Final project

pavan

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```
library(ggplot2)

## Warning: package 'ggplot2' was built under R version 4.1.2

library(readr)
library(mice)

## Warning: package 'mice' was built under R version 4.1.2

##
## Attaching package: 'mice'

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

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

library(lattice)
library(cluster)
library(MASS)
library(PCAmixdata)

## Warning: package 'PCAmixdata' was built under R version 4.1.2

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
```

```
setwd("C:/Users/pavankumar pendela/Desktop/R/ppendela-74790/ppendela-
74790/final project")
dataset <- read.csv("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.rm 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
```

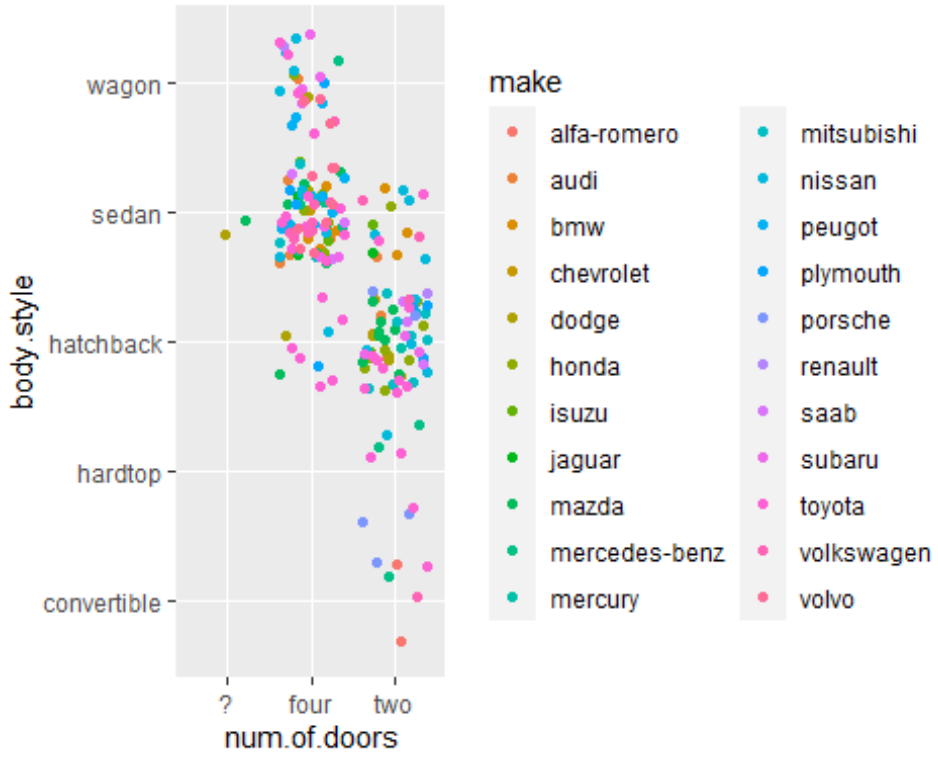
```
9295
## 132    3.9             8.70          ?        ?       23          31
9895
## 133   3.07             9.31        110     5250       21          28
11850
## 134   3.07             9.30        110     5250       21          28
12170
## 135   2.07             9.30        110     5250       21          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
```

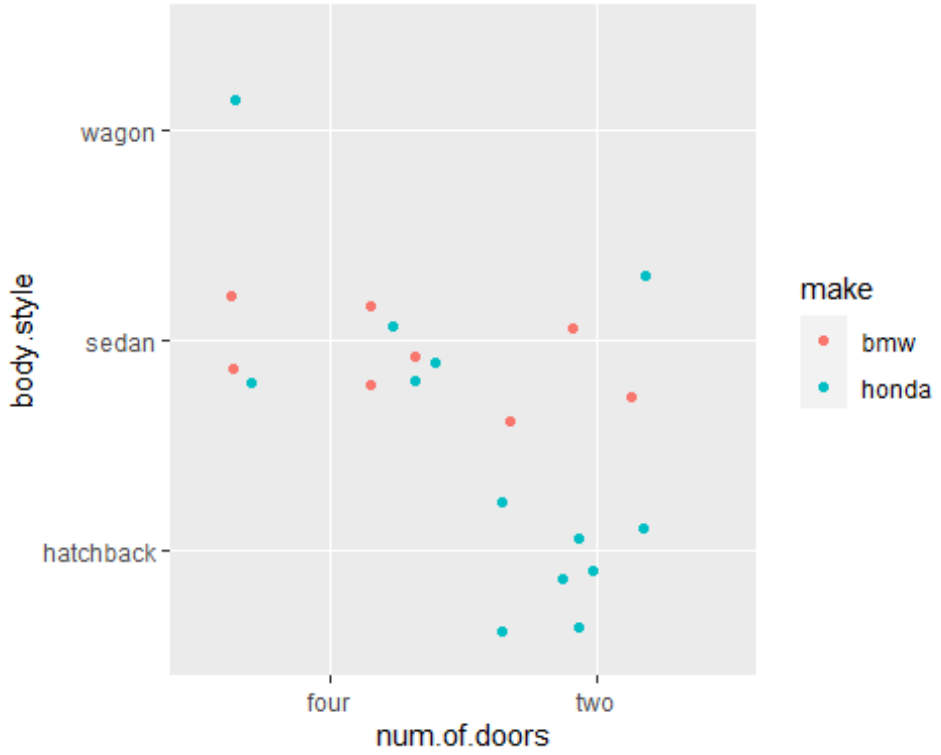
15690
182 3.35 9.20 156 5200 19 24
15750
183 3.4 23.00 52 4800 37 46
7775
184 3.4 9.00 85 5250 27 34
7975
185 3.4 23.00 52 4800 37 46
7995
186 3.4 9.00 85 5250 27 34
8195
187 3.4 9.00 85 5250 27 34
8495
188 3.4 23.00 68 4500 37 42
9495
189 3.4 10.00 100 5500 26 32
9995
190 3.4 8.50 90 5500 24 29
11595
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

#Plot body style vs number of doors (color:make)
f <- ggplot(dataset, aes(num.of.doors, body.style))
f + geom_jitter(aes(color=make))
```

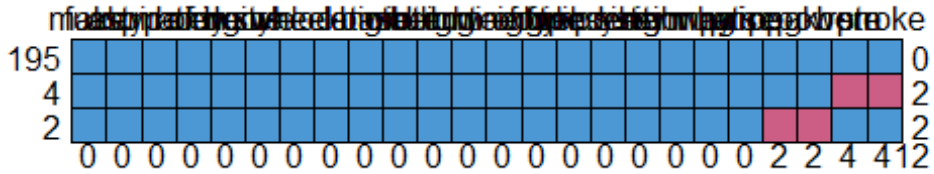



```
#Just honda & bmw
f2 <- ggplot(subset(dataset,make=="honda" | make=="bmw"), aes(num.of.doors,
body.style))
f2 + geom_jitter(aes(color=make))
```



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 numerics
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))

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

#Have a look at where we are missing values by 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

#Estimate values using mice package
tempData <- mice(dataset,m=1,maxit=5,meth='pmm',seed=500)

##
##  iter imp variable
##   1   1  bore  stroke  horsepower  peak.rpm
```

```
##   2   1  bore  stroke  horsepower  peak.rpm
##   3   1  bore  stroke  horsepower  peak.rpm
##   4   1  bore  stroke  horsepower  peak.rpm
##   5   1  bore  stroke  horsepower  peak.rpm

## Warning: Number of logged events: 10

summary(tempData)

## Class: mids
## Number of multiple imputations:  1
## 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 take a look at the imputed values & plot to see if our values are sensible

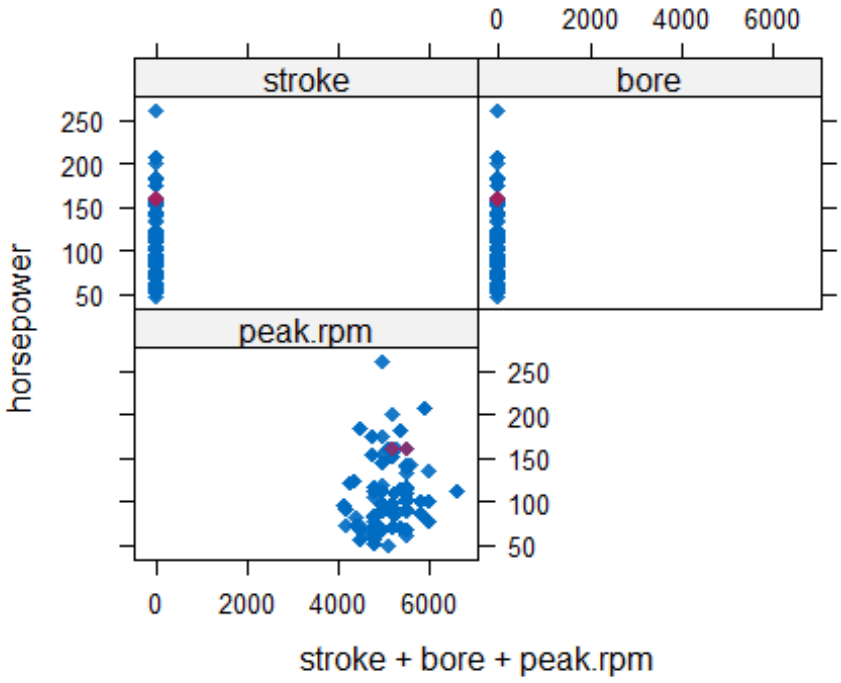
```
tempData$imp$horsepower

##       1
## 131 160
## 132 161

tempData$imp$stroke

##       1
## 56 2.19
## 57 3.40
## 58 3.50
## 59 3.23

tempData$imp$bore
```

```
##       1
## 56 3.01
## 57 2.97
## 58 3.01
## 59 3.17
```

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

```
##        1
## 131 5500
## 132 5200
```

```
#Plot of vals
xyplot(tempData, horsepower ~ stroke + bore + peak.rpm,pch=18,cex=1)
```




```
#Overwrite missing
dataset <- complete(tempData,1)

#Final check 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
```

```
#Scaling the numeric variables
ind <- sapply(dataset, is.numeric)
dataset_scale<-dataset
dataset_scale[ind] <- lapply(dataset[ind], scale)
```

```
str(dataset)
```

