Volpe R Course: Session 4, Communicating Results

Instructors: Don Fisher, Dan Flynn, Jessie Yang
Course webpage: `http://bit.ly/volpeR`

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Overview

Last session:

- Data exploration
  - Aggregation
  - Merging and Matching

Today: Communicating results

- Regular expression review
- Basic graphics
- `ggplot2` package
- Basic analysis

Regular expressions

Quick digression to review material from last session!

The use of `sub` above is an example of *regular expression*. These are very flexible and form the basis for all search engines. In R, there are number of ways to use regular expressions, with `grep` and `sub` being two of the most common ones. `regexpr` also provides additional options for those familiar with Perl or Python.

```
text1 <- c("Testing", "matching ", " and substitutions")

grep("testing", text1, ignore.case = TRUE) # Pattern matching

sub(" +$", "", text1) # find and replace trailing whitespace
grep("^ ", text1) # find elements which start with a whitespace
grep("^[A-Z]", text1) # find elements which start with a capital letter
```

Homework review

We will review example solutions to the homework assignments here

Make summary tables using `aggregate` and other functions

Make a subset using `grep`

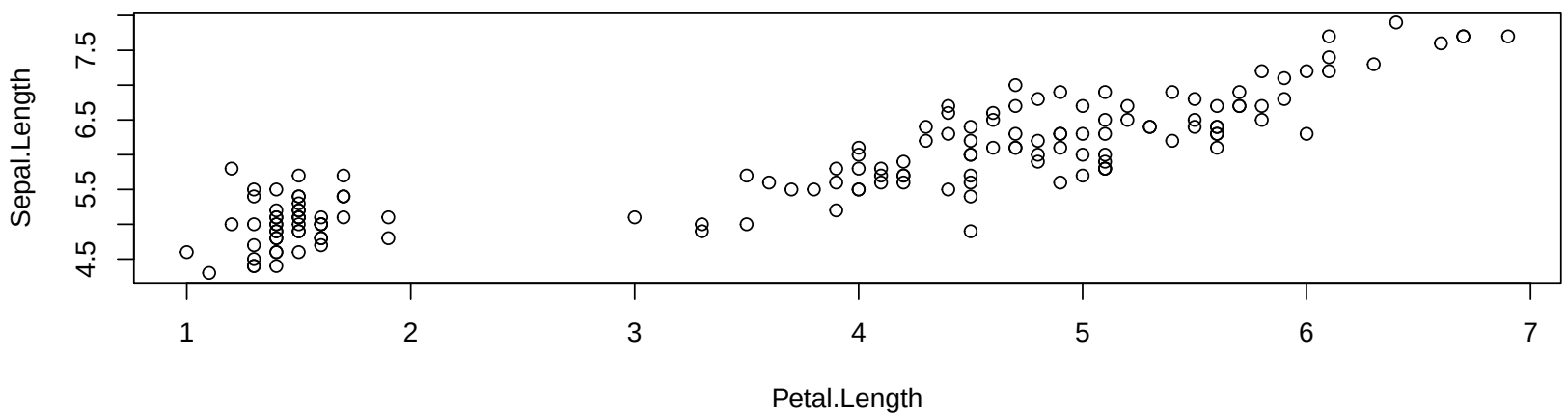
Use `merge`

Basic graphics

You have already seen the power of `plot()` in examples. We have used it to make scatterplots, but also to make diagnostic plots of linear models. When in doubt, you can always try to `plot()` an object and R will make a guess about what kind of plot you want.

Example:

```
data(iris) # see ?iris

# Formula (y ~ x) versus (x, y) specification
plot(Sepal.Length ~ Petal.Length, data = iris)
```

