# Getting Started with R

## Back to Basics

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Analysis and Data Tools for Science

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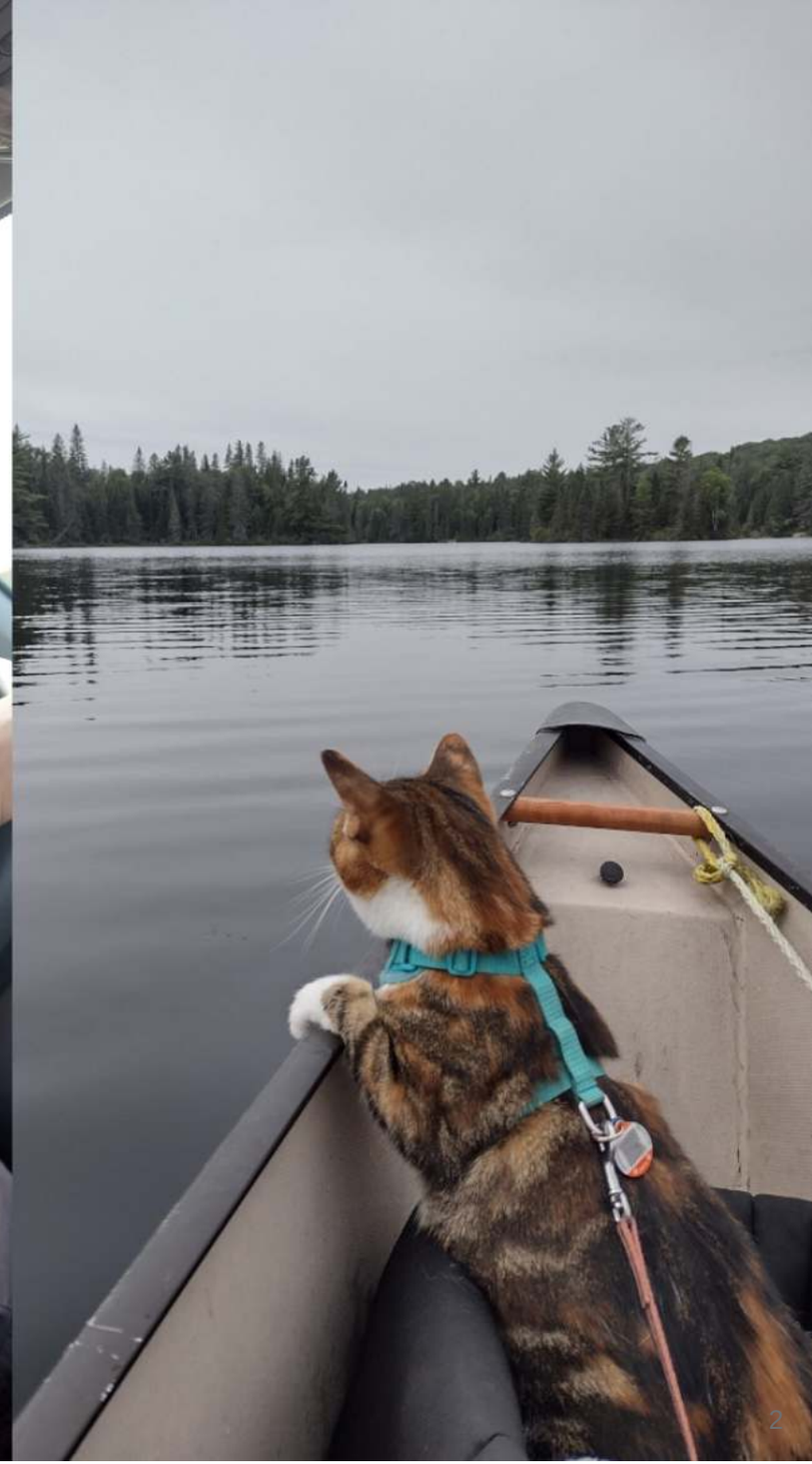
# These are me and my creatures



# This is my garden

# Introductions

## Dr. Steffi LaZerte

- Background in Biology (Animal Behaviour)
- Working with R since 2007
- Professional R programmer/consultant since 2017
- rOpenSci Community Assistant

# What about you?

- Name
- Background (Role, Area of study, etc.)
- Familiarity with R or Programming
- Creatures (furry, feathery, scaley, humanoid, green or otherwise)?

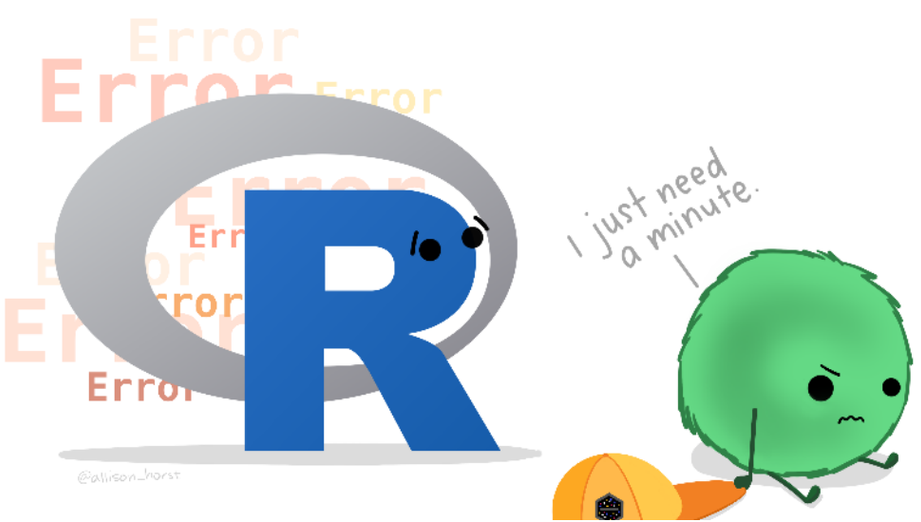
# About this Workshop

## Format

- I will provide you tools and workflow to get started with R
- We'll have hands-on activities, lectures, and demonstrations

## R is hard: But have no fear!

- **Don't expect to remember everything!**
- Copy/Paste is your friend (never apologize for using it!)
- Consider this workshop a resource to return to



# What is R?

# RStudio vs. R

RStudio

R

- **RStudio** is not **R**
- RStudio is a User Interface or IDE (integrated development environment)
  - (i.e., Makes coding simpler)

# Open RStudio

# R is a Programming language

A programming **language** is a way to give instructions in order to get a computer to do something

- You need to know the language (i.e., the code)
- Computers don't know what you mean, only what you type (unfortunately)
- Spelling, punctuation, and capitalization all matter!

