PSTAT 5LS Lab 2

Professor Miller

July 6, 2023

Section 1

Learning Objectives

R Learning Objectives

1. Learn how to make a frequency table and a two-way frequency table in R
2. Learn how to make a bar chart in R
3. Learn how to find the five-number summary of a variable, and find a specific numeric summary (statistic) in R
4. Learn how to make a histogram in R
5. Learn how to make a boxplot in R
6. Learn how to make side-by-side boxplots in R

Statistical Learning Objectives

1. Understand when to make a bar chart.
2. Understand when to make a frequency/two-way frequency table.
3. Be able to use these graphical summaries to discuss data.
4. Understand when to make a bar chart versus a boxplot or a histogram.
5. Understand when to make a side-by-side boxplot and how to use this type of comparison
6. Understand when to make a frequency/two-way frequency table versus a number summary.
7. Be able to use these graphical and numerical summaries to discuss data.

Functions covered in this lab

1. `table()`
2. `barplot()`
3. `summary()`
4. `hist()`
5. `min()`, `mean()`, `median()`, `max()`, `sd()`, `IQR()`
6. `boxplot()`

Section 2

Lab Tutorial

Penguins data set

We're back to hanging out with our penguin friends.

```
penguins <- read.csv("penguins.csv", stringsAsFactors = TRUE)
```

Notice that we added the additional argument `stringsAsFactors = TRUE` to the `read.csv()` function. This is important because the R default is to NOT do this. We want to be able to distinguish between something called a *string*, which is a phrase or word, and a **factor**, which represents the levels of a categorical variable. Basically, by setting `stringsAsFactors = TRUE`, we are letting R know to expect that any words or phrases in the data actually relate to categorical variables.

Go ahead and run the `loadPenguins` chunk of your `lab2-notes.Rmd` markdown file, and verify that the `penguins` data is in your environment in the top right corner of your RStudio project.

Frequency Tables

Let's start with the `species` variable. Is this a categorical or numeric variable? How do you know?

To make a frequency table of a categorical variable, we use the `table()` function. Try this code out on your `lab2-notes.Rmd` file in the `tryit1` code chunk of your notes file. Recall that code goes **in the middle** of the chunk and not on the first or last line of the chunk.

```
table(penguins$species)
```

```
##
##    Adelie Chinstrap    Gentoo
##       146        68       119
```

Frequency Tables continued

So, there are 119 Gentoo penguins in the data.

Notice that inside the table function, we have something that looks a little weird. We wrote `penguins$species`. This is how we tell R to use the `species` variable **inside the data frame** `penguins`. The dollar sign ($) tells R to look inside the data frame `penguins` for the column called `species`.

Frequency Table Common Error

It's very important that you tell R *which data frame* the variable you're interested in is from. Let's see what happens when we don't:

```
table(species)
```

```
## Error in eval(expr, envir, enclos): object 'species' not fo
```

Notice that we get an error message here, stating that the "object 'species' not found".

Two-Way Frequency Tables (Contingency Tables)

We can also make "two-way" frequency tables (sometimes called "contingency tables") to summarize counts for two categorical variables. Try this in the `tryit2` code chunk in your notes file.

```
table(penguins$species, penguins$island)
```