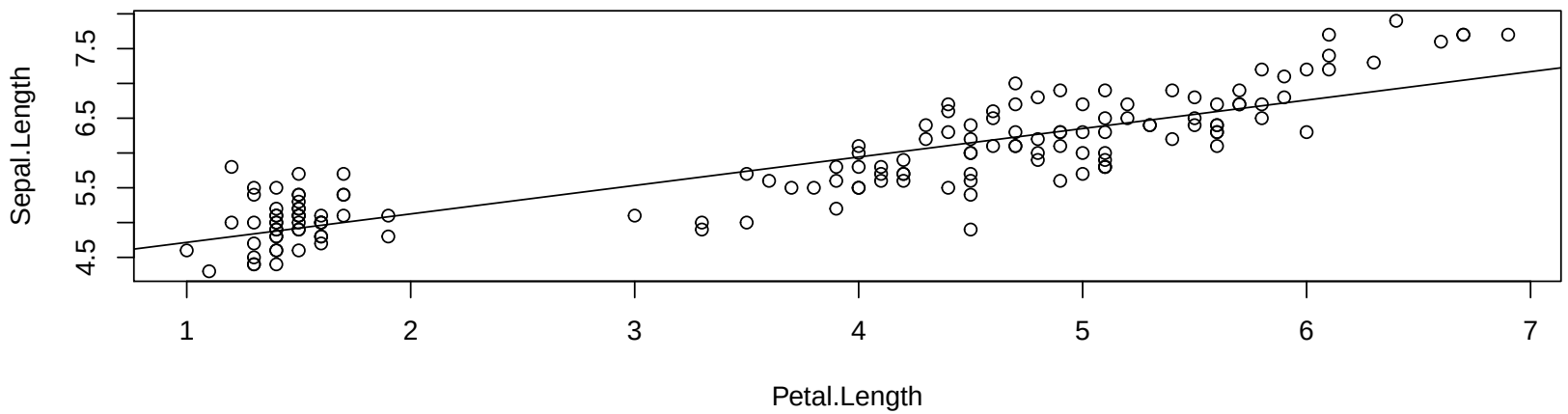



```
plot(iris$Petal.Length, iris$Sepal.Length) # identical
```

Basic graphics (plus some analysis)

You frequently want to analyze what the trend of the data is statistically, not just graphically. We can use a simple linear model and plot the result using `lm()`:

```
plot(Sepal.Length  ~ Petal.Length, data = iris)

summary(linmod <- lm(Sepal.Length ~ Petal.Length, data = iris))

abline(linmod)
```



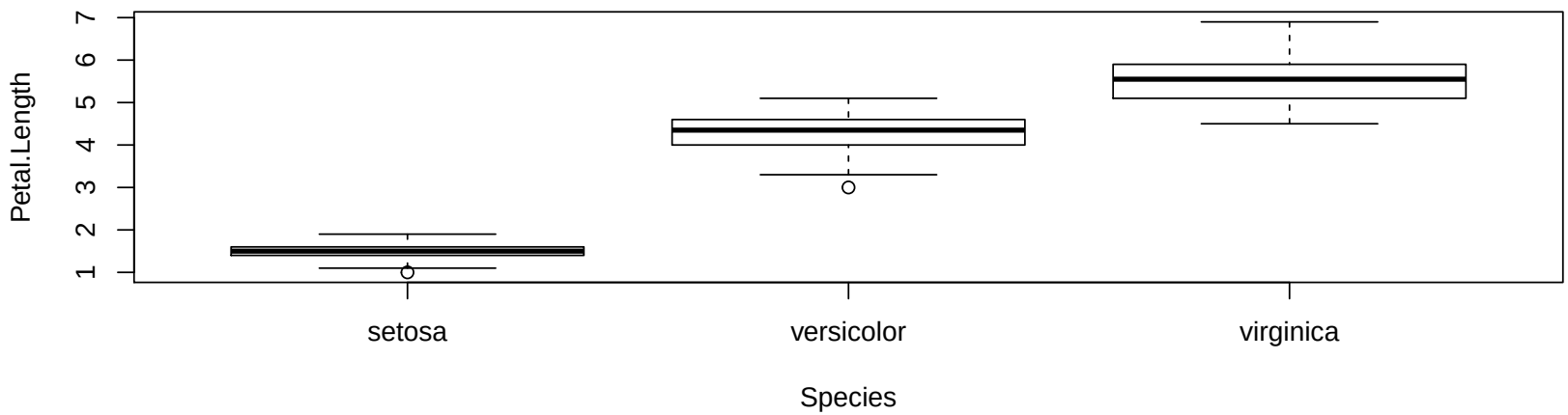
Interpretation:

What is the slope of this line? How would you interpret it?

