Programming Fundamentals

Algorithms; Variable types; Syntax

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Intended Learning Outcomes

By end the day you will be able to:

- Define what an algorithm is
- Use pseudocode to help simplify programming
- Describe different data structures
- Identify different variable types
- Feel more comfortable with R and RStudio

Algorithms

“A process or set of rules to be followed to solve a problem or task.”

Examples of Algorithms

Directions

Step 1

Preheat oven to 350 degrees F (175 degrees C). Grease and flour an 8-inch square pan.

Step 2

In a large saucepan, melt 1/2 cup butter. Remove from heat, and stir in sugar, eggs, and 1 teaspoon vanilla. Beat in 1/3 cup cocoa, 1/2 cup flour, salt, and baking powder. Spread batter into prepared pan.

Step 3

Bake in preheated oven for 25 to 30 minutes. Do not overcook.

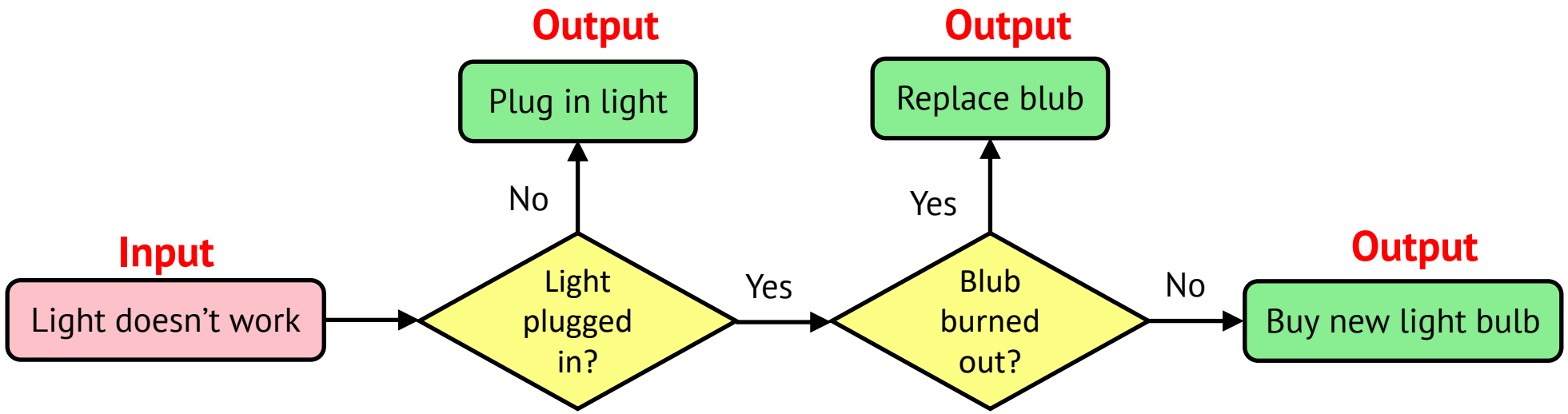
Step 4

To Make Frosting: Combine 3 tablespoons softened butter, 3 tablespoons cocoa, honey, 1 teaspoon vanilla extract, and 1 cup confectioners' sugar. Stir until smooth. Frost brownies while they are still warm.

Chocolate Brownie

Pseudocode

- Plain English syntax of code
- Can be used to represent or write an algorithm
- Uses verbs, variables, conditional statements and loops to perform task (covered in more detail tomorrow)



Variables and Types

- Information is stored as variables

```
MyForename <- “Josh”
```

Character

```
MyAge <- 31
```

Numeric (integer or float)

```
Iam31 <- TRUE
```

Logical

Variables and Types

Variables with more information

```
MyFullname <- c("Josh", "Alexander", "Hodge-Grace")
```

