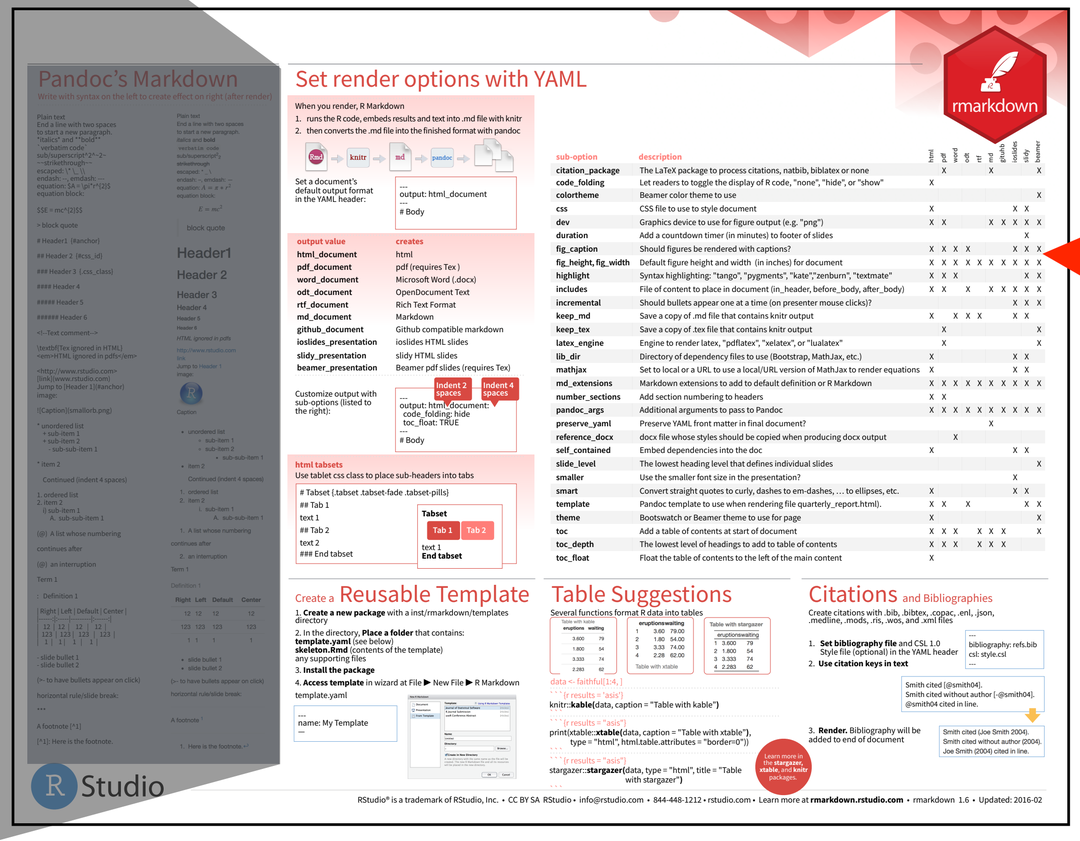
- slide bullet 1
- slide bullet 2

(>- to have bullets appear on click)

horizontal rule/slide break:

A footnote [1]

1. Here is the footnote. ↩



Pandoc's Markdown

Write with syntax on the left to create effect on right (after render)

Set render options with YAML

When you render, R Markdown
1. runs the R code, embeds results and text into .md file with knitr
2. then converts the .md file into the finished format with pandoc

Set a document's default output format in the YAML header:

```
---
output: html_document
---
# Body
```

| output value | creates |
|---|---|
| html_document | html |
| pdf_document | pdf (requires Tex ) |
| word_document | Microsoft Word (.docx) |
| odt_document | OpenDocument Text |
| rtf_document | Rich Text Format |
| md_document | Markdown |
| github_document | Github compatible markdown |
| ioslides_presentation | ioslides HTML slides |
| slidy_presentation | slidy HTML slides |
| beamer_presentation | Beamer pdf slides (requires Tex) |

Customize output with sub-options (listed to the right):

Indent 2 spaces / Indent 4 spaces

```
---
output: html_document:
  code_folding: hide
  toc_float: TRUE
---
# Body
```

html tabsets
Use tablet css class to place sub-headers into tabs

```
# Tabset {.tabset .tabset-fade .tabset-pills}
## Tab 1
text 1
## Tab 2
text 2
### End tabset
```