## For example

### R, what is 56 times 5.8?

```
56 * 5.8
```

```
[1] 324.8
```

# Use code to tell R what to do

## R, what is the average of numbers 1, 2, 3, 4?

```
mean(c(1, 2, 3, 4))
```

```
[1] 2.5
```

## R, save this value for later

```
steffis_mean <- mean(c(1, 2, 3, 4))
```

## R, multiply this value by 6

```
steffis_mean * 6
```

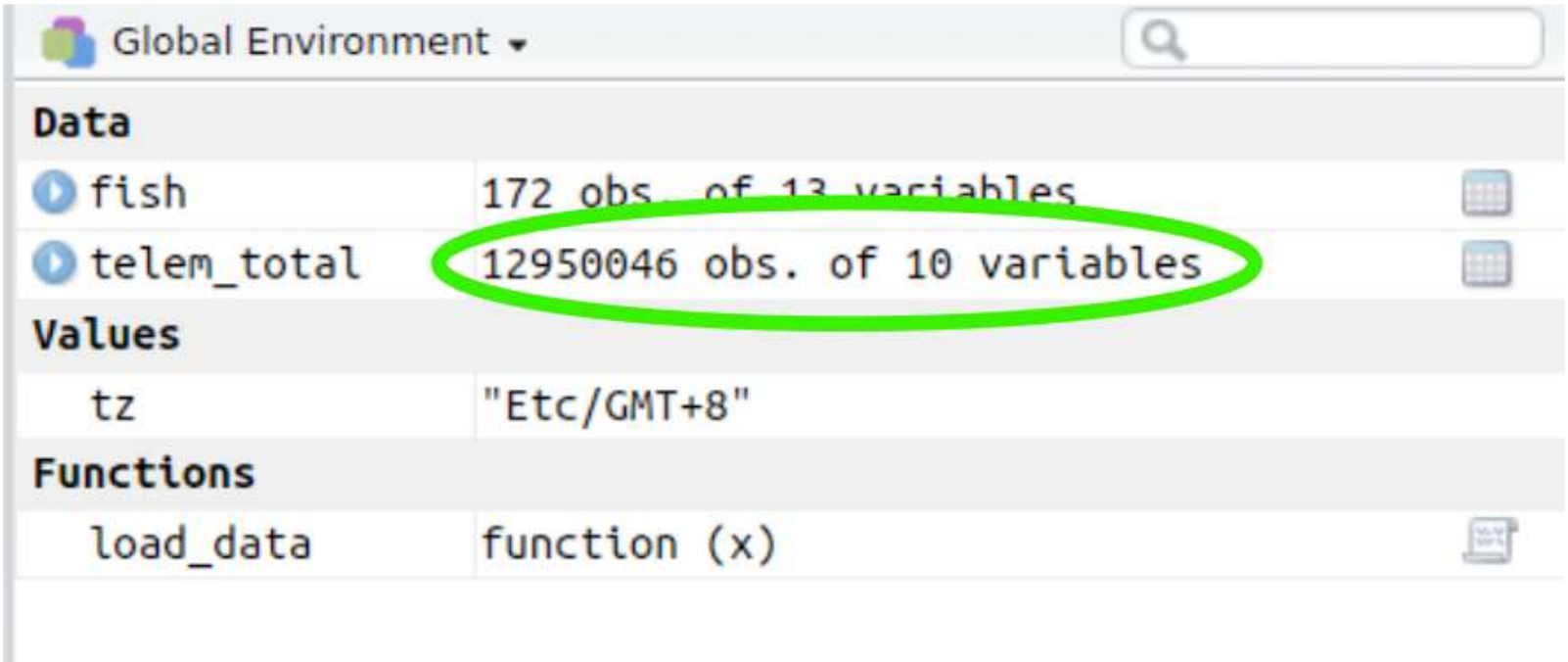
```
[1] 15
```

# Why R?

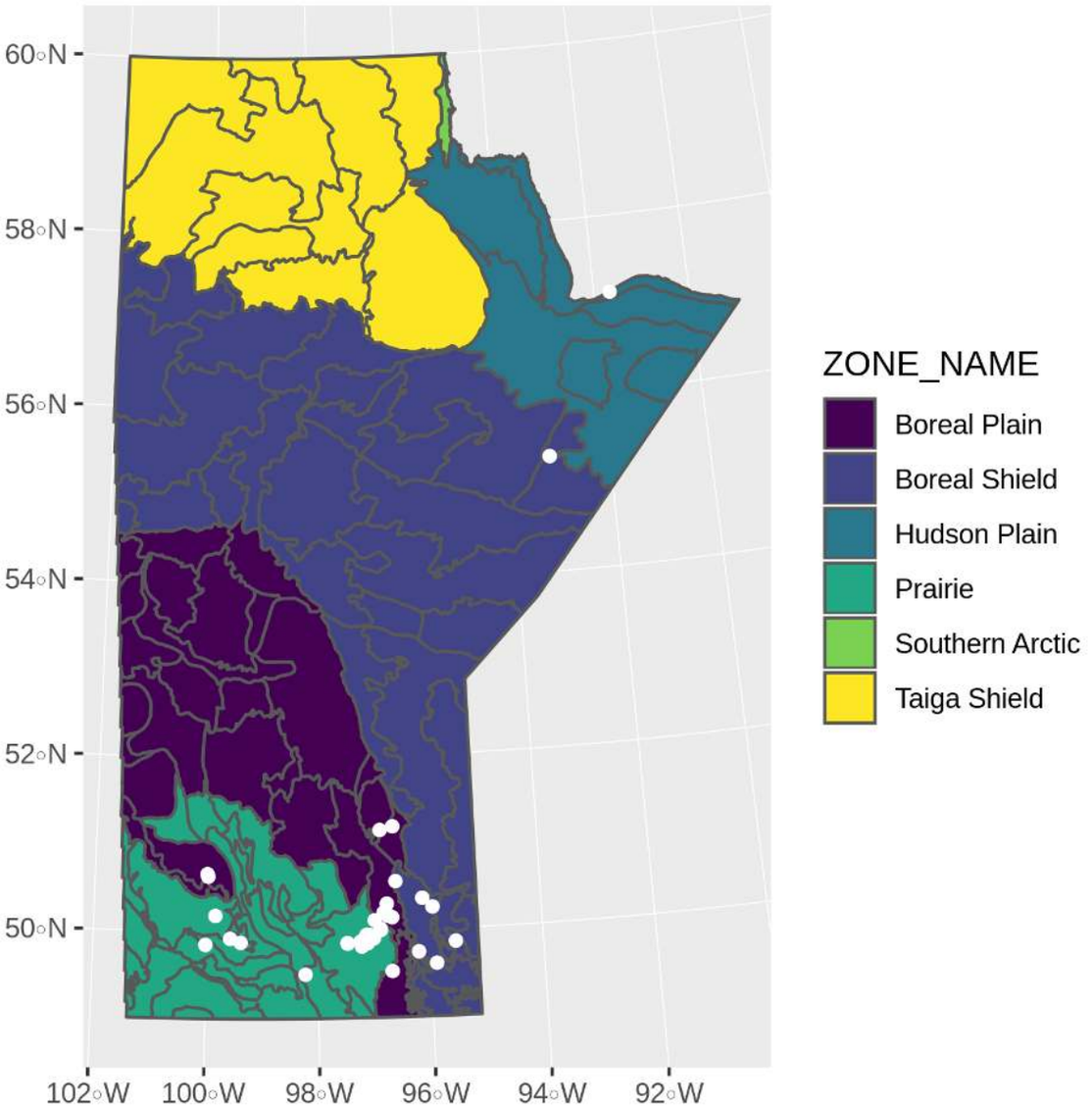
# R is hard

```
# Get in circle around city
circle <- data.frame()
cutoff <- 10
for(i in unique(gps$region)) {
  n <- nrow(gps[gps$region == i,])  ##number of IDs
  if(i == "wil") tmp <- geocode("Williams Lake, Canada")
  if(i == "kam") tmp <- geocode("Kamloops, Canada")
  if(i == "kel") tmp <- geocode("Kelowna, Canada")
  temp <- data.frame()
  for(a in 1:n){
    if(a <= cutoff) temp <- rbind(temp, gcDestination(lon = tmp$lon,
                                                      lat = tmp$lat,
                                                      bearing = (a*(360/(cutoff))-360/(cutoff)),
                                                      dist = 20,
                                                      dist.units = "km",
                                                      model = "WGS84"))
    if(a > cutoff) temp <- rbind(temp, gcDestination(lon = tmp$lon,
                                                     lat = tmp$lat,
                                                     bearing = ((a-cutoff)*(360/(max(table(gps$region
))-10))-360/(max(table(gps$region))-cutoff)),
                                                     dist = 35,
                                                     dist.units = "km",
                                                     model = "WGS84"))
  }
  circle <- rbind(circle, cbind(temp,
                                region = i,
                                hab = gps$hab[gps$region == i],
                                spl = gps$spl.orig[gps$region == i],
```

