STAT 215A Fall 2020
Week 1

James Duncan

I stand on the shoulders of giants!

Thanks to Becca, Zoe, and Tiffany and other past GSIs for their hard work.

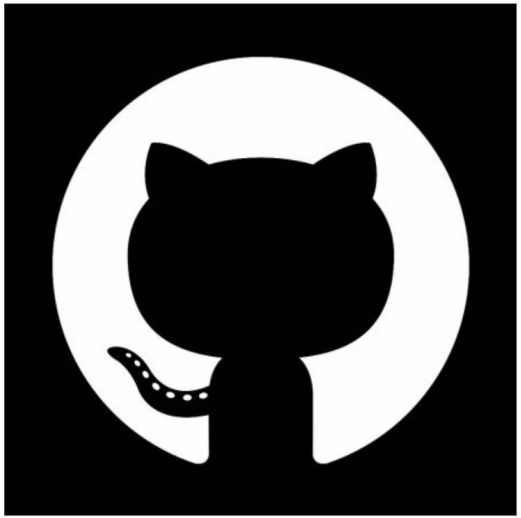
Slides on bCourses and GitHub

- https://github.com/jpdunc23/stat-215a-fall-2020

Breakout, ~5 minutes

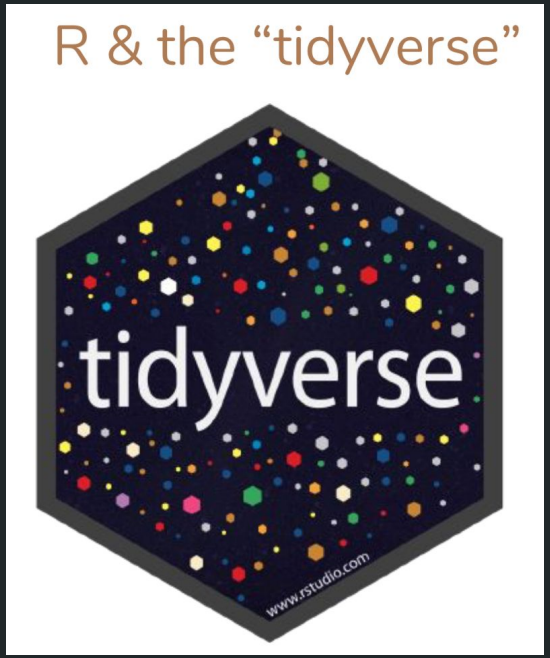
- Different breakout groups for lab than lecture
- Introduce yourself to your neighbors
  - Name, major, year
  - What did you do this past summer?
- Create Slack channels, exchange emails, set up coffee chats

Git & Github



- Git basics
- Set up GitHub repos

R & the “tidyverse”

