WEEK 2

R BASICS AND R MARKDOWN

TODAY'S TOPICS

- A few more R and RStudio tips (projects, style)
- R Packages
- Intro to the "tidyverse"
- Pipes
- R Markdown: present and share your work in a report
- Paths and files

EFFECTIVE USE OF RStudio®

- Last time:
  - Work in the RStudio app, not the R app
  - Tab for autocompletion and helpful tips
  - Panes: Source, Console, Environment, Viewer

EFFECTIVE USE OF RStudio®

- Use RStudio to divide your work into distinct Projects

Do you keep every file in one giant folder?

I hope not…

37,515 items

EFFECTIVE USE OF RStudio®

- An RStudio Project is associated with one **folder** on your computer (called the "working directory")
    - R will save files to and open files from this folder
        - Use a different project for any distinct "unit" of your work
            - Examples: analysis for one manuscript, thesis chapter, or class project
- Tip: for now, when creating a new Project always use a new empty folder

YOUR TURN

- Create a new Project called “Data Viz Activities”
- Create a new R script file called “hello.R”
- In hello.R, use the `print()` function to print the word "Hello!" to the console.

```
print("Hello!")
```

- Save the file
- Source the file (i.e., run the entire script) using Cmd/Ctrl + Shift + S
- Close the Project
- Re-open the “Data Viz Activities” project.

EFFECTIVE USE OF RStudio®

- A project remembers the state of your "working environment" and keeps it separate from that of other projects.
    - Which objects you have created in R
    - Which files are open
    - A history of commands that you have used
- When you reopen a project, you *can* restore the workspace in same condition that you left it, but I don't recommend it.

BASIC R: IMPORTANT REMINDERS

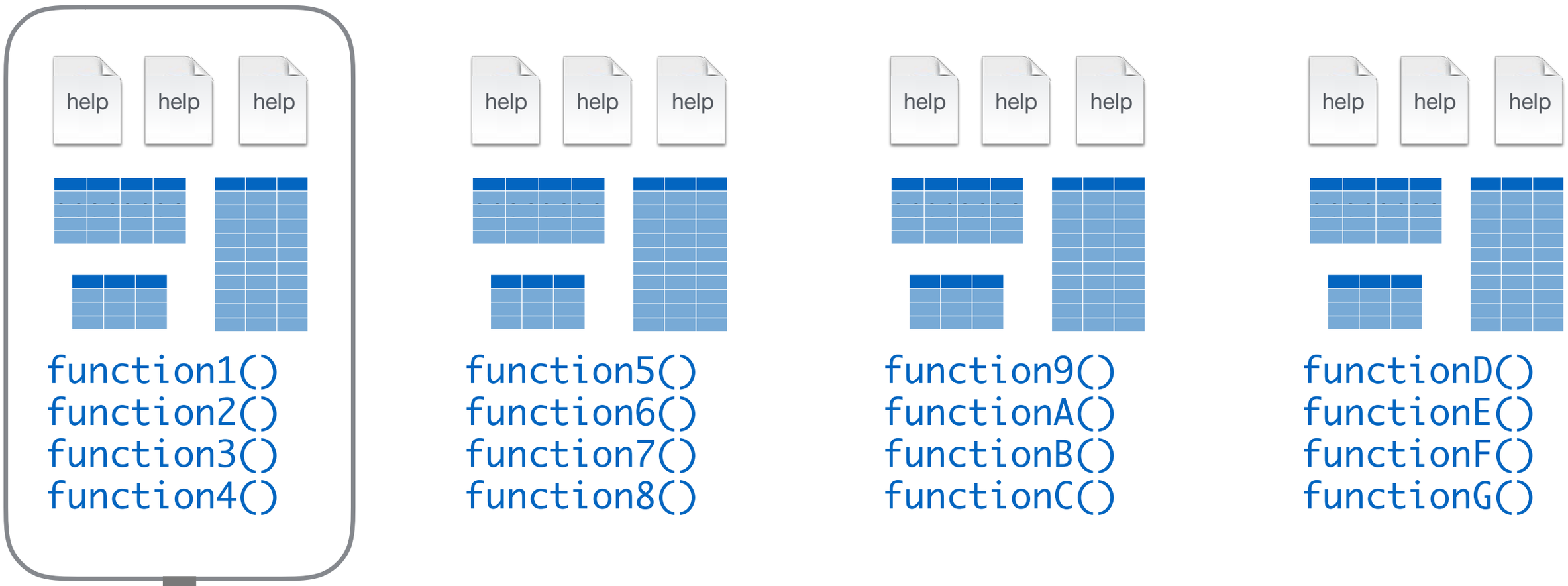
- In R everything has a name
    - Aim for short, meaningful names
    - Style guide recommends names in all lowercase, with words separated by underscores (e.g., `my_name`).
- You do things using functions and operators
    - Example functions: `c()`, `mean()`, `summary()`
    - Example operators: `+`, `<-`
        - Tip: for assignment (`<-`), use RStudio shortcut ⌥ + - in macOS, Alt + - in Windows

BASIC R: IMPORTANT REMINDERS

- Comments (lines that R does not try to evaluate) start with #
    - Good code includes lots of comments!
- Computers are stupid: R can't guess what you want to do. Attention to detail is important!

