**Workshop: Dealing with Data in R**

# Getting started with R

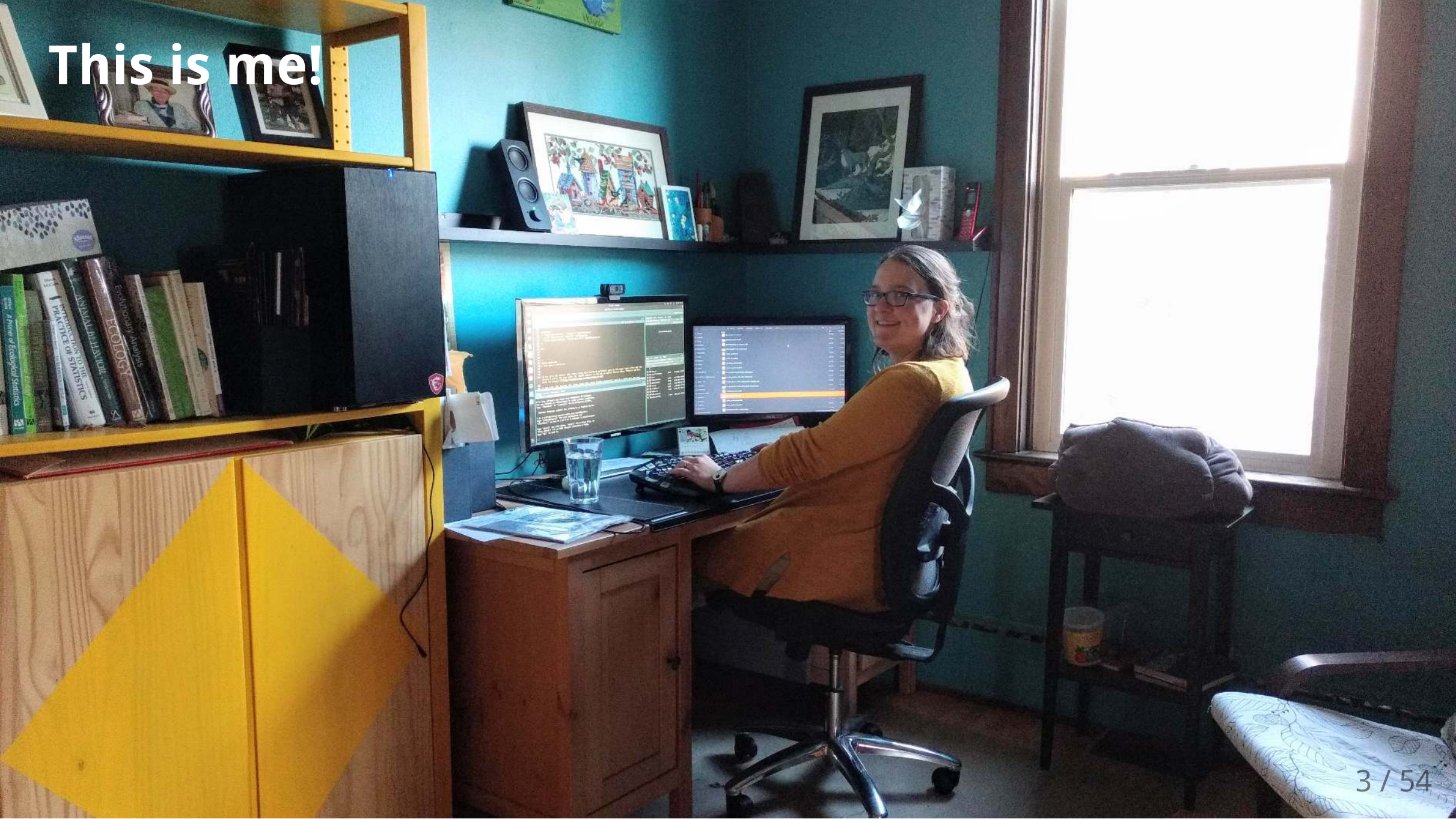
**Back to Basics**

Steffi LaZerte https://steffilazerte.ca | *Compiled: 2022-01-28*

# Online workshops can be challenging

- **Consider keeping your video on** (if possible)
  - We're here together!
  - Kids? Pets? Spouses? No problem
  - But ultimately, you need be comfortable! (and you absolutely have the right to privacy at home)
- **Interrupt me!**
  - Generally keep yourself muted but un-mute anytime to ask questions
- **Ask Questions!**
  - Group trouble-shooting is really valuable
  - If you have a problem, others may also (or may have it in the future)
- **Screen-sharing**
  - I may ask you to share your screen with the group (feel free to decline)
  - For privacy, close your email etc. Or just share your RStudio window

# This is me!


Introduction to the Practice of Statistics
Evolutionary Analysis
ANIMAL BEHAVIOR
ECOLOGY
A Primer of Ecological Statistics

