Introduction to Data Science in the Tidyverse

Amelia McNamara and Hadley Wickham

Acknowledgements

Major contributions by Garrett Grolemund, Amelia McNamara, Mike Smith, Charlotte Wickham, and Hadley Wickham.

Previous versions of this material available at

https://github.com/rstudio-education/master-the-tidyverse
https://github.com/AmeliaMN/IntroToR
https://github.com/cwickham/data-science-in-tidyverse
https://github.com/AmeliaMN/data-science-in-tidyverse

Workshop Policies

- Identify the exits closest to you in case of emergency

- Please review the rstudio::conf code of conduct that applies to all workshops. Issues can be addressed three ways:
  - In person: contact any rstudio::conf staff member or the conference registration desk
  - By email: send a message to conf@rstudio.com
  - By phone: call 844-448-1212

- Please do not photograph people wearing red lanyards

- A chill-out room is available for neurologically diverse attendees on the 4th floor of tower 1

Introducing your teaching staff

Instructors:

Amelia McNamara (she/her)	@AmeliaMN
Hadley Wickham (he/him)	@hadleywickham

TAs:

Jesse Mostipak (she/her)	@kierisi
Ben Baumer (he/him)	@BaumerBen
Matthew Flickinger (he/him)	@EmEmEff
Mike Smith (he/him)	@MikeKSmith
David Keyes (he/him)	@dgkeyes

Your Turn

Introduce yourself to your neighbors:

- Who are you?
- What you do with data?
- How would you describe your experience with R?

No sticky note: "I'm happily working on it"

Blue sticky note: "I'm all done and ready to move on"

Orange sticky note: "I'm stuck, can someone help me?"

Alternatively, flag one of us down

Hopefully, color-blind friendly, let me know if not.

This class is heavily based on

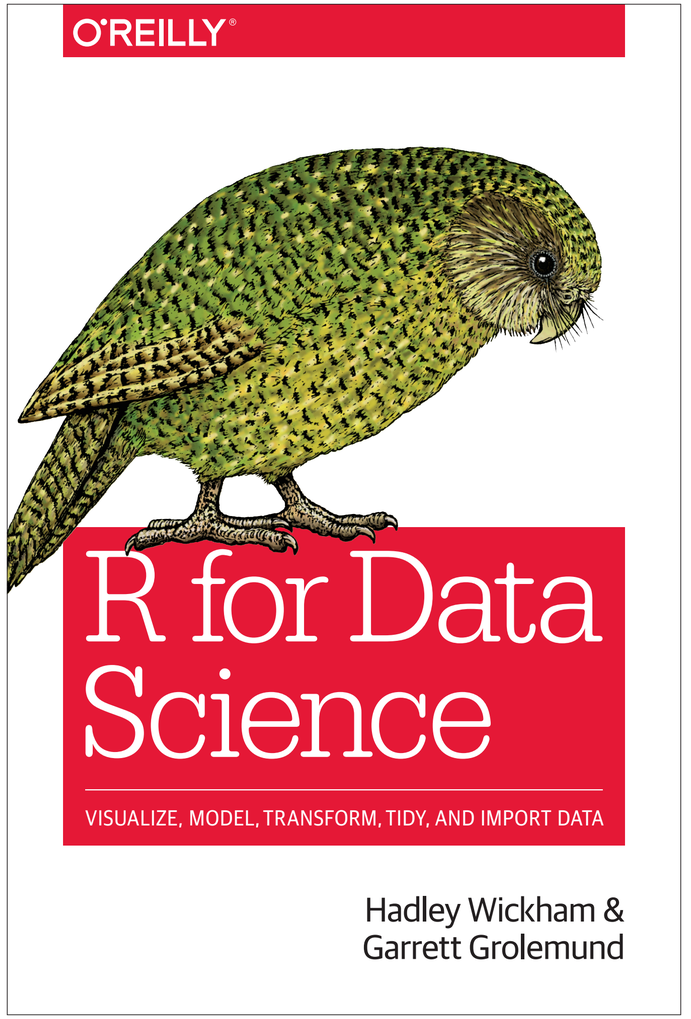
R for Data Science

http://r4ds.had.co.nz/

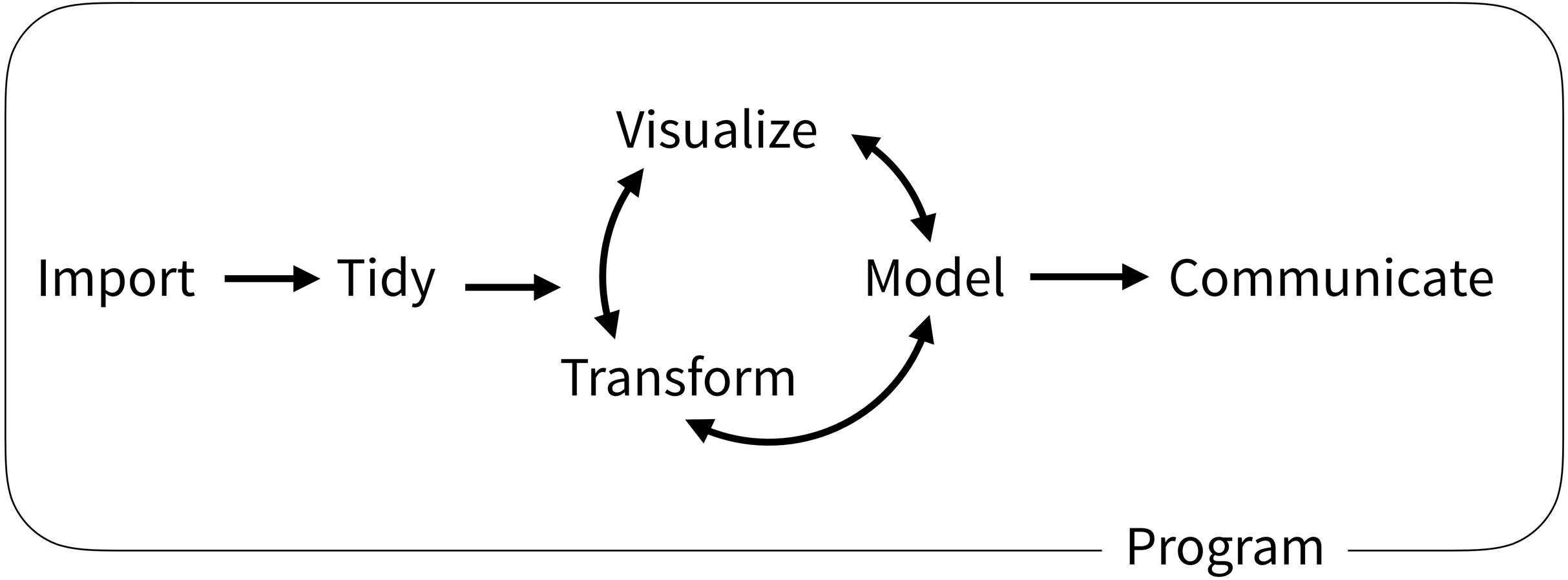
Links to the relevant sections of the book

In R4DS

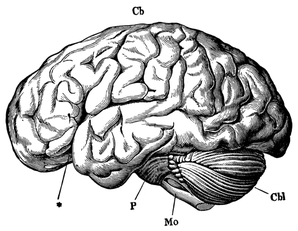
Introduction



(Applied) **Data Science**



R - A computer language for scientists

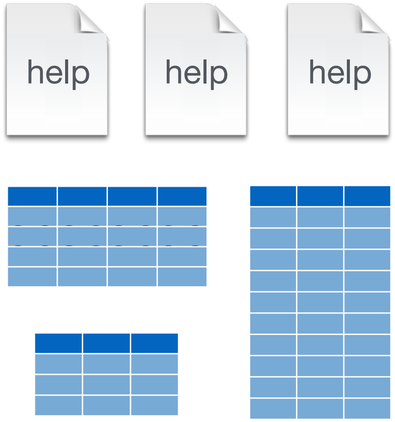


Human thought

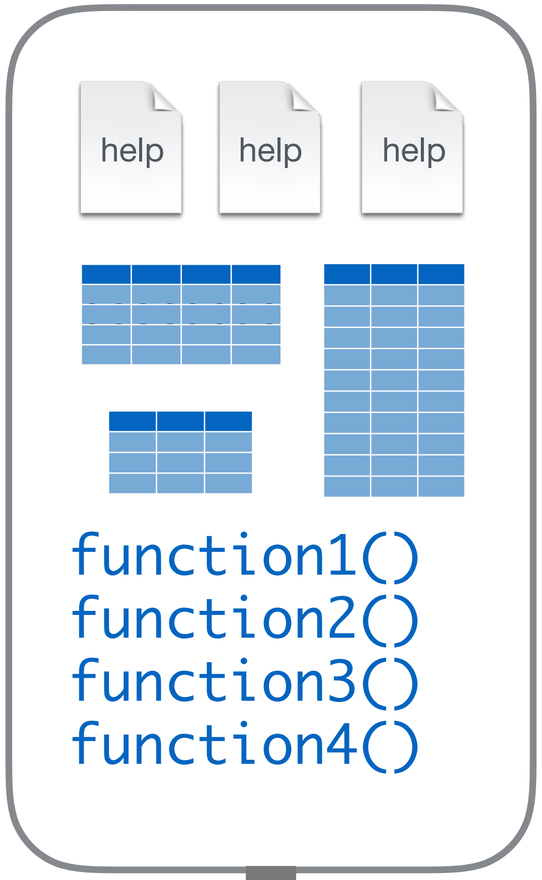
R

C++

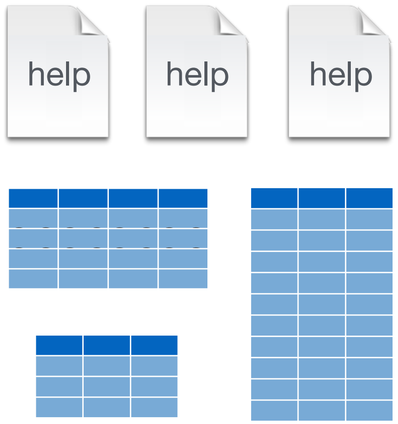
Machine language



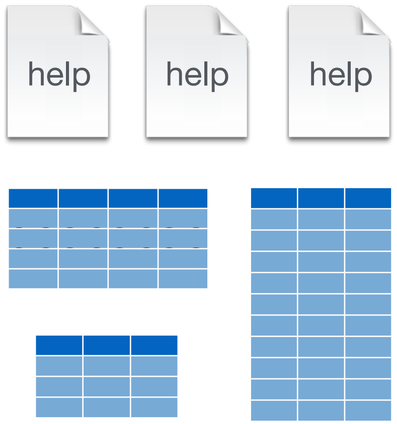

```
function1()
function2()
function3()
function4()
```



