Meet the toolkit: programming

Data Science in a Box

datasciencebox.org

Course toolkit

Course operation

- Course website
- Moodle

Doing data science

- Programming:
  - R
  - RStudio (server)
  - tidyverse
  - R Markdown
- Version control and collaboration:
  - Git
  - GitHub

Learning goals

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- gain insight from data, **reproducibly**
- gain insight from data, reproducibly, **using modern programming tools and techniques**
- gain insight from data, reproducibly **and collaboratively**, using modern programming tools and techniques
- gain insight from data, reproducibly **(with literate programming and version control)** and collaboratively, using modern programming tools and techniques

Reproducible data analysis

Reproducibility checklist

What does it mean for a data analysis to be "reproducible"?

Reproducibility checklist

> What does it mean for a data analysis to be "reproducible"?

Near-term goals:

- Are the tables and figures reproducible from the code and data?
- Does the code actually do what you think it does?
- In addition to what was done, is it clear *why* it was done?

Long-term goals:

- Can the code be used for other data?
- Can you extend the code to do other things?

Toolkit for reproducibility

- Scriptability $\rightarrow$ R
- Literate programming (code, narrative, output in one place) $\rightarrow$ R Markdown
- Version control $\rightarrow$ Git / GitHub

R and RStudio

R and RStudio

- R is an open-source statistical **programming language**
- R is also an environment for statistical computing and graphics
- It's easily extensible with *packages*

- RStudio is a convenient interface for R called an **IDE** (integrated development environment), e.g. *"I write R code in the RStudio IDE"*
- RStudio is not a requirement for programming with R, but it's very commonly used by R programmers and data scientists