Tabset: Tab 1 | Tab 2
text 1
End tabset

rmarkdown

| sub-option | description | html | pdf | word | odt | rtf | md | github_document | ioslides | slidy | beamer |
|---|---|---|---|---|---|---|---|---|---|---|---|
| citation_package | The LaTeX package to process citations, natbib, biblatex or none | | X | | | | X | | | | X |
| code_folding | Let readers to toggle the display of R code, "none", "hide", or "show" | X | | | | | | | | | |
| colortheme | Beamer color theme to use | | | | | | | | | | X |
| css | CSS file to use to style document | X | | | | | | | | X | X |
| dev | Graphics device to use for figure output (e.g. "png") | X | X | | | | X | X | X | X | X |
| duration | Add a countdown timer (in minutes) to footer of slides | | | | | | | | | X | |
| fig_caption | Should figures be rendered with captions? | X | X | X | X | | | | X | X | X |
| fig_height, fig_width | Default figure height and width (in inches) for document | X | X | X | X | X | X | X | X | X | X |
| highlight | Syntax highlighting: "tango", "pygments", "kate","zenburn", "textmate" | X | X | X | | | | | | X | X |
| includes | File of content to place in document (in_header, before_body, after_body) | X | X | | X | | X | X | X | X | X |
| incremental | Should bullets appear one at a time (on presenter mouse clicks)? | | | | | | | | X | X | X |
| keep_md | Save a copy of .md file that contains knitr output | X | | X | X | X | | | X | X | |
| keep_tex | Save a copy of .tex file that contains knitr output | | X | | | | | | | | X |
| latex_engine | Engine to render latex, "pdflatex", "xelatex", or "lualatex" | | X | | | | | | | | X |
| lib_dir | Directory of dependency files to use (Bootstrap, MathJax, etc.) | X | | | | | | | X | X | |
| mathjax | Set to local or a URL to use a local/URL version of MathJax to render equations | X | | | | | | | X | X | |
| md_extensions | Markdown extensions to add to default definition or R Markdown | X | X | X | X | X | X | X | X | X | X |
| number_sections | Add section numbering to headers | X | X | | | | | | | | |
| pandoc_args | Additional arguments to pass to Pandoc | X | X | X | X | X | X | X | X | X | X |
| preserve_yaml | Preserve YAML front matter in final document? | | | | | | X | | | | |
| reference_docx | docx file whose styles should be copied when producing docx output | | | X | | | | | | | |
| self_contained | Embed dependencies into the doc | X | | | | | | | X | X | |
| slide_level | The lowest heading level that defines individual slides | | | | | | | | | | X |
| smaller | Use the smaller font size in the presentation? | | | | | | | | X | | |
| smart | Convert straight quotes to curly, dashes to em-dashes, … to ellipses, etc. | X | | | | | | | X | X | |
| template | Pandoc template to use when rendering file quarterly_report.html). | X | X | | X | | | | | X | X |
| theme | Bootswatch or Beamer theme to use for page | X | | | | | | | | | X |
| toc | Add a table of contents at start of document | X | X | X | | X | X | X | | | X |
| toc_depth | The lowest level of headings to add to table of contents | X | X | X | | X | X | X | | | |
| toc_float | Float the table of contents to the left of the main content | X | | | | | | | | | |

Create a Reusable Template

1. **Create a new package** with a inst/rmarkdown/templates directory
2. In the directory, **Place a folder** that contains: **template.yaml** (see below) **skeleton.Rmd** (contents of the template) any supporting files
3. **Install the package**
4. **Access template** in wizard at File ▶ New File ▶ R Markdown

template.yaml

```
---
name: My Template
---
```

Table Suggestions

Several functions format R data into tables

```
data <- faithful[1:4, ]
```

```
knitr::kable(data, caption = "Table with kable")
```

```
print(xtable::xtable(data, caption = "Table with xtable"),
      type = "html", html.table.attributes = "border=0")
```

```
stargazer::stargazer(data, type = "html", title = "Table with stargazer")
```

Learn more in the **stargazer, xtable**, and **knitr** packages.

Citations and Bibliographies

Create citations with .bib, .bibtex, .copac, .enl, .json, .medline, .mods, .ris, .wos, and .xml files

1. **Set bibliography file** and CSL 1.0 Style file (optional) in the YAML header

```
---
bibliography: refs.bib
csl: style.csl
---
```

2. **Use citation keys in text**

Smith cited [@smith04].
Smith cited without author [-@smith04].
@smith04 cited in line.

Smith cited (Joe Smith 2004).
Smith cited without author (2004).
Joe Smith (2004) cited in line.