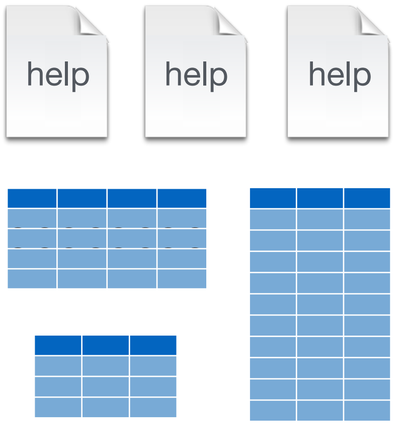

```
function1()
function2()
function3()
function4()
```



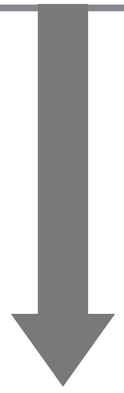

```
function5()
function6()
function7()
function8()
```



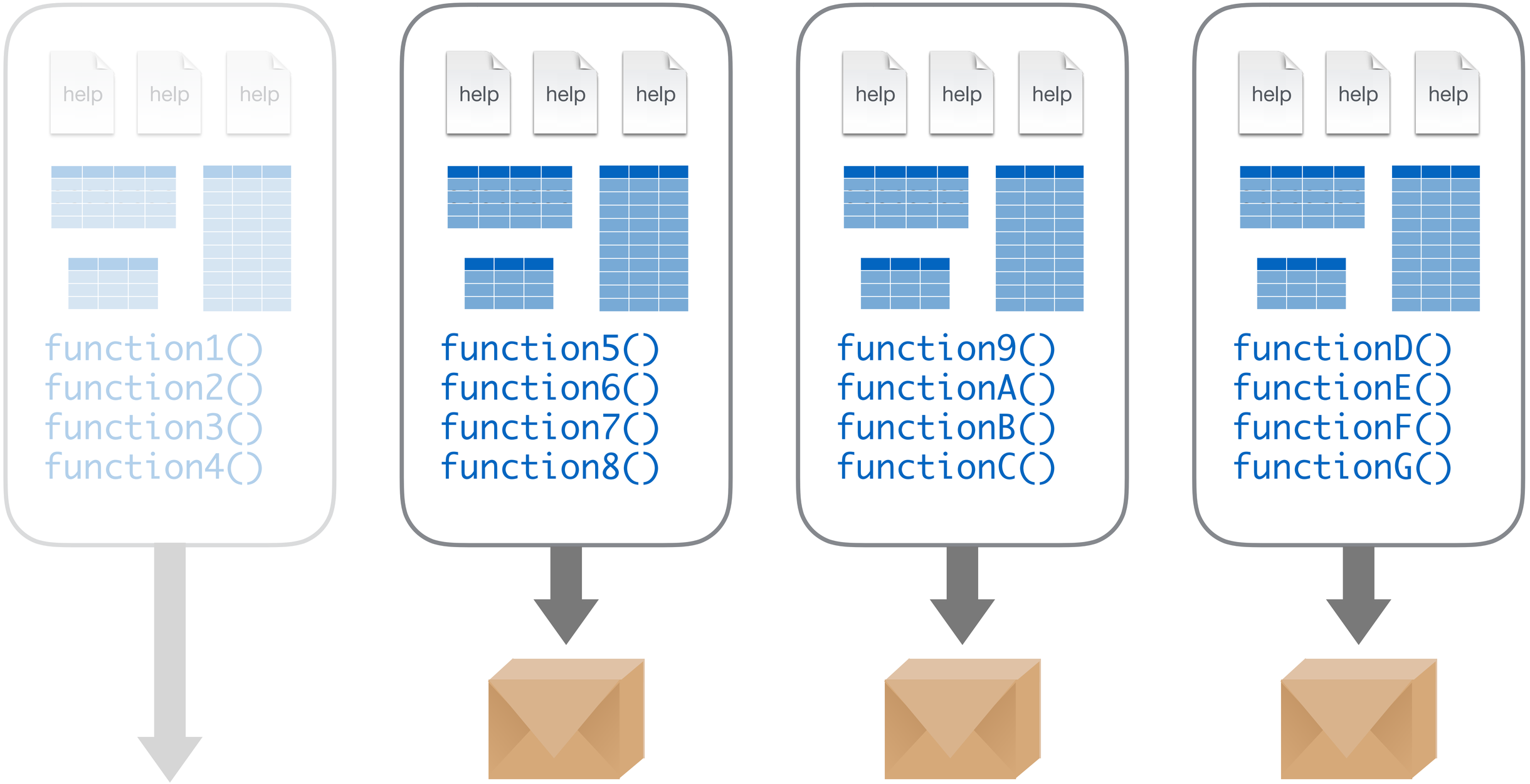

```
function9()
functionA()
functionB()
functionC()
```




```
functionD()
functionE()
functionF()
functionG()
```

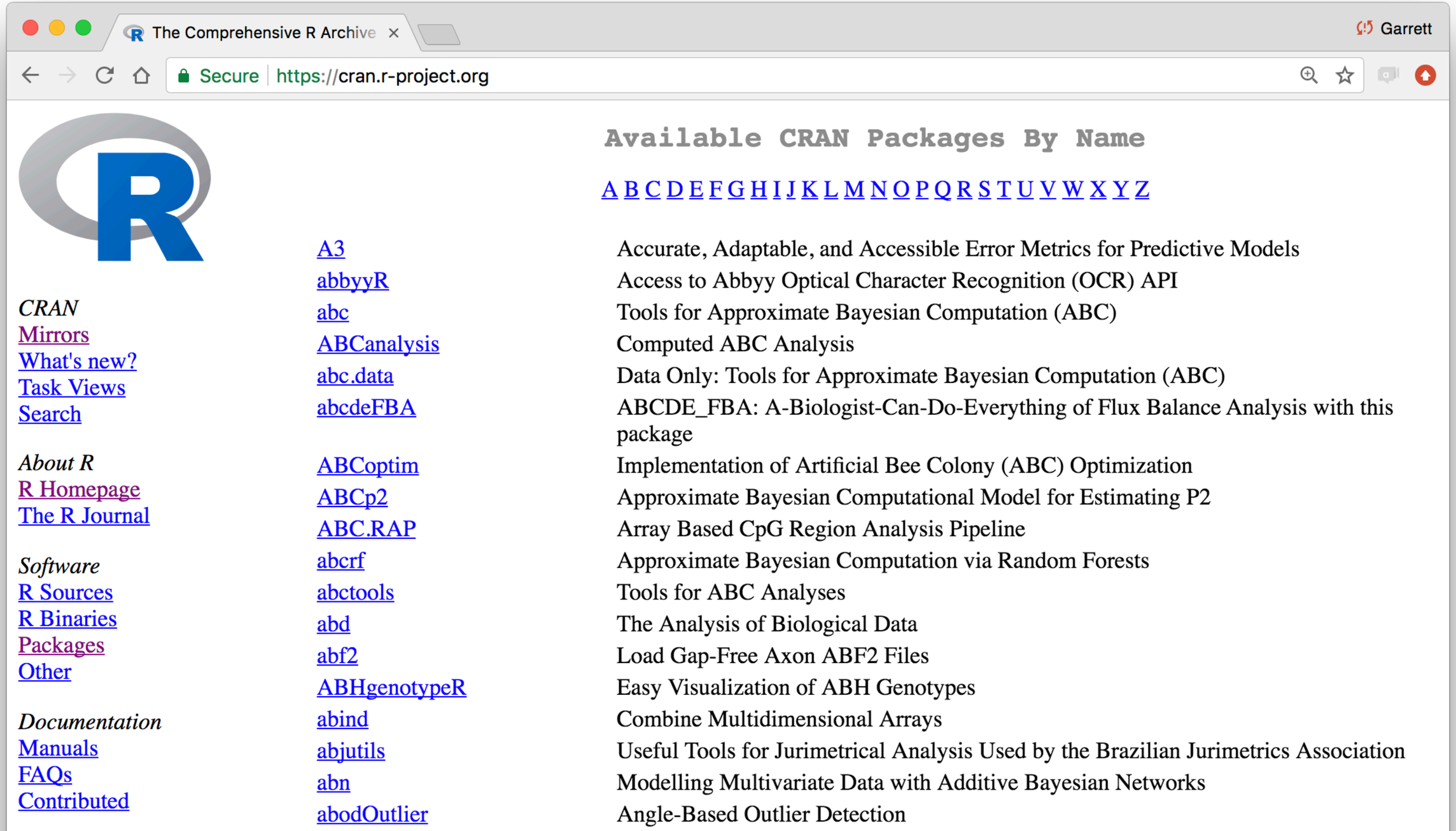


Base R



Base R

R Packages



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Packages
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Manuals
FAQs
Contributed