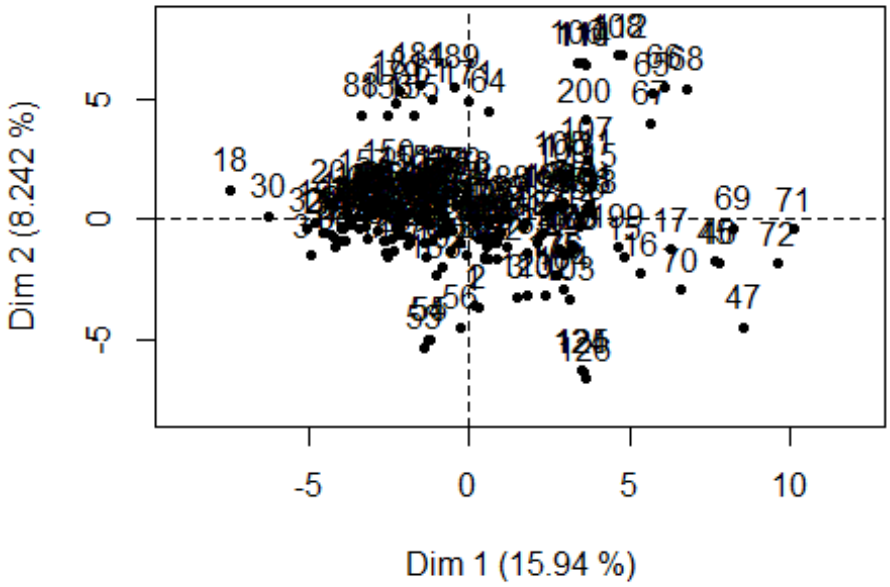
```
## 'data.frame':    201 obs. of  24 variables:
##  $ make             : chr  "alfa-romero" "alfa-romero" "alfa-romero"
"audi" ...
##  $ fuel.type        : chr  "gas" "gas" "gas" "gas" ...
##  $ aspiration       : chr  "std" "std" "std" "std" ...
##  $ num.of.doors     : chr  "two" "two" "two" "four" ...
##  $ 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 ...
```

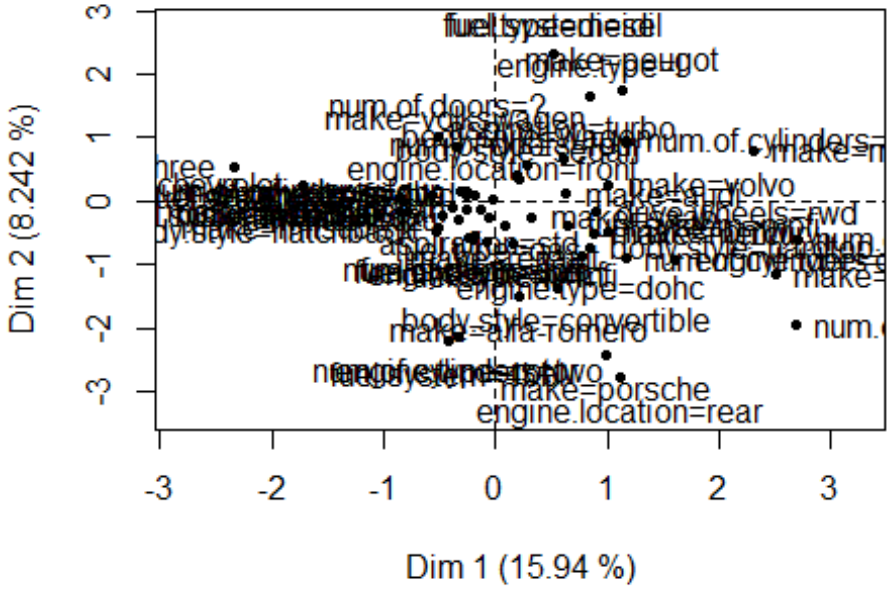
#Renaming the levels of a variable to avoid clashes for this method

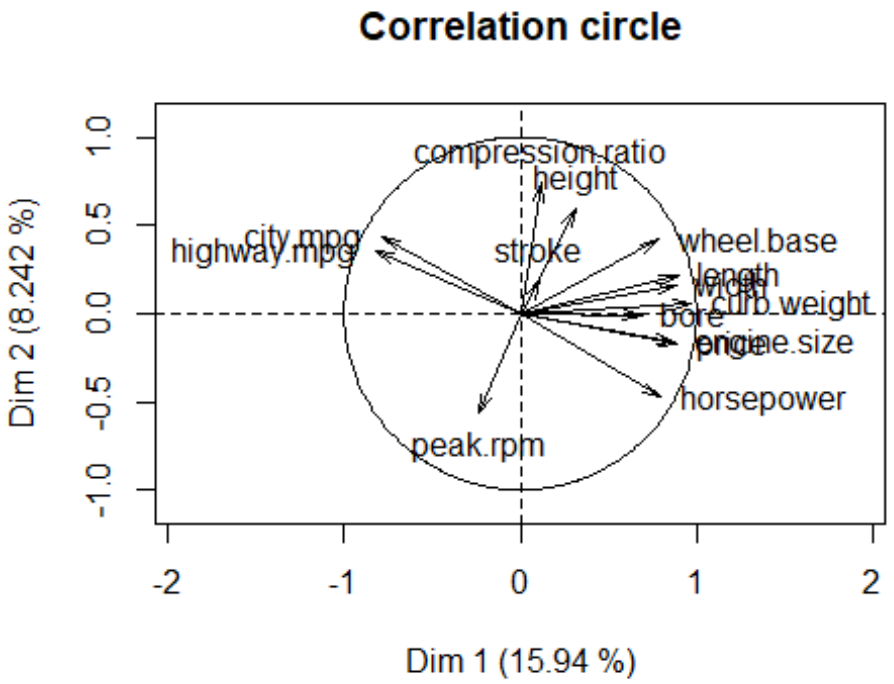
```
levels(dataset_scale$num.of.cylinders)

## NULL

head(dataset_scale$num.of.cylinders)

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

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

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

#Split data into qual and quant
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=4,graph=TRUE, rename.level = TRUE)
```

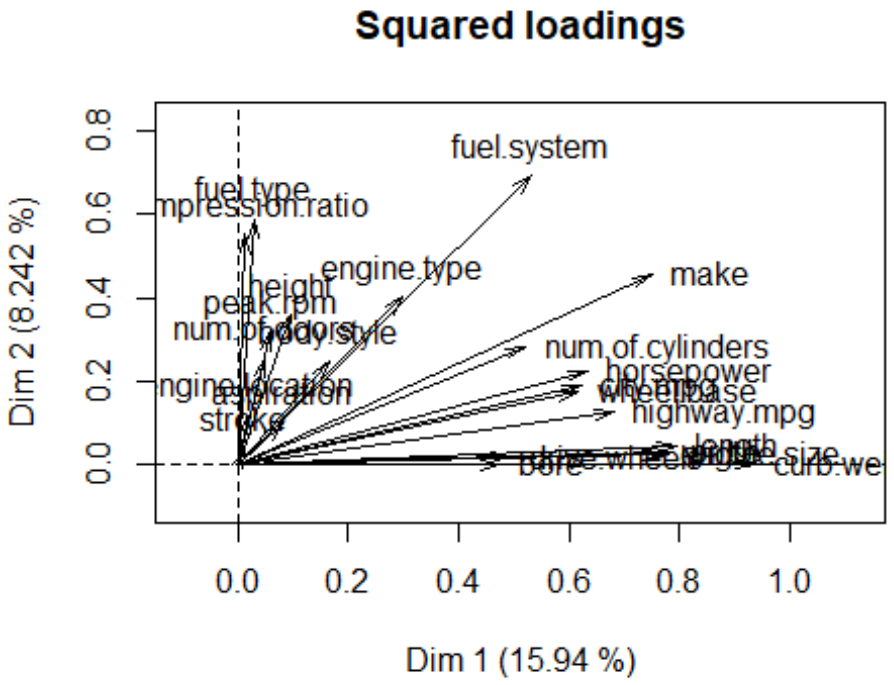
Individuals component map



Levels component map




Correlation circle
compression.ratio
height
city.mpg
highway.mpg
stroke
wheel.base
curb.weight
bore
horsepower
peak.rpm
Dim 2 (8.242 %)
Dim 1 (15.94 %)
1.0
0.5
0.0
-0.5
-1.0
-2
-1
0
1
2


Squared loadings
fuel.system
fuel.type
engine.type
make
height
peak.rpm
num.of.cylinders
horsepower
highway.mpg
stroke
Dim 2 (8.242 %)
Dim 1 (15.94 %)
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

```
pca

##
## Call:
```

```
## PCAmix(X.quanti = X.quanti, X.quali = X.quali, ndim = 4, rename.level =
TRUE,     graph = TRUE)
##
## Method = Principal Component of mixed data (PCAmix)
##
##
## "name" "description"
## "$eig" "eigenvalues of the principal components (PC) "
## "$ind" "results for the individuals (coord,contrib,cos2)"
## "$quanti" "results for the quantitative variables (coord,contrib,cos2)"
## "$levels" "results for the levels of the qualitative variables
(coord,contrib,cos2)"
## "$quali" "results for the qualitative variables (contrib,relative
contrib)"
## "$sqload" "squared loadings"
## "$coef" "coef of the linear combinations defining the PC"

pca$eig

##          Eigenvalue   Proportion Cumulative
## dim 1  10.200461578 15.938221216   15.93822
## dim 2   5.275161583  8.242439973   24.18066
## dim 3   3.445090975  5.382954648   29.56362
## dim 4   3.145297493  4.914527332   34.47814
## dim 5   2.845485722  4.446071441   38.92421
## dim 6   2.340494140  3.657022094   42.58124
## dim 7   2.232606337  3.488447401   46.06968
## dim 8   2.209515074  3.452367304   49.52205
## dim 9   1.934509223  3.022670661   52.54472
## dim 10  1.791925098  2.799882965   55.34461
## dim 11  1.777327061  2.777073532   58.12168
## dim 12  1.737091015  2.714204711   60.83588
## dim 13  1.649437139  2.577245530   63.41313
## dim 14  1.459770167  2.280890886   65.69402
## dim 15  1.406289366  2.197327134   67.89135
## dim 16  1.372351839  2.144299749   70.03565
## dim 17  1.316114447  2.056428823   72.09208
## dim 18  1.259287349  1.967636483   74.05971
## dim 19  1.211205973  1.892509333   75.95222
## dim 20  1.132000555  1.768750867   77.72097
## dim 21  1.112813940  1.738771781   79.45974
## dim 22  1.049710075  1.640171992   81.09992
## dim 23  1.024309827  1.600484105   82.70040
## dim 24  0.944201038  1.475314122   84.17571
## dim 25  0.911992827  1.424988793   85.60070
## dim 26  0.867920643  1.356126004   86.95683
## dim 27  0.779351418  1.217736590   88.17457
## dim 28  0.763773949  1.193396795   89.36796
## dim 29  0.706662797  1.104160621   90.47212
## dim 30  0.610994972  0.954679644   91.42680
```

```
## dim 31  0.599402389  0.936566233   92.36337
## dim 32  0.509754042  0.796490691   93.15986
## dim 33  0.468653688  0.732271388   93.89213
## dim 34  0.435021304  0.679720788   94.57185
## dim 35  0.412255296  0.644148900   95.21600
## dim 36  0.347057451  0.542277267   95.75828
## dim 37  0.332933040  0.520207875   96.27849
## dim 38  0.311461159  0.486658060   96.76514
## dim 39  0.262006933  0.409385833   97.17453
## dim 40  0.232914205  0.363928446   97.53846
## dim 41  0.193142337  0.301784901   97.84024
## dim 42  0.174499600  0.272655626   98.11290
## dim 43  0.162565173  0.254008083   98.36691
## dim 44  0.159642859  0.249441968   98.61635
## dim 45  0.134962378  0.210878716   98.82723
## dim 46  0.125869721  0.196671440   99.02390
## dim 47  0.106955479  0.167117936   99.19102
## dim 48  0.096592407  0.150925636   99.34194
## dim 49  0.087280481  0.136375751   99.47832
## dim 50  0.065885221  0.102945658   99.58126
## dim 51  0.057790614  0.090297834   99.67156
## dim 52  0.050692474  0.079206990   99.75077
## dim 53  0.040504093  0.063287646   99.81406
## dim 54  0.038134343  0.059584910   99.87364
## dim 55  0.026777719  0.041840186   99.91548
## dim 56  0.018245218  0.028508153   99.94399
## dim 57  0.013608762  0.021263690   99.96525
## dim 58  0.011927669  0.018636983   99.98389
## dim 59  0.007829980  0.012234345   99.99612
## dim 60  0.002480346  0.003875541  100.00000
```

```
pca$ind$coord
```