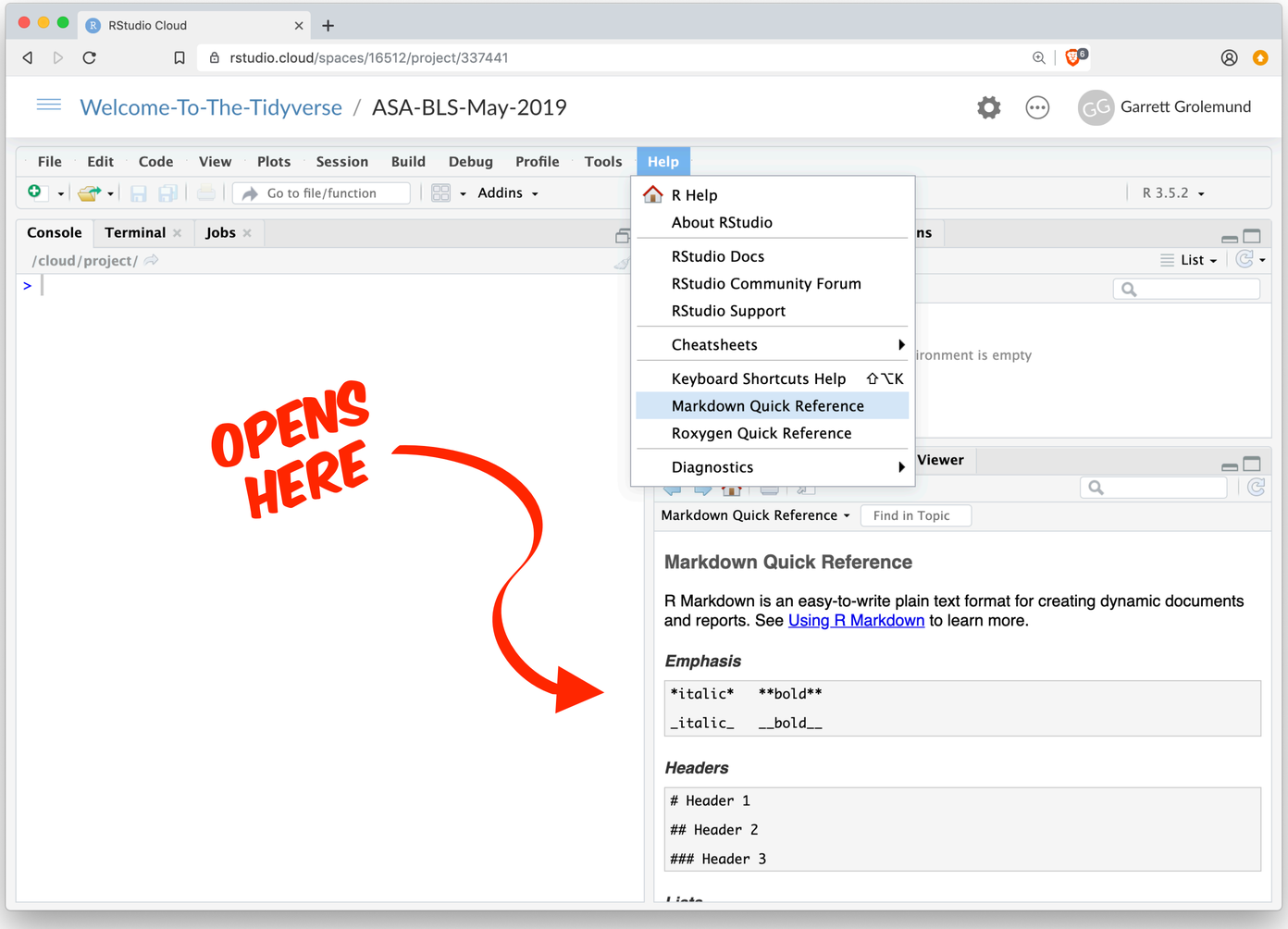
3. **Render.** Bibliography will be added to end of document

RStudio® is a trademark of RStudio, Inc. • CC BY SA RStudio • info@rstudio.com • 844-448-1212 • rstudio.com • Learn more at **rmarkdown.rstudio.com** • rmarkdown 1.6 • Updated: 2016-02