Available CRAN Packages By Name

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A3	Accurate, Adaptable, and Accessible Error Metrics for Predictive Models
abbyyR	Access to Abbyy Optical Character Recognition (OCR) API
abc	Tools for Approximate Bayesian Computation (ABC)
ABCanalysis	Computed ABC Analysis
abc.data	Data Only: Tools for Approximate Bayesian Computation (ABC)
abcdeFBA	ABCDE_FBA: A-Biologist-Can-Do-Everything of Flux Balance Analysis with this package
ABCoptim	Implementation of Artificial Bee Colony (ABC) Optimization
ABCp2	Approximate Bayesian Computational Model for Estimating P2
ABC.RAP	Array Based CpG Region Analysis Pipeline
abcrf	Approximate Bayesian Computation via Random Forests
abctools	Tools for ABC Analyses
abd	The Analysis of Biological Data
abf2	Load Gap-Free Axon ABF2 Files
ABHgenotypeR	Easy Visualization of ABH Genotypes
abind	Combine Multidimensional Arrays
abjutils	Useful Tools for Jurimetrical Analysis Used by the Brazilian Jurimetrics Association
abn	Modelling Multivariate Data with Additive Bayesian Networks
abodOutlier	Angle-Based Outlier Detection

Using packages

1

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

Downloads files to "computer"

1 x per "computer"

2

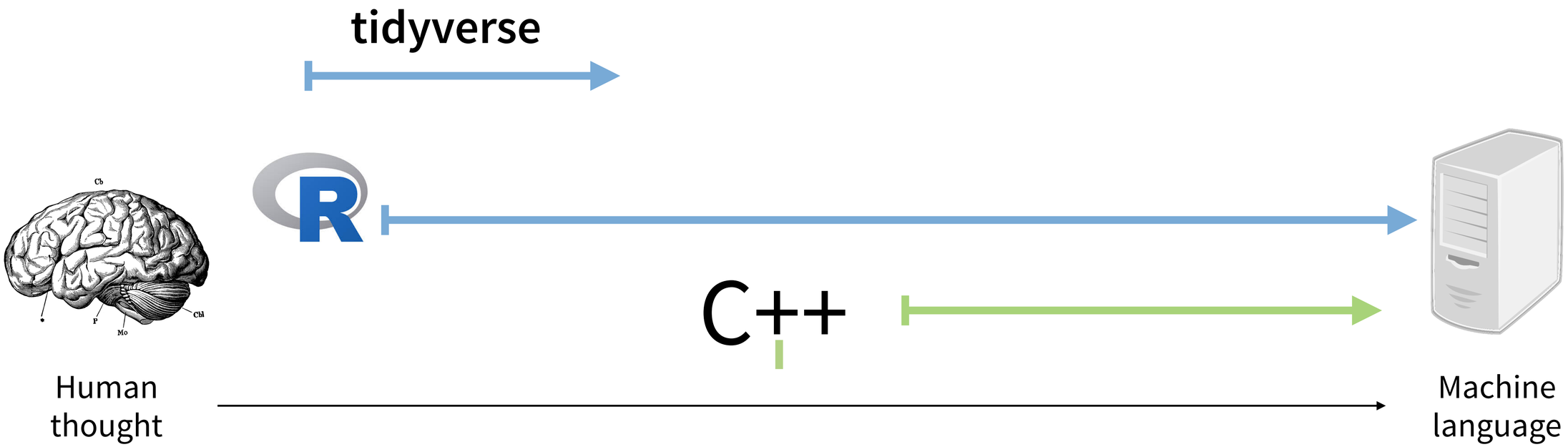
```
library("foo")
```

Loads package

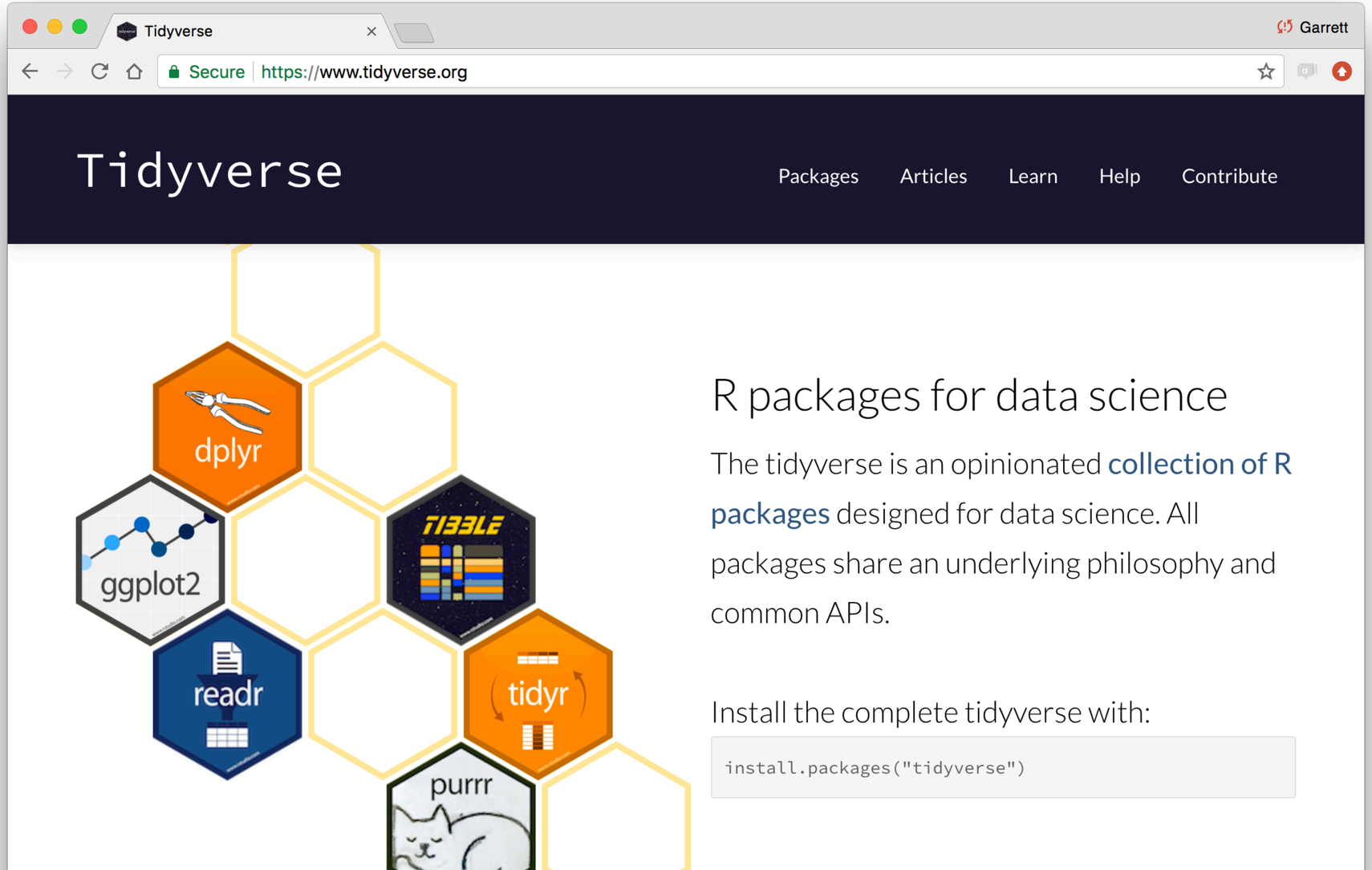
1 x per R Session

I've done this for you for this workshop

The tidyverse - A set of R packages to unify some data science tasks

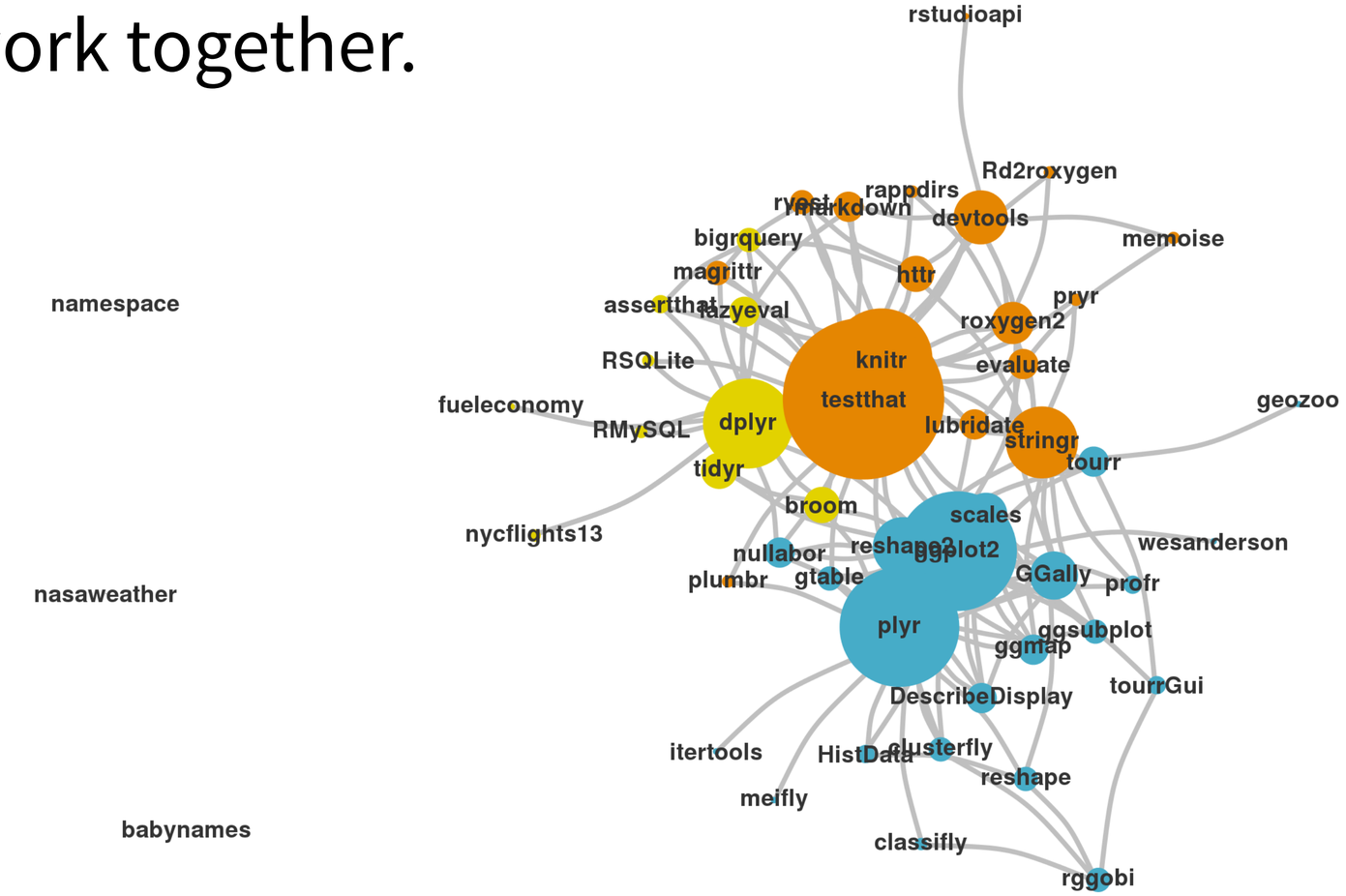


tidyverse.org



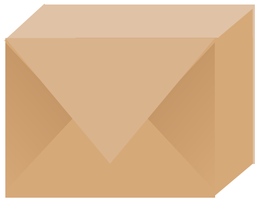
The Tidyverse

A collection of modern R packages that share common philosophies, embed best practices, and are designed to work together.



