Week 3 Summary

Leo Soccio

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Tuesday, Jan 17

> **!** TIL
>
> Include a *very brief* summary of what you learnt in this class here.
> Today, I learnt the following concepts in class:
>
> 1. Reading in files
> 2. Reviewed basic dyplr functions
> 3. Reviewed basic ggplot2 functions

Provide more concrete details here. You can also use footnotes[1] if you like

Reading in files

Manually hard coding data into R (tedious for data sets any larger than this):

```
data_hard_code <- data.frame(
  Name = c("Alice", "Bob", "Charlie"),
  Age = c(21,25,35),
  Height = c(5.5,6.2,5.9)
)
```

[1] You can include some footnotes here

```
data_hard_code
```

```
     Name Age Height
1   Alice  21    5.5
2     Bob  25    6.2
3 Charlie  35    5.9
```

Reading in a csv file:

```
data_from_csv <- read.csv("./data12423.csv")

data_from_csv
```

```
     name age height
1   Alice  21    5.5
2     Bob  25    6.2
3 Charlie  35    5.9
```

More advanced and efficient methods to read files:

- "read_csv" from tidyverse
- "data.table" package in R

Now that we have a dataset, we can begin to analyze it.

dyplr and ggplot2 are very helpful for **Exploratory Data Analysis.**

dyplr

dyplr provides a set of "verbs" for manipulating data.

We will use the mpg dataset as an example.

```
library(ggplot2)
library(dplyr)
```

```
Attaching package: 'dplyr'
```

```
The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```r
head(mpg,5)
```

```
# A tibble: 5 x 11
  manufacturer model displ  year   cyl trans      drv     cty   hwy fl    class
  <chr>        <chr> <dbl> <int> <int> <chr>      <chr> <int> <int> <chr> <chr>
1 audi         a4      1.8  1999     4 auto(l5)   f        18    29 p     compa~
2 audi         a4      1.8  1999     4 manual(m5) f        21    29 p     compa~
3 audi         a4      2    2008     4 manual(m6) f        20    31 p     compa~
4 audi         a4      2    2008     4 auto(av)   f        21    30 p     compa~
5 audi         a4      2.8  1999     6 auto(l5)   f        16    26 p     compa~
```

We will also look at the Iris dataset.

```r
head(iris,5)
```

```
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1         3.5          1.4         0.2  setosa
2          4.9         3.0          1.4         0.2  setosa
3          4.7         3.2          1.3         0.2  setosa
4          4.6         3.1          1.5         0.2  setosa
5          5.0         3.6          1.4         0.2  setosa
```

Cleaning datasets:

- Distinct cases where a particular variable's values are of the same data type.
- Every observation has its own row, every variable has its own column

This is what dyplr is for.

Examples:

```r
mpg%>%
  select(c(model,displ)) # selects particular columns
```

```
# A tibble: 234 x 2
   model      displ
   <chr>      <dbl>
 1 a4           1.8
 2 a4           1.8
 3 a4           2
 4 a4           2
 5 a4           2.8
 6 a4           2.8
 7 a4           3.1
 8 a4 quattro   1.8
 9 a4 quattro   1.8
10 a4 quattro   2
# ... with 224 more rows
```

```r
iris%>%
  mutate(Sepal_Area = Sepal.Length * Sepal.Width) # creates a new variable based on existi
```

```
    Sepal.Length Sepal.Width Petal.Length Petal.Width    Species Sepal_Area
1            5.1         3.5          1.4         0.2     setosa      17.85
2            4.9         3.0          1.4         0.2     setosa      14.70
3            4.7         3.2          1.3         0.2     setosa      15.04
4            4.6         3.1          1.5         0.2     setosa      14.26
5            5.0         3.6          1.4         0.2     setosa      18.00
6            5.4         3.9          1.7         0.4     setosa      21.06
7            4.6         3.4          1.4         0.3     setosa      15.64
8            5.0         3.4          1.5         0.2     setosa      17.00
9            4.4         2.9          1.4         0.2     setosa      12.76
10           4.9         3.1          1.5         0.1     setosa      15.19
11           5.4         3.7          1.5         0.2     setosa      19.98
12           4.8         3.4          1.6         0.2     setosa      16.32
13           4.8         3.0          1.4         0.1     setosa      14.40
14           4.3         3.0          1.1         0.1     setosa      12.90
15           5.8         4.0          1.2         0.2     setosa      23.20
16           5.7         4.4          1.5         0.4     setosa      25.08
17           5.4         3.9          1.3         0.4     setosa      21.06
18           5.1         3.5          1.4         0.3     setosa      17.85
```

