Getting Started with R

Back to Basics

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Analysis and Data Tools for Science

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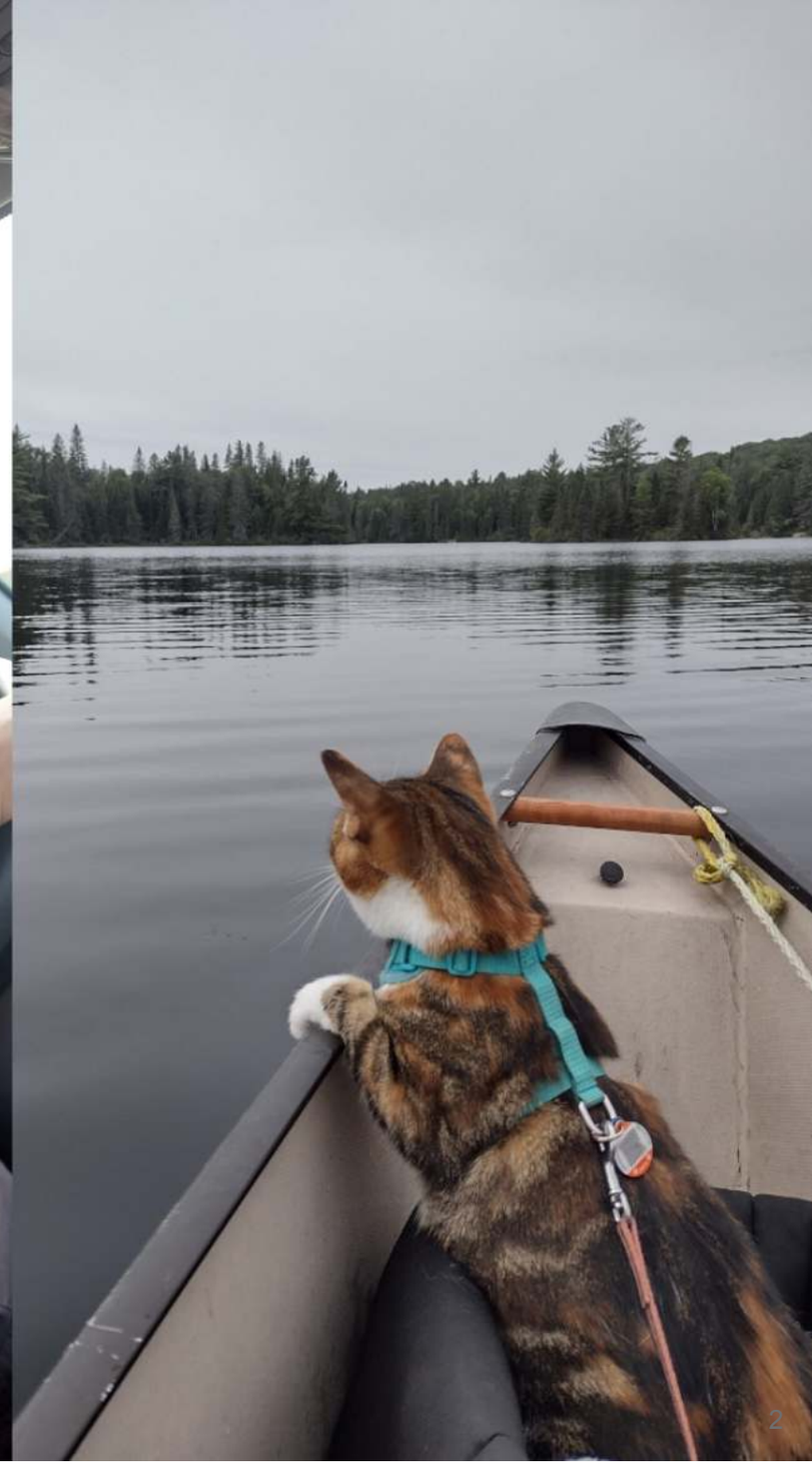
This is me and my creatures



This is my garden

Introductions

Dr. Steffi LaZerte

- Background in Biology (Animal Behaviour)
- Working with R since 2007
- Professional R programmer/consultant since 2017
- Fifth year giving BU R Workshop!
- rOpenSci Community Assistant

What about you?