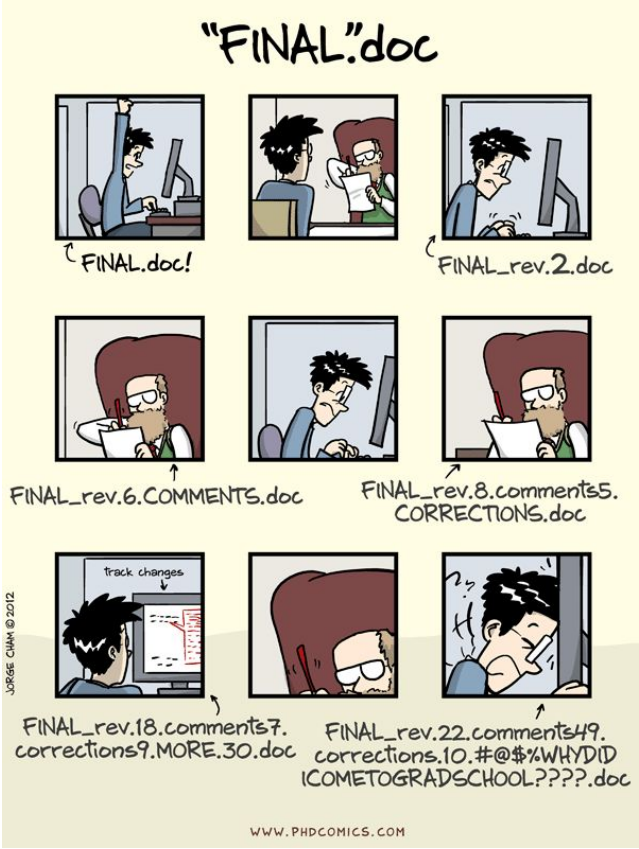


- R Markdown and knitr
- Tidyverse intro

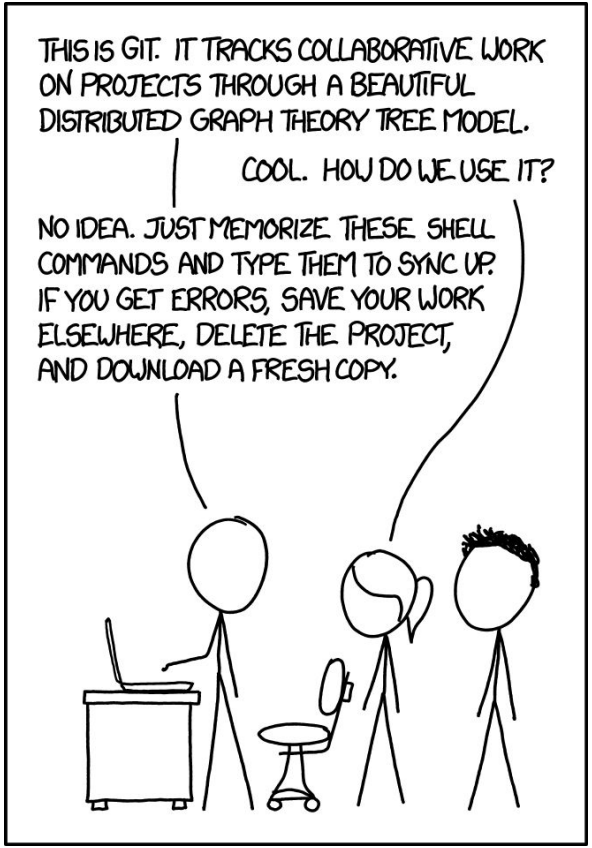
So, what is git?

- A version control system
- Stores data as a series of snapshots
- If files have not changed, it will simply access the file from a previous commit instead of saving it again
- Allows access to all the committed steps along the way

The problem



The solution



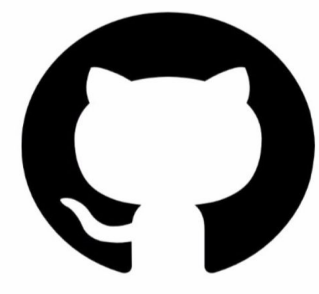
Git vs. GitHub

Local Git Repository

- You have a local version of the folder on your computer
- History stored in .git file
- Only you can see the changes made in the local version

Remote GitHub Repository

- On the GitHub website lives a remote version of the folder
- Everyone can see these changes (if repository is public)



Why is this important?

- Imagine working on a project with several collaborators...
- Using Git/GitHub allows everyone to have their own local version of the project while still maintaining a “master” version of the project, hosted remotely on GitHub
- You can make changes freely without people seeing what you are doing
    - You can thoroughly test your changes before adding to the master copy
- Version control!!
    - Especially great if your changes create bugs because you can backtrack/revert

Typical Pipeline

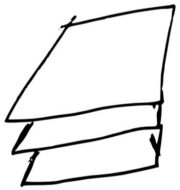
(1) git pull

(to retrieve the most recent version from the server)

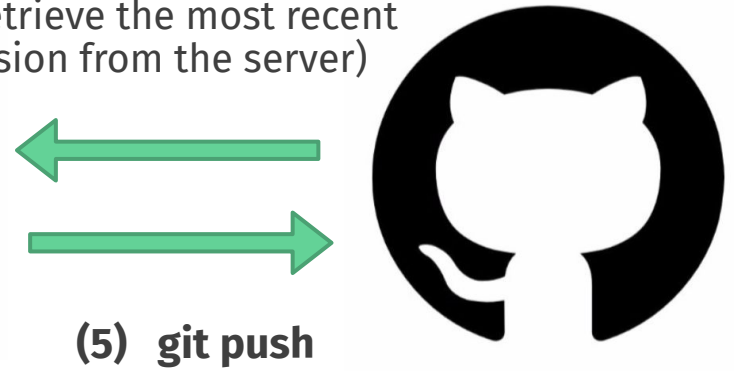
Remote Repository

(2) make local changes

(e.g. create file called filename.txt)



Local Repo



(3) git add filename.txt

(4) git commit -m “add description”

(add and commit when you have made some changes and want to be able to save your current checkpoint as a snapshot)

(5) git push

(make changes available to everyone with access to the repo)

Warning: Good idea to `git pull` before you `git push` and then you may have to mitigate any merge conflicts.

