Getting Started with R

Back to Basics

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Analysis and Data Tools for Science

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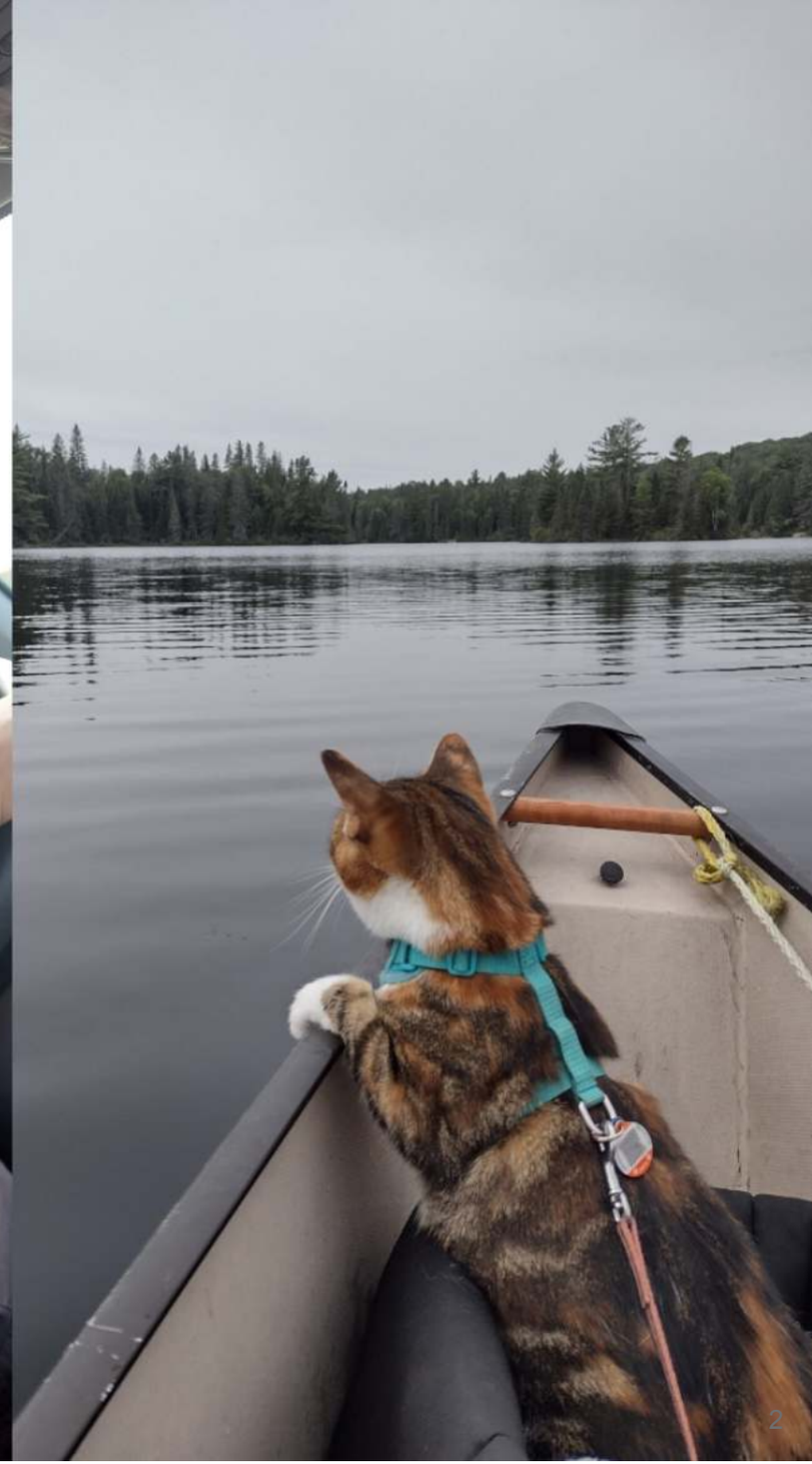
These are me and my creatures



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

Introductions

Dr. Alex Koiter (Today's Teaching Assistant)

- Physical Geographer
- Working with R since 2010
- Associate Professor in Geography and Environment, Brandon University

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 activities, lectures, and demonstrations
- Video on or off, however works best for you!

Questions

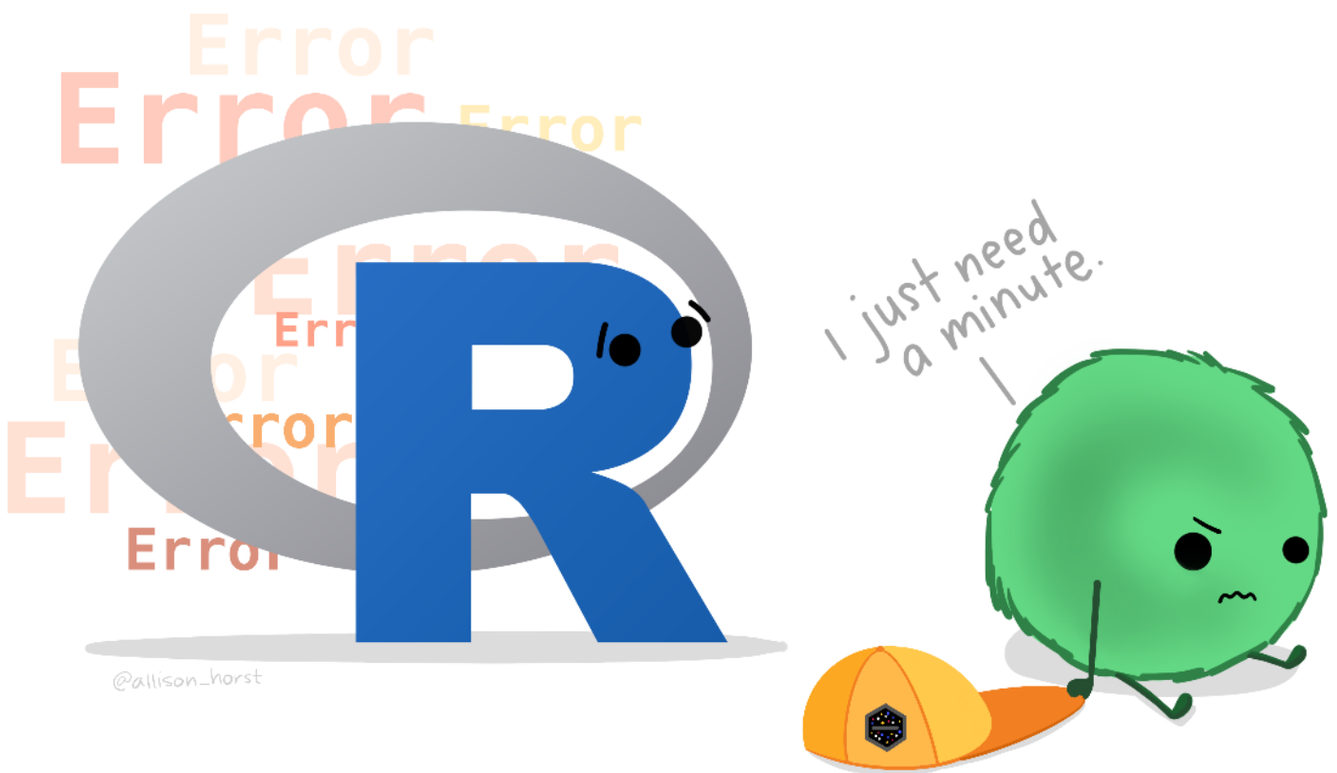
- Ask questions by un-muting, or ask in the chat (Alex will monitor)
  - Workshop-related questions we'll address together
  - Specific, system-related problems, Alex will help you in the "Troubleshooting Room"

