Final project

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```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.2.2
```

```
library(readr)
library(mice)
```

```
## Warning: package 'mice' was built under R version 4.2.2
```

```
##
## Attaching package: 'mice'
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following objects are masked from 'package:base':
##
##     cbind, rbind
```

```
library(lattice)
```

```
## Warning: package 'lattice' was built under R version 4.2.2
```

```
library(cluster)
```

```
## Warning: package 'cluster' was built under R version 4.2.2
```

```
library(MASS)
library(PCAmixdata)
```

```
## Warning: package 'PCAmixdata' was built under R version 4.2.2
```

```
library(dplyr)
```

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

```
## The following object is masked from 'package:MASS':
##
##     select

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
dataset <- read.csv("C:/Users/prath/Downloads/archive/Automobile_data.csv")
summary(dataset)
```

```
##    symboling       normalized.losses      make            fuel.type
##  Min.   :-2.0000   Length:205         Length:205         Length:205
##  1st Qu.: 0.0000   Class :character   Class :character   Class :character
##  Median : 1.0000   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 0.8341
##  3rd Qu.: 2.0000
##  Max.   : 3.0000
##   aspiration        num.of.doors        body.style        drive.wheels
##  Length:205         Length:205         Length:205         Length:205
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  engine.location      wheel.base         length          width
##  Length:205         Min.   : 86.60   Min.   :141.1   Min.   :60.30
##  Class :character   1st Qu.: 94.50   1st Qu.:166.3   1st Qu.:64.10
##  Mode  :character   Median : 97.00   Median :173.2   Median :65.50
##                     Mean   : 98.76   Mean   :174.0   Mean   :65.91
##                     3rd Qu.:102.40   3rd Qu.:183.1   3rd Qu.:66.90
##                     Max.   :120.90   Max.   :208.1   Max.   :72.30
##      height       curb.weight   engine.type        num.of.cylinders
##  Min.   :47.80   Min.   :1488   Length:205         Length:205
##  1st Qu.:52.00   1st Qu.:2145   Class :character   Class :character
##  Median :54.10   Median :2414   Mode  :character   Mode  :character
##  Mean   :53.72   Mean   :2556
##  3rd Qu.:55.50   3rd Qu.:2935
##  Max.   :59.80   Max.   :4066
##   engine.size    fuel.system           bore              stroke
##  Min.   : 61.0   Length:205         Length:205         Length:205
##  1st Qu.: 97.0   Class :character   Class :character   Class :character
##  Median :120.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   :126.9
##  3rd Qu.:141.0
##  Max.   :326.0
##  compression.ratio  horsepower          peak.rpm            city.mpg
##  Min.   : 7.00     Length:205         Length:205         Min.   :13.00
##  1st Qu.: 8.60     Class :character   Class :character   1st Qu.:19.00
```

```
##  Median : 9.00     Mode  :character   Mode  :character   Median :24.00
##  Mean   :10.14                                          Mean   :25.22
##  3rd Qu.: 9.40                                          3rd Qu.:30.00
##  Max.   :23.00                                          Max.   :49.00
##   highway.mpg       price
##  Min.   :16.00   Length:205
##  1st Qu.:25.00   Class :character
##  Median :30.00   Mode  :character
##  Mean   :30.75
##  3rd Qu.:34.00
##  Max.   :54.00
```

```
data.frame(dataset)
```

```
##     symboling normalized.losses         make fuel.type aspiration num.of.doors
## 1           3                 ?  alfa-romero       gas        std          two
## 2           3                 ?  alfa-romero       gas        std          two
## 3           1                 ?  alfa-romero       gas        std          two
## 4           2               164         audi       gas        std         four
## 5           2               164         audi       gas        std         four
## 6           2                 ?         audi       gas        std          two
## 7           1               158         audi       gas        std         four
## 8           1                 ?         audi       gas        std         four
## 9           1               158         audi       gas      turbo         four
## 10          0                 ?         audi       gas      turbo          two
## 11          2               192          bmw       gas        std          two
## 12          0               192          bmw       gas        std         four
## 13          0               188          bmw       gas        std          two
## 14          0               188          bmw       gas        std         four
## 15          1                 ?          bmw       gas        std         four
## 16          0                 ?          bmw       gas        std         four
## 17          0                 ?          bmw       gas        std          two
## 18          0                 ?          bmw       gas        std         four
## 19          2               121    chevrolet       gas        std          two
## 20          1                98    chevrolet       gas        std          two
## 21          0                81    chevrolet       gas        std         four
## 22          1               118        dodge       gas        std          two
## 23          1               118        dodge       gas        std          two
## 24          1               118        dodge       gas      turbo          two
## 25          1               148        dodge       gas        std         four
## 26          1               148        dodge       gas        std         four
## 27          1               148        dodge       gas        std         four
## 28          1               148        dodge       gas      turbo            ?
## 29         -1               110        dodge       gas        std         four
## 30          3               145        dodge       gas      turbo          two
## 31          2               137        honda       gas        std          two
## 32          2               137        honda       gas        std          two
## 33          1               101        honda       gas        std          two
## 34          1               101        honda       gas        std          two
## 35          1               101        honda       gas        std          two
## 36          0               110        honda       gas        std         four
## 37          0                78        honda       gas        std         four
## 38          0               106        honda       gas        std          two
## 39          0               106        honda       gas        std          two
```

```
## 40          0                 85          honda       gas        std          four
## 41          0                 85          honda       gas        std          four
## 42          0                 85          honda       gas        std          four
## 43          1                107          honda       gas        std           two
## 44          0                  ?          isuzu       gas        std          four
## 45          1                  ?          isuzu       gas        std           two
## 46          0                  ?          isuzu       gas        std          four
## 47          2                  ?          isuzu       gas        std           two
## 48          0                145         jaguar       gas        std          four
## 49          0                  ?         jaguar       gas        std          four
## 50          0                  ?         jaguar       gas        std           two
## 51          1                104          mazda       gas        std           two
## 52          1                104          mazda       gas        std           two
## 53          1                104          mazda       gas        std           two
## 54          1                113          mazda       gas        std          four
## 55          1                113          mazda       gas        std          four
## 56          3                150          mazda       gas        std           two
## 57          3                150          mazda       gas        std           two
## 58          3                150          mazda       gas        std           two
## 59          3                150          mazda       gas        std           two
## 60          1                129          mazda       gas        std           two
## 61          0                115          mazda       gas        std          four
## 62          1                129          mazda       gas        std           two
## 63          0                115          mazda       gas        std          four
## 64          0                  ?          mazda    diesel        std             ?
## 65          0                115          mazda       gas        std          four
## 66          0                118          mazda       gas        std          four
## 67          0                  ?          mazda    diesel        std          four
## 68         -1                 93 mercedes-benz    diesel      turbo          four
## 69         -1                 93 mercedes-benz    diesel      turbo          four
## 70          0                 93 mercedes-benz    diesel      turbo           two
## 71         -1                 93 mercedes-benz    diesel      turbo          four
## 72         -1                  ? mercedes-benz       gas        std          four
## 73          3                142 mercedes-benz       gas        std           two
## 74          0                  ? mercedes-benz       gas        std          four
## 75          1                  ? mercedes-benz       gas        std           two
## 76          1                  ?       mercury       gas      turbo           two
## 77          2                161    mitsubishi       gas        std           two
## 78          2                161    mitsubishi       gas        std           two
## 79          2                161    mitsubishi       gas        std           two
## 80          1                161    mitsubishi       gas      turbo           two
## 81          3                153    mitsubishi       gas      turbo           two
## 82          3                153    mitsubishi       gas        std           two
## 83          3                  ?    mitsubishi       gas      turbo           two
## 84          3                  ?    mitsubishi       gas      turbo           two
## 85          3                  ?    mitsubishi       gas      turbo           two
## 86          1                125    mitsubishi       gas        std          four
## 87          1                125    mitsubishi       gas        std          four
## 88          1                125    mitsubishi       gas      turbo          four
## 89         -1                137    mitsubishi       gas        std          four
## 90          1                128        nissan       gas        std           two
## 91          1                128        nissan    diesel        std           two
## 92          1                128        nissan       gas        std           two
## 93          1                122        nissan       gas        std          four
```

```
## 94          1                103         nissan       gas        std         four
## 95          1                128         nissan       gas        std          two
## 96          1                128         nissan       gas        std          two
## 97          1                122         nissan       gas        std         four
## 98          1                103         nissan       gas        std         four
## 99          2                168         nissan       gas        std          two
## 100         0                106         nissan       gas        std         four
## 101         0                106         nissan       gas        std         four
## 102         0                128         nissan       gas        std         four
## 103         0                108         nissan       gas        std         four
## 104         0                108         nissan       gas        std         four
## 105         3                194         nissan       gas        std          two
## 106         3                194         nissan       gas      turbo          two
## 107         1                231         nissan       gas        std          two
## 108         0                161         peugot       gas        std         four
## 109         0                161         peugot    diesel      turbo         four
## 110         0                  ?         peugot       gas        std         four
## 111         0                  ?         peugot    diesel      turbo         four
## 112         0                161         peugot       gas        std         four
## 113         0                161         peugot    diesel      turbo         four
## 114         0                  ?         peugot       gas        std         four
## 115         0                  ?         peugot    diesel      turbo         four
## 116         0                161         peugot       gas        std         four
## 117         0                161         peugot    diesel      turbo         four
## 118         0                161         peugot       gas      turbo         four
## 119         1                119       plymouth       gas        std          two
## 120         1                119       plymouth       gas      turbo          two
## 121         1                154       plymouth       gas        std         four
## 122         1                154       plymouth       gas        std         four
## 123         1                154       plymouth       gas        std         four
## 124        -1                 74       plymouth       gas        std         four
## 125         3                  ?       plymouth       gas      turbo          two
## 126         3                186        porsche       gas        std          two
## 127         3                  ?        porsche       gas        std          two
## 128         3                  ?        porsche       gas        std          two
## 129         3                  ?        porsche       gas        std          two
## 130         1                  ?        porsche       gas        std          two
## 131         0                  ?        renault       gas        std         four
## 132         2                  ?        renault       gas        std          two
## 133         3                150           saab       gas        std          two
## 134         2                104           saab       gas        std         four
## 135         3                150           saab       gas        std          two
## 136         2                104           saab       gas        std         four
## 137         3                150           saab       gas      turbo          two
## 138         2                104           saab       gas      turbo         four
## 139         2                 83         subaru       gas        std          two
## 140         2                 83         subaru       gas        std          two
## 141         2                 83         subaru       gas        std          two
## 142         0                102         subaru       gas        std         four
## 143         0                102         subaru       gas        std         four
## 144         0                102         subaru       gas        std         four
## 145         0                102         subaru       gas        std         four
## 146         0                102         subaru       gas      turbo         four
## 147         0                 89         subaru       gas        std         four
```