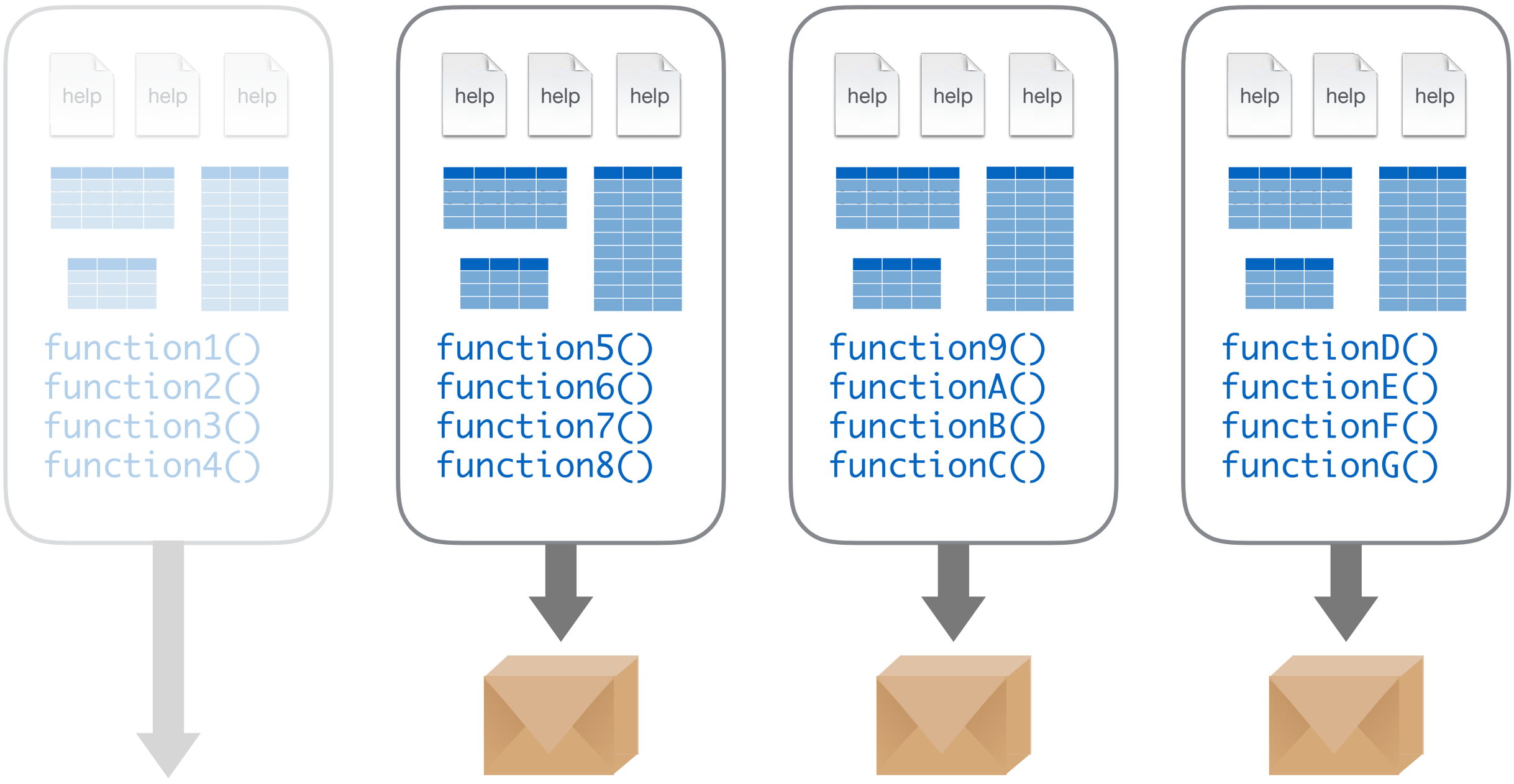
R PACKAGES

R PACKAGES

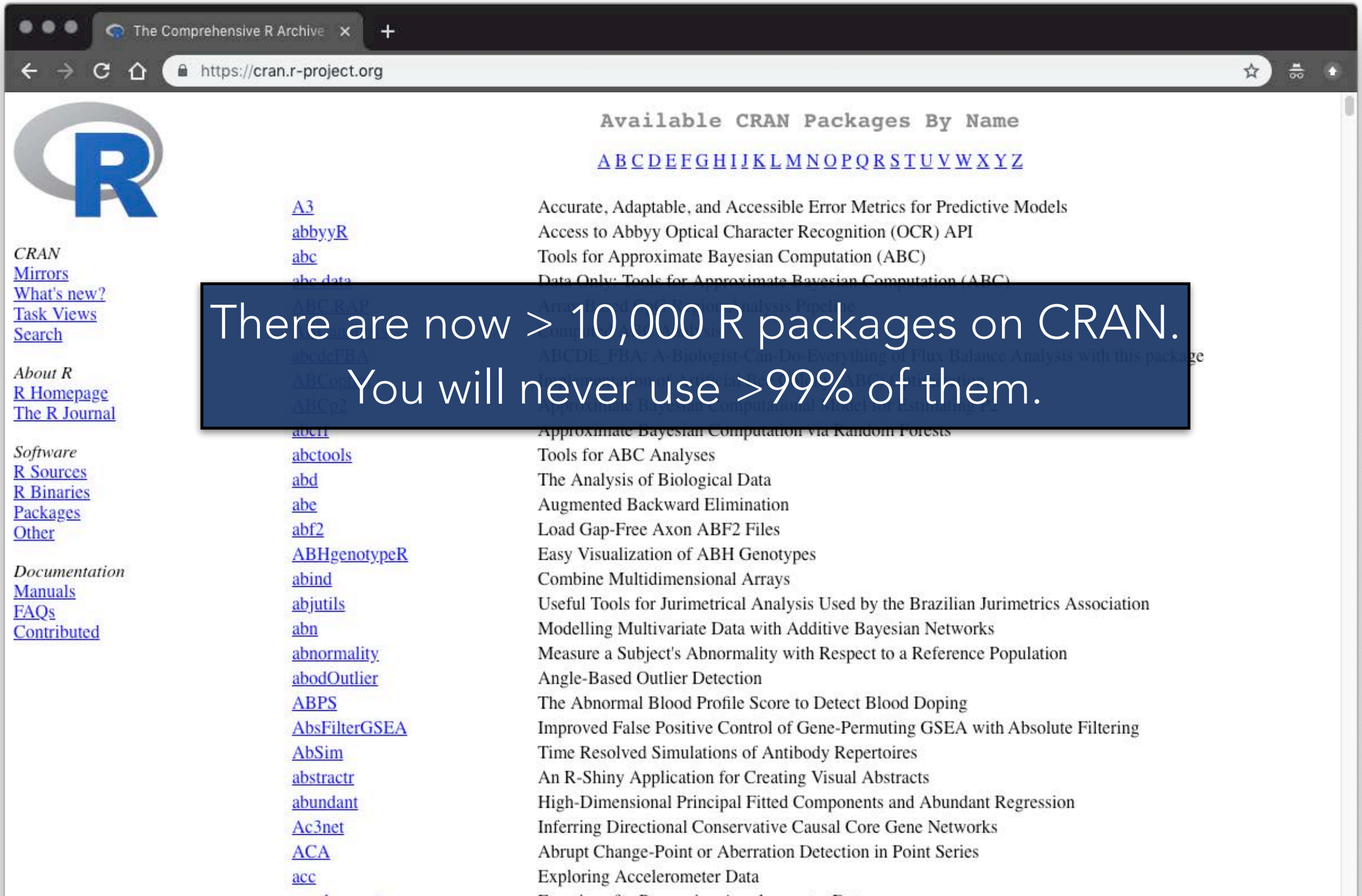


Base R

R PACKAGES



R PACKAGES



There are now > 10,000 R packages on CRAN.
You will never use >99% of them.