ON BACK OF RMARKDOWN CHEAT SHEET

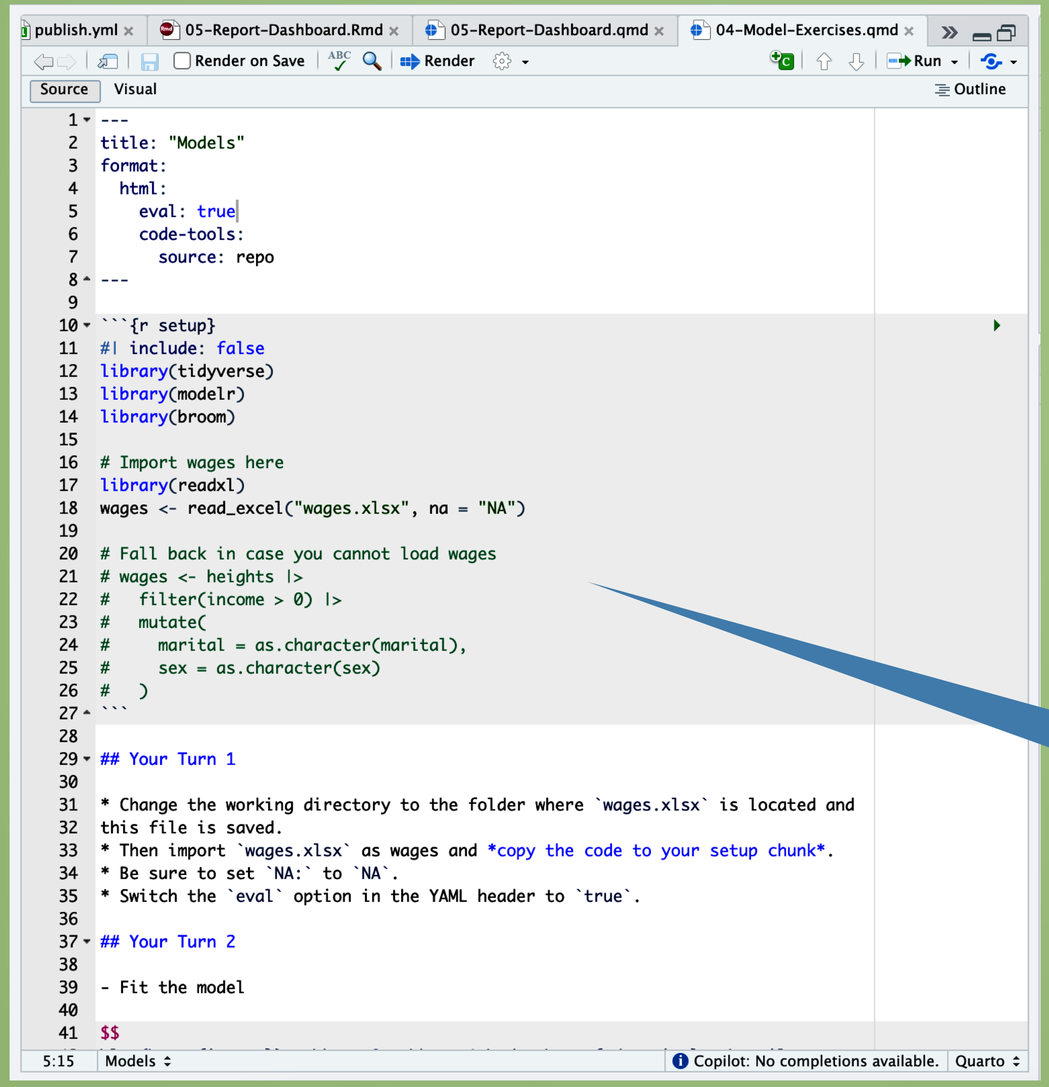
# IDE Reference

## Go to **Help > Markdown Quick Reference**




quarto

# Code




**Code chunks surrounded by ```**

# Code chunks

Insert a chunk of R code with

