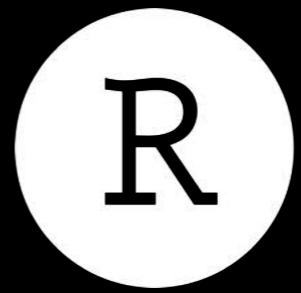


TODAY'S TOPICS

- A few more RStudio tips: Panes and Projects
- Basic R: some important reminders
- Intro to the “tidyverse” (and installing some packages)
- R Markdown: learn how to present and share your work in a report

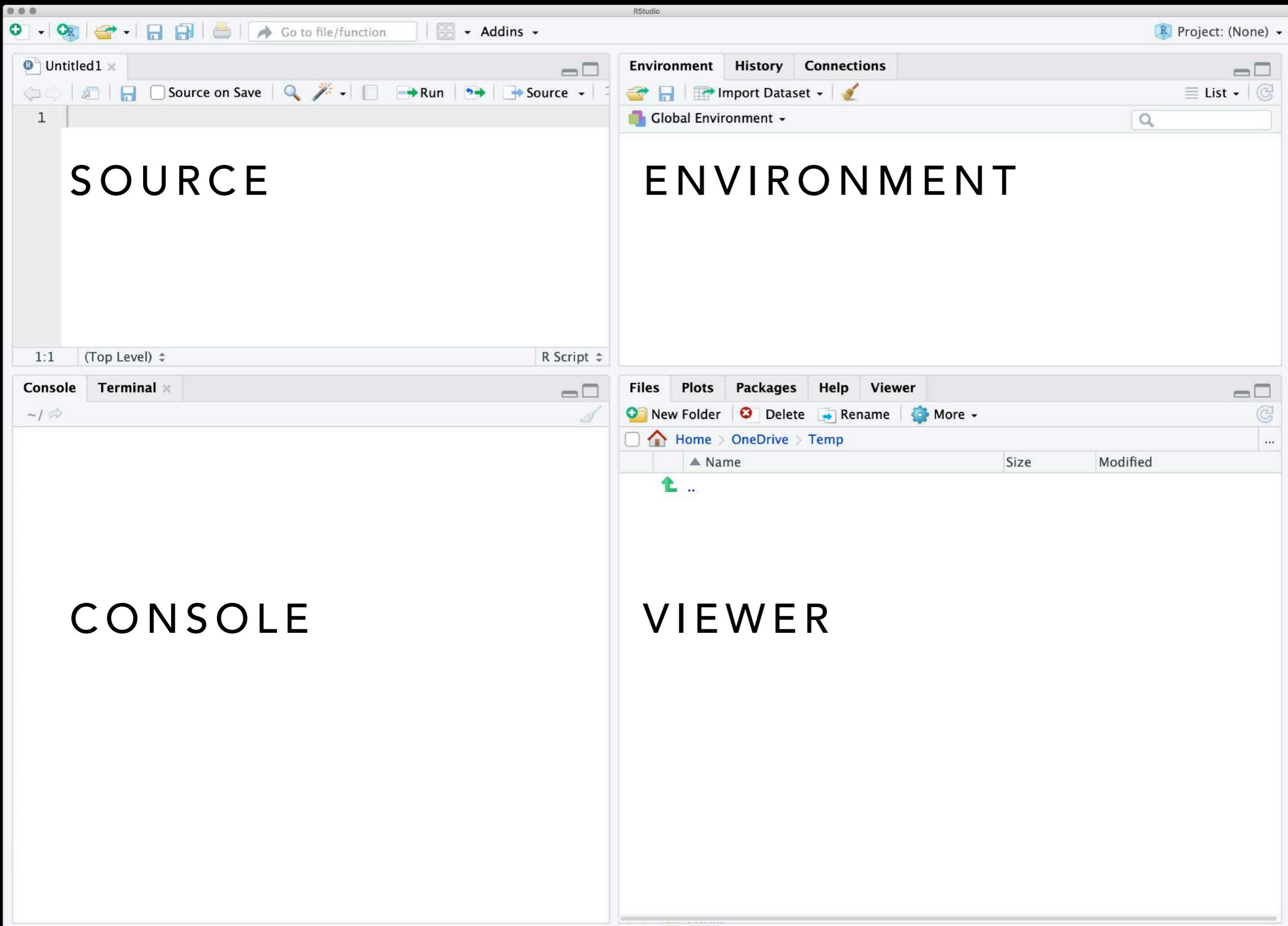


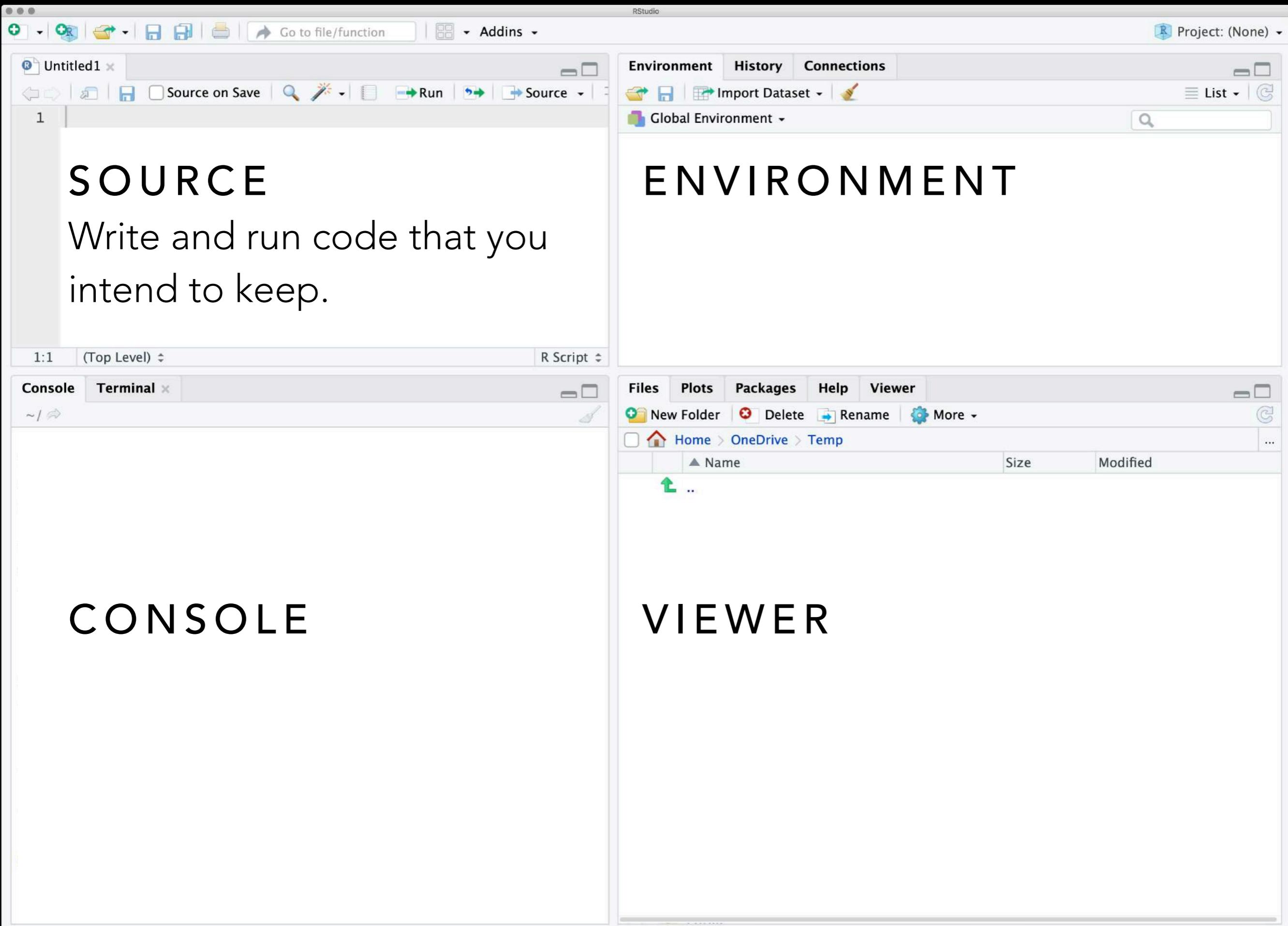
EFFECTIVE USE OF



Studio[®]

- Last time:
 - Work in the RStudio app, not the R app
 - Tab for autocompletion and helpful tips
 - **View()** function to view an object
 - Panes: Source, Console, Environment, Viewer





The image shows the RStudio interface with four main sections labeled SOURCE, ENVIRONMENT, CONSOLE, and VIEWER.

- SOURCE**: Located in the top-left pane, it contains a code editor window titled "Untitled1" with the number "1" at the top left. The status bar below the editor shows "1:1 (Top Level) R Script". Below the editor are tabs for "Console" and "Terminal".
- ENVIRONMENT**: Located in the top-right pane, it displays the Global Environment. It includes tabs for "Environment", "History", and "Connections". Buttons for "Import Dataset" and "Global Environment" are also present.
- CONSOLE**: Located in the bottom-left pane, it displays the R console output. The status bar shows "1:1 (Top Level) R Script". Below the status bar are tabs for "Console" and "Terminal".
- VIEWER**: Located in the bottom-right pane, it shows a file browser with the path "Home > OneDrive > Temp". It includes tabs for "Files", "Plots", "Packages", "Help", and "Viewer".