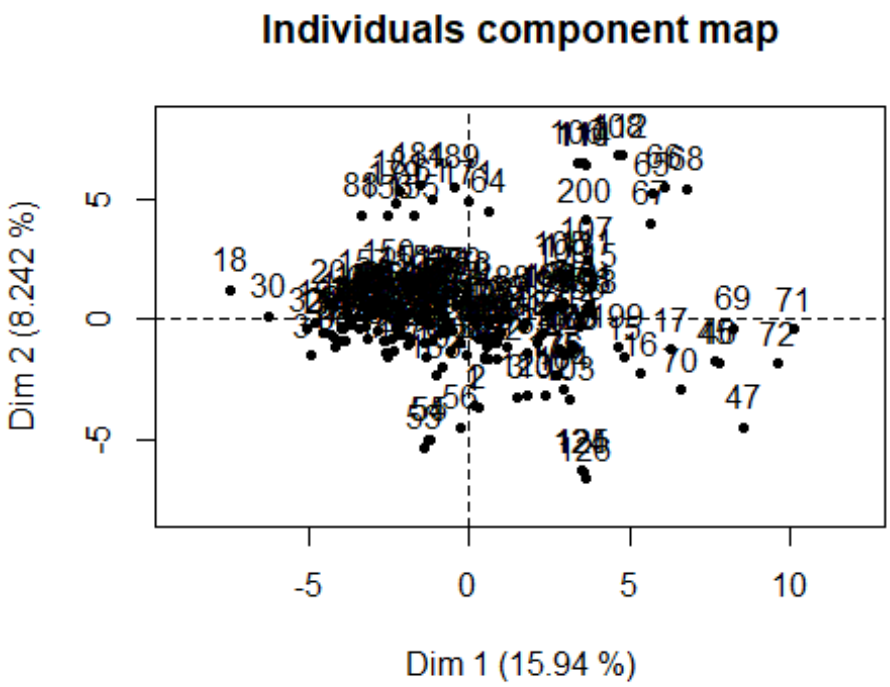
```
##           dim 1        dim 2        dim 3        dim 4
## 1    0.19650526 -3.587546891 -0.699996878 -0.089497107
## 2    0.30181064 -3.616309767 -0.693102700 -0.109154311
## 3    1.46838606 -3.213797892  0.656383155 -1.569945213
## 4   -0.05328226  0.156315198 -0.056602741 -0.453303727
## 5    1.73520893 -0.156195203 -0.647345200  0.470948165
## 6    1.00816634 -0.527462026  0.662552764 -0.972284283
## 7    2.79343327  0.644605342  0.508954917 -0.621226980
## 8    2.92788528  0.734432312  0.196399202 -0.197707497
## 9    3.77398265  0.628938495  0.839520997 -0.786855328
## 10   0.57259551 -1.135521856 -0.507925659  0.439488567
## 11   0.72419962 -0.704318983 -0.777378540  0.640616299
## 12   2.13629914 -0.998088856 -0.492678346 -0.422195074
## 13   2.30759624 -0.560738661 -0.759927059 -0.219917584
## 14   3.45376209 -0.297176001 -0.696760083 -0.106136742
## 15   4.82021425 -1.573268619 -0.551137042 -0.546454418
## 16   5.30534638 -2.246882943 -0.093387815 -0.911948181
```

```
## 17   6.30613731 -1.241758399 -0.345980501 -0.499445842
## 18  -7.44888577  1.226422669 -0.638832695  0.427911681
## 19  -4.80725607 -0.104874986 -0.132239915 -0.536529098
## 20  -4.34440626  0.705502626 -0.656110820 -0.273250413
## 21  -4.53255421 -0.524156760  0.299384626 -0.977364572
## 22  -4.15917694 -0.779238029  0.344994232 -0.895324577
## 23  -2.35347158 -1.312457153  0.775418685 -1.226580477
## 24  -3.98456001 -0.358762176  0.090397571 -0.701537272
## 25  -3.72305573 -0.008850652 -0.164369731 -0.652955804
## 26  -3.69092094 -0.017627876 -0.162265917 -0.658954358
## 27  -2.15765794 -0.285230314  0.835014113 -1.260812300
## 28  -0.73706366  1.204112811 -1.033706445  0.218526585
## 29   0.49342500 -1.541162249  1.379023791 -2.572392793
## 30  -6.23977250  0.138270508  0.692960909 -2.372349585
## 31  -4.93671374 -1.508969220  1.073280853 -2.153461285
## 32  -5.04457502 -0.391644874  0.672189220 -1.636300889
## 33  -4.19110200 -1.170965745  1.043881231 -1.953729241
## 34  -4.16067710 -1.175922851  1.046139254 -1.958004738
## 35  -3.26331287  0.003647827  0.434759834 -1.550338668
## 36  -3.22563432  0.454471306 -0.113651378 -0.950964312
## 37  -2.69492135 -0.908681613  1.022322160 -1.994149458
## 38  -2.62173553 -0.917564337  1.027995150 -2.003160613
## 39  -2.04400685  0.020473394  0.458583751 -1.681526341
## 40  -2.30824271 -0.078799097  0.358914889 -1.668578994
## 41  -0.83382748 -0.363863677  0.195176945 -1.088051309
## 42  -1.90201486 -0.680860252  0.492381116 -1.383773688
## 43  -1.52013013 -0.019716495 -0.671183228  0.378423675
## 44  -0.62007284 -1.272250950  0.477989691 -0.202459831
## 45   7.65820097 -1.749055129  0.435141008 -2.291203217
## 46   7.77384415 -1.780641648  0.442711986 -2.312790162
## 47   8.56957773 -4.503569462  0.500467260 -2.838052648
## 48  -3.44235173 -0.414384625  0.700858626  0.441776112
## 49  -3.70957956 -0.232649116  0.667926858  0.357279499
## 50  -3.68211204 -0.239103694  0.669808286  0.352590888
## 51  -3.12062489  0.611794120  0.147308316  0.633836197
## 52  -3.05336775  0.604472941  0.118122907  0.648714649
## 53  -1.43976299 -5.297490459  9.233517077  8.876379255
## 54  -1.31116979 -4.996510147 10.103791153  7.619943026
## 55  -1.20267113 -4.988657793 10.153041596  7.521654960
## 56  -0.30371084 -4.504032903  6.904260615  5.194929045
## 57  -1.31369238 -0.188259943  0.769599907  0.244214109
## 58  -0.87346529  0.797684095  0.140682257  0.588387090
## 59  -1.25236645 -0.205010370  0.773614819  0.232766486
## 60  -0.81213936  0.780933668  0.144697169  0.576939468
## 61  -1.13334466  4.990121100  2.262822063  0.093021622
## 62  -1.00064029  0.418836173  0.404859363  0.517977028
## 63   1.68942430 -0.330190941  0.145297801  1.028088930
## 64   0.61246966  4.534108417  1.999727857  0.372965083
## 65   5.74516209  5.221921670  2.363959282 -1.000175589
## 66   6.09213108  5.538530277  1.937201515 -0.484037421
```

```
## 67   5.61973533  3.989801026  2.542044117 -1.461714444
## 68   6.77623948  5.458891965  2.493191703 -0.990872619
## 69   8.26266393 -0.341350161  0.185102565 -1.146582332
## 70   6.57297468 -2.923443914  0.409430964 -1.920718745
## 71  10.11083113 -0.402357847  0.089703194 -1.555822270
## 72   9.62458392 -1.821695869  0.229050301 -2.054755075
## 73   2.79618956 -1.178464867  0.240415231 -0.085395248
## 74  -4.31131777 -0.614601347  0.494325806 -1.254093785
## 75  -3.92275338 -0.867547441  0.541717415 -1.172569587
## 76  -3.87068680 -0.869194731  0.546124203 -1.177024250
## 77  -2.54022143 -1.538995059  1.443699188 -2.231687809
## 78  -1.35442030 -1.546917837  1.580874338 -2.345555634
## 79  -1.88997049 -1.028431902  0.536457299 -1.310815509
## 80   0.47123992 -1.626089078  1.520239403 -2.716164778
## 81   0.60938880 -1.643380512  1.524013271 -2.728832614
## 82   0.59900946 -1.639497684  1.523416924 -2.726456406
## 83  -1.48115097  0.007327813 -0.117342439 -0.942160976
## 84  -1.41560173 -0.002193452 -0.112385653 -0.950887271
## 85  -0.91886448 -0.519299084  0.928758446 -1.982242896
## 86  -1.15048599 -0.874687433  0.680519641 -1.859654956
## 87  -3.11431350  0.201760194 -0.415976200 -0.541855366
## 88  -3.39367703  4.335496175  1.219965249 -1.100737752
## 89  -3.05697816  0.192177208 -0.411740144 -0.550013549
## 90  -2.90396326  0.627186095 -0.680767972 -0.347394323
## 91  -2.73675425  0.653273795 -0.937676613  0.049447828
## 92  -3.01481479  0.187576533 -0.408430835 -0.554988632
## 93  -3.22506536 -0.292508298 -0.077969139 -0.668379982
## 94  -2.86179989  0.622585420 -0.677458664 -0.352369406
## 95  -2.70633947  0.647690749 -0.935469157  0.044910993
## 96  -2.83383398 -0.425019688 -0.502177391 -0.755420313
## 97  -1.59047797  0.073251205 -0.340794526 -0.581872603
## 98  -1.35001963  0.419690194 -0.597671592 -0.533223175
## 99   2.95108596 -1.442696087 -0.661127951 -0.985768992
## 100  3.23354658 -1.216540065 -1.024782824 -0.505033552
## 101  2.80527439 -1.294317844 -0.685250497 -1.024333617
## 102  2.37175147 -3.195286912  0.288593639 -1.421931578
## 103  3.13772324 -3.282528065  0.521760337 -1.620365469
## 104  2.95177028 -2.906371907  0.340396056 -1.351753081
## 105  2.90211995  1.906083248 -0.370963279  2.027447365
## 106  3.40472459  6.510992000  1.219898834  1.417132742
## 107  3.68390663  2.503287862 -0.754148206  2.631519829
## 108  4.62395403  6.836130298  0.888511789  2.127415422
## 109  2.94365120  1.629257330 -1.056465090  3.027463332
## 110  3.56669373  6.478278332  1.231417597  1.391724016
## 111  3.66648432  2.007444301 -1.325150958  3.532248615
## 112  4.76892713  6.808058891  0.898917849  2.105179322
## 113  3.10018378  1.863510757 -0.357081453  1.995300895
## 114  3.60348929  6.468228076  1.233826545  1.384855442
## 115  3.82343377  1.411860412 -0.090254793  1.682462731
## 116 -4.48421906 -0.514450636  0.296941186 -0.982686749
```

```
## 117 -2.59957332 -1.403095628  1.271322027 -1.968715270
## 118 -3.96080772 -0.350308798  0.086001308 -0.705917910
## 119 -3.46427499  0.097281982 -0.175985477 -0.615303825
## 120 -3.26052750  0.084955525 -0.169562185 -0.656672529
## 121 -0.70535344  1.212392870 -1.044316075  0.218059359
## 122  0.84682938 -1.632803287  1.468162374 -2.173186279
## 123  1.83095061 -3.145710195 -0.640467542  0.016222898
## 124  3.53505079 -6.301465113 -3.509837974  1.011319989
## 125  3.58761587 -6.315822622 -3.506396620  1.001507741
## 126  3.62315420 -6.613955778 -3.538050881  1.010358799
## 127  0.60981208 -0.214616409 -0.333933163 -0.890228131
## 128 -0.05857454 -1.496839713  0.721540256 -1.808911900
## 129  0.50829611 -0.715912676 -0.335488950  0.076642969
## 130  0.90776910  0.071234992 -0.860707532  0.330175741
## 131 -0.25353026 -0.982808244 -0.401483372  0.683913980
## 132  1.06182205  0.042360074 -0.849573953  0.306946655
## 133  1.81568444 -1.388926746 -0.081206859 -0.219524638
## 134  2.22167796 -0.602306358 -0.605610055  0.033004302
## 135 -3.19275597 -0.792262735 -3.303752835  2.958944379
## 136 -2.44663924 -0.791796299 -3.158528866  2.731725641
## 137 -2.16151071 -0.594607906 -4.253864976  3.997104101
## 138 -1.86709111  0.266559419 -3.474273929  2.826122951
## 139 -1.44848831  0.258290461 -3.507364522  2.919996076
## 140 -0.74991938 -0.544572613 -3.255740455  2.775575372
## 141 -0.70935952 -0.114953289 -4.479225569  4.268168985
## 142  0.16511023 -0.134837648 -4.192462333  3.935033908
## 143 -1.35719354  0.151726502 -3.791275499  3.368587709
## 144 -0.52432176 -0.438919750 -3.589474174  3.252190297
## 145 -0.76163722  0.129605460 -4.847484046  4.712757047
## 146  0.61266083 -0.129831066 -4.507764456  4.464703635
## 147 -3.77665541  0.264325669 -0.397463136 -0.192421927
## 148 -3.51749798  0.116060857 -0.367083342 -0.151705977
## 149 -3.39266957  0.549337993 -0.638705049  0.052226381
## 150 -2.49236100  1.559662684 -1.453020373  0.794802356
## 151 -1.98809031  1.310813915 -2.403350926  2.058397521
## 152 -1.47556012  1.342668052 -2.356156075  2.034672839
## 153 -2.60675400  0.716685369 -0.854076777  0.078048704
## 154 -2.82146080  0.340958060 -0.583578126  0.014089531
## 155 -1.71348392  4.293894420  0.894854026 -0.319516167
## 156 -2.52991208  4.290692182  1.094508137 -0.527047301
## 157 -3.25951558  1.175742122 -0.936381739 -0.102830703
## 158 -2.58205810  0.202531149 -0.556817737  0.054967300
## 159 -2.30758958  0.548063378 -0.810802829  0.100777783
## 160 -2.10123156 -0.020339405 -0.426023408  0.167605963
## 161 -2.30671948 -0.373605757 -0.166640635  0.113569304
## 162 -0.85796401 -1.974628316 -0.004214278 -0.110068816
## 163 -1.06134932 -2.328468969  0.255306149 -0.164497965
## 164  0.68076697 -0.942337946 -0.287776527 -0.566698212
## 165  0.72011888 -0.953924710 -0.285266757 -0.574394946
## 166  0.30567711 -0.835701278  0.142387838 -0.498756628
```

```
## 167  0.85878895 -0.961832567 -0.273809509 -0.587733156
## 168  0.45609576 -0.842626764  0.154946938 -0.512533086
## 169  1.20351177 -1.174044587 -0.340209376 -0.559340111
## 170 -0.38857113  1.217892435 -0.574502189 -0.424187210
## 171 -0.04815914  4.896182782  1.209471124 -0.288684434
## 172 -0.41923909  0.647165298 -0.234591125 -0.493843919
## 173 -0.11544210  1.098474643 -0.546134877 -0.399941518
## 174 -0.34923753  0.637266207 -0.229276314 -0.503050353
## 175  2.68769804 -2.308022158  0.347639131 -0.862436644
## 176  2.73010609 -2.330348162  0.353743298 -0.850005813
## 177  3.16893473 -1.217852540 -0.333009224 -0.456236228
## 178  3.18256339 -1.134250723 -0.639464876  0.025101988
## 179 -2.30385070  4.861740503  1.526804238 -0.757361378
## 180 -1.37999246  0.430720758  0.018391251 -0.640571542
## 181 -2.16012123  5.295722941  1.256885720 -0.554500471
## 182 -1.23626299  0.864703196 -0.251527267 -0.437710636
## 183 -1.18874193  0.864926163 -0.247368163 -0.441053566
## 184 -1.53838907  5.614425901  1.472475134 -0.670643132
## 185 -0.93837554  0.646316834 -0.145715983 -0.468678701
## 186 -1.39445027 -0.979672030 -0.180385975 -0.766985157
## 187 -1.85756782 -0.979520882  0.513471020 -0.884925658
## 188  1.14166902  0.509289213  0.378491211 -0.692794331
## 189 -0.44771636  5.515449653  1.644177920 -0.619128033
## 190 -0.14254458  0.827809316 -0.363359282  0.007276803
## 191  2.35338204  0.343745147 -0.740262289  0.669976004
## 192  2.52054359  0.579980775 -1.127410073  1.160132322
## 193  2.43506485  0.345380013 -0.737194447  0.639909068
## 194  2.59534234  0.580352420 -1.125042437  1.130034290
## 195  3.46119541  0.087964838 -0.435112132  0.503776111
## 196  3.62441005  0.323182838 -0.822684659  0.993791771
## 197  2.90451078  0.433791073 -0.596695322  0.627980434
## 198  3.83797462  0.316290559 -0.356250100  0.452870640
## 199  4.66775519 -1.141624224 -0.764908399  0.248751765
## 200  3.61748262  4.151197654  1.673225445 -0.259758092
## 201  3.67148643  0.551994119 -0.295382308  0.533211213

#Plot of PCA coordinates
plot(pca,choice="ind")
```