# But R is powerful (and reproducible)!



# R is also beautiful

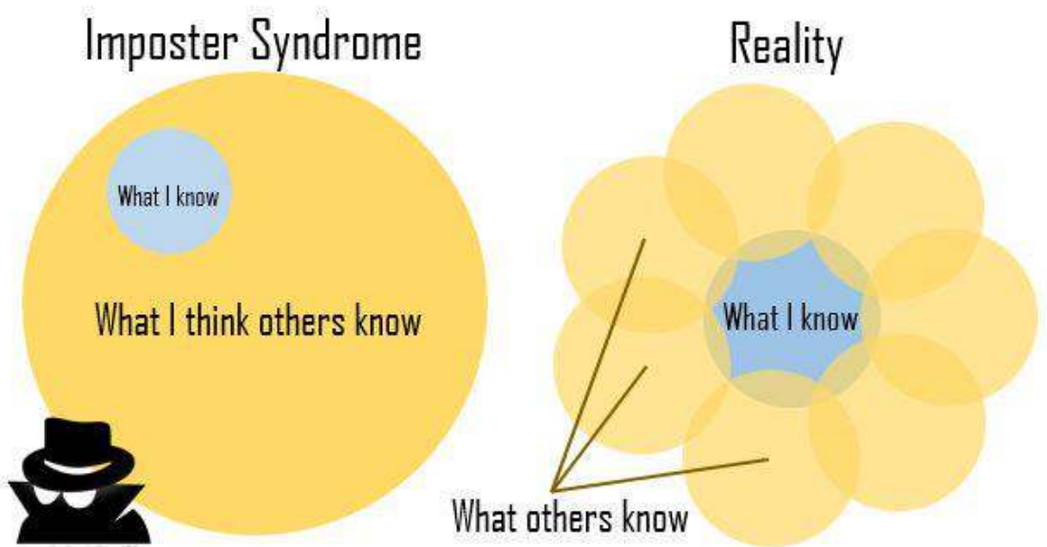


# R is affordable (i.e., free!)

R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

Impost 
Syndrome

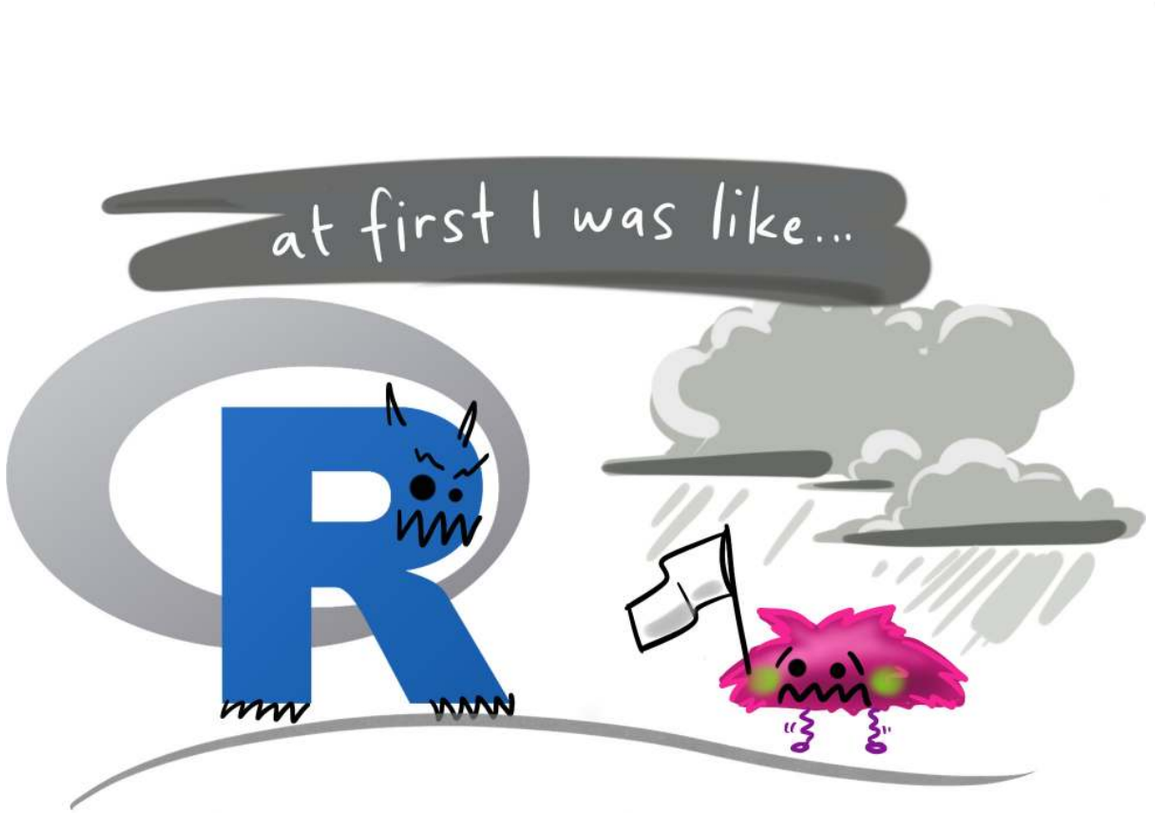
# Impost R Syndrome




**Moral of the story?**

Make friends, code in groups, learn together and don’t beat yourself up

# The Goal




# About R

# Code, Output, Scripts

## Code

- The actual commands

## Output

- The result of running code or a script

## Script

- A text file full of code that you want to run
- You should always keep your code in a script

## For example:

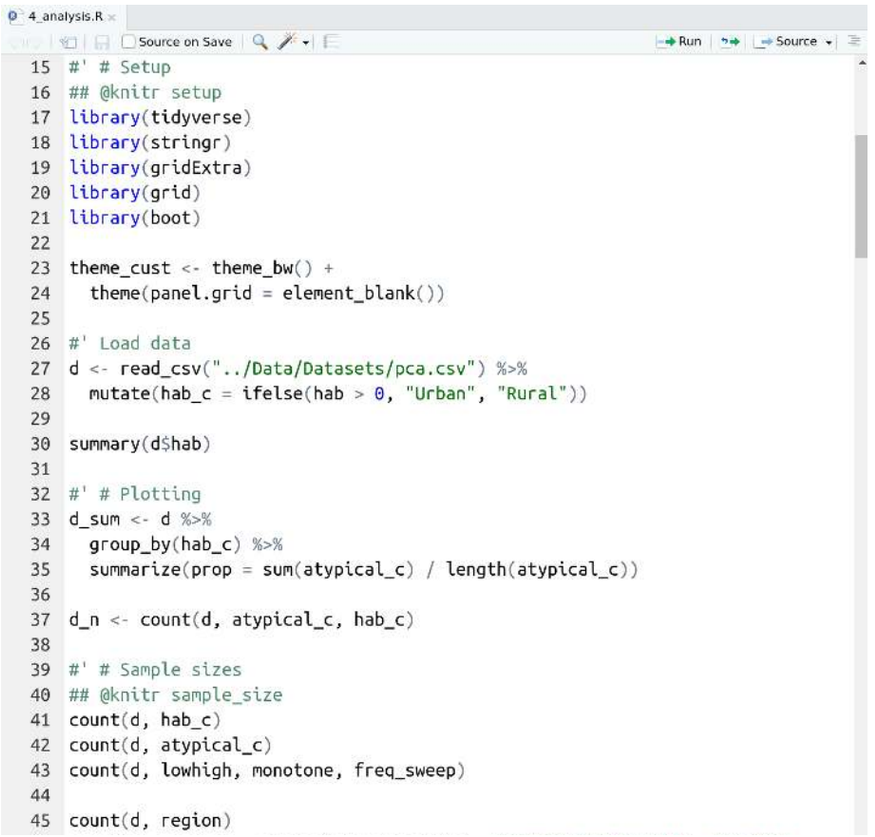
```
mean(c(1, 2, 3, 4))
```

Code

```
[1] 2.5
```

Output

Script



# RStudio Features

## Projects

- Handles working directories
- Organizes your work

## Changing Options: Tools > Global Options

- General > Restore RData into workspace at startup (NO!)
- General > Save workspace to on exit (NEVER!)
- Code > Insert matching parens/quotes (Personal preference)

Let's change some options in RStudio!