19	5.7	3.8	1.7	0.3	setosa	21.66
20	5.1	3.8	1.5	0.3	setosa	19.38
21	5.4	3.4	1.7	0.2	setosa	18.36
22	5.1	3.7	1.5	0.4	setosa	18.87
23	4.6	3.6	1.0	0.2	setosa	16.56
24	5.1	3.3	1.7	0.5	setosa	16.83
25	4.8	3.4	1.9	0.2	setosa	16.32
26	5.0	3.0	1.6	0.2	setosa	15.00
27	5.0	3.4	1.6	0.4	setosa	17.00
28	5.2	3.5	1.5	0.2	setosa	18.20
29	5.2	3.4	1.4	0.2	setosa	17.68
30	4.7	3.2	1.6	0.2	setosa	15.04
31	4.8	3.1	1.6	0.2	setosa	14.88
32	5.4	3.4	1.5	0.4	setosa	18.36
33	5.2	4.1	1.5	0.1	setosa	21.32
34	5.5	4.2	1.4	0.2	setosa	23.10
35	4.9	3.1	1.5	0.2	setosa	15.19
36	5.0	3.2	1.2	0.2	setosa	16.00
37	5.5	3.5	1.3	0.2	setosa	19.25
38	4.9	3.6	1.4	0.1	setosa	17.64
39	4.4	3.0	1.3	0.2	setosa	13.20
40	5.1	3.4	1.5	0.2	setosa	17.34
41	5.0	3.5	1.3	0.3	setosa	17.50
42	4.5	2.3	1.3	0.3	setosa	10.35
43	4.4	3.2	1.3	0.2	setosa	14.08
44	5.0	3.5	1.6	0.6	setosa	17.50
45	5.1	3.8	1.9	0.4	setosa	19.38
46	4.8	3.0	1.4	0.3	setosa	14.40
47	5.1	3.8	1.6	0.2	setosa	19.38
48	4.6	3.2	1.4	0.2	setosa	14.72
49	5.3	3.7	1.5	0.2	setosa	19.61
50	5.0	3.3	1.4	0.2	setosa	16.50
51	7.0	3.2	4.7	1.4	versicolor	22.40
52	6.4	3.2	4.5	1.5	versicolor	20.48
53	6.9	3.1	4.9	1.5	versicolor	21.39
54	5.5	2.3	4.0	1.3	versicolor	12.65
55	6.5	2.8	4.6	1.5	versicolor	18.20
56	5.7	2.8	4.5	1.3	versicolor	15.96
57	6.3	3.3	4.7	1.6	versicolor	20.79
58	4.9	2.4	3.3	1.0	versicolor	11.76
59	6.6	2.9	4.6	1.3	versicolor	19.14
60	5.2	2.7	3.9	1.4	versicolor	14.04
61	5.0	2.0	3.5	1.0	versicolor	10.00