Getting help

- Share your screen
- Share your code
  - In chat
  - Or in a community notebook: https://collabedit.com/kxyap

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
```

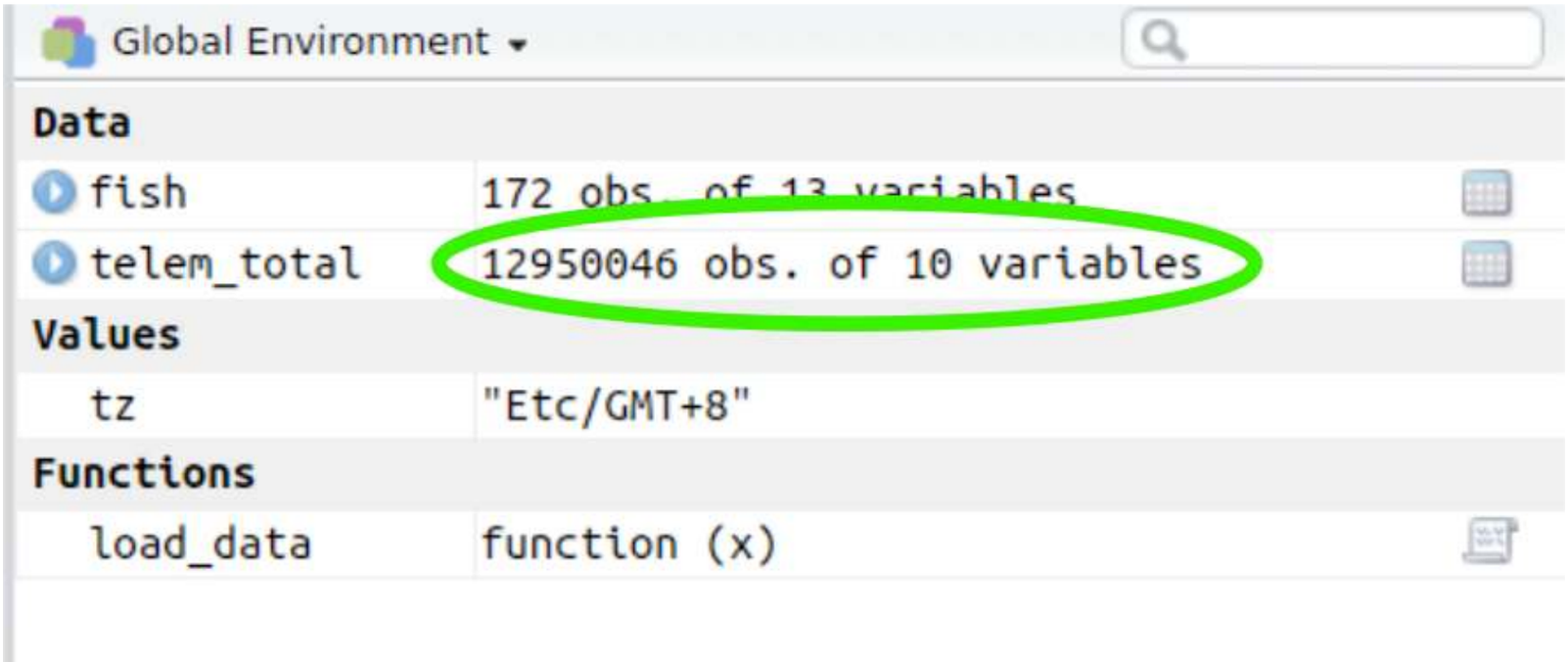
```
[1] 15
```

Why R?

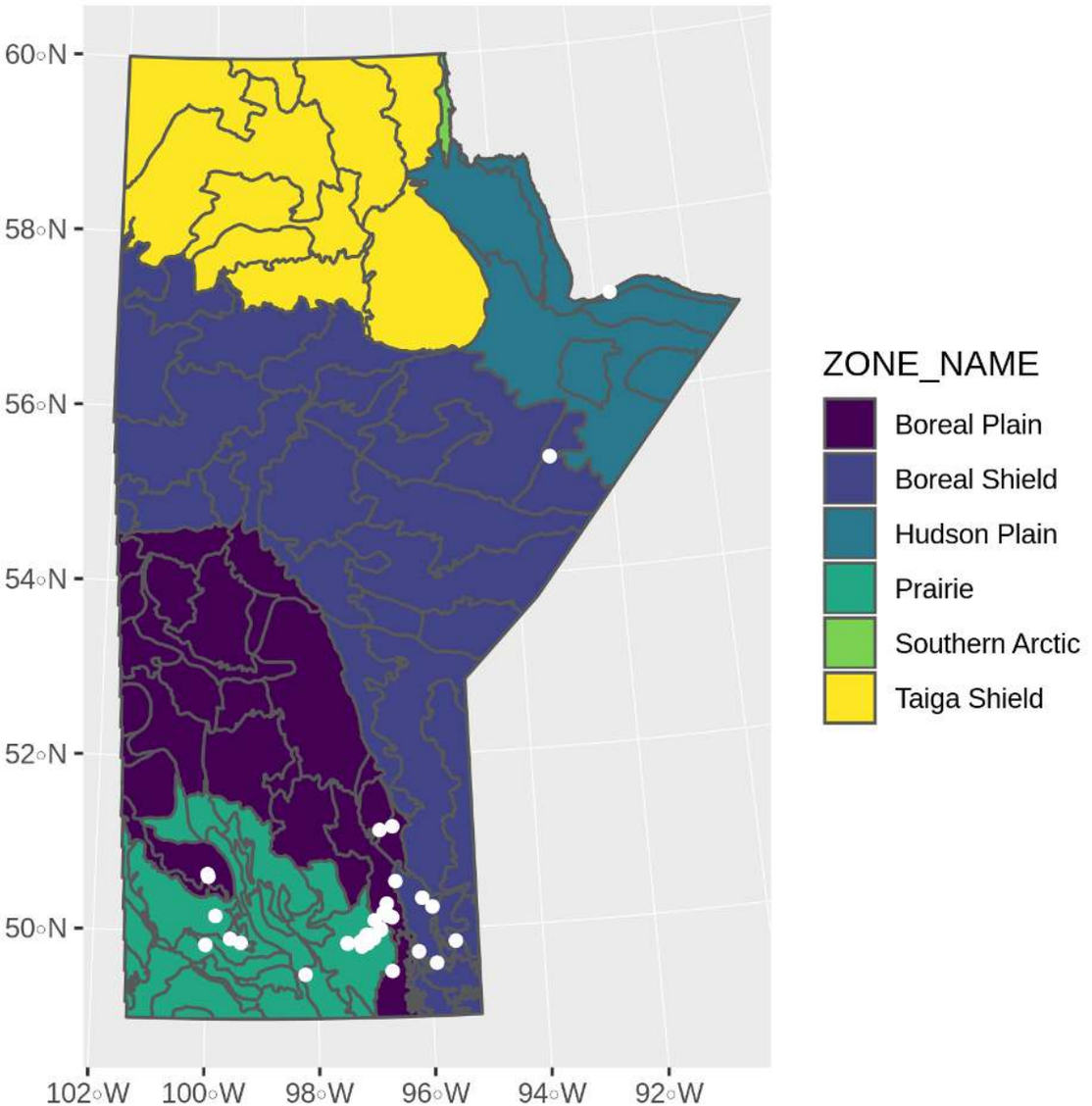
R is hard