Display by Adolfo Álvarez

tidyverse



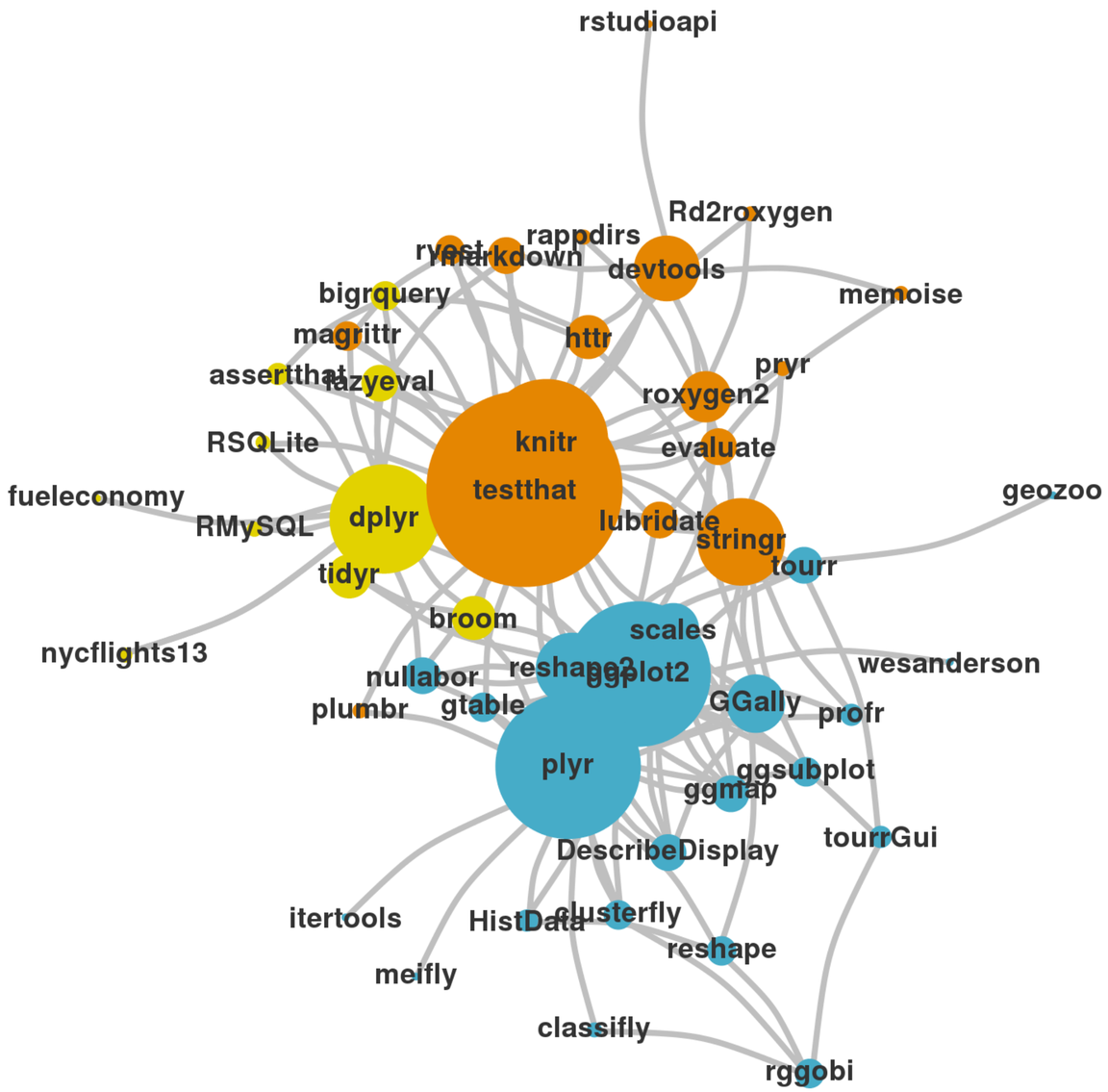
An R package that serves as a short cut for installing and loading the components of the tidyverse.

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

```
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")
```



```
install.packages("tidyverse")
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does the equivalent of