Character Vector

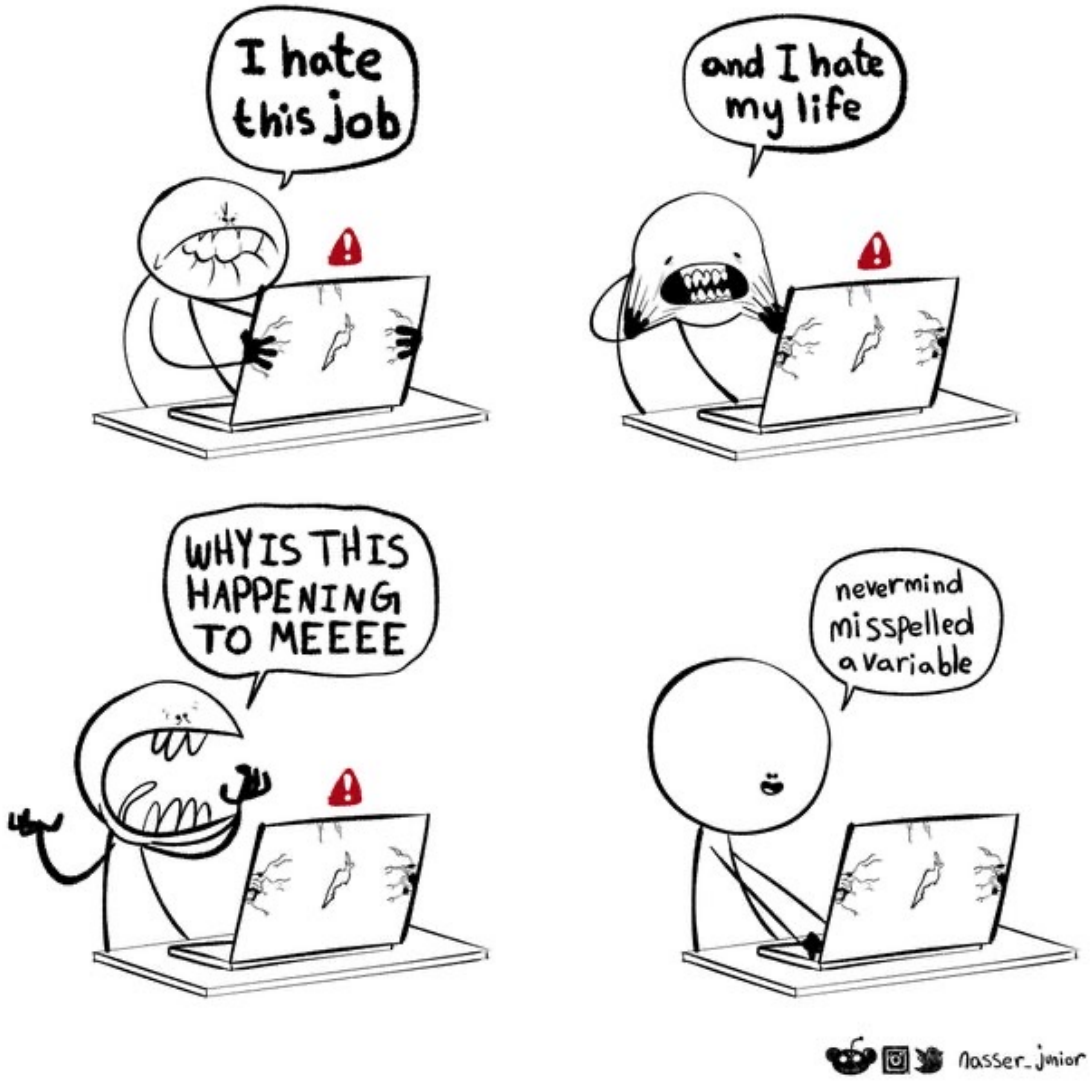
```
MyDoB <- c(12, 11, 1989)
```

Numeric Vector

```
Iam31 <- c(TRUE, FALSE)
```

Logical Vector

Naming Variables



- R is case sensitive
- Keep variable names simple
- Keep column names simple

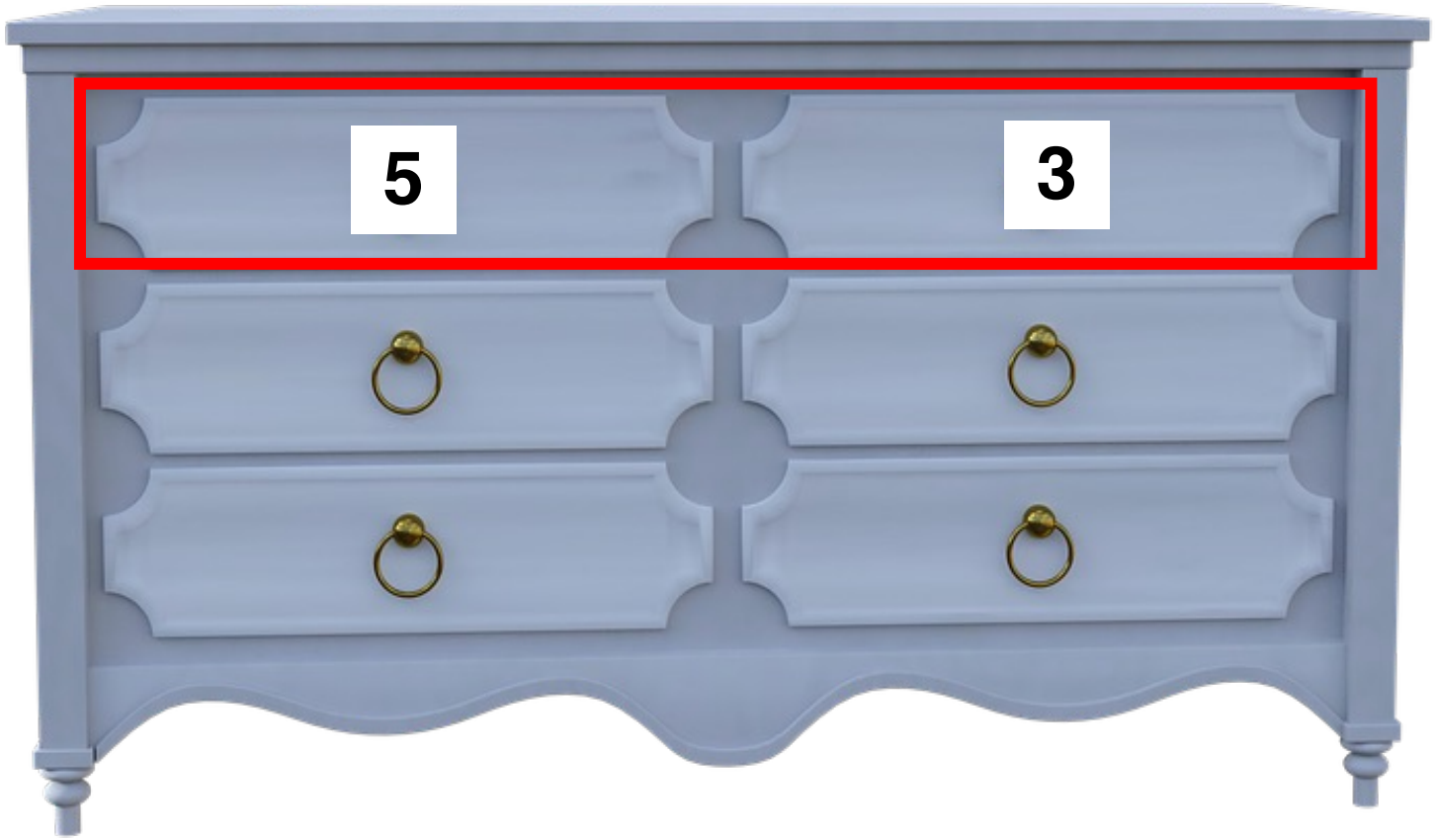
Data Structures