Time to set up your GitHub repos...

Before class, hopefully you:

1. Installed Git on your system (https://git-scm.com/book/en/v2/Getting-Started-Installing-Git)

2. Signed up for GitHub (https://github.com/)

3. ~~Went to https://education.github.com/students and signed up for the student pack to get unlimited private repositories via GitHub Pro.~~

   As of January 2019, GitHub allows unlimited private repos for individuals (but you can still get lots of benefits from the GitHub Student Developer Pack: https://education.github.com/pack).

Setting up your GitHub repo

4. Locally on your machine, open a terminal and change directories to where you want to keep class materials

5. Clone my stat-215-a repository: **git clone https://github.com/jpdunc23/stat-215-a** This will create a copy of my repository on your own computer

```
james@james-HP-Spectre-x360  ~  git clone https://github.com/jpdunc23/stat-215-a
```

6. On the GitHub website, log in and create a **private** remote repository called **stat-215-a**. Add me (**jpdunc23**) as a collaborator for this repository (check out settings on the repo website).

Setting up your GitHub repo

7. Back in the terminal, change directories to your local stat-215-a folder: **cd ./stat-215-a**

8. Set the origin of your local repo to be the remote repo that you just made: **git remote set-url origin https://github.com/USERNAME/stat-215-a.git** (change USERNAME to your username). This tells git which remote repository to push your changes to when you use git push.

```
james@james-HP-Spectre-x360  ~  cd ./stat-215-a
james@james-HP-Spectre-x360  ~/stat-215-a  git remote set-url origin https://github.com/jpdunc23/stat-215-a.git
```

9. Edit *info.txt* to reflect your own information.

Setting up your GitHub repo

10. Now we need to push the changes you made to your remote repo:

    a. In terminal, type **git status** and you should see that *info.txt* has been modified:

```
 james@james-HP-Spectre-x360  ~/stat-215-a  master ●  git status
On branch master
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
        modified:   info.txt
```

    b. Add (**git add info.txt**) and commit (**git commit -m "Updated info.txt with my own information"**) your edited *info.txt* file.

```
 james@james-HP-Spectre-x360  ~/stat-215-a  master ●  git add info.txt
 james@james-HP-Spectre-x360  ~/stat-215-a  master +  git status
On branch master
Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
        modified:   info.txt

 james@james-HP-Spectre-x360  ~/stat-215-a  master +  git commit -m"Updated info.txt with my own information"
[master 01b9350] Updated info.txt with my own information
 1 file changed, 1 insertion(+)
```

    c. Finally, use **git push** to send your changes to the remote repo on GitHub

5 min break


tidyverse
www.rstudio.com

R Tidyverse


dplyr
ggplot2
forcats
TIBBLE
tidyr
readr
stringr
purrr

Tidy Data is at the core of the Tidyverse

1. Each variable forms a column
2. Each observation forms a row
3. Each type of observational unit forms a table

For more on tidy data: http://vita.had.co.nz/papers/tidy-data.pdf

For an introduction to R and tidyverse: https://r4ds.had.co.nz/

Nice resource: http://www.rebeccabarter.com/tutorials/

For more advanced topics in R: https://adv-r.hadley.nz/

If you ever run into questions or need help with R: Google and StackOverflow are your friend

Tidyverse is great, but not perfect: https://github.com/matloff/TidyverseSkeptic


dplyr
dplyr.tidyverse.org

dplyr: “Grammar of data manipulation”