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

About this Workshop

Format

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

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
```

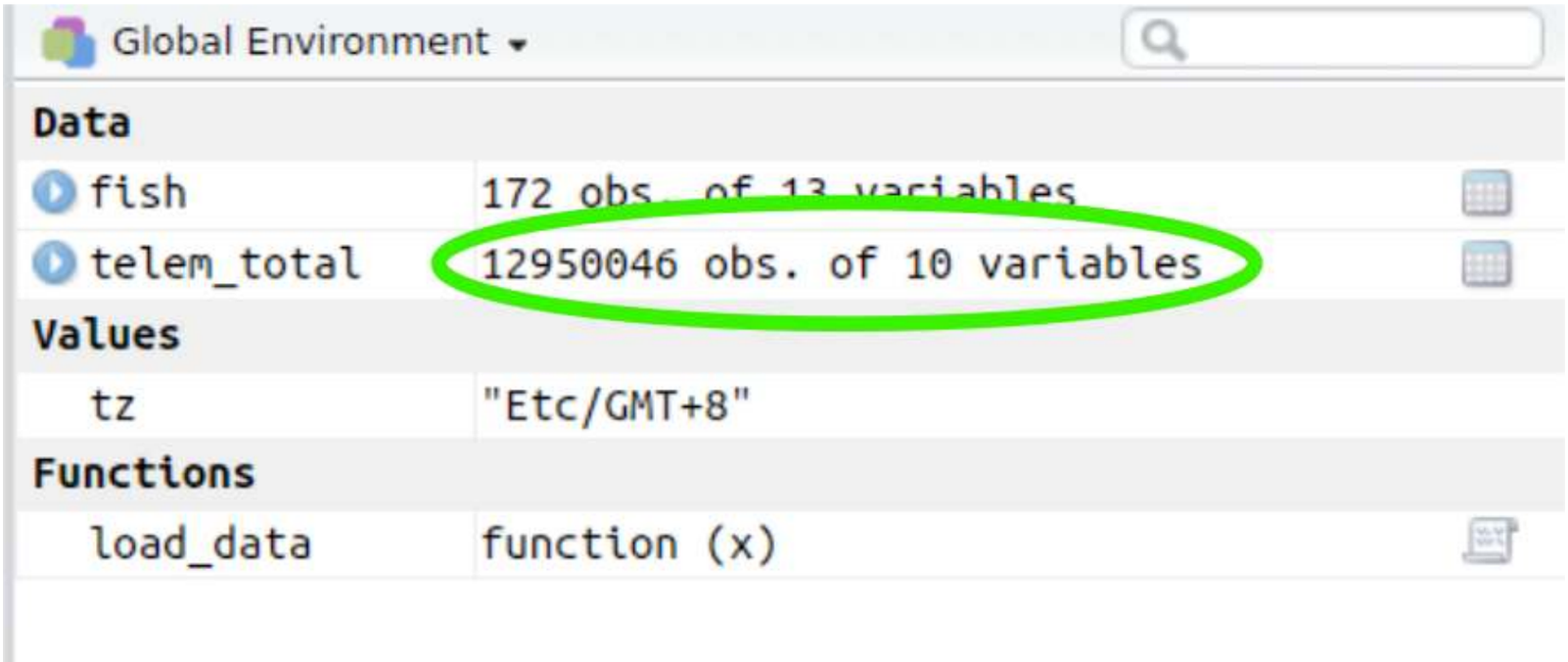
```
[1] 15
```

Why R?

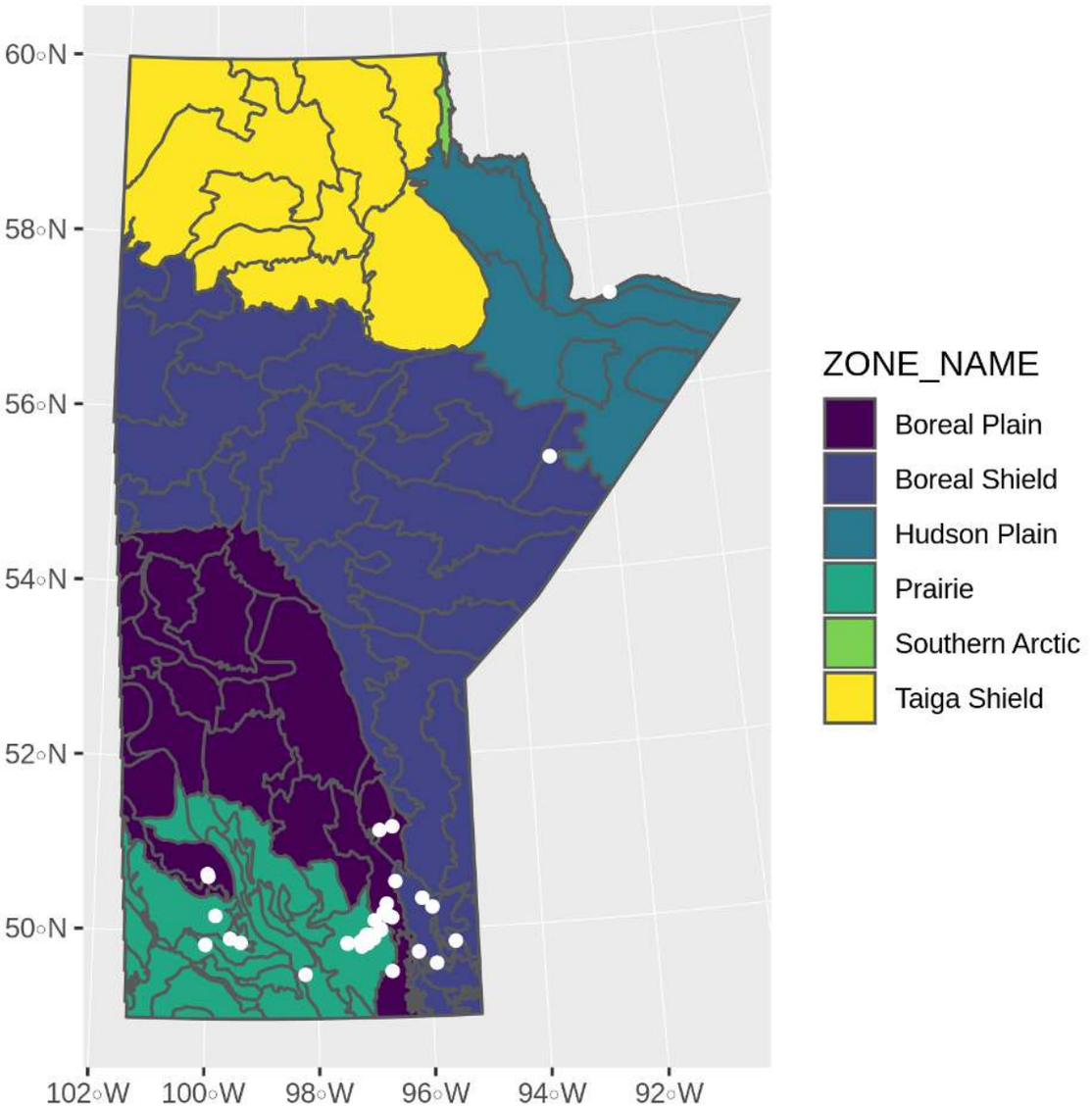
R is hard

```
# 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

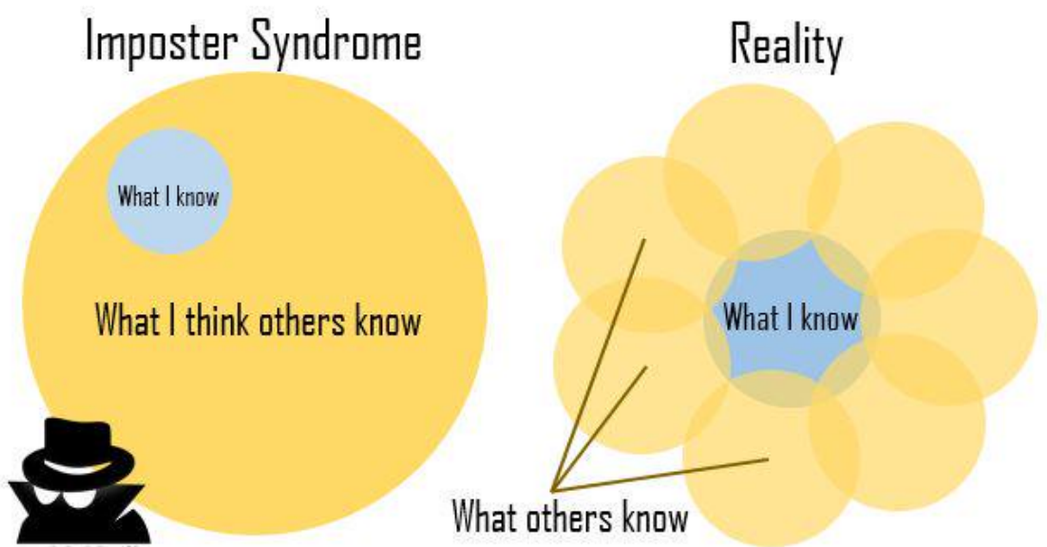


R is affordable (i.e., free!)