Basic graphics (plus some analysis)

We have often looked at boxplots for categorical data. The analysis that corresponds to a simple boxplot is an "Analysis of Variance" or ANOVA. In R, you can do this analysis with the aov function:

```
plot(Petal.Length ~ Species,
     data = iris)
```




```
summary(aovmod <- aov(Petal.Length ~ Species, data = iris))
coef(aovmod)
```

Interpretation:

What is the model estimate for the mean value of *Iris versicolor* petal lengths?

Basic graphics

Back to graphics! The power of the base graphics package in R is control of each element of the plot. The challenge is knowing how to exercise that control.

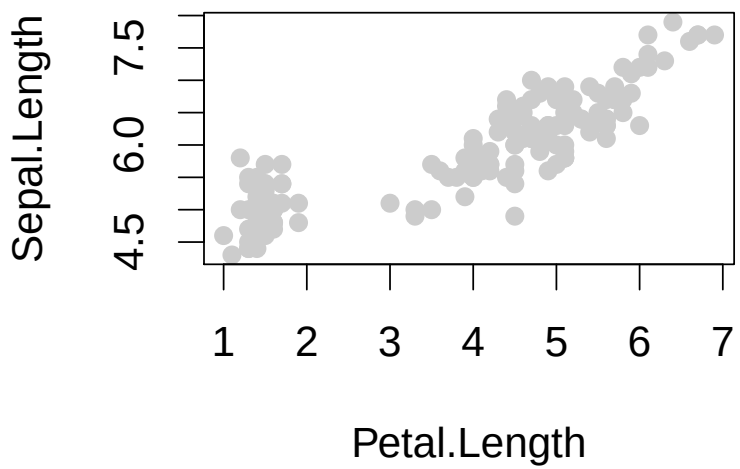
`par()` sets graphics parameters and contains much of what you want to do. Highlights from `par`:

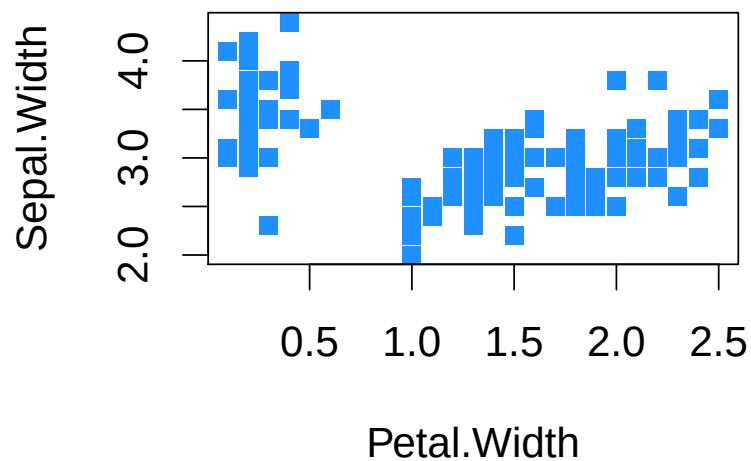
```
mfrow - matrix format. Set to c(1, 2) for two panel figure, adjacent
pch   - plotting character.
lty   - line type. Try lty = 2 or lty = 3
cex   - character expansion. Very useful for making symbols more visible
mar   - margins. Set to mar = rep(1, 4) for narrow margins all around.
col   - colors, see colors() for full list or
www.nceas.ucsb.edu/~frazier/RSpatialGuides/colorPaletteCheatsheet.pdf)
```

`?par` for the full list.

Basic graphics

```
par(mfrow = c(1, 2),
    pch = 16,
    cex = 1.5) # makes everything bigger

plot(Sepal.Length ~ Petal.Length,
     col = "grey80",
          data = iris)

plot(Sepal.Width ~ Petal.Width,
     col = "dodgerblue",
     pch = 15, # can override par settings
          data = iris)
```