# These are my creatures

# This is my garden

# This is my work*

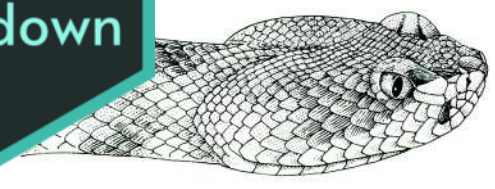
Agriculture and Agri-Food Canada

BRITISH COLUMBIA

weathercan

Shiny

rmarkdown



Motus
Wildlife Tracking System

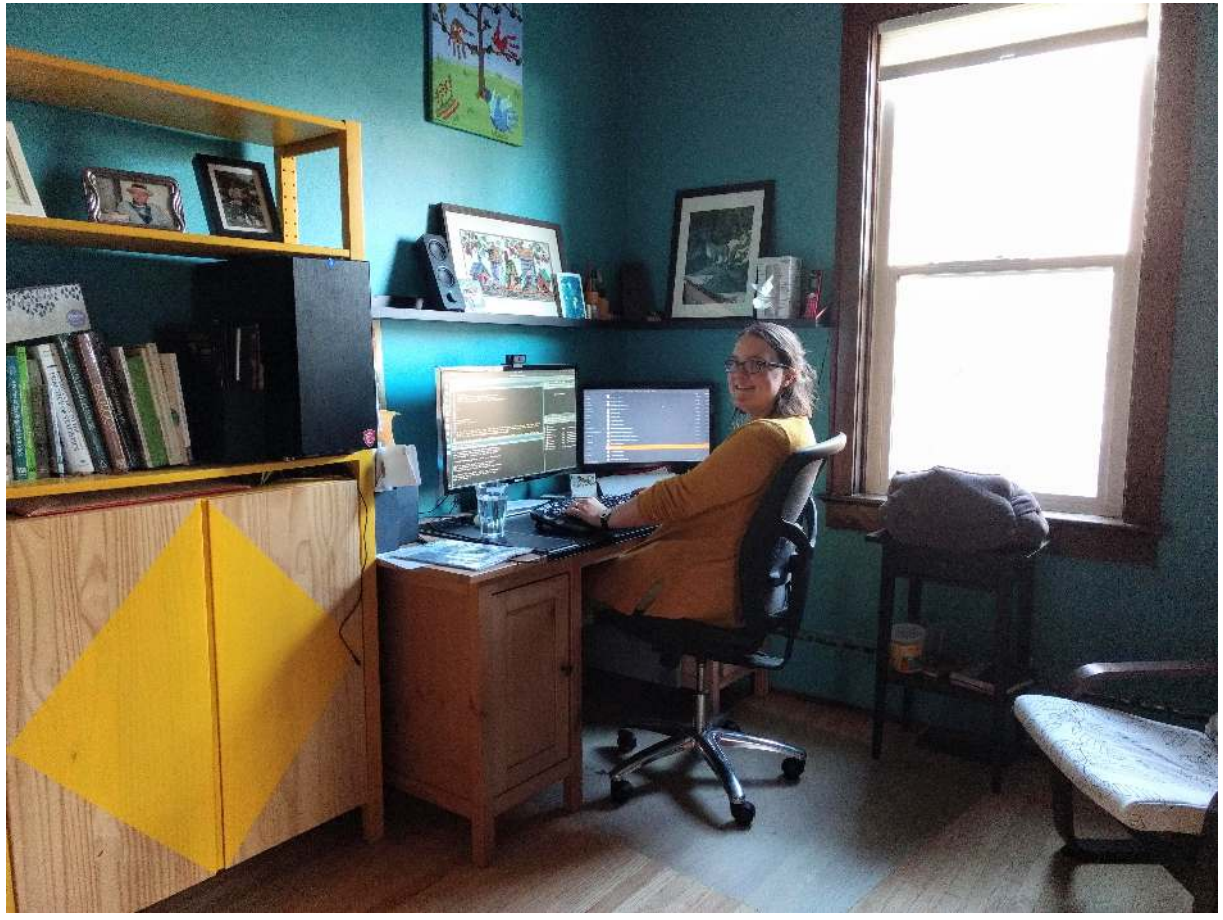
BIRDS CANADA OISEAUX CANADA

(* On, with, and for)

# Introductions

## Dr. Steffi LaZerte

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



# Introductions

## Dr. Alex Koiter

**Backup helper today**

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

# What about you?

- Name
- Creatures? (share on camera!)
- Background (Role, Area of study, etc.)
- Familiarity with R or Programming
- Something you're proud of!