```
install.packages("ggplot2")
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install.packages("readr")
install.packages("purrr")
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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")
```

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

does the equivalent of

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

Day 1

Introduction and Visualize Data	9:00 - 10:30
Morning Break	10:30 - 11:00
Visualize and Transform	11:00 - 12:30
Lunch	12:30 - 2:00
Transform	2:00 - 3:30
Afternoon Break	3:30 - 4:00
Tidy Data/ Case Study	4:00 - 5:00

Day 2

Data types	9:00 - 10:30
Morning Break	10:30 - 11:00
Iteration with purr	11:00 - 12:30
Lunch	12:30 - 2:00
Modeling and organization	2:00 - 3:30
Afternoon Break	3:30 - 4:00
Organize and wrap-up	4:00 - 5:00


R

RStudio: a software program

1. like Microsoft Word, Excel, etc.
2. built to help you write R code, run R code, and analyze data with R
3. text editor, version control, keyboard shortcuts, debugging tools, and much more

RMarkdown (let's start!)

Data Science in the Tidyverse

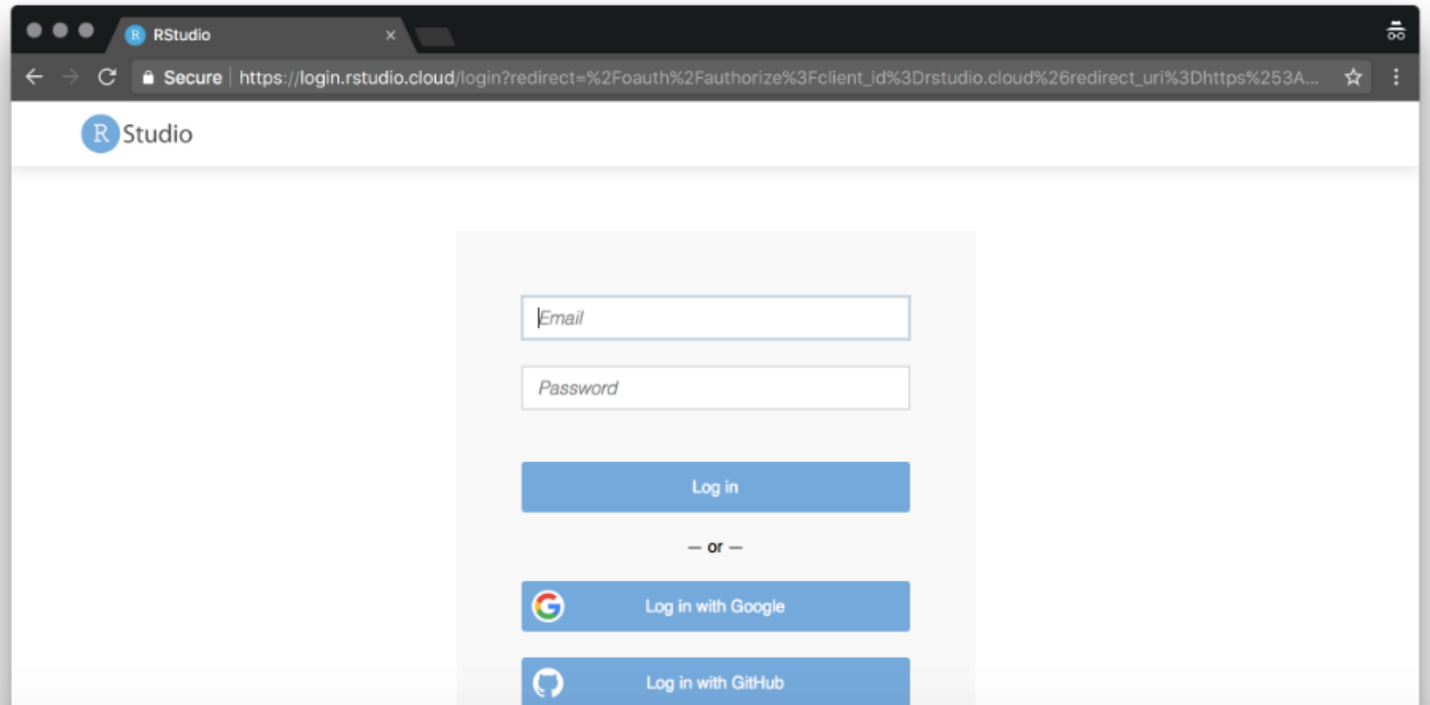
Go to http://bit.ly/rstudio2019setup

and follow instructions

To get started:

To get set up follow these steps:

1. Visit the project at https://rstudio.cloud/project/163983
2. Log in using google, github, shinyapps.io or "Sign Up".



Your Turn

Instructions with screenshots at bit.ly/rstudio2019setup

First, if you haven't already

- visit https://rstudio.cloud/project/163983
- Log In / Sign Up
- "Save a copy" of the project
- Open data-science-in-the-tidyverse.Rproj

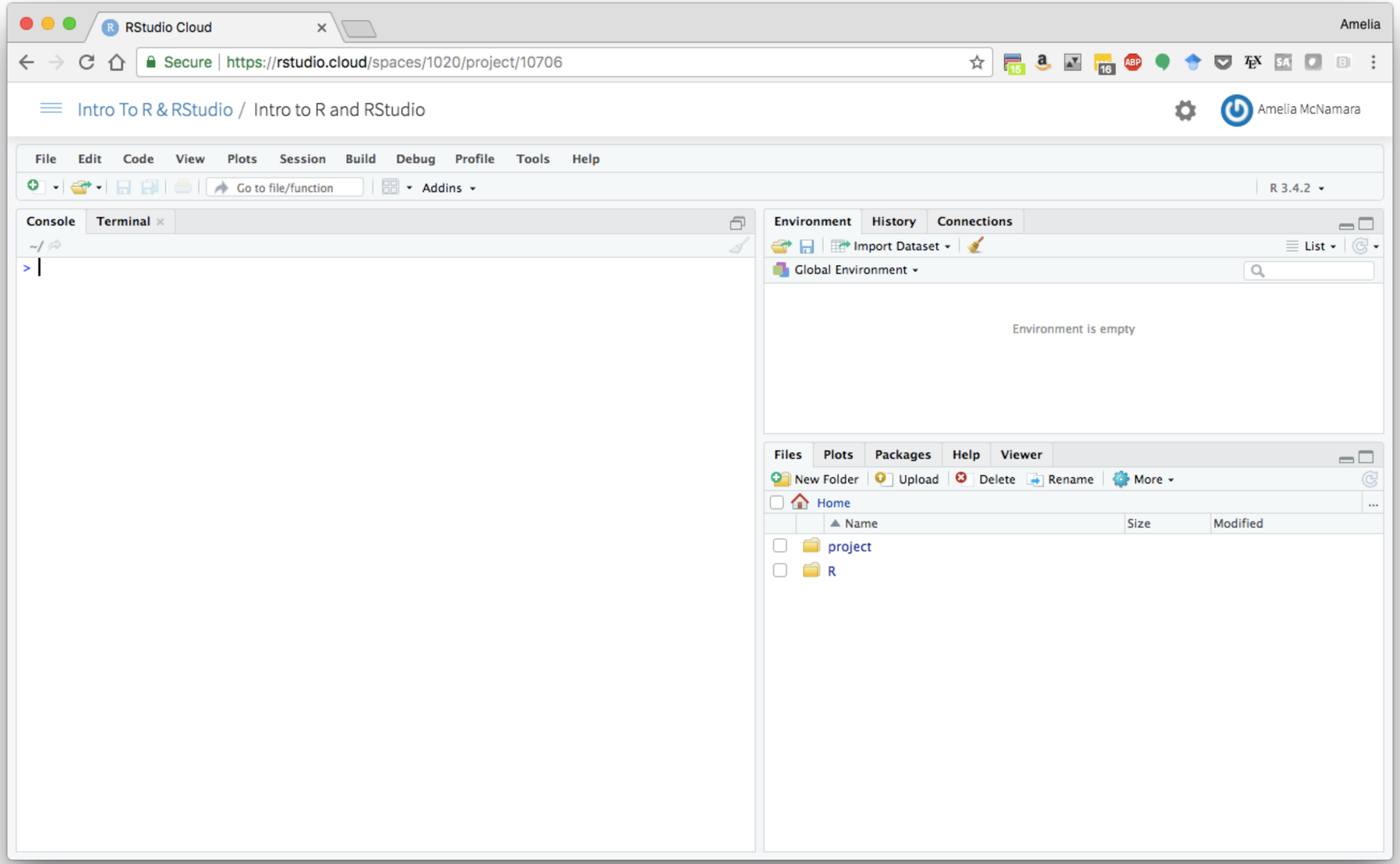
When you have your copy of the project, let us know by putting up the **Blue** post-it.

Then, open **00-Getting-started.Rmd** and look around

RMarkdown

An authoring format for Data Science.

RStudio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Addins
R 3.4.2
Console
Terminal
~/
>
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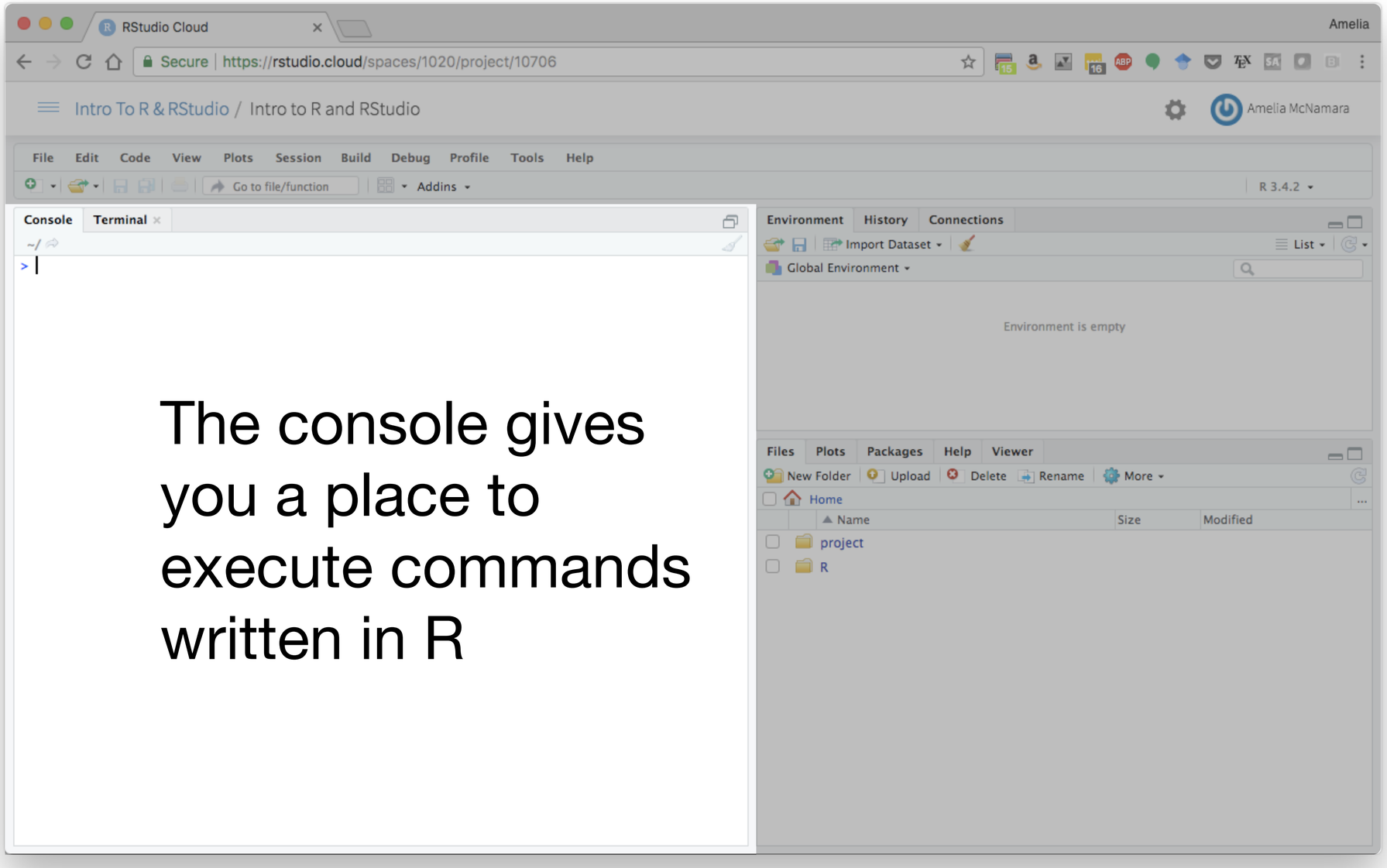
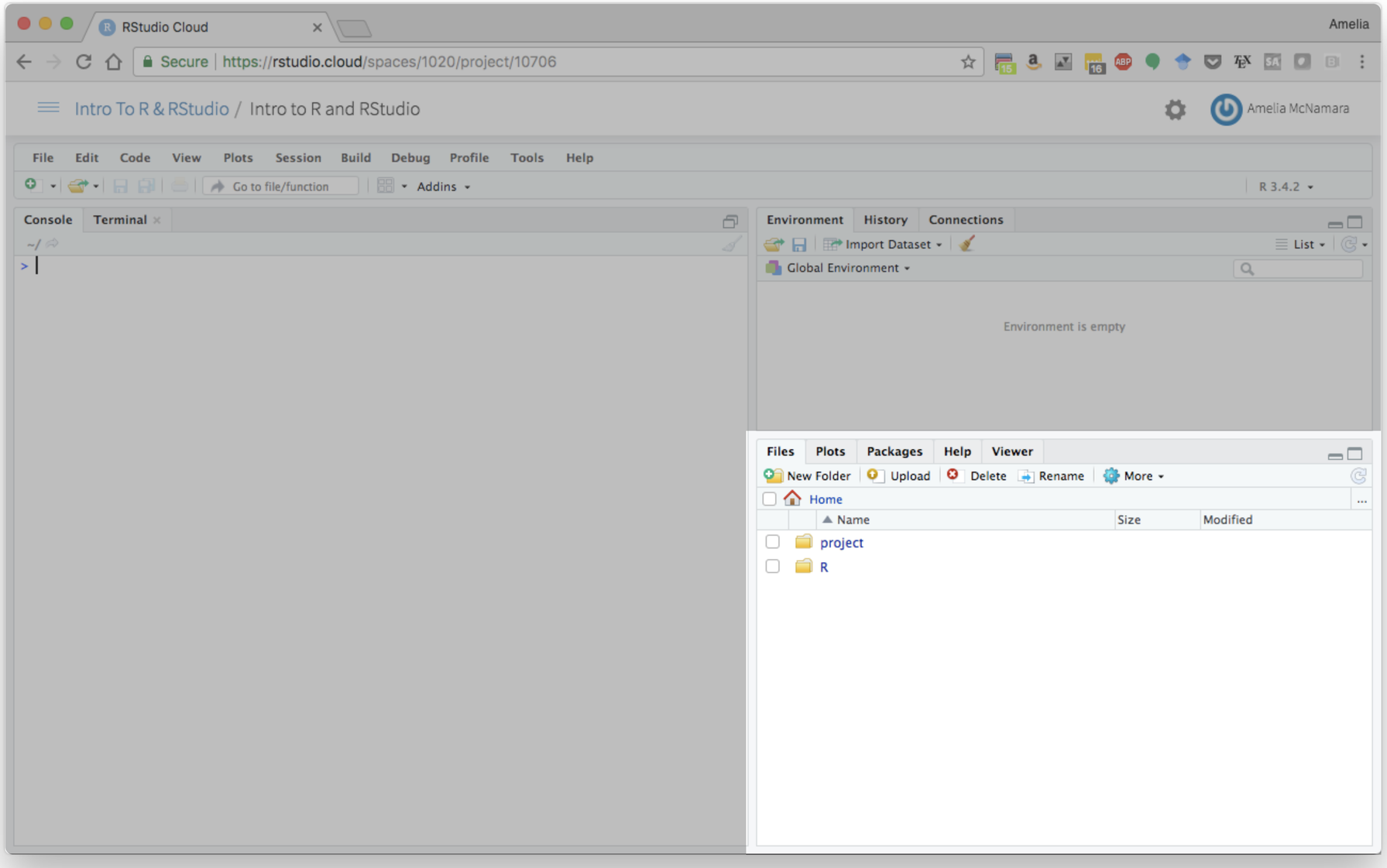
History
Connections
Import Dataset
List
Global Environment
Environment is empty
Files
Plots
Packages
Help
Viewer
New Folder
Upload
Delete
Rename
More
Home
Name
Size
Modified
project
R

RStudio



The console gives you a place to execute commands written in R

RStudio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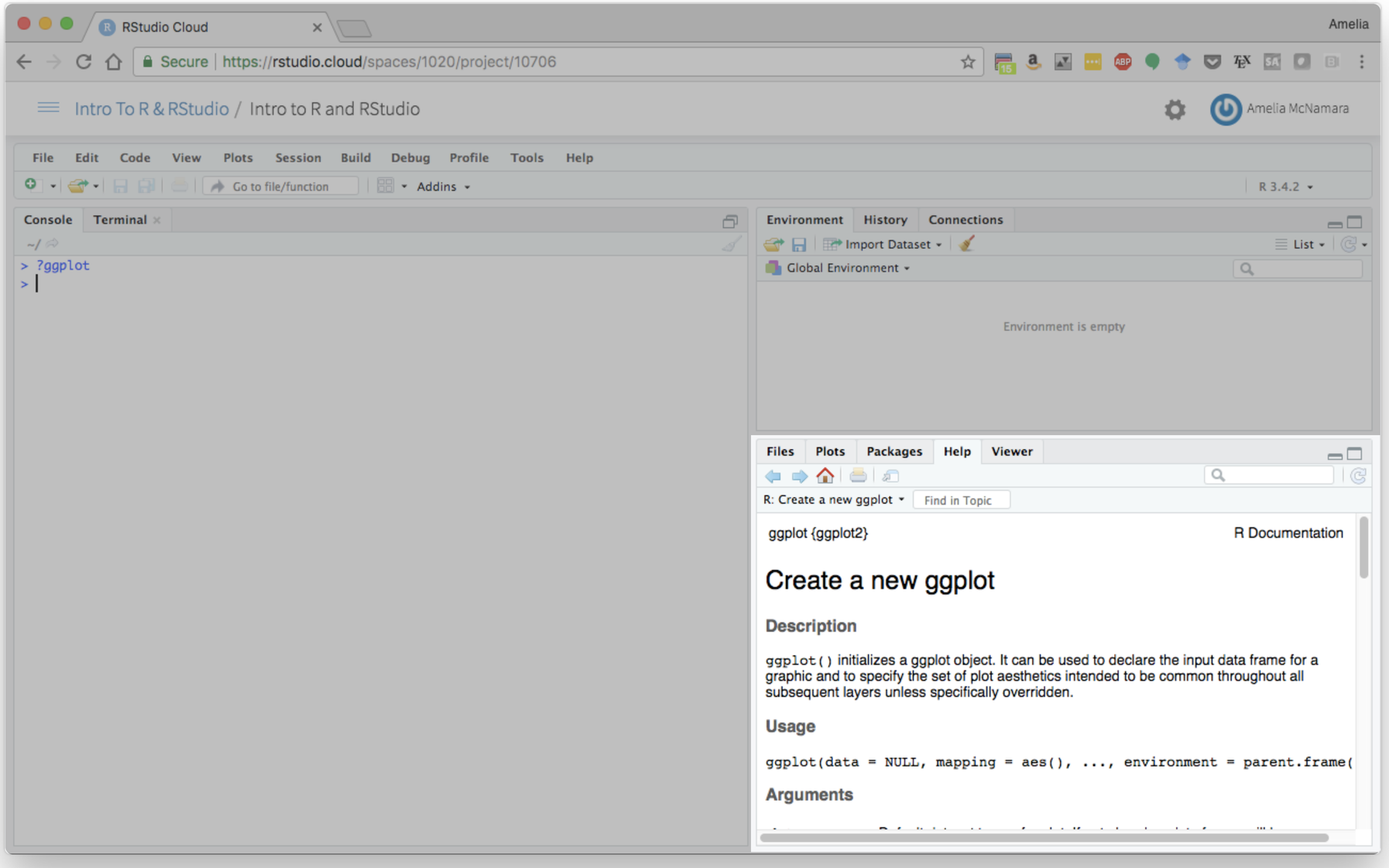
Home
Name
Size
Modified
project
R

RStudio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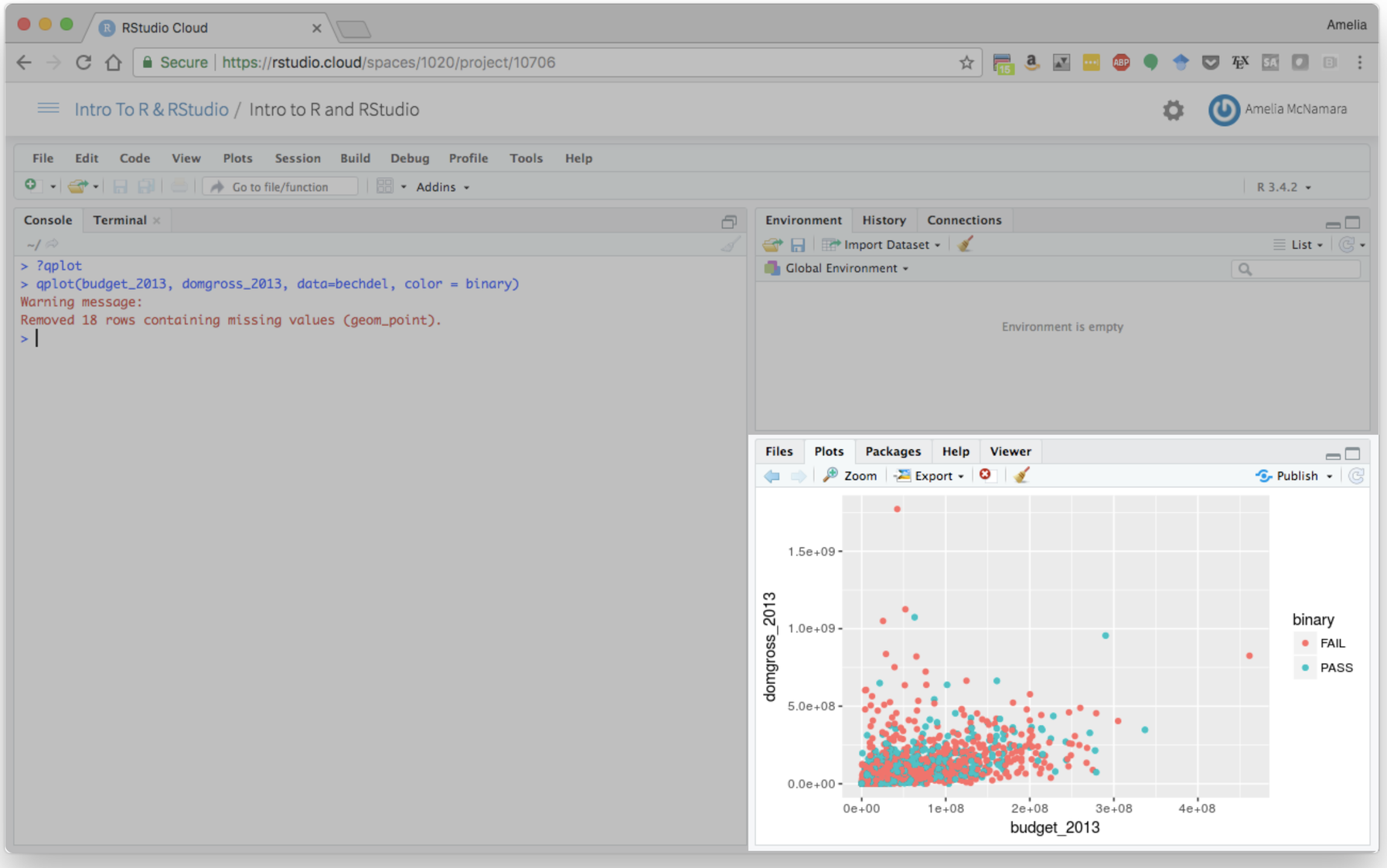
Go to file/function
Addins
R 3.4.2
Console Terminal
~/
> ?ggplot
>
Environment History Connections
Import Dataset
List
Global Environment
Environment is empty
Files Plots Packages Help Viewer
R: Create a new ggplot
Find in Topic
ggplot {ggplot2}
R Documentation
Create a new ggplot
Description
ggplot() initializes a ggplot object. It can be used to declare the input data frame for a graphic and to specify the set of plot aesthetics intended to be common throughout all subsequent layers unless specifically overridden.
Usage