```
# 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

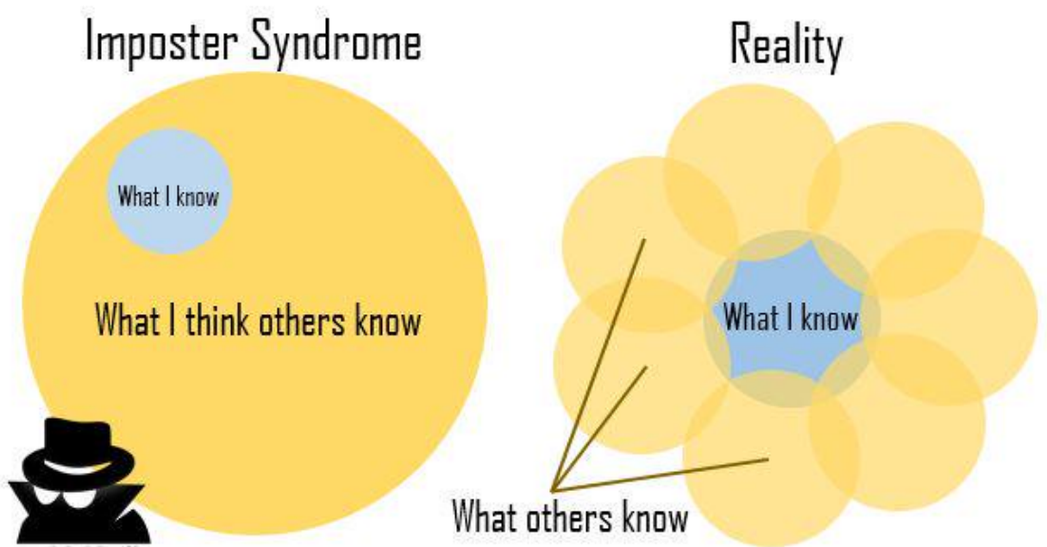


R is affordable (i.e., free!)

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:

