HW 1

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Contents

Question 1: Define supervised and unsupervised learning. What are the difference(s) between them?

In supervised learning input data with certain classes is provided into the model along with the output, meanwhile in unsupervised learning only the input data is provided into the model which we use to be able to find clusters without knowing exact accuracy.

Question 2: Explain the difference between a regression model and a classification model, specifically in the context of machine learning

A regression model is used to be able to predict continuous values in a model meanwhile for the classification model it is used to be able to predict the discrete values.

Question 3: Name two commonly used metrics for regression ML problems. Name two commonly used metrics for classification ML problems.

For Regression ML problems a common metric is that the response variable is quantitative and also uses the mean squared error and the RMSE to measure the model performance. Meanwhile for the classification ML problems the response variable is qualitative and is using the error test or F-1 to see the model performance.

Question 4: As discussed, statistical models can be used for different purposes. These purposes can generally be classified into the following three categories. Provide a brief description of each.

Descriptive models: Descriptive models choose the model that is best visually seen to emphasize a trend in the data, it will summarize the data without interpreting it.

Predictive models: The Predictive model is aimed to predict the best Y with the most minimum reducible error, and is not focused on hypothesis tests, it uses relationships with other models to predict future relationships.

Inferential models: Are made to state the relationship between the outcome and predictor and are often aimed to test theories, by the use of hypothesis testing and confidence intervals.

Question 5: Define mechanistic. Define empirically-driven. How do these model types differ? How are they similar?

Mechanistic models will be able to describe data after specifying assumptions made, such as the parametric form for f and be able to put known factors from surrounding data into the model that is given at hand. For a mechanistic model some important information about the model needs to be known. An empirical model with be able to describe some data with low assumptions about the data not assuming much about f. Empirical model is used hen there are a lot of unknowns.

A mechanistic model is easier to understand due to being able to inrepret the parameters and their relationships and roles within the model. However this model might be subject to high bias as the assumptions made bout the data. Meanwhile an empirical model might suffer from high variance.

Question 6:

Given a voter's profile/data, how likely is it that they will vote in favor of the candidate?

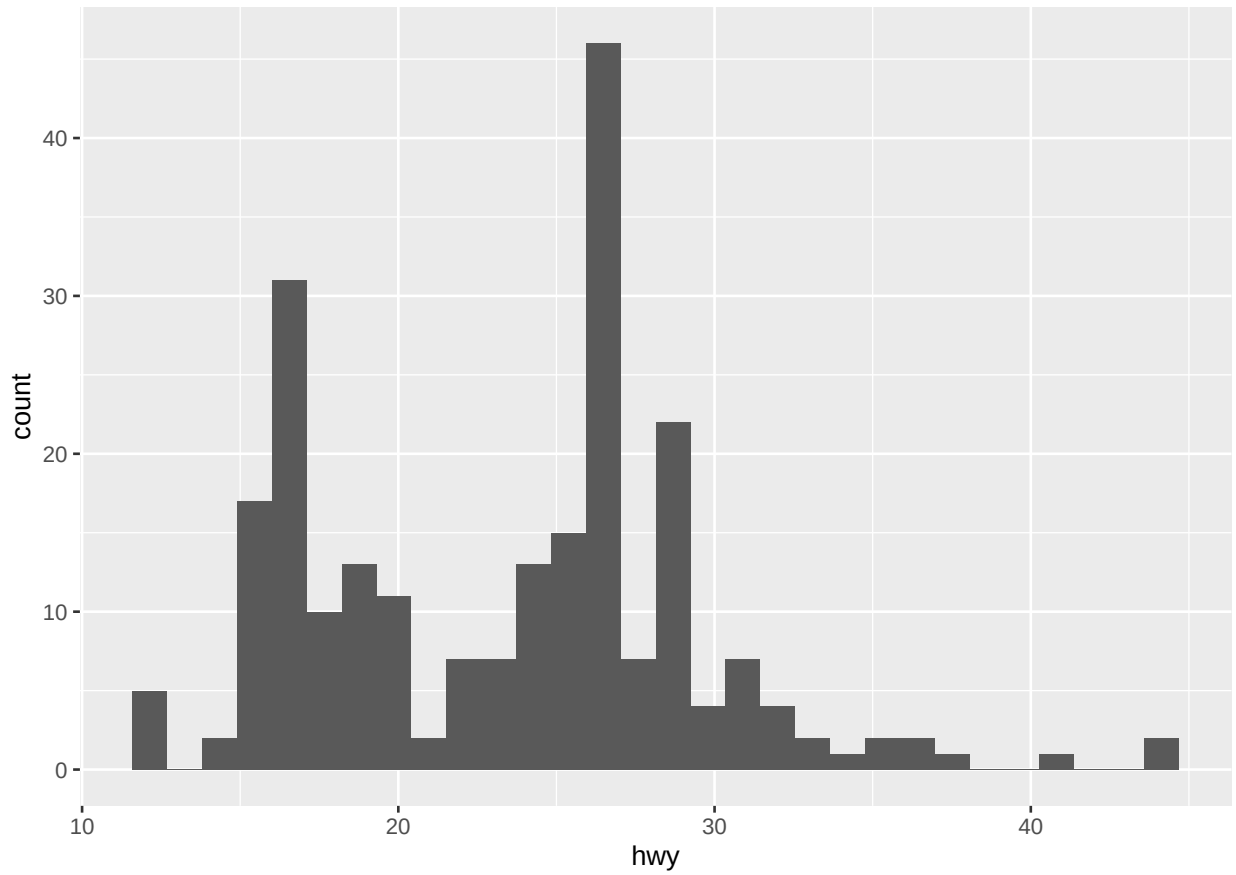
This is seen as a inferential model and this is due to being able to look at data and facts to infer how the voter will most likely be able to favor the candidate there is no past history or information given to be able to predict the candidate.

In the second option the fact that the voter already had history and knows the candidate through personal contact this would make the model become a predictive one, as we are trying to predict the future using some predictive factors.