62	5.9	3.0	4.2	1.5	versicolor	17.70
63	6.0	2.2	4.0	1.0	versicolor	13.20
64	6.1	2.9	4.7	1.4	versicolor	17.69
65	5.6	2.9	3.6	1.3	versicolor	16.24
66	6.7	3.1	4.4	1.4	versicolor	20.77
67	5.6	3.0	4.5	1.5	versicolor	16.80
68	5.8	2.7	4.1	1.0	versicolor	15.66
69	6.2	2.2	4.5	1.5	versicolor	13.64
70	5.6	2.5	3.9	1.1	versicolor	14.00
71	5.9	3.2	4.8	1.8	versicolor	18.88
72	6.1	2.8	4.0	1.3	versicolor	17.08
73	6.3	2.5	4.9	1.5	versicolor	15.75
74	6.1	2.8	4.7	1.2	versicolor	17.08
75	6.4	2.9	4.3	1.3	versicolor	18.56
76	6.6	3.0	4.4	1.4	versicolor	19.80
77	6.8	2.8	4.8	1.4	versicolor	19.04
78	6.7	3.0	5.0	1.7	versicolor	20.10
79	6.0	2.9	4.5	1.5	versicolor	17.40
80	5.7	2.6	3.5	1.0	versicolor	14.82
81	5.5	2.4	3.8	1.1	versicolor	13.20
82	5.5	2.4	3.7	1.0	versicolor	13.20
83	5.8	2.7	3.9	1.2	versicolor	15.66
84	6.0	2.7	5.1	1.6	versicolor	16.20
85	5.4	3.0	4.5	1.5	versicolor	16.20
86	6.0	3.4	4.5	1.6	versicolor	20.40
87	6.7	3.1	4.7	1.5	versicolor	20.77
88	6.3	2.3	4.4	1.3	versicolor	14.49
89	5.6	3.0	4.1	1.3	versicolor	16.80
90	5.5	2.5	4.0	1.3	versicolor	13.75
91	5.5	2.6	4.4	1.2	versicolor	14.30
92	6.1	3.0	4.6	1.4	versicolor	18.30
93	5.8	2.6	4.0	1.2	versicolor	15.08
94	5.0	2.3	3.3	1.0	versicolor	11.50
95	5.6	2.7	4.2	1.3	versicolor	15.12
96	5.7	3.0	4.2	1.2	versicolor	17.10
97	5.7	2.9	4.2	1.3	versicolor	16.53
98	6.2	2.9	4.3	1.3	versicolor	17.98
99	5.1	2.5	3.0	1.1	versicolor	12.75
100	5.7	2.8	4.1	1.3	versicolor	15.96
101	6.3	3.3	6.0	2.5	virginica	20.79
102	5.8	2.7	5.1	1.9	virginica	15.66
103	7.1	3.0	5.9	2.1	virginica	21.30
104	6.3	2.9	5.6	1.8	virginica	18.27

105	6.5	3.0	5.8	2.2	virginica	19.50
106	7.6	3.0	6.6	2.1	virginica	22.80
107	4.9	2.5	4.5	1.7	virginica	12.25
108	7.3	2.9	6.3	1.8	virginica	21.17
109	6.7	2.5	5.8	1.8	virginica	16.75
110	7.2	3.6	6.1	2.5	virginica	25.92
111	6.5	3.2	5.1	2.0	virginica	20.80
112	6.4	2.7	5.3	1.9	virginica	17.28
113	6.8	3.0	5.5	2.1	virginica	20.40
114	5.7	2.5	5.0	2.0	virginica	14.25
115	5.8	2.8	5.1	2.4	virginica	16.24
116	6.4	3.2	5.3	2.3	virginica	20.48
117	6.5	3.0	5.5	1.8	virginica	19.50
118	7.7	3.8	6.7	2.2	virginica	29.26
119	7.7	2.6	6.9	2.3	virginica	20.02
120	6.0	2.2	5.0	1.5	virginica	13.20
121	6.9	3.2	5.7	2.3	virginica	22.08
122	5.6	2.8	4.9	2.0	virginica	15.68
123	7.7	2.8	6.7	2.0	virginica	21.56
124	6.3	2.7	4.9	1.8	virginica	17.01
125	6.7	3.3	5.7	2.1	virginica	22.11
126	7.2	3.2	6.0	1.8	virginica	23.04
127	6.2	2.8	4.8	1.8	virginica	17.36
128	6.1	3.0	4.9	1.8	virginica	18.30
129	6.4	2.8	5.6	2.1	virginica	17.92
130	7.2	3.0	5.8	1.6	virginica	21.60
131	7.4	2.8	6.1	1.9	virginica	20.72
132	7.9	3.8	6.4	2.0	virginica	30.02
133	6.4	2.8	5.6	2.2	virginica	17.92
134	6.3	2.8	5.1	1.5	virginica	17.64
135	6.1	2.6	5.6	1.4	virginica	15.86
136	7.7	3.0	6.1	2.3	virginica	23.10
137	6.3	3.4	5.6	2.4	virginica	21.42
138	6.4	3.1	5.5	1.8	virginica	19.84
139	6.0	3.0	4.8	1.8	virginica	18.00
140	6.9	3.1	5.4	2.1	virginica	21.39
141	6.7	3.1	5.6	2.4	virginica	20.77
142	6.9	3.1	5.1	2.3	virginica	21.39
143	5.8	2.7	5.1	1.9	virginica	15.66
144	6.8	3.2	5.9	2.3	virginica	21.76
145	6.7	3.3	5.7	2.5	virginica	22.11
146	6.7	3.0	5.2	2.3	virginica	20.10
147	6.3	2.5	5.0	1.9	virginica	15.75

```
148          6.5         3.0          5.2         2.0  virginica      19.50
149          6.2         3.4          5.4         2.3  virginica      21.08
150          5.9         3.0          5.1         1.8  virginica      17.70
```

```
mpg%>%
  filter(class == "compact") # selects particular cases based on a set of criteria
```

```
# A tibble: 47 x 11
   manufacturer model      displ  year   cyl trans drv     cty   hwy fl    class
   <chr>        <chr>      <dbl> <int> <int> <chr> <chr> <int> <int> <chr> <chr>
 1 audi         a4           1.8  1999     4 auto~ f        18    29 p     comp~
 2 audi         a4           1.8  1999     4 manu~ f        21    29 p     comp~
 3 audi         a4           2    2008     4 manu~ f        20    31 p     comp~
 4 audi         a4           2    2008     4 auto~ f        21    30 p     comp~
 5 audi         a4           2.8  1999     6 auto~ f        16    26 p     comp~
 6 audi         a4           2.8  1999     6 manu~ f        18    26 p     comp~
 7 audi         a4           3.1  2008     6 auto~ f        18    27 p     comp~
 8 audi         a4 quattro   1.8  1999     4 manu~ 4        18    26 p     comp~
 9 audi         a4 quattro   1.8  1999     4 auto~ 4        16    25 p     comp~
10 audi         a4 quattro   2    2008     4 manu~ 4        20    28 p     comp~
# ... with 37 more rows
```