## Packages

- Can use the package manager to install packages
- Can use the manager to load them as well, but not recommended

# Getting Ready

📂 Open New File

(make sure you're in the RStudio Project)

✏️ Write `library(tidyverse)` at the top

💾 Save this new script

(consider names like `intro.R` or `1_getting_started.R`)

# Your first *real* code!

# First Code

```
# First load the packages
library(palmerpenguins)
library(ggplot2)

# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

1. **Copy/paste or type** this into the **script** window in RStudio
    - You may have to go to File > New File > R Script
2. Click on the **first line of code**
3. **Run the code**
    - Click 'Run' button (upper right) **or**
    - Use the short-cut `Ctrl-Enter`
4. **Repeat** until all the code has run

# First Code

```
# First load the packages
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ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```
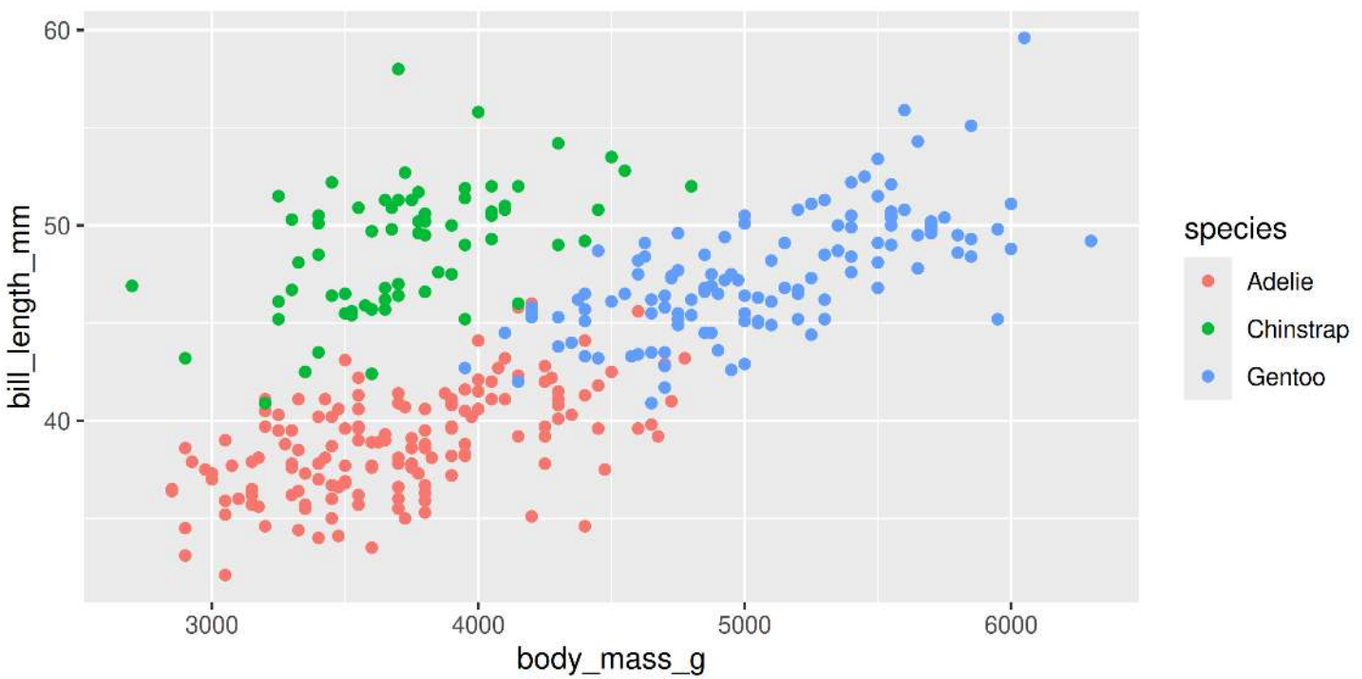

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```



# First Code

Let's talk about the *parts* of the code first
Later we'll talk about why this works

```
# First load the packages
library(palmerpenguins)
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ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
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```

```
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```

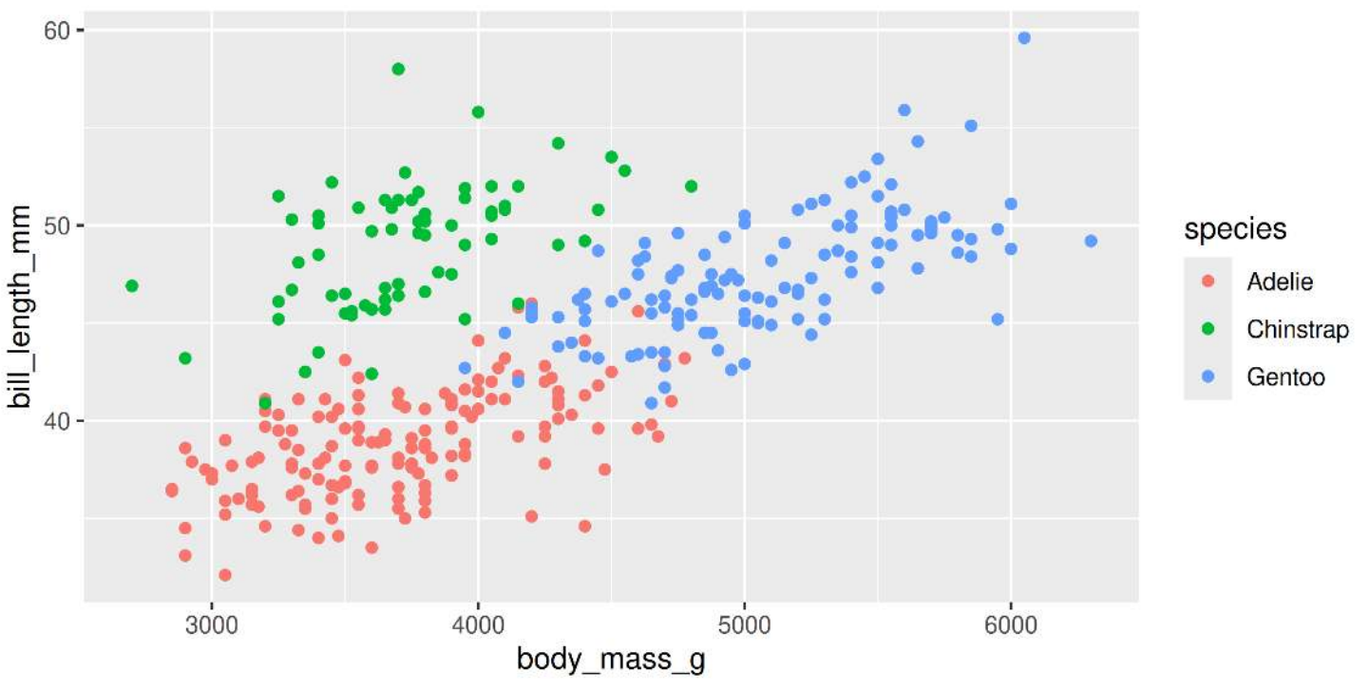

# First Code

Packages
ggplot2 and palmerpenguins

```
# First load the packages
library(palmerpenguins)
library(ggplot2)

# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

```
Warning: Removed 2 rows containing missing values or values outside the scale range
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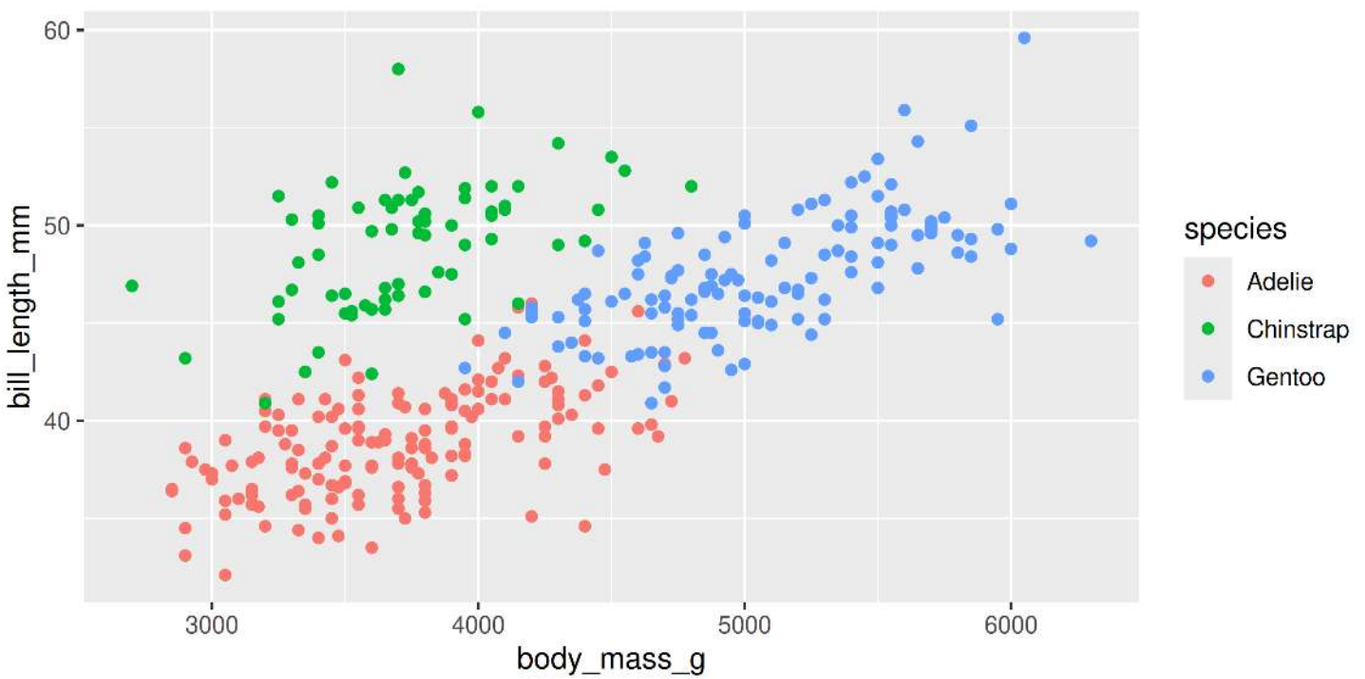