ggplot(data = NULL, mapping = aes(), ..., environment = parent.frame(
Arguments

RStudio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Addins
R 3.4.2
Console Terminal
> ?qplot
> qplot(budget_2013, domgross_2013, data=bechdel, color = binary)
Warning message:
Removed 18 rows containing missing values (geom_point).
>
Environment History Connections
Import Dataset
List
Global Environment
Environment is empty
Files Plots Packages Help Viewer
Zoom
Export
Publish
1.5e+09
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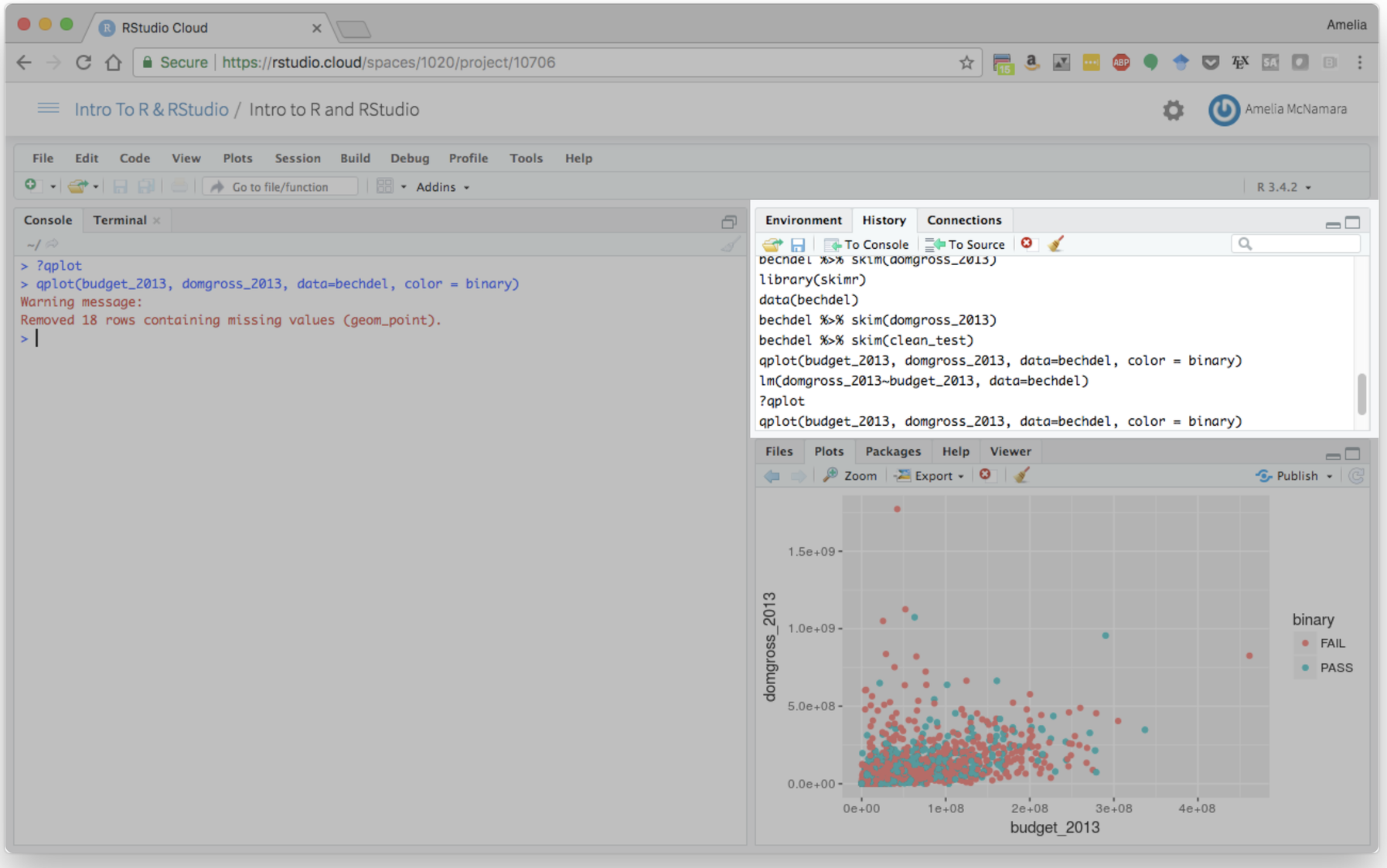
5.0e+08
0.0e+00
domgross_2013
0e+00
1e+08
2e+08
3e+08
4e+08
budget_2013
binary
FAIL
PASS

RStudio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Warning message:
Removed 18 rows containing missing values (geom_point).
>
Environment
History
Connections
To Console
To Source
library(skimr)
data(bechdel)
bechdel %>% skim(domgross_2013)
bechdel %>% skim(clean_test)
qplot(budget_2013, domgross_2013, data=bechdel, color = binary)
lm(domgross_2013~budget_2013, data=bechdel)
?qplot
qplot(budget_2013, domgross_2013, data=bechdel, color = binary)
Files
Plots
Packages
Help
Viewer
Zoom
Export
Publish
1.5e+09
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domgross_2013
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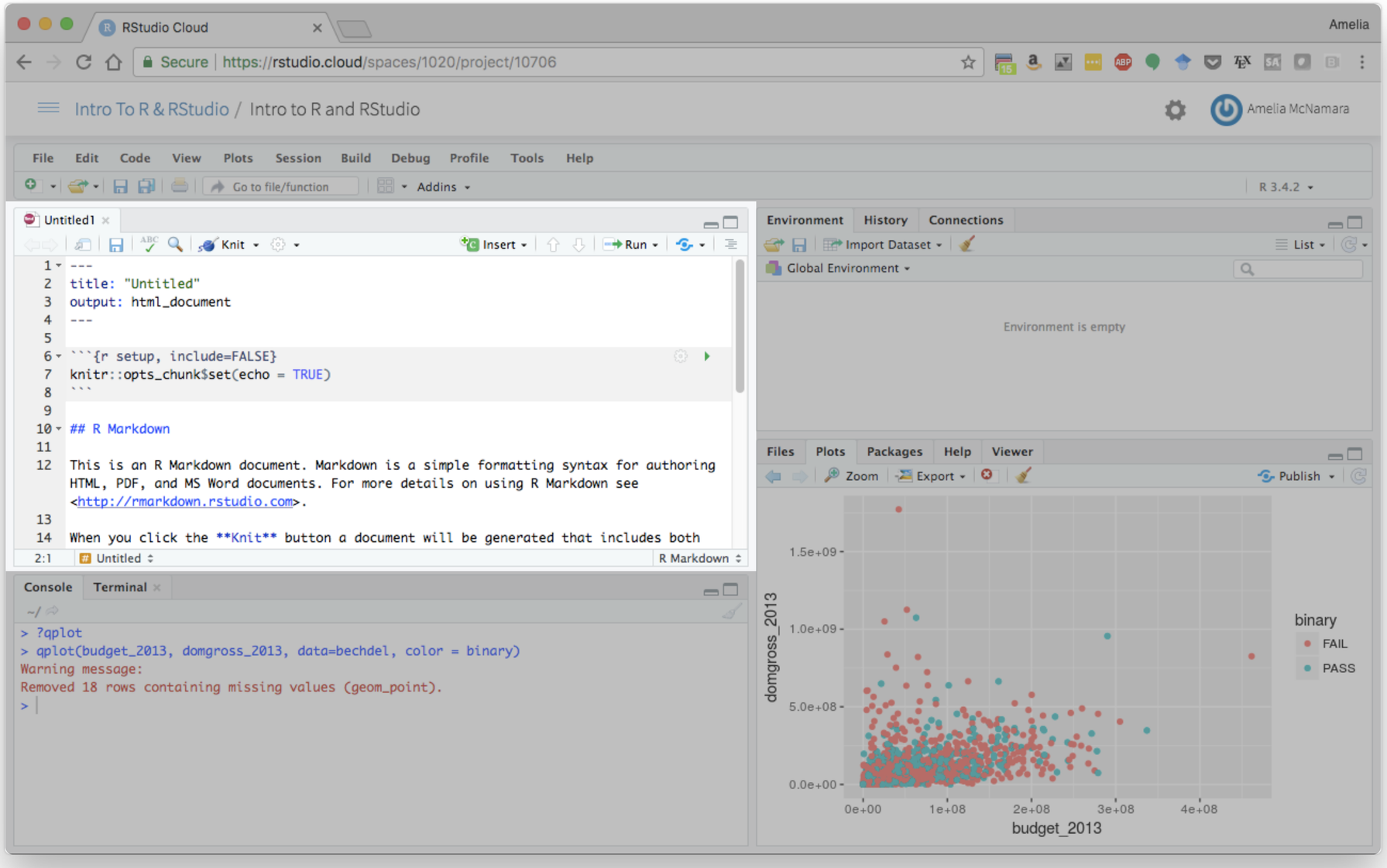
1e+08
2e+08
3e+08
4e+08
budget_2013
binary
FAIL
PASS

RStudio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Amelia McNamara
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
R 3.4.2
Untitled1
Knit
Insert
Run
1 ---
2 title: "Untitled"
3 output: html_document
4 ---
5
6 ```{r setup, include=FALSE}
7 knitr::opts_chunk$set(echo = TRUE)
8 ```
9
10 ## R Markdown
11
12 This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.
13
14 When you click the **Knit** button a document will be generated that includes both
2:1 Untitled
R Markdown
Console Terminal
~/
> ?qplot
> qplot(budget_2013, domgross_2013, data=bechdel, color = binary)
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domgross_2013
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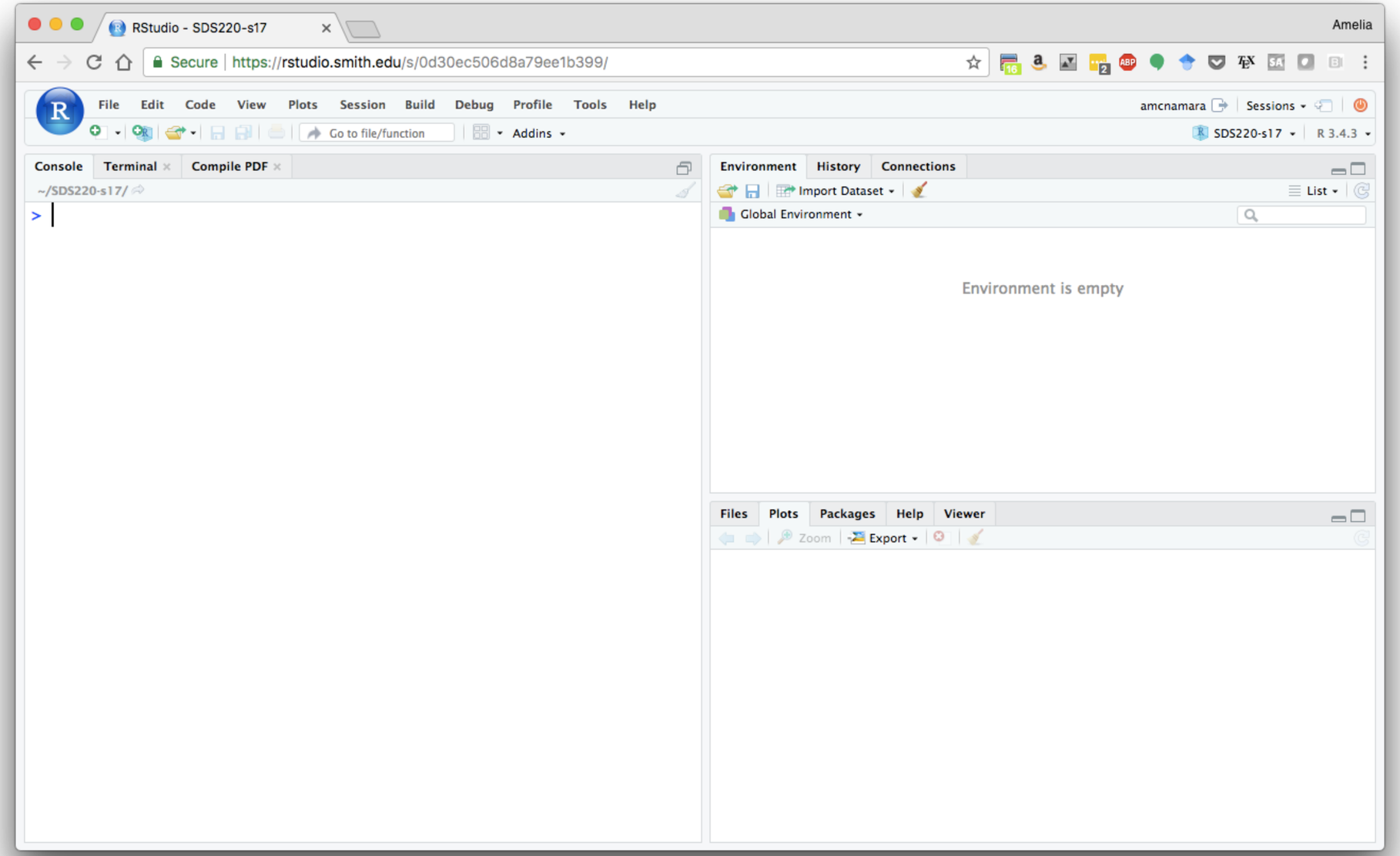
1e+08
2e+08
3e+08
4e+08
budget_2013
binary
FAIL
PASS

RStudio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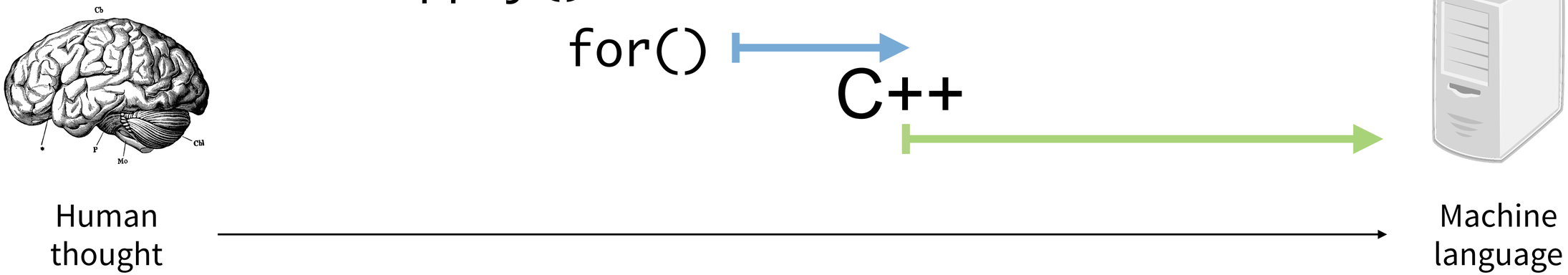
File Edit Code View Plots Session Build Debug Profile Tools Help
amcnamara | Sessions
Go to file/function | Addins
SDS220-s17 | R 3.4.3
Console Terminal Compile PDF
~/SDS220-s17/
>
Environment History Connections
Import Dataset | List
Global Environment
Environment is empty
Files Plots Packages Help Viewer
Zoom | Export

R - A computer language for scientists



R Syntax Comparison : : **CHEAT SHEET**

Dollar sign syntax

`goal(data$x, data$y)`

SUMMARY STATISTICS:

one continuous variable:
```
mean(mtcars$mpg)
```

one categorical variable:
```
table(mtcars$cyl)
```

two categorical variables:
```
table(mtcars$cyl, mtcars$am)
```

one continuous, one categorical:
```
mean(mtcars$mpg[mtcars$cyl==4])
mean(mtcars$mpg[mtcars$cyl==6])
mean(mtcars$mpg[mtcars$cyl==8])
```

PLOTTING:

one continuous variable:
```
hist(mtcars$disp)

