Programming Toolkit for Data Science

Programming Toolkit: R

Course toolkit

Course operation

- Moodle
- Slack
- Zoom

Doing data science

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

Learning goals

By the end of the course, you will be able to...

- gain insight from data
- reproducibly **and collaboratively**,
- using modern programming tools and techniques

The following content is based on Mine Çetinkaya-Rundel's excellent book Data Science in a Box

Reproducible data analysis

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

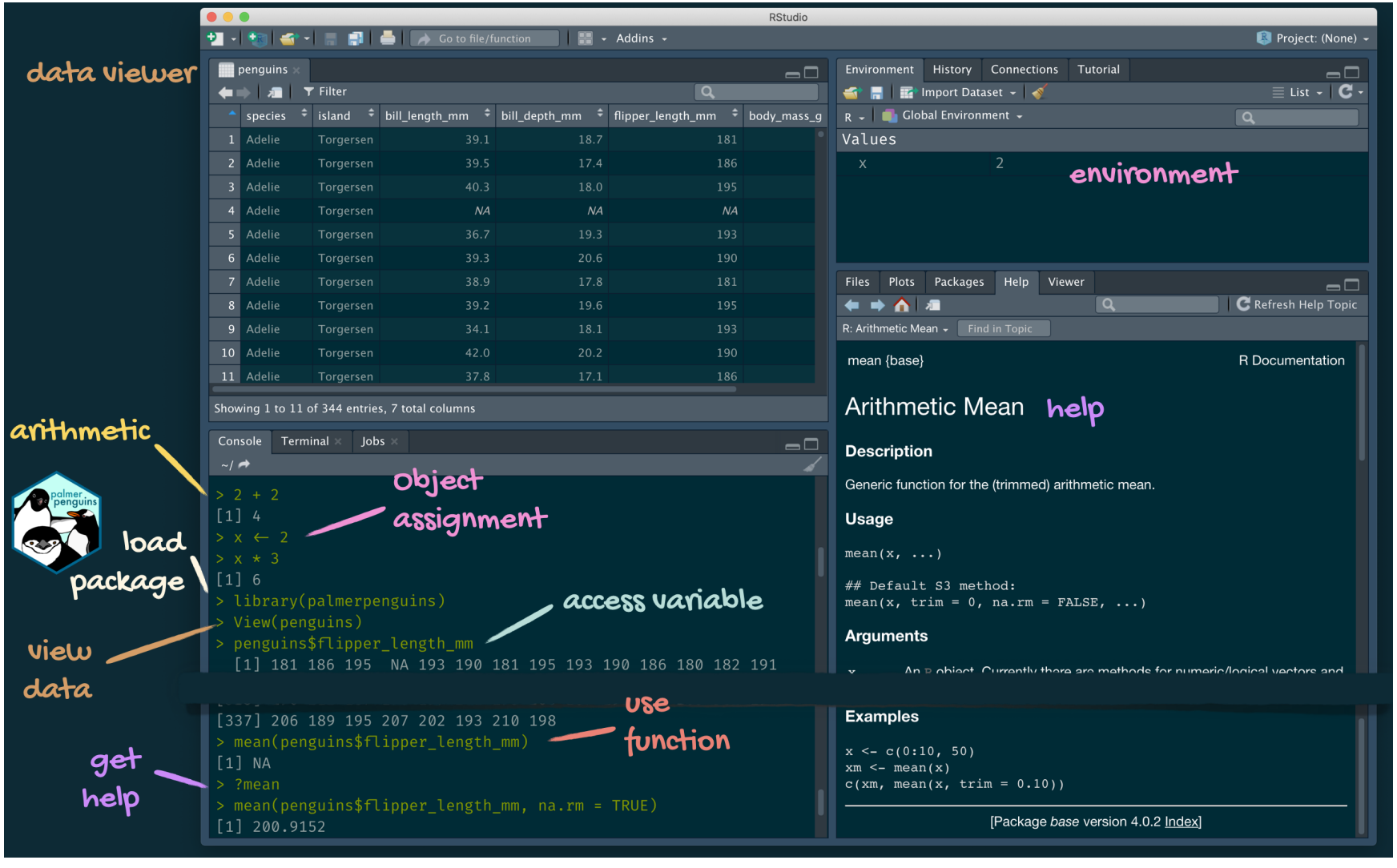
R packages

- **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 2020, 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)
```

- 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
```