```
## 148         0                89        subaru       gas        std         four
## 149         0                85        subaru       gas        std         four
## 150         0                85        subaru       gas      turbo         four
## 151         1                87        toyota       gas        std          two
## 152         1                87        toyota       gas        std          two
## 153         1                74        toyota       gas        std         four
## 154         0                77        toyota       gas        std         four
## 155         0                81        toyota       gas        std         four
## 156         0                91        toyota       gas        std         four
## 157         0                91        toyota       gas        std         four
## 158         0                91        toyota       gas        std         four
## 159         0                91        toyota    diesel        std         four
## 160         0                91        toyota    diesel        std         four
## 161         0                91        toyota       gas        std         four
## 162         0                91        toyota       gas        std         four
## 163         0                91        toyota       gas        std         four
## 164         1               168        toyota       gas        std          two
## 165         1               168        toyota       gas        std          two
## 166         1               168        toyota       gas        std          two
## 167         1               168        toyota       gas        std          two
## 168         2               134        toyota       gas        std          two
## 169         2               134        toyota       gas        std          two
## 170         2               134        toyota       gas        std          two
## 171         2               134        toyota       gas        std          two
## 172         2               134        toyota       gas        std          two
## 173         2               134        toyota       gas        std          two
## 174        -1                65        toyota       gas        std         four
## 175        -1                65        toyota    diesel      turbo         four
## 176        -1                65        toyota       gas        std         four
## 177        -1                65        toyota       gas        std         four
## 178        -1                65        toyota       gas        std         four
## 179         3               197        toyota       gas        std          two
## 180         3               197        toyota       gas        std          two
## 181        -1                90        toyota       gas        std         four
## 182        -1                 ?        toyota       gas        std         four
## 183         2               122    volkswagen    diesel        std          two
## 184         2               122    volkswagen       gas        std          two
## 185         2                94    volkswagen    diesel        std         four
## 186         2                94    volkswagen       gas        std         four
## 187         2                94    volkswagen       gas        std         four
## 188         2                94    volkswagen    diesel      turbo         four
## 189         2                94    volkswagen       gas        std         four
## 190         3                 ?    volkswagen       gas        std          two
## 191         3               256    volkswagen       gas        std          two
## 192         0                 ?    volkswagen       gas        std         four
## 193         0                 ?    volkswagen    diesel      turbo         four
## 194         0                 ?    volkswagen       gas        std         four
## 195        -2               103         volvo       gas        std         four
## 196        -1                74         volvo       gas        std         four
## 197        -2               103         volvo       gas        std         four
## 198        -1                74         volvo       gas        std         four
## 199        -2               103         volvo       gas      turbo         four
## 200        -1                74         volvo       gas      turbo         four
## 201        -1                95         volvo       gas        std         four
```

```
## 202        -1                95         volvo       gas      turbo         four
## 203        -1                95         volvo       gas        std         four
## 204        -1                95         volvo    diesel      turbo         four
## 205        -1                95         volvo       gas      turbo         four
##      body.style drive.wheels engine.location wheel.base length width height
## 1   convertible          rwd           front       88.6  168.8  64.1   48.8
## 2   convertible          rwd           front       88.6  168.8  64.1   48.8
## 3     hatchback          rwd           front       94.5  171.2  65.5   52.4
## 4         sedan          fwd           front       99.8  176.6  66.2   54.3
## 5         sedan          4wd           front       99.4  176.6  66.4   54.3
## 6         sedan          fwd           front       99.8  177.3  66.3   53.1
## 7         sedan          fwd           front      105.8  192.7  71.4   55.7
## 8         wagon          fwd           front      105.8  192.7  71.4   55.7
## 9         sedan          fwd           front      105.8  192.7  71.4   55.9
## 10    hatchback          4wd           front       99.5  178.2  67.9   52.0
## 11        sedan          rwd           front      101.2  176.8  64.8   54.3
## 12        sedan          rwd           front      101.2  176.8  64.8   54.3
## 13        sedan          rwd           front      101.2  176.8  64.8   54.3
## 14        sedan          rwd           front      101.2  176.8  64.8   54.3
## 15        sedan          rwd           front      103.5  189.0  66.9   55.7
## 16        sedan          rwd           front      103.5  189.0  66.9   55.7
## 17        sedan          rwd           front      103.5  193.8  67.9   53.7
## 18        sedan          rwd           front      110.0  197.0  70.9   56.3
## 19    hatchback          fwd           front       88.4  141.1  60.3   53.2
## 20    hatchback          fwd           front       94.5  155.9  63.6   52.0
## 21        sedan          fwd           front       94.5  158.8  63.6   52.0
## 22    hatchback          fwd           front       93.7  157.3  63.8   50.8
## 23    hatchback          fwd           front       93.7  157.3  63.8   50.8
## 24    hatchback          fwd           front       93.7  157.3  63.8   50.8
## 25    hatchback          fwd           front       93.7  157.3  63.8   50.6
## 26        sedan          fwd           front       93.7  157.3  63.8   50.6
## 27        sedan          fwd           front       93.7  157.3  63.8   50.6
## 28        sedan          fwd           front       93.7  157.3  63.8   50.6
## 29        wagon          fwd           front      103.3  174.6  64.6   59.8
## 30    hatchback          fwd           front       95.9  173.2  66.3   50.2
## 31    hatchback          fwd           front       86.6  144.6  63.9   50.8
## 32    hatchback          fwd           front       86.6  144.6  63.9   50.8
## 33    hatchback          fwd           front       93.7  150.0  64.0   52.6
## 34    hatchback          fwd           front       93.7  150.0  64.0   52.6
## 35    hatchback          fwd           front       93.7  150.0  64.0   52.6
## 36        sedan          fwd           front       96.5  163.4  64.0   54.5
## 37        wagon          fwd           front       96.5  157.1  63.9   58.3
## 38    hatchback          fwd           front       96.5  167.5  65.2   53.3
## 39    hatchback          fwd           front       96.5  167.5  65.2   53.3
## 40        sedan          fwd           front       96.5  175.4  65.2   54.1
## 41        sedan          fwd           front       96.5  175.4  62.5   54.1
## 42        sedan          fwd           front       96.5  175.4  65.2   54.1
## 43        sedan          fwd           front       96.5  169.1  66.0   51.0
## 44        sedan          rwd           front       94.3  170.7  61.8   53.5
## 45        sedan          fwd           front       94.5  155.9  63.6   52.0
## 46        sedan          fwd           front       94.5  155.9  63.6   52.0
## 47    hatchback          rwd           front       96.0  172.6  65.2   51.4
## 48        sedan          rwd           front      113.0  199.6  69.6   52.8
## 49        sedan          rwd           front      113.0  199.6  69.6   52.8
```

```
## 50        sedan          rwd          front      102.0  191.7  70.6   47.8
## 51    hatchback          fwd          front       93.1  159.1  64.2   54.1
## 52    hatchback          fwd          front       93.1  159.1  64.2   54.1
## 53    hatchback          fwd          front       93.1  159.1  64.2   54.1
## 54        sedan          fwd          front       93.1  166.8  64.2   54.1
## 55        sedan          fwd          front       93.1  166.8  64.2   54.1
## 56    hatchback          rwd          front       95.3  169.0  65.7   49.6
## 57    hatchback          rwd          front       95.3  169.0  65.7   49.6
## 58    hatchback          rwd          front       95.3  169.0  65.7   49.6
## 59    hatchback          rwd          front       95.3  169.0  65.7   49.6
## 60    hatchback          fwd          front       98.8  177.8  66.5   53.7
## 61        sedan          fwd          front       98.8  177.8  66.5   55.5
## 62    hatchback          fwd          front       98.8  177.8  66.5   53.7
## 63        sedan          fwd          front       98.8  177.8  66.5   55.5
## 64        sedan          fwd          front       98.8  177.8  66.5   55.5
## 65    hatchback          fwd          front       98.8  177.8  66.5   55.5
## 66        sedan          rwd          front      104.9  175.0  66.1   54.4
## 67        sedan          rwd          front      104.9  175.0  66.1   54.4
## 68        sedan          rwd          front      110.0  190.9  70.3   56.5
## 69        wagon          rwd          front      110.0  190.9  70.3   58.7
## 70      hardtop          rwd          front      106.7  187.5  70.3   54.9
## 71        sedan          rwd          front      115.6  202.6  71.7   56.3
## 72        sedan          rwd          front      115.6  202.6  71.7   56.5
## 73  convertible          rwd          front       96.6  180.3  70.5   50.8
## 74        sedan          rwd          front      120.9  208.1  71.7   56.7
## 75      hardtop          rwd          front      112.0  199.2  72.0   55.4
## 76    hatchback          rwd          front      102.7  178.4  68.0   54.8
## 77    hatchback          fwd          front       93.7  157.3  64.4   50.8
## 78    hatchback          fwd          front       93.7  157.3  64.4   50.8
## 79    hatchback          fwd          front       93.7  157.3  64.4   50.8
## 80    hatchback          fwd          front       93.0  157.3  63.8   50.8
## 81    hatchback          fwd          front       96.3  173.0  65.4   49.4
## 82    hatchback          fwd          front       96.3  173.0  65.4   49.4
## 83    hatchback          fwd          front       95.9  173.2  66.3   50.2
## 84    hatchback          fwd          front       95.9  173.2  66.3   50.2
## 85    hatchback          fwd          front       95.9  173.2  66.3   50.2
## 86        sedan          fwd          front       96.3  172.4  65.4   51.6
## 87        sedan          fwd          front       96.3  172.4  65.4   51.6
## 88        sedan          fwd          front       96.3  172.4  65.4   51.6
## 89        sedan          fwd          front       96.3  172.4  65.4   51.6
## 90        sedan          fwd          front       94.5  165.3  63.8   54.5
## 91        sedan          fwd          front       94.5  165.3  63.8   54.5
## 92        sedan          fwd          front       94.5  165.3  63.8   54.5
## 93        sedan          fwd          front       94.5  165.3  63.8   54.5
## 94        wagon          fwd          front       94.5  170.2  63.8   53.5
## 95        sedan          fwd          front       94.5  165.3  63.8   54.5
## 96    hatchback          fwd          front       94.5  165.6  63.8   53.3
## 97        sedan          fwd          front       94.5  165.3  63.8   54.5
## 98        wagon          fwd          front       94.5  170.2  63.8   53.5
## 99      hardtop          fwd          front       95.1  162.4  63.8   53.3
## 100   hatchback          fwd          front       97.2  173.4  65.2   54.7
## 101       sedan          fwd          front       97.2  173.4  65.2   54.7
## 102       sedan          fwd          front      100.4  181.7  66.5   55.1
## 103       wagon          fwd          front      100.4  184.6  66.5   56.1
```