# 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

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# ImpostR Syndrome

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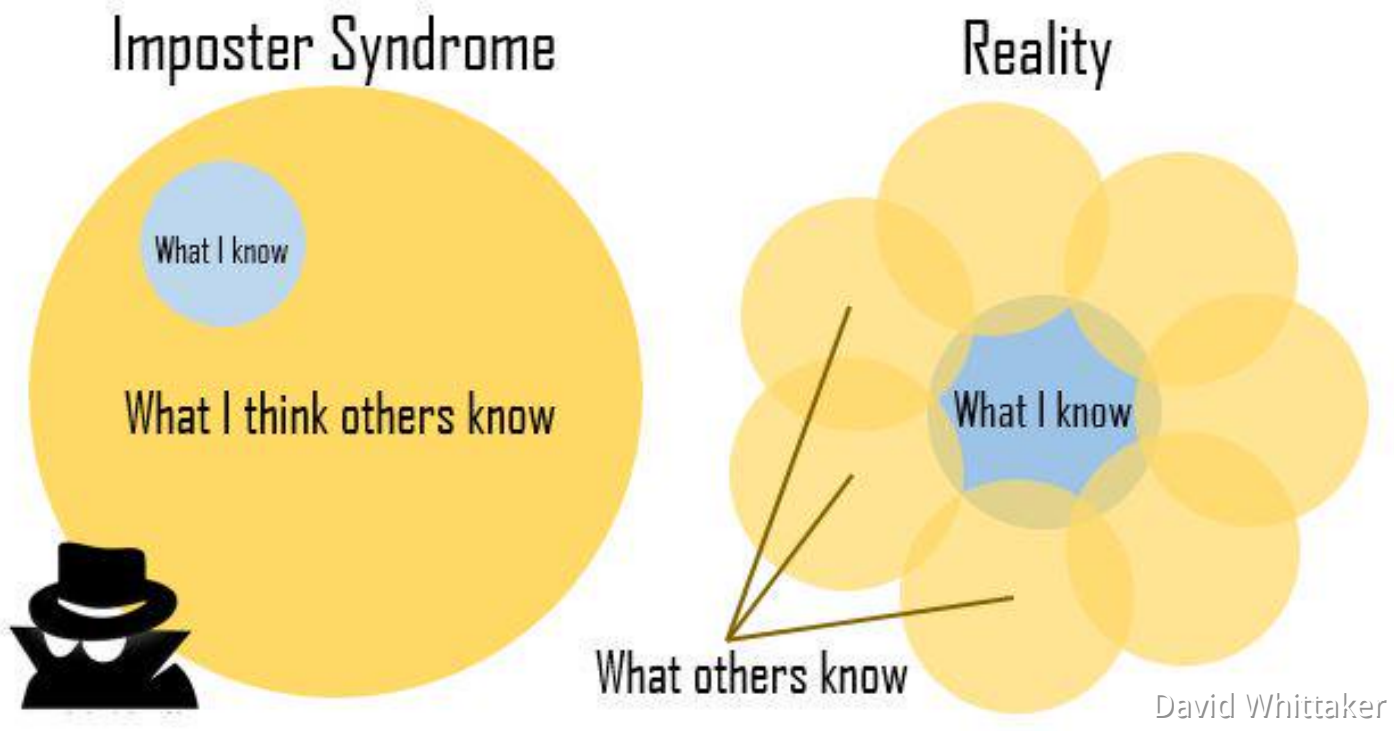
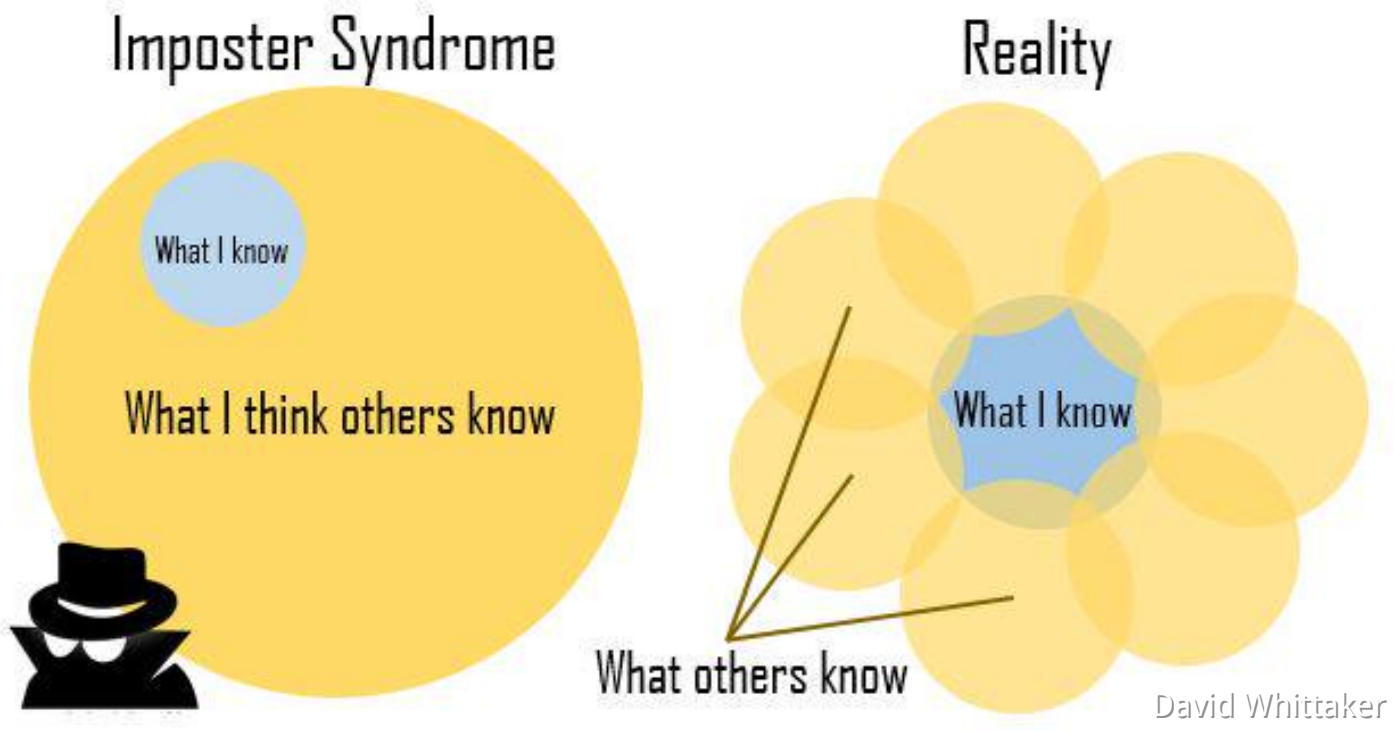



David Whittaker

Impost R Syndrome

# ImpostR Syndrome




Impost R Syndrome

**Moral of the story?**
Make friends, code in groups, learn together and don't beat yourself up


Artwork by @allison_horst

# All about R

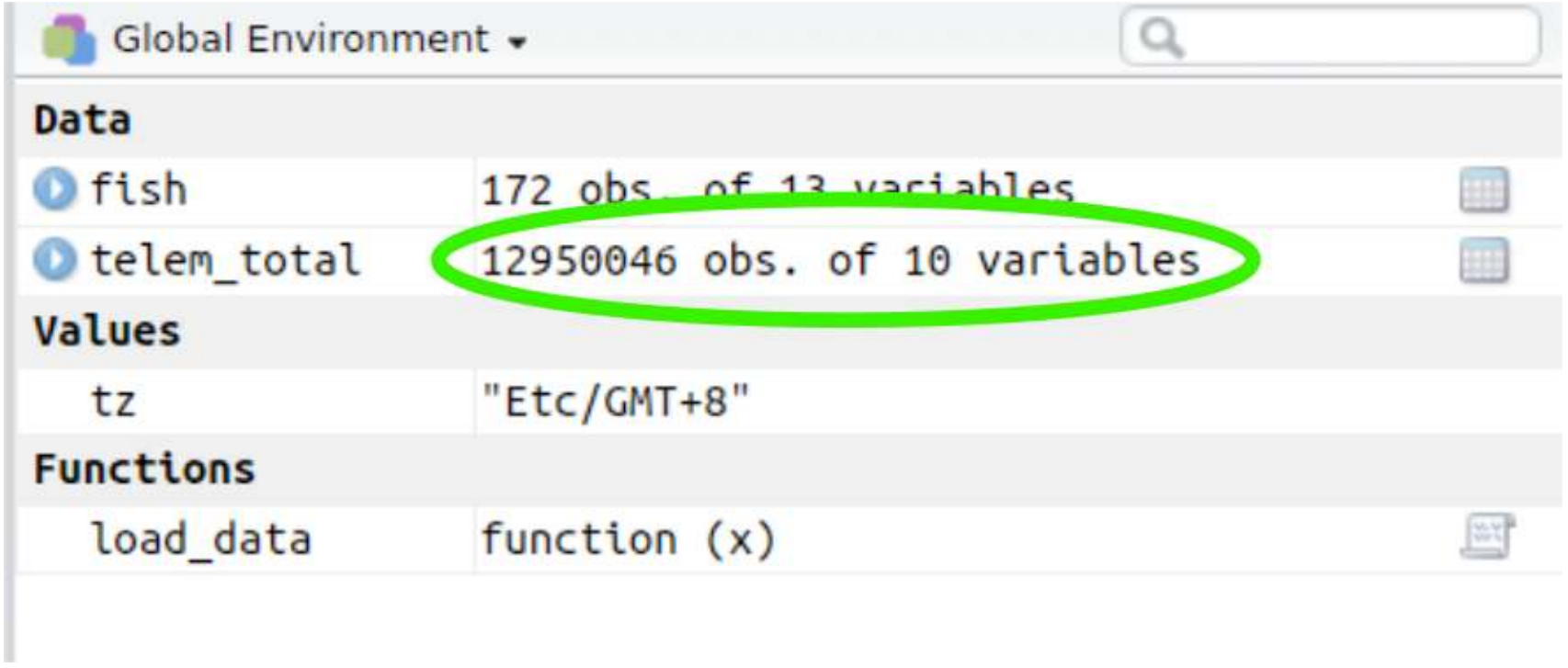
# Why R?