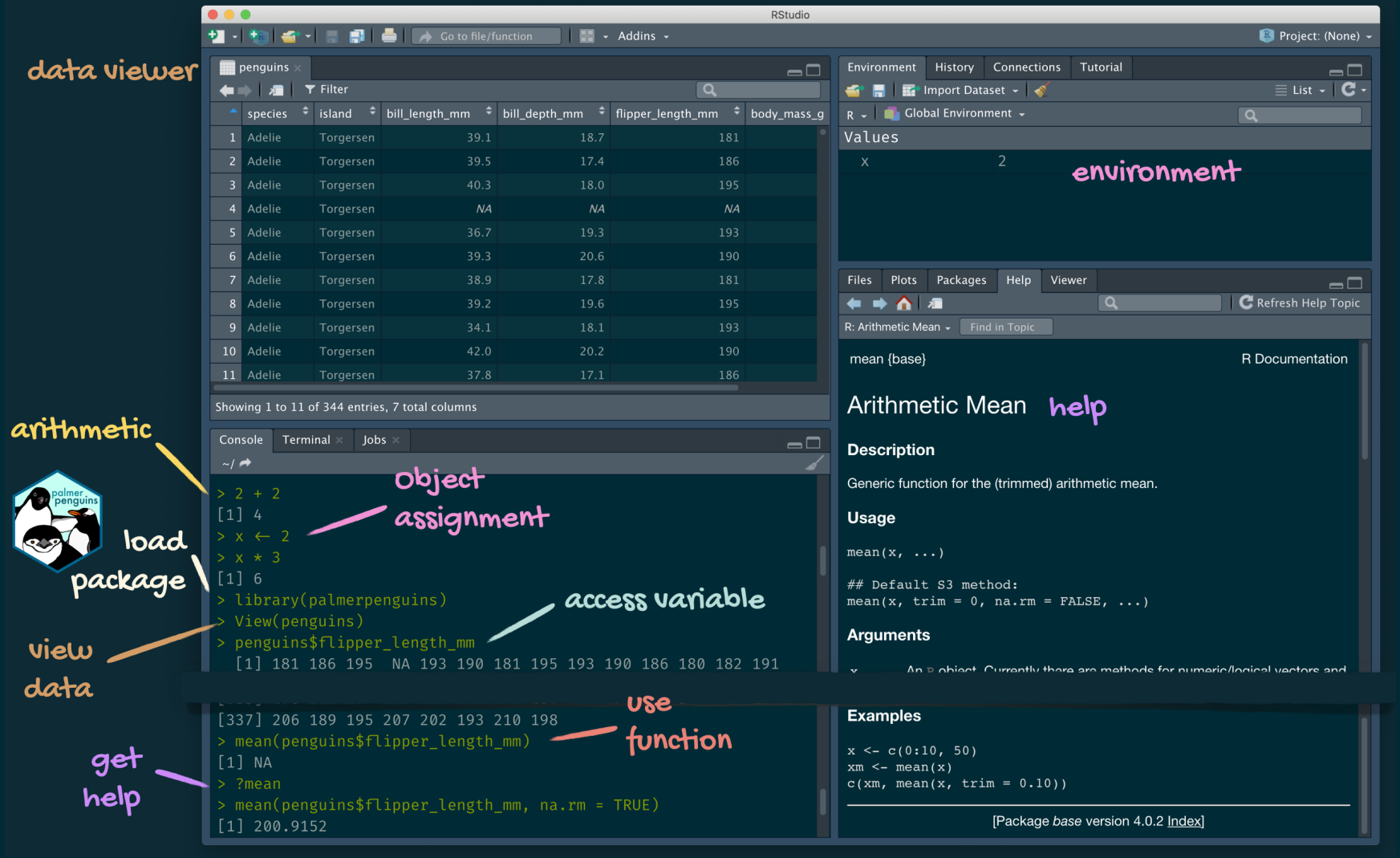
R packages

- **Packages** are the fundamental units of reproducible R code. They include reusable R functions, the documentation that describes how to use them, and sample data[1]
- As of September 2022, there are over 16,000 R packages available on **CRAN** (the Comprehensive R Archive Network)[2]
- We're going to work with a small (but important) subset of these!

[1] Wickham and Bryan, R Packages.

[2] CRAN contributed packages.

Tour: R and RStudio



A short list (for now) of R essentials

- Functions are (most often) verbs, followed by what they will be applied to in parentheses:

```
do_this(to_this)
do_that(to_this, to_that, with_those)
```

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```

- Packages are installed with the `install.packages` function and loaded with the `library` function, once per session:

```
install.packages("package_name")
library(package_name)
```

R essentials (continued)

- Columns (variables) in data frames are accessed with `$`:

```
dataframe$var_name
```

R essentials (continued)

- Columns (variables) in data frames are accessed with `$`:

```
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```

- Object documentation can be accessed with `?`