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

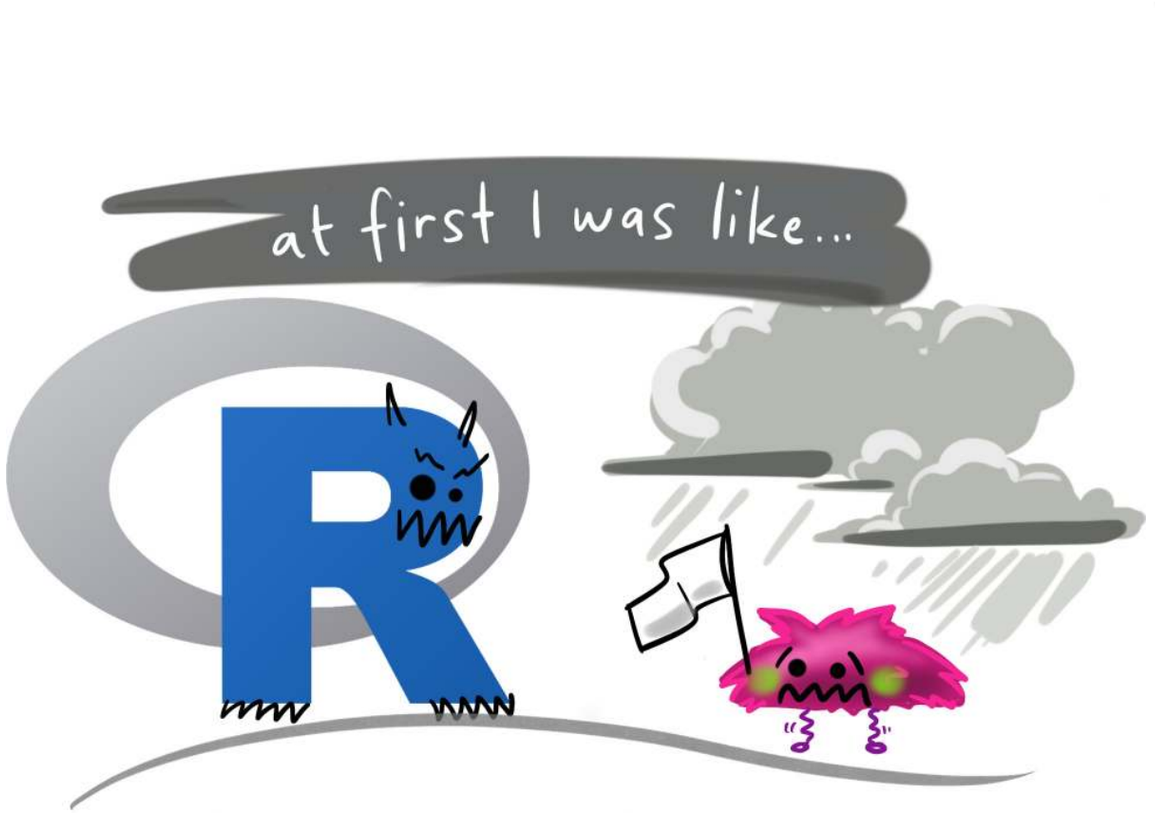
Impost R Syndrome



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:

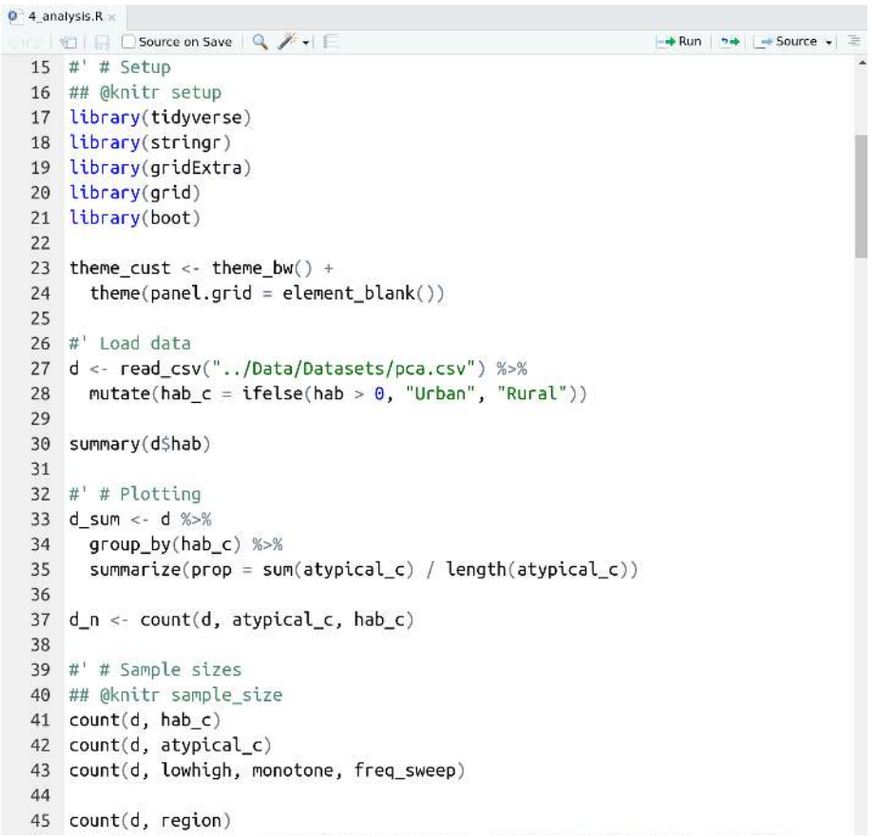
```
mean(c(1, 2, 3, 4))
```

Code

```
[1] 2.5
```

Output

Script



RStudio vs. R

RStudio

R

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

RStudio Features

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)