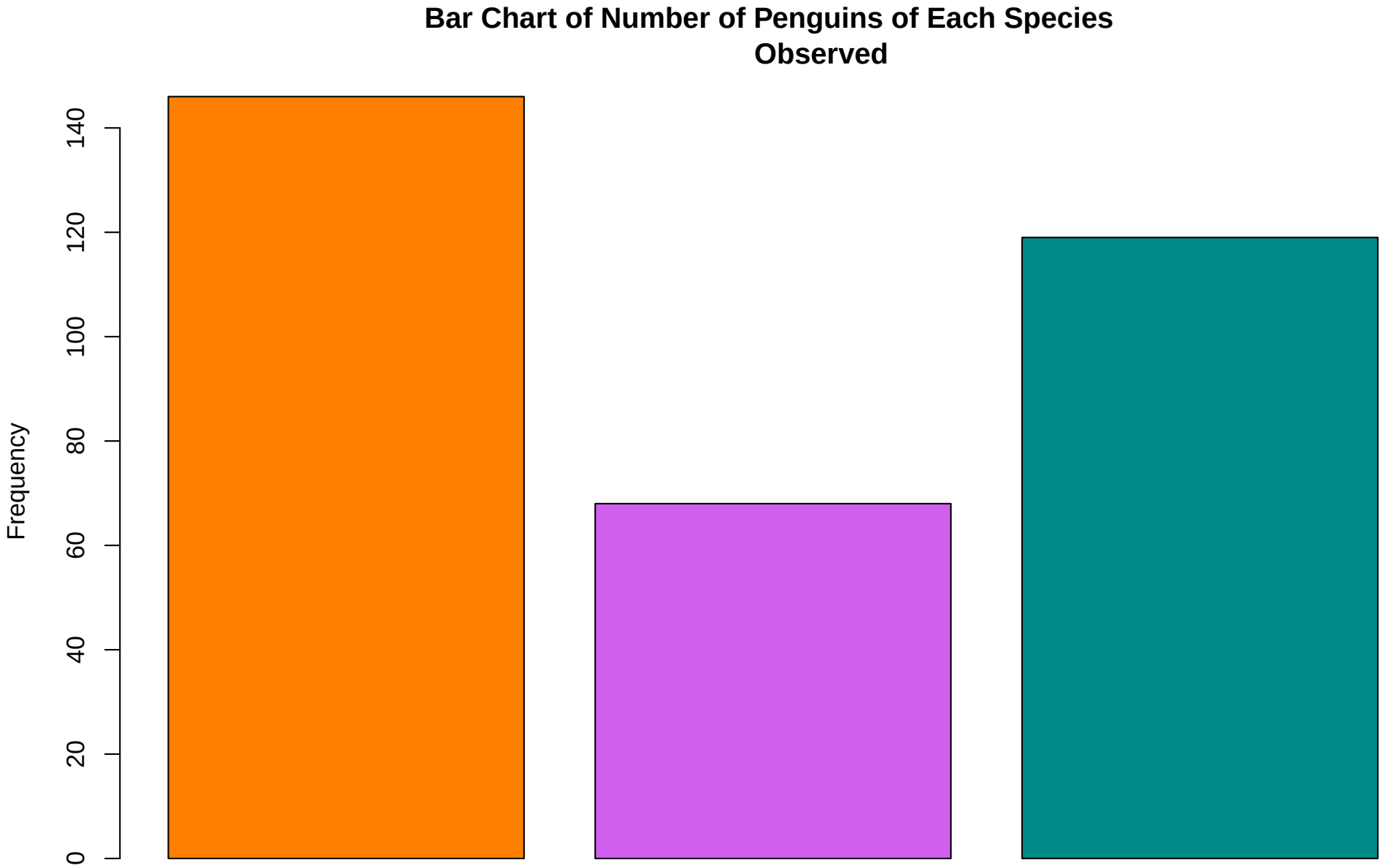
```
##
##                Biscoe Dream Torgersen
##    Adelie          44    55         47
##    Chinstrap        0    68          0
##    Gentoo         119     0          0
```

Data is **R**eally **C**ool, so the first variable you give to `table()` is in the **r**ows of the table, and the second is in the **c**olumns.

Bar Charts in R

Let's explore our `penguins` data by making a plot that will help us visualize a categorical variable. We'll start by looking at the number of penguins observed of each species. We have provided to you the code in the `tryit3` code chunk - all you need to do is run it!

Bar Chart of species in penguins



Bar Chart Code for species in penguins

```
barplot(table(penguins$species),
     xlab = "Species",
     ylab = "Frequency",
     main = "Bar Chart of Number of Penguins of Each Species
            Observed",
     col = c("darkorange1", "mediumorchid2", "darkcyan"))
```

Bar Charts Code for `species` in `penguins` continued

Notice that we included the table from earlier in our code!

Also notice that we included some arguments, such as

- `xlab`, the label on the x (or horizontal) axis
- `ylab`, the label on the y (or vertical) axis
- `main`, the title of the graph, and
- a nice way to add some fun to an otherwise boring plot - `col` for colors. We have three species of penguins, so we picked out three colors that we thought best represented each species. There are lots and lots of colors that you can try. There is a color palette "cheat sheet" from UCSB's own National Center for Ecological Analysis and Synthesis posted on Canvas if you want to check it out.

How to Find Help in R

R has built-in "documentation" for every function. If you want to find that documentation, you can Google it, but that takes too long. So it's better to use R's built in help! In the R console, just type a question mark `?` followed by the name of the function you want help with, then hit enter. For example, `?barplot` will bring up the documentation for the `barplot()` function.