1. Vectors: one dimension of same data type
2. Matrices: two dimensions of the same data type
3. Arrays: n-dimensions of the same data type
4. Dataframes: two dimensions of mixed data types
5. Lists: n-dimensions of mixed data types

The Chest of Drawers of Vectors

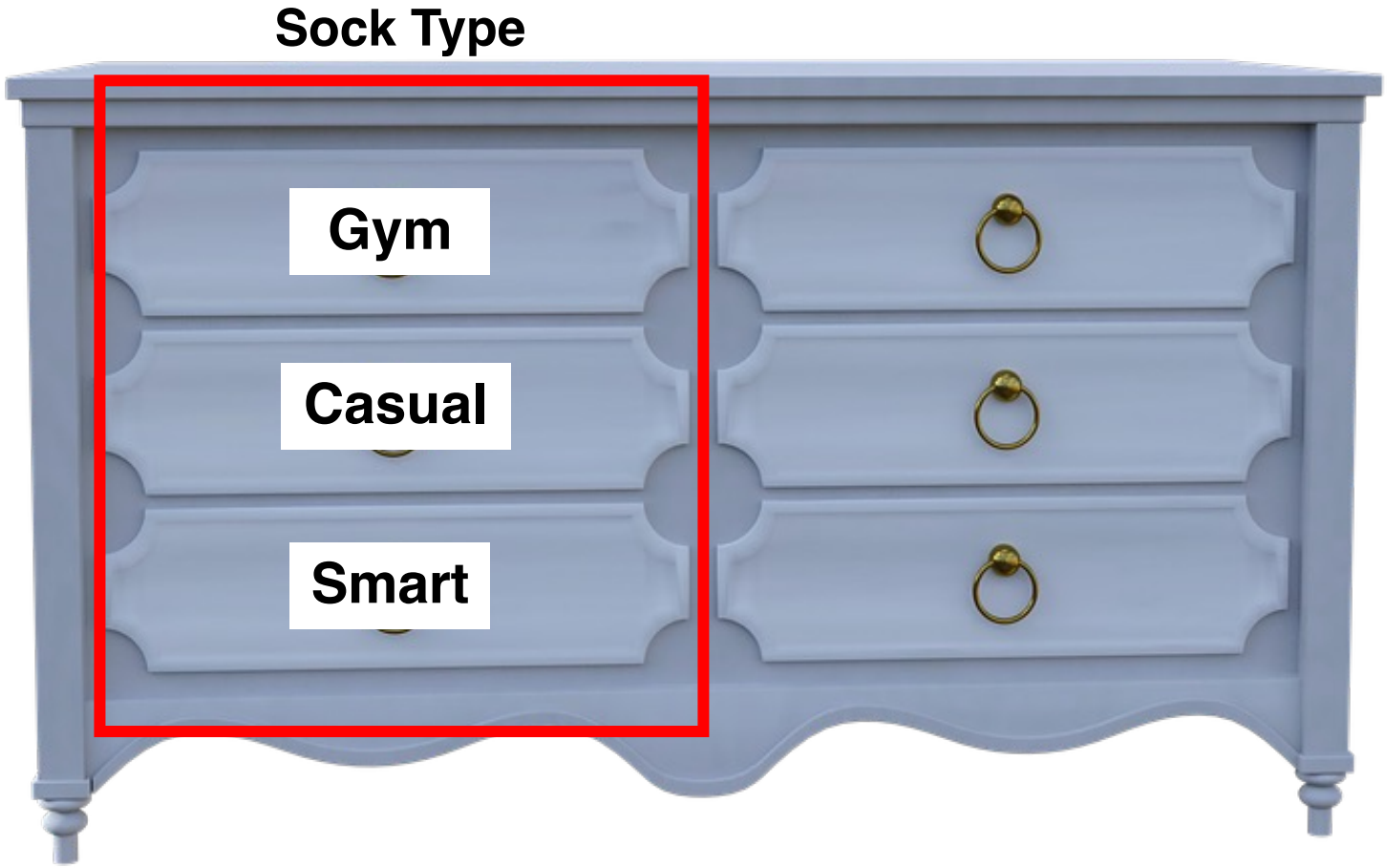
- Vectors: one dimension of same data type