Projects

- Handles working directories
- Organizes your work

Let's take a look at 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

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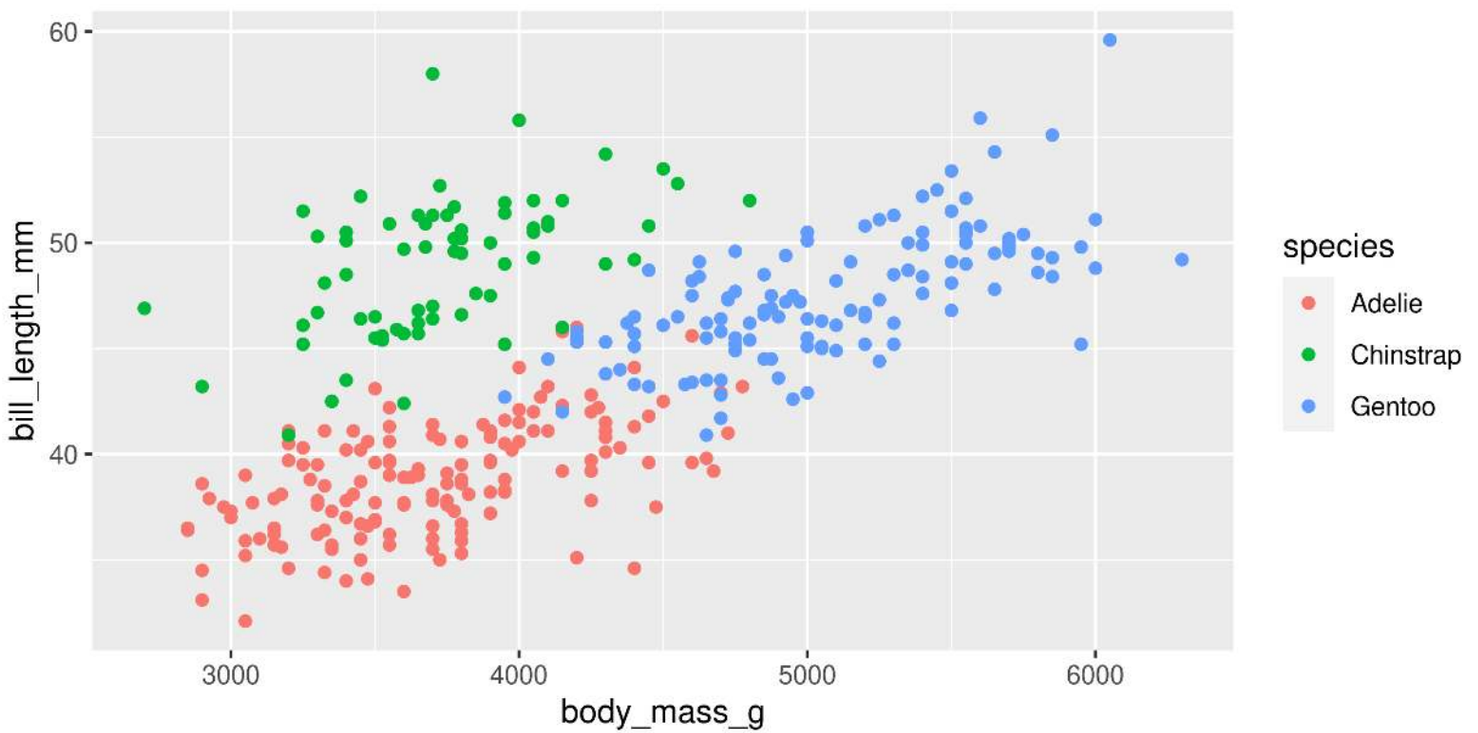
```