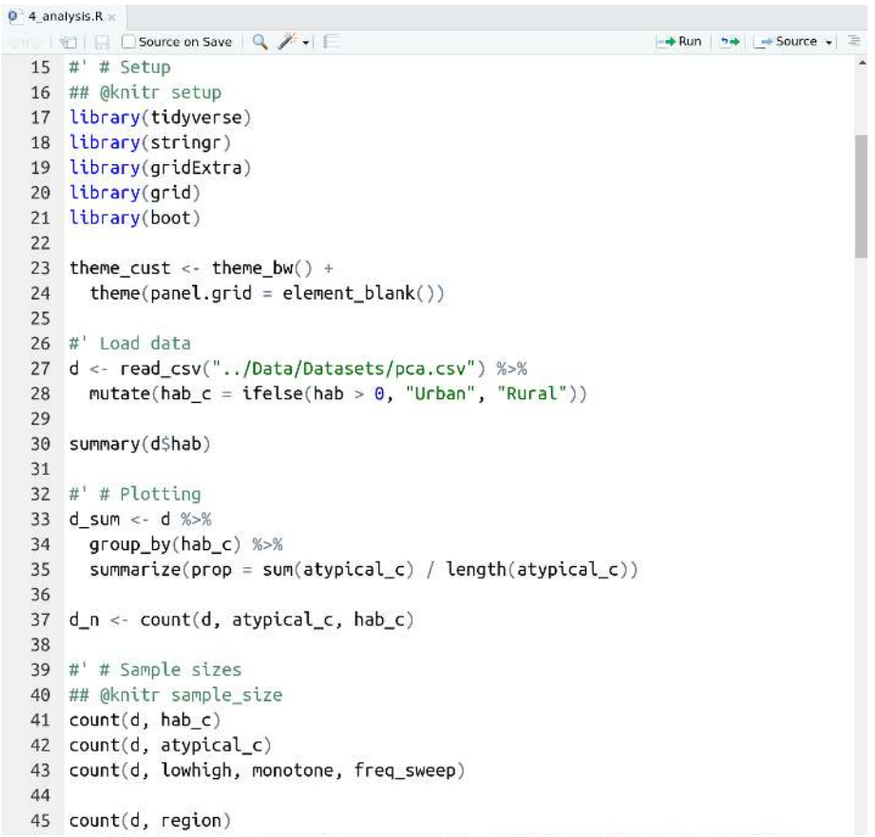
```
mean(c(1, 2, 3, 4))
```

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()
```

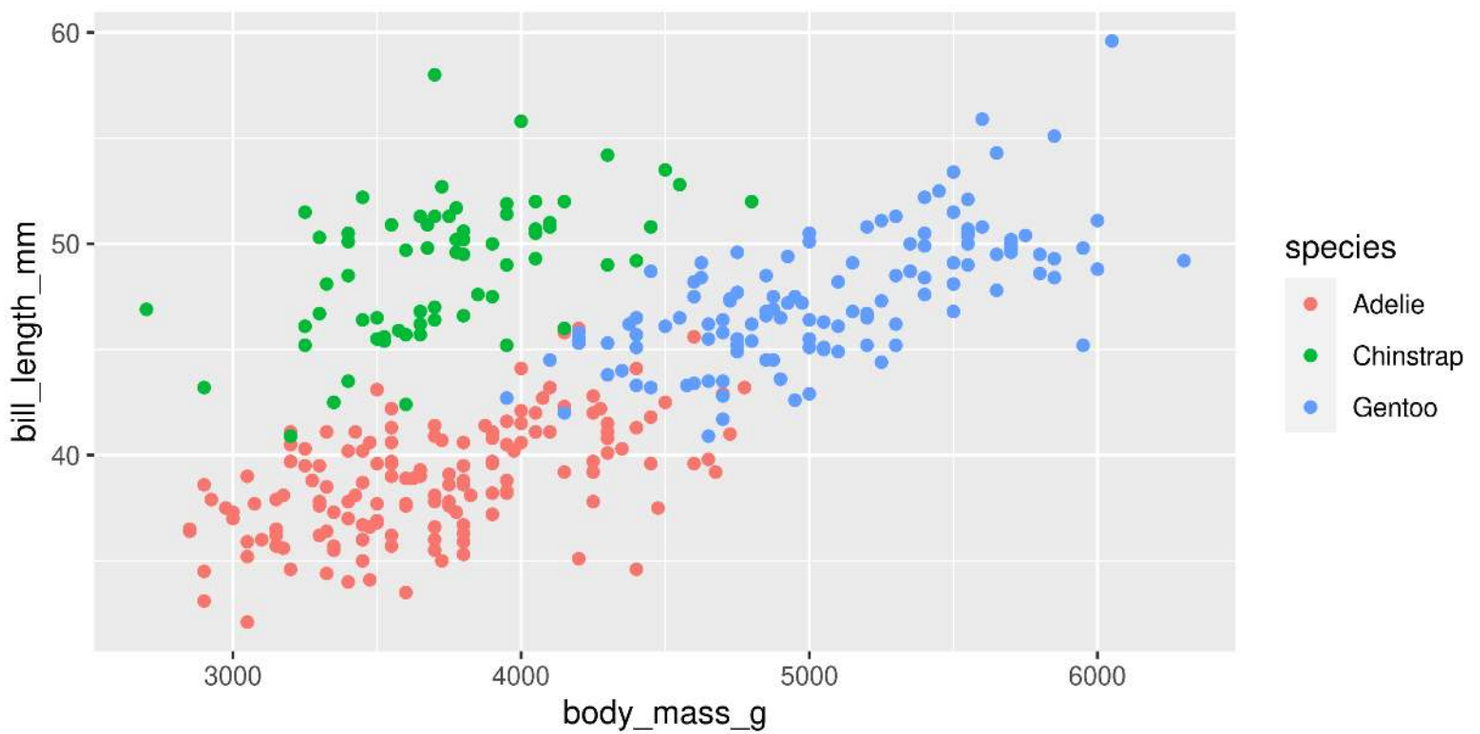
1. **Copy/paste or type** this into the **script** window in RStudio
    - You may have to go to File > New File > R Script
2. Click on the **first line of code**
3. **Run the code**
    - Click 'Run' button (upper right) **or**
    - Use the short-cut `Ctrl-Enter`
4. **Repeat** until all the code has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

First Code

```
# First load the packages
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 (`geom_point()`).
```



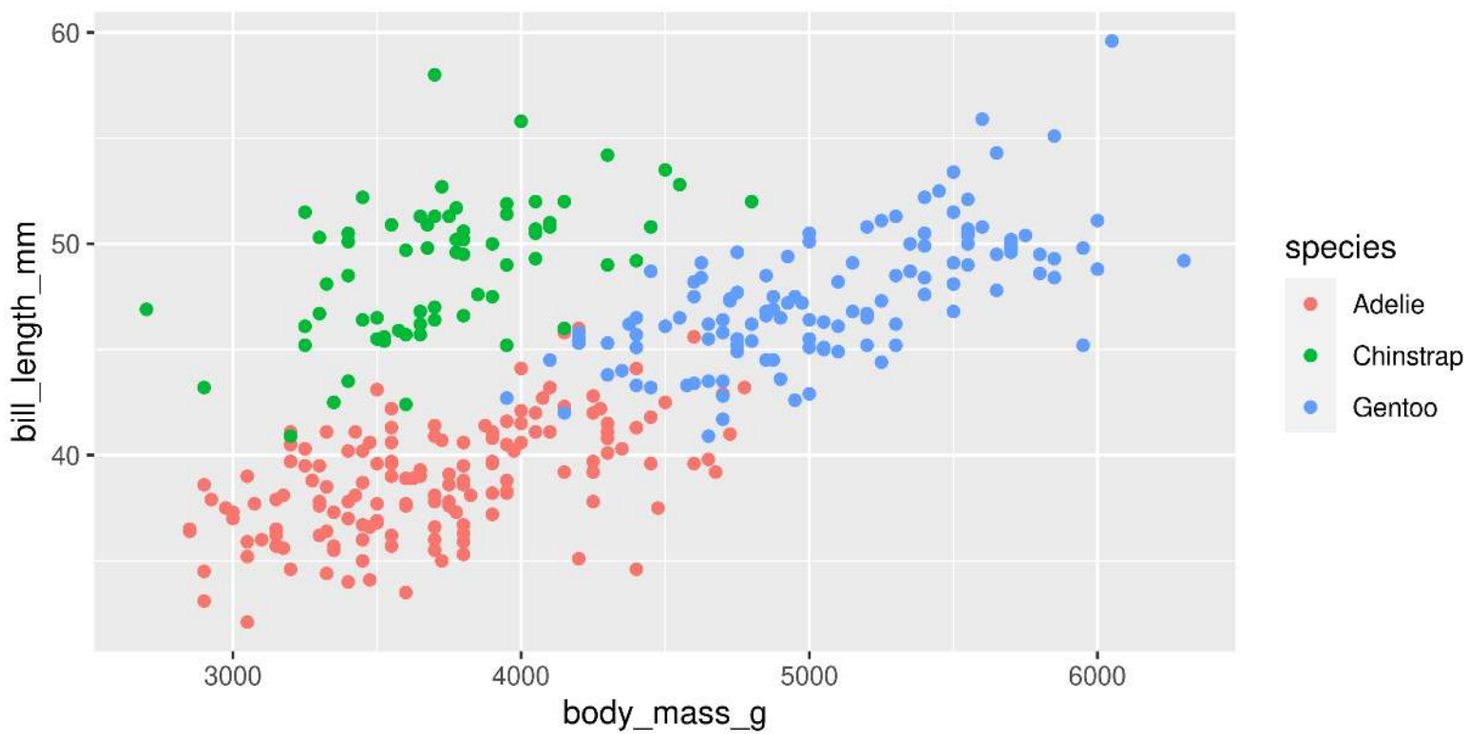
First Code

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)) +
  geom_point()
```