Let's try this in the `tryit4` code chunk in your notes file.

At the end of the help file you *may* find an example of how to use the function. These examples are generally super helpful! You can directly run them using the `example()` function – e.g., `example(barplot)`.

The most useful feature of help in R is a list of a function's arguments and a quick explanation of what each argument does. You may not be able to fully understand some of the terms in the documentation just yet, but try it out and your TA will be able to help!

Numerical Summaries

Let's start with the `flipper_length_mm` variable. Is this a categorical or quantitative variable? How do you know?

We can use R to summarize data numerically. We'll use the `summary()` function to do that for a given variable. Here, we'll summarize the `flipper_length_mm` variable, which is the length of the penguins' flippers (in millimeters). Try this code out on in the `tryit5` code chunk.

```
summary(penguins$flipper_length_mm)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     172     190     197     201     213     231
```

Numerical Summaries

You might have noticed that the `summary()` function doesn't give you the standard deviation of the variable. To get the standard deviation, use the `sd()` function in addition to the `summary()` function.

Summarize the `flipper_length_mm` variable again adding the code to get the standard deviation as well. Try this code out on in the `tryit6` code chunk.

```
summary(penguins$flipper_length_mm)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     172     190     197     201     213     231
```

```
sd(penguins$flipper_length_mm)
```

```
## [1] 14.01577
```

Number Summaries continued

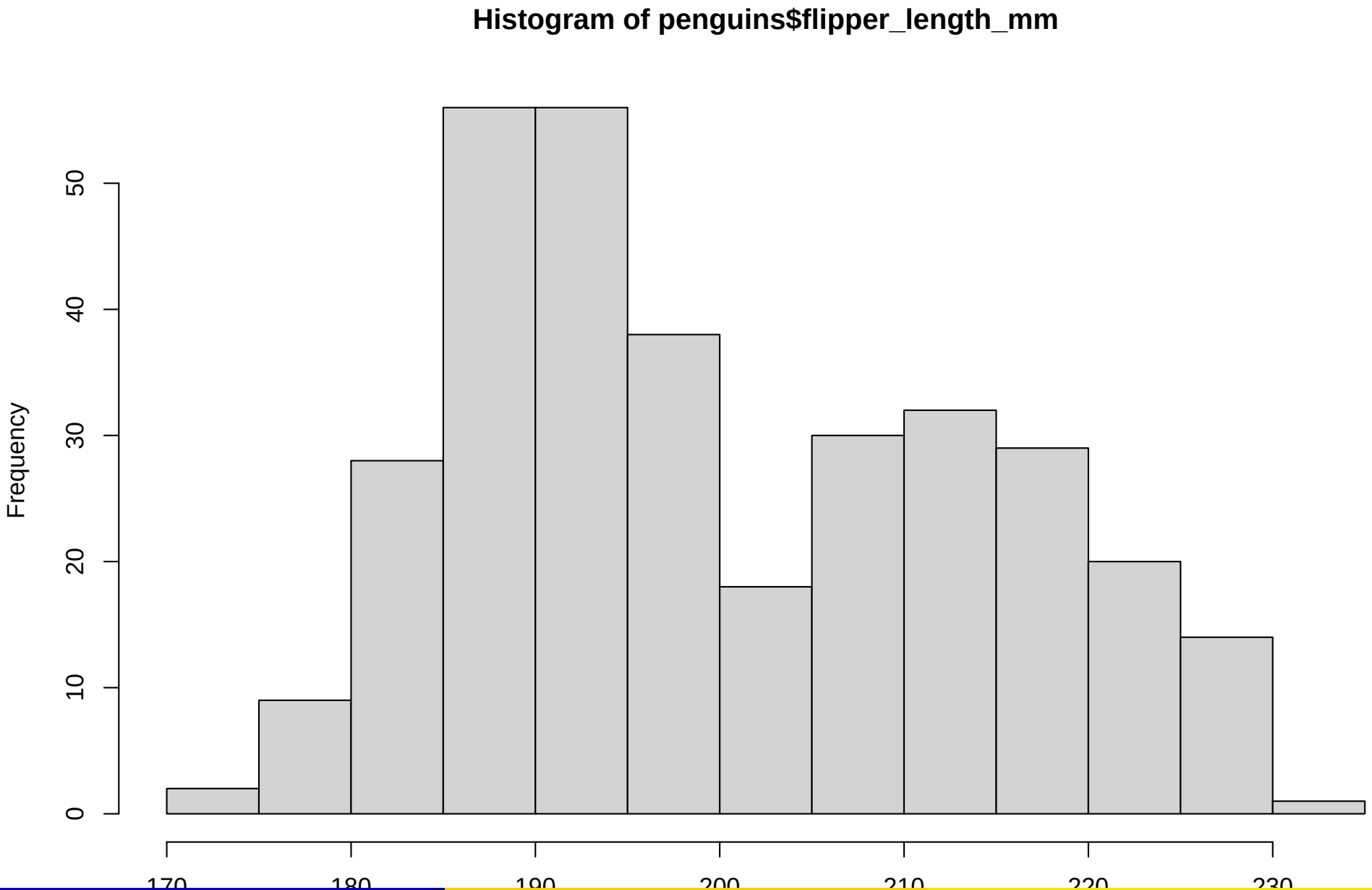
You can always get just the one numerical summary you're looking for using the function for that specific summary. Try these out in the `tryit7` code chunk.

```
min(penguins$flipper_length_mm)
mean(penguins$flipper_length_mm)
median(penguins$flipper_length_mm)
max(penguins$flipper_length_mm)
sd(penguins$flipper_length_mm)
IQR(penguins$flipper_length_mm)
```