- Contains functions for manipulating variables in a data frame or tibble:
  - **filter()**: find rows where a specified condition is true.
  - **select()**: keep or remove certain variables / features.
  - **rename()**: for renaming columns.
  - **mutate()**: modifying/creating new columns.
  - **group_by()**: change the scope of each function from operating on the entire dataset to operating on subgroups.
  - **summarize()**: reduces multiple values down to a single summary.
  - **arrange()**: order rows in a data frame using specific column(s).
- The first argument of each function is a data frame (or tibble)
- The result is always a new data frame (or tibble).

dplyr: Piping operator (%>%)

- Pronounce “%>%” as “then”
- Piping is a way of chaining together functions so that you don’t have to keep redefining variables.
- Piping always puts the object being piped into the first argument of the function:

Piping

```
> iris %>%
+   group_by(Species) %>%
+   summarise(n = n())
# A tibble: 3 x 2
  Species        n
  <fct>      <int>
1 setosa        50
2 versicolor    50
3 virginica     50
```

No Piping

```
> iris_by_species <- group_by(iris, Species)
> summarise(iris_by_species, n = n())
# A tibble: 3 x 2
  Species        n
  <fct>      <int>
1 setosa        50
2 versicolor    50
3 virginica     50
```

dplyr::filter()

- Finds rows where the specified condition is true
- Ex. Extract observations corresponding to the species “versicolor”

Piping + Filter

```
> iris %>%
+   filter(Species == "versicolor") %>%
+   head()
  Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
1          7.0         3.2          4.7         1.4 versicolor
2          6.4         3.2          4.5         1.5 versicolor
3          6.9         3.1          4.9         1.5 versicolor
4          5.5         2.3          4.0         1.3 versicolor
5          6.5         2.8          4.6         1.5 versicolor
6          5.7         2.8          4.5         1.3 versicolor
```

Base R

```
> head(iris[iris$Species == "versicolor", ])
   Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
51          7.0         3.2          4.7         1.4 versicolor
52          6.4         3.2          4.5         1.5 versicolor
53          6.9         3.1          4.9         1.5 versicolor
54          5.5         2.3          4.0         1.3 versicolor
55          6.5         2.8          4.6         1.5 versicolor
56          5.7         2.8          4.5         1.3 versicolor
```

- See also filter_all(), filter_if(), and filter_at()

dplyr::select() and dplyr::rename()

- select(): keep certain variables, or remove certain variables
- rename(): rename columns
- Ex. Get Sepal.Length and Sepal.Width columns and rename to Length and Width, respectively

Piping + select + rename

```
> iris %>%
+   select(Sepal.Length, Sepal.Width) %>%
+   rename(Length = Sepal.Length,
+          Width = Sepal.Width) %>%
+   head()
  Length Width
1    5.1   3.5
2    4.9   3.0
3    4.7   3.2
4    4.6   3.1
5    5.0   3.6
6    5.4   3.9
```

Base R

```
> iris_sepal <- iris[, c("Sepal.Length", "Sepal.Width")]
> colnames(iris_sepal) <- c("Length", "Width")
> head(iris_sepal)
  Length Width
1    5.1   3.5
2    4.9   3.0
3    4.7   3.2
4    4.6   3.1
5    5.0   3.6
6    5.4   3.9
```

- See also select_all(), select_if(), select_at(), rename_all(), rename_if(), rename_at(), but note that scoped verbs have been superseded by the newer across().

dplyr::select_if()

- select_if(): keep or remove certain variables if a condition holds
- Ex. Get numeric columns only

```
> iris %>%
+   select_if(is.numeric) %>%
+   head()
  Sepal.Length Sepal.Width Petal.Length Petal.Width
1          5.1         3.5          1.4         0.2
2          4.9         3.0          1.4         0.2
3          4.7         3.2          1.3         0.2
4          4.6         3.1          1.5         0.2
5          5.0         3.6          1.4         0.2
6          5.4         3.9          1.7         0.4
```

Note: scoped verbs (ending with **_if()**, **_at()**, and **_all()**) have been superseded by the use of **across()**.

dplyr::mutate()

- Create new variables consisting of functions of existing variables.
- Ex. Create a new variable which is the sum of the Sepal Length and Sepal Width