```
Warning: Removed 2 rows containing missing values (`geom_point()`).
```



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)) +
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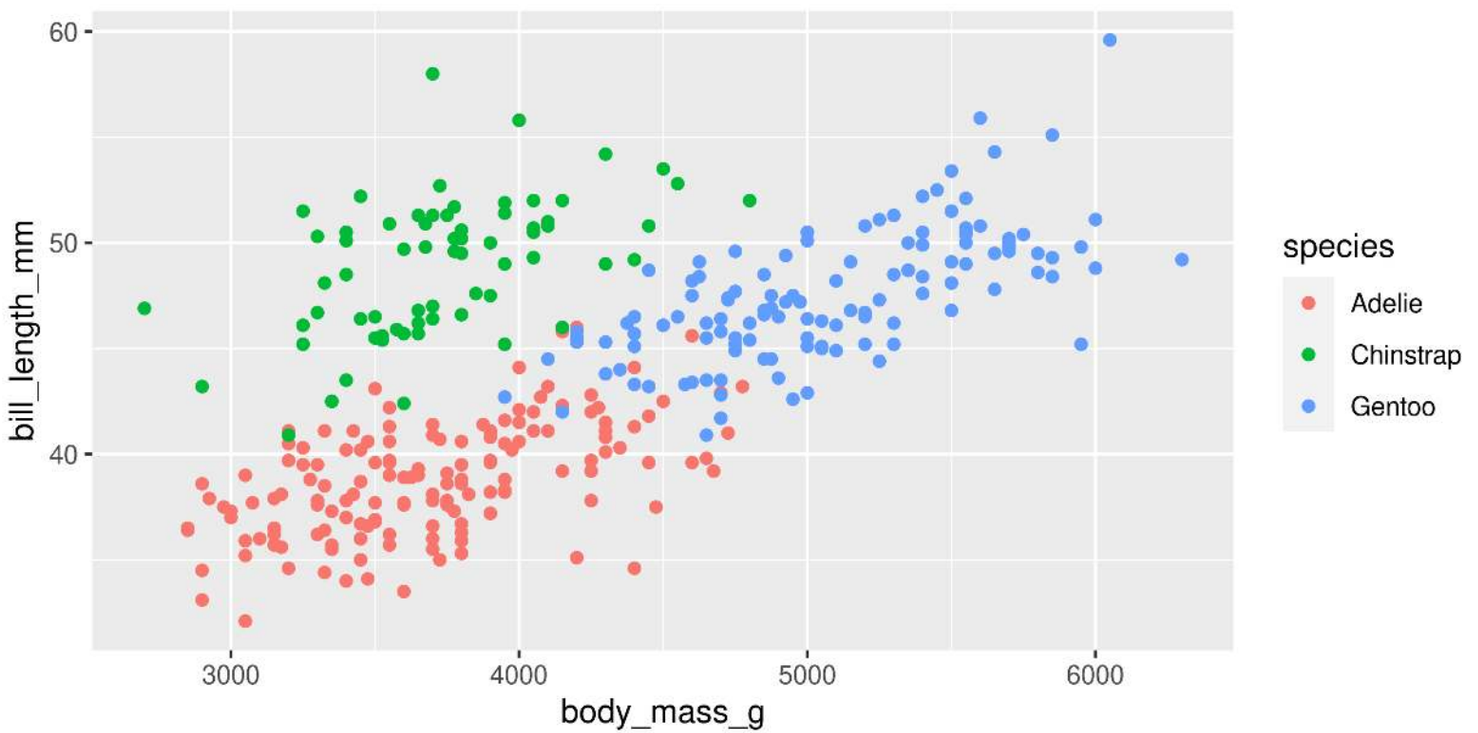

First Code

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

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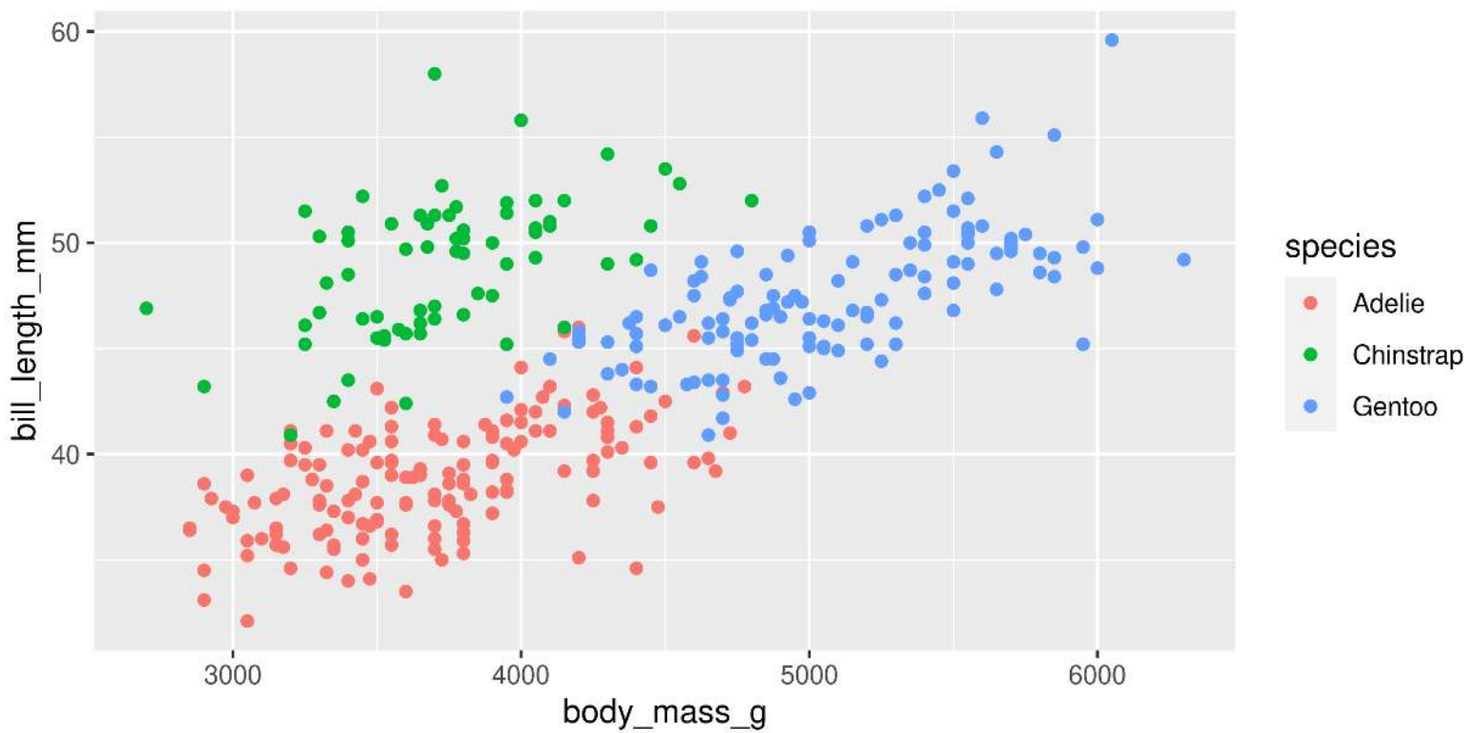

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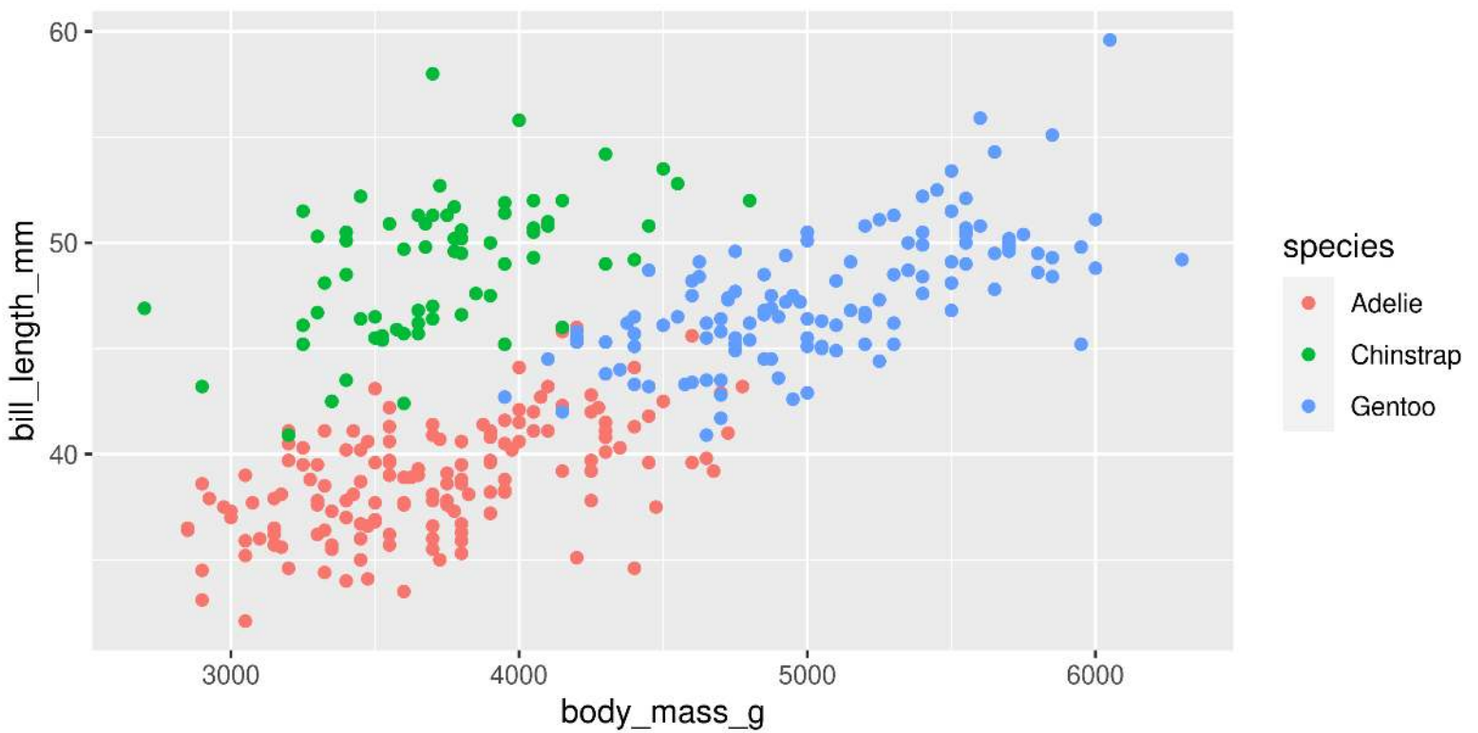
# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