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

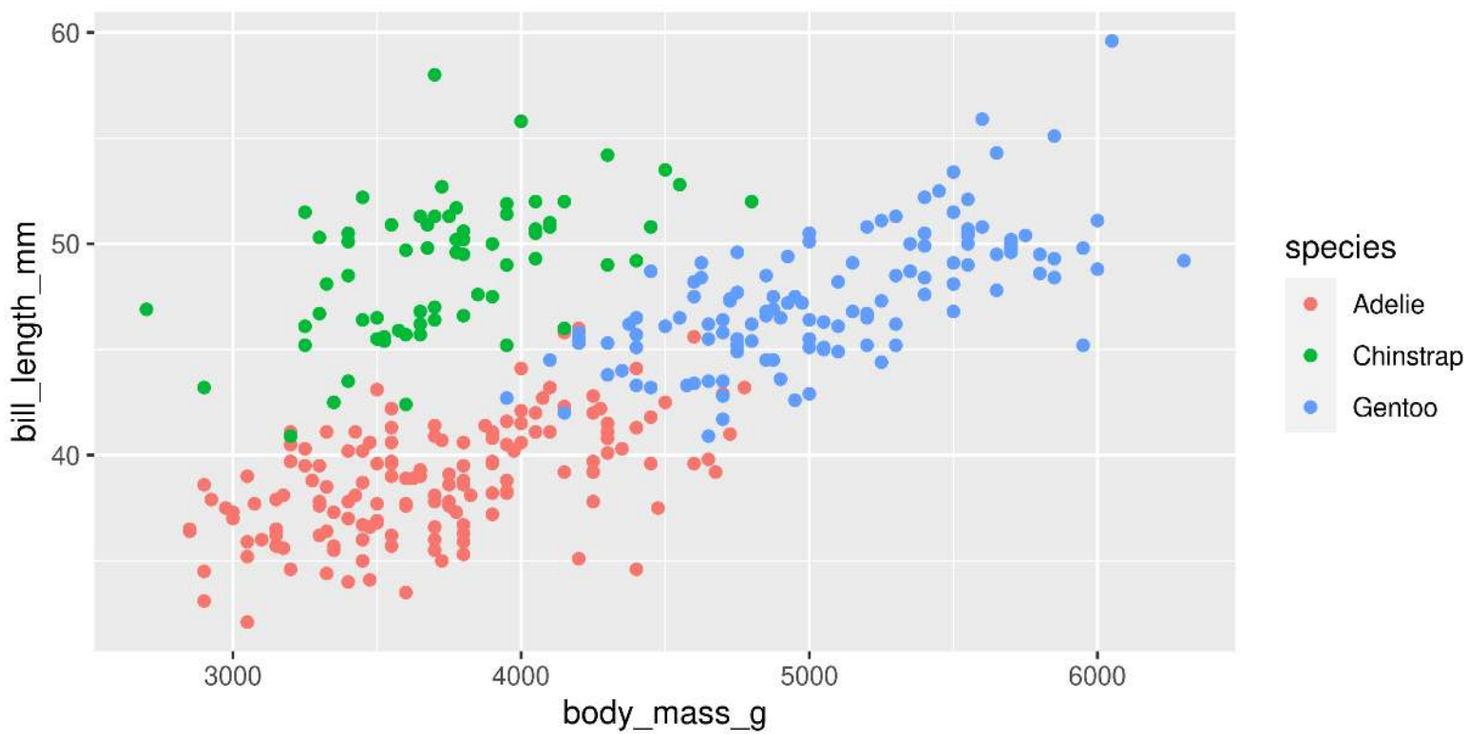


First Code

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

```
1  # First load the packages
2  library(palmerpenguins)
3  library(ggplot2)
4
5  # Now create the figure
6  ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
7    geom_point()
```