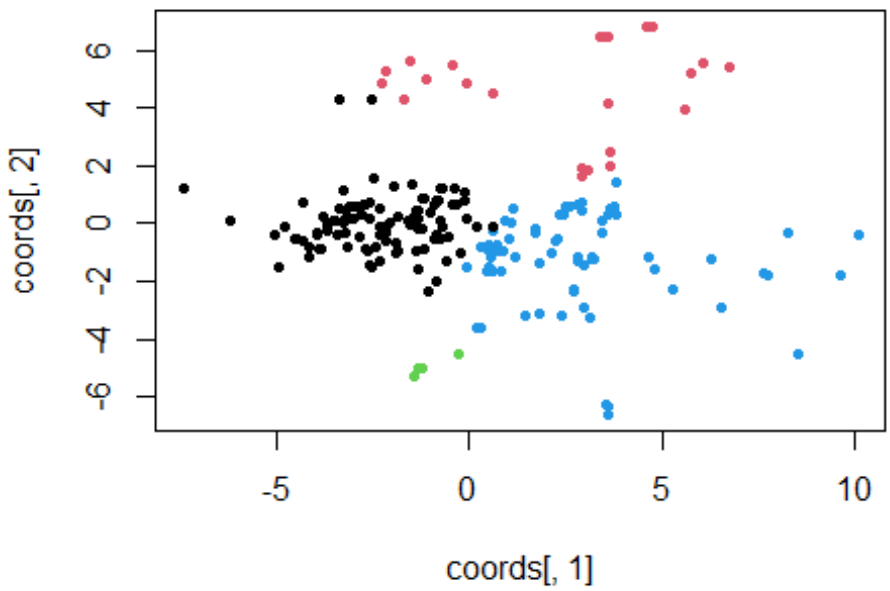



```
#conver to data frame
coords<-as.data.frame(pca$ind$coord)
```