## 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],
```

# Why R?

## But R is powerful (and reproducible)!



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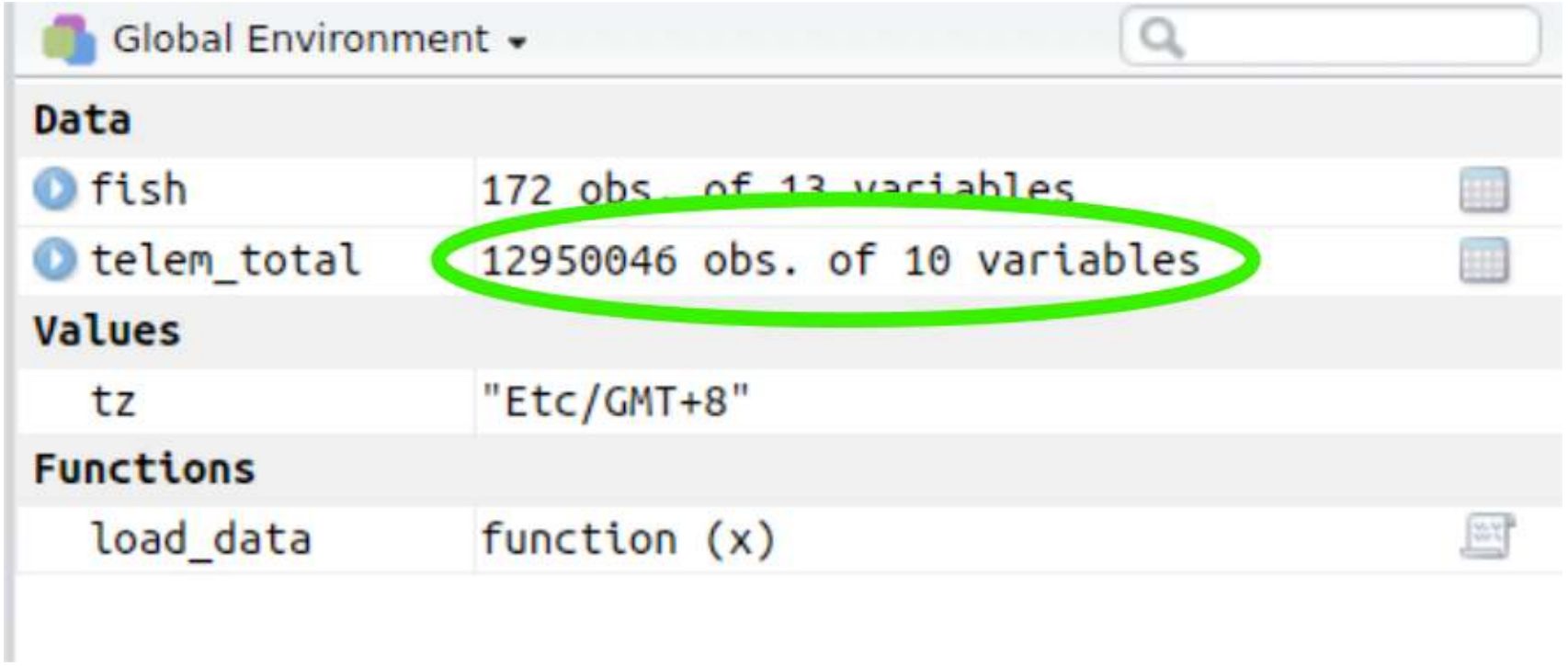
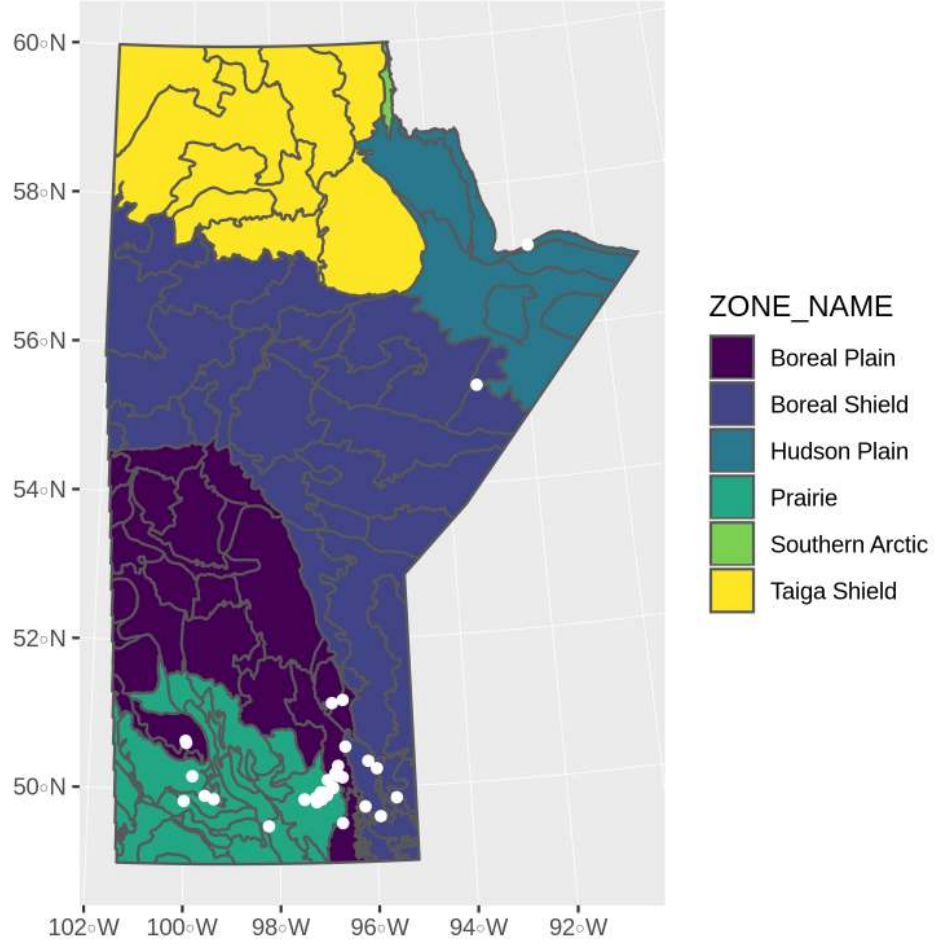



(I made these slides with **R**markdown)

# Why R?

## R is also beautiful



# Why R?

## 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.

# What is R?

# R is 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
```