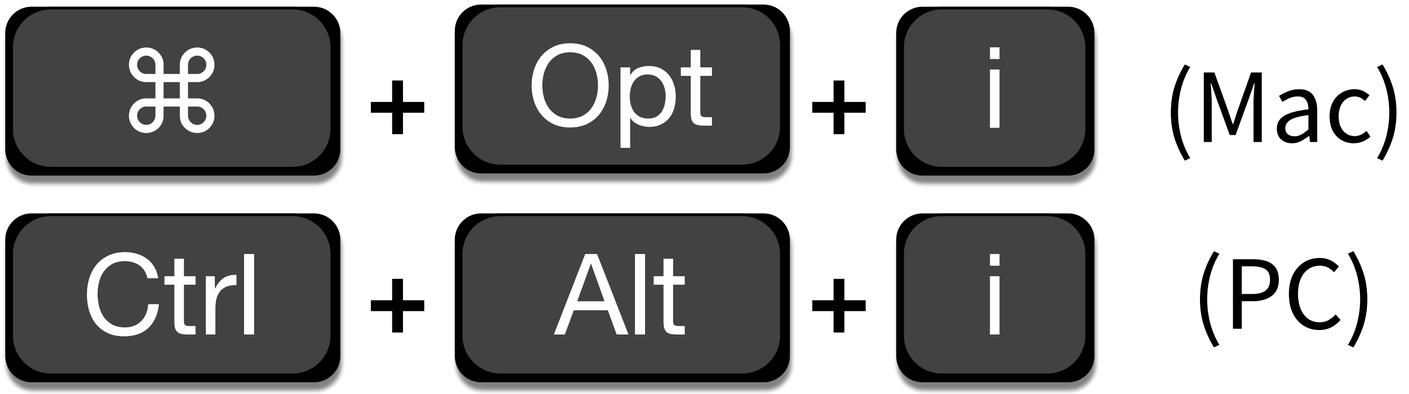
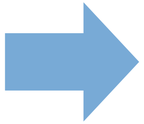
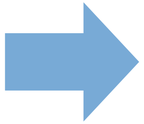
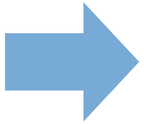