USING PACKAGES

1

```
install.packages("foo")
```

Downloads files to computer

1 x per computer

2

```
library("foo")
```

Loads package

1 x per R Session

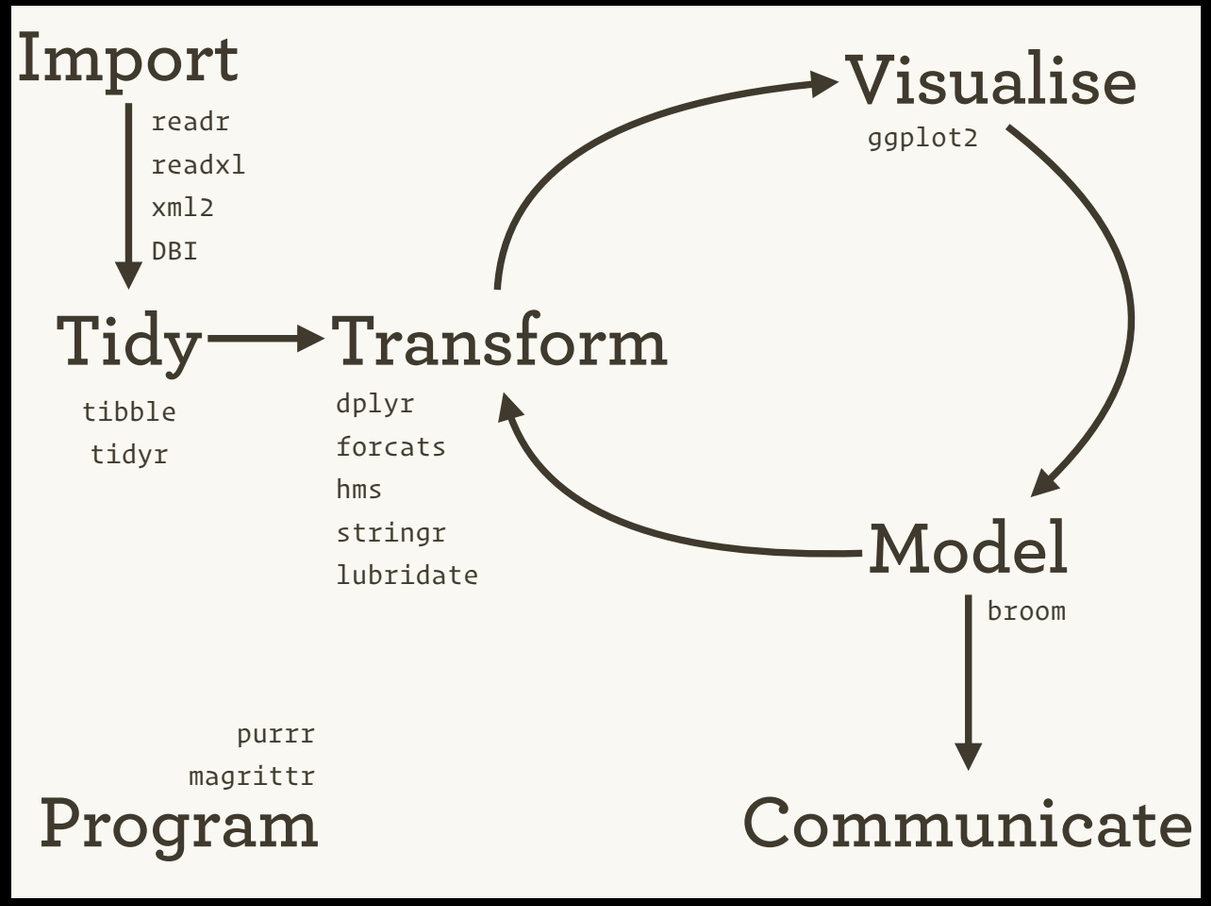
THE TIDYVERSE

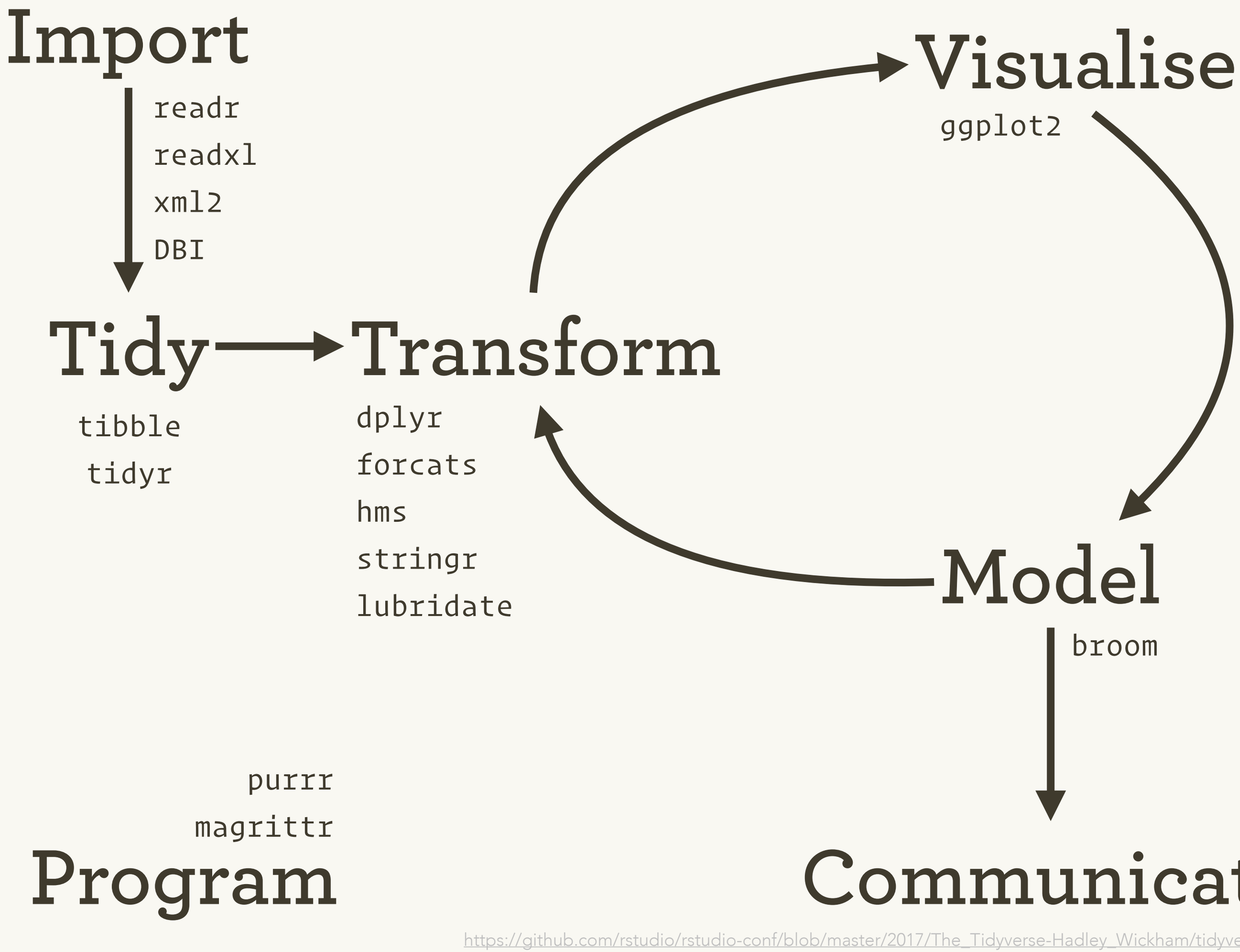
THE TIDYVERSE

- A collection of R packages for working with and visualizing data that share an underlying philosophy and are designed to work together.