```
## 104       sedan          fwd          front      100.4  184.6  66.5   55.1
## 105   hatchback          rwd          front       91.3  170.7  67.9   49.7
## 106   hatchback          rwd          front       91.3  170.7  67.9   49.7
## 107   hatchback          rwd          front       99.2  178.5  67.9   49.7
## 108       sedan          rwd          front      107.9  186.7  68.4   56.7
## 109       sedan          rwd          front      107.9  186.7  68.4   56.7
## 110       wagon          rwd          front      114.2  198.9  68.4   58.7
## 111       wagon          rwd          front      114.2  198.9  68.4   58.7
## 112       sedan          rwd          front      107.9  186.7  68.4   56.7
## 113       sedan          rwd          front      107.9  186.7  68.4   56.7
## 114       wagon          rwd          front      114.2  198.9  68.4   56.7
## 115       wagon          rwd          front      114.2  198.9  68.4   58.7
## 116       sedan          rwd          front      107.9  186.7  68.4   56.7
## 117       sedan          rwd          front      107.9  186.7  68.4   56.7
## 118       sedan          rwd          front      108.0  186.7  68.3   56.0
## 119   hatchback          fwd          front       93.7  157.3  63.8   50.8
## 120   hatchback          fwd          front       93.7  157.3  63.8   50.8
## 121   hatchback          fwd          front       93.7  157.3  63.8   50.6
## 122       sedan          fwd          front       93.7  167.3  63.8   50.8
## 123       sedan          fwd          front       93.7  167.3  63.8   50.8
## 124       wagon          fwd          front      103.3  174.6  64.6   59.8
## 125   hatchback          rwd          front       95.9  173.2  66.3   50.2
## 126   hatchback          rwd          front       94.5  168.9  68.3   50.2
## 127     hardtop          rwd           rear       89.5  168.9  65.0   51.6
## 128     hardtop          rwd           rear       89.5  168.9  65.0   51.6
## 129 convertible          rwd           rear       89.5  168.9  65.0   51.6
## 130   hatchback          rwd          front       98.4  175.7  72.3   50.5
## 131       wagon          fwd          front       96.1  181.5  66.5   55.2
## 132   hatchback          fwd          front       96.1  176.8  66.6   50.5
## 133   hatchback          fwd          front       99.1  186.6  66.5   56.1
## 134       sedan          fwd          front       99.1  186.6  66.5   56.1
## 135   hatchback          fwd          front       99.1  186.6  66.5   56.1
## 136       sedan          fwd          front       99.1  186.6  66.5   56.1
## 137   hatchback          fwd          front       99.1  186.6  66.5   56.1
## 138       sedan          fwd          front       99.1  186.6  66.5   56.1
## 139   hatchback          fwd          front       93.7  156.9  63.4   53.7
## 140   hatchback          fwd          front       93.7  157.9  63.6   53.7
## 141   hatchback          4wd          front       93.3  157.3  63.8   55.7
## 142       sedan          fwd          front       97.2  172.0  65.4   52.5
## 143       sedan          fwd          front       97.2  172.0  65.4   52.5
## 144       sedan          fwd          front       97.2  172.0  65.4   52.5
## 145       sedan          4wd          front       97.0  172.0  65.4   54.3
## 146       sedan          4wd          front       97.0  172.0  65.4   54.3
## 147       wagon          fwd          front       97.0  173.5  65.4   53.0
## 148       wagon          fwd          front       97.0  173.5  65.4   53.0
## 149       wagon          4wd          front       96.9  173.6  65.4   54.9
## 150       wagon          4wd          front       96.9  173.6  65.4   54.9
## 151   hatchback          fwd          front       95.7  158.7  63.6   54.5
## 152   hatchback          fwd          front       95.7  158.7  63.6   54.5
## 153   hatchback          fwd          front       95.7  158.7  63.6   54.5
## 154       wagon          fwd          front       95.7  169.7  63.6   59.1
## 155       wagon          4wd          front       95.7  169.7  63.6   59.1
## 156       wagon          4wd          front       95.7  169.7  63.6   59.1
## 157       sedan          fwd          front       95.7  166.3  64.4   53.0
```

```
## 158   hatchback          fwd           front       95.7  166.3  64.4   52.8
## 159       sedan          fwd           front       95.7  166.3  64.4   53.0
## 160   hatchback          fwd           front       95.7  166.3  64.4   52.8
## 161       sedan          fwd           front       95.7  166.3  64.4   53.0
## 162   hatchback          fwd           front       95.7  166.3  64.4   52.8
## 163       sedan          fwd           front       95.7  166.3  64.4   52.8
## 164       sedan          rwd           front       94.5  168.7  64.0   52.6
## 165   hatchback          rwd           front       94.5  168.7  64.0   52.6
## 166       sedan          rwd           front       94.5  168.7  64.0   52.6
## 167   hatchback          rwd           front       94.5  168.7  64.0   52.6
## 168     hardtop          rwd           front       98.4  176.2  65.6   52.0
## 169     hardtop          rwd           front       98.4  176.2  65.6   52.0
## 170   hatchback          rwd           front       98.4  176.2  65.6   52.0
## 171     hardtop          rwd           front       98.4  176.2  65.6   52.0
## 172   hatchback          rwd           front       98.4  176.2  65.6   52.0
## 173 convertible          rwd           front       98.4  176.2  65.6   53.0
## 174       sedan          fwd           front      102.4  175.6  66.5   54.9
## 175       sedan          fwd           front      102.4  175.6  66.5   54.9
## 176   hatchback          fwd           front      102.4  175.6  66.5   53.9
## 177       sedan          fwd           front      102.4  175.6  66.5   54.9
## 178   hatchback          fwd           front      102.4  175.6  66.5   53.9
## 179   hatchback          rwd           front      102.9  183.5  67.7   52.0
## 180   hatchback          rwd           front      102.9  183.5  67.7   52.0
## 181       sedan          rwd           front      104.5  187.8  66.5   54.1
## 182       wagon          rwd           front      104.5  187.8  66.5   54.1
## 183       sedan          fwd           front       97.3  171.7  65.5   55.7
## 184       sedan          fwd           front       97.3  171.7  65.5   55.7
## 185       sedan          fwd           front       97.3  171.7  65.5   55.7
## 186       sedan          fwd           front       97.3  171.7  65.5   55.7
## 187       sedan          fwd           front       97.3  171.7  65.5   55.7
## 188       sedan          fwd           front       97.3  171.7  65.5   55.7
## 189       sedan          fwd           front       97.3  171.7  65.5   55.7
## 190 convertible          fwd           front       94.5  159.3  64.2   55.6
## 191   hatchback          fwd           front       94.5  165.7  64.0   51.4
## 192       sedan          fwd           front      100.4  180.2  66.9   55.1
## 193       sedan          fwd           front      100.4  180.2  66.9   55.1
## 194       wagon          fwd           front      100.4  183.1  66.9   55.1
## 195       sedan          rwd           front      104.3  188.8  67.2   56.2
## 196       wagon          rwd           front      104.3  188.8  67.2   57.5
## 197       sedan          rwd           front      104.3  188.8  67.2   56.2
## 198       wagon          rwd           front      104.3  188.8  67.2   57.5
## 199       sedan          rwd           front      104.3  188.8  67.2   56.2
## 200       wagon          rwd           front      104.3  188.8  67.2   57.5
## 201       sedan          rwd           front      109.1  188.8  68.9   55.5
## 202       sedan          rwd           front      109.1  188.8  68.8   55.5
## 203       sedan          rwd           front      109.1  188.8  68.9   55.5
## 204       sedan          rwd           front      109.1  188.8  68.9   55.5
## 205       sedan          rwd           front      109.1  188.8  68.9   55.5
##     curb.weight engine.type num.of.cylinders engine.size fuel.system bore
## 1          2548        dohc             four         130        mpfi 3.47
## 2          2548        dohc             four         130        mpfi 3.47
## 3          2823        ohcv              six         152        mpfi 2.68
## 4          2337         ohc             four         109        mpfi 3.19
## 5          2824         ohc             five         136        mpfi 3.19
```