Other verbs include summary(), pivot_longer(), pivot_wider(), left_join(), inner_join(), etc.

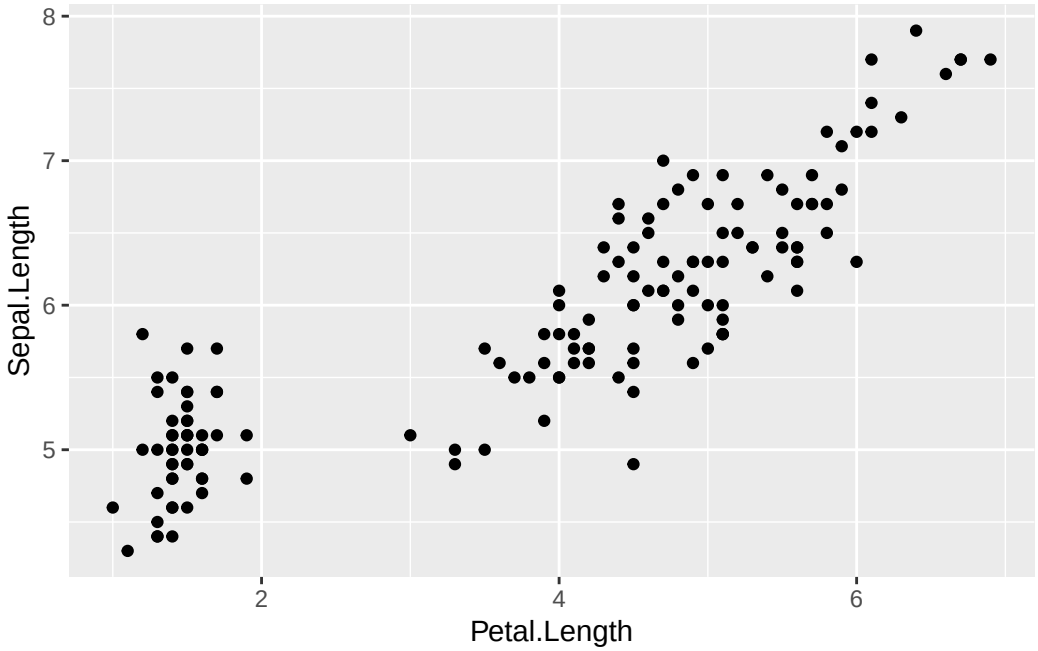
ggplot2

- The "gg" in ggplot2 stands for "Grammar of Graphics". There is NO ggplot1.