boxplot(mtcars$disp)
```

one categorical variable:
```
barplot(table(mtcars$cyl))
```

two continuous variables:
```
plot(mtcars$disp, mtcars$mpg)
```

two categorical variables:
```
mosaicplot(table(mtcars$am, mtcars$cyl))
```

one continuous, one categorical:
```
histogram(mtcars$disp[mtcars$cyl==4])
histogram(mtcars$disp[mtcars$cyl==6])
histogram(mtcars$disp[mtcars$cyl==8])

boxplot(mtcars$disp[mtcars$cyl==4])
boxplot(mtcars$disp[mtcars$cyl==6])
boxplot(mtcars$disp[mtcars$cyl==8])
```

WRANGLING:

subsetting:
```
mtcars[mtcars$mpg>30, ]
```

making a new variable:
```
mtcars$efficient[mtcars$mpg>30] <- TRUE
mtcars$efficient[mtcars$mpg<30] <- FALSE
```

Formula syntax

`goal(y~x|z, data=data, group=w)`

SUMMARY STATISTICS:

one continuous variable:
```
mosaic::mean(~mpg, data=mtcars)
```

one categorical variable:
```
mosaic::tally(~cyl, data=mtcars)
```

two categorical variables:
```
mosaic::tally(cyl~am, data=mtcars)
```

one continuous, one categorical:
```
mosaic::mean(mpg~cyl, data=mtcars)
```

tilde

PLOTTING:

one continuous variable:
```
lattice::histogram(~disp, data=mtcars)