```
## 6          2507         ohc            five         136        mpfi 3.19
## 7          2844         ohc            five         136        mpfi 3.19
## 8          2954         ohc            five         136        mpfi 3.19
## 9          3086         ohc            five         131        mpfi 3.13
## 10         3053         ohc            five         131        mpfi 3.13
## 11         2395         ohc            four         108        mpfi  3.5
## 12         2395         ohc            four         108        mpfi  3.5
## 13         2710         ohc             six         164        mpfi 3.31
## 14         2765         ohc             six         164        mpfi 3.31
## 15         3055         ohc             six         164        mpfi 3.31
## 16         3230         ohc             six         209        mpfi 3.62
## 17         3380         ohc             six         209        mpfi 3.62
## 18         3505         ohc             six         209        mpfi 3.62
## 19         1488           l           three          61        2bbl 2.91
## 20         1874         ohc            four          90        2bbl 3.03
## 21         1909         ohc            four          90        2bbl 3.03
## 22         1876         ohc            four          90        2bbl 2.97
## 23         1876         ohc            four          90        2bbl 2.97
## 24         2128         ohc            four          98        mpfi 3.03
## 25         1967         ohc            four          90        2bbl 2.97
## 26         1989         ohc            four          90        2bbl 2.97
## 27         1989         ohc            four          90        2bbl 2.97
## 28         2191         ohc            four          98        mpfi 3.03
## 29         2535         ohc            four         122        2bbl 3.34
## 30         2811         ohc            four         156         mfi  3.6
## 31         1713         ohc            four          92        1bbl 2.91
## 32         1819         ohc            four          92        1bbl 2.91
## 33         1837         ohc            four          79        1bbl 2.91
## 34         1940         ohc            four          92        1bbl 2.91
## 35         1956         ohc            four          92        1bbl 2.91
## 36         2010         ohc            four          92        1bbl 2.91
## 37         2024         ohc            four          92        1bbl 2.92
## 38         2236         ohc            four         110        1bbl 3.15
## 39         2289         ohc            four         110        1bbl 3.15
## 40         2304         ohc            four         110        1bbl 3.15
## 41         2372         ohc            four         110        1bbl 3.15
## 42         2465         ohc            four         110        mpfi 3.15
## 43         2293         ohc            four         110        2bbl 3.15
## 44         2337         ohc            four         111        2bbl 3.31
## 45         1874         ohc            four          90        2bbl 3.03
## 46         1909         ohc            four          90        2bbl 3.03
## 47         2734         ohc            four         119        spfi 3.43
## 48         4066        dohc             six         258        mpfi 3.63
## 49         4066        dohc             six         258        mpfi 3.63
## 50         3950        ohcv          twelve         326        mpfi 3.54
## 51         1890         ohc            four          91        2bbl 3.03
## 52         1900         ohc            four          91        2bbl 3.03
## 53         1905         ohc            four          91        2bbl 3.03
## 54         1945         ohc            four          91        2bbl 3.03
## 55         1950         ohc            four          91        2bbl 3.08
## 56         2380       rotor             two          70        4bbl    ?
## 57         2380       rotor             two          70        4bbl    ?
## 58         2385       rotor             two          70        4bbl    ?
## 59         2500       rotor             two          80        mpfi    ?
```

```
## 60         2385         ohc          four         122        2bbl 3.39
## 61         2410         ohc          four         122        2bbl 3.39
## 62         2385         ohc          four         122        2bbl 3.39
## 63         2410         ohc          four         122        2bbl 3.39
## 64         2443         ohc          four         122         idi 3.39
## 65         2425         ohc          four         122        2bbl 3.39
## 66         2670         ohc          four         140        mpfi 3.76
## 67         2700         ohc          four         134         idi 3.43
## 68         3515         ohc          five         183         idi 3.58
## 69         3750         ohc          five         183         idi 3.58
## 70         3495         ohc          five         183         idi 3.58
## 71         3770         ohc          five         183         idi 3.58
## 72         3740        ohcv         eight         234        mpfi 3.46
## 73         3685        ohcv         eight         234        mpfi 3.46
## 74         3900        ohcv         eight         308        mpfi  3.8
## 75         3715        ohcv         eight         304        mpfi  3.8
## 76         2910         ohc          four         140        mpfi 3.78
## 77         1918         ohc          four          92        2bbl 2.97
## 78         1944         ohc          four          92        2bbl 2.97
## 79         2004         ohc          four          92        2bbl 2.97
## 80         2145         ohc          four          98        spdi 3.03
## 81         2370         ohc          four         110        spdi 3.17
## 82         2328         ohc          four         122        2bbl 3.35
## 83         2833         ohc          four         156        spdi 3.58
## 84         2921         ohc          four         156        spdi 3.59
## 85         2926         ohc          four         156        spdi 3.59
## 86         2365         ohc          four         122        2bbl 3.35
## 87         2405         ohc          four         122        2bbl 3.35
## 88         2403         ohc          four         110        spdi 3.17
## 89         2403         ohc          four         110        spdi 3.17
## 90         1889         ohc          four          97        2bbl 3.15
## 91         2017         ohc          four         103         idi 2.99
## 92         1918         ohc          four          97        2bbl 3.15
## 93         1938         ohc          four          97        2bbl 3.15
## 94         2024         ohc          four          97        2bbl 3.15
## 95         1951         ohc          four          97        2bbl 3.15
## 96         2028         ohc          four          97        2bbl 3.15
## 97         1971         ohc          four          97        2bbl 3.15
## 98         2037         ohc          four          97        2bbl 3.15
## 99         2008         ohc          four          97        2bbl 3.15
## 100        2324         ohc          four         120        2bbl 3.33
## 101        2302         ohc          four         120        2bbl 3.33
## 102        3095        ohcv           six         181        mpfi 3.43
## 103        3296        ohcv           six         181        mpfi 3.43
## 104        3060        ohcv           six         181        mpfi 3.43
## 105        3071        ohcv           six         181        mpfi 3.43
## 106        3139        ohcv           six         181        mpfi 3.43
## 107        3139        ohcv           six         181        mpfi 3.43
## 108        3020           l          four         120        mpfi 3.46
## 109        3197           l          four         152         idi  3.7
## 110        3230           l          four         120        mpfi 3.46
## 111        3430           l          four         152         idi  3.7
## 112        3075           l          four         120        mpfi 3.46
## 113        3252           l          four         152         idi  3.7
```

```
## 114        3285          l           four         120        mpfi 3.46
## 115        3485          l           four         152         idi  3.7
## 116        3075          l           four         120        mpfi 3.46
## 117        3252          l           four         152         idi  3.7
## 118        3130          l           four         134        mpfi 3.61
## 119        1918        ohc           four          90        2bbl 2.97
## 120        2128        ohc           four          98        spdi 3.03
## 121        1967        ohc           four          90        2bbl 2.97
## 122        1989        ohc           four          90        2bbl 2.97
## 123        2191        ohc           four          98        2bbl 2.97
## 124        2535        ohc           four         122        2bbl 3.35
## 125        2818        ohc           four         156        spdi 3.59
## 126        2778        ohc           four         151        mpfi 3.94
## 127        2756       ohcf            six         194        mpfi 3.74
## 128        2756       ohcf            six         194        mpfi 3.74
## 129        2800       ohcf            six         194        mpfi 3.74
## 130        3366      dohcv          eight         203        mpfi 3.94
## 131        2579        ohc           four         132        mpfi 3.46
## 132        2460        ohc           four         132        mpfi 3.46
## 133        2658        ohc           four         121        mpfi 3.54
## 134        2695        ohc           four         121        mpfi 3.54
## 135        2707        ohc           four         121        mpfi 2.54
## 136        2758        ohc           four         121        mpfi 3.54
## 137        2808       dohc           four         121        mpfi 3.54
## 138        2847       dohc           four         121        mpfi 3.54
## 139        2050       ohcf           four          97        2bbl 3.62
## 140        2120       ohcf           four         108        2bbl 3.62
## 141        2240       ohcf           four         108        2bbl 3.62
## 142        2145       ohcf           four         108        2bbl 3.62
## 143        2190       ohcf           four         108        2bbl 3.62
## 144        2340       ohcf           four         108        mpfi 3.62
## 145        2385       ohcf           four         108        2bbl 3.62
## 146        2510       ohcf           four         108        mpfi 3.62
## 147        2290       ohcf           four         108        2bbl 3.62
## 148        2455       ohcf           four         108        mpfi 3.62
## 149        2420       ohcf           four         108        2bbl 3.62
## 150        2650       ohcf           four         108        mpfi 3.62
## 151        1985        ohc           four          92        2bbl 3.05
## 152        2040        ohc           four          92        2bbl 3.05
## 153        2015        ohc           four          92        2bbl 3.05
## 154        2280        ohc           four          92        2bbl 3.05
## 155        2290        ohc           four          92        2bbl 3.05
## 156        3110        ohc           four          92        2bbl 3.05
## 157        2081        ohc           four          98        2bbl 3.19
## 158        2109        ohc           four          98        2bbl 3.19
## 159        2275        ohc           four         110         idi 3.27
## 160        2275        ohc           four         110         idi 3.27
## 161        2094        ohc           four          98        2bbl 3.19
## 162        2122        ohc           four          98        2bbl 3.19
## 163        2140        ohc           four          98        2bbl 3.19
## 164        2169        ohc           four          98        2bbl 3.19
## 165        2204        ohc           four          98        2bbl 3.19
## 166        2265       dohc           four          98        mpfi 3.24
## 167        2300       dohc           four          98        mpfi 3.24
```

```
## 168        2540         ohc            four         146        mpfi 3.62
## 169        2536         ohc            four         146        mpfi 3.62
## 170        2551         ohc            four         146        mpfi 3.62
## 171        2679         ohc            four         146        mpfi 3.62
## 172        2714         ohc            four         146        mpfi 3.62
## 173        2975         ohc            four         146        mpfi 3.62
## 174        2326         ohc            four         122        mpfi 3.31
## 175        2480         ohc            four         110         idi 3.27
## 176        2414         ohc            four         122        mpfi 3.31
## 177        2414         ohc            four         122        mpfi 3.31
## 178        2458         ohc            four         122        mpfi 3.31
## 179        2976        dohc             six         171        mpfi 3.27
## 180        3016        dohc             six         171        mpfi 3.27
## 181        3131        dohc             six         171        mpfi 3.27
## 182        3151        dohc             six         161        mpfi 3.27
## 183        2261         ohc            four          97         idi 3.01
## 184        2209         ohc            four         109        mpfi 3.19
## 185        2264         ohc            four          97         idi 3.01
## 186        2212         ohc            four         109        mpfi 3.19
## 187        2275         ohc            four         109        mpfi 3.19
## 188        2319         ohc            four          97         idi 3.01
## 189        2300         ohc            four         109        mpfi 3.19
## 190        2254         ohc            four         109        mpfi 3.19
## 191        2221         ohc            four         109        mpfi 3.19
## 192        2661         ohc            five         136        mpfi 3.19
## 193        2579         ohc            four          97         idi 3.01
## 194        2563         ohc            four         109        mpfi 3.19
## 195        2912         ohc            four         141        mpfi 3.78
## 196        3034         ohc            four         141        mpfi 3.78
## 197        2935         ohc            four         141        mpfi 3.78
## 198        3042         ohc            four         141        mpfi 3.78
## 199        3045         ohc            four         130        mpfi 3.62
## 200        3157         ohc            four         130        mpfi 3.62
## 201        2952         ohc            four         141        mpfi 3.78
## 202        3049         ohc            four         141        mpfi 3.78
## 203        3012        ohcv             six         173        mpfi 3.58
## 204        3217         ohc             six         145         idi 3.01
## 205        3062         ohc            four         141        mpfi 3.78
##     stroke compression.ratio horsepower peak.rpm city.mpg highway.mpg price
## 1     2.68              9.00        111     5000       21          27 13495
## 2     2.68              9.00        111     5000       21          27 16500
## 3     3.47              9.00        154     5000       19          26 16500
## 4      3.4             10.00        102     5500       24          30 13950
## 5      3.4              8.00        115     5500       18          22 17450
## 6      3.4              8.50        110     5500       19          25 15250
## 7      3.4              8.50        110     5500       19          25 17710
## 8      3.4              8.50        110     5500       19          25 18920
## 9      3.4              8.30        140     5500       17          20 23875
## 10     3.4              7.00        160     5500       16          22     ?
## 11     2.8              8.80        101     5800       23          29 16430
## 12     2.8              8.80        101     5800       23          29 16925
## 13    3.19              9.00        121     4250       21          28 20970
## 14    3.19              9.00        121     4250       21          28 21105
## 15    3.19              9.00        121     4250       20          25 24565
```