Histograms in R

One type of graphical display for a quantitative variable is a histogram. Histograms in R are also pretty easy – you just use the `hist()` function.

Histogram of Flipper Length of Penguins



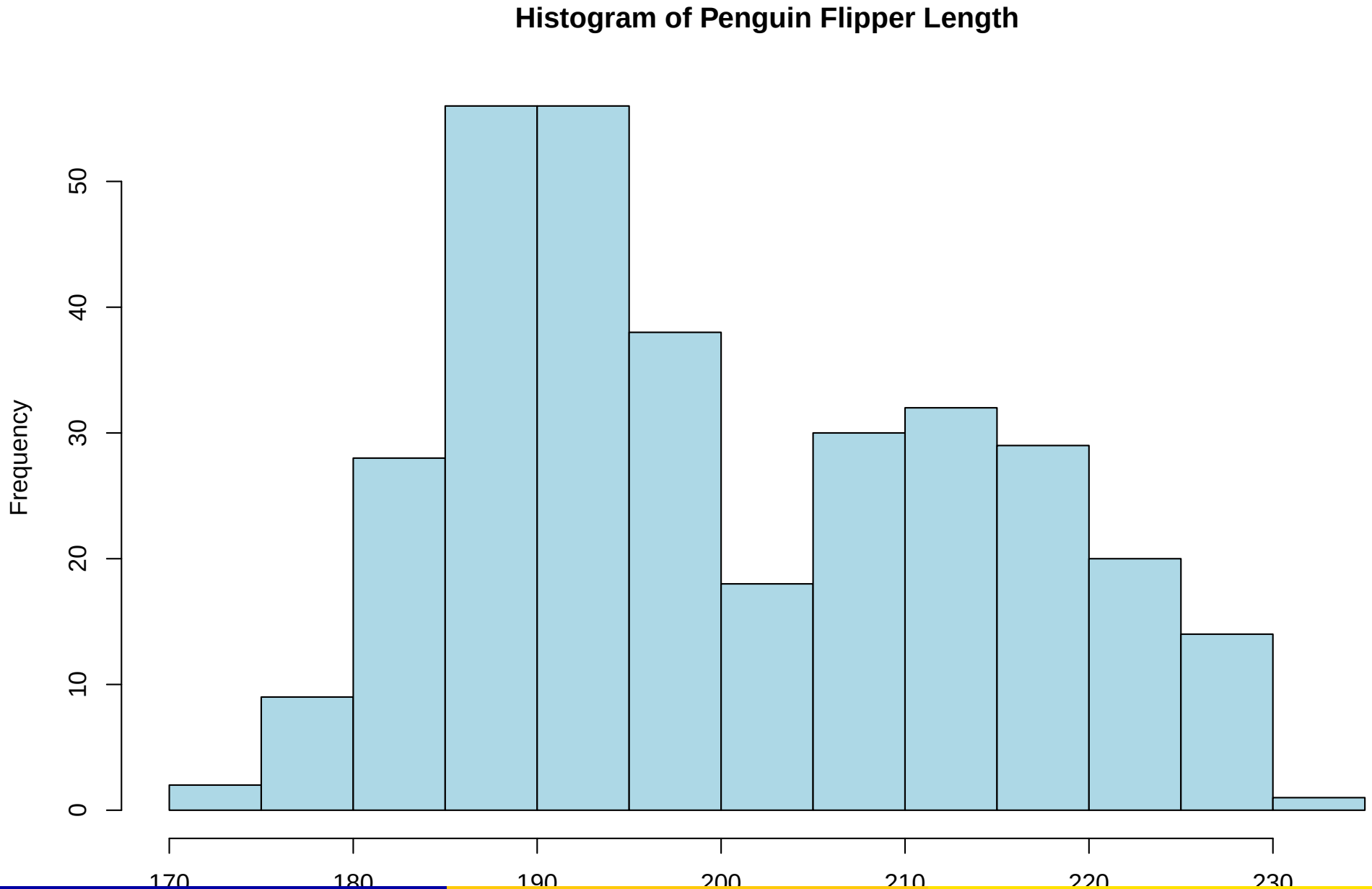
Don't Forget Labels and Titles!

```
hist(penguins$flipper_length_mm)
```