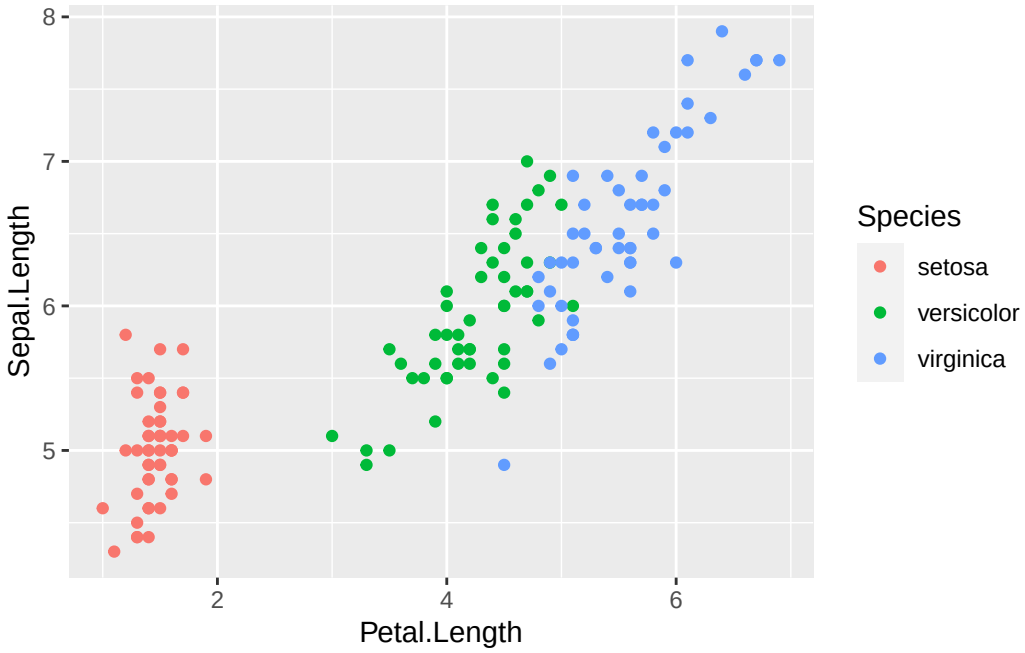
Quick example:

```
plt <- ggplot(iris) # use the iris dataset for ggplot

plt + geom_point(aes(x=Petal.Length, y=Sepal.Length)) # add points to the graph
```

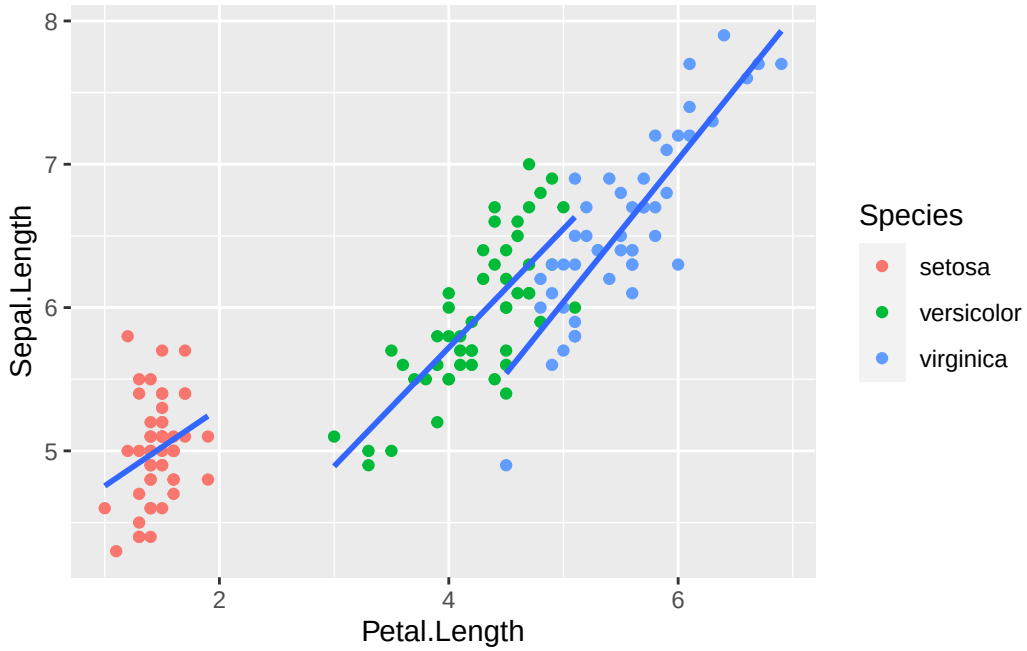



```
plt + geom_point(aes(x=Petal.Length, y=Sepal.Length, color=Species)) # color by species
```



```
plt + geom_point(aes(x=Petal.Length, y=Sepal.Length, color=Species)) +
  geom_smooth(aes(x=Petal.Length, y=Sepal.Length, group=Species), method="lm", se=FALSE) #
```

```
`geom_smooth()` using formula = 'y ~ x'
```