```
## 16    3.39          8.00      182     5400       16          22 30760
## 17    3.39          8.00      182     5400       16          22 41315
## 18    3.39          8.00      182     5400       15          20 36880
## 19    3.03          9.50       48     5100       47          53  5151
## 20    3.11          9.60       70     5400       38          43  6295
## 21    3.11          9.60       70     5400       38          43  6575
## 22    3.23          9.41       68     5500       37          41  5572
## 23    3.23          9.40       68     5500       31          38  6377
## 24    3.39          7.60      102     5500       24          30  7957
## 25    3.23          9.40       68     5500       31          38  6229
## 26    3.23          9.40       68     5500       31          38  6692
## 27    3.23          9.40       68     5500       31          38  7609
## 28    3.39          7.60      102     5500       24          30  8558
## 29    3.46          8.50       88     5000       24          30  8921
## 30     3.9          7.00      145     5000       19          24 12964
## 31    3.41          9.60       58     4800       49          54  6479
## 32    3.41          9.20       76     6000       31          38  6855
## 33    3.07         10.10       60     5500       38          42  5399
## 34    3.41          9.20       76     6000       30          34  6529
## 35    3.41          9.20       76     6000       30          34  7129
## 36    3.41          9.20       76     6000       30          34  7295
## 37    3.41          9.20       76     6000       30          34  7295
## 38    3.58          9.00       86     5800       27          33  7895
## 39    3.58          9.00       86     5800       27          33  9095
## 40    3.58          9.00       86     5800       27          33  8845
## 41    3.58          9.00       86     5800       27          33 10295
## 42    3.58          9.00      101     5800       24          28 12945
## 43    3.58          9.10      100     5500       25          31 10345
## 44    3.23          8.50       78     4800       24          29  6785
## 45    3.11          9.60       70     5400       38          43     ?
## 46    3.11          9.60       70     5400       38          43     ?
## 47    3.23          9.20       90     5000       24          29 11048
## 48    4.17          8.10      176     4750       15          19 32250
## 49    4.17          8.10      176     4750       15          19 35550
## 50    2.76         11.50      262     5000       13          17 36000
## 51    3.15          9.00       68     5000       30          31  5195
## 52    3.15          9.00       68     5000       31          38  6095
## 53    3.15          9.00       68     5000       31          38  6795
## 54    3.15          9.00       68     5000       31          38  6695
## 55    3.15          9.00       68     5000       31          38  7395
## 56       ?          9.40      101     6000       17          23 10945
## 57       ?          9.40      101     6000       17          23 11845
## 58       ?          9.40      101     6000       17          23 13645
## 59       ?          9.40      135     6000       16          23 15645
## 60    3.39          8.60       84     4800       26          32  8845
## 61    3.39          8.60       84     4800       26          32  8495
## 62    3.39          8.60       84     4800       26          32 10595
## 63    3.39          8.60       84     4800       26          32 10245
## 64    3.39         22.70       64     4650       36          42 10795
## 65    3.39          8.60       84     4800       26          32 11245
## 66    3.16          8.00      120     5000       19          27 18280
## 67    3.64         22.00       72     4200       31          39 18344
## 68    3.64         21.50      123     4350       22          25 25552
## 69    3.64         21.50      123     4350       22          25 28248
```

```
## 70    3.64    21.50   123   4350   22   25 28176
## 71    3.64    21.50   123   4350   22   25 31600
## 72     3.1     8.30   155   4750   16   18 34184
## 73     3.1     8.30   155   4750   16   18 35056
## 74    3.35     8.00   184   4500   14   16 40960
## 75    3.35     8.00   184   4500   14   16 45400
## 76    3.12     8.00   175   5000   19   24 16503
## 77    3.23     9.40    68   5500   37   41  5389
## 78    3.23     9.40    68   5500   31   38  6189
## 79    3.23     9.40    68   5500   31   38  6669
## 80    3.39     7.60   102   5500   24   30  7689
## 81    3.46     7.50   116   5500   23   30  9959
## 82    3.46     8.50    88   5000   25   32  8499
## 83    3.86     7.00   145   5000   19   24 12629
## 84    3.86     7.00   145   5000   19   24 14869
## 85    3.86     7.00   145   5000   19   24 14489
## 86    3.46     8.50    88   5000   25   32  6989
## 87    3.46     8.50    88   5000   25   32  8189
## 88    3.46     7.50   116   5500   23   30  9279
## 89    3.46     7.50   116   5500   23   30  9279
## 90    3.29     9.40    69   5200   31   37  5499
## 91    3.47    21.90    55   4800   45   50  7099
## 92    3.29     9.40    69   5200   31   37  6649
## 93    3.29     9.40    69   5200   31   37  6849
## 94    3.29     9.40    69   5200   31   37  7349
## 95    3.29     9.40    69   5200   31   37  7299
## 96    3.29     9.40    69   5200   31   37  7799
## 97    3.29     9.40    69   5200   31   37  7499
## 98    3.29     9.40    69   5200   31   37  7999
## 99    3.29     9.40    69   5200   31   37  8249
## 100   3.47     8.50    97   5200   27   34  8949
## 101   3.47     8.50    97   5200   27   34  9549
## 102   3.27     9.00   152   5200   17   22 13499
## 103   3.27     9.00   152   5200   17   22 14399
## 104   3.27     9.00   152   5200   19   25 13499
## 105   3.27     9.00   160   5200   19   25 17199
## 106   3.27     7.80   200   5200   17   23 19699
## 107   3.27     9.00   160   5200   19   25 18399
## 108   3.19     8.40    97   5000   19   24 11900
## 109   3.52    21.00    95   4150   28   33 13200
## 110   3.19     8.40    97   5000   19   24 12440
## 111   3.52    21.00    95   4150   25   25 13860
## 112   2.19     8.40    95   5000   19   24 15580
## 113   3.52    21.00    95   4150   28   33 16900
## 114   2.19     8.40    95   5000   19   24 16695
## 115   3.52    21.00    95   4150   25   25 17075
## 116   3.19     8.40    97   5000   19   24 16630
## 117   3.52    21.00    95   4150   28   33 17950
## 118   3.21     7.00   142   5600   18   24 18150
## 119   3.23     9.40    68   5500   37   41  5572
## 120   3.39     7.60   102   5500   24   30  7957
## 121   3.23     9.40    68   5500   31   38  6229
## 122   3.23     9.40    68   5500   31   38  6692
## 123   3.23     9.40    68   5500   31   38  7609
```

```
## 124   3.46              8.50         88     5000       24          30  8921
## 125   3.86              7.00        145     5000       19          24 12764
## 126   3.11              9.50        143     5500       19          27 22018
## 127    2.9              9.50        207     5900       17          25 32528
## 128    2.9              9.50        207     5900       17          25 34028
## 129    2.9              9.50        207     5900       17          25 37028
## 130   3.11             10.00        288     5750       17          28     ?
## 131    3.9              8.70          ?        ?       23          31  9295
## 132    3.9              8.70          ?        ?       23          31  9895
## 133   3.07              9.31        110     5250       21          28 11850
## 134   3.07              9.30        110     5250       21          28 12170
## 135   2.07              9.30        110     5250       21          28 15040
## 136   3.07              9.30        110     5250       21          28 15510
## 137   3.07              9.00        160     5500       19          26 18150
## 138   3.07              9.00        160     5500       19          26 18620
## 139   2.36              9.00         69     4900       31          36  5118
## 140   2.64              8.70         73     4400       26          31  7053
## 141   2.64              8.70         73     4400       26          31  7603
## 142   2.64              9.50         82     4800       32          37  7126
## 143   2.64              9.50         82     4400       28          33  7775
## 144   2.64              9.00         94     5200       26          32  9960
## 145   2.64              9.00         82     4800       24          25  9233
## 146   2.64              7.70        111     4800       24          29 11259
## 147   2.64              9.00         82     4800       28          32  7463
## 148   2.64              9.00         94     5200       25          31 10198
## 149   2.64              9.00         82     4800       23          29  8013
## 150   2.64              7.70        111     4800       23          23 11694
## 151   3.03              9.00         62     4800       35          39  5348
## 152   3.03              9.00         62     4800       31          38  6338
## 153   3.03              9.00         62     4800       31          38  6488
## 154   3.03              9.00         62     4800       31          37  6918
## 155   3.03              9.00         62     4800       27          32  7898
## 156   3.03              9.00         62     4800       27          32  8778
## 157   3.03              9.00         70     4800       30          37  6938
## 158   3.03              9.00         70     4800       30          37  7198
## 159   3.35             22.50         56     4500       34          36  7898
## 160   3.35             22.50         56     4500       38          47  7788
## 161   3.03              9.00         70     4800       38          47  7738
## 162   3.03              9.00         70     4800       28          34  8358
## 163   3.03              9.00         70     4800       28          34  9258
## 164   3.03              9.00         70     4800       29          34  8058
## 165   3.03              9.00         70     4800       29          34  8238
## 166   3.08              9.40        112     6600       26          29  9298
## 167   3.08              9.40        112     6600       26          29  9538
## 168    3.5              9.30        116     4800       24          30  8449
## 169    3.5              9.30        116     4800       24          30  9639
## 170    3.5              9.30        116     4800       24          30  9989
## 171    3.5              9.30        116     4800       24          30 11199
## 172    3.5              9.30        116     4800       24          30 11549
## 173    3.5              9.30        116     4800       24          30 17669
## 174   3.54              8.70         92     4200       29          34  8948
## 175   3.35             22.50         73     4500       30          33 10698
## 176   3.54              8.70         92     4200       27          32  9988
## 177   3.54              8.70         92     4200       27          32 10898
```