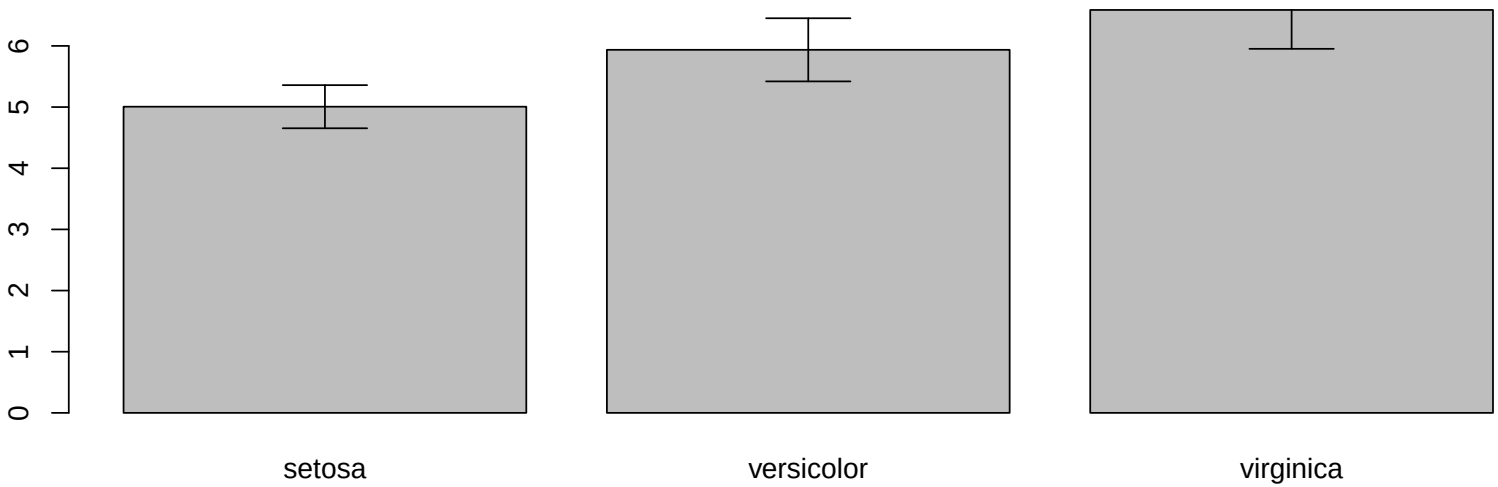




Basic graphics

`barplot()` can be used to create a bar chart, but it is a bit clunky to add error bars. Basic workflow:

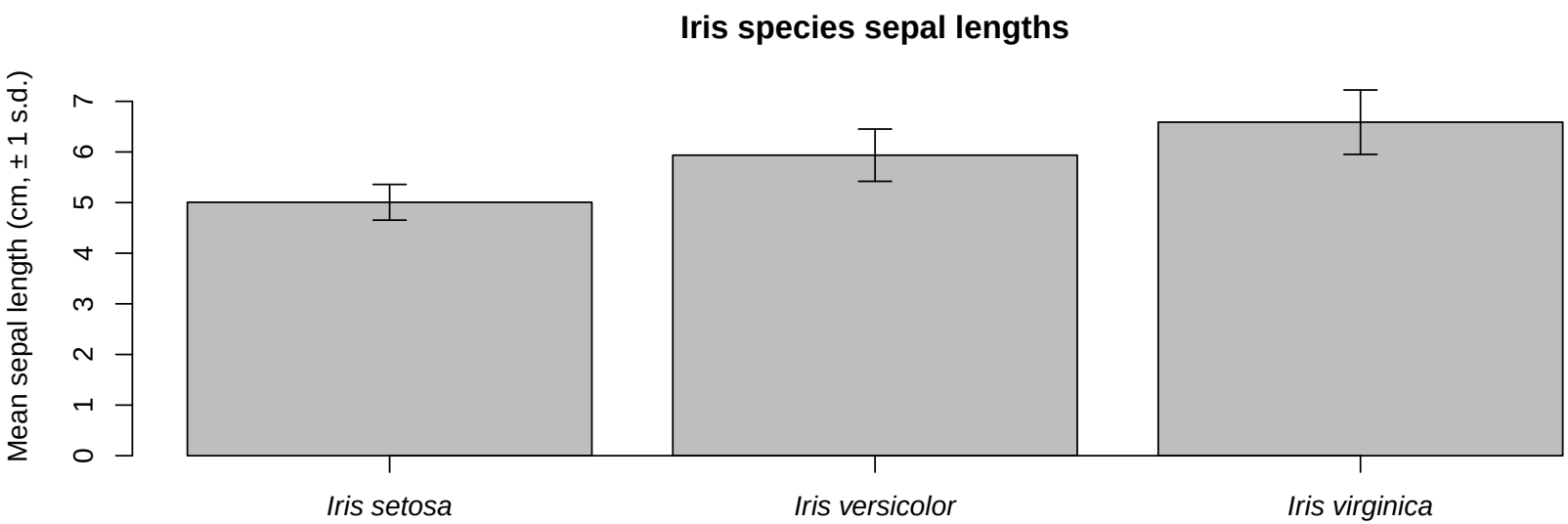
```
means <- tapply(iris$Sepal.Length, iris$Species, mean)
sds <-  tapply(iris$Sepal.Length, iris$Species, sd)

# save the location of the bars as 'bp'
bp <- barplot(means)

arrows(bp, means+sds, # see ?arrows
       bp, means-sds,
       angle = 90,
       code = 3)
```