THE TIDYVERSE

- Goal: solve complex problems by combining simple, uniform pieces.



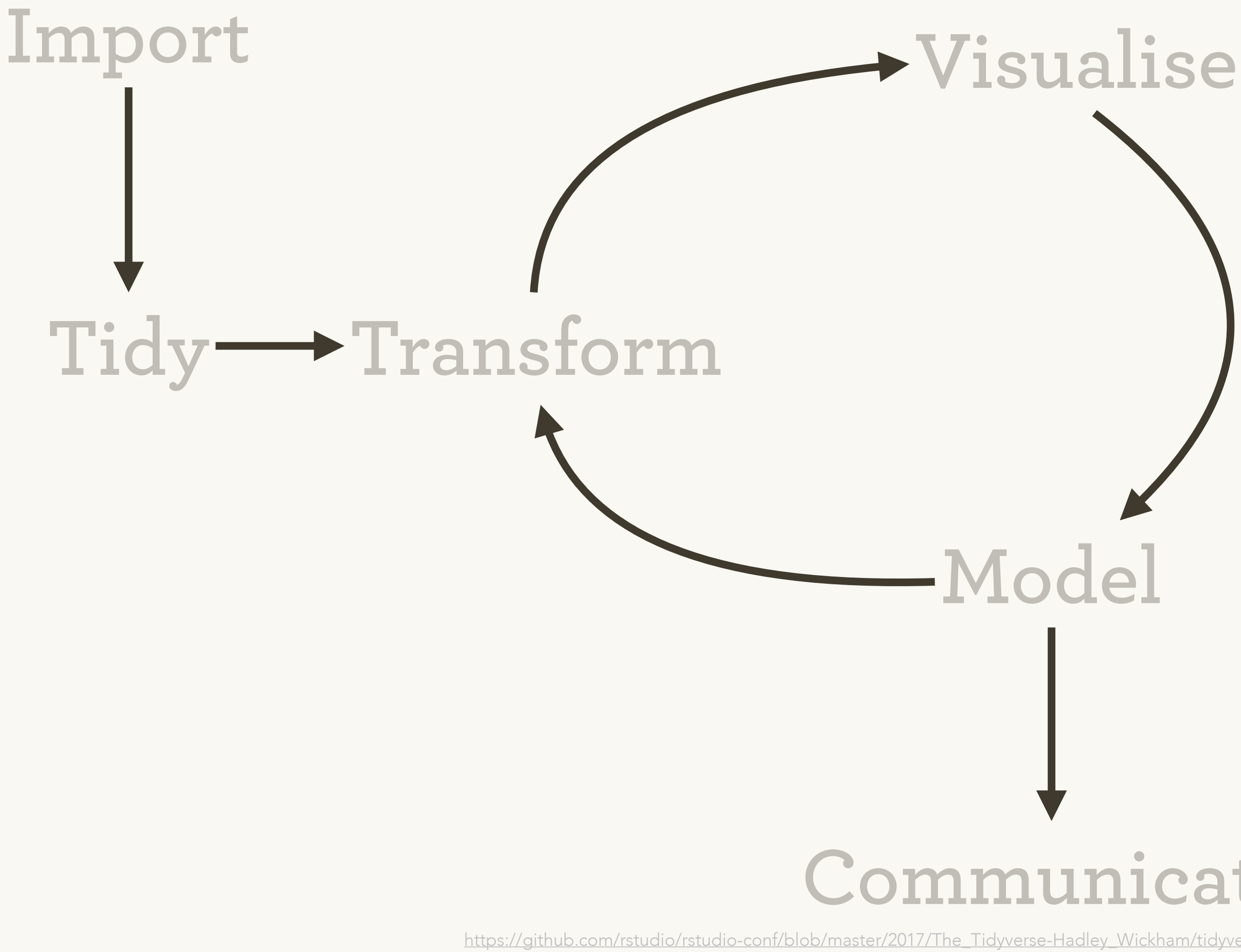


https://github.com/rstudio/rstudio-conf/blob/master/2017/The_Tidyverse-Hadley_Wickham/tidyverse.pdf

No matter how complex and polished the individual operations are, it is often the quality of the glue that most directly determines the power of the system.