The image shows the RStudio interface with four main panes:

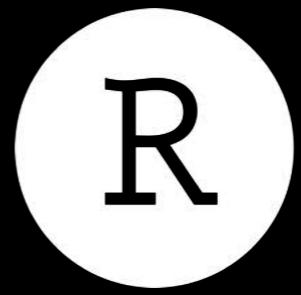
- SOURCE**: Write and run code that you intend to keep.
- ENVIRONMENT**: View objects, functions, etc. View command history.
- CONSOLE**: View executed code. Use sparingly for experimentation.
- VIEWER**: A file browser showing a directory structure: Home > OneDrive > Temp. The contents pane is empty, showing only a single up arrow icon.

The image shows the RStudio interface with four main panes:

- SOURCE**: Write and run code that you intend to keep.
- ENVIRONMENT**: View objects, functions, etc. View command history.
- CONSOLE**: View executed code. Use sparingly for experimentation.
- VIEWER**: View files in working directory, packages, image outputs, etc.

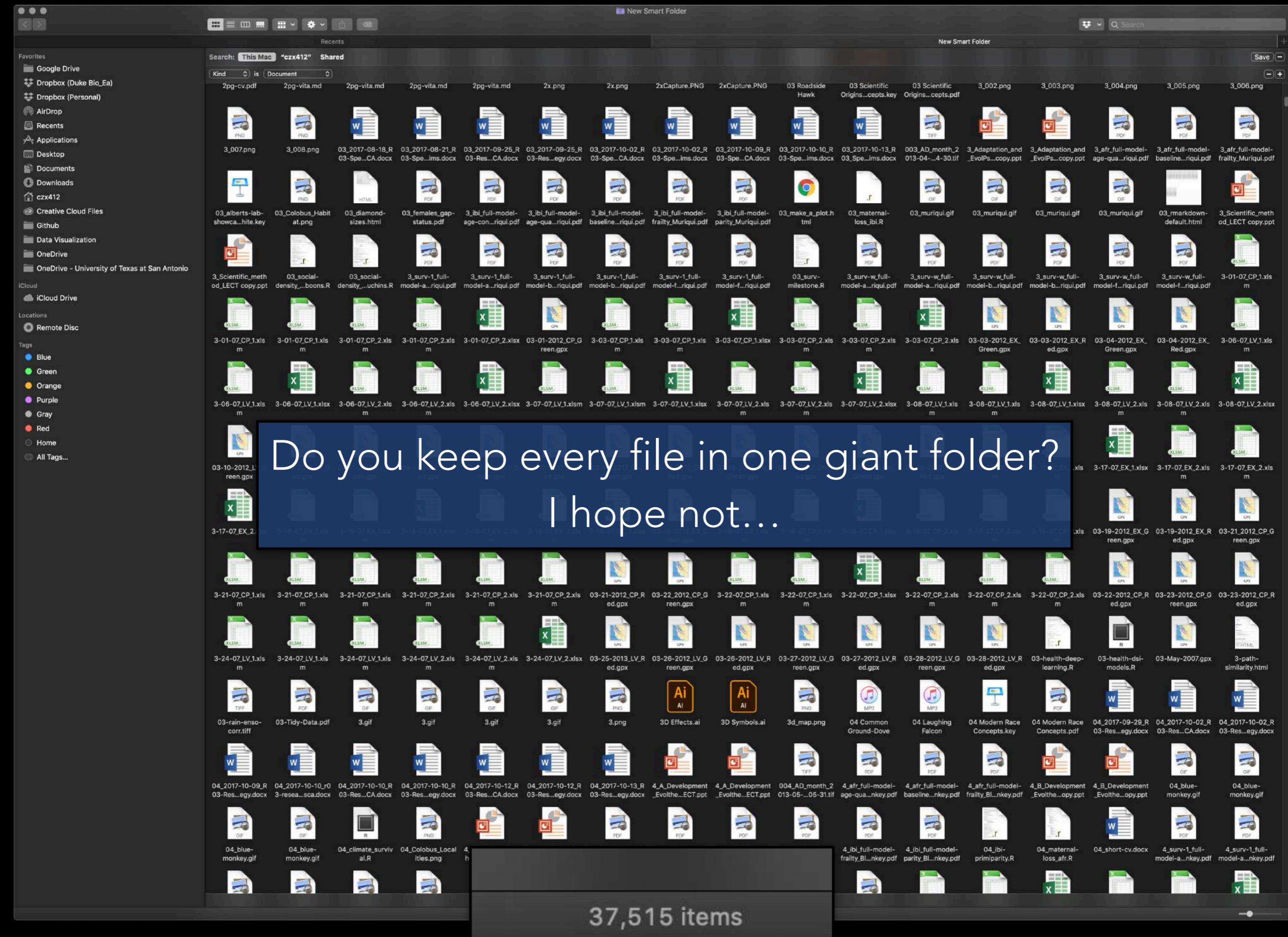
The SOURCE pane contains a code editor with a script named "Untitled1". The ENVIRONMENT pane shows the Global Environment. The CONSOLE pane shows the R Script tab. The VIEWER pane shows a file browser for the "Temp" folder in OneDrive.