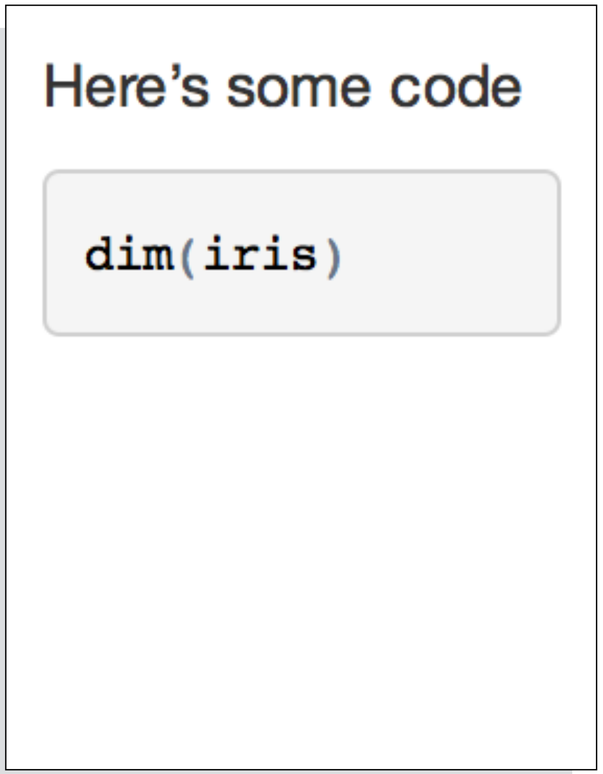
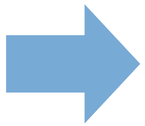
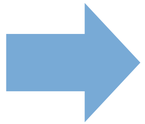
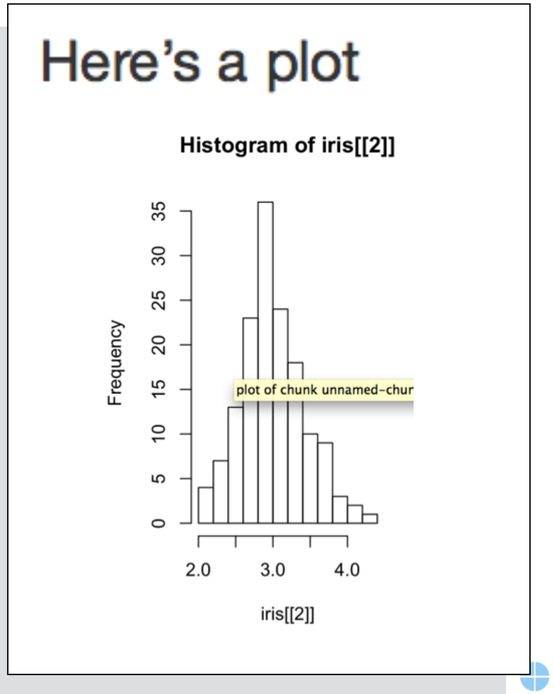
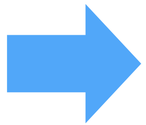
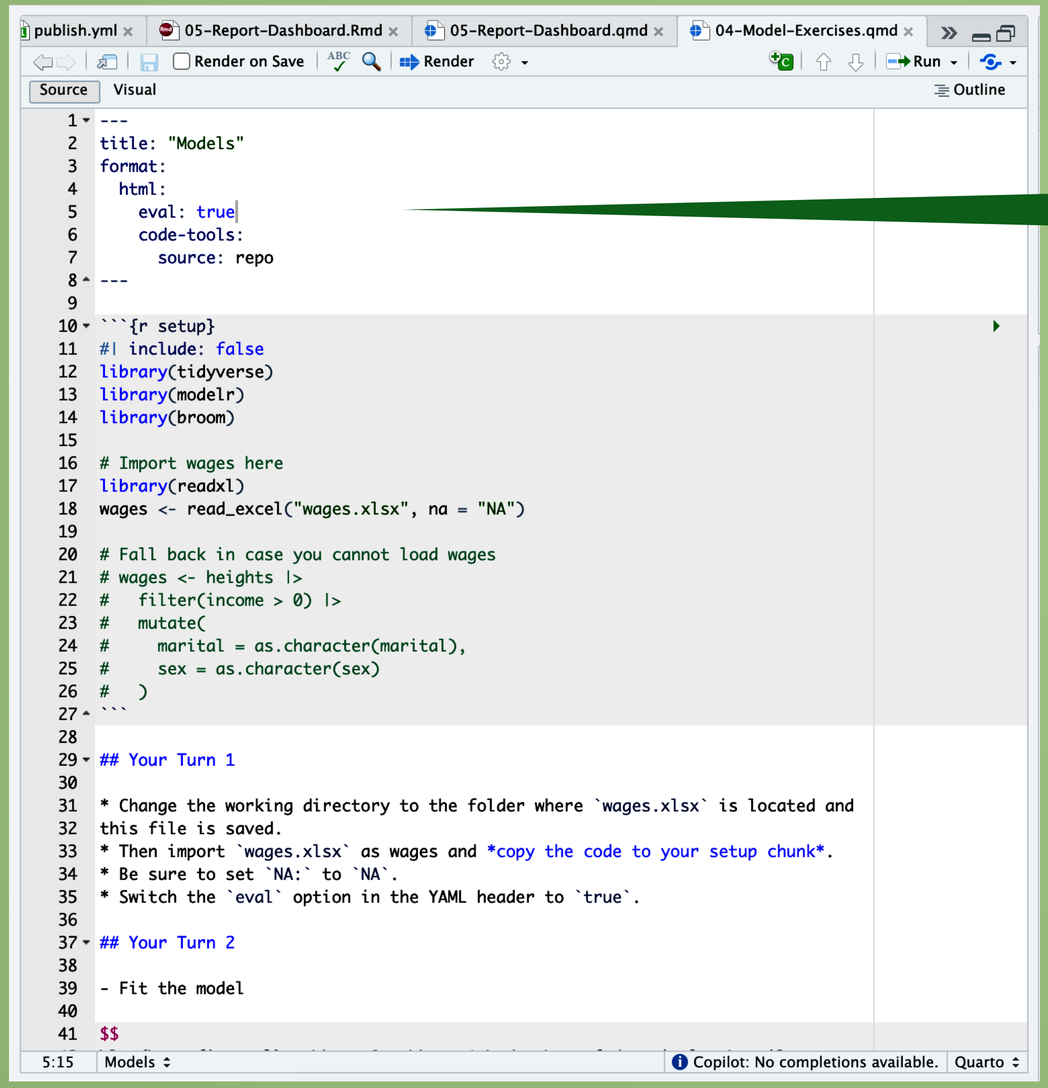