```
?mean
```

tidyverse

tidyverse.org

- The **tidyverse** is an opinionated collection of R packages designed for data science
- All packages share an underlying philosophy and a common grammar

rmarkdown

rmarkdown.rstudio.com

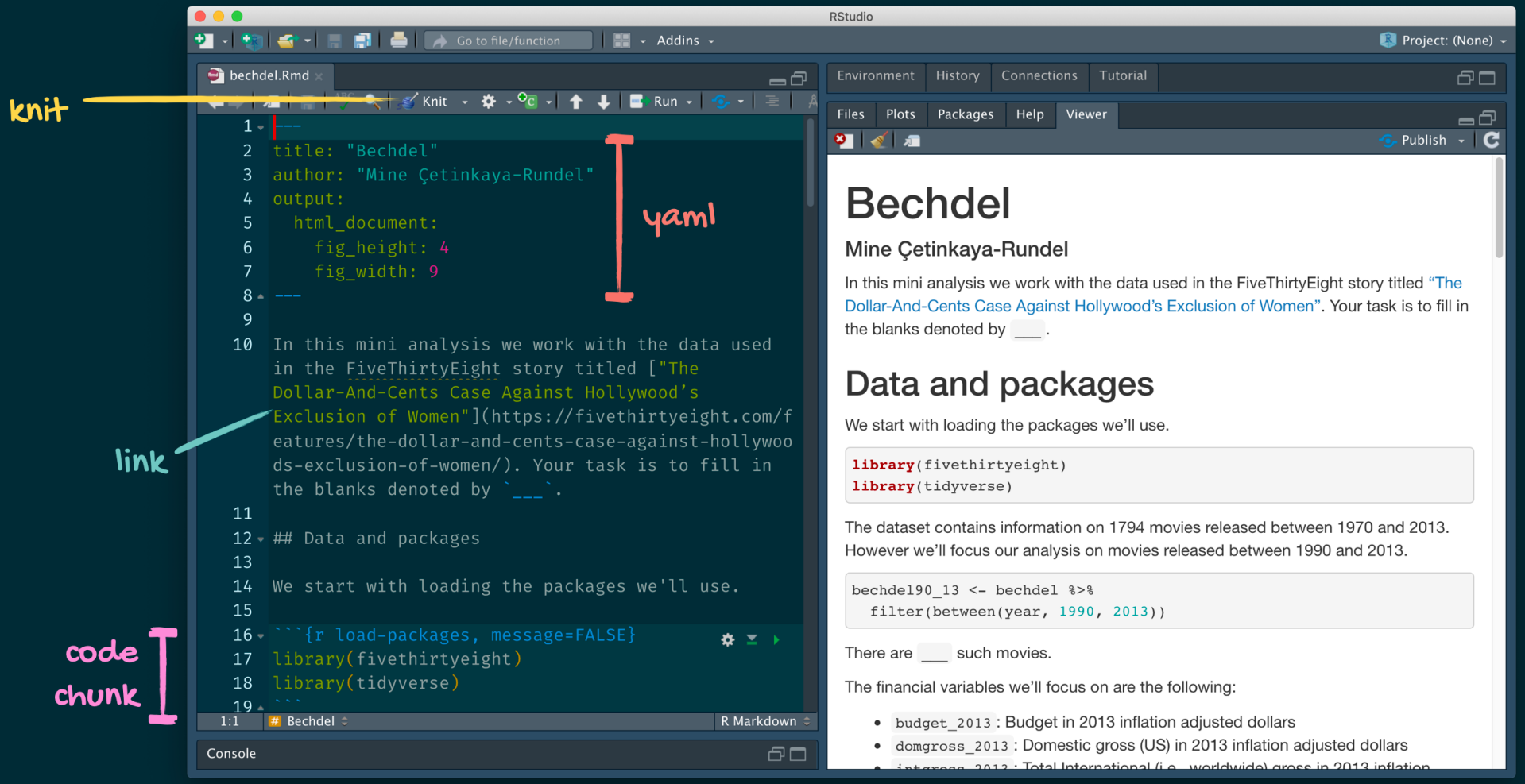
- **rmarkdown** and the various packages that support it enable R users to write their code and prose in reproducible computational documents
- We will generally refer to R Markdown documents (with `.Rmd` extension), e.g. *"Do this in your R Markdown document"* and rarely discuss loading the rmarkdown package

R Markdown

R Markdown

- Fully reproducible reports -- each time you knit the analysis is ran from the beginning
- Simple markdown syntax for text
- Code goes in chunks, defined by three backticks, narrative goes outside of chunks

Tour: R Markdown



Environments

> The environment of your R Markdown document is separate from the Console!

Remember this, and expect it to bite you a few times as you're learning to work with R Markdown!

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First, run the following in the console

```
x <- 2
x * 3
```

> All looks good, eh?

Environments

First, run the following in the console

```
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x * 3
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> All looks good, eh?