Exercise 1:

```
library(ggplot2)
data(mpg)
ggplot(mpg, aes(x=hwy)) + geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

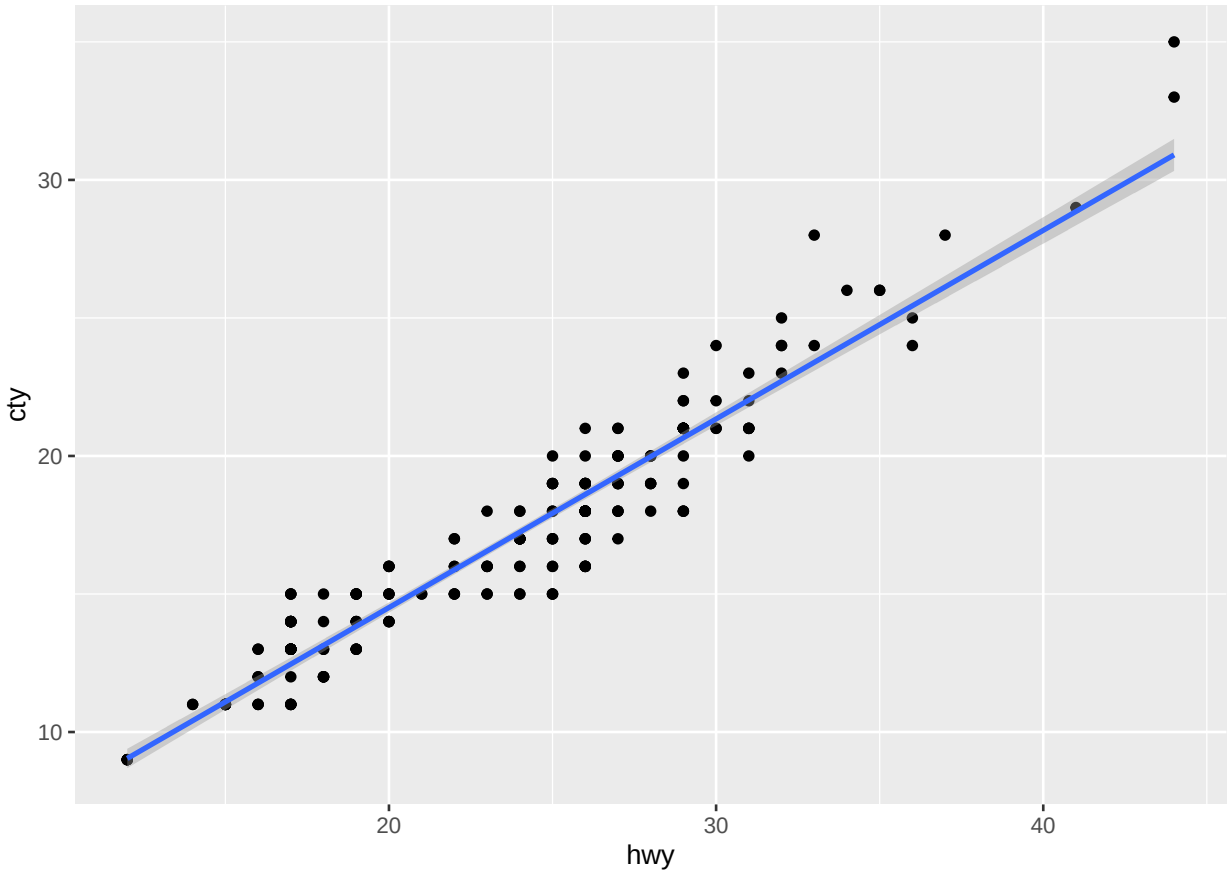


By looking at this histogram we are able to see how many cars are within each of the subsets of miles per gallon on the highway. We can see that there are peaks around 16 and 26 mpg which could count for trucks and SUV and the second peak is for sedans and coupes.

Exercise 2)

```
ggplot(mpg, aes(x=hwy, y=cty)) + geom_point()+ geom_smooth(method = lm)
```

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



It is seen that there is a linear relationship between hwy and cty mpg values. Thinking about the model this would make sense because a high fuel economy car should be able to hold this on the hwy and cty with little difference.

Exercise 3)

```
head(mpg)
```

```
## # A tibble: 6 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(15)   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(15)   f        16    26 p     compa~
## 6 audi         a4      2.8  1999     6 manual(m5) f        18    26 p     compa~
```

```
data.frame(mpg)
```

```
##     manufacturer                 model displ year cyl      trans drv cty hwy
## 1           audi                    a4   1.8 1999   4   auto(15)   f  18  29
## 2           audi                    a4   1.8 1999   4 manual(m5)   f  21  29
## 3           audi                    a4   2.0 2008   4 manual(m6)   f  20  31
## 4           audi                    a4   2.0 2008   4   auto(av)   f  21  30
```