```
Warning: Removed 2 rows containing missing values (`geom_point()`).
```

+
(Specific to ggplot)



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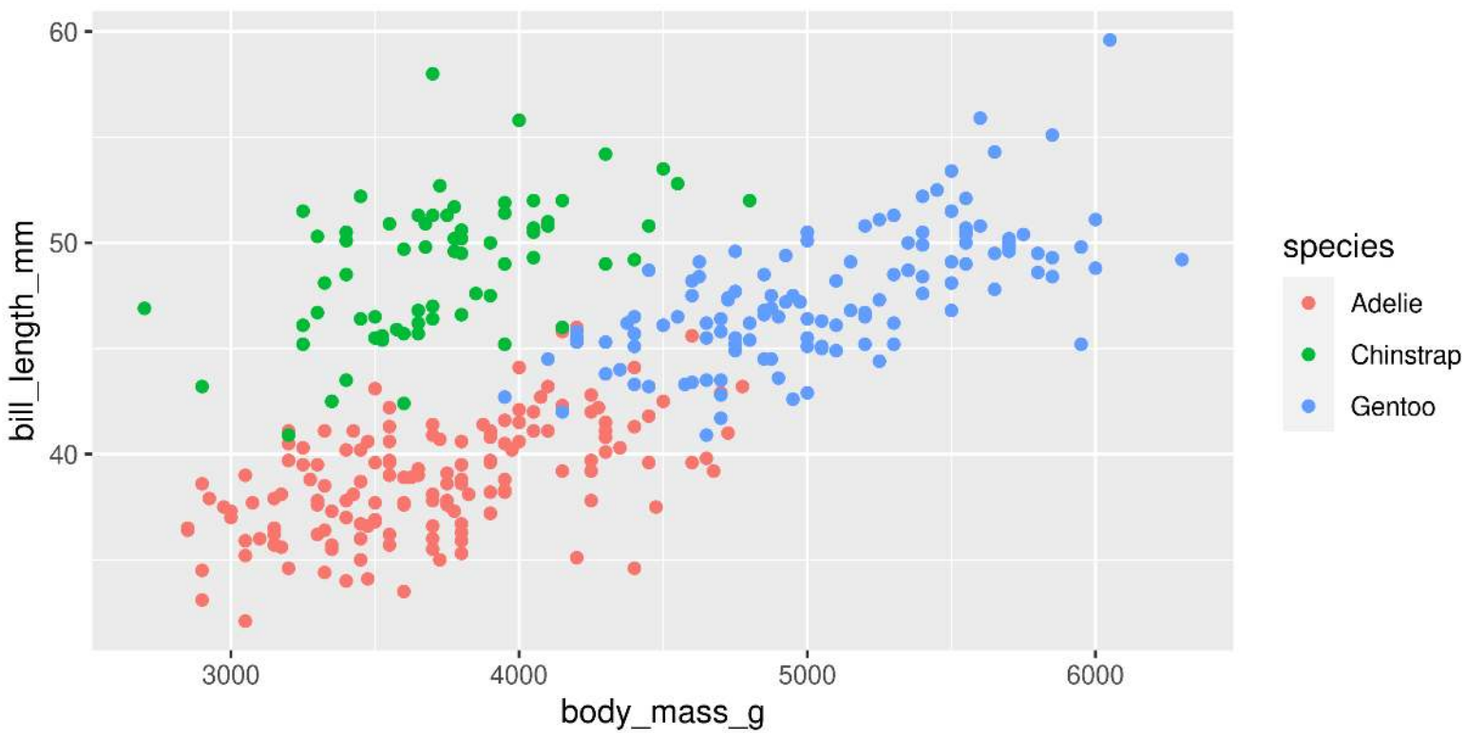
Warning: Removed 2 rows containing missing values (`geom_point()`).
```

Figure!