Basic graphics

Improve a graphic by ensuring that there are clear labels (`arrows` code not shown).

```
par(mar = c(3, 4, 3, 1)) # Narrowing margins
bp <- barplot(means,
              ylab = "Mean sepal length (cm, ? 1 s.d.)",
              main = "Iris species sepal lengths",
              xaxt = "n", # suppress axis plotting here
              ylim = c(0, 7.5))

axis(side = 1, at = bp,
     labels = paste("Iris", c("setosa", "versicolor","virginica")),
     font = 3)
```



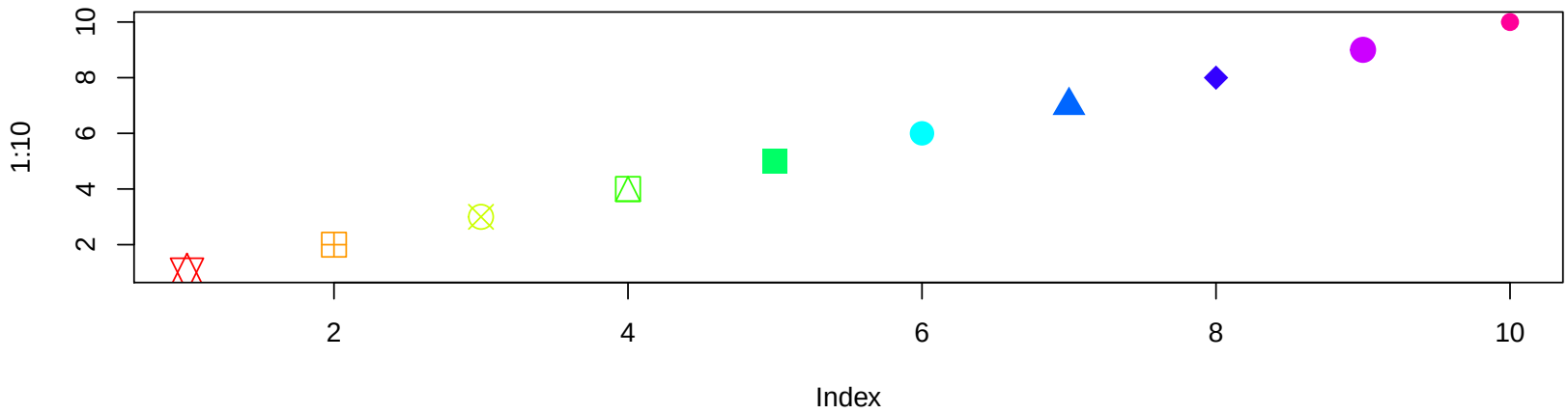
Basic graphics

Save your graphics typically as pdf or jpeg. You can do this by putting `pdf()` and `dev.off()` around your code, or by using `dev.print()`.

```
pdf("Test graphic.pdf", width = 4, height = 6)
plot(1:10, pch = 1:10, col = 1:10, cex = 2)
dev.off()
```

```
## pdf
##   2
```

```
plot(1:10, pch = 11:20, col = rainbow(10), cex = 2)
```