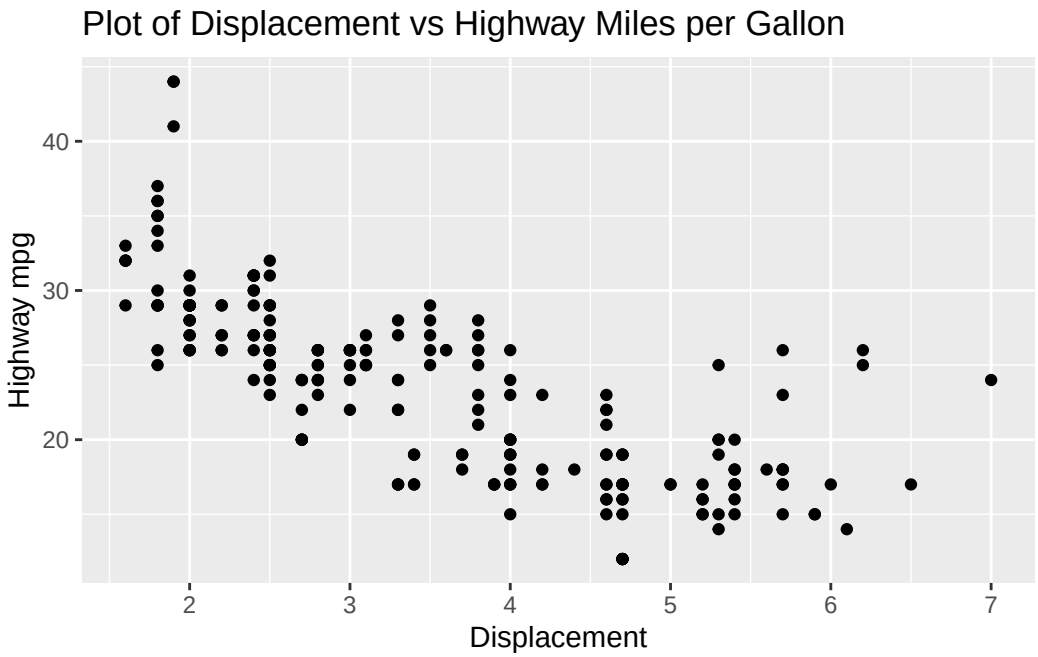
Thursday, Jan 19

> **!** TIL
>
> Include a *very brief* summary of what you learnt in this class here.
> Today, I learnt the following concepts in class:
>
> 1. How to use the ggThemeAssist package
> 2. Basics of the forcats package and factors
> 3. Basics of the map() function
> 4. Brief purrr introduction

Provide more concrete details here:

ggthemeassist

```
ggplot(mpg) +
  geom_point(aes(x=displ, y=hwy)) + theme(plot.background = element_rect(fill = "white"))
    x = "Displacement", y = "Highway mpg")
```




```
# highlight code --> "addins" at top of RStudio --> ggThemeAssist
```

More on data types

1. string, ex. "this is a string"
2. integer, ex. 3
3. double, ex. 2.24
4. booleans, ex. TRUE
5. **Factors** for categorical variables.

Factors and forcats package

Factors are used in categorical variables, let's look at an example:

"var" contains the country code for people in North America

```r
var <- c(
  "USA",
  "USA",
  "CAN",
  "CAN",
  "CAN",
  "CAN",
  "MEX",
  "MEX"
  )
var
```

```
[1] "USA" "USA" "CAN" "CAN" "CAN" "CAN" "MEX" "MEX"
```

To tell R that this is categorical and not just a vector of strings, specify using as.factor()

```r
as.factor(var)
```

```
[1] USA USA CAN CAN CAN CAN MEX MEX
Levels: CAN MEX USA
```