EFFECTIVE USE OF

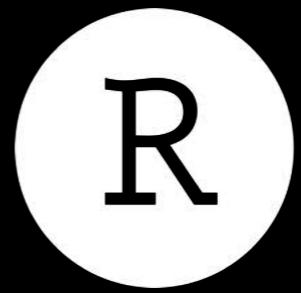


R Studio[®]

- Use RStudio to divide your work into distinct **Projects**



EFFECTIVE USE OF



R Studio[®]

- 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 “ANT 6973 Activities”
- Create a new R script file called “basics.R”
- In basics.R, create an object called my_name and assign it your name.
- Save the file
- Close the Project
- Create a new Project called “ANT 6973 Project 1”
- Switch back to the “ANT 6973 Activities” Project

```
my_name <- "Fernando Campos"
```



EFFECTIVE USE OF



- 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.

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: `+`, `<-`
- Comments (lines that R does not try to evaluate) start with `#`
- Computers are stupid

YOUR TURN

Please complete DataCamp course:

*Introduction to R, Chapter 1:
"Intro to basics"*

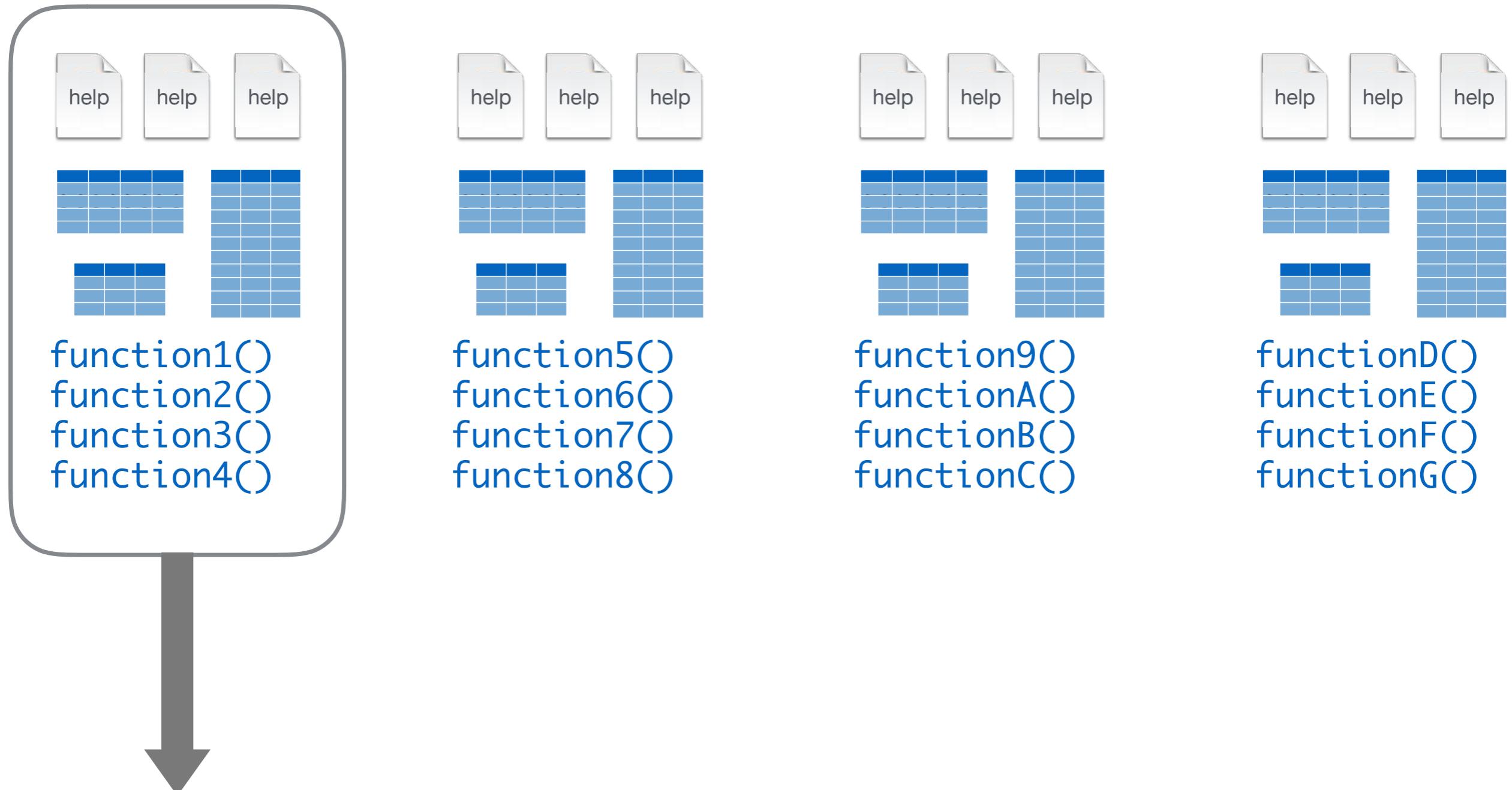


It's short!

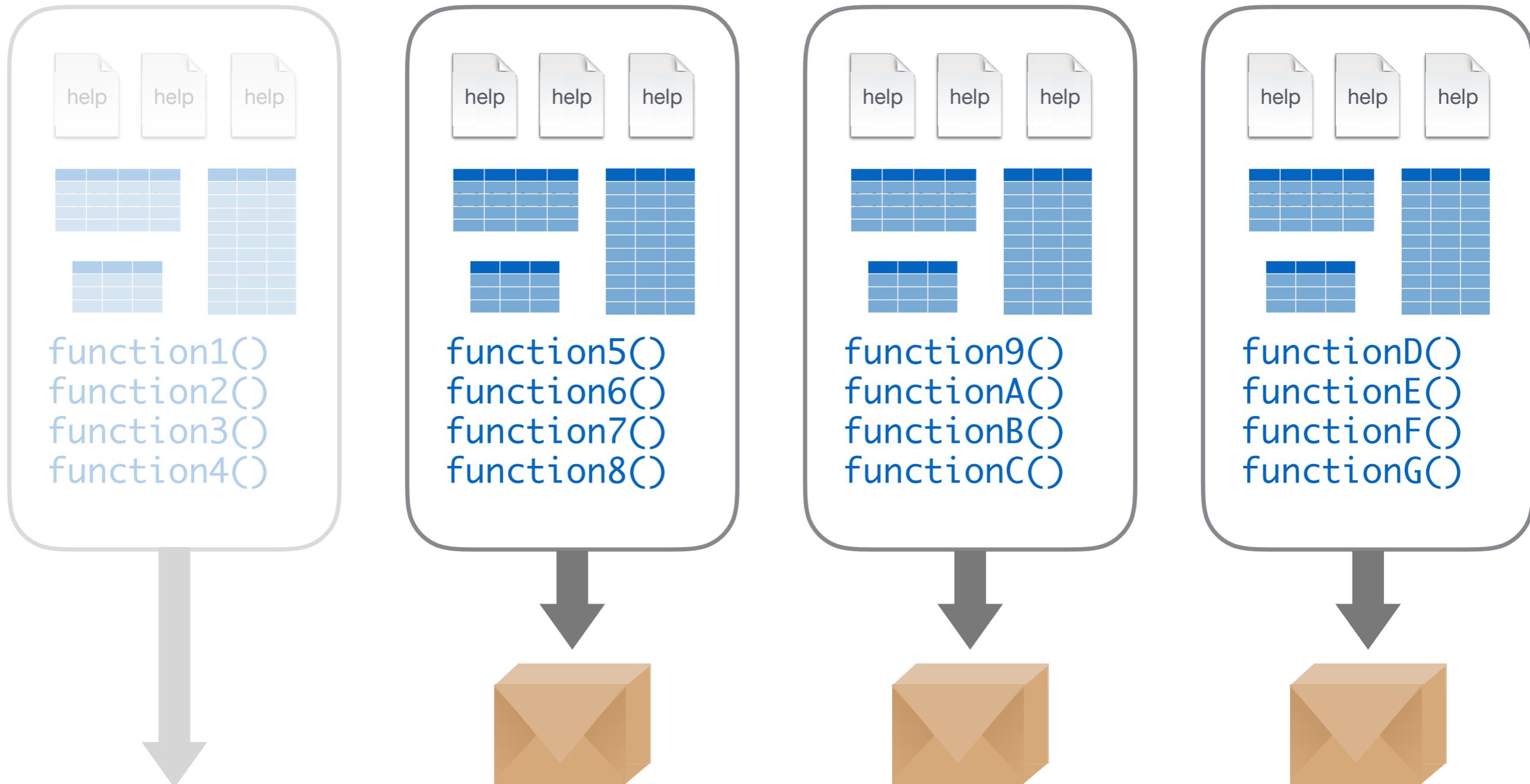
20.00

R PACKAGES

R PACKAGES



R PACKAGES



Base R

R Packages

R PACKAGES

The screenshot shows the official CRAN website at <https://cran.r-project.org>. The page features the R logo and navigation links for CRAN mirrors, what's new, task views, and search. A prominent dark blue banner in the center states: "There are now > 10,000 R packages on CRAN. You will never use 99% of them." To the right of the banner, a section titled "Available CRAN Packages By Name" lists packages from A to Z with their descriptions.