— *Hal Abelson*

https://github.com/rstudio/rstudio-conf/blob/master/2017/The_Tidyverse-Hadley_Wickham/tidyverse.pdf

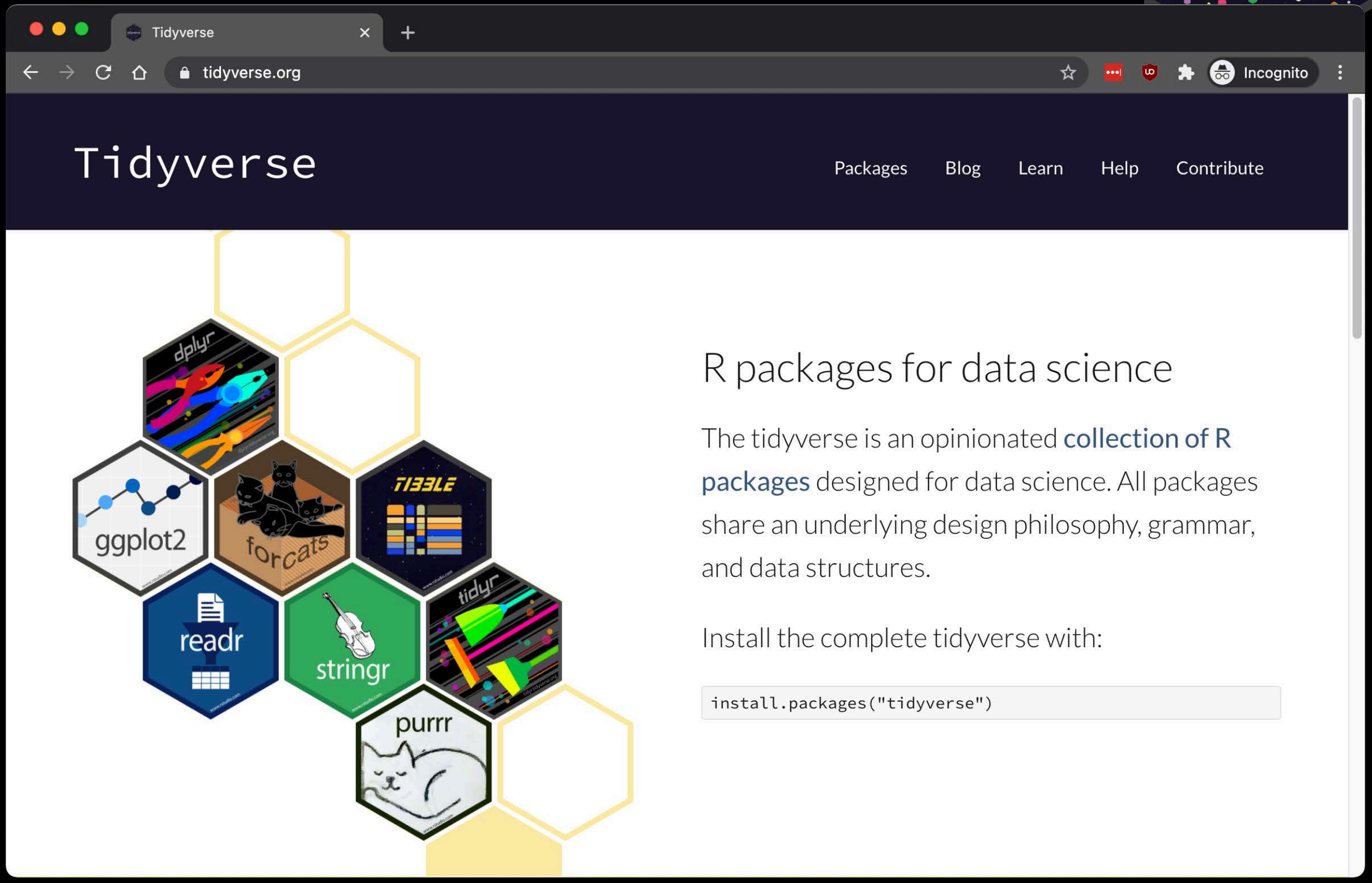


https://github.com/rstudio/rstudio-conf/blob/master/2017/The_Tidyverse-Hadley_Wickham/tidyverse.pdf

THE TIDYVERSE

- Advantages:
  - Consistency: it's a *dialect* of R that is more readable, with pieces designed to work together
  - Coverage: end-to-end support for most data analysis goals and workflows
  - Critical Mass: huge and rapidly growing community of users—it's quickly becoming a standard
- It's a path of least resistance for inexperienced users to become proficient in data visualization and exploration

THE TIDYVERSE



THE TIDYVERSE

- For simplicity, there's an R package called "tidyverse" that's just a short cut for installing and loading this integrated system of packages that work together.

- Let's install the complete tidyverse by typing:

```
install.packages("tidyverse")
```

THE TIDYVERSE

This:

```
install.packages("tidyverse")
```

Does the equivalent of:

```
install.packages("ggplot2")
install.packages("dplyr")
install.packages("tidyr")
install.packages("readr")
install.packages("purrr")
install.packages("tibble")
install.packages("stringr")
install.packages("forcats")
install.packages("hms")
install.packages("lubridate")
install.packages("feather")
install.packages("haven")
install.packages("httr")
install.packages("jsonlite")
install.packages("readxl")
install.packages("rvest")
install.packages("xml2")
install.packages("DBI")
install.packages("modelr")
install.packages("broom")
install.packages("cli")
install.packages("crayon")
install.packages("dbplyr")
install.packages("magrittr")
install.packages("pillar")
install.packages("reprex")
install.packages("rlang")
install.packages("rstudioapi")
```

THE TIDYVERSE

But this:

```
library("tidyverse")
```

Only loads the core:

```
library("ggplot2")
library("dplyr")
library("tidyr")
library("readr")
library("purrr")
library("tibble")
library("stringr")
library("forcats")
```

- These are the most general (and useful) parts.
- We will use all except for the “purrr” package.