Piping + mutate

```
> iris %>%
+   mutate(Sepal.Sum = Sepal.Width + Sepal.Length) %>%
+   head()
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species Sepal.Sum
1          5.1         3.5          1.4         0.2  setosa       8.6
2          4.9         3.0          1.4         0.2  setosa       7.9
3          4.7         3.2          1.3         0.2  setosa       7.9
4          4.6         3.1          1.5         0.2  setosa       7.7
5          5.0         3.6          1.4         0.2  setosa       8.6
6          5.4         3.9          1.7         0.4  setosa       9.3
```

Base R

```
> iris$Sepal.Sum <- iris$Sepal.Width + iris$Sepal.Length
> head(iris)
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species Sepal.Sum
1          5.1         3.5          1.4         0.2  setosa       8.6
2          4.9         3.0          1.4         0.2  setosa       7.9
3          4.7         3.2          1.3         0.2  setosa       7.9
4          4.6         3.1          1.5         0.2  setosa       7.7
5          5.0         3.6          1.4         0.2  setosa       8.6
6          5.4         3.9          1.7         0.4  setosa       9.3
```

- See also mutate_all(), mutate_if(), and mutate_at(), but note that scoped verbs have been superseded by the newer across().

dplyr::mutate_at()

- Mutate at existing variables via some function
- Ex. Multiply each of Sepal.Length and Sepal.Width by 2

```
> iris %>%
+   mutate_at(vars(contains("Sepal")), list(~ 2 * .)) %>%
+   head()
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species Sepal.Sum
1         10.2         7.0          1.4         0.2  setosa      17.2
2          9.8         6.0          1.4         0.2  setosa      15.8
3          9.4         6.4          1.3         0.2  setosa      15.8
4          9.2         6.2          1.5         0.2  setosa      15.4
5         10.0         7.2          1.4         0.2  setosa      17.2
6         10.8         7.8          1.7         0.4  setosa      18.6
```

Note: scoped verbs (ending with **_if()**, **_at()**, and **_all()**) have been superseded by the use of **across()**.

dplyr::group_by() and dplyr::summarise()

- group_by(): changes the scope of each function from operating on the entire dataset to operating on it group-by-group.
- summarise(): reduces multiple values down to a single summary.
- Ex. Compute the mean and median Sepal.Length for each Species

```
> iris %>%
+   group_by(Species) %>%
+   summarise(Sepal.Length.mean = mean(Sepal.Length),
+             Sepal.Length.median = median(Sepal.Length))
# A tibble: 3 x 3
  Species    Sepal.Length.mean Sepal.Length.median
  <fct>                  <dbl>               <dbl>
1 setosa                  5.01                5
2 versicolor              5.94                5.9
3 virginica               6.59                6.5
```

dplyr::arrange()

- Order rows by an expression involving its variables.
- Ex. Order rows first by decreasing Petal Length and then by increasing Sepal Width (if there are ties among the Petal Length)

```
> iris %>%
+   arrange(desc(Petal.Length), Sepal.Width) %>%
+   head()
  Sepal.Length Sepal.Width Petal.Length Petal.Width   Species
1          7.7         2.6          6.9         2.3 virginica
2          7.7         2.8          6.7         2.0 virginica
3          7.7         3.8          6.7         2.2 virginica
4          7.6         3.0          6.6         2.1 virginica
5          7.9         3.8          6.4         2.0 virginica
6          7.3         2.9          6.3         1.8 virginica
```


tidyr
tidyr.tidyverse.org

tidyr: “Grammar of Tidy Data”

- Used to be called “reshape2”
- Contains functions for changing the shape of the data from long-form to wide-form.
- Main functions
  - **spread():** to go from long to wide format
  - **gather():** to go from wide to long format

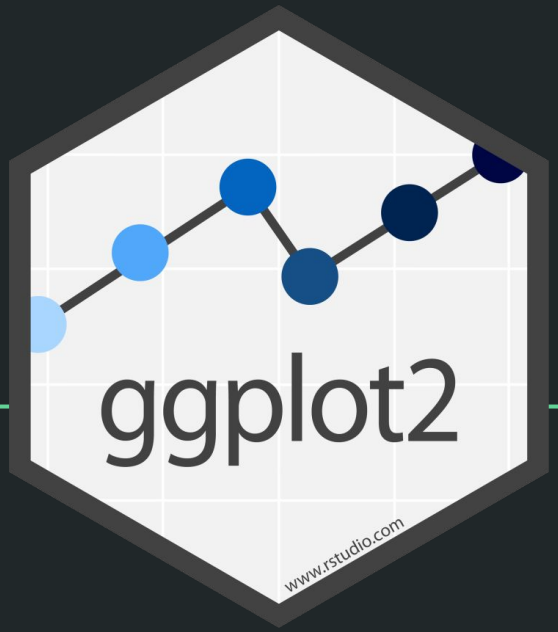
tidyr::spread() vs tidyr::gather()