So here we've got a histogram. Notice that we didn't provide the `main`, `xlab`, and `ylab` arguments that we'd normally use for a plot title and an axis label, but R still gave us a title and labels. This is nice, but the labels are *horrible*: nobody (other than you) knows what `penguin$flipper_length_mm` means, so we don't want to use that as a title or axis label.

The moral of the story is to **always provide `main`, `xlab`, and `ylab` arguments when making a plot!**

That Same Histogram with Labels and a Title



Histogram Code

Try this code out in the `tryit8` code chunk. Watch out for the dreaded typos! If you get an error message, try to debug it yourself before asking for help!

```
hist(penguins$flipper_length_mm,
     main = "Histogram of Penguin Flipper Length",
     xlab = "Flipper Length (mm)",
     col = "lightblue")
```

Describing Histograms

Recall from lecture that we describe distributions by addressing four aspects:

1. Shape (number of modes + symmetry or lack thereof)
2. Center
3. Spread/Variability
4. Outliers

A handy mnemonic to remember what to comment about is **SOCS**:

Shape **O**utliers **C**enter **S**pread

Note: Be sure to mention whether there are or are not outliers. Not saying anything doesn't let us know that you know to check for outliers.

Describing Histograms

Describe the distribution of flipper lengths.

Describing Histograms

Do you think that the mean is the best measure of center? Why or why not?

Describing Histograms

Describe the spread (variability) of the distribution of flipper length.