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

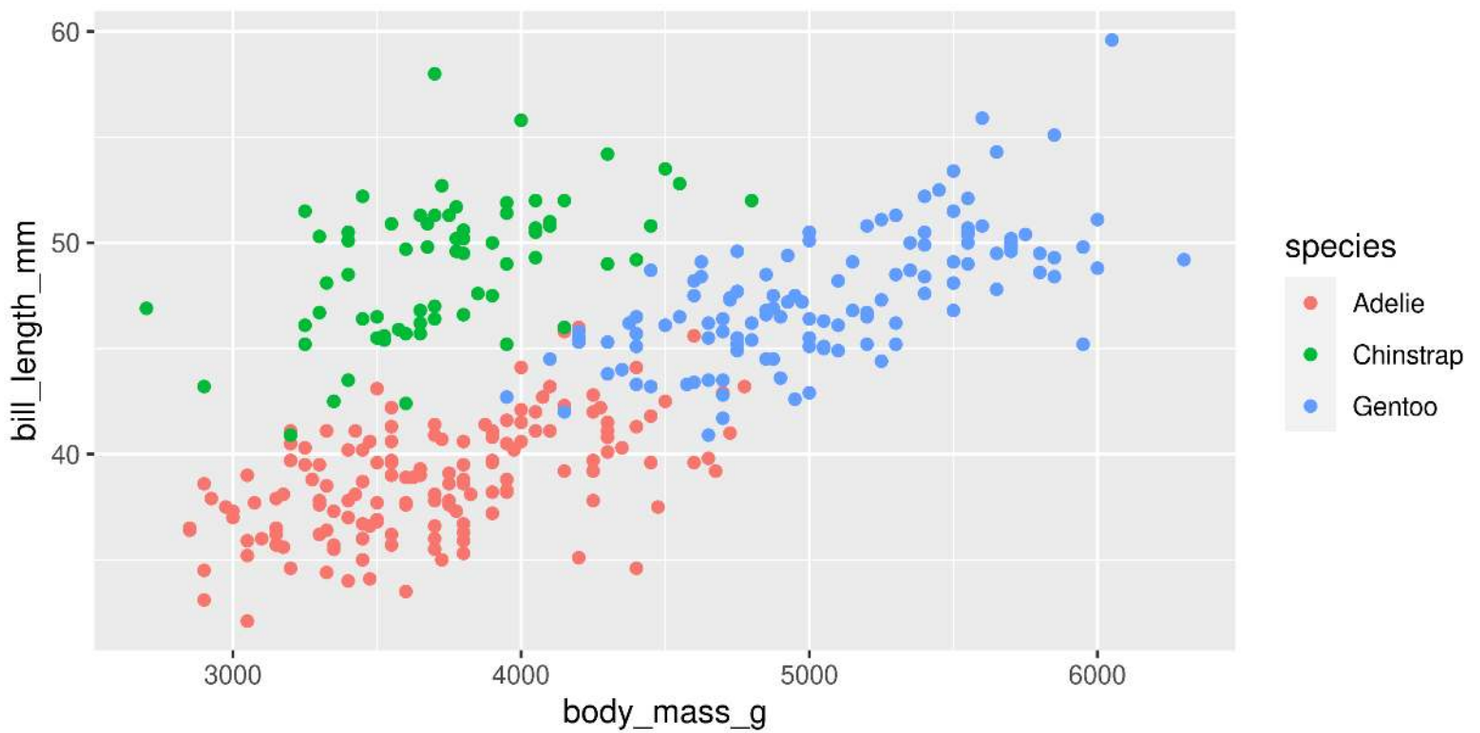


First Code

```
1  # First load the packages
2  library(palmerpenguins)
3  library(ggplot2)
4
5  # Now create the figure
6  ggplot(data = penguins, aes(x = body_mass_g, y = bill_length_mm, colour = species)) +
7    geom_point()
```

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

+
(Specific to ggplot)



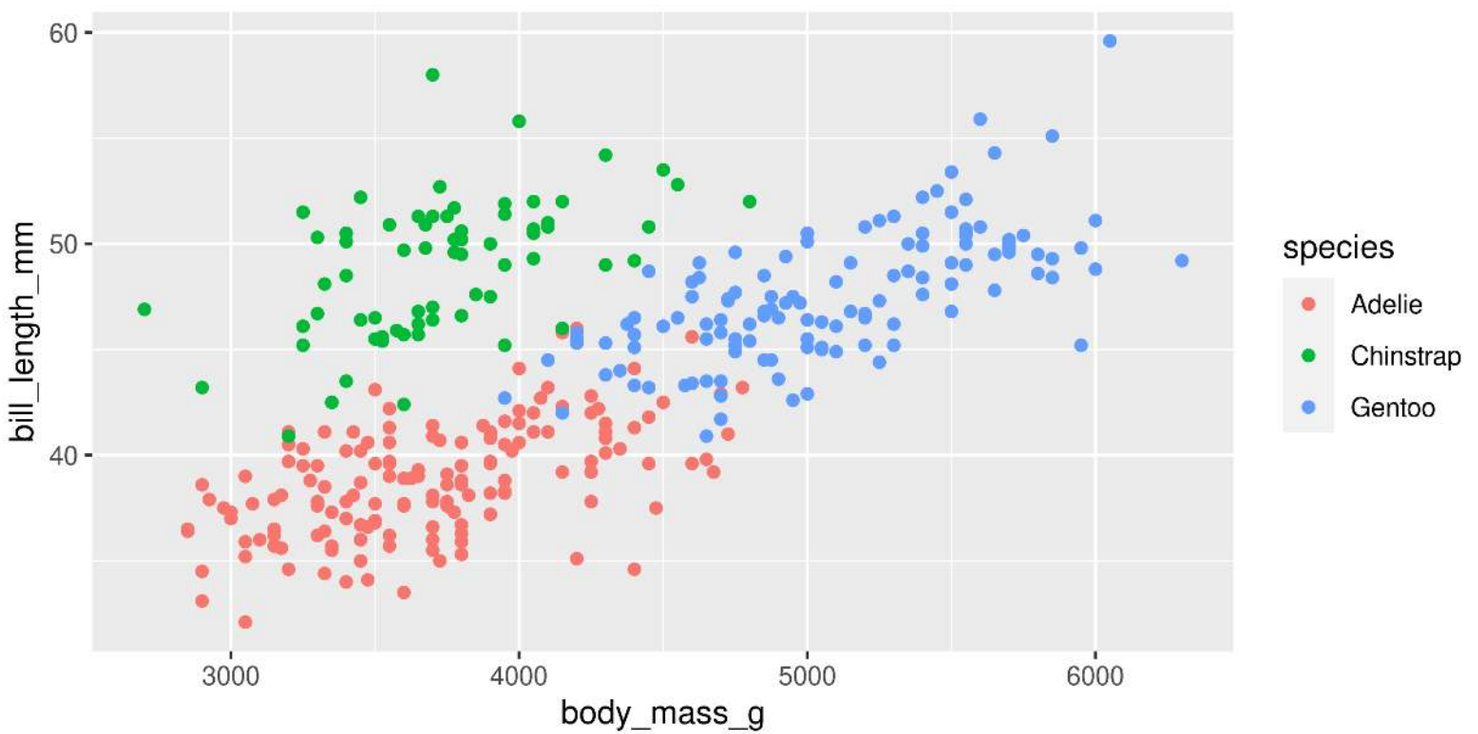
First Code

```
# 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()
```

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

Figure!