Number of Socks



The Chest of Drawers of Vectors

- Vectors: one dimension of same data type



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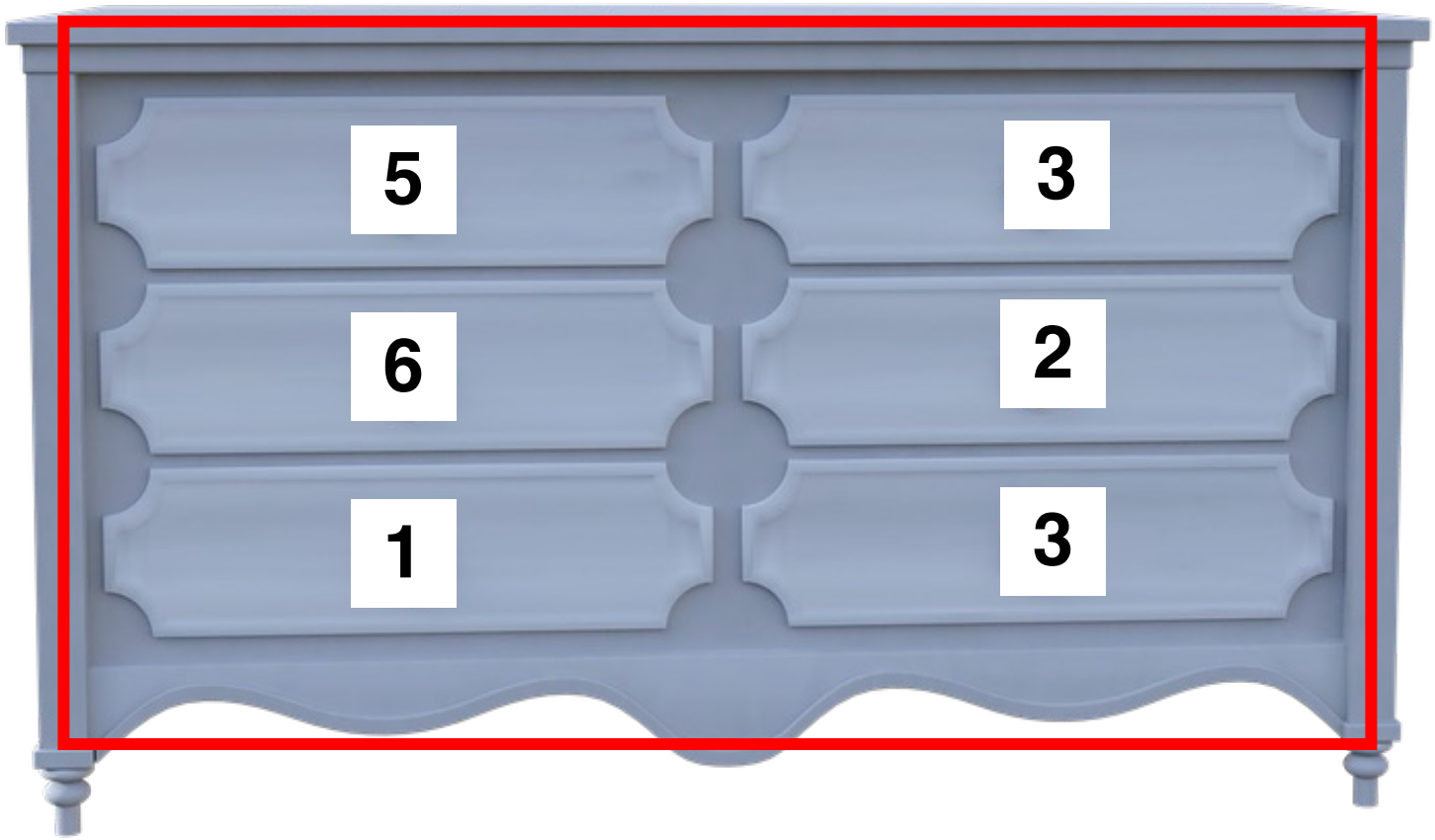
The Matrix of Drawers

- Matrix: two dimensions of the same data type

Number of Socks



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The Array of Drawers

- Arrays: n-dimensions of the same data type

Number of Items

Data Structures

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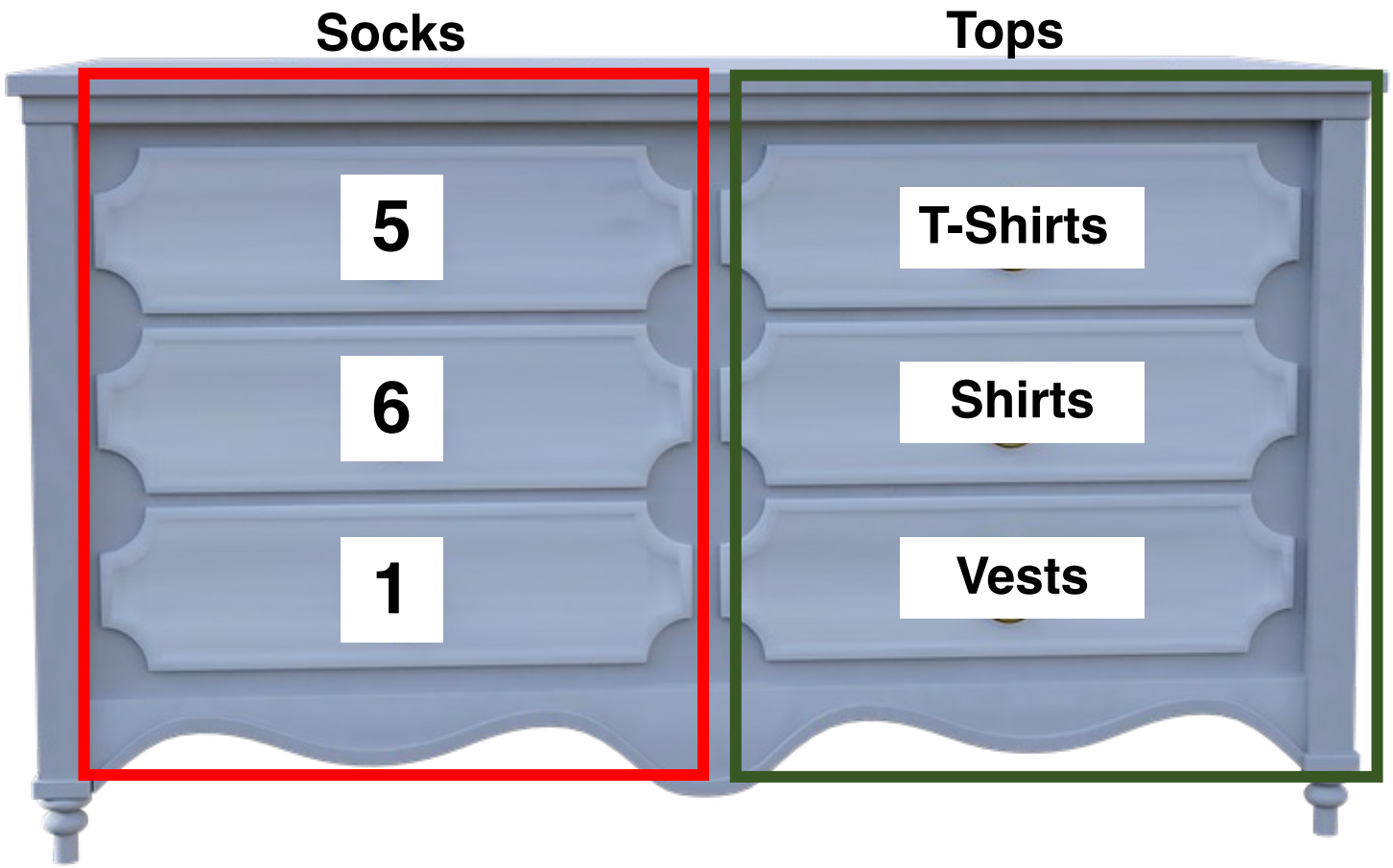
Chest of Drawers as Dataframes