lattice::bwplot(~disp, data=mtcars)
```

one categorical variable:
```
mosaic::bargraph(~cyl, data=mtcars)
```

two continuous variables:
```
lattice::xyplot(mpg~disp, data=mtcars)
```

two categorical variables:
```
mosaic::bargraph(~am, data=mtcars, group=cyl)
```

one continuous, one categorical:
```
lattice::histogram(~disp|cyl, data=mtcars)

lattice::bwplot(cyl~disp, data=mtcars)
```

The variety of R syntaxes give you many ways to "say" the same thing

read **across** the cheatsheet to see how different syntaxes approach the same problem

Tidyverse syntax

`data %>% goal(x)`

SUMMARY STATISTICS:

one continuous variable:
```
mtcars %>% dplyr::summarize(mean(mpg))
```

one categorical variable:
```
mtcars %>% dplyr::group_by(cyl) %>%
dplyr::summarize(n())
```

the pipe

two categorical variables:
```
mtcars %>% dplyr::group_by(cyl, am) %>%
dplyr::summarize(n())
```

one continuous, one categorical:
```
mtcars %>%  dplyr::group_by(cyl) %>%
  dplyr::summarize(mean(mpg))
```

PLOTTING:

one continuous variable:
```
ggplot2::qplot(x=mpg, data=mtcars, geom = "histogram")

ggplot2::qplot(y=disp, x=1, data=mtcars, geom="boxplot")
```

one categorical variable:
```
ggplot2::qplot(x=cyl, data=mtcars, geom="bar")
```

two continuous variables:
```
ggplot2::qplot(x=disp, y=mpg, data=mtcars, geom="point")
```

two categorical variables:
```
ggplot2::qplot(x=factor(cyl), data=mtcars, geom="bar") +
       facet_grid(.~am)
```

one continuous, one categorical:
```
ggplot2::qplot(x=disp, data=mtcars, geom = "histogram") +
       facet_grid(.~cyl)

ggplot2::qplot(y=disp, x=factor(cyl), data=mtcars,
              geom="boxplot")
```

WRANGLING:

subsetting:
```
mtcars %>% dplyr::filter(mpg>30)
```

making a new variable:
```
mtcars <- mtcars %>%
dplyr::mutate(efficient = if_else(mpg>30,  TRUE, FALSE))
```

SMITH COLLEGE

https://www.rstudio.com/resources/cheatsheets/

Introduction to Data Science in the Tidyverse

Amelia McNamara and Hadley Wickham