spread: convert long format to wide format

```
> iris_wide <- iris_long %>%
+   spread(key = "Variable", value = "Value")
> head(iris_wide)
   id    Species Petal.Length Petal.Width Sepal.Length Sepal.Sum Sepal.Width
1   1     setosa          1.4         0.2          5.1       8.6         3.5
2  10     setosa          1.5         0.1          4.9       8.0         3.1
3 100 versicolor          4.1         1.3          5.7       8.5         2.8
4 101  virginica          6.0         2.5          6.3       9.6         3.3
5 102  virginica          5.1         1.9          5.8       8.5         2.7
6 103  virginica          5.9         2.1          7.1      10.1         3.0
```

gather: convert wide format to long format

```
> iris_long <- iris %>%
+   rownames_to_column("id") %>%
+   gather(key = "Variable", value = "Value", -Species, -id)
> head(iris_long)
  id Species     Variable Value
1  1  setosa Sepal.Length   5.1
2  2  setosa Sepal.Length   4.9
3  3  setosa Sepal.Length   4.7
4  4  setosa Sepal.Length   4.6
5  5  setosa Sepal.Length   5.0
6  6  setosa Sepal.Length   5.4
```


ggplot2
www.rstudio.com

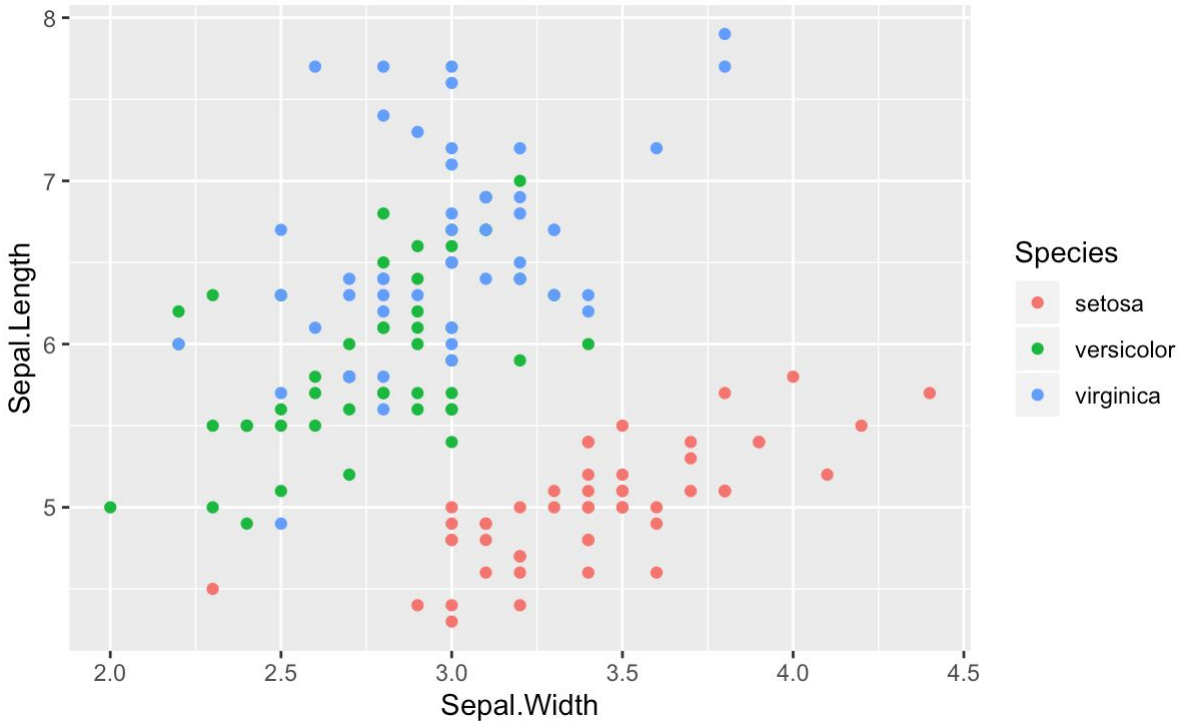
ggplot2: “Grammar of Graphics”