- Data Frames: two dimensions of mixed data types



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Repositories, Packages and Functions

- A repository is a place where packages are located so you can install them.
  - The Comprehensive R Archive Network (CRAN)
  - Bioconductor
  - Github

- Packages are a collection of functions in a well-defined format

- Function is a piece of code that executes an action over an input

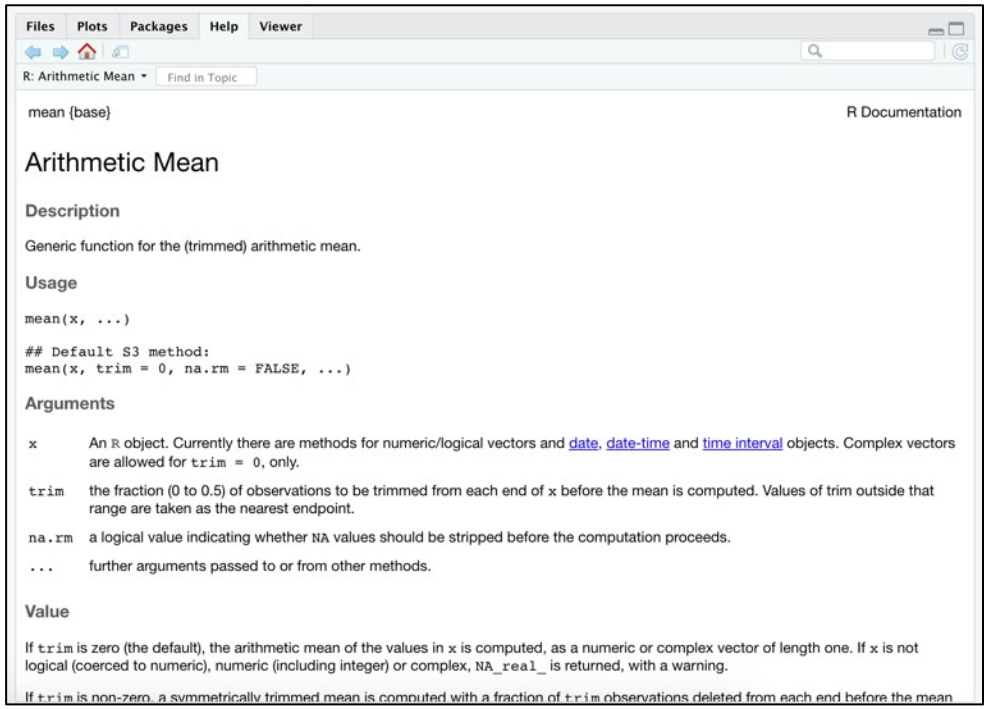
Building Blocks of a Function

```
function(arg1, arg2,…etc)
```