Available CRAN Packages By Name

[A3](#)
[abyyR](#)
[abc](#)
[abc.data](#)
[ABC.RAP](#)
[abcdeFBA](#)
[ABCoptim](#)
[ABCp2](#)
[abctf](#)
[abctools](#)
[abd](#)
[abe](#)
[abf2](#)
[ABHgenotypeR](#)
[abind](#)
[abjutils](#)
[abn](#)
[abnormality](#)
[abodOutlier](#)
[ABPS](#)
[AbsFilterGSEA](#)
[AbSim](#)
[abstractr](#)
[abundant](#)
[Ac3net](#)
[ACA](#)
[acc](#)

Accurate, Adaptable, and Accessible Error Metrics for Predictive Models
Access to Abbyy Optical Character Recognition (OCR) API
Tools for Approximate Bayesian Computation (ABC)
Data Only: Tools for Approximate Bayesian Computation (ABC)
Array-Based C-GC Residual Analysis Pipeline
ABCDE_FBA: A-Biologist-Can-Do-Everything of Flux Balance Analysis with this package
Implementation of Artificial Bayesian Coevolution (ABC) Optimization
Approximate Bayesian Computational Model for Estimating P-values
Approximate Bayesian Computation via Random Forests
Tools for ABC Analyses
The Analysis of Biological Data
Augmented Backward Elimination
Load Gap-Free Axon ABF2 Files
Easy Visualization of ABH Genotypes
Combine Multidimensional Arrays
Useful Tools for Jurimetical Analysis Used by the Brazilian Jurimetrics Association
Modelling Multivariate Data with Additive Bayesian Networks
Measure a Subject's Abnormality with Respect to a Reference Population
Angle-Based Outlier Detection
The Abnormal Blood Profile Score to Detect Blood Doping
Improved False Positive Control of Gene-Permuting GSEA with Absolute Filtering
Time Resolved Simulations of Antibody Repertoires
An R-Shiny Application for Creating Visual Abstracts
High-Dimensional Principal Fitted Components and Abundant Regression
Inferring Directional Conservative Causal Core Gene Networks
Abrupt Change-Point or Aberration Detection in Point Series
Exploring Accelerometer Data