- 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

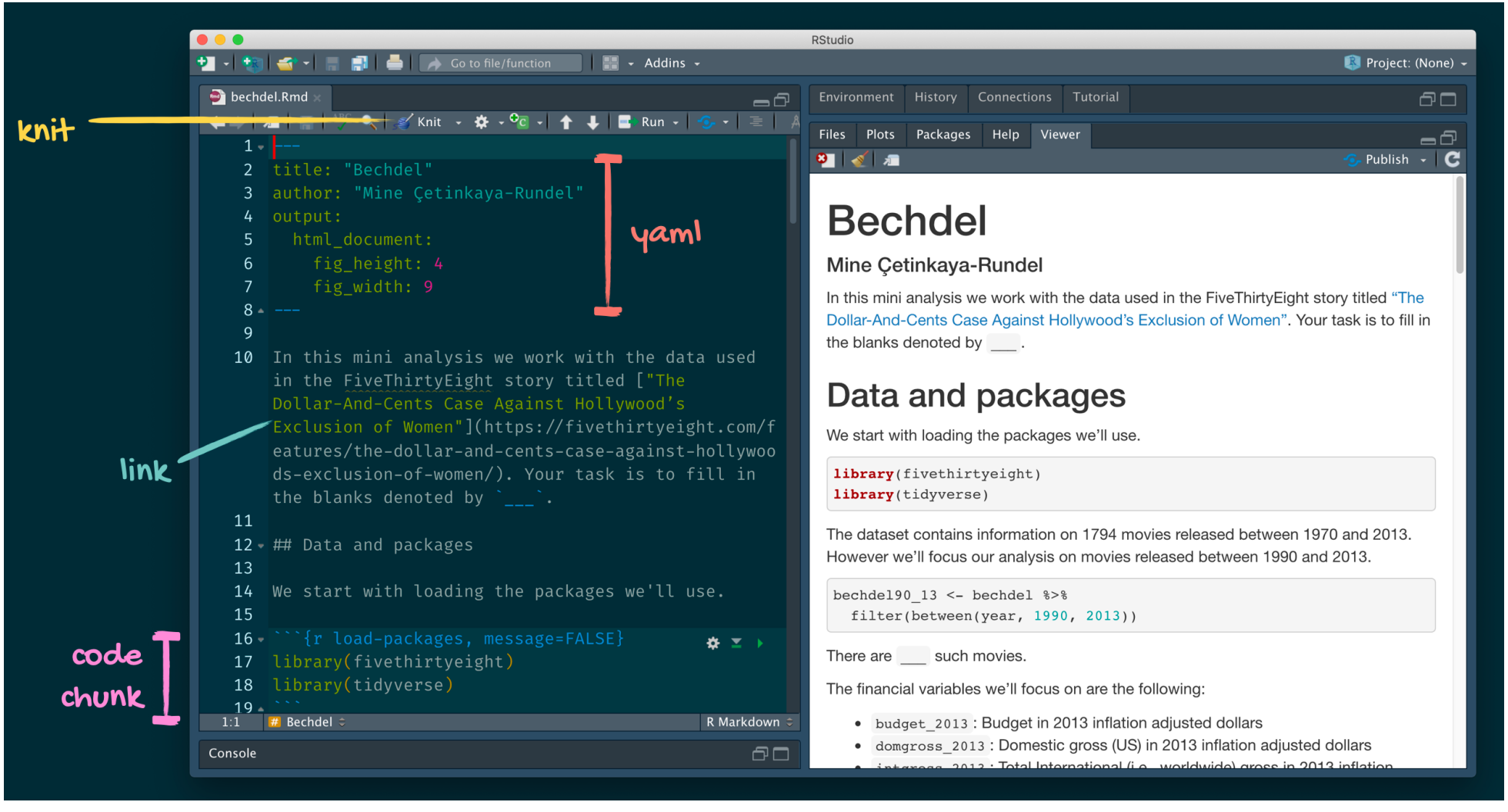
rmarkdown.rstudio.com

- **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

- 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!

Environments

First, run the following in the console

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

All looks good, eh?

Then, add the following in an R chunk in your R Markdown document and knit it.