# 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))
```

# 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
```

# 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

# Code, Output, Scripts

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- You should always keep your code in a script

## For example:

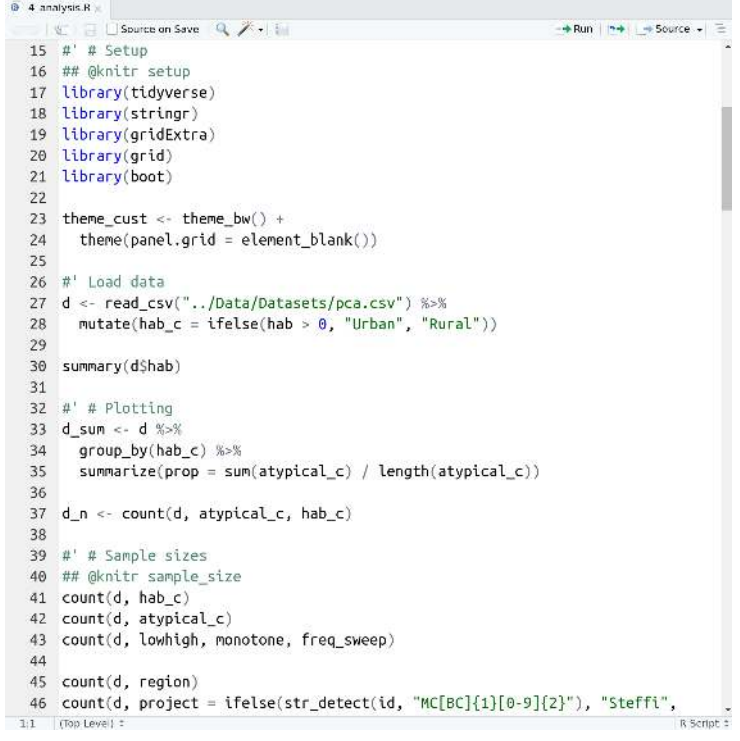
```
mean(c(1, 2, 3, 4))
```

**Code**

```
## [1] 2.5
```

**Output**

**Script**



# RStudio vs. R



- **RStudio** is not **R**
- RStudio is a User Interface or IDE (integrated development environment)
  - (i.e., Makes coding simpler)
- But sometimes tries to be **too** helpful

# 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

## Packages

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

# Let's take a look at RStudio

# Your first *real* code!

# First Code

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

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

- Copy/paste or type this into the script window in RStudio
  - You may have to go to File > New File > R Script
- Click anywhere on the first line of code
- Use the 'Run' button to run this code, **or** use the short-cut **`Ctrl-Enter`**
  - Repeat until all the code has run