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

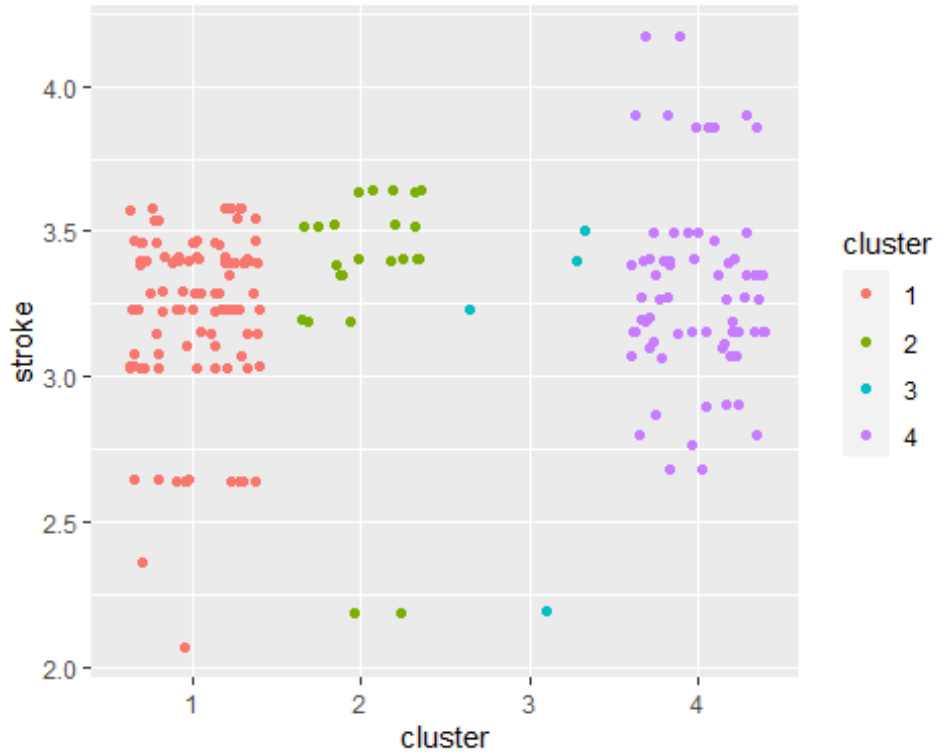
```
#Apply K means to cluster
km <- kmeans(coords, centers = 4)
km

## K-means clustering with 4 clusters of sizes 105, 23, 4, 69
##
## Cluster means:
##       dim 1      dim 2      dim 3       dim 4
## 1 -2.353906  0.0167301 -0.4317801 -0.08364006
## 2  2.407926  4.6684026  1.0819828  0.63912530
## 3 -1.064329 -4.9466728  9.0986526  7.30322657
## 4  2.841089 -1.2948294 -0.2310623 -0.50913887
##
## 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   1   4   4   4   4   4   4   4   4   4   4   4   4   4   1
1   1
##  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38
39  40
##   1   1   1   1   1   1   1   1   4   1   1   1   1   1   1   1   1   1
```

```
1   1
##  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57  58
59  60
##   1   1   1   1   4   4   4   1   1   1   1   1   3   3   3   3   1   1
1   1
##  61  62  63  64  65  66  67  68  69  70  71  72  73  74  75  76  77  78
79  80
##   2   1   4   2   2   2   2   2   4   4   4   4   4   1   1   1   1   1
1   4
##  81  82  83  84  85  86  87  88  89  90  91  92  93  94  95  96  97  98
99 100
##   4   4   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
4   4
## 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118
119 120
##   4   4   4   4   2   2   2   2   2   2   2   2   2   2   4   1   1   1
1   1
## 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138
139 140
##   1   4   4   4   4   4   4   4   4   4   1   4   4   4   1   1   1   1
1   1
## 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158
159 160
##   1   1   1   1   1   1   1   1   1   1   1   1   1   1   2   1   1   1
1   1
## 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178
179 180
##   1   1   1   4   4   4   4   4   4   1   2   1   1   1   4   4   4   4
2   1
## 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198
199 200
##   2   1   1   2   1   1   1   4   2   1   4   4   4   4   4   4   4   4
4   2
## 201
##   4
##
## Within cluster sum of squares by cluster:
## [1] 786.74212 316.52786  15.14614 702.67442
##  (between_SS / total_SS =  58.9 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
"tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"

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

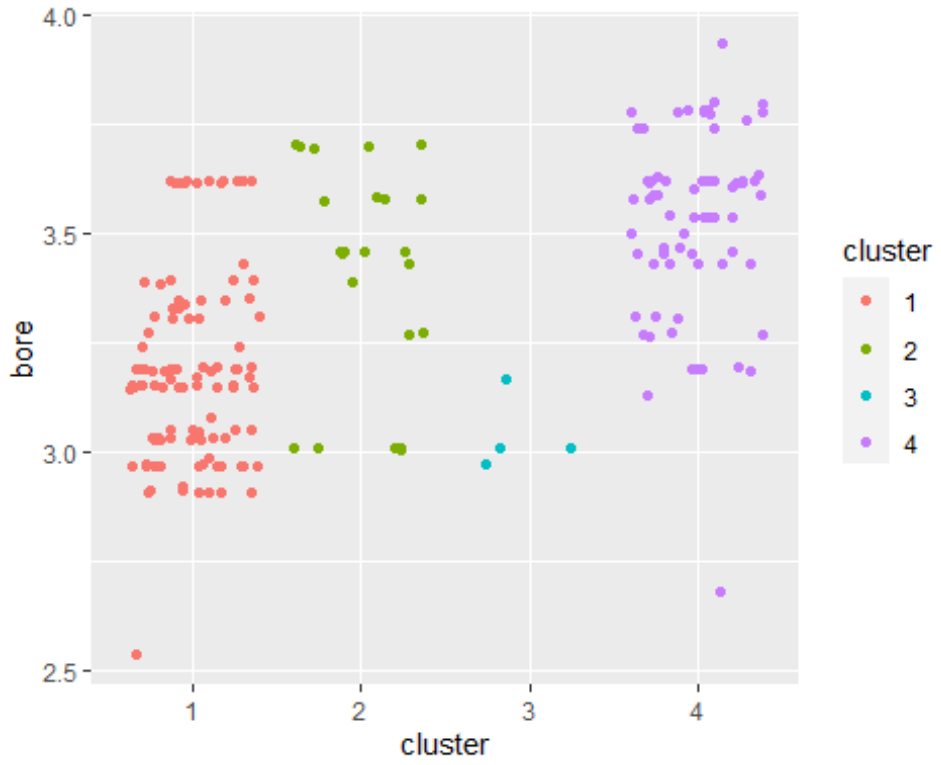



```
dataset$cluster<-as.factor(km$cluster)

f <- ggplot(dataset, aes(cluster, price,color=cluster))
f + geom_jitter()
```

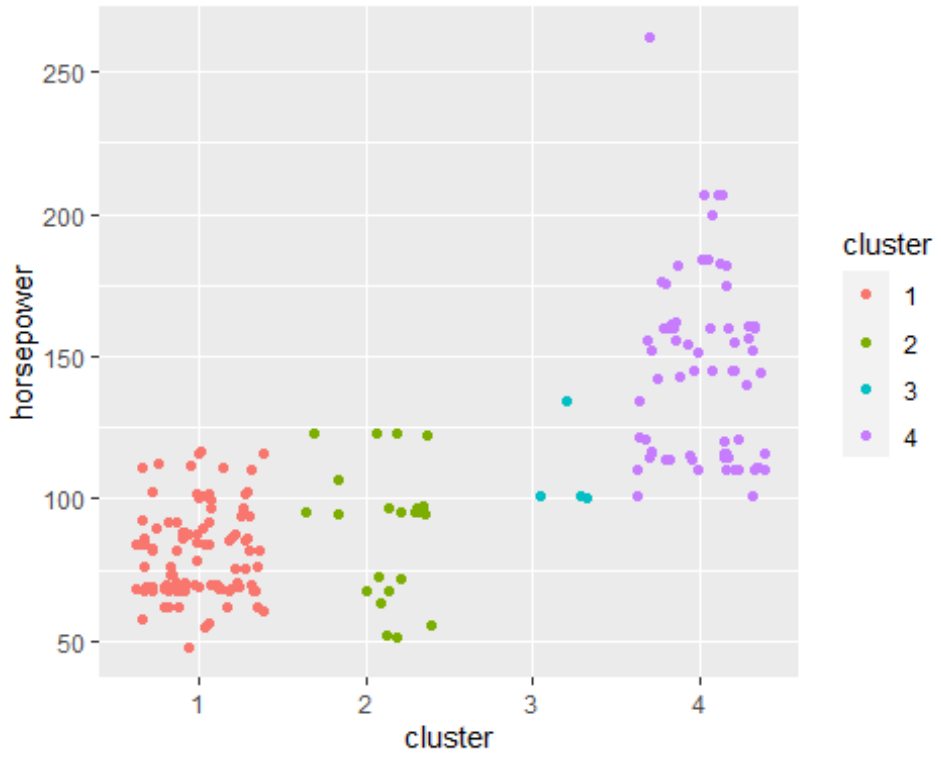