```
## 5          audi                  a4   2.8 1999   6   auto(l5)   f  16  26
## 6          audi                  a4   2.8 1999   6 manual(m5)   f  18  26
## 7          audi                  a4   3.1 2008   6   auto(av)   f  18  27
## 8          audi           a4 quattro   1.8 1999   4 manual(m5)   4  18  26
## 9          audi           a4 quattro   1.8 1999   4   auto(l5)   4  16  25
## 10         audi           a4 quattro   2.0 2008   4 manual(m6)   4  20  28
## 11         audi           a4 quattro   2.0 2008   4   auto(s6)   4  19  27
## 12         audi           a4 quattro   2.8 1999   6   auto(l5)   4  15  25
## 13         audi           a4 quattro   2.8 1999   6 manual(m5)   4  17  25
## 14         audi           a4 quattro   3.1 2008   6   auto(s6)   4  17  25
## 15         audi           a4 quattro   3.1 2008   6 manual(m6)   4  15  25
## 16         audi           a6 quattro   2.8 1999   6   auto(l5)   4  15  24
## 17         audi           a6 quattro   3.1 2008   6   auto(s6)   4  17  25
## 18         audi           a6 quattro   4.2 2008   8   auto(s6)   4  16  23
## 19    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  14  20
## 20    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  11  15
## 21    chevrolet c1500 suburban 2wd   5.3 2008   8   auto(l4)   r  14  20
## 22    chevrolet c1500 suburban 2wd   5.7 1999   8   auto(l4)   r  13  17
## 23    chevrolet c1500 suburban 2wd   6.0 2008   8   auto(l4)   r  12  17
## 24    chevrolet           corvette   5.7 1999   8 manual(m6)   r  16  26
## 25    chevrolet           corvette   5.7 1999   8   auto(l4)   r  15  23
## 26    chevrolet           corvette   6.2 2008   8 manual(m6)   r  16  26
## 27    chevrolet           corvette   6.2 2008   8   auto(s6)   r  15  25
## 28    chevrolet           corvette   7.0 2008   8 manual(m6)   r  15  24
## 29    chevrolet      k1500 tahoe 4wd   5.3 2008   8   auto(l4)   4  14  19
## 30    chevrolet      k1500 tahoe 4wd   5.3 2008   8   auto(l4)   4  11  14
## 31    chevrolet      k1500 tahoe 4wd   5.7 1999   8   auto(l4)   4  11  15
## 32    chevrolet      k1500 tahoe 4wd   6.5 1999   8   auto(l4)   4  14  17
## 33    chevrolet              malibu   2.4 1999   4   auto(l4)   f  19  27
## 34    chevrolet              malibu   2.4 2008   4   auto(l4)   f  22  30
## 35    chevrolet              malibu   3.1 1999   6   auto(l4)   f  18  26
## 36    chevrolet              malibu   3.5 2008   6   auto(l4)   f  18  29
## 37    chevrolet              malibu   3.6 2008   6   auto(s6)   f  17  26
## 38        dodge         caravan 2wd   2.4 1999   4   auto(l3)   f  18  24
## 39        dodge         caravan 2wd   3.0 1999   6   auto(l4)   f  17  24
## 40        dodge         caravan 2wd   3.3 1999   6   auto(l4)   f  16  22
## 41        dodge         caravan 2wd   3.3 1999   6   auto(l4)   f  16  22
## 42        dodge         caravan 2wd   3.3 2008   6   auto(l4)   f  17  24
## 43        dodge         caravan 2wd   3.3 2008   6   auto(l4)   f  17  24
## 44        dodge         caravan 2wd   3.3 2008   6   auto(l4)   f  11  17
## 45        dodge         caravan 2wd   3.8 1999   6   auto(l4)   f  15  22
## 46        dodge         caravan 2wd   3.8 1999   6   auto(l4)   f  15  21
## 47        dodge         caravan 2wd   3.8 2008   6   auto(l6)   f  16  23
## 48        dodge         caravan 2wd   4.0 2008   6   auto(l6)   f  16  23
## 49        dodge   dakota pickup 4wd   3.7 2008   6 manual(m6)   4  15  19
## 50        dodge   dakota pickup 4wd   3.7 2008   6   auto(l4)   4  14  18
## 51        dodge   dakota pickup 4wd   3.9 1999   6   auto(l4)   4  13  17
## 52        dodge   dakota pickup 4wd   3.9 1999   6 manual(m5)   4  14  17
## 53        dodge   dakota pickup 4wd   4.7 2008   8   auto(l5)   4  14  19
## 54        dodge   dakota pickup 4wd   4.7 2008   8   auto(l5)   4  14  19
## 55        dodge   dakota pickup 4wd   4.7 2008   8   auto(l5)   4   9  12
## 56        dodge   dakota pickup 4wd   5.2 1999   8 manual(m5)   4  11  17
## 57        dodge   dakota pickup 4wd   5.2 1999   8   auto(l4)   4  11  15
## 58        dodge         durango 4wd   3.9 1999   6   auto(l4)   4  13  17
```