Another example:

```r
head(iris,3)
```

```
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1         3.5          1.4         0.2  setosa
2          4.9         3.0          1.4         0.2  setosa
3          4.7         3.2          1.3         0.2  setosa
```

```r
iris$Species
```

```
  [1] setosa     setosa     setosa     setosa     setosa     setosa
  [7] setosa     setosa     setosa     setosa     setosa     setosa
 [13] setosa     setosa     setosa     setosa     setosa     setosa
 [19] setosa     setosa     setosa     setosa     setosa     setosa
 [25] setosa     setosa     setosa     setosa     setosa     setosa
 [31] setosa     setosa     setosa     setosa     setosa     setosa
```

```
 [37] setosa     setosa     setosa     setosa     setosa     setosa
 [43] setosa     setosa     setosa     setosa     setosa     setosa
 [49] setosa     setosa     versicolor versicolor versicolor versicolor
 [55] versicolor versicolor versicolor versicolor versicolor versicolor
 [61] versicolor versicolor versicolor versicolor versicolor versicolor
 [67] versicolor versicolor versicolor versicolor versicolor versicolor
 [73] versicolor versicolor versicolor versicolor versicolor versicolor
 [79] versicolor versicolor versicolor versicolor versicolor versicolor
 [85] versicolor versicolor versicolor versicolor versicolor versicolor
 [91] versicolor versicolor versicolor versicolor versicolor versicolor
 [97] versicolor versicolor versicolor versicolor virginica  virginica
[103] virginica  virginica  virginica  virginica  virginica  virginica
[109] virginica  virginica  virginica  virginica  virginica  virginica
[115] virginica  virginica  virginica  virginica  virginica  virginica
[121] virginica  virginica  virginica  virginica  virginica  virginica
[127] virginica  virginica  virginica  virginica  virginica  virginica
[133] virginica  virginica  virginica  virginica  virginica  virginica
[139] virginica  virginica  virginica  virginica  virginica  virginica
[145] virginica  virginica  virginica  virginica  virginica  virginica
Levels: setosa versicolor virginica
```

Also look at mpg

```
head(mpg, 3)
```

```
# A tibble: 3 x 11
  manufacturer model displ  year   cyl trans      drv     cty   hwy fl    class
  <chr>        <chr> <dbl> <int> <int> <chr>      <chr> <int> <int> <chr> <chr>
1 audi         a4      1.8  1999     4 auto(l5)   f        18    29 p     compa~
2 audi         a4      1.8  1999     4 manual(m5) f        21    29 p     compa~
3 audi         a4      2    2008     4 manual(m6) f        20    31 p     compa~
```

```
as.factor(mpg$class)
```

```
  [1] compact    compact    compact    compact    compact    compact
  [7] compact    compact    compact    compact    compact    compact
 [13] compact    compact    compact    midsize    midsize    midsize
 [19] suv        suv        suv        suv        suv        2seater
 [25] 2seater    2seater    2seater    2seater    suv        suv
 [31] suv        suv        midsize    midsize    midsize    midsize
```

```
 [37] midsize    minivan    minivan    minivan    minivan    minivan
 [43] minivan    minivan    minivan    minivan    minivan    minivan
 [49] pickup     pickup     pickup     pickup     pickup     pickup
 [55] pickup     pickup     pickup     suv        suv        suv
 [61] suv        suv        suv        suv        pickup     pickup
 [67] pickup     pickup     pickup     pickup     pickup     pickup
 [73] pickup     pickup     suv        suv        suv        suv
 [79] suv        suv        suv        suv        suv        pickup
 [85] pickup     pickup     pickup     pickup     pickup     pickup
 [91] subcompact subcompact subcompact subcompact subcompact subcompact
 [97] subcompact subcompact subcompact subcompact subcompact subcompact
[103] subcompact subcompact subcompact subcompact subcompact subcompact
[109] midsize    midsize    midsize    midsize    midsize    midsize
[115] midsize    subcompact subcompact subcompact subcompact subcompact
[121] subcompact subcompact suv        suv        suv        suv
[127] suv        suv        suv        suv        suv        suv
[133] suv        suv        suv        suv        suv        suv
[139] suv        suv        suv        compact    compact    midsize
[145] midsize    midsize    midsize    midsize    midsize    midsize
[151] suv        suv        suv        suv        midsize    midsize
[157] midsize    midsize    midsize    suv        suv        suv
[163] suv        suv        suv        subcompact subcompact subcompact
[169] subcompact compact    compact    compact    compact    suv
[175] suv        suv        suv        suv        suv        midsize
[181] midsize    midsize    midsize    midsize    midsize    midsize
[187] compact    compact    compact    compact    compact    compact
[193] compact    compact    compact    compact    compact    compact
[199] suv        suv        pickup     pickup     pickup     pickup
[205] pickup     pickup     pickup     compact    compact    compact
[211] compact    compact    compact    compact    compact    compact
[217] compact    compact    compact    compact    compact    subcompact
[223] subcompact subcompact subcompact subcompact subcompact midsize
[229] midsize    midsize    midsize    midsize    midsize    midsize
Levels: 2seater compact midsize minivan pickup subcompact suv
```

When working with data, we will often need to specify the data type so keeping track of things like this is very useful.