# First Code

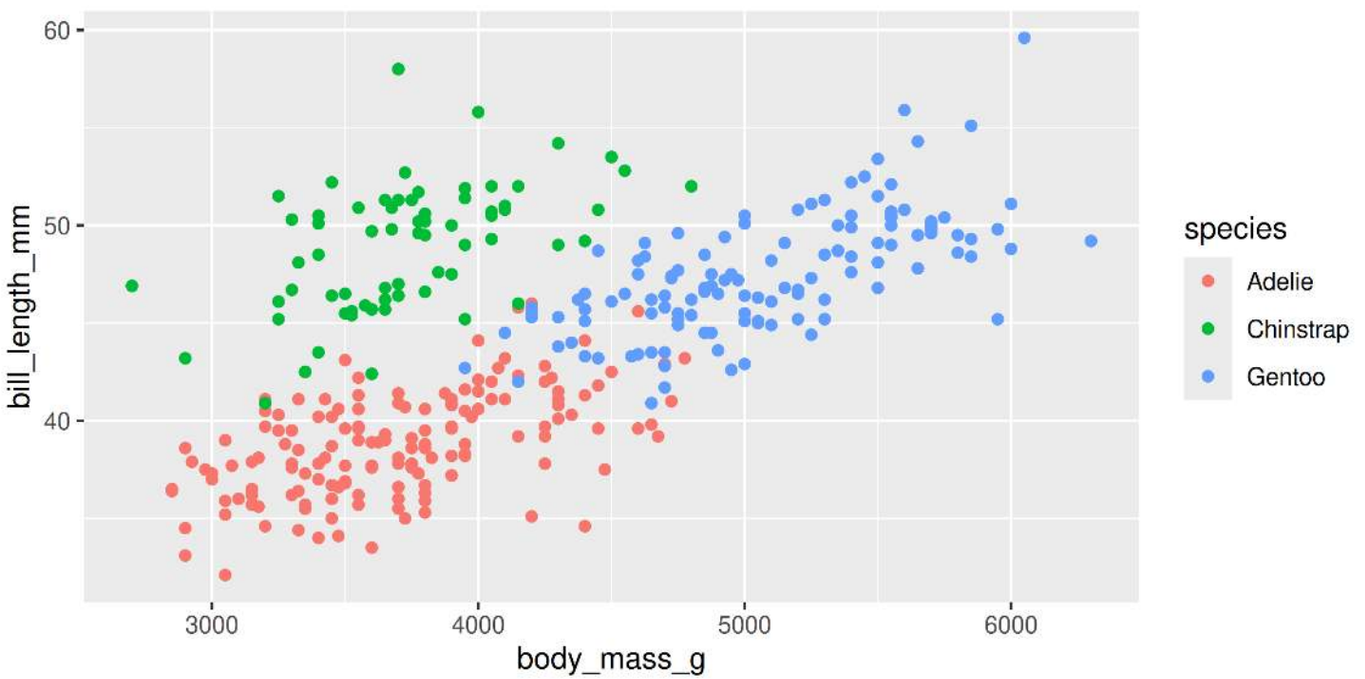
Functions

`library(),ggplot(),aes(),geom_point()`

```
# First load the packages
library(palmerpenguins)
library(ggplot2)

# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```



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# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```
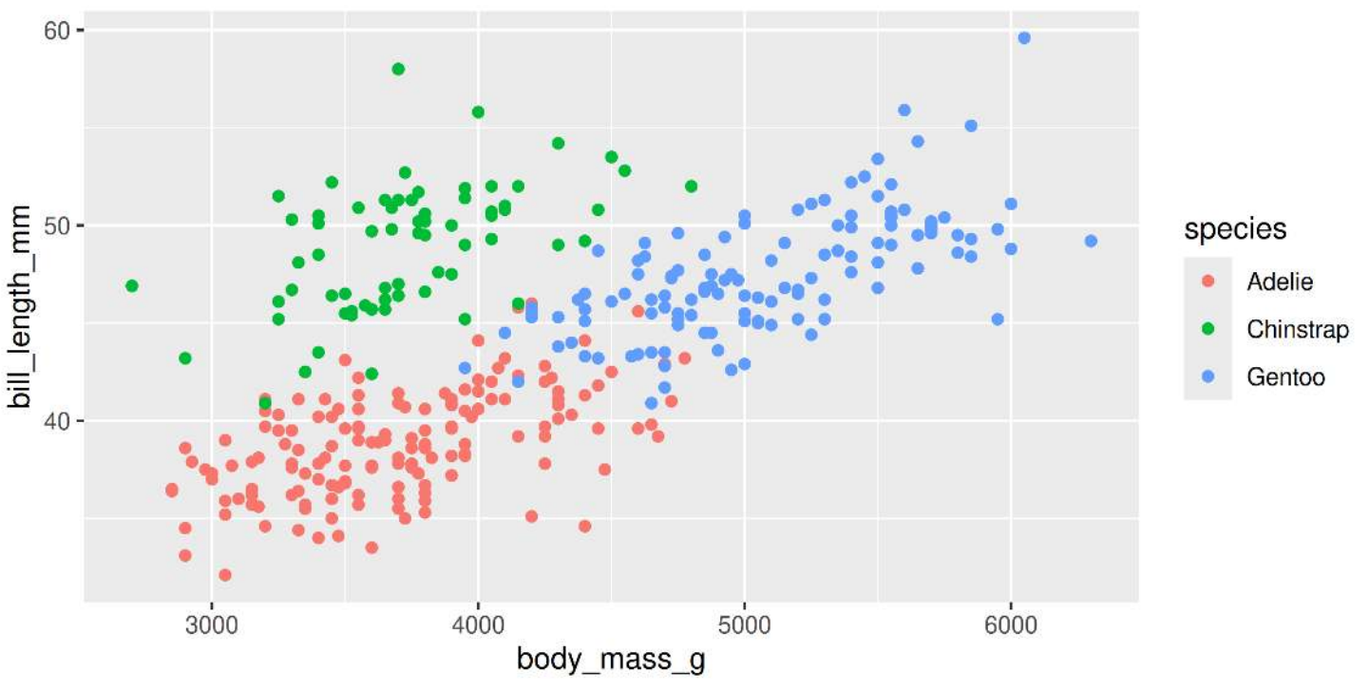

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```

+
(Specific to ggplot)



# First Code

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# First load the packages
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```