```
## 59         dodge            durango 4wd   4.7 2008   8   auto(l5)   4  13  17
## 60         dodge            durango 4wd   4.7 2008   8   auto(l5)   4   9  12
## 61         dodge            durango 4wd   4.7 2008   8   auto(l5)   4  13  17
## 62         dodge            durango 4wd   5.2 1999   8   auto(l4)   4  11  16
## 63         dodge            durango 4wd   5.7 2008   8   auto(l5)   4  13  18
## 64         dodge            durango 4wd   5.9 1999   8   auto(l4)   4  11  15
## 65         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4  12  16
## 66         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4   9  12
## 67         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4  13  17
## 68         dodge    ram 1500 pickup 4wd   4.7 2008   8   auto(l5)   4  13  17
## 69         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4  12  16
## 70         dodge    ram 1500 pickup 4wd   4.7 2008   8 manual(m6)   4   9  12
## 71         dodge    ram 1500 pickup 4wd   5.2 1999   8   auto(l4)   4  11  15
## 72         dodge    ram 1500 pickup 4wd   5.2 1999   8 manual(m5)   4  11  16
## 73         dodge    ram 1500 pickup 4wd   5.7 2008   8   auto(l5)   4  13  17
## 74         dodge    ram 1500 pickup 4wd   5.9 1999   8   auto(l4)   4  11  15
## 75          ford         expedition 2wd   4.6 1999   8   auto(l4)   r  11  17
## 76          ford         expedition 2wd   5.4 1999   8   auto(l4)   r  11  17
## 77          ford         expedition 2wd   5.4 2008   8   auto(l6)   r  12  18
## 78          ford           explorer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 79          ford           explorer 4wd   4.0 1999   6 manual(m5)   4  15  19
## 80          ford           explorer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 81          ford           explorer 4wd   4.0 2008   6   auto(l5)   4  13  19
## 82          ford           explorer 4wd   4.6 2008   8   auto(l6)   4  13  19
## 83          ford           explorer 4wd   5.0 1999   8   auto(l4)   4  13  17
## 84          ford        f150 pickup 4wd   4.2 1999   6   auto(l4)   4  14  17
## 85          ford        f150 pickup 4wd   4.2 1999   6 manual(m5)   4  14  17
## 86          ford        f150 pickup 4wd   4.6 1999   8 manual(m5)   4  13  16
## 87          ford        f150 pickup 4wd   4.6 1999   8   auto(l4)   4  13  16
## 88          ford        f150 pickup 4wd   4.6 2008   8   auto(l4)   4  13  17
## 89          ford        f150 pickup 4wd   5.4 1999   8   auto(l4)   4  11  15
## 90          ford        f150 pickup 4wd   5.4 2008   8   auto(l4)   4  13  17
## 91          ford                mustang   3.8 1999   6 manual(m5)   r  18  26
## 92          ford                mustang   3.8 1999   6   auto(l4)   r  18  25
## 93          ford                mustang   4.0 2008   6 manual(m5)   r  17  26
## 94          ford                mustang   4.0 2008   6   auto(l5)   r  16  24
## 95          ford                mustang   4.6 1999   8   auto(l4)   r  15  21
## 96          ford                mustang   4.6 1999   8 manual(m5)   r  15  22
## 97          ford                mustang   4.6 2008   8 manual(m5)   r  15  23
## 98          ford                mustang   4.6 2008   8   auto(l5)   r  15  22
## 99          ford                mustang   5.4 2008   8 manual(m6)   r  14  20
## 100        honda                  civic   1.6 1999   4 manual(m5)   f  28  33
## 101        honda                  civic   1.6 1999   4   auto(l4)   f  24  32
## 102        honda                  civic   1.6 1999   4 manual(m5)   f  25  32
## 103        honda                  civic   1.6 1999   4 manual(m5)   f  23  29
## 104        honda                  civic   1.6 1999   4   auto(l4)   f  24  32
## 105        honda                  civic   1.8 2008   4 manual(m5)   f  26  34
## 106        honda                  civic   1.8 2008   4   auto(l5)   f  25  36
## 107        honda                  civic   1.8 2008   4   auto(l5)   f  24  36
## 108        honda                  civic   2.0 2008   4 manual(m6)   f  21  29
## 109      hyundai                 sonata   2.4 1999   4   auto(l4)   f  18  26
## 110      hyundai                 sonata   2.4 1999   4 manual(m5)   f  18  27
## 111      hyundai                 sonata   2.4 2008   4   auto(l4)   f  21  30
## 112      hyundai                 sonata   2.4 2008   4 manual(m5)   f  21  31
```