```
## 178   3.54              8.70         92     4200       27          32 11248
## 179   3.35              9.30        161     5200       20          24 16558
## 180   3.35              9.30        161     5200       19          24 15998
## 181   3.35              9.20        156     5200       20          24 15690
## 182   3.35              9.20        156     5200       19          24 15750
## 183    3.4             23.00         52     4800       37          46  7775
## 184    3.4              9.00         85     5250       27          34  7975
## 185    3.4             23.00         52     4800       37          46  7995
## 186    3.4              9.00         85     5250       27          34  8195
## 187    3.4              9.00         85     5250       27          34  8495
## 188    3.4             23.00         68     4500       37          42  9495
## 189    3.4             10.00        100     5500       26          32  9995
## 190    3.4              8.50         90     5500       24          29 11595
## 191    3.4              8.50         90     5500       24          29  9980
## 192    3.4              8.50        110     5500       19          24 13295
## 193    3.4             23.00         68     4500       33          38 13845
## 194    3.4              9.00         88     5500       25          31 12290
## 195   3.15              9.50        114     5400       23          28 12940
## 196   3.15              9.50        114     5400       23          28 13415
## 197   3.15              9.50        114     5400       24          28 15985
## 198   3.15              9.50        114     5400       24          28 16515
## 199   3.15              7.50        162     5100       17          22 18420
## 200   3.15              7.50        162     5100       17          22 18950
## 201   3.15              9.50        114     5400       23          28 16845
## 202   3.15              8.70        160     5300       19          25 19045
## 203   2.87              8.80        134     5500       18          23 21485
## 204    3.4             23.00        106     4800       26          27 22470
## 205   3.15              9.50        114     5400       19          25 22625
```

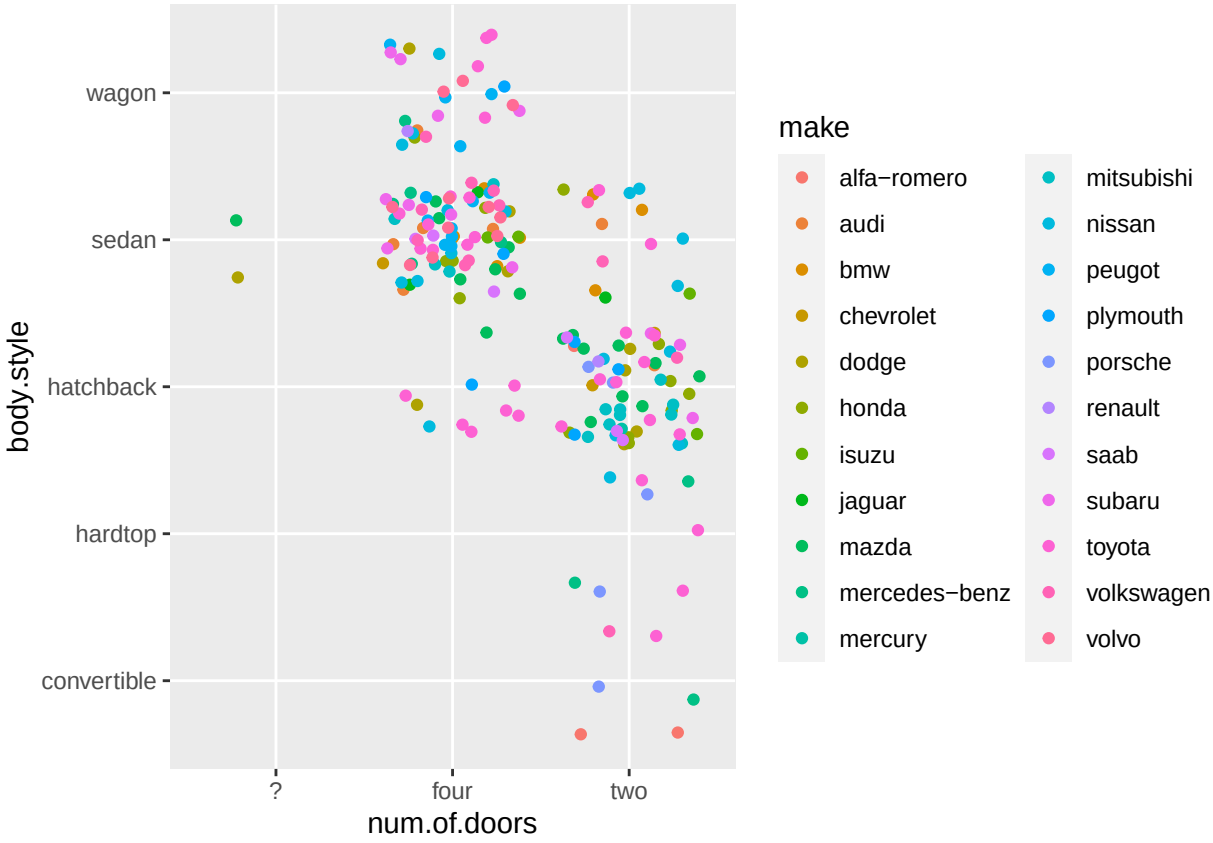
```
summary(dataset)
```

```
##    symboling       normalized.losses      make            fuel.type
##  Min.   :-2.0000   Length:205         Length:205         Length:205
##  1st Qu.: 0.0000   Class :character   Class :character   Class :character
##  Median : 1.0000   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 0.8341
##  3rd Qu.: 2.0000
##  Max.   : 3.0000
##   aspiration        num.of.doors        body.style        drive.wheels
##  Length:205         Length:205         Length:205         Length:205
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  engine.location      wheel.base         length          width
##  Length:205         Min.   : 86.60   Min.   :141.1   Min.   :60.30
##  Class :character   1st Qu.: 94.50   1st Qu.:166.3   1st Qu.:64.10
##  Mode  :character   Median : 97.00   Median :173.2   Median :65.50
##                     Mean   : 98.76   Mean   :174.0   Mean   :65.91
##                     3rd Qu.:102.40   3rd Qu.:183.1   3rd Qu.:66.90
##                     Max.   :120.90   Max.   :208.1   Max.   :72.30
##      height       curb.weight   engine.type        num.of.cylinders
##  Min.   :47.80   Min.   :1488   Length:205         Length:205
```

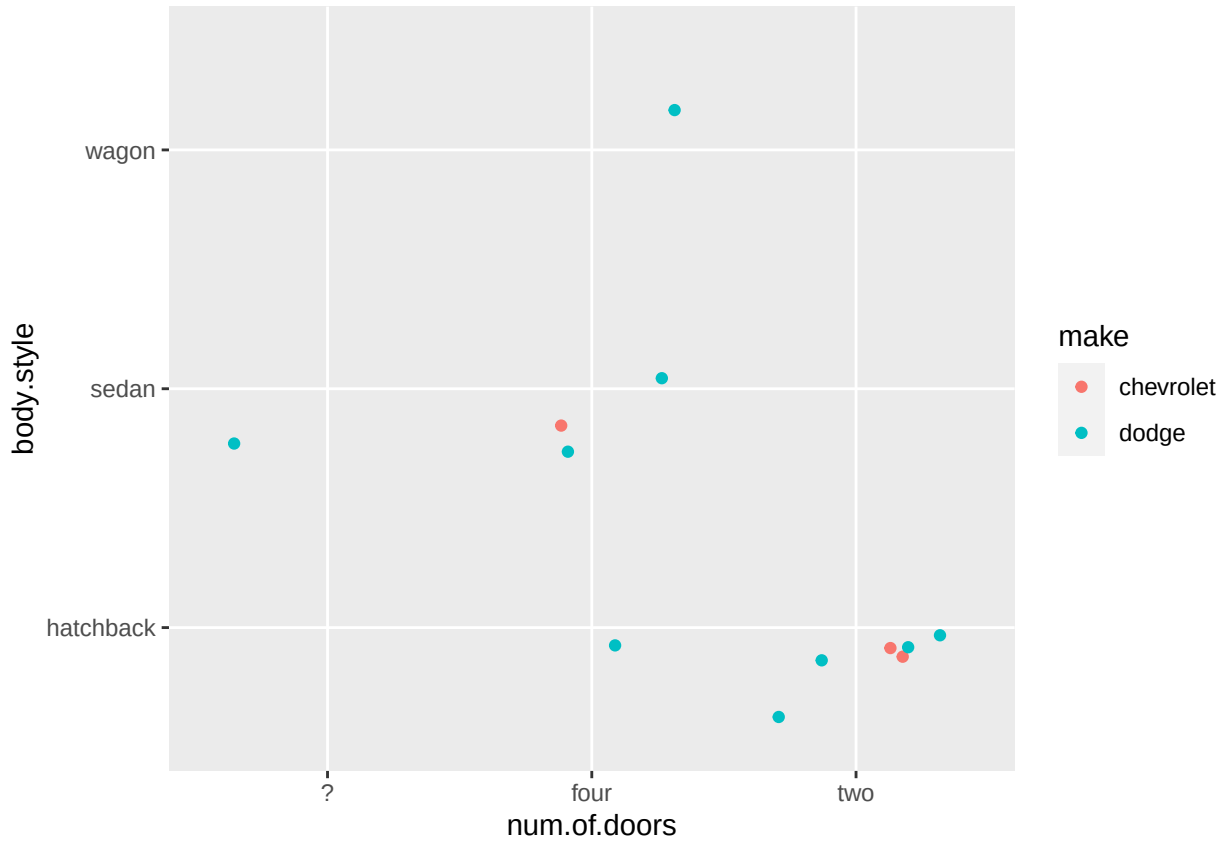
```
##  1st Qu.:52.00   1st Qu.:2145   Class :character   Class :character
##  Median :54.10   Median :2414   Mode  :character   Mode  :character
##  Mean   :53.72   Mean   :2556
##  3rd Qu.:55.50   3rd Qu.:2935
##  Max.   :59.80   Max.   :4066
##   engine.size    fuel.system           bore              stroke
##  Min.   : 61.0   Length:205         Length:205         Length:205
##  1st Qu.: 97.0   Class :character   Class :character   Class :character
##  Median :120.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   :126.9
##  3rd Qu.:141.0
##  Max.   :326.0
##  compression.ratio  horsepower          peak.rpm           city.mpg
##  Min.   : 7.00     Length:205         Length:205         Min.   :13.00
##  1st Qu.: 8.60     Class :character   Class :character   1st Qu.:19.00
##  Median : 9.00     Mode  :character   Mode  :character   Median :24.00
##  Mean   :10.14                                           Mean   :25.22
##  3rd Qu.: 9.40                                           3rd Qu.:30.00
##  Max.   :23.00                                           Max.   :49.00
##   highway.mpg       price
##  Min.   :16.00   Length:205
##  1st Qu.:25.00   Class :character
##  Median :30.00   Mode  :character
##  Mean   :30.75
##  3rd Qu.:34.00
##  Max.   :54.00
```