```
g <- ggplot(dataset, aes(cluster, stroke,color=cluster))
g + geom_jitter()
```



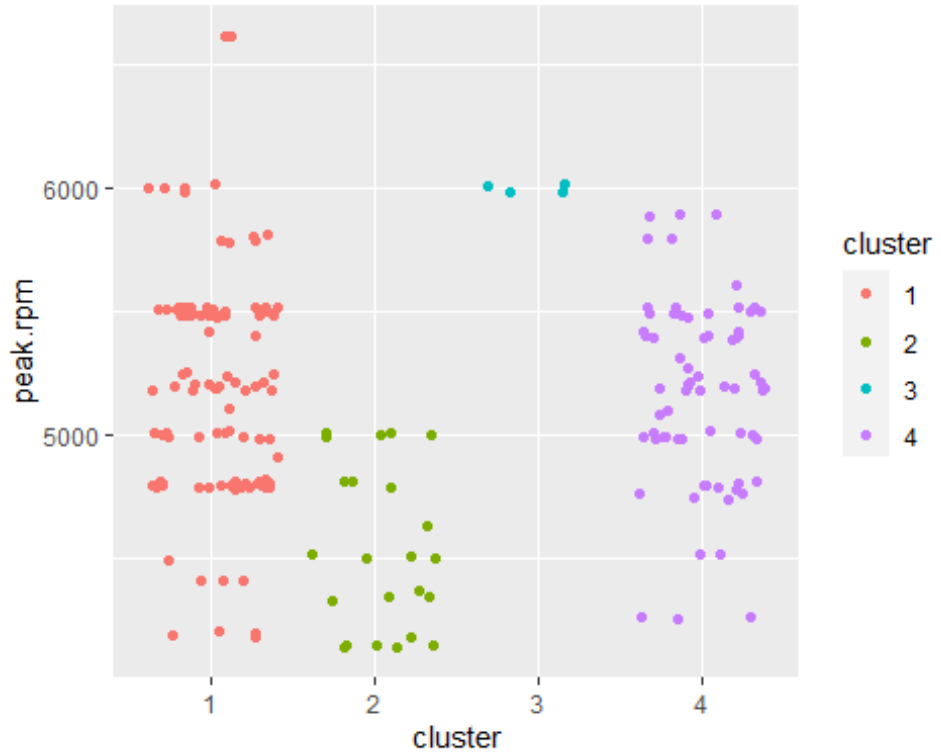
```
h <- ggplot(dataset, aes(cluster, bore,color=cluster))
h + geom_jitter()
```



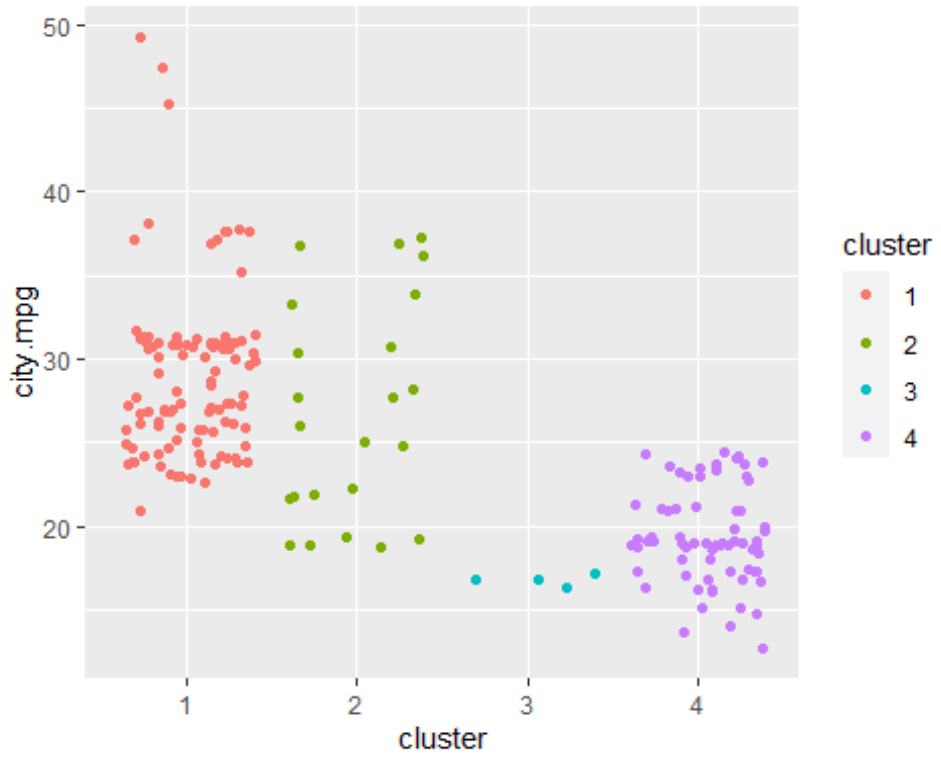

```
i <- ggplot(dataset, aes(cluster, horsepower,color=cluster))
i + geom_jitter()
```



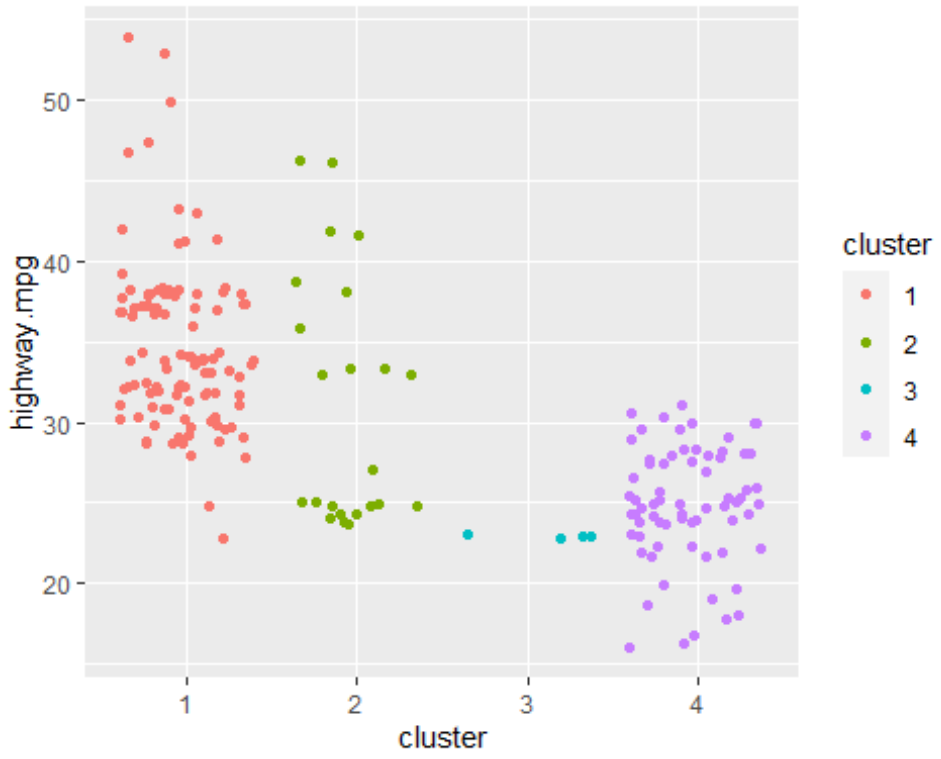

```
j <- ggplot(dataset, aes(cluster, peak.rpm,color=cluster))
j + geom_jitter()
```



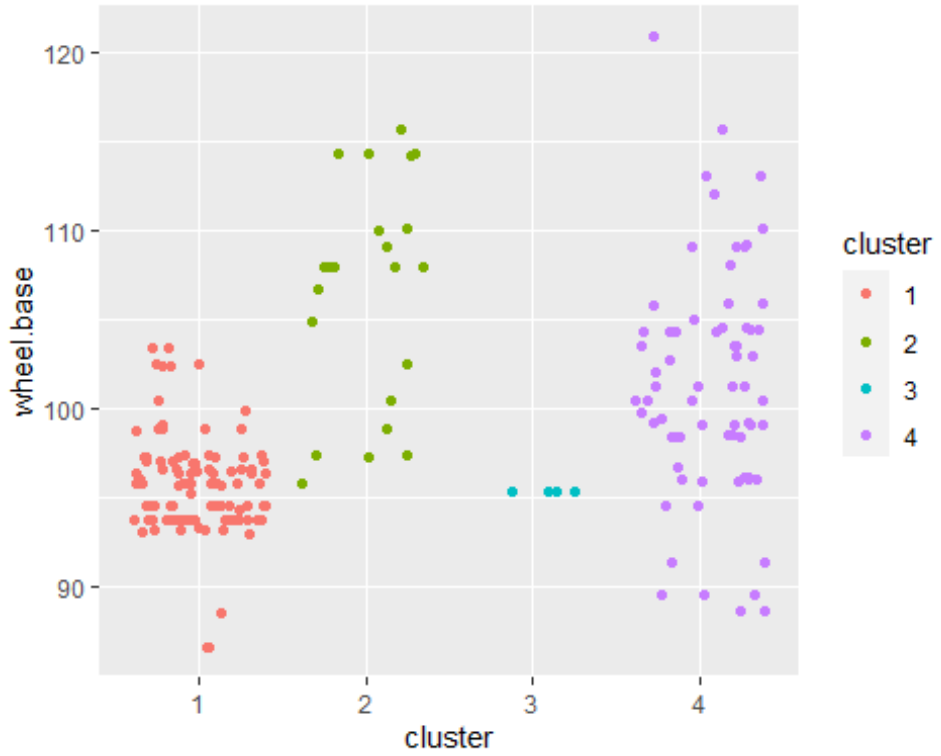
```
k <- ggplot(dataset, aes(cluster, city.mpg,color=cluster))
k + geom_jitter()
```



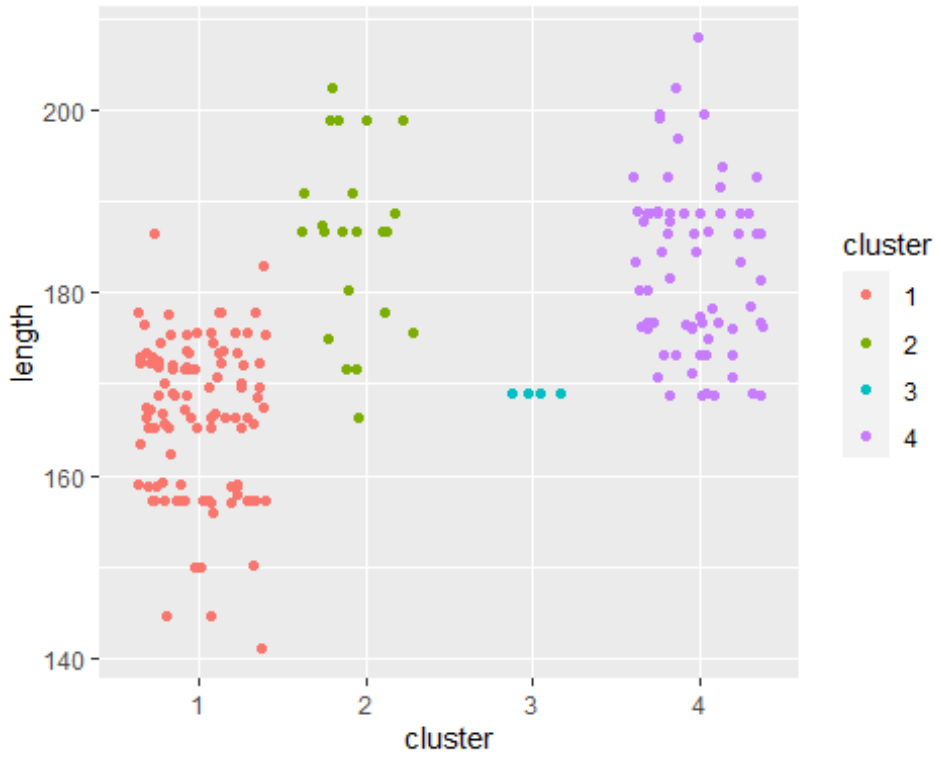