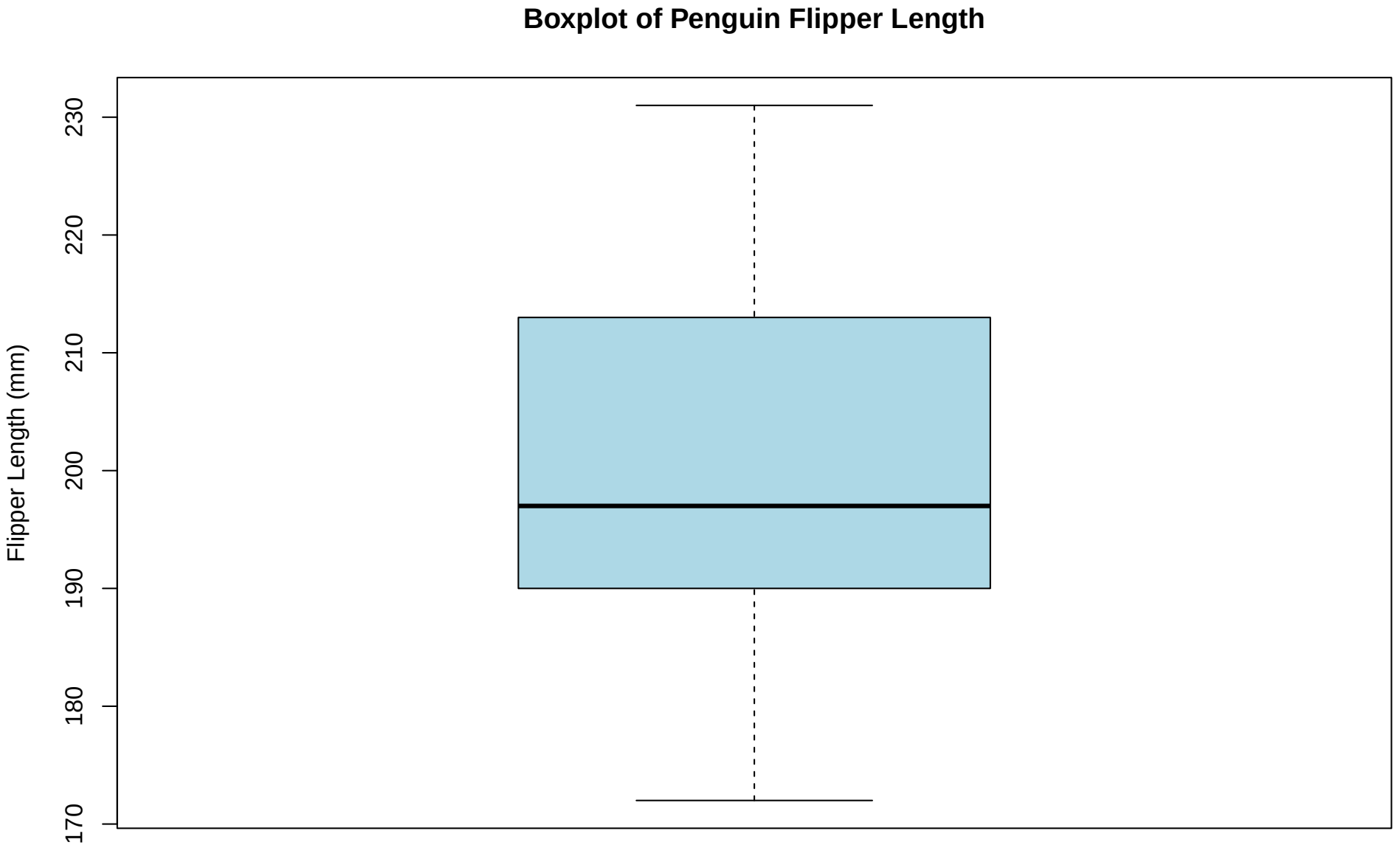
Describing Histograms

Are there any outliers or other unusual features that you'd like to mention about the distribution of flipper length?

Boxplots in R

Another type of graphical display for a quantitative variable is a boxplot. The command for making a boxplot in R is pretty simple: it's just `boxplot()`. To make a boxplot of a single variable, just give R the name of the data set, a dollar sign ($), then the name of the variable. Also provide the arguments `main` and `ylab` for a plot title and y-axis label.

Boxplot of the Flipper Length of Penguins



Code for the Boxplot of the Flipper Length of Penguins

Try this code out yourself in the `tryit9` code chunk. Watch out for the dreaded typos! If you get an error message, try to debug it yourself before asking for help!

```
boxplot(penguins$flipper_length_mm,
        main = "Boxplot of Penguin Flipper Length",
        ylab = "Flipper Length (mm)",
        col = "lightblue")
```

Describing Boxplots

True or False:

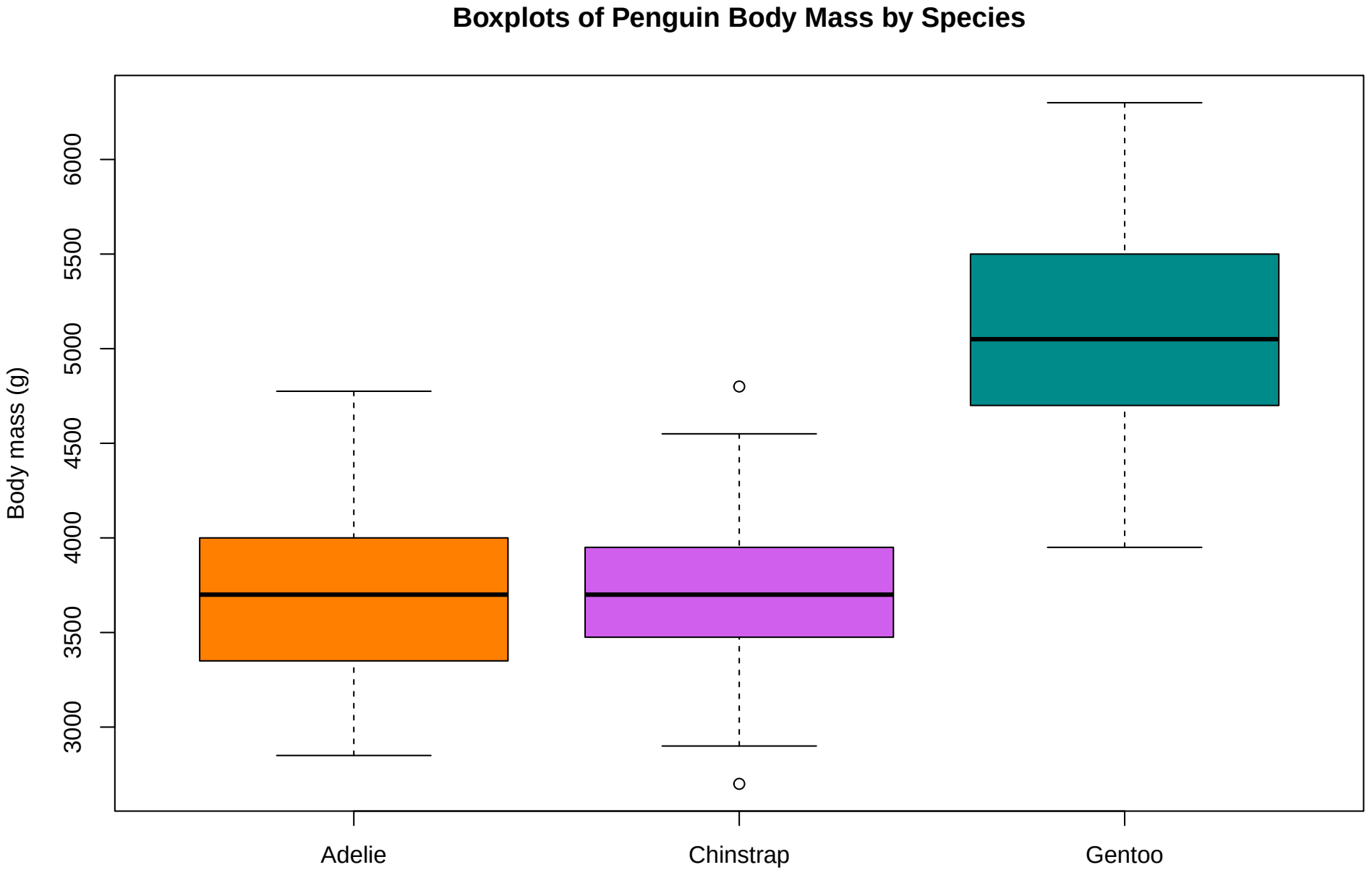
The boxplot of flipper lengths appears to be unimodal and symmetric.

Side-by-side Boxplots

Sometimes we're interested in comparing two or more groups using "side-by-side" boxplots. We can compare the different species of penguins' body masses in this way, still using the `boxplot` function. We have provided the code in the `tryit10` code chunk.

```
boxplot(penguins$body_mass_g ~ penguins$species,
        main = "Boxplots of Penguin Body Mass by Species",
        ylab = "Body mass (g)",
        xlab = "Species",
        col = c("darkorange1", "mediumorchid2", "darkcyan"))
```

Side-by-side Boxplots Continued



Penguin Body Mass By Species

Does it appear that a penguin's body mass is affected by its species, for the penguins in Palmer Archipelago? Why or why not?

Another Way to Code Side-by-side Boxplots

Another way to get the same side-by-side boxplots the to specify the variables themselves and adding in the code `data = penguins`.

It's up to you which of the two ways to specify the variables you use. We all have different things we prefer in coding. Try out some different options to find your style!

```
boxplot(body_mass_g ~ species, data = penguins,
        main = "Boxplots of Penguin Body Mass by Species",
        ylab = "Body mass (g)",
        xlab = "Species",
        col = c("darkorange1", "mediumorchid2", "darkcyan"))
```

Another Side-by-side Boxplot

Now, in the `tryit11` code chunk, you will make a side-by-side boxplot of the numeric variable `flipper_length_mm` by the categorical variable `island` in the `penguins` data.

Another Side-by-side Boxplot