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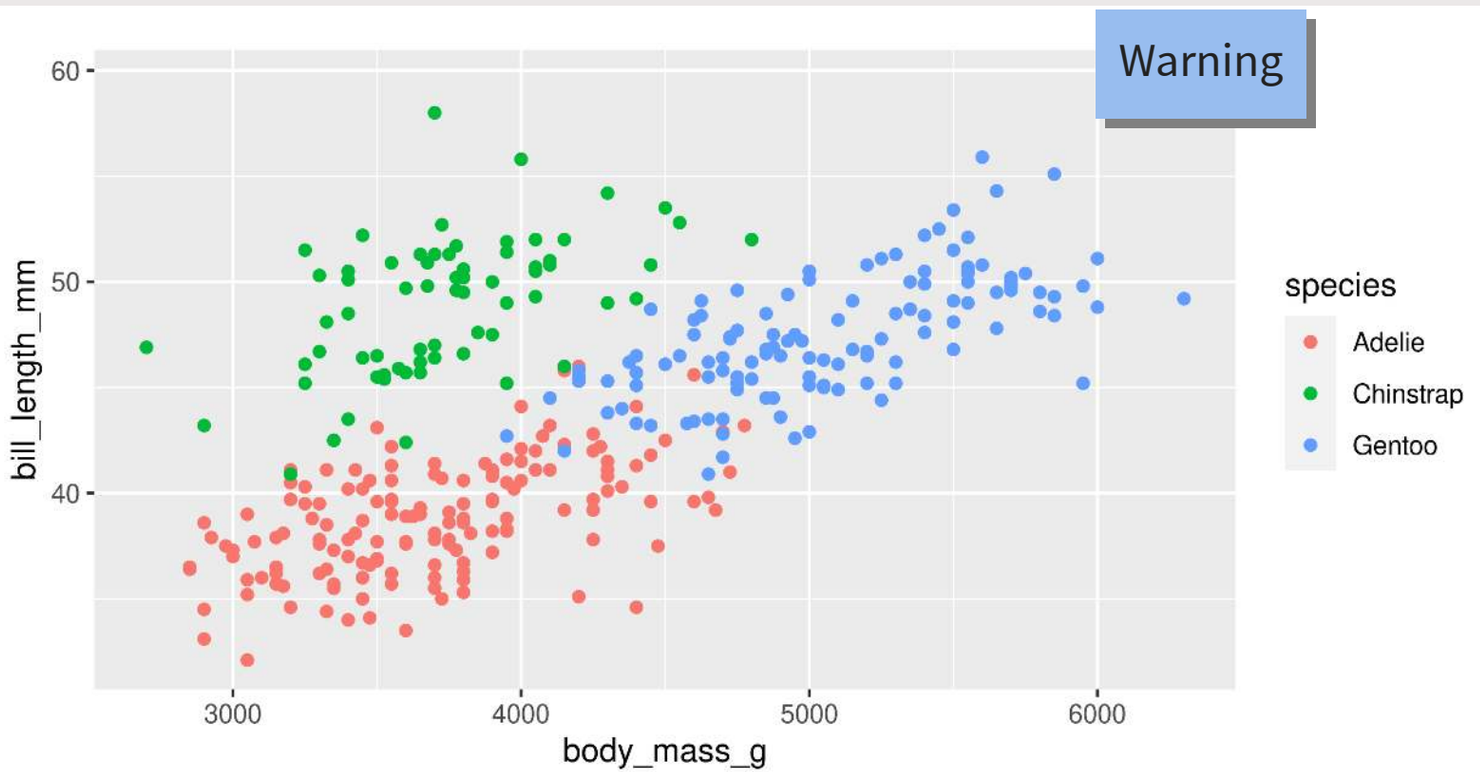

First Code

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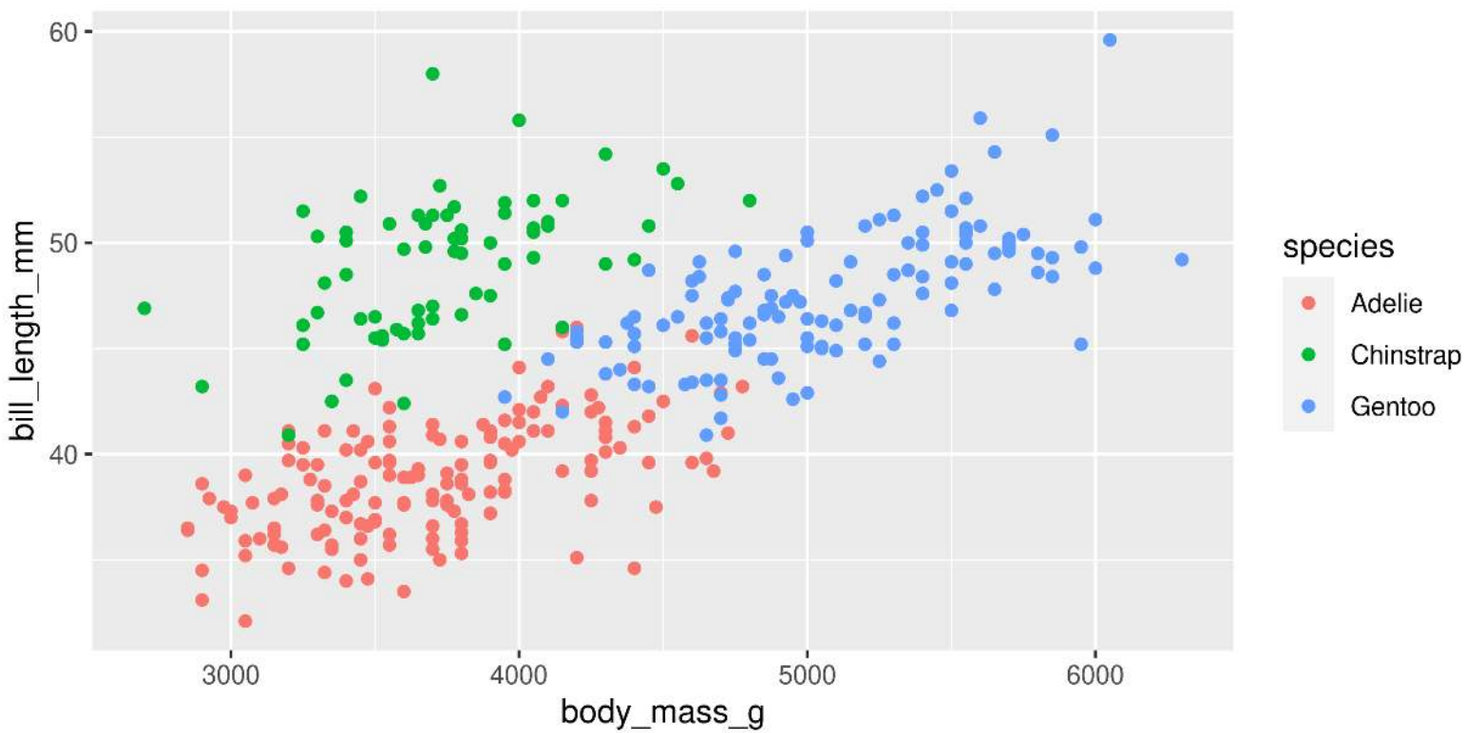
# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
  geom_point()
```

Comments