```
dataset$symboling <- NULL
dataset$normalized.losses <- NULL
```

```
#Comparison between doors count and body type (color:make)
f <- ggplot(dataset, aes(num.of.doors, body.style))
f + geom_jitter(aes(color=make))
```




```
#Just chevrolet & dodge
f2 <- ggplot(subset(dataset,make=="chevrolet" | make=="dodge"), aes(num.of.doors, body.style))
f2 + geom_jitter(aes(color=make))
```



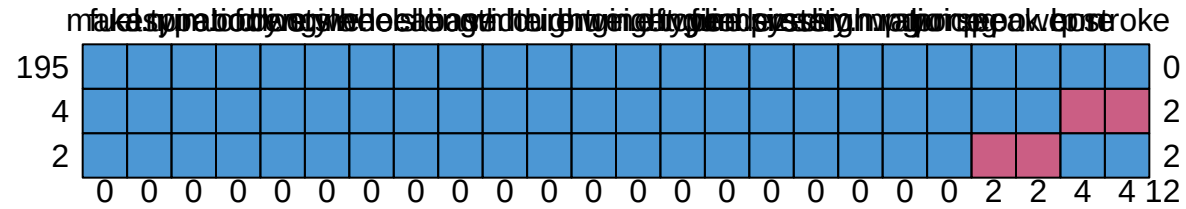
Data cleaning

```
#Code "?" to NA
dataset$horsepower[dataset$horsepower == "?"] <- NA
dataset$price[dataset$price == "?"] <- NA
dataset$stroke[dataset$stroke == "?"] <- NA
dataset$bore[dataset$bore == "?"] <- NA
dataset$peak.rpm[dataset$peak.rpm == "?"] <- NA


#convert to numerical forms
dataset$horsepower<-as.numeric(as.character(dataset$horsepower))
dataset$price<-as.numeric(as.character(dataset$price))
dataset$stroke<-as.numeric(as.character(dataset$stroke))
dataset$bore<-as.numeric(as.character(dataset$bore))
dataset$peak.rpm<-as.numeric(as.character(dataset$peak.rpm))

#the elimination of no price observations
dataset<-subset(dataset, !is.na(price))

#Check to see what values we are missing via obs.
md.pattern(dataset)
```




```
##     make fuel.type aspiration num.of.doors body.style drive.wheels
## 195    1         1          1            1          1            1
## 4      1         1          1            1          1            1
## 2      1         1          1            1          1            1
##        0         0          0            0          0            0
##     engine.location wheel.base length width height curb.weight engine.type
## 195               1          1      1     1      1           1           1
## 4                 1          1      1     1      1           1           1
## 2                 1          1      1     1      1           1           1
##                   0          0      0     0      0           0           0
##     num.of.cylinders engine.size fuel.system compression.ratio city.mpg
## 195                1           1           1                 1        1
## 4                  1           1           1                 1        1
## 2                  1           1           1                 1        1
##                    0           0           0                 0        0
##     highway.mpg price horsepower peak.rpm bore stroke
## 195           1     1          1        1    1      1  0
## 4             1     1          1        1    0      0  2
## 2             1     1          0        0    1      1  2
##               0     0          2        2    4      4 12
```

```
#Utilize the mice package to estimate values.
tempData <- mice(dataset,m=2,maxit=6,meth='pmm',seed=456)
```

```
##
```

```
##  iter imp variable
##   1   1  bore  stroke  horsepower  peak.rpm
##   1   2  bore  stroke  horsepower  peak.rpm
##   2   1  bore  stroke  horsepower  peak.rpm
##   2   2  bore  stroke  horsepower  peak.rpm
##   3   1  bore  stroke  horsepower  peak.rpm
##   3   2  bore  stroke  horsepower  peak.rpm
##   4   1  bore  stroke  horsepower  peak.rpm
##   4   2  bore  stroke  horsepower  peak.rpm
##   5   1  bore  stroke  horsepower  peak.rpm
##   5   2  bore  stroke  horsepower  peak.rpm
##   6   1  bore  stroke  horsepower  peak.rpm
##   6   2  bore  stroke  horsepower  peak.rpm

## Warning: Number of logged events: 10
```

```
summary(tempData)
```

```
## Class: mids
## Number of multiple imputations:  2
## Imputation methods:
##              make         fuel.type        aspiration      num.of.doors
##                ""                ""                ""                ""
##        body.style      drive.wheels   engine.location        wheel.base
##                ""                ""                ""                ""
##            length             width            height       curb.weight
##                ""                ""                ""                ""
##       engine.type  num.of.cylinders       engine.size       fuel.system
##                ""                ""                ""                ""
##              bore            stroke compression.ratio        horsepower
##             "pmm"             "pmm"                ""             "pmm"
##          peak.rpm          city.mpg       highway.mpg             price
##             "pmm"                ""                ""                ""
## PredictorMatrix:
##              make fuel.type aspiration num.of.doors body.style drive.wheels
## make            0         0          0            0          0            0
## fuel.type       0         0          0            0          0            0
## aspiration      0         0          0            0          0            0
## num.of.doors    0         0          0            0          0            0
## body.style      0         0          0            0          0            0
## drive.wheels    0         0          0            0          0            0
##              engine.location wheel.base length width height curb.weight
## make                       0          1      1     1      1           1
## fuel.type                  0          1      1     1      1           1
## aspiration                 0          1      1     1      1           1
## num.of.doors               0          1      1     1      1           1
## body.style                 0          1      1     1      1           1
## drive.wheels               0          1      1     1      1           1
##              engine.type num.of.cylinders engine.size fuel.system bore stroke
## make                   0                0           1           0    1      1
## fuel.type              0                0           1           0    1      1
## aspiration             0                0           1           0    1      1
## num.of.doors           0                0           1           0    1      1
```

```
## body.style             0               0           1           0    1      1
## drive.wheels           0               0           1           0    1      1
##              compression.ratio horsepower peak.rpm city.mpg highway.mpg price
## make                         1          1        1        1           1     1
## fuel.type                    1          1        1        1           1     1
## aspiration                   1          1        1        1           1     1
## num.of.doors                 1          1        1        1           1     1
## body.style                   1          1        1        1           1     1
## drive.wheels                 1          1        1        1           1     1
## Number of logged events:  10
##   it im dep     meth          out
## 1  0  0     constant         make
## 2  0  0     constant    fuel.type
## 3  0  0     constant   aspiration
## 4  0  0     constant num.of.doors
## 5  0  0     constant   body.style
## 6  0  0     constant drive.wheels
```

Let's examine the imputed values and plot them to determine whether our values are acceptable.

```
tempData$imp$horsepower
```

```
##       1   2
## 131 110 110
## 132 123 162
```

```
tempData$imp$stroke
```

```
##       1    2
## 56 2.36 2.90
## 57 2.64 3.39
## 58 2.64 2.64
## 59 2.19 2.68
```

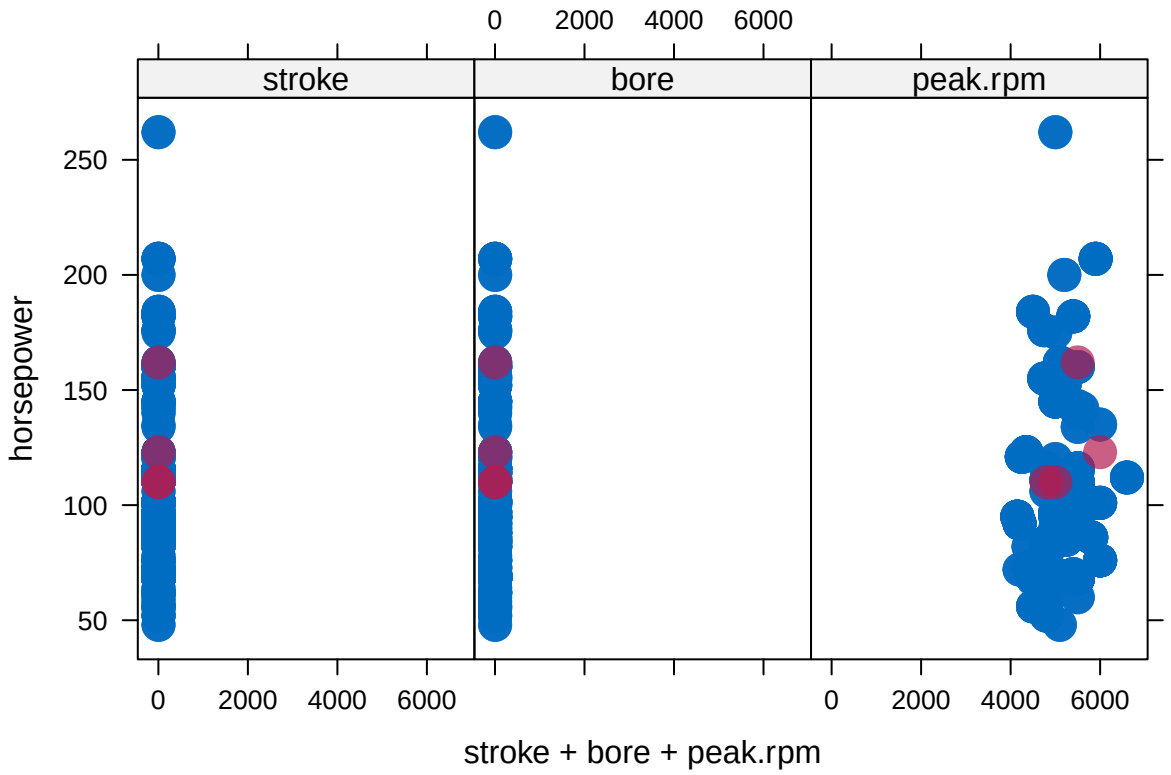
```
tempData$imp$bore
```