- Always begin with **ggplot(data.frame)**
- Then add layers to the base plot by using + (similar to piping %>%)
  - Examples of layers you may want to add:
    - **geom_point()**
    - **geom_histogram()**
    - **geom_text()**
    - **theme()**
    - **scale_x_continuous()**
    - **labs()**

```
> ggplot(iris) +
+   geom_point(aes(x = Sepal.Width, y = Sepal.Length, color = Species))
```

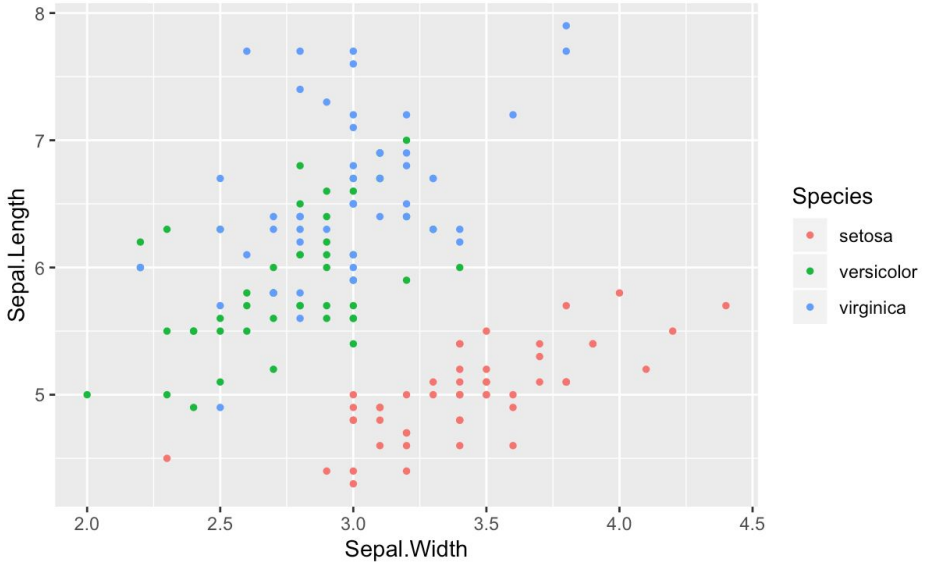
- You can do many many things with ggplot, and I can’t even begin to list the different layers, color themes, formatting options that you can specify in ggplot. **Google will be your best friend here!**

ggplot2: “Grammar of Graphics”