- Arguments are variables required for the function to be executed

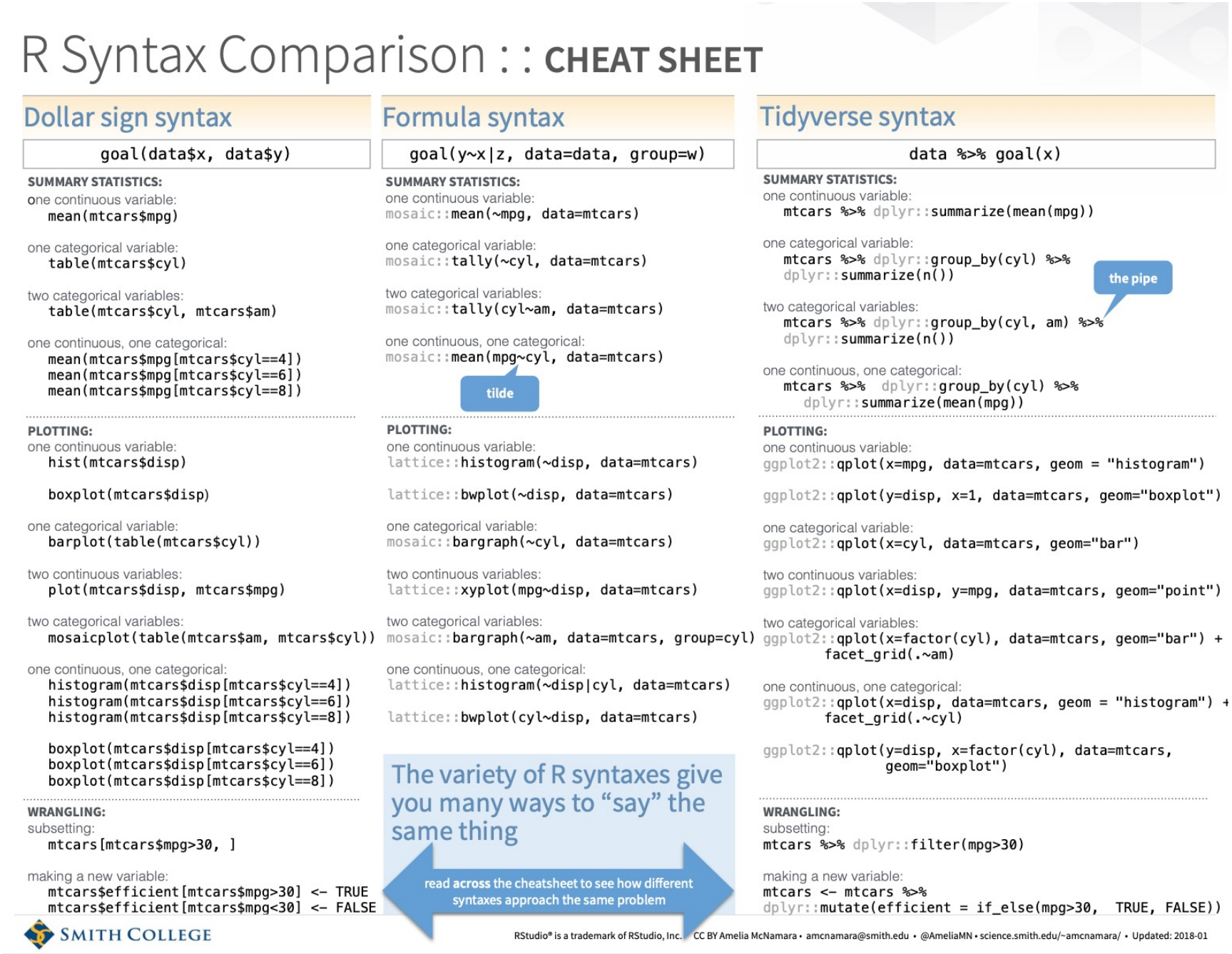
```
mean(x)
x= numerical vector

vector <- c(1,2,3)
mean(vector)
2
```