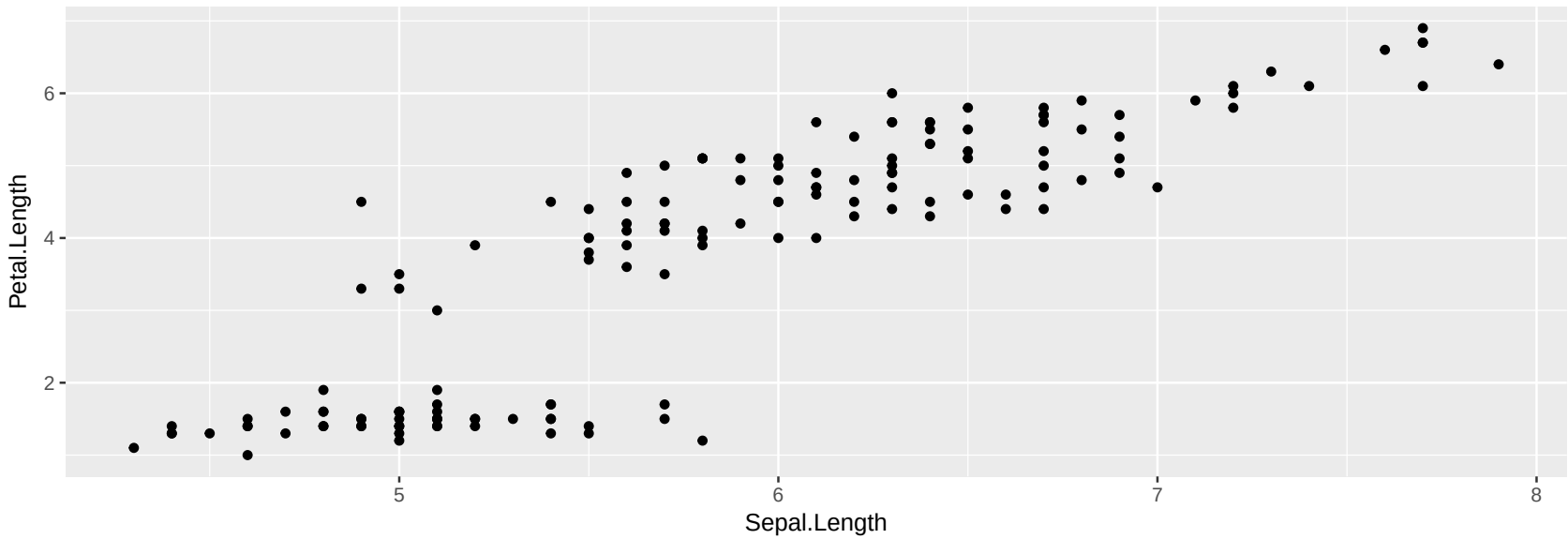



```
dev.print(device = jpeg, file = "Test graphic.jpg", height = 500, width = 800)
```

ggplot graphics

A different model of graphics has recently become popular. `ggplots` use a different 'grammar' of graphics, and can be great for quickly making visually-appealing graphics. Mastering the control of each element can take time.