PIPES

PIPES

- Recall: in R, you do most things using functions

```
my_numbers <- -1:5

mean(my_numbers)
```

PIPES

- Pass thing on left into function on the right (as the first argument)

```
x %>% f() becomes f(x)
```

```
x %>% f(y) becomes f(x, y)
```

PIPES

- Why use this? Suppose you have a *sequence* of operations to perform on your data.

```
my_numbers <- -1:5
```

- *"Take the data, first take the square root of each number, then exponentiate each number, then take the mean."*

PIPES

- Option 1: execute each function one by one, using the previous result in each subsequent function

```
result_1 <- sqrt(my_numbers)
result_2 <- exp(result_1)
result_final <- mean(result_2)
```

PIPES

- Option 2: nest the functions; functions will be evaluated from inner-most to outer-most

```
result_final <- mean(exp(sqrt(my_numbers)))
```

PIPES

- Option 3: chain the functions together in their natural sequence using pipes

```
result_final <- my_numbers %>%
  sqrt() %>%
  exp() %>%
  mean()
```

- More human-readable:

"Take the data, then take the square root of each number, then exponentiate each number, then take the mean."

YOUR TURN

- In a new R script, run this code and describe what happens. *Why* is a warning produced? (hint: step through the code)

```
my_numbers <- -1:5

result_final <- my_numbers %>%
  sqrt() %>%
  exp() %>%
  mean()
```

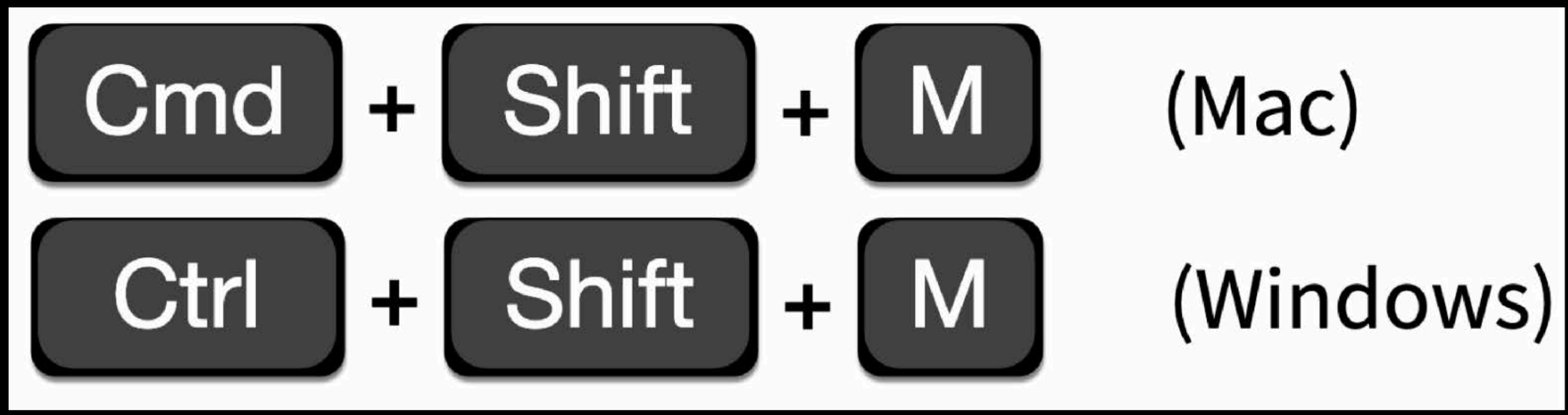
- Read the help file for the **mean** function to find an argument that lets you take the mean of the *real* numbers only in the last step. Add it to the code above.

PIPES, PIPES EVERYWHERE...

- All tidyverse packages (except for ggplot2) are designed to facilitate pipe-based workflows
    - The first argument of most functions is the "data."
- ggplot2 is an older package that predates the pipe
    - It's too late to change ggplot2 now, and it has its own pipe of sorts (the "+" operator)
- `%>%` is part of the tidyverse, but sometime soon, base R will add its own pipe, so keep an eye out: `|>`

A SHORTCUT TO THE PIPE

- Instead of typing out "%>%" each time…



A SHORTCUT TO THE PIPE

- Why M? The pipe comes from the **m**agrittr package.

"The Treachery of Images"

Famous 1929 painting by surrealist painter René **M**agritte

WHEN TO USE PIPES

- Pipes are most useful for rewriting fairly short linear sequences of operations.
- If you have lots of steps (~10 or more), it's still a good idea to make an intermediate object to make code more readable.

MORE USEFUL EXAMPLE

- gapminder package provides a data set on GDP and life expectancy over time, by country and continent

```
install.packages("gapminder")
library("gapminder")
View(gapminder)
```

country	continent	year	lifeExp	pop	gdpPercap
Afghanistan	Asia	1952	28.801	8425333	779.4453
Afghanistan	Asia	1957	30.332	9240934	820.8530
Afghanistan	Asia	1962	31.997	10267083	853.1007
Afghanistan	Asia	1967	34.020	11537966	836.1971
Afghanistan	Asia	1972	36.088	13079460	739.9811
Afghanistan	Asia	1977	38.438	14880372	786.1134
Afghanistan	Asia	1982	39.854	12881816	978.0114
Afghanistan	Asia	1987	40.822	13867957	852.3959
Afghanistan	Asia	1992	41.674	16317921	649.3414
Afghanistan	Asia	1997	41.763	22227415	635.3414

PIPES


```
count(filter(gapminder, year == 2007), continent)
```

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

PIPES


```
count(filter(gapminder, year == 2007), continent)
```

Data

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

PIPES


```
count(filter(gapminder, year == 2007), continent)
```

Step 1

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

PIPES


```
count(filter(gapminder, year == 2007), continent)
```

Step 2

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

REWRITE THIS USING PIPES


```
count(filter(gapminder, year == 2007), continent)
```

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

REWRITE THIS USING PIPES


```
gapminder %>%
  filter(year == 2007) %>%
  count(continent)
```

Data

Step 1

Step 2

continent	n
Africa	52
Americas	25
Asia	33
Europe	30
Oceania	2

R Markdown

R Markdown

- Basic idea behind it
- How to write in markdown
- Putting together an R Markdown file

R Markdown

- Sometimes, you want narrative/explanation and outputs (e.g. visualizations) in the same document.