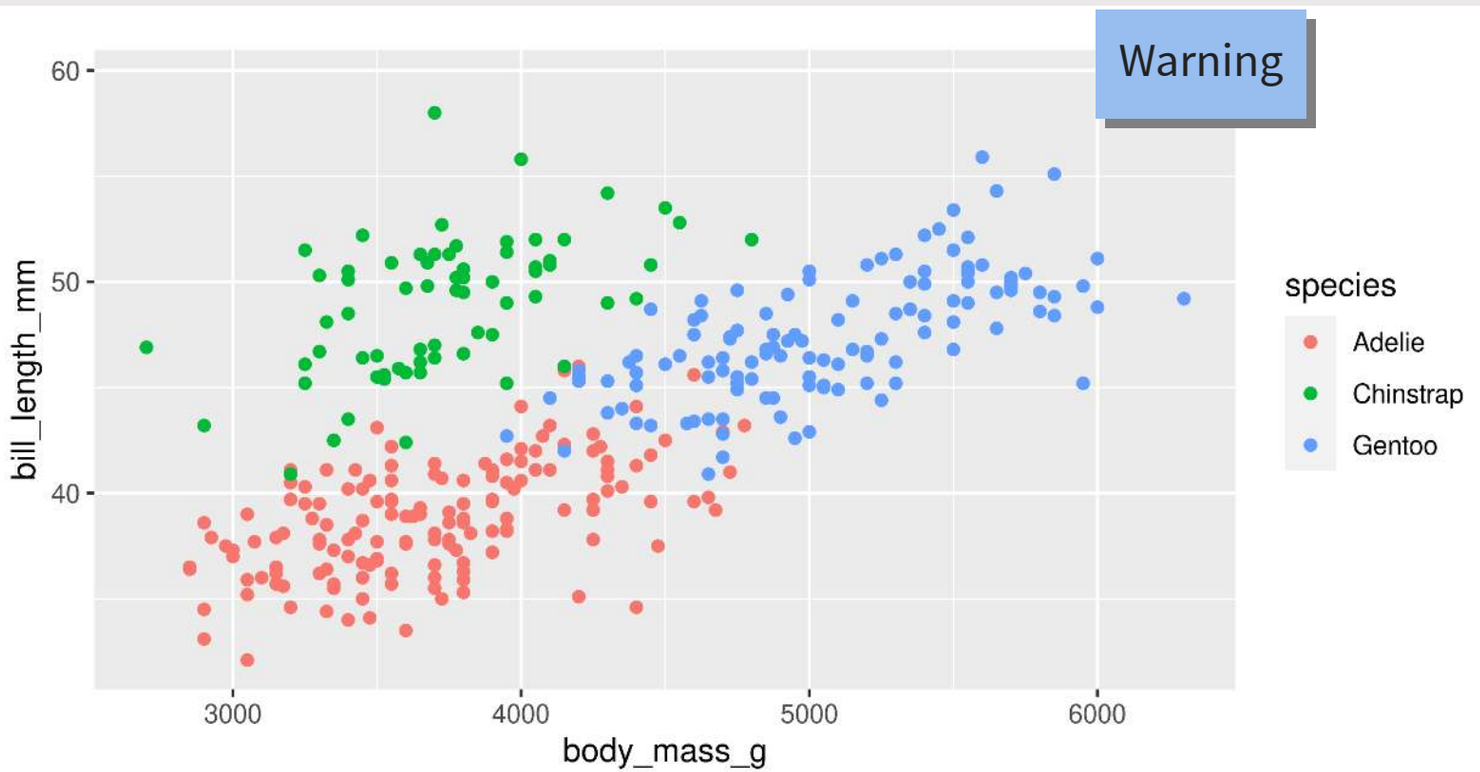


First Code

```
# 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()
```

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



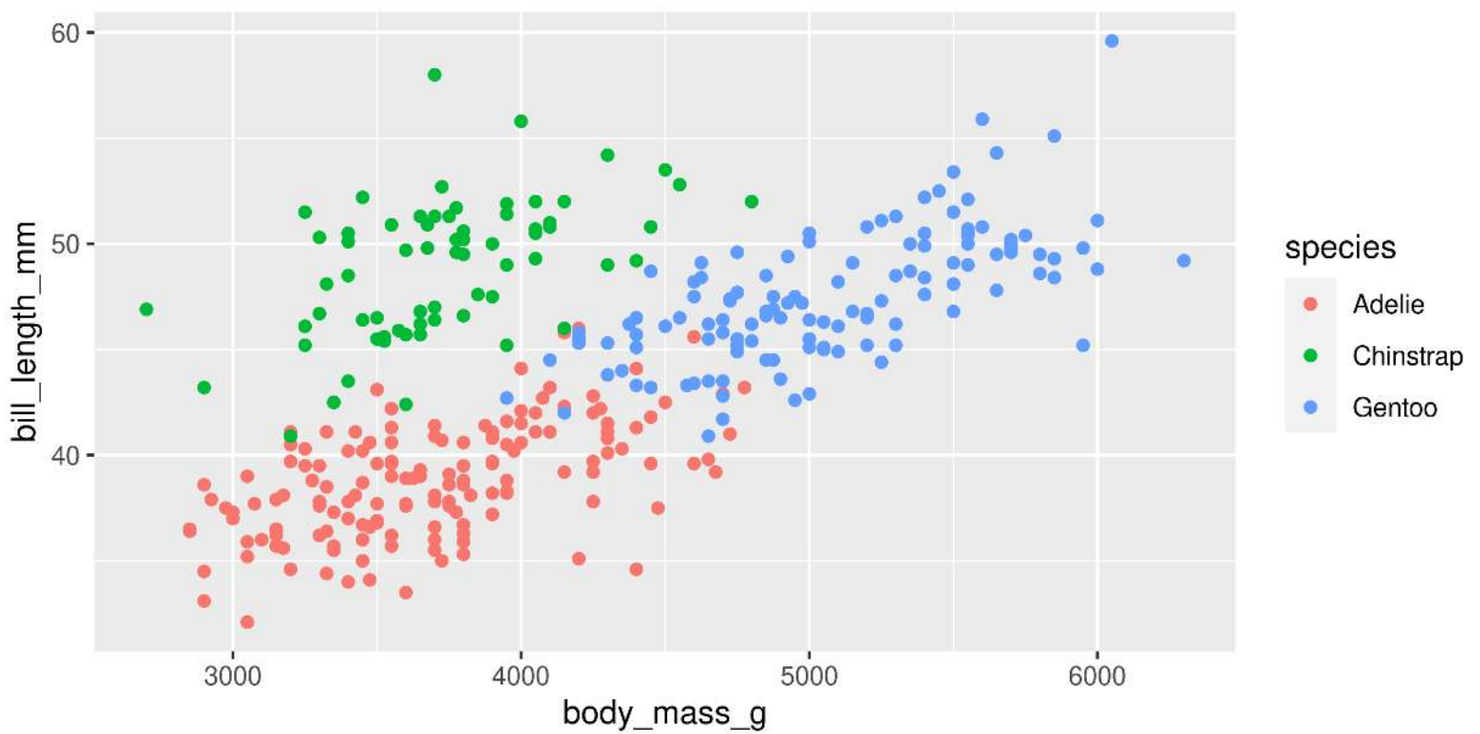
First Code

```
# 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 (`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

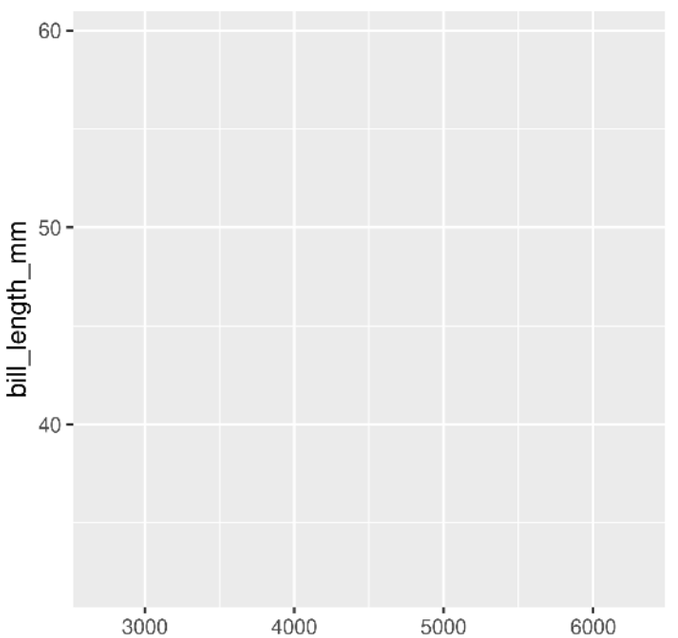
e.g., `library()` - Loads an R package so we can use it's functions and other objects it supplies