```
##       1    2
## 56 3.62 3.62
## 57 3.43 3.46
## 58 3.62 3.78
## 59 3.27 3.54
```

```
tempData$imp$peak.rpm
```

```
##        1    2
## 131 4800 5000
## 132 6000 5500
```

```
#Plot of vals
xyplot(tempData, horsepower ~ stroke + bore + peak.rpm,pch=19,cex=2)
```




```
#Overwrite missing
dataset <- complete(tempData,1)
#one last look for missing and ?
colSums(is.na(dataset))
```

```
##              make         fuel.type        aspiration      num.of.doors
##                 0                 0                 0                 0
##        body.style      drive.wheels   engine.location        wheel.base
##                 0                 0                 0                 0
##            length             width            height       curb.weight
##                 0                 0                 0                 0
##       engine.type  num.of.cylinders       engine.size       fuel.system
##                 0                 0                 0                 0
##              bore            stroke compression.ratio        horsepower
##                 0                 0                 0                 0
##          peak.rpm          city.mpg       highway.mpg             price
##                 0                 0                 0                 0
```

```
colSums(dataset == '?')
```

```
##              make         fuel.type        aspiration      num.of.doors
```

```
##                0                0                0                2
##       body.style      drive.wheels   engine.location       wheel.base
##                0                0                0                0
##           length            width           height      curb.weight
##                0                0                0                0
##      engine.type  num.of.cylinders      engine.size      fuel.system
##                0                0                0                0
##             bore           stroke compression.ratio       horsepower
##                0                0                0                0
##         peak.rpm         city.mpg      highway.mpg            price
##                0                0                0                0
```

```
#The numerical variables are scaled
ind <- sapply(dataset, is.numeric)
dataset_scale<-dataset
dataset_scale[ind] <- lapply(dataset[ind], scale)
str(dataset)
```

```
## 'data.frame':    201 obs. of  24 variables:
##  $ make             : chr  "alfa-romero" "alfa-romero" "alfa-romero" "audi" ...
##  $ fuel.type        : chr  "gas" "gas" "gas" "gas" ...
##  $ aspiration       : chr  "std" "std" "std" "std" ...
##  $ num.of.doors     : chr  "two" "two" "two" "four" ...
##  $ body.style       : chr  "convertible" "convertible" "hatchback" "sedan" ...
##  $ drive.wheels     : chr  "rwd" "rwd" "rwd" "fwd" ...
##  $ engine.location  : chr  "front" "front" "front" "front" ...
##  $ wheel.base       : num  88.6 88.6 94.5 99.8 99.4 ...
##  $ length           : num  169 169 171 177 177 ...
##  $ width            : num  64.1 64.1 65.5 66.2 66.4 66.3 71.4 71.4 71.4 64.8 ...
##  $ height           : num  48.8 48.8 52.4 54.3 54.3 53.1 55.7 55.7 55.9 54.3 ...
##  $ curb.weight      : int  2548 2548 2823 2337 2824 2507 2844 2954 3086 2395 ...
##  $ engine.type      : chr  "dohc" "dohc" "ohcv" "ohc" ...
##  $ num.of.cylinders : chr  "four" "four" "six" "four" ...
##  $ engine.size      : int  130 130 152 109 136 136 136 136 131 108 ...
##  $ fuel.system      : chr  "mpfi" "mpfi" "mpfi" "mpfi" ...
##  $ bore             : num  3.47 3.47 2.68 3.19 3.19 3.19 3.19 3.19 3.13 3.5 ...
##  $ stroke           : num  2.68 2.68 3.47 3.4 3.4 3.4 3.4 3.4 3.4 2.8 ...
##  $ compression.ratio: num  9 9 9 10 8 8.5 8.5 8.5 8.3 8.8 ...
##  $ horsepower       : num  111 111 154 102 115 110 110 110 140 101 ...
##  $ peak.rpm         : num  5000 5000 5000 5500 5500 5500 5500 5500 5500 5800 ...
##  $ city.mpg         : int  21 21 19 24 18 19 19 19 17 23 ...
##  $ highway.mpg      : int  27 27 26 30 22 25 25 25 20 29 ...
##  $ price            : num  13495 16500 16500 13950 17450 ...
```

#For this method, renaming a variable's levels will prevent conflicts.

```
levels(dataset_scale$num.of.cylinders)
```

```
## NULL
```

```
head(dataset_scale$num.of.cylinders)
```

```
## [1] "four" "four" "six"  "four" "five" "five"
```

```
levels(dataset_scale$num.of.cylinders)<-c('cyl_five', 'cyl_eight', 'cyl_six', 'cyl_four', 'cyl_two', 'cy
head(dataset_scale$num.of.cylinders)
```

```
## [1] "four" "four" "six"  "four" "five" "five"
```

```
#Separate qualitative and quantitative data
X.quanti <- dataset_scale[,c(8:12,15,17:24)]
X.quali <- dataset_scale[,c(1:7,13,14,16)]
#pca<-PCAmix(X.quanti,X.quali,ndim=4)
pca <-PCAmix(X.quanti,X.quali,ndim=2,graph=FALSE, rename.level = TRUE)
```

```
#converting to a data frame
coords<-as.data.frame(pca$ind$coord)
```

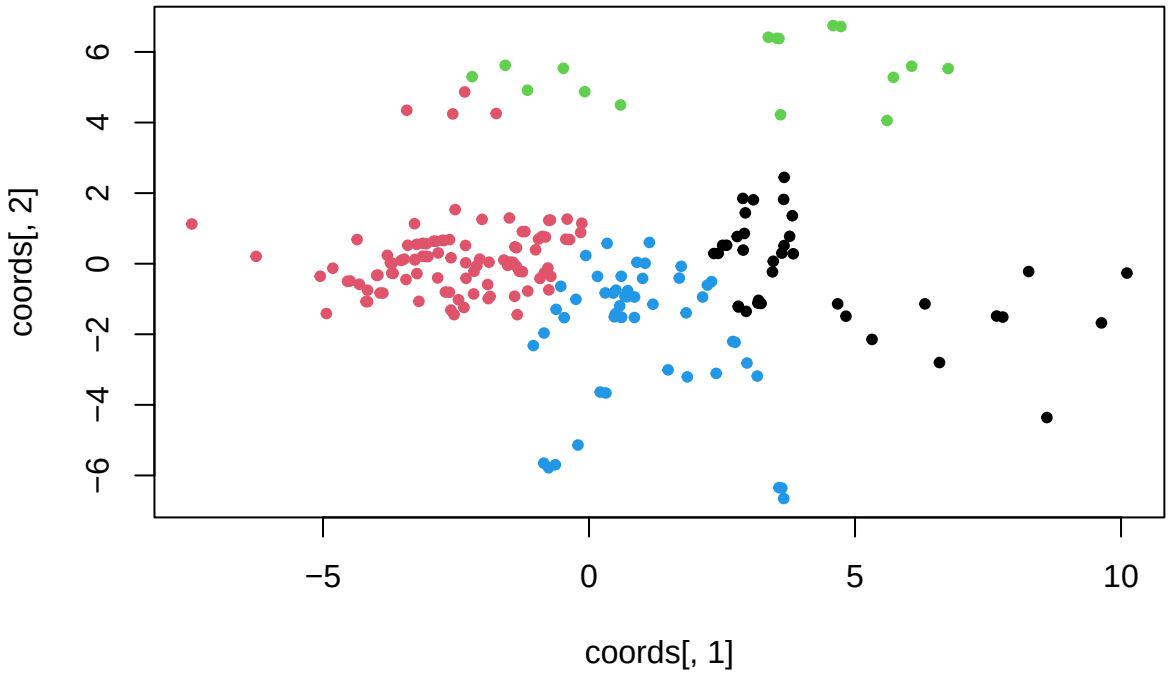
Next we apply k means to cluster based on our PCA, I choose 4 as this looks natural from assessing by eye

```
#To cluster, use K means.
km <- kmeans(coords, centers = 4)
km
```

```
## K-means clustering with 4 clusters of sizes 36, 99, 16, 50
##
## Cluster means:
##        dim 1      dim 2
## 1  4.3972475 -0.2562090
## 2 -2.5208041  0.1817961
## 3  2.6651738  5.5049506
## 4  0.9723184 -1.9370700
##
## Clustering vector:
##   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
##   4   4   4   4   4   4   1   1   1   4   4   4   4   1   1   1   1   2   2   2
##  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
##   2   2   2   2   2   2   2   2   4   2   2   2   2   2   2   2   2   2   2   2
##  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57  58  59  60
##   2   2   2   4   1   1   1   2   2   2   2   2   4   4   4   4   2   2   2   2
##  61  62  63  64  65  66  67  68  69  70  71  72  73  74  75  76  77  78  79  80
##   3   2   4   3   3   3   3   3   1   1   1   1   1   2   2   2   2   2   2   4
##  81  82  83  84  85  86  87  88  89  90  91  92  93  94  95  96  97  98  99 100
##   4   4   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   2   1   1
## 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120
##   1   4   4   4   1   3   1   3   1   3   1   3   1   3   1   2   2   2   2   2
## 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140
##   2   4   4   4   4   4   4   4   4   4   4   4   4   4   2   2   2   2   2   2
## 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160
##   2   4   2   4   2   4   2   2   2   2   2   2   2   2   2   2   2   2   2   2
## 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180
##   2   4   4   4   4   4   4   4   4   2   3   2   2   2   4   4   1   1   2   2
## 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200
##   3   2   2   3   2   2   2   4   3   2   1   1   1   1   1   1   1   1   1   3
## 201
##   1
```

```
##
## Within cluster sum of squares by cluster:
## [1] 241.7718 308.7079 146.0921 260.6335
##  (between_SS / total_SS =  69.3 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
plot(coords[,1], coords[,2], col = km$cluster, pch = 20)
```




```
dataset$cluster<-as.factor(km$cluster)
```