- You might even want to share or show the analysis steps and R code that you used.

- What are some situations where this would be useful?

R Markdown

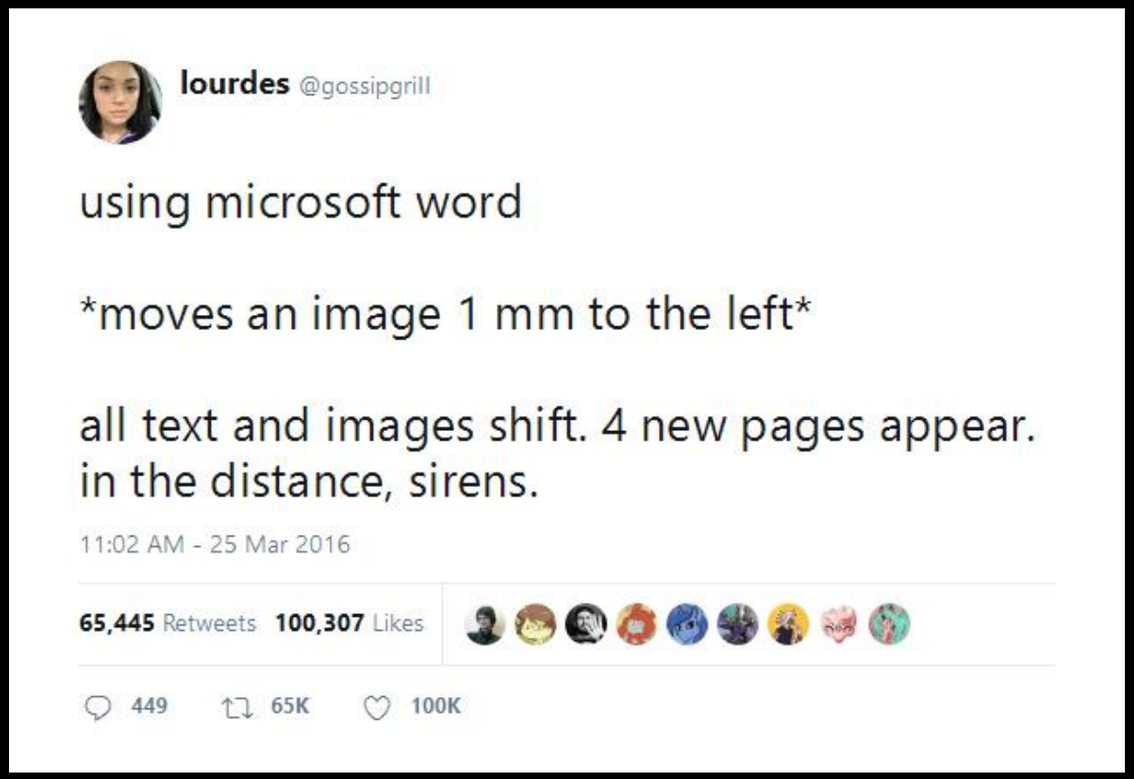
- R Markdown is a system for "knitting together" these different things into a single high-quality document, report, or presentation.

Kieran Healy, *Data Visualization: A practical Introduction*, Fig. 2.1

EXAMPLES

R Markdown

- But ***why?*** Why not do it all in Word?
  - Copying tables and code is annoying and error-prone.
  - Word is bad at keeping a consistent layout when there are figures.
  - If data or analysis changes, just re-knit and entire report is updated.



MARKDOWN

- The foundation is a method of formatting plain text called Markdown

- Philosophy: very easy to read and easy to write

- Widely used and can be converted to many output formats

- Simple formatting only

  - Paragraphs, headings, emphasis (bold/italic), numbered or bulleted lists, hyperlinks, images

~/OneDrive - University of Texas at San Antonio/

Go to file/function | Addins

Environment | History | Connections

01_markdown-basics.Rmd

Knit | Insert | Run

```
1  # Top-level heading
2
3  ## Second-level heading
4
5  ### Third-level heading
6
7  This is an R Markdown document that contains no code. The purpose is
   to show you how to write in markdown.
8
9  Use asterisks to show emphasis. For example, you can make *italicized*
   or **bold text** by enclosing in one or two asterisks.
10
11 Force a line break
12 by adding two spaces
13 at the end.
14
15 ### Lists
22    - A nested item is indented 4 spaces
23
24 Create an ordered list by using numbers:
25
26 1. Item 1
27 2. Item 2
28 3. Item 3
29
30 Plain http addresses are automatically converted to links:
   https://www.campos-lab.net/courses/ant6973-s2019/
31
32 Or you can use a linked phrase like this: [Course
   Website](https://www.campos-lab.net/courses/ant6973-s2019/)
```

13:12 | Third-level heading | R Markdown

~/OneDrive - University of Texas at San Antonio/Teaching/Data Visualization/activities/ant6937-activities/01_markdown-basics.html

01_markdown-basics.html | Open in Browser | Find | Publish

Top-level heading

Second-level heading

Third-level heading

This is an R Markdown document that contains no code. The purpose is to show you how to write in markdown.

Use asterisks to show emphasis. For example, you can make *italicized* or **bold text** by enclosing in one or two asterisks.

Force a line break
by adding two spaces
at the end.