```
l <- ggplot(dataset, aes(cluster, highway.mpg,color=cluster))
l + geom_jitter()
```



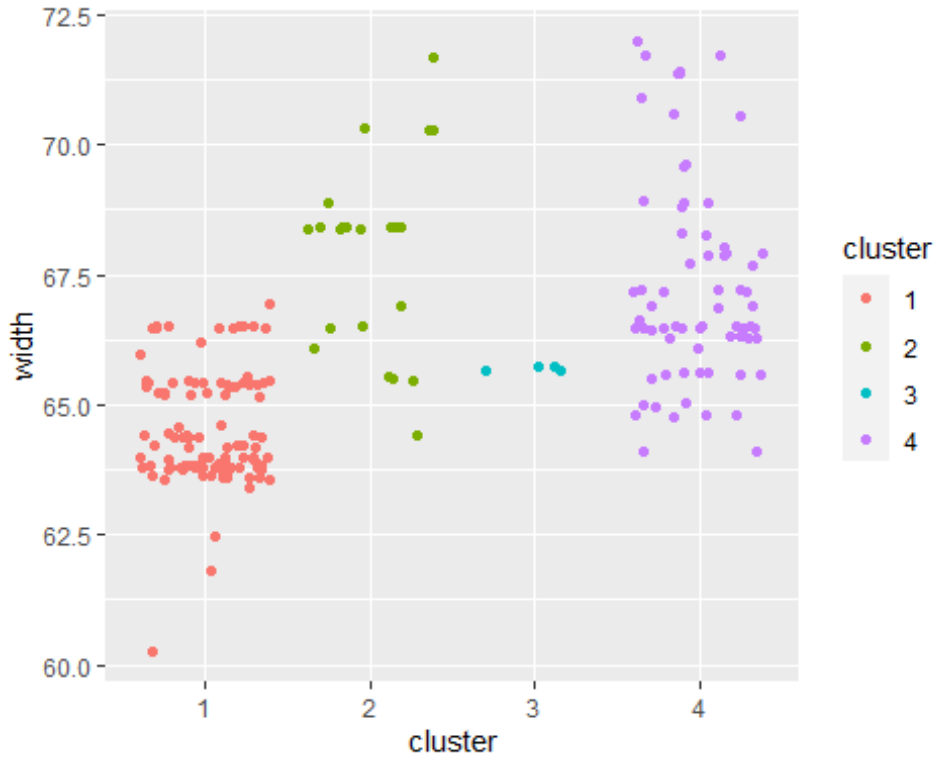

```
m <- ggplot(dataset, aes(cluster, wheel.base,color=cluster))
m + geom_jitter()
```



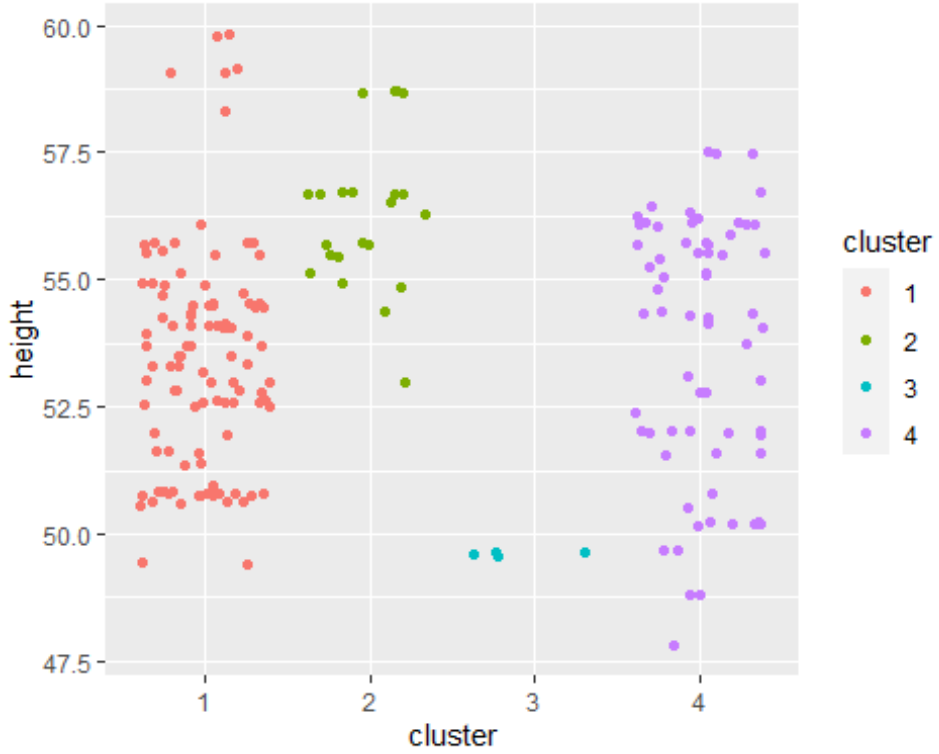
```
n <- ggplot(dataset, aes(cluster, length,color=cluster))
n + geom_jitter()
```



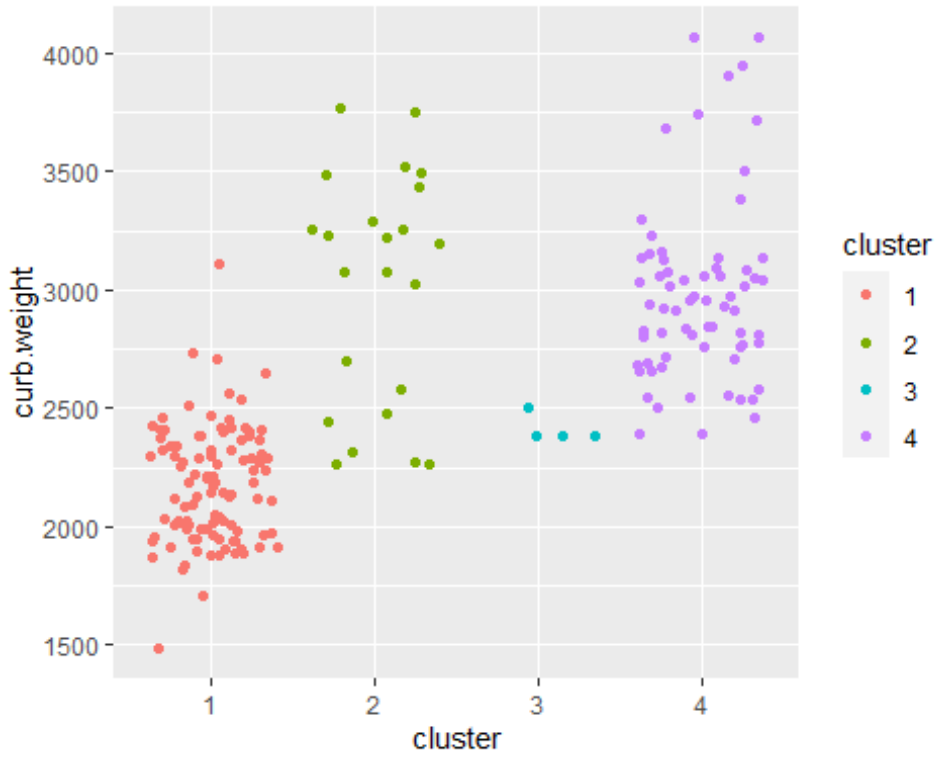

```
n <- ggplot(dataset, aes(cluster, width,color=cluster))
n + geom_jitter()
```



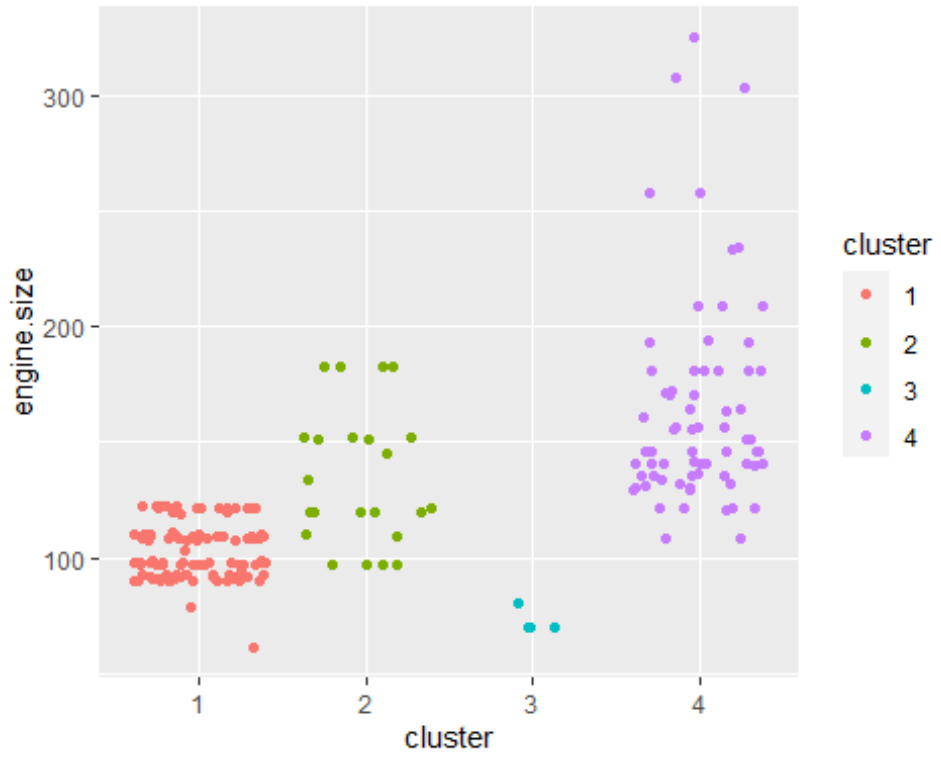