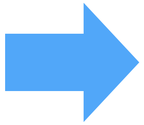
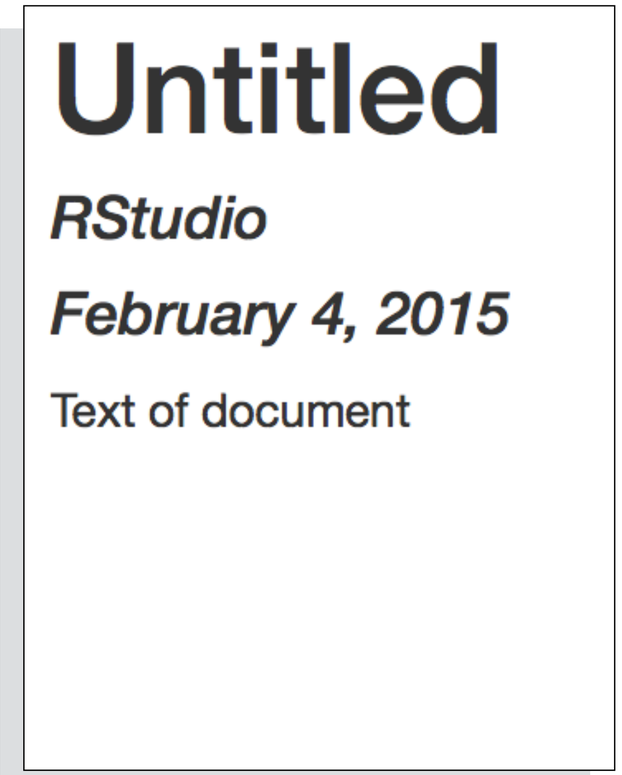
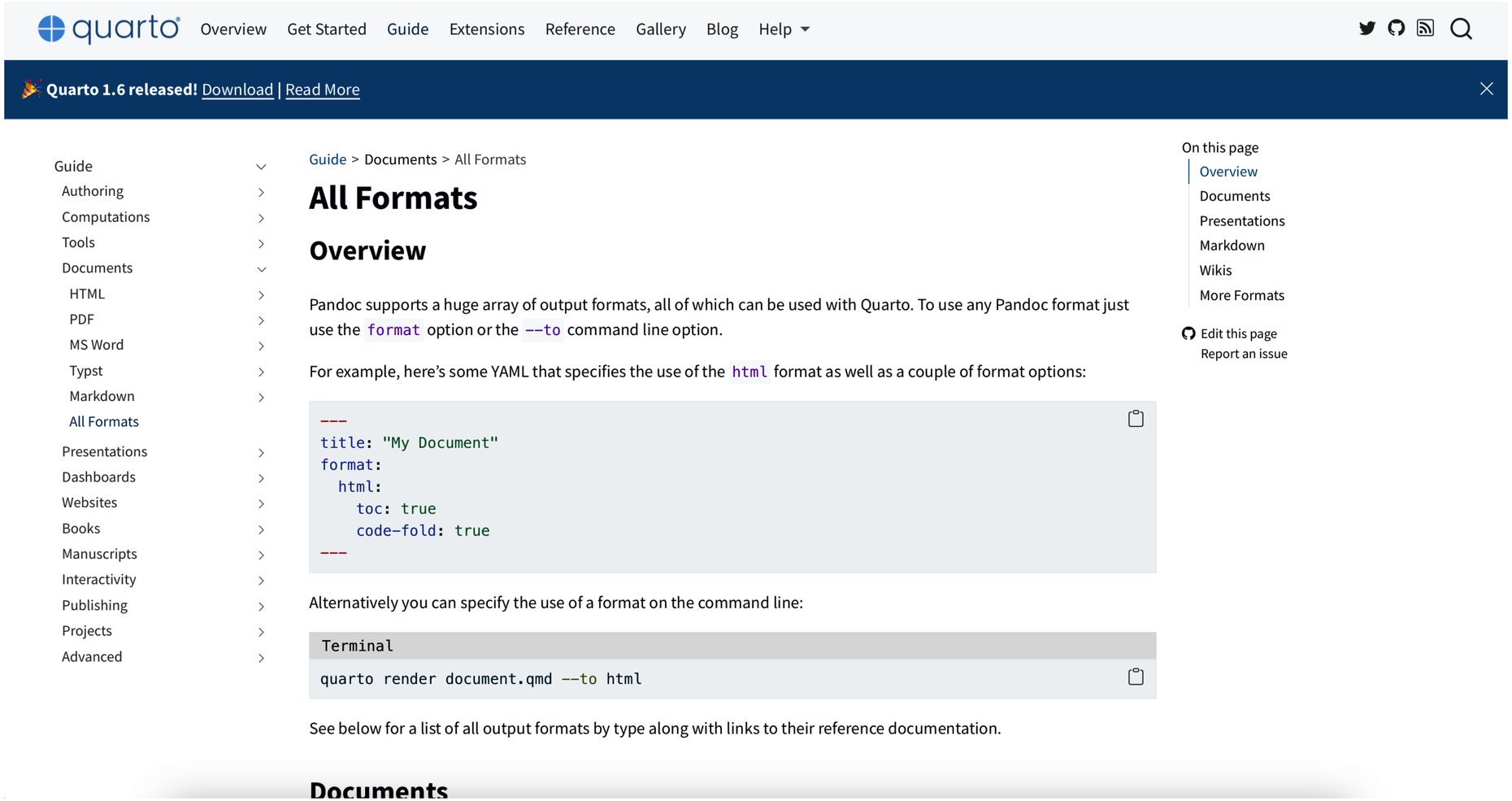
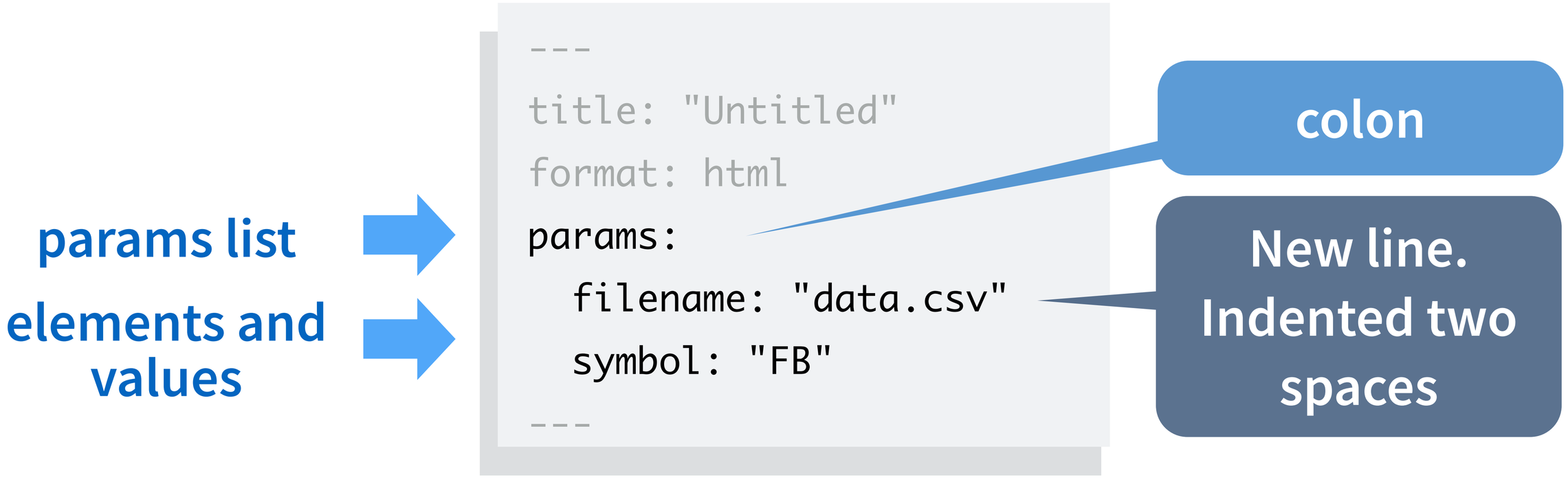
````
```{r}
# some code
```
````