```
## 113      hyundai                sonata   2.5 1999   6   auto(l4)   f  18  26
## 114      hyundai                sonata   2.5 1999   6 manual(m5)   f  18  26
## 115      hyundai                sonata   3.3 2008   6   auto(l5)   f  19  28
## 116      hyundai               tiburon   2.0 1999   4   auto(l4)   f  19  26
## 117      hyundai               tiburon   2.0 1999   4 manual(m5)   f  19  29
## 118      hyundai               tiburon   2.0 2008   4 manual(m5)   f  20  28
## 119      hyundai               tiburon   2.0 2008   4   auto(l4)   f  20  27
## 120      hyundai               tiburon   2.7 2008   6   auto(l4)   f  17  24
## 121      hyundai               tiburon   2.7 2008   6 manual(m6)   f  16  24
## 122      hyundai               tiburon   2.7 2008   6 manual(m5)   f  17  24
## 123         jeep     grand cherokee 4wd   3.0 2008   6   auto(l5)   4  17  22
## 124         jeep     grand cherokee 4wd   3.7 2008   6   auto(l5)   4  15  19
## 125         jeep     grand cherokee 4wd   4.0 1999   6   auto(l4)   4  15  20
## 126         jeep     grand cherokee 4wd   4.7 1999   8   auto(l4)   4  14  17
## 127         jeep     grand cherokee 4wd   4.7 2008   8   auto(l5)   4   9  12
## 128         jeep     grand cherokee 4wd   4.7 2008   8   auto(l5)   4  14  19
## 129         jeep     grand cherokee 4wd   5.7 2008   8   auto(l5)   4  13  18
## 130         jeep     grand cherokee 4wd   6.1 2008   8   auto(l5)   4  11  14
## 131   land rover            range rover   4.0 1999   8   auto(l4)   4  11  15
## 132   land rover            range rover   4.2 2008   8   auto(s6)   4  12  18
## 133   land rover            range rover   4.4 2008   8   auto(s6)   4  12  18
## 134   land rover            range rover   4.6 1999   8   auto(l4)   4  11  15
## 135      lincoln          navigator 2wd   5.4 1999   8   auto(l4)   r  11  17
## 136      lincoln          navigator 2wd   5.4 1999   8   auto(l4)   r  11  16
## 137      lincoln          navigator 2wd   5.4 2008   8   auto(l6)   r  12  18
## 138      mercury        mountaineer 4wd   4.0 1999   6   auto(l5)   4  14  17
## 139      mercury        mountaineer 4wd   4.0 2008   6   auto(l5)   4  13  19
## 140      mercury        mountaineer 4wd   4.6 2008   8   auto(l6)   4  13  19
## 141      mercury        mountaineer 4wd   5.0 1999   8   auto(l4)   4  13  17
## 142       nissan                altima   2.4 1999   4 manual(m5)   f  21  29
## 143       nissan                altima   2.4 1999   4   auto(l4)   f  19  27
## 144       nissan                altima   2.5 2008   4   auto(av)   f  23  31
## 145       nissan                altima   2.5 2008   4 manual(m6)   f  23  32
## 146       nissan                altima   3.5 2008   6 manual(m6)   f  19  27
## 147       nissan                altima   3.5 2008   6   auto(av)   f  19  26
## 148       nissan                maxima   3.0 1999   6   auto(l4)   f  18  26
## 149       nissan                maxima   3.0 1999   6 manual(m5)   f  19  25
## 150       nissan                maxima   3.5 2008   6   auto(av)   f  19  25
## 151       nissan         pathfinder 4wd   3.3 1999   6   auto(l4)   4  14  17
## 152       nissan         pathfinder 4wd   3.3 1999   6 manual(m5)   4  15  17
## 153       nissan         pathfinder 4wd   4.0 2008   6   auto(l5)   4  14  20
## 154       nissan         pathfinder 4wd   5.6 2008   8   auto(s5)   4  12  18
## 155      pontiac             grand prix   3.1 1999   6   auto(l4)   f  18  26
## 156      pontiac             grand prix   3.8 1999   6   auto(l4)   f  16  26
## 157      pontiac             grand prix   3.8 1999   6   auto(l4)   f  17  27
## 158      pontiac             grand prix   3.8 2008   6   auto(l4)   f  18  28
## 159      pontiac             grand prix   5.3 2008   8   auto(s4)   f  16  25
## 160       subaru           forester awd   2.5 1999   4 manual(m5)   4  18  25
## 161       subaru           forester awd   2.5 1999   4   auto(l4)   4  18  24
## 162       subaru           forester awd   2.5 2008   4 manual(m5)   4  20  27
## 163       subaru           forester awd   2.5 2008   4 manual(m5)   4  19  25
## 164       subaru           forester awd   2.5 2008   4   auto(l4)   4  20  26
## 165       subaru           forester awd   2.5 2008   4   auto(l4)   4  18  23
## 166       subaru            impreza awd   2.2 1999   4   auto(l4)   4  21  26
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## 167       subaru            impreza awd   2.2 1999   4 manual(m5)   4  19  26
## 168       subaru            impreza awd   2.5 1999   4 manual(m5)   4  19  26
## 169       subaru            impreza awd   2.5 1999   4   auto(l4)   4  19  26
## 170       subaru            impreza awd   2.5 2008   4   auto(s4)   4  20  25
## 171       subaru            impreza awd   2.5 2008   4   auto(s4)   4  20  27
## 172       subaru            impreza awd   2.5 2008   4 manual(m5)   4  19  25
## 173       subaru            impreza awd   2.5 2008   4 manual(m5)   4  20  27
## 174       toyota            4runner 4wd   2.7 1999   4 manual(m5)   4  15  20
## 175       toyota            4runner 4wd   2.7 1999   4   auto(l4)   4  16  20
## 176       toyota            4runner 4wd   3.4 1999   6   auto(l4)   4  15  19
## 177       toyota            4runner 4wd   3.4 1999   6 manual(m5)   4  15  17
## 178       toyota            4runner 4wd   4.0 2008   6   auto(l5)   4  16  20
## 179       toyota            4runner 4wd   4.7 2008   8   auto(l5)   4  14  17
## 180       toyota                 camry   2.2 1999   4 manual(m5)   f  21  29
## 181       toyota                 camry   2.2 1999   4   auto(l4)   f  21  27
## 182       toyota                 camry   2.4 2008   4 manual(m5)   f  21  31
## 183       toyota                 camry   2.4 2008   4   auto(l5)   f  21  31
## 184       toyota                 camry   3.0 1999   6   auto(l4)   f  18  26
## 185       toyota                 camry   3.0 1999   6 manual(m5)   f  18  26
## 186       toyota                 camry   3.5 2008   6   auto(s6)   f  19  28
## 187       toyota           camry solara   2.2 1999   4   auto(l4)   f  21  27
## 188       toyota           camry solara   2.2 1999   4 manual(m5)   f  21  29
## 189       toyota           camry solara   2.4 2008   4 manual(m5)   f  21  31
## 190       toyota           camry solara   2.4 2008   4   auto(s5)   f  22  31
## 191       toyota           camry solara   3.0 1999   6   auto(l4)   f  18  26
## 192       toyota           camry solara   3.0 1999   6 manual(m5)   f  18  26
## 193       toyota           camry solara   3.3 2008   6   auto(s5)   f  18  27
## 194       toyota                corolla   1.8 1999   4   auto(l3)   f  24  30
## 195       toyota                corolla   1.8 1999   4   auto(l4)   f  24  33
## 196       toyota                corolla   1.8 1999   4 manual(m5)   f  26  35
## 197       toyota                corolla   1.8 2008   4 manual(m5)   f  28  37
## 198       toyota                corolla   1.8 2008   4   auto(l4)   f  26  35
## 199       toyota land cruiser wagon 4wd   4.7 1999   8   auto(l4)   4  11  15
## 200       toyota land cruiser wagon 4wd   5.7 2008   8   auto(s6)   4  13  18
## 201       toyota      toyota tacoma 4wd   2.7 1999   4 manual(m5)   4  15  20
## 202       toyota      toyota tacoma 4wd   2.7 1999   4   auto(l4)   4  16  20
## 203       toyota      toyota tacoma 4wd   2.7 2008   4 manual(m5)   4  17  22
## 204       toyota      toyota tacoma 4wd   3.4 1999   6 manual(m5)   4  15  17
## 205       toyota      toyota tacoma 4wd   3.4 1999   6   auto(l4)   4  15  19
## 206       toyota      toyota tacoma 4wd   4.0 2008   6 manual(m6)   4  15  18
## 207       toyota      toyota tacoma 4wd   4.0 2008   6   auto(l5)   4  16  20
## 208   volkswagen                   gti   2.0 1999   4 manual(m5)   f  21  29
## 209   volkswagen                   gti   2.0 1999   4   auto(l4)   f  19  26
## 210   volkswagen                   gti   2.0 2008   4 manual(m6)   f  21  29
## 211   volkswagen                   gti   2.0 2008   4   auto(s6)   f  22  29
## 212   volkswagen                   gti   2.8 1999   6 manual(m5)   f  17  24
## 213   volkswagen                 jetta   1.9 1999   4 manual(m5)   f  33  44
## 214   volkswagen                 jetta   2.0 1999   4 manual(m5)   f  21  29
## 215   volkswagen                 jetta   2.0 1999   4   auto(l4)   f  19  26
## 216   volkswagen                 jetta   2.0 2008   4   auto(s6)   f  22  29
## 217   volkswagen                 jetta   2.0 2008   4 manual(m6)   f  21  29
## 218   volkswagen                 jetta   2.5 2008   5   auto(s6)   f  21  29
## 219   volkswagen                 jetta   2.5 2008   5 manual(m5)   f  21  29
## 220   volkswagen                 jetta   2.8 1999   6   auto(l4)   f  16  23
```