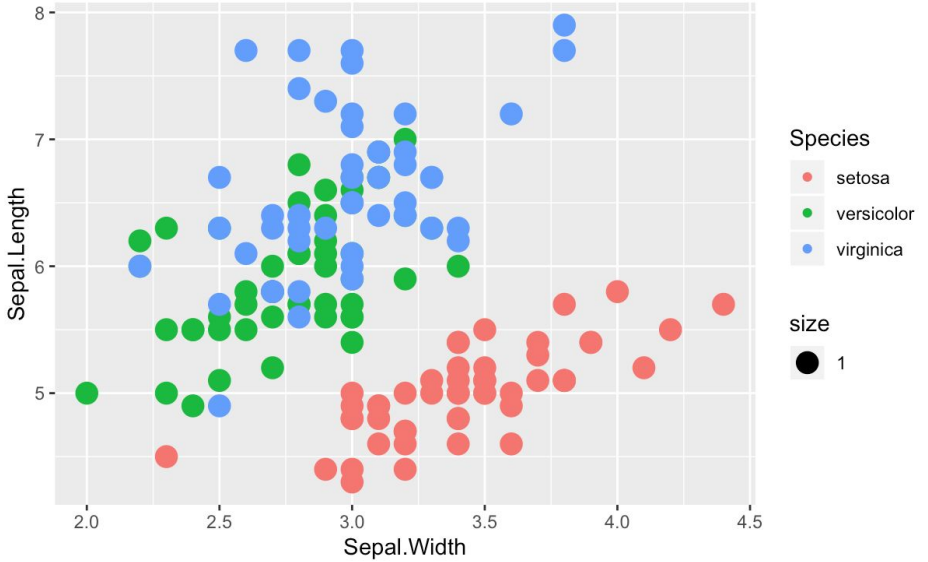


ggplot2: “Grammar of Graphics”

```
> ggplot(iris) +
+   geom_point(aes(x = Sepal.Width, y = Sepal.Length,
+                  color = Species), size = 1)
```

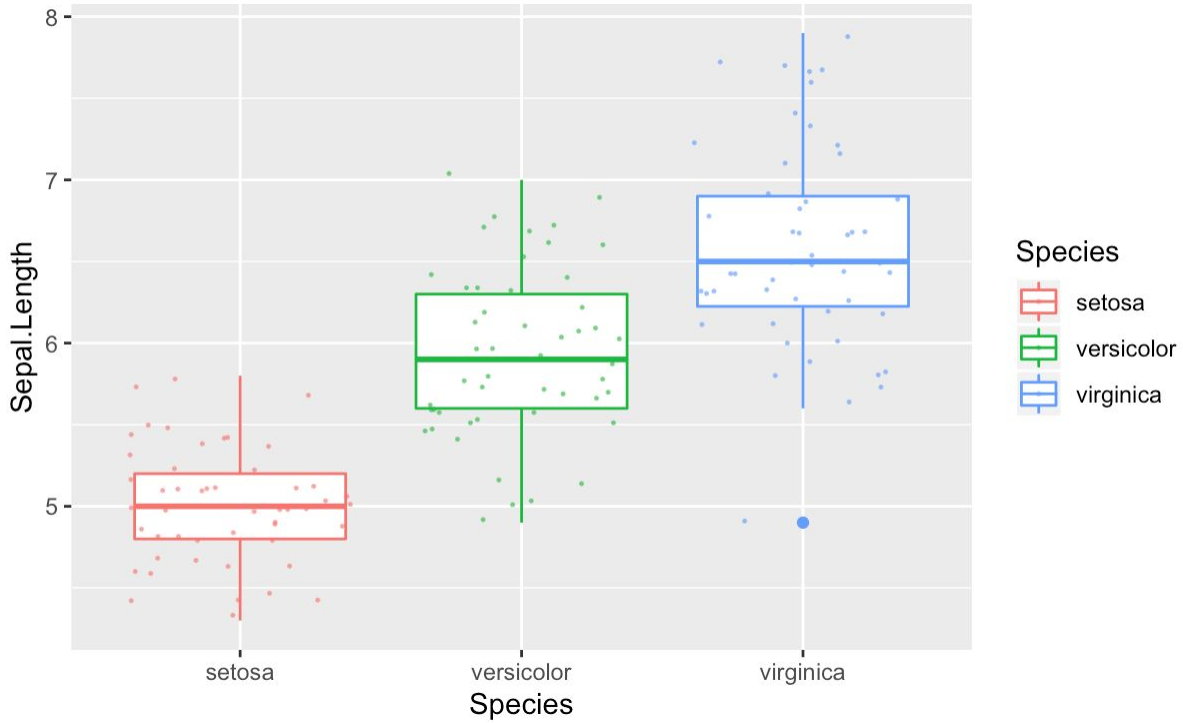



```
> ggplot(iris) +
+   geom_point(aes(x = Sepal.Width, y = Sepal.Length,
+                  color = Species, size = 1))
```



ggplot2: “Grammar of Graphics”

```
> ggplot(iris) +
+   aes(x = Species, y = Sepal.Length, color = Species) +
+   geom_boxplot() +
+   geom_jitter(size = .25, alpha = .5)
```



Let’s get some practice…

For next week

- Lab 0 is due next Friday (Sep 4)
- Lab 0 is not for a grade, but at a minimum, please submit an empty project/lab so that we can ensure your GitHub is working accordingly
- Tentative agenda for next week:
  - Workflow + R Markdown
  - Tips and tricks to make life easier in R/R Markdown
  - Lab 1 Assigned