When you render the report, R Markdown will run the code and include its results. R Markdown will also remove the ```` ```{r} ```` and ```` ``` ````.

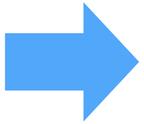
quarto

# Code chunks

Insert a chunk of R code with

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




quarto

# chunk options

By default, R Markdown includes both the code and its results

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



Here's some code

```
dim(iris)
```

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

quarto

# echo

Add options in the chunk by starting the line with `#|`.
**echo: false** hides the code.

````
Here's some code
```{r}
#| echo: false
dim(iris)
```
````



Here's some code

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

Very useful for plots

quarto

# eval

**eval: false** prevents the code from being run. As a result, no results will be displayed with the code.

````
Here's some code
```{r}
#| eval: false
dim(iris)
```
````






quarto

# include

**include: false** runs the code, but prevents both the code and the results from appearing (e.g. to setup).

````
Here's some code
```{r}
#| include: false
dim(iris)
```
````



Here's some code





quarto

# fig-height, fig-width

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

````
Here's a plot
```{r}
#| echo: false
#| fig-width: 3
#| fig-height: 5
hist(iris[[2]])
```
````






quarto

# Pop Quiz

Do you notice the **TODOs** in 05-RMarkdown-Exercises.qmd?

Do you notice the long **setup** chunk**?**

# Inline code

Place code in a sentence with `` `r <code>` ``.
Quarto will replace the code with its results.

```
Today is
`r Sys.Date()`.
```



Today is 2015-04-16.





quarto

# Inline code

Code whose results are inserted into the text.

```
Today is `r Sys.Date()`.
```

**Surround with `r `**

**Code to run. Only the result will be included.**

quarto

# Your Turn 1

In **05-RMarkdown-Exercises.qmd**:

1. Replace every Garrett with your name
2. Replace every TODO with inline R code
3. Check that the setup chunk is not included with the output
4. Ensure that only the output of the plot chunk is shown (not the code)
5. Knit the document

# YAML




A YAML header surrounded by — — —

# YAML

A section of key:value pairs
separated by dashed lines ———

```
---
title: "Untitled"
author: "RStudio"
date: "February 4, 2015"
format: html
---
Text of document
```






quarto

# format

## The format: field sets the format of the final report




quarto

# Parameters

# Your Turn 2

Open **05-RMarkdown-Parameters.qmd**.

Render the document.

Change the name property in the YAML header and re-render document. What happened?

# Parameters

A list of values that you can call in R code chunks








quarto

# Using Parameters

Call parameter values as elements of the params list, **`params$num`**

````
---
params:
  num: 42
---
The value of the
parameter is
`r params$num`, e.g.

```{r}
params$num
```
````



The value of the parameter is 42, e.g.

```
params$num
```

```
## [1] 42
```

quarto

# quarto::quarto_render() + for

```
names <- c("Alice", "Bob", "Cathy")

for (name in names) {
  quarto::quarto_render(“05-RMarkdown-
Parameters.Rmd”,
          execute_params = list(data = name))
}
```

quarto

# Demo

# Report Reproducibly with