Lists

1. Item 1
2. Item 2
3. Item 3

Plain http addresses are automatically converted to links: https://www.campos-lab.net/courses/ant6973-s2019/

Or you can use a linked phrase like this: Course Website

If you forget, you can find a handy reference sheet in RStudio with *Help > Markdown Quick Reference*

YOUR TURN

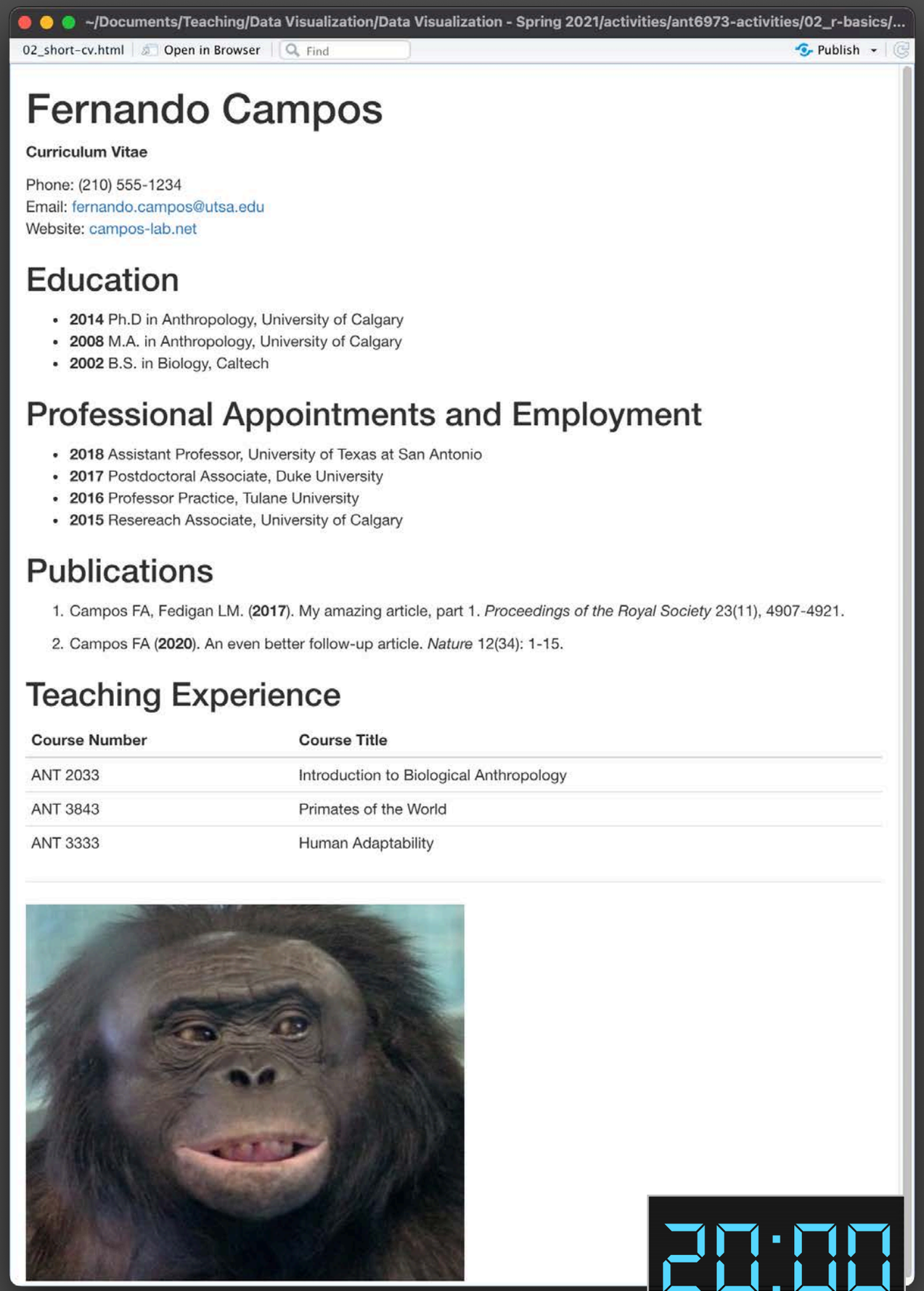
Create a basic CV in markdown
(you can make stuff up!)

In Rstudio:

File > New File > Markdown File

YOUR TURN

- Top-level heading is your name
- Include contact info: phone, email, and link to some website.
- Include 2nd-level headings for education, employment, publications, and teaching
- Each section should include a bulleted or numbered list of items, or a table
- Highlight years in bold and (possibly fake) journal names in italics
- Embed some kind of image at the bottom



R Markdown

- What's in an R Markdown file?

R Markdown

- What's in an R Markdown file?
  - An optional short header

At the top

```
---
<Header stuff goes here>
---
```

R Markdown

- What's in an R Markdown file?
  - An optional short header

At the top

```
---
<Header stuff goes here>
---
```

- Plain text with markdown formatting

R Markdown

- What's in an R Markdown file?
  - An optional short header

At the top

```
---
<Header stuff goes here>
---
```

  - Plain text with markdown formatting
  - Optional chunks of R code

Interspersed

```
```{r}
<R code goes here>
```
```

R Markdown

- What's in an R Markdown file?
  - An optional short header

```
---
<Header stuff goes here>
---
```

- Plain text with markdown formatting
- Optional chunks of R code

```
```{r}
<R code goes here>
```
```

Kieran Healy, *Data Visualization: A practical Introduction*, Fig. 2.1

R Markdown


````
```{r}
<R code goes here>
```
````

R Markdown


````
```{r optional-chunk-name, <options for chunk behavior>}
<R code goes here>
```
````

R Markdown

- Let's experiment. In RStudio, create an new R Markdown file by going to:

- File > New File > R Markdown…

~/OneDrive - University of Texas at San Antonio/Teaching/Data Visualization/activities/ant6937-activities - RStudio Source Editor

01_rmarkdown-default.Rmd

Knit

Process the whole document

Insert

Run

```
---
title: "R Markdown Practice"
author: "Fernando Campos"
date: "1/20/2019"
output: html_document
---

```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for
details on using R Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button a document will be generated that includ
code chunks within the document. You can embed an R code chunk like this:

```{r cars}
summary(cars)
```

Including Plots

You can also embed plots, for example:

```{r pressure, echo=FALSE}
plot(pressure)
```

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.
```

Header with information about document

Chunk of R code

Run this chunk

Notes & discussion
with formatting instructions

Chunk of R code

Run all chunks
up to here

Chunk of R code

Set options
for chunk

31:1 Including Plots R Markdown

R Markdown

- That's the tip of the iceberg, but should be enough for creating a basic report.

- If you want to know how to do more, there's an entire (free!) book on R Markdown:

  - https://bookdown.org/yihui/rmarkdown/

Paths and Files

LET'S LEARN MORE ABOUT PATHS...

- Go to this week's assignments on the course website.
- Download paths-project.zip and unzip the file somewhere on your computer.
- **Open the project!**
- Follow along as we complete the activity.
- *Nothing to turn in!*