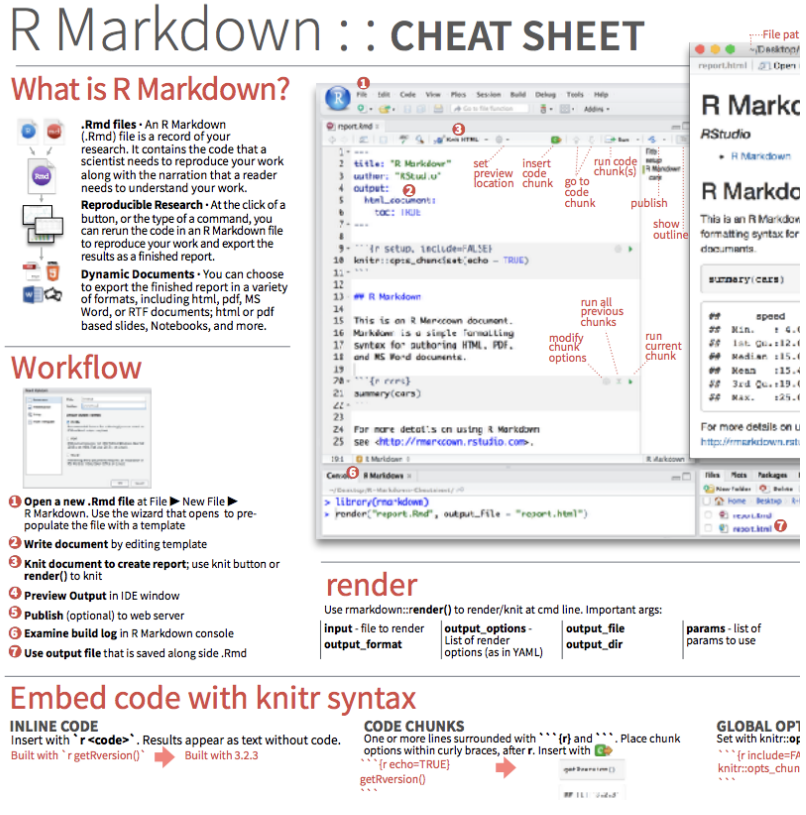
```
x * 3
```

What happens? Why the error?

R Markdown help

R Markdown Cheat Sheet

Help -> Cheatsheets



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

render

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

input - file to render **output_format**	**output_options** - List of render options (as in YAML)	**output_file** **output_dir**	**params** - list of params to use

Embed code with knitr syntax

INLINE CODE
Insert with `` `r <code>` ``. Results appear as text without code.
Built with `` `r getRversion()` `` ➡ Built with 3.2.3

CODE CHUNKS
One or more lines surrounded with ```` ```{r} ```` and ```` ``` ````. Place chunk options within curly braces, after **r**. Insert with

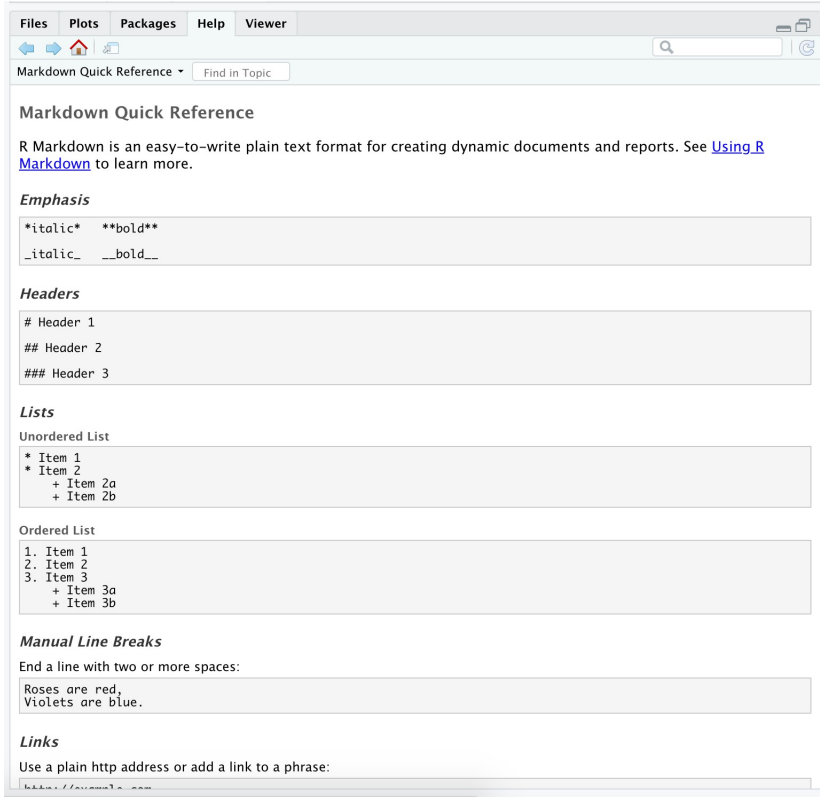
```
```{r echo=TRUE}
getRversion()
```
```

GLOBAL OPT
Set with knitr::op

```
```{r include=FA
knitr::opts_chun
```
```

Markdown Quick Reference

Help -> Markdown Quick Reference



Files | Plots | Packages | Help | Viewer

Markdown Quick Reference | Find in Topic

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
```

Ordered List

```
1. Item 1
2. Item 2
3. Item 3
    + Item 3a
    + Item 3b
```

Manual Line Breaks

End a line with two or more spaces:

```
Roses are red,
Violets are blue.
```

Links

Use a plain http address or add a link to a phrase:

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

Your turn: `AE 02 – Bechdel + R Markdown`

- The Bechdel test asks whether a work of fiction features at least two women who talk to each other about something other than a man, and there must be two women named characters.
- Go to RStudio Cloud and start the assignment `AE 02 – Bechdel + R Markdown`.
- Open and knit the R Markdown document `bechdel.Rmd`, review the document, and fill in the blanks.