```
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:

```
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` (also `tibbles`)
- These are objects with names (like functions)
- Here are two **built-in** examples (part of R)

rows x columns

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
Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0
Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0

- 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

```
1 a <- c("apples", 12, "pears", 5, 8)
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[2:5]      # 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]
```

Your Turn: Vectors and Data frames

Try out the following code…

Vectors

```
1 a[2]
```

```
[1] "12"
```

```
1 a[2:5]     # What does : do?
```

```
[1] "12"    "pears" "5"     "8"
```

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

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

Data frames

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

```
   x   y z
3 s3 103 c
```

```
1 my_data[3, 1]
```

```
[1] "s3"
```

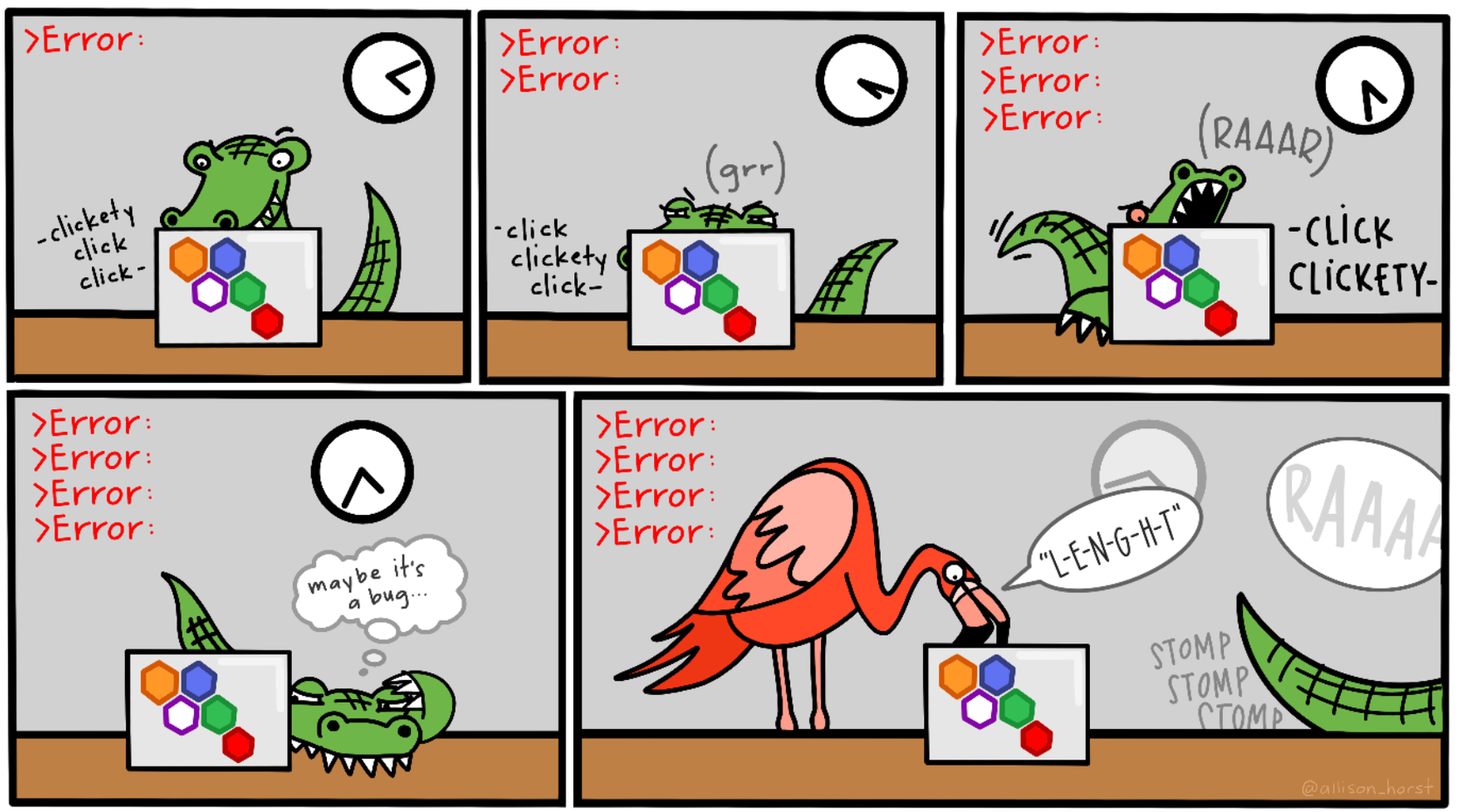
```
1 my_data[, 1:2]
```

```
   x   y
1 s1 101
2 s2 102
3 s3 103
4 s4 104
```

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] "2024-02-21"
```

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

```
1 Sys.Date
```

```
function ()
as.Date(as.POSIXlt(Sys.time()))
<bytecode: 0x561fe69e47b8>
<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

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

Easier to read

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

(But the same, coding-wise)

Let’s go!