```
Warning: Removed 2 rows containing missing values (`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., `write_csv()` - Saves the `mtcars` data frame as a csv file

```
1 write_csv(mtcars, path = "mtcars.csv")
```

Does something and returns something

e.g., `sd()` - returns the standard deviation of a vector

```
1 sd(c(4, 10, 21, 55))
```

```
[1] 22.78157
```

functions()

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

```
1 ggplot(data = msleep, aes(x = sleep_total, y = sleep_rem, colour = vore)) +
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:

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

```
[1] 5.333333
```

By order:

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

- These are objects with names (like functions)
- We can use `<-` to assign values to objects (assignment)

Vector (1 dimension)

```
1 my_letters <- c("a", "b", "c")
2 my_letters
```

```
[1] "a" "b" "c"
```

- Use `c()` to create a vector

Data frame (2 dimensions)

```
1 my_data <- data.frame(x = c("s1", "s2", "s3", "s4"),
2                       y = c(101, 102, 103, 104),
3                       z = c("a", "b", "c", "d"))
4 my_data
```

```
  x   y z
1 s1 101 a
2 s2 102 b
3 s3 103 c
4 s4 104 d
```

- Columns have different types of variables

rows x columns

Your Turn: Vectors and Data frames

Try out the following code…

- What is the output in your console?
- How does your `environment` change (upper right panel)?

Vectors

```
1 a <- c("apples", 12, "bananas")
2 a
```

Data frames

```
1 my_data <- data.frame(x = c("s1", "s2", "s3", "s4"),
2                       y = c(101, 102, 103, 104),
3                       z = c("a", "b", "c", "d"))
4 my_data
```

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

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

Data frames

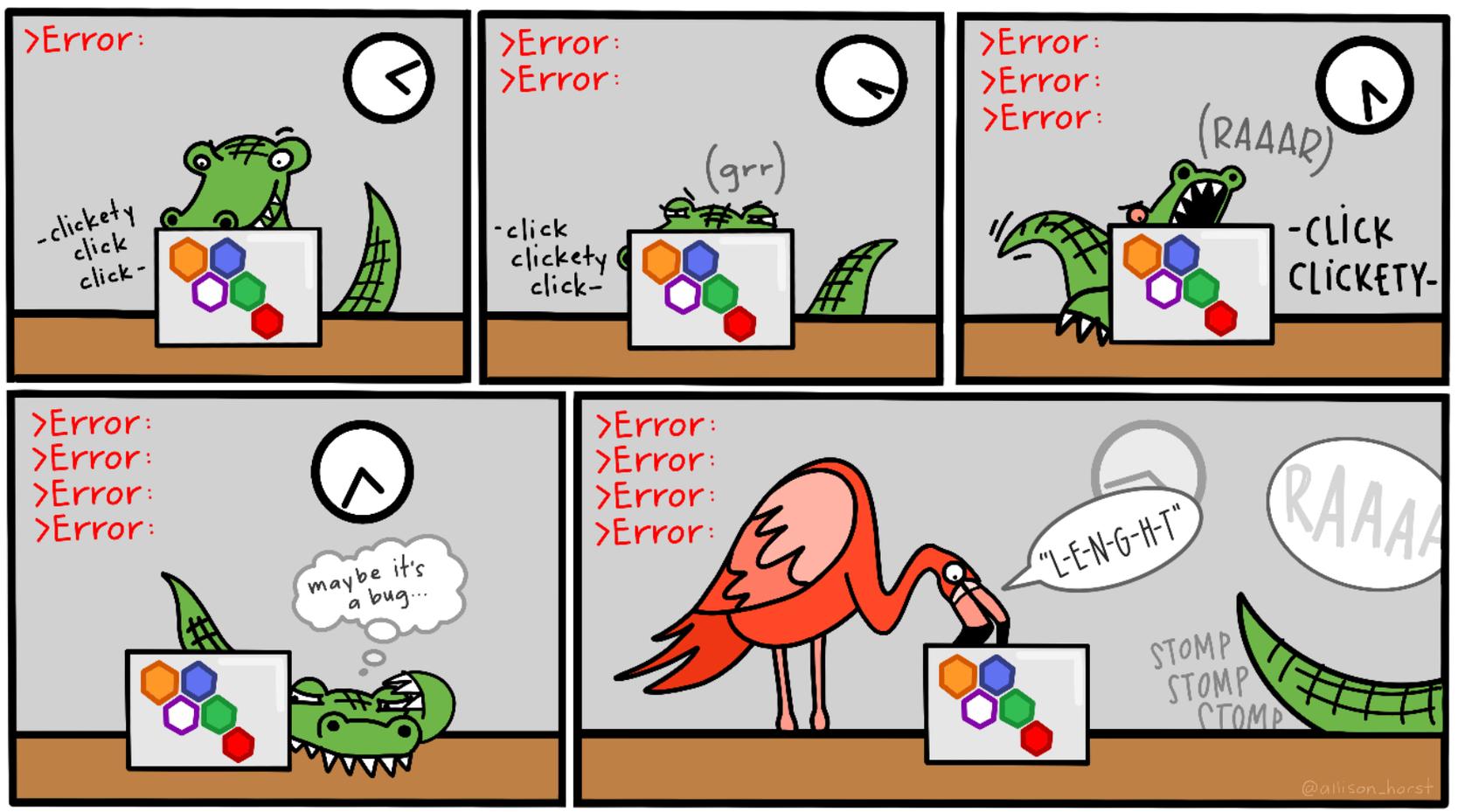
- `x$colname` to pull columns out as vector
- `x[row, col]` to access rows/columns

```
my_data[3, ]   # Why the comma?
my_data[3, 1]
my_data[, 1:2]
```

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] "2023-04-19"
```

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

```
1  Sys.Date
```

```
function ()
as.Date(as.POSIXlt(Sys.time()))
<bytecode: 0x55ac45cc8650>
<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!