```
o <- ggplot(dataset, aes(cluster, height,color=cluster))
o + geom_jitter()
```



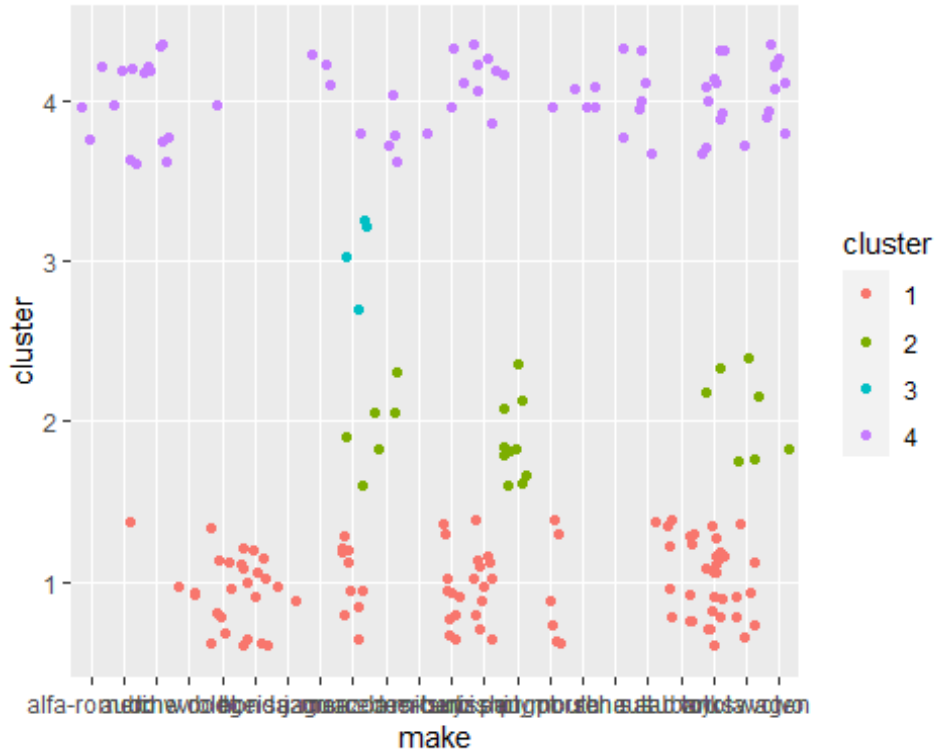
```
p <- ggplot(dataset, aes(cluster, curb.weight,color=cluster))
p + geom_jitter()
```



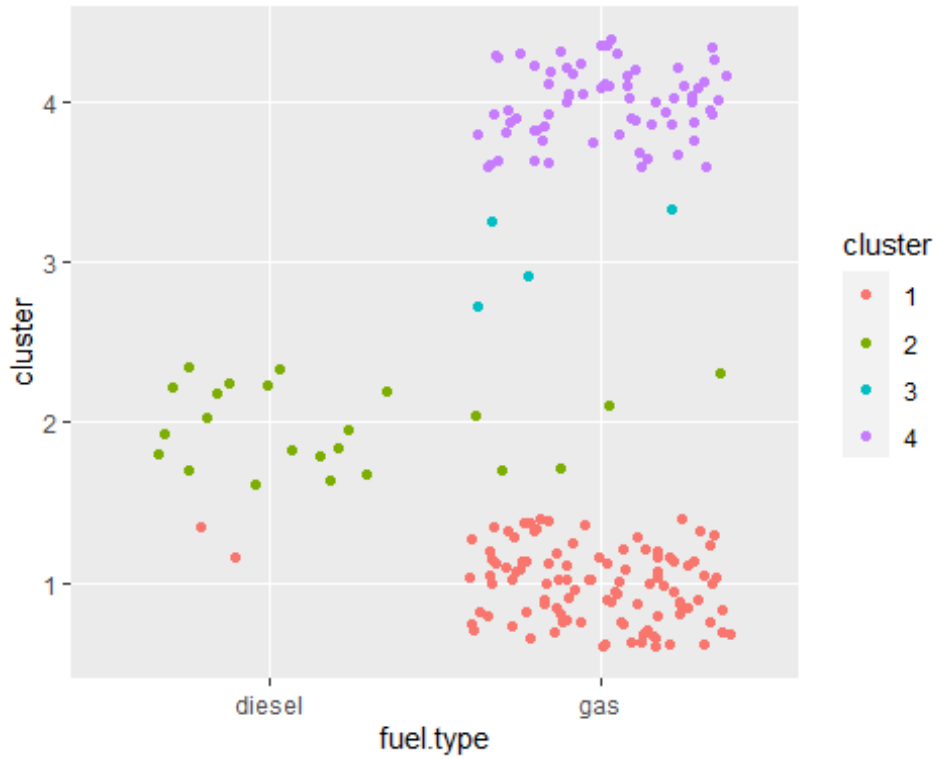

```
q <- ggplot(dataset, aes(cluster, engine.size,color=cluster))
q + geom_jitter()
```



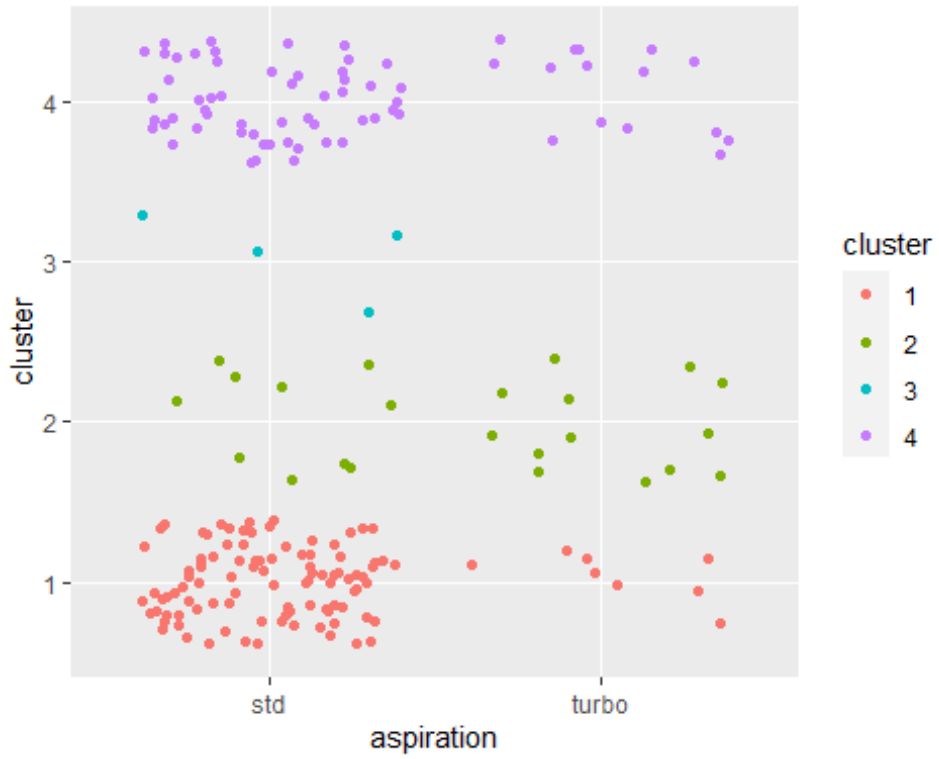

```
r <- ggplot(dataset, aes(make,cluster,color=cluster))
r + geom_jitter()
```



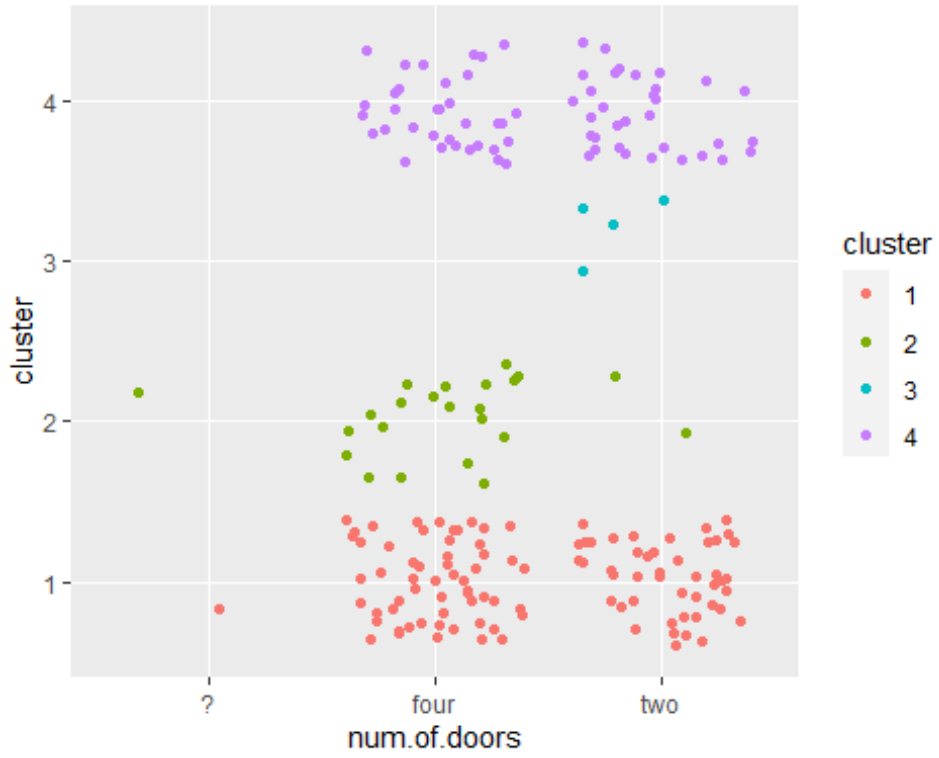
```
s <- ggplot(dataset, aes(fuel.type,cluster,color=cluster))
s + geom_jitter()
```



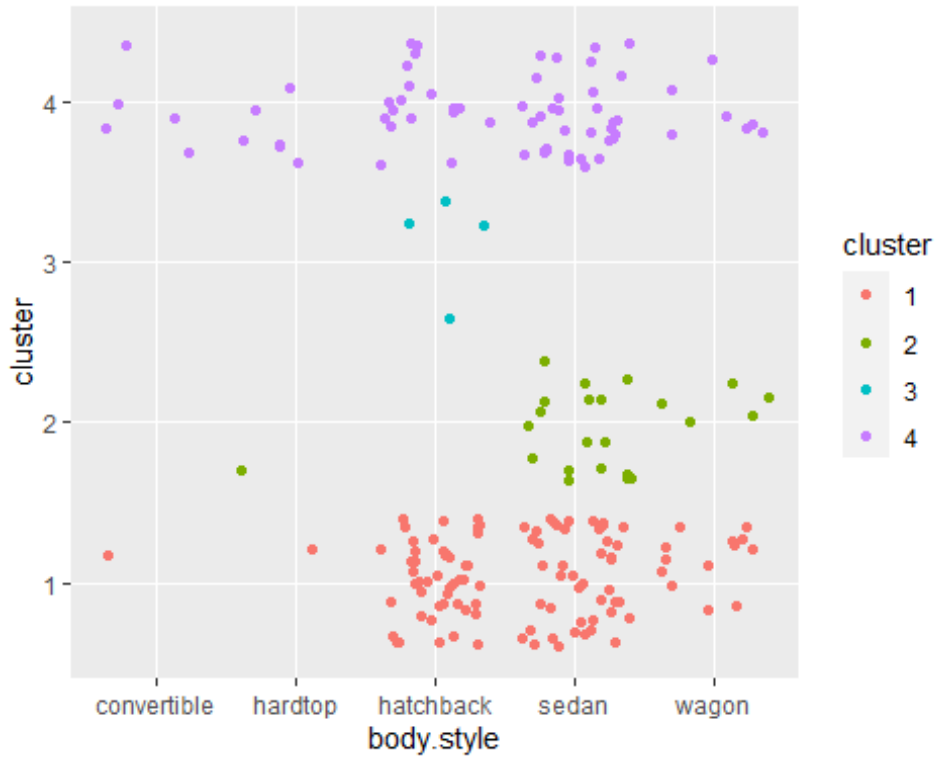

```
t <- ggplot(dataset, aes(aspiration,cluster,color=cluster))
t + geom_jitter()
```