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

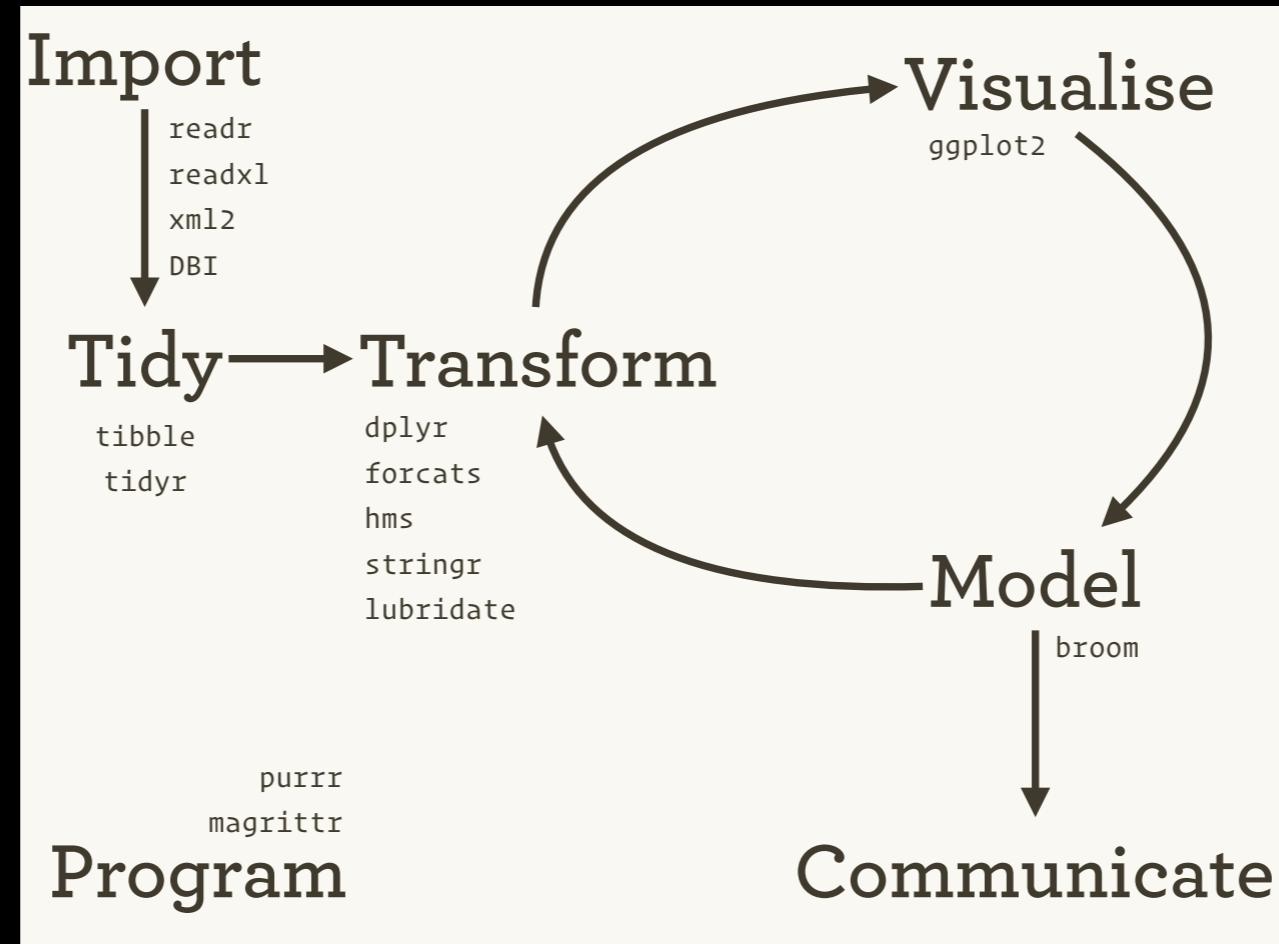


- A collection of R packages for working with and visualizing data that share an underlying philosophy and are designed to work together.

THE TIDYVERSE



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



Import → Visualise

readr
readxl
xml2
DBI

Tidy → Transform

tibble
tidyr

dplyr
forcats
hms
stringr
lubridate

purrr
magrittr

Visualise

ggplot2

Model

broom

Program

Communicate

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*

Import



Tidy → Transform



Visualise



Model



Communicate

THE TIDYVERSE



- Advantages:
 - Consistency: it's a *sub-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

A screenshot of the tidyverse website (<https://www.tidyverse.org>) displayed in a web browser. The page has a dark blue header with the word "Tidyverse" in white. Below the header is a navigation bar with links for "Packages", "Articles", "Learn", "Help", and "Contribute". The main content area features a graphic of six hexagonal packages arranged in a hexagonal pattern: dplyr (orange, top), ggplot2 (light gray, bottom-left), readr (dark blue, bottom-center), purrr (white with black outline, bottom-left), tibble (dark blue with yellow text, center), and tidyr (orange, bottom-right). To the right of the graphic is a text block describing the tidyverse as an opinionated collection of R packages designed for data science, sharing a common design philosophy, grammar, and data structures. It also provides instructions for installing the complete tidyverse with the command "install.packages('tidyverse')".

Tidyverse

Packages Articles Learn Help Contribute

R packages for data science

The tidyverse is an opinionated **collection of R packages** designed for data science. All packages share an underlying design philosophy, grammar, and data structures.

Install the complete tidyverse with:

```
install.packages("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("hms")
install.packages("stringr")
install.packages("lubridate")
install.packages("forcats")
install.packages("DBI")
install.packages("haven")
install.packages("httr")
install.packages("jsonlite")
install.packages("readxl")
install.packages("rvest")
install.packages("xml2")
install.packages("modelr")
install.packages("broom")
```

THE TIDYVERSE



But this:

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

Only loads the core:

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

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

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



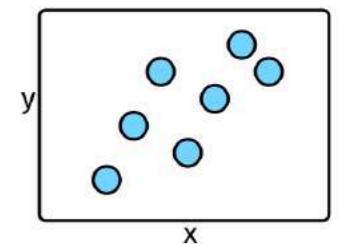
- R Markdown is a system for “knitting together” these different things into a single high-quality document, report, or presentation.