```
Warning: Removed 2 rows containing missing values or values outside the scale range
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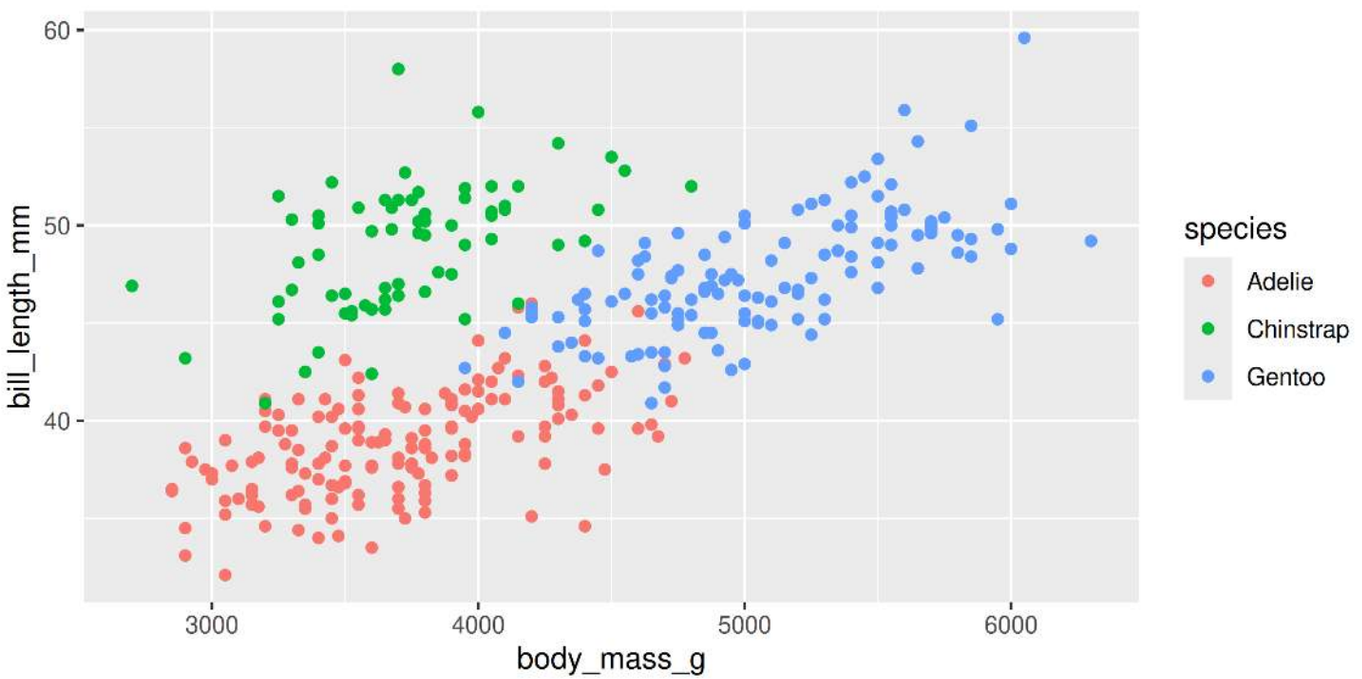
```

Figure!



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  geom_point()
```
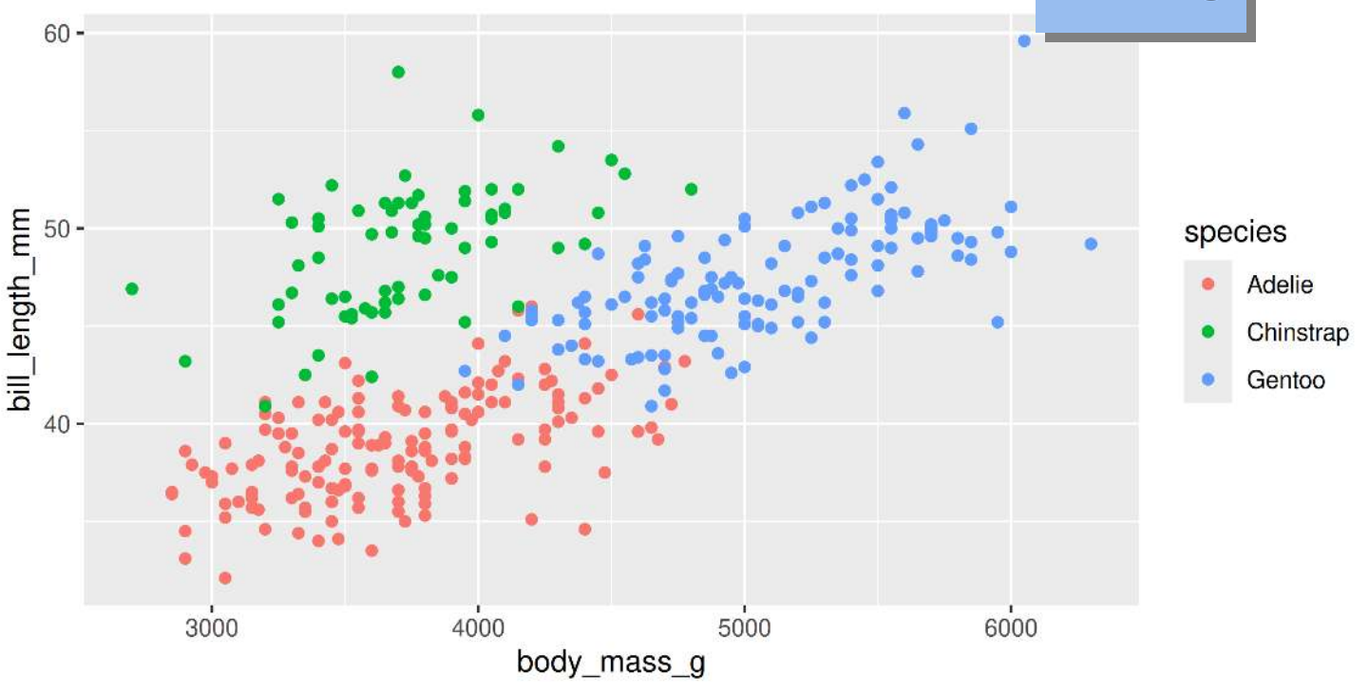

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```

Warning

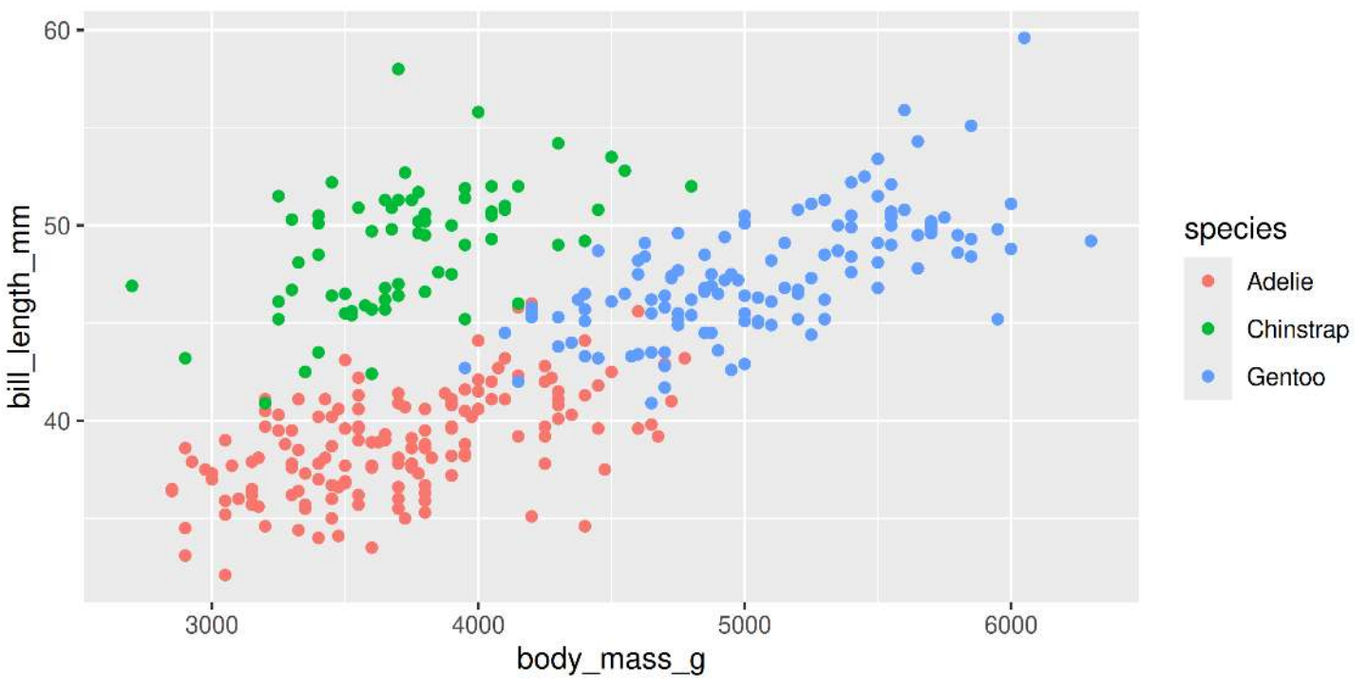


# First Code

```
# First load the packages
library(palmerpenguins)
library(ggplot2)

# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

Comments