The forcats package is useful when working with factors:

```
library(forcats)
manufacturer <- as.factor(mpg$manufacturer)
```

```
fct_reorder(manufacturer, mpg$hwy, min)
```

```
  [1] audi       audi       audi       audi       audi       audi
  [7] audi       audi       audi       audi       audi       audi
 [13] audi       audi       audi       audi       audi       audi
 [19] chevrolet  chevrolet  chevrolet  chevrolet  chevrolet  chevrolet
 [25] chevrolet  chevrolet  chevrolet  chevrolet  chevrolet  chevrolet
 [31] chevrolet  chevrolet  chevrolet  chevrolet  chevrolet  chevrolet
 [37] chevrolet  dodge      dodge      dodge      dodge      dodge
 [43] dodge      dodge      dodge      dodge      dodge      dodge
 [49] dodge      dodge      dodge      dodge      dodge      dodge
 [55] dodge      dodge      dodge      dodge      dodge      dodge
 [61] dodge      dodge      dodge      dodge      dodge      dodge
 [67] dodge      dodge      dodge      dodge      dodge      dodge
 [73] dodge      dodge      ford       ford       ford       ford
 [79] ford       ford       ford       ford       ford       ford
 [85] ford       ford       ford       ford       ford       ford
 [91] ford       ford       ford       ford       ford       ford
 [97] ford       ford       ford       honda      honda      honda
[103] honda      honda      honda      honda      honda      honda
[109] hyundai    hyundai    hyundai    hyundai    hyundai    hyundai
[115] hyundai    hyundai    hyundai    hyundai    hyundai    hyundai
[121] hyundai    hyundai    jeep       jeep       jeep       jeep
[127] jeep       jeep       jeep       jeep       land rover land rover
[133] land rover land rover lincoln    lincoln    lincoln    mercury
[139] mercury    mercury    mercury    nissan     nissan     nissan
[145] nissan     nissan     nissan     nissan     nissan     nissan
[151] nissan     nissan     nissan     nissan     pontiac    pontiac
[157] pontiac    pontiac    pontiac    subaru     subaru     subaru
[163] subaru     subaru     subaru     subaru     subaru     subaru
[169] subaru     subaru     subaru     subaru     subaru     toyota
[175] toyota     toyota     toyota     toyota     toyota     toyota
[181] toyota     toyota     toyota     toyota     toyota     toyota
[187] toyota     toyota     toyota     toyota     toyota     toyota
[193] toyota     toyota     toyota     toyota     toyota     toyota
[199] toyota     toyota     toyota     toyota     toyota     toyota
[205] toyota     toyota     toyota     volkswagen volkswagen volkswagen
[211] volkswagen volkswagen volkswagen volkswagen volkswagen volkswagen
[217] volkswagen volkswagen volkswagen volkswagen volkswagen volkswagen
[223] volkswagen volkswagen volkswagen volkswagen volkswagen volkswagen
[229] volkswagen volkswagen volkswagen volkswagen volkswagen volkswagen
15 Levels: dodge jeep chevrolet ford land rover toyota lincoln ... honda
```

We will return to this in a few weeks for logistic regression.

purr package

This package provides functional programming tools. Example:

Consider this task:

1. Take a number i
2. Create a matrix with random entries of dimension i times i
3. Compute the average of the elements of the matrix
4. Print result

```
#using for
results<-c()
for(i in 1:10){
  M <- matrix(
    runif(i*i), nrow=i
  )
  results[i]<- mean(M)
}
results
```

```
 [1] 0.2820774 0.6853294 0.5115422 0.6298439 0.4910000 0.5177038 0.5870312
 [8] 0.4791319 0.4583217 0.4757166
```

A functional way to approach the same problem: i -> M[ixi] -> mean(M)

```
library(purrr)
map(
  1:10,
  function(i){
    mean(
      matrix(
        c(1:i*i), nrow=i
      )
    )
  }
)
```

```
[[1]]
[1] 1
```

```
[[2]]
[1] 3

[[3]]
[1] 6

[[4]]
[1] 10

[[5]]
[1] 15

[[6]]
[1] 21

[[7]]
[1] 28

[[8]]
[1] 36

[[9]]
[1] 45

[[10]]
[1] 55
```