Then, add the following in an R chunk in your R Markdown document

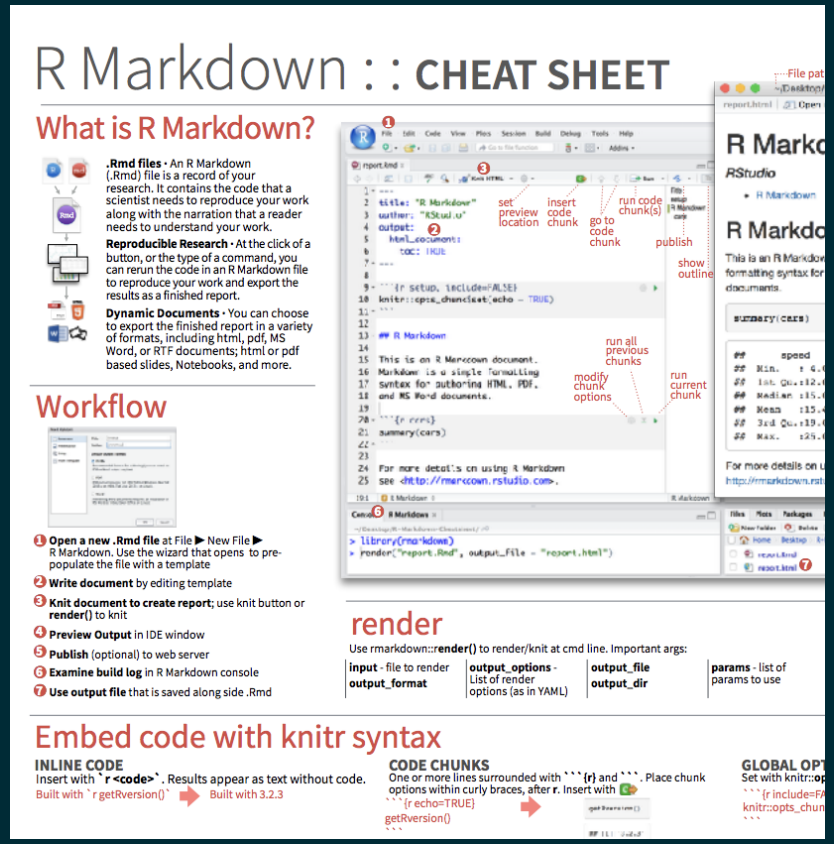
```
x * 3
```

> What happens? Why the error?

R Markdown help

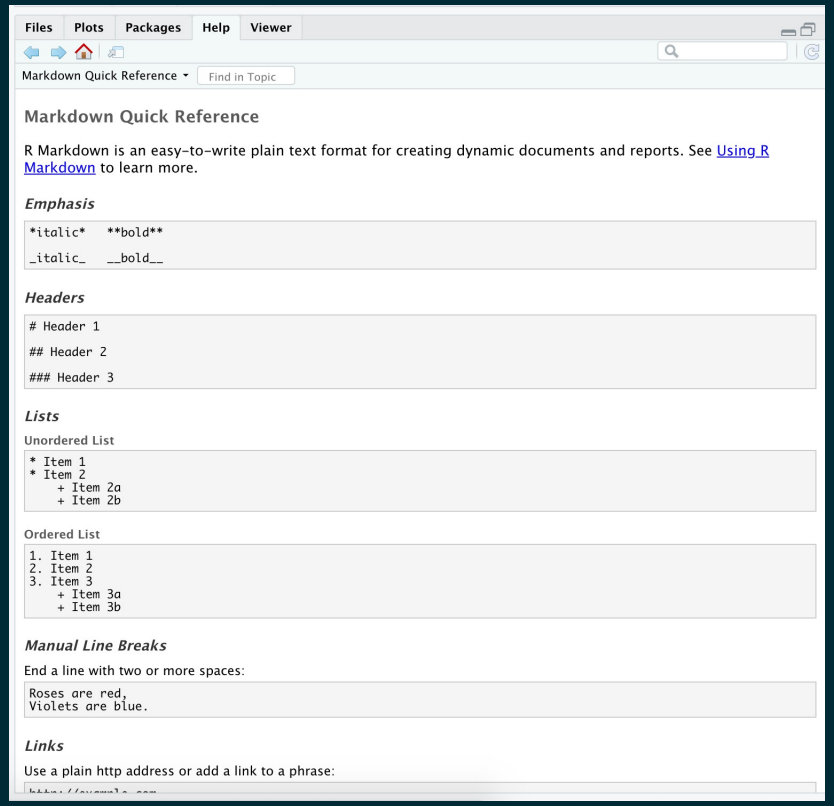
R Markdown Cheat Sheet

`Help -> Cheatsheets`



Markdown Quick Reference

`Help -> Markdown Quick Reference`



How will we use R Markdown?

- Every assignment / report / project / etc. is an R Markdown document
- You'll always have a template R Markdown document to start with
- The amount of scaffolding in the template will decrease over the semester

What's with all the hexes?

Mitchell O'Hara-Wild, useR! 2018 feature wall