```
## 221   volkswagen             jetta   2.8 1999   6 manual(m5)   f  17  24
## 222   volkswagen        new beetle   1.9 1999   4 manual(m5)   f  35  44
## 223   volkswagen        new beetle   1.9 1999   4   auto(l4)   f  29  41
## 224   volkswagen        new beetle   2.0 1999   4 manual(m5)   f  21  29
## 225   volkswagen        new beetle   2.0 1999   4   auto(l4)   f  19  26
## 226   volkswagen        new beetle   2.5 2008   5 manual(m5)   f  20  28
## 227   volkswagen        new beetle   2.5 2008   5   auto(s6)   f  20  29
## 228   volkswagen            passat   1.8 1999   4 manual(m5)   f  21  29
## 229   volkswagen            passat   1.8 1999   4   auto(l5)   f  18  29
## 230   volkswagen            passat   2.0 2008   4   auto(s6)   f  19  28
## 231   volkswagen            passat   2.0 2008   4 manual(m6)   f  21  29
## 232   volkswagen            passat   2.8 1999   6   auto(l5)   f  16  26
## 233   volkswagen            passat   2.8 1999   6 manual(m5)   f  18  26
## 234   volkswagen            passat   3.6 2008   6   auto(s6)   f  17  26
##     fl      class
## 1    p    compact
## 2    p    compact
## 3    p    compact
## 4    p    compact
## 5    p    compact
## 6    p    compact
## 7    p    compact
## 8    p    compact
## 9    p    compact
## 10   p    compact
## 11   p    compact
## 12   p    compact
## 13   p    compact
## 14   p    compact
## 15   p    compact
## 16   p    midsize
## 17   p    midsize
## 18   p    midsize
## 19   r        suv
## 20   e        suv
## 21   r        suv
## 22   r        suv
## 23   r        suv
## 24   p    2seater
## 25   p    2seater
## 26   p    2seater
## 27   p    2seater
## 28   p    2seater
## 29   r        suv
## 30   e        suv
## 31   r        suv
## 32   d        suv
## 33   r    midsize
## 34   r    midsize
## 35   r    midsize
## 36   r    midsize
## 37   r    midsize
## 38   r    minivan
## 39   r    minivan
```

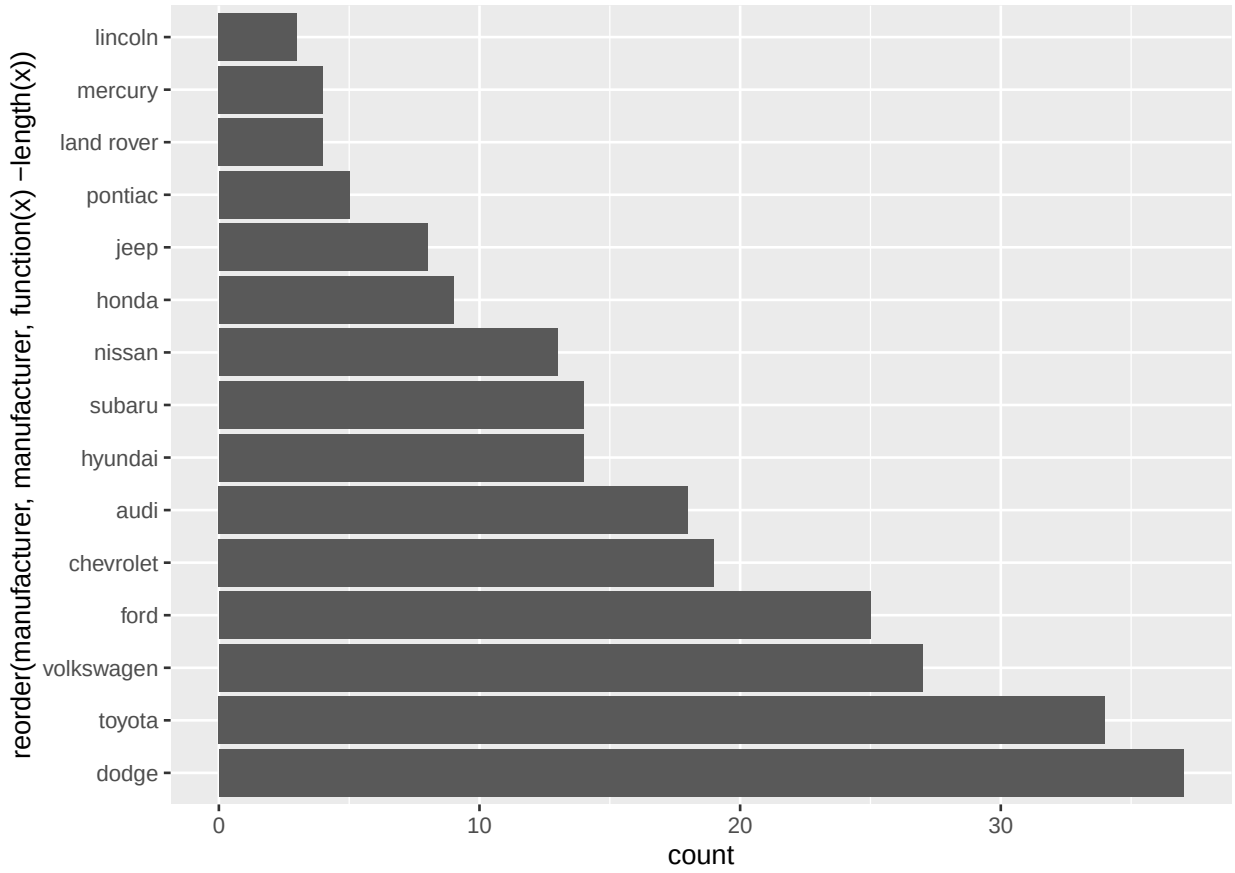
```
## 40   r    minivan
## 41   r    minivan
## 42   r    minivan
## 43   r    minivan
## 44   e    minivan
## 45   r    minivan
## 46   r    minivan
## 47   r    minivan
## 48   r    minivan
## 49   r     pickup
## 50   r     pickup
## 51   r     pickup
## 52   r     pickup
## 53   r     pickup
## 54   r     pickup
## 55   e     pickup
## 56   r     pickup
## 57   r     pickup
## 58   r        suv
## 59   r        suv
## 60   e        suv
## 61   r        suv
## 62   r        suv
## 63   r        suv
## 64   r        suv
## 65   r     pickup
## 66   e     pickup
## 67   r     pickup
## 68   r     pickup
## 69   r     pickup
## 70   e     pickup
## 71   r     pickup
## 72   r     pickup
## 73   r     pickup
## 74   r     pickup
## 75   r        suv
## 76   r        suv
## 77   r        suv
## 78   r        suv
## 79   r        suv
## 80   r        suv
## 81   r        suv
## 82   r        suv
## 83   r        suv
## 84   r     pickup
## 85   r     pickup
## 86   r     pickup
## 87   r     pickup
## 88   r     pickup
## 89   r     pickup
## 90   r     pickup
## 91   r subcompact
## 92   r subcompact
## 93   r subcompact
```