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ggplot(data = penguins, aes(x = body_mass_g, y = flipper_length_mm, colour = species)) +
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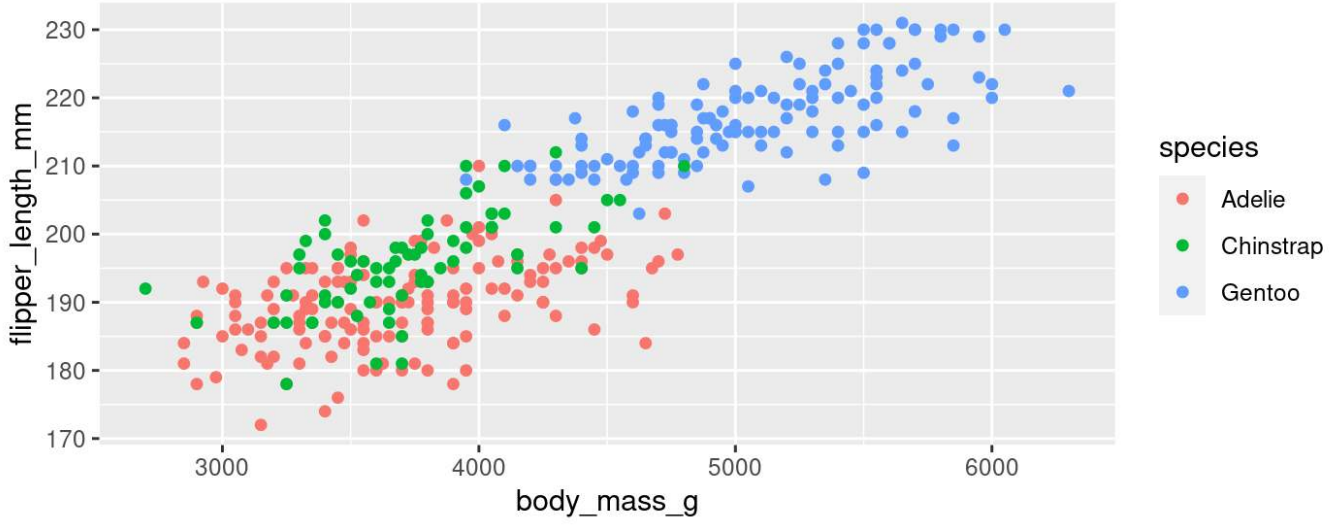
```

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



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Packages
**tidyverse** and **palmerpenguins**

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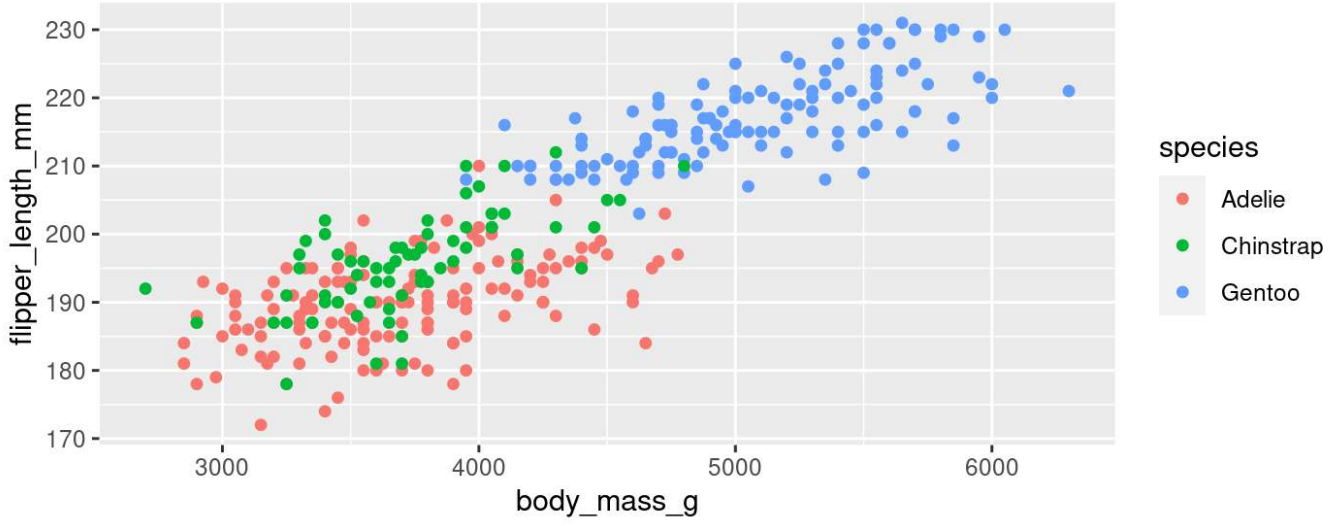

# First Code

Functions:
**library()**, **ggplot()**
**aes()**, and **geom_point()**

```
# First load the packages
library(tidyverse)
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# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = flipper_length_mm, colour = species)) +
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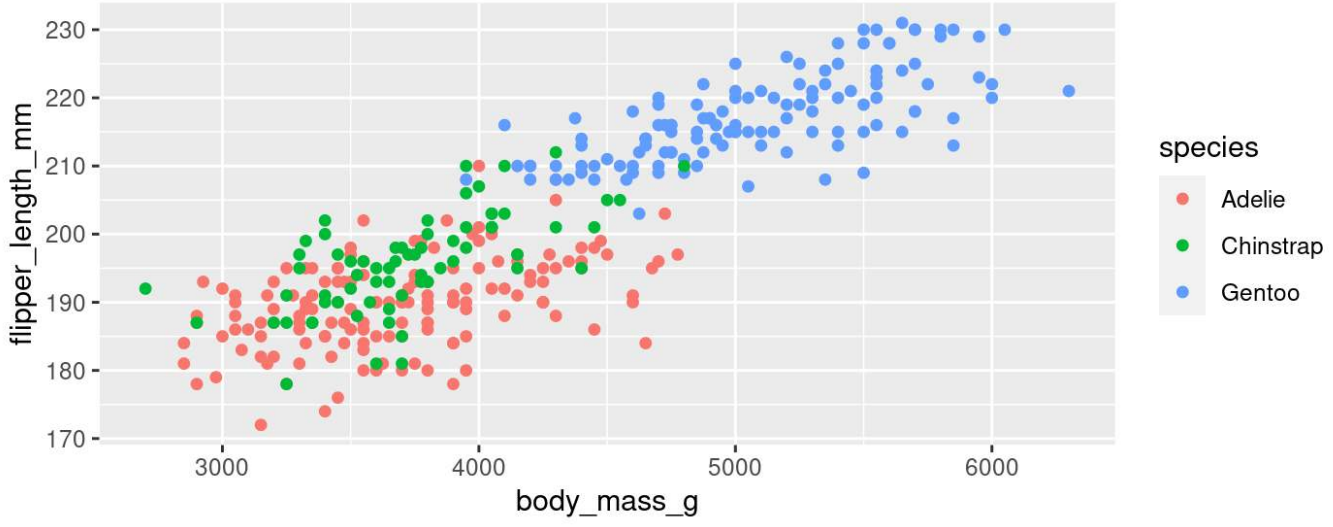