Report notes.Rmd
We can see this **relationship** in a scatterplot.

```
```{r my-code}
p <- ggplot(data, mapping)
p + geom_point()
...```
As you can see, this plot looks pretty nice.
```

knit in R

Report notes.pdf  
We can see this *relationship* in a scatterplot.



As you can see, this plot looks pretty nice.

# 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.

lourdes @gossipgrill

using microsoft word

\*moves an image 1 mm to the left\*

all text and images shift. 4 new pages appear. in the distance, sirens.

11:02 AM - 25 Mar 2016

65,445 Retweets 100,307 Likes

449 65K 100K

# 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

# Fernando Campos

Phone: (210) 555-1234

Email: fernando.campos@utsa.edu

Website: [campos-lab.net](http://campos-lab.net)

## Education

- **2014** Ph.D in Anthropology, University of Calgary
  - **2008** M.A. in Anthropology, University of Calgary
  - **2002** B.S. in Biology, Caltech

## Professional Appointments and Employment

- **2018** Assistant Professor, University of Texas at San Antonio
  - **2017** Postdoctoral Associate, Duke University
  - **2016** Professor Practice, Tulane University
  - **2015** Reserach Associate, University of Calgary

## Publications

1. Campos FA (2018). My fake article, part 1. *Journal That Scoffs at Science and Nature* 12(34): 1-15.
  2. Campos FA, Morris WF, Alberts SC, Altmann J, Brockman DK, Cords M, Pusey A, Stoinski T, Strier KB, and Fedigan LM. (2017). Does climate influence the demography of wild primates? Evidence from long-term life-history data in seven species. *Global Change Biology* 23(11), 4907-4921.

The screenshot shows the RStudio interface with two panes. The left pane is the code editor for '01\_markdown-basics.Rmd', displaying R Markdown syntax. The right pane is the preview window showing the rendered HTML output.

```
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
8 to show you how to write in markdown.
9
10 Use asterisks to show emphasis. For example, you can make *italicized*
11 or **bold text** by enclosing in one or two asterisks.
12
13 Force a line break
14 by adding two spaces
15 at the end.
16
17 #### Lists
```

**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**

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

```
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:
31 https://www.campos-lab.net/courses/ant6973-s2019/
32
33 Or you can use a linked phrase like this: [Course
34 Website](https://www.campos-lab.net/courses/ant6973-s2019/)
```

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](#)

# YOUR TURN

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

- Title should be your name
- Include contact info: phone, email, and link to some website.
- Include headings for education, employment, and publications
- Each section should include a bulleted or numbered list of items
- Highlight years in bold and (possibly fake) journal names in italics

The screenshot shows a web browser window with the title "Fernando Campos". The page content includes:

**Fernando Campos**

Phone: (210) 555-1234  
Email: [fernando.campos@utsa.edu](mailto:fernando.campos@utsa.edu)  
Website: [campos-lab.net](http://www.campos-lab.net)

**Education**

- **2014** Ph.D in Anthropology, University of Calgary
- **2008** M.A. in Anthropology, University of Calgary
- **2002** B.S. in Biology, Caltech

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**Publications**

1. Campos FA (**2018**). My fake article, part 1. *Journal That Scoffs at Science and Nature* 12(34): 1-15.
2. Campos FA, Morris WF, Alberts SC, Altmann J, Brockman DK, Cords M, Pusey A, Stoinski T, Strier KB, and Fedigan LM. (**2017**). Does climate influence the demography of wild primates? Evidence from long-term life-history data in seven species. *Global Change Biology* 23(11), 4907-4921.

20:00

# 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>  
```
```

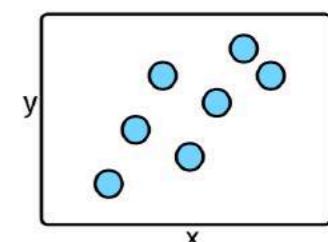
# Report notes.Rmd  
We can see this \*relationship\*  
in a scatterplot.

```
```{r my-code}  
p <- ggplot(data, mapping)  
p + geom_point()  
```
```

As you can see, this plot  
looks pretty nice.

knit in R

Report notes.pdf  
We can see this *relationship*  
in a scatterplot.



As you can see, this plot  
looks pretty nice.

# 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 a new R Markdown file by going to:
  - File > New File > R Markdown...

01\_rmarkdown-default.Rmd

**Process the whole document**

**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**

**Set options for chunk**

```

1 ---

2 title: "R Markdown Practice"

3 author: "Fernando Campos"

4 date: "1/20/2019"

5 output: html_document

6 ---

7

8 ```{r setup, include=FALSE}

9 knitr::opts_chunk$set(echo = TRUE)

10 ...

11

12 ## R Markdown

13

14 This is an R Markdown document. Markdown is a simple formatting syntax for

details on using R Markdown see <http://rmarkdown.rstudio.com>.

15

16 When you click the Knit button a document will be generated that includes

code chunks within the document. You can embed an R code chunk like this:

17

18 ```{r cars}

19 summary(cars)

20 ...

21

22 ## Including Plots

23

24 You can also embed plots, for example:

25

26 ```{r pressure, echo=FALSE}

27 plot(pressure)

28 ...

29

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

31

```

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/>

# YOUR TURN

Please complete DataCamp course:

*Reporting with R Markdown,*  
Chapter 1: “Authoring R  
Markdown Reports”

Don’t worry if you don’t understand the R code used in the chunk. The course is focused on *building a report*, not writing code.