```
## 94   r subcompact
## 95   r subcompact
## 96   r subcompact
## 97   r subcompact
## 98   r subcompact
## 99   p subcompact
## 100  r subcompact
## 101  r subcompact
## 102  r subcompact
## 103  p subcompact
## 104  r subcompact
## 105  r subcompact
## 106  r subcompact
## 107  c subcompact
## 108  p subcompact
## 109  r    midsize
## 110  r    midsize
## 111  r    midsize
## 112  r    midsize
## 113  r    midsize
## 114  r    midsize
## 115  r    midsize
## 116  r subcompact
## 117  r subcompact
## 118  r subcompact
## 119  r subcompact
## 120  r subcompact
## 121  r subcompact
## 122  r subcompact
## 123  d        suv
## 124  r        suv
## 125  r        suv
## 126  r        suv
## 127  e        suv
## 128  r        suv
## 129  r        suv
## 130  p        suv
## 131  p        suv
## 132  r        suv
## 133  r        suv
## 134  p        suv
## 135  r        suv
## 136  p        suv
## 137  r        suv
## 138  r        suv
## 139  r        suv
## 140  r        suv
## 141  r        suv
## 142  r    compact
## 143  r    compact
## 144  r    midsize
## 145  r    midsize
## 146  p    midsize
## 147  p    midsize
```

```
## 148  r    midsize
## 149  r    midsize
## 150  p    midsize
## 151  r        suv
## 152  r        suv
## 153  p        suv
## 154  p        suv
## 155  r    midsize
## 156  p    midsize
## 157  r    midsize
## 158  r    midsize
## 159  p    midsize
## 160  r        suv
## 161  r        suv
## 162  r        suv
## 163  p        suv
## 164  r        suv
## 165  p        suv
## 166  r subcompact
## 167  r subcompact
## 168  r subcompact
## 169  r subcompact
## 170  p    compact
## 171  r    compact
## 172  p    compact
## 173  r    compact
## 174  r        suv
## 175  r        suv
## 176  r        suv
## 177  r        suv
## 178  r        suv
## 179  r        suv
## 180  r    midsize
## 181  r    midsize
## 182  r    midsize
## 183  r    midsize
## 184  r    midsize
## 185  r    midsize
## 186  r    midsize
## 187  r    compact
## 188  r    compact
## 189  r    compact
## 190  r    compact
## 191  r    compact
## 192  r    compact
## 193  r    compact
## 194  r    compact
## 195  r    compact
## 196  r    compact
## 197  r    compact
## 198  r    compact
## 199  r        suv
## 200  r        suv
## 201  r     pickup
```

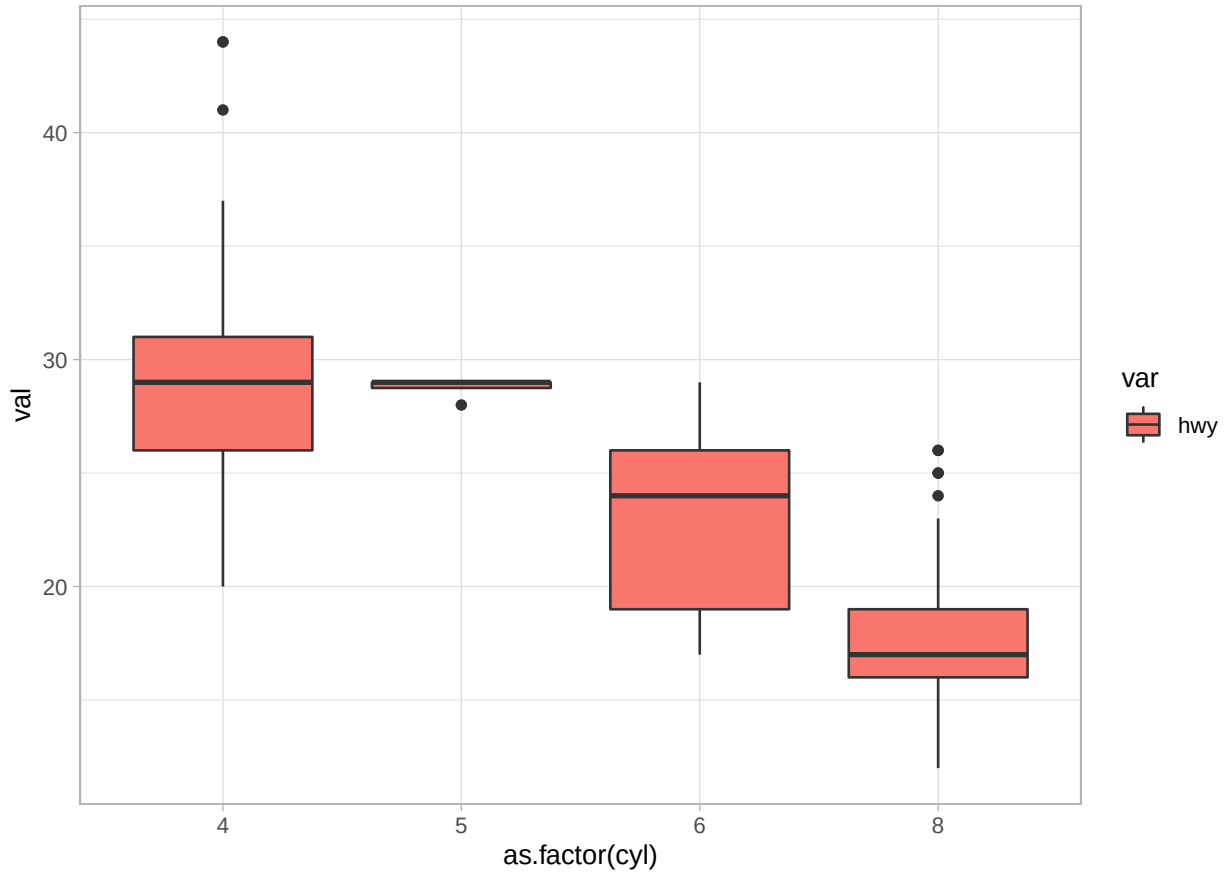
```
## 202  r     pickup
## 203  r     pickup
## 204  r     pickup
## 205  r     pickup
## 206  r     pickup
## 207  r     pickup
## 208  r    compact
## 209  r    compact
## 210  p    compact
## 211  p    compact
## 212  r    compact
## 213  d    compact
## 214  r    compact
## 215  r    compact
## 216  p    compact
## 217  p    compact
## 218  r    compact
## 219  r    compact
## 220  r    compact
## 221  r    compact
## 222  d subcompact
## 223  d subcompact
## 224  r subcompact
## 225  r subcompact
## 226  r subcompact
## 227  r subcompact
## 228  p    midsize
## 229  p    midsize
## 230  p    midsize
## 231  p    midsize
## 232  p    midsize
## 233  p    midsize
## 234  p    midsize
```