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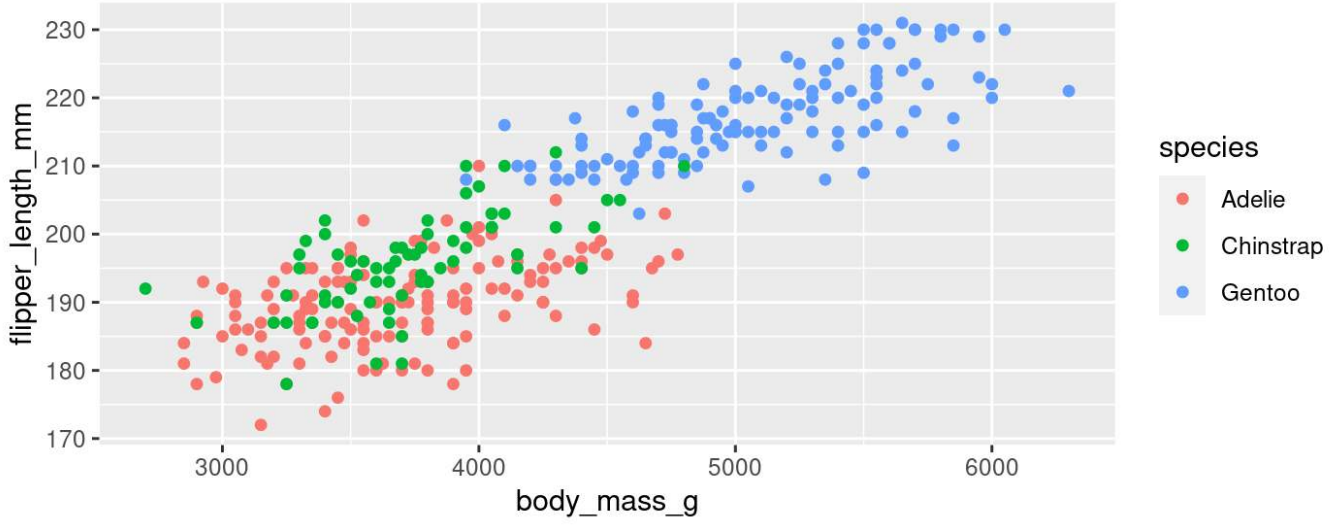
# Now create the figure
ggplot(data = penguins, aes(x = body_mass_g, y = flipper_length_mm, colour = species)) +
  geom_point()
```

+
(Specific to **ggplot**)

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



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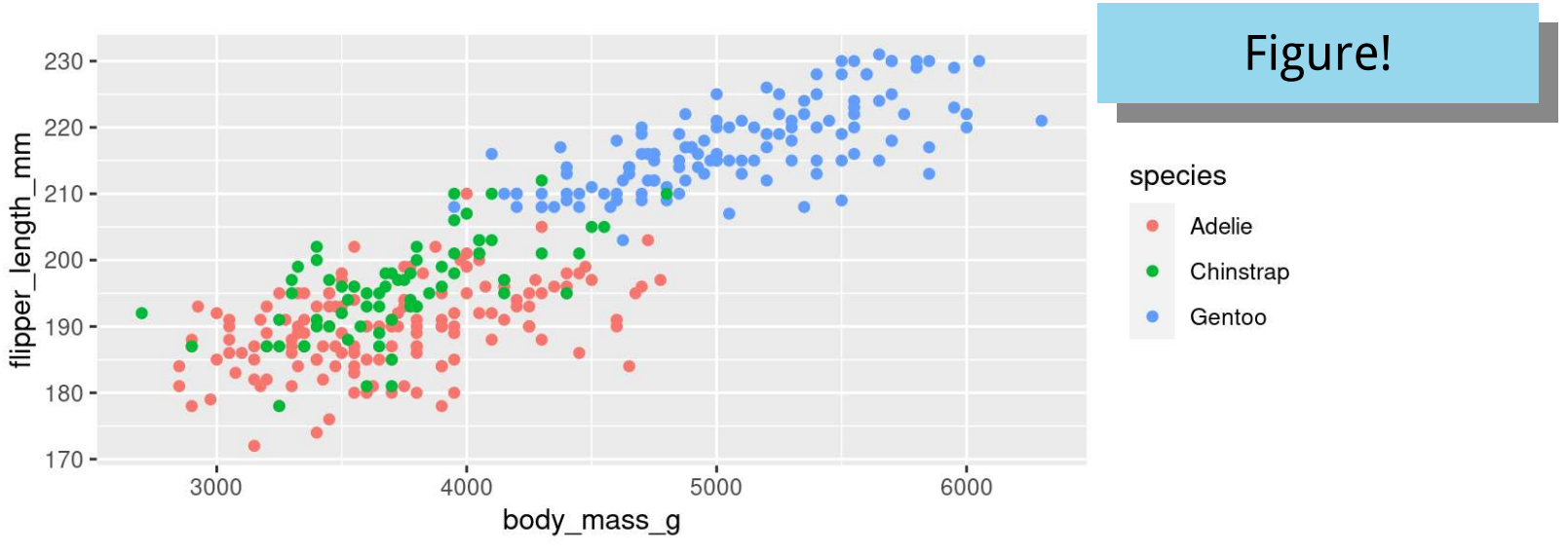

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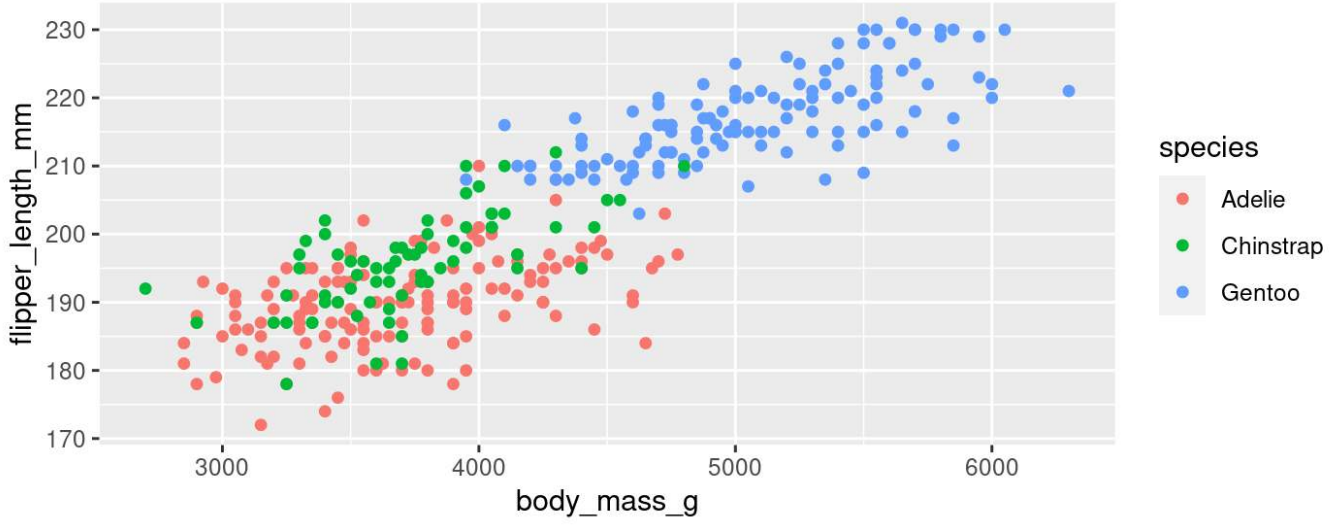
Warning



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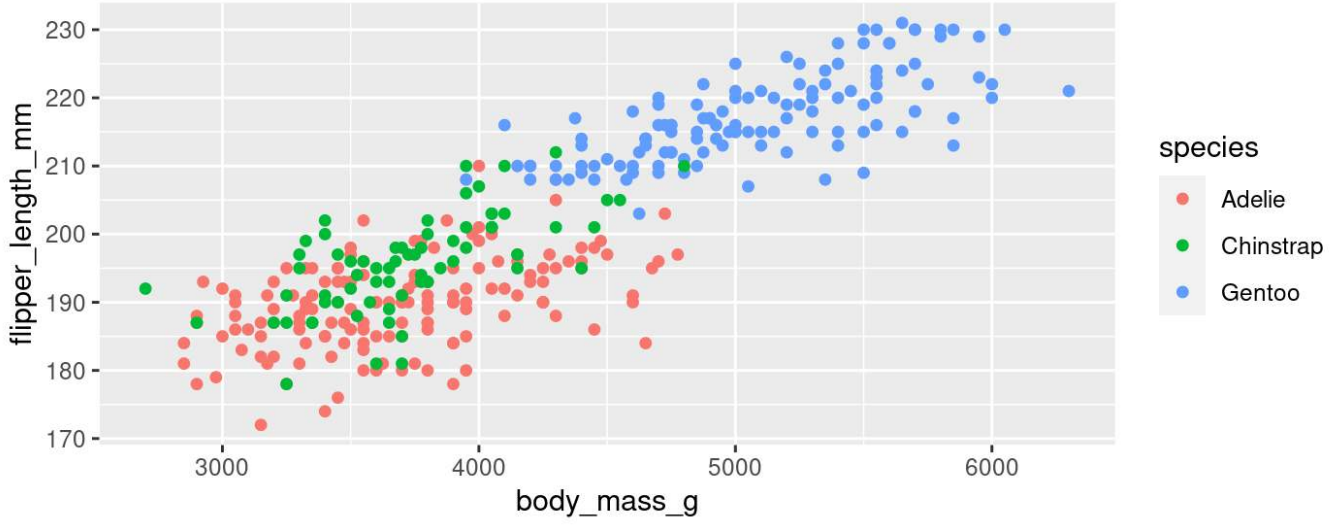
```