```
Warning: Removed 2 rows containing missing values or values outside the scale range
(`geom_point()`).
```



# R Basics: Objects

Objects are *things* in the environment

(Check out the **Environment** pane in RStudio)

# functions()

## Do things, Return things

### Does something but returns nothing

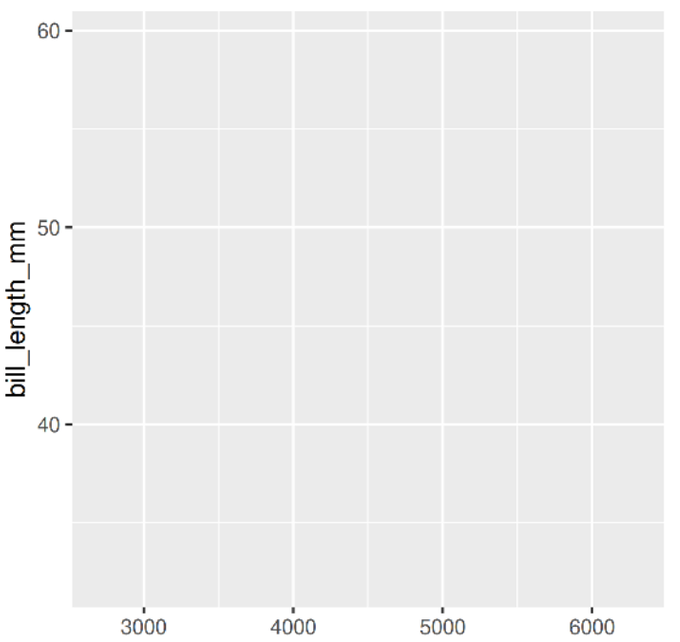
e.g., `library()` - Loads an R package so we can use it's functions and other objects it supplies

```
1 library(palmerpenguins)
```

### Does something and returns something

e.g., `ggplot()` - Creates and returns a basic plot

```
1 ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm))
```



# functions()

- Functions can take **arguments** (think 'options')
- `data`, `x`, `y`, `colour`

```
1 ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
2   geom_point()
```

- Arguments defined by **name** or by **position**
- With correct position, do not need to specify by name

## By name:

```
1 mean(x = c(1, 5, 10))
```

```
[1] 5.333333
```

## By order:

```
1 mean(c(1, 5, 10))
```

```
[1] 5.333333
```

# functions()

## Watch out for ‘hidden’ arguments

### By name:

```
1 mean(x = c(1, 5, 10, NA),
2      na.rm = TRUE)
```

```
[1] 5.333333
```

### By order:

```
1 mean(c(1, 5, 10, NA),
2      TRUE)
```

```
Error in mean.default(c(1, 5, 10, NA), TRUE): 'trim' must
be numeric of length one
```

This error states that we’ve assigned the argument `trim` to a non-valid argument

Where did **`trim`** come from?

# R documentation

```
1 ?mean
```

mean {base} R Documentation

## Arithmetic Mean

### Description

Generic function for the (trimmed) arithmetic mean.

### Usage

```
mean(x, ...)

## Default S3 method:
mean(x, trim = 0, na.rm = FALSE, ...)
```

### Arguments

| | |
|---|---|
| x | An R object. Currently there are methods for numeric/logical vectors and date, date-time and time interval objects. Complex vectors are allowed for `trim = 0`, only. |
| trim | the fraction (0 to 0.5) of observations to be trimmed from each end of x before the mean is computed. Values of trim outside that range are taken as the nearest endpoint. |
| na.rm | a logical value indicating whether NA values should be stripped before the computation proceeds. |
| ... | further arguments passed to or from other methods. |

# Data

- Generally kept in `vectors` or `data.frames` (also `tibbles`)
- These are objects with names (like functions)
- Here are two **built-in** examples (part of R)

## Vector (1 dimension)

```
1 month.name
```

```
 [1] "January"   "February"  "March"
 [4] "April"     "May"       "June"
 [7] "July"      "August"    "September"
[10] "October"   "November"  "December"
```

## Data frame (2 dimensions)

```
1 mtcars
```

| | mpg | cyl | disp | hp | drat | wt | qsec | vs |
|---|---|---|---|---|---|---|---|---|
| Mazda RX4 | 21.0 | 6 | 160.0 | 110 | 3.90 | 2.620 | 16.46 | 0 |
| Mazda RX4 Wag | 21.0 | 6 | 160.0 | 110 | 3.90 | 2.875 | 17.02 | 0 |
| Datsun 710 | 22.8 | 4 | 108.0 | 93 | 3.85 | 2.320 | 18.61 | 1 |
| Hornet 4 Drive | 21.4 | 6 | 258.0 | 110 | 3.08 | 3.215 | 19.44 | 1 |
| Hornet Sportabout | 18.7 | 8 | 360.0 | 175 | 3.15 | 3.440 | 17.02 | 0 |
| Valiant | 18.1 | 6 | 225.0 | 105 | 2.76 | 3.460 | 20.22 | 1 |
| Duster 360 | 14.3 | 8 | 360.0 | 245 | 3.21 | 3.570 | 15.84 | 0 |
| Merc 240D | 24.4 | 4 | 146.7 | 62 | 3.69 | 3.190 | 20.00 | 1 |
| Merc 230 | 22.8 | 4 | 140.8 | 95 | 3.92 | 3.150 | 22.90 | 1 |
| Merc 280 | 19.2 | 6 | 167.6 | 123 | 3.92 | 3.440 | 18.30 | 1 |
| Merc 280C | 17.8 | 6 | 167.6 | 123 | 3.92 | 3.440 | 18.90 | 1 |
| Merc 450SE | 16.4 | 8 | 275.8 | 180 | 3.07 | 4.070 | 17.40 | 0 |
| Merc 450SL | 17.3 | 8 | 275.8 | 180 | 3.07 | 3.730 | 17.60 | 0 |
| Merc 450SLC | 15.2 | 8 | 275.8 | 180 | 3.07 | 3.780 | 18.00 | 0 |
| Cadillac Fleetwood | 10.4 | 8 | 472.0 | 205 | 2.93 | 5.250 | 17.98 | 0 |
| Lincoln Continental | 10.4 | 8 | 460.0 | 215 | 3.00 | 5.424 | 17.82 | 0 |
| Chrysler Imperial | 14.7 | 8 | 440.0 | 230 | 3.23 | 5.345 | 17.42 | 0 |
| Fiat 128 | 32.4 | 4 | 78.7 | 66 | 4.08 | 2.200 | 19.47 | 1 |
| Honda Civic | 30.4 | 4 | 75.7 | 52 | 4.93 | 1.615 | 18.52 | 1 |
| Toyota Corolla | 33.9 | 4 | 71.1 | 65 | 4.22 | 1.835 | 19.90 | 1 |
| Toyota Corona | 21.5 | 4 | 120.1 | 97 | 3.70 | 2.465 | 20.01 | 1 |
| Dodge Challenger | 15.5 | 8 | 318.0 | 150 | 2.76 | 3.520 | 16.87 | 0 |
| AMC Javelin | 15.2 | 8 | 304.0 | 150 | 3.15 | 3.435 | 17.30 | 0 |
| Camaro Z28 | 13.3 | 8 | 350.0 | 245 | 3.73 | 3.840 | 15.41 | 0 |
| Pontiac Firebird | 19.2 | 8 | 400.0 | 175 | 3.08 | 3.845 | 17.05 | 0 |
| Fiat X1-9 | 27.3 | 4 | 79.0 | 66 | 4.08 | 1.935 | 18.90 | 1 |
| Porsche 914-2 | 26.0 | 4 | 120.3 | 91 | 4.43 | 2.140 | 16.70 | 0 |
| Lotus Europa | 30.4 | 4 | 95.1 | 113 | 3.77 | 1.513 | 16.90 | 1 |

- Columns have different types of variables

# Your Turn: Vectors and Data frames

**Try out the following code…**

- Here we will make a vector and a data frame
- What is the output in your console?
- How does your `environment` change (upper right panel)?

### Vectors