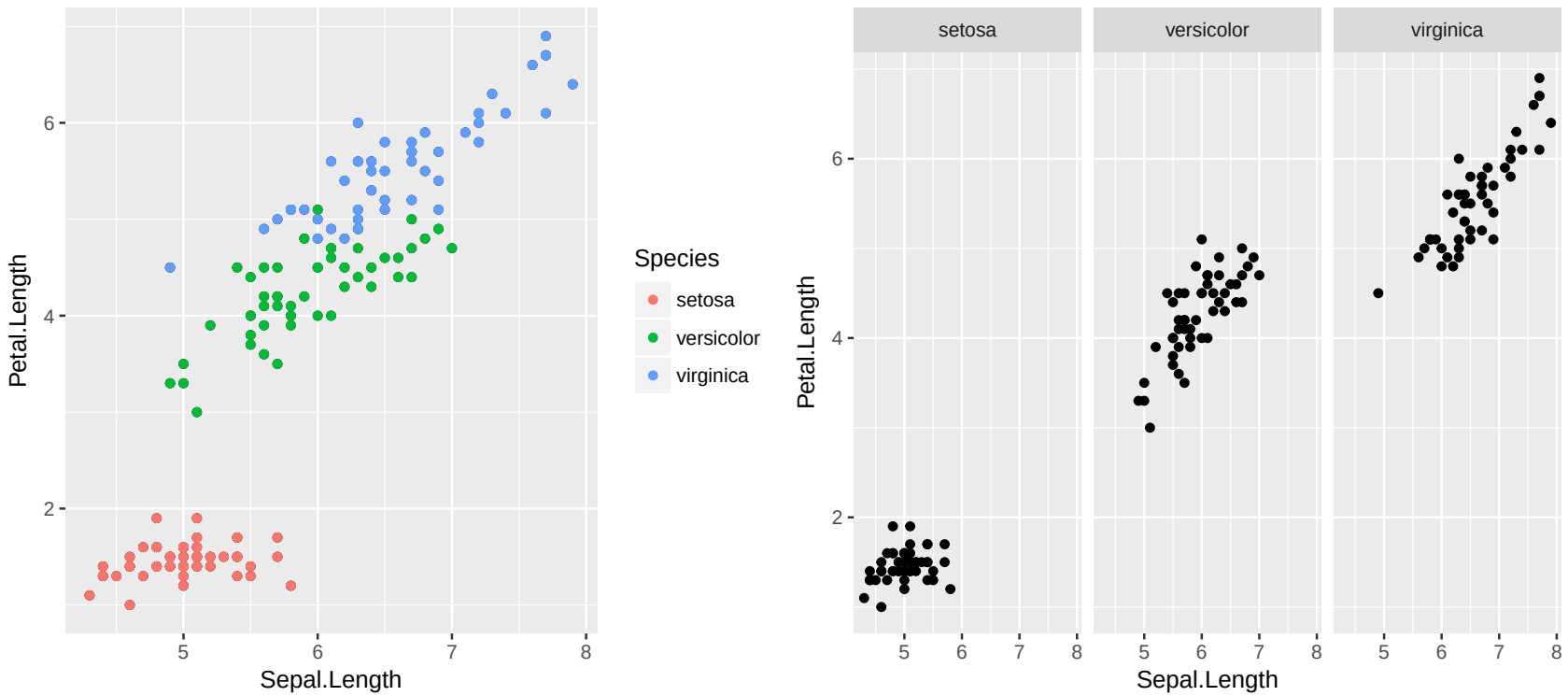
```
library(ggplot2) # install.packages('ggplot2')
#       Dataset                x                y          type of plot
gp1 <- ggplot(iris) + aes(Sepal.Length, Petal.Length) + geom_point()

gp1
```



ggplot graphics

You can use one basic graph data set and do different versions of it. Two ways of visualizing a factor grouping:

```
gp1 + geom_point(aes(color = Species))
gp1 + facet_wrap(~ Species)
```



Interactive

These can be made interactive in an HTML document using `plot.ly`. See `https://plot.ly/r/` if interested in trying this! You will need to download several packages, so this code will not work for you immediately:

```
library(plotly)
ggplotly(ex1)
```

Tables in R

Carrying out any analysis in R generates a lot of tables. A few options:

- Copy and paste
- Sink
- Save to text file

Simplest is copy and paste from the console window into Excel, then use text-to-columns. But not repeatable!

Tables in R

You can 'sink' your output to a text file. First, set up all your analysis, then put `sink()` before and after your block of code.

```
sink("Test Sink.txt")
with(iris, cor.test(Sepal.Width, Petal.Width))
table(iris$Species)
sink()
```

Or, more commonly, output a data frame to a text file directly:

```
write.csv(iris[1:10,], file = "Iris Test.csv", row.names = F)
```

R Markdown

A better way for writing a report is to take advantage of the relatively recent tool, R Markdown. A few resources:

`http://rmarkdown.rstudio.com/`
`http://rmarkdown.rstudio.com/authoring_quick_tour.html`

Go to File > New File ... > R Markdown

Select HTML or Word as the default output, and then try clicking 'knit'.

You may need to `install.packages("rmarkdown")`

Homework review: Outliers

Time permitting, we will go back to the Hubway data and examine the question of outliers

We will review `tripduration` outliers from the Hubway data.