R Syntax

- Syntax is the structure of statements in a computer language



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)
```

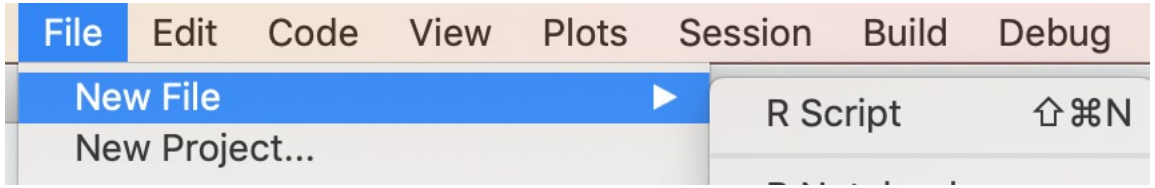
making a new variable:
```
mtcars <- mtcars %>%
dplyr::mutate(efficient = if_else(mpg>30,  TRUE, FALSE))
```

SMITH COLLEGE

Rules of Scripting

1. Readability
2. Architecture First
3. Keep it Simple
4. Comments
5. Modularise and Develop Iteratively
6. Strive for Automation

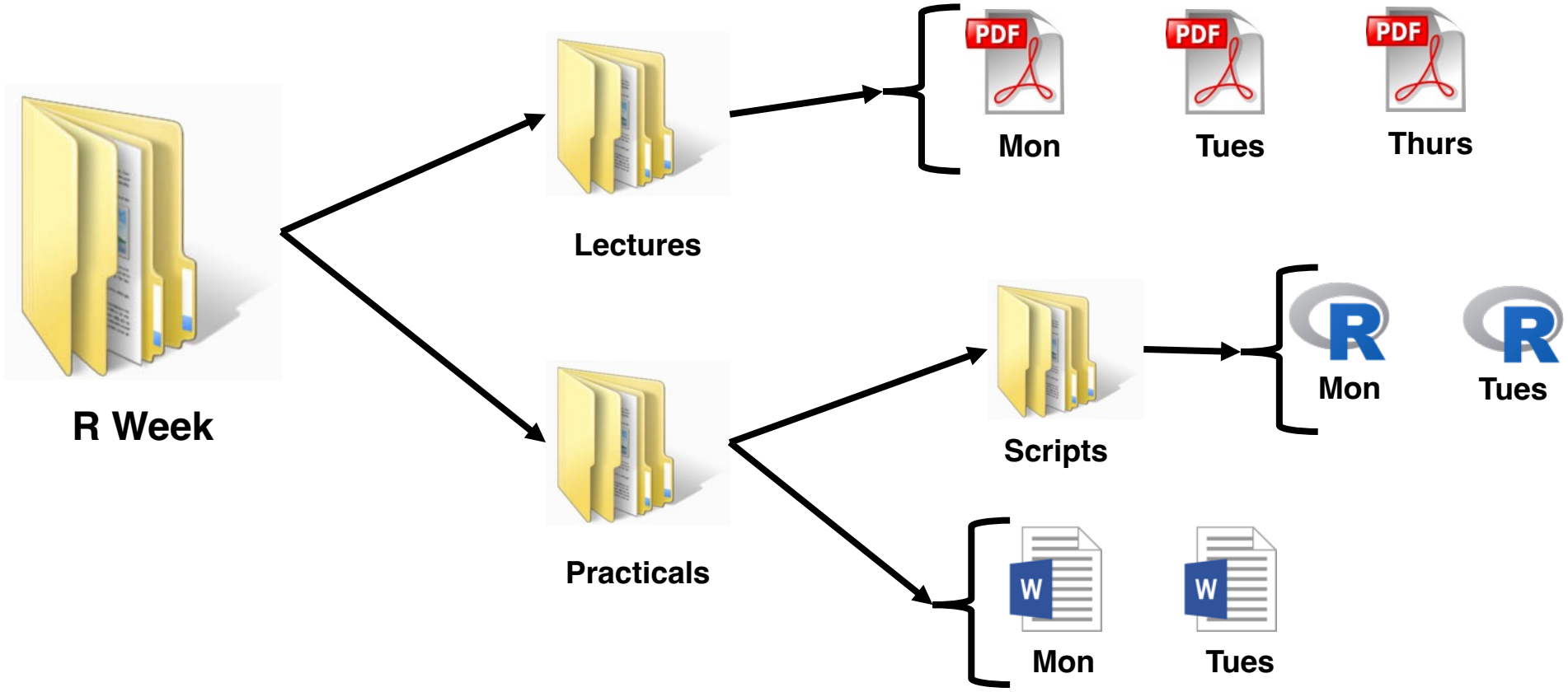
Rules of Scripting



1. Readability
2. Architecture First → **PLAN**
3. Keep it Simple
4. Comments ##Import Data##
5. Modularise and Develop Iteratively
6. Strive for Automation

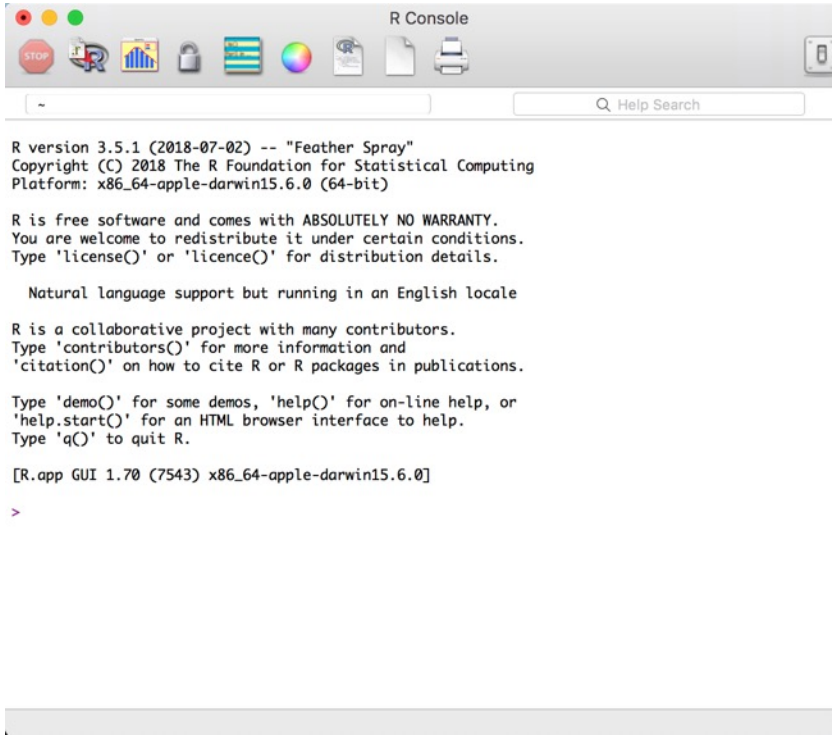
Directories

"File system cataloging computer files and other directories"

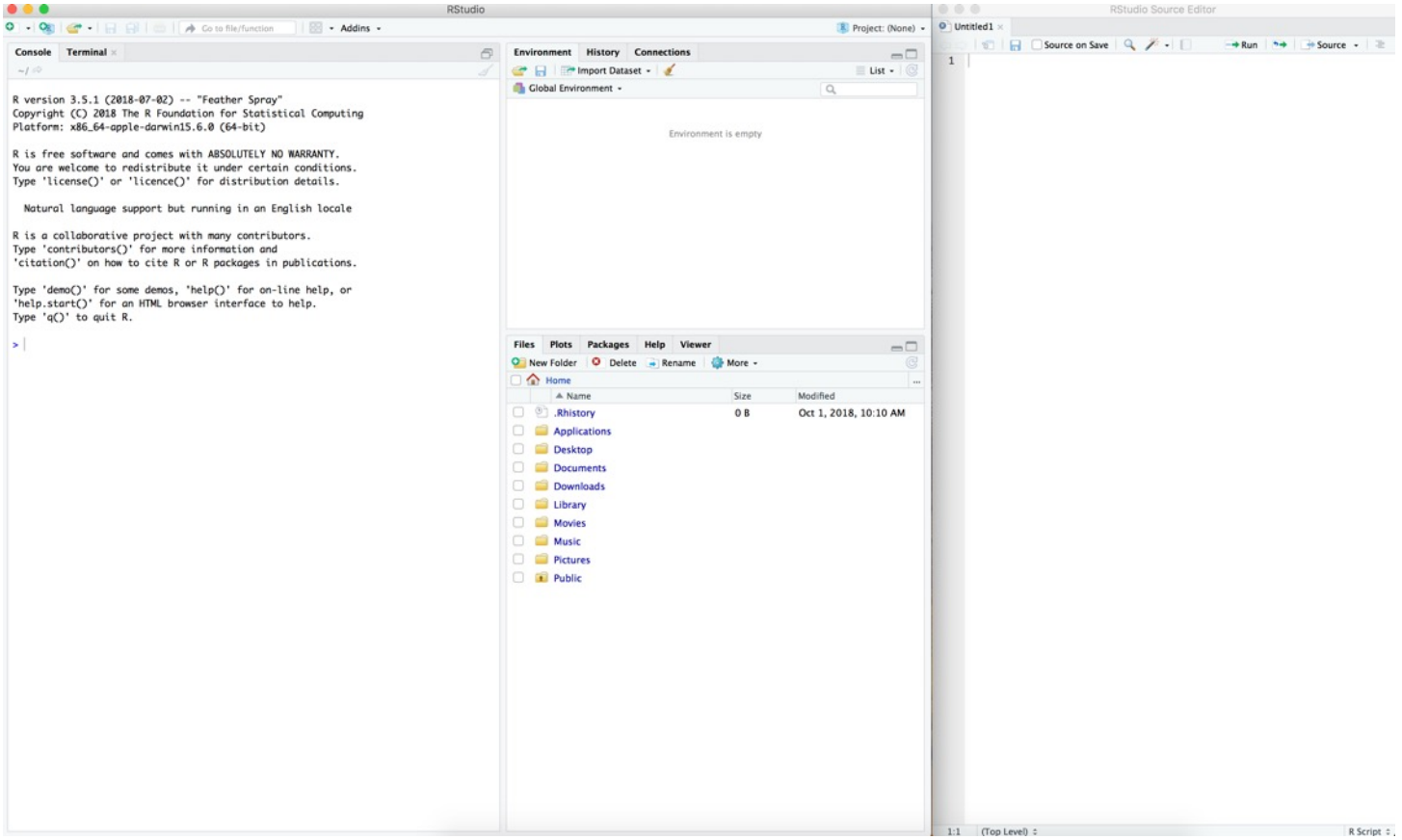