```
fruit <- c("apples", "bananas", "pears", "oranges", "melons")
fruit
```

### Data frames

```
production <- data.frame(
  site  = c("east", "east", "west", "west"),
  fruit = c("apples", "bananas", "apples", "bananas"),
  count = c(20, 60, 30, 50))
production
```

# Your Turn: Vectors and Data frames

**Try out the following code…**

- What does `:` do?
- What does `c()` do?
- Why use a comma with data frames?

### Vectors

- Use `[index]` to access part of a vector
- Can access multiple parts at once

```
fruit
fruit[2]
fruit[2:5]     # What does : do?
fruit[c(1, 3)] # What does c() do?
```

### Data frames

- `x$colname` to pull columns out as vector
- `x[row, col]` to access rows/columns

```
production$fruit
production[3]
production[3, ]   # Why the comma?
production[3, 1]
production[, 1:2]
```

# Your Turn: Vectors and Data frames

**Try out the following code…**

## Vectors

```
fruit
```

```
[1] "apples"  "bananas" "pears"   "oranges" "melons"
```

```
fruit[2]
```

```
[1] "bananas"
```

```
fruit[2:5]     # What does : do?
```

```
[1] "bananas" "pears"   "oranges" "melons"
```

```
fruit[c(1, 3)] # What does c() do?
```

```
[1] "apples" "pears"
```

## Data frames

```
production$fruit
```

```
[1] "apples"  "bananas" "apples"  "bananas"
```

```
production[3]
```

```
  count
1    20
2    60
3    30
4    50
```

```
production[3, ]   # Why the comma?
```

```
  site  fruit count
3 west apples    30
```

```
production[3, 1]
```

```
[1] "west"
```

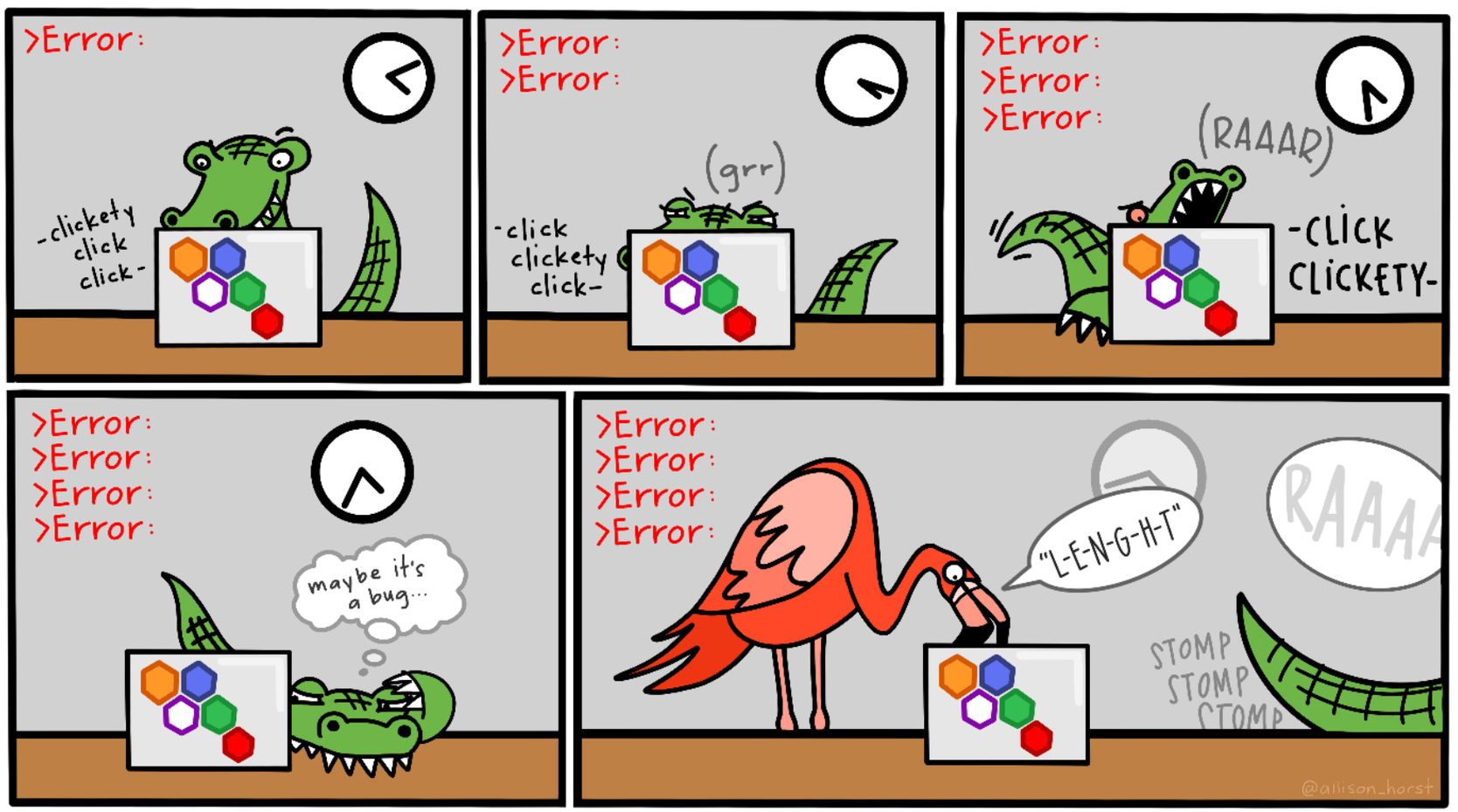
```
production[, 1:2]
```

```
  site   fruit
1 east  apples
2 east bananas
3 west  apples
4 west bananas
```

# Miscellaneous

# R has spelling and punctuation

- R cares about spelling
- R is also case sensitive! (`Apple` is not the same as `apple`)



# R has spelling and punctuation

- Commas are used to separate arguments in functions

This is correct:

```
1 mean(c(5, 7, 10))  # [1] 7.333333
```

This is **not** correct:

```
1 mean(c(5 7 10))
```

>80% of learning R is learning to **troubleshoot**!

# R has spelling and punctuation

### Spaces usually don't matter unless they change meanings

```
5>=6    # [1] FALSE
5 >=6   # [1] FALSE
5 >= 6  # [1] FALSE
5 > = 6 # Error: unexpected '=' in "5 > ="
```

### Periods don't matter either, but can be used in the same way as letters

(But don't)

```
apple.oranges <- "fruit"
```

# Assignments and Equal signs

## Use `<-` to assign values to objects

```
1 a <- "hello"
```

## Use `=` to set function arguments

```
1 mean(x = c(4, 9, 10))
```

## Use `==` to determine equivalence (logical)

```
1 10 == 10 # [1] TRUE
2 10 == 9  # [1] FALSE
```

# Braces/Brackets

## Round brackets: ( )

- Identify functions (even if there are no arguments)

```
1 Sys.Date() # Get the Current Date
```

```
[1] "2025-01-12"
```

- Without the ( ), R spits out information on the function:

```
1 Sys.Date
```

```
function ()
as.Date(as.POSIXlt(Sys.time()))
<bytecode: 0x5738c8209fa0>
<environment: namespace:base>
```

( ) must be associated with a **function** (Well, *almost* always)

# Square brackets: []

- Extract parts of objects

```
1 LETTERS
```

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

```
1 LETTERS[1]
```

```
[1] "A"
```

```
1 LETTERS[26]
```

```
[1] "Z"
```

`[]` have to be associated with an **object** that has dimensions (Always!)

# Improving code readability

**Use spaces like you would in sentences:**

```
1 a <- mean(c(4, 10, 13))
```

is easier to read than

```
1 a<-mean(c(4,10,13))
```

(But the same, coding-wise)

# Improving code readability

**Don’t be afraid to use line breaks (‘Enters’) to make the code more readable**

**Hard to read**

```
1 a <- data.frame(exp = c("A", "B", "A", "B", "A", "B"), sub = c("A1", "A1", "A2", "A2", "A3", "A3"), res = c(10, 12, 45,
```

**Easier to read**

```
1 a <- data.frame(exp = c("A", "B", "A", "B", "A", "B"),
2                 sub = c("A1", "A1", "A2", "A2", "A3", "A3"),
3                 res = c(10, 12, 45, 12, 12, 13))
```

(But the same, coding-wise)

# Let’s go!