Comments
(Start with #)

```
## 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

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

### Does something and returns something

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

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

```
## [1] 22.78157
```

# functions()

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

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

# functions()

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

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

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

## By name:

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

```
## [1] 5.333333
```

## By order:

```
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
```

# 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
```

# 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

```
?mean
```

# R documentation

```
?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)

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

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

## Data frame (2 dimensions)

rows x columns

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

my_data
```

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

# Vectors

## Use `c()` to create a vector

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

## Use `x[index]` to access part of a vector

```
a[3] # [1] "bananas"
```

## Vectors contain one type of variable

(Even if you try to make it with more)

```
class(a) # [1] "character"
```

# Data frames (also tibbles)

```
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
- **`x$colname`** to pull columns out as vector
- **`x[row, col]`** to access rows and columns of a data frame

# Your Turn: Vectors and Data frames

Try out the following code...

1. What is the output in your console?
2. How does your **`environment`** change (upper right panel)?

### Vectors

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

### Data frames

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

# Your Turn: Vectors and Data frames

Try out the following code...

### Vectors

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

### Data frames

```
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`**)
- Commas are used to separate arguments in functions

## For example

This is correct:

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

This is **not** correct:

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

```
## Error: <text>:1:10: unexpected numeric constant
## 1: mean(c(5 7
##              ^
```

# R has spelling and punctuation

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

This is correct:

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

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

This is **not** correct:

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

```
## Error: <text>:1:10: unexpected numeric constant
## 1: mean(c(5 7
##              ^
```

# 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

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

## Use = to set function arguments

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

## Use == to determine equivalence (logical)

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

# Braces/Brackets

## Round brackets: ( )

- Identify functions (even if there are no arguments)

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

```
## [1] "2022-01-28"
```

# Braces/Brackets

## Round brackets: `()`

- Identify functions (even if there are no arguments)

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

```
## [1] "2022-01-28"
```

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

```
Sys.Date
```

```
## function ()
## as.Date(as.POSIXlt(Sys.time()))
## <bytecode: 0x557a57306070>
## <environment: namespace:base>
```

# Braces/Brackets

## Round brackets: `()`

- Identify functions (even if there are no arguments)

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

```
## [1] "2022-01-28"
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## function ()
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## <bytecode: 0x557a57306070>
## <environment: namespace:base>
```

`()` must be associated with a **function**

(Well, *almost* always)

# Braces/Brackets

## Square brackets: []

- Extract parts of objects

```
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"
```

```
LETTERS[1]
```

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

```
LETTERS[26]
```

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

# Braces/Brackets

## Square brackets: []

- Extract parts of objects

```
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"
```

```
LETTERS[1]
```

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

```
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:**

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

is easier to read than

```
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, 12, 45, 12, 12, 13))
```

### 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!