The R Environment

Basic



IDE – RStudio




RStudio® Cloud

Accessing RStudio

Windows

Mac

https://cran.ma.imperial.ac.uk/

https://rstudio.com/products/rstudio/download/#download

Installing and Loading Packages

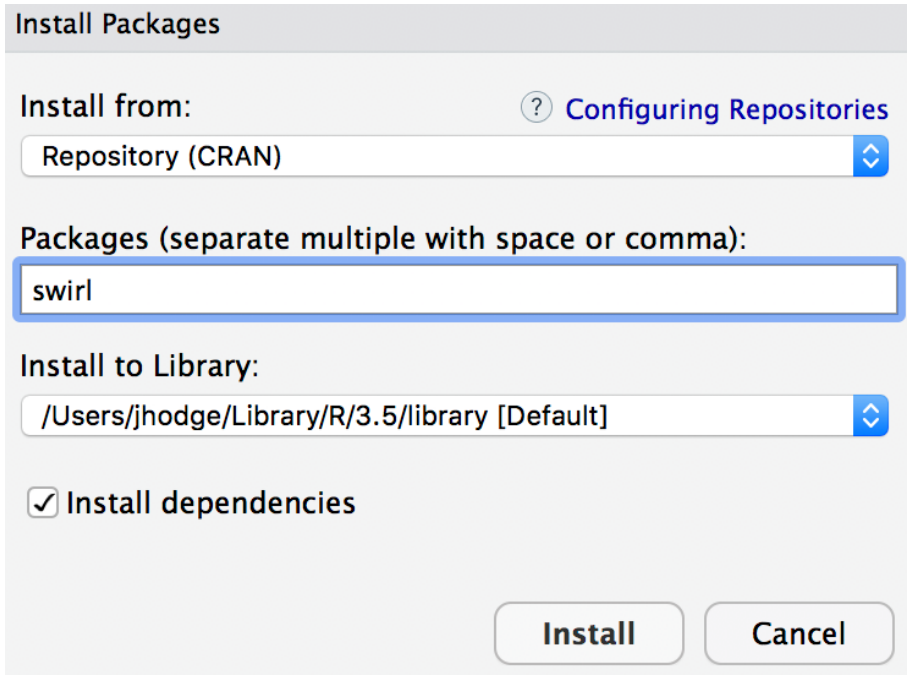
```
##Install swirl##
> install.packages("swirl")



##Load swirl##
> library("swirl")
| Hi! Type swirl() when you are
ready to begin.



##Help for swirl function##
> ?swirl
```



What's Next?

- Introduces R in a fun and easy way to learning R programming basics.
- Visit https://swirlstats.com/
- Complete by next session:
  - *R Programming*

```
1: Basic Building Blocks                3: Sequences of Numbers
4: Vectors                              5: Missing Values
6: Subsetting Vectors                   7: Matrices and Data Frames
8: Logic
```