```
ggplot(mpg, aes(x = reorder(manufacturer, manufacturer, function(x) - length(x)))) + geom_bar()+ coord_
```



Lincoln least and dodge the most. Exercise 4)

```
library(data.table)
mpg2 <- setDT(copy(mpg))
mpg_plot <- melt(mpg2,measure.vars = c("hwy"),value.name = "val",variable.name = "var")
ggplot(mpg_plot, aes(x = as.factor(cyl),y = val,fill = var))+
  geom_boxplot()+
  theme_light()
```

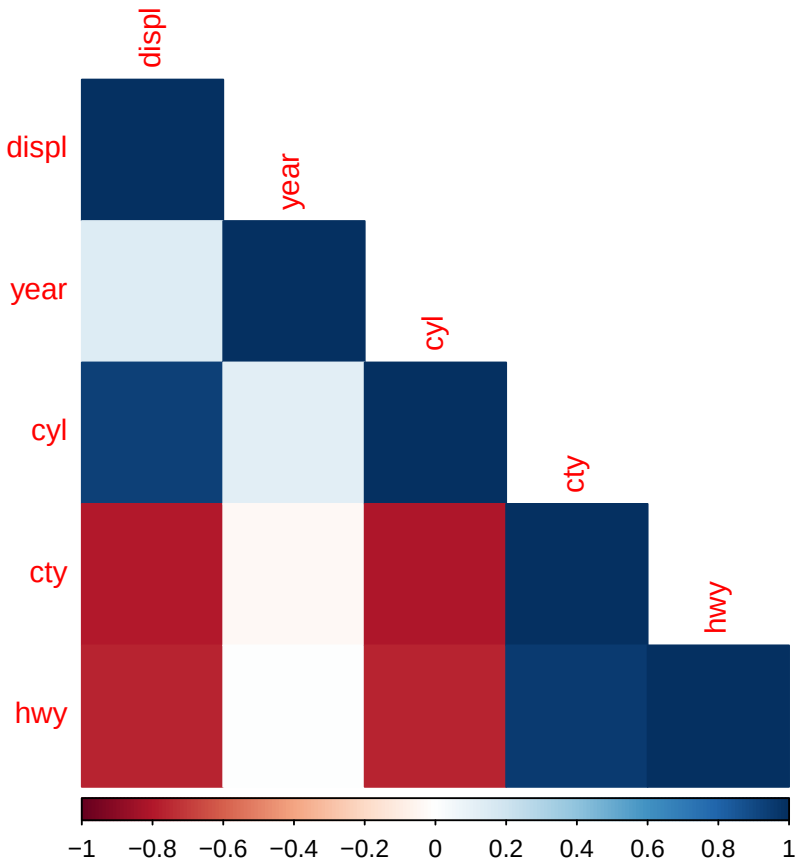


Higher # of cylinders tend means lower values for highway mpg. Exercise 5)

```
library(corrplot)
```

```
## corrplot 0.92 loaded
```

```
data = mpg
data1 = data[ , sapply(data, is.numeric)]
corrplot(cor(data1), method = "color", type = "lower")
```



The city and highway mpg are both negatively correlated with engine displacement and the # of cylinders. MPG on city and highway are strongly correlated. These all make sense as mpg was stated in exercise 2 and for the more powerful engines there is less fuel efficiency. In addition, # of cylinders and engine displacement are strongly correlated due to larger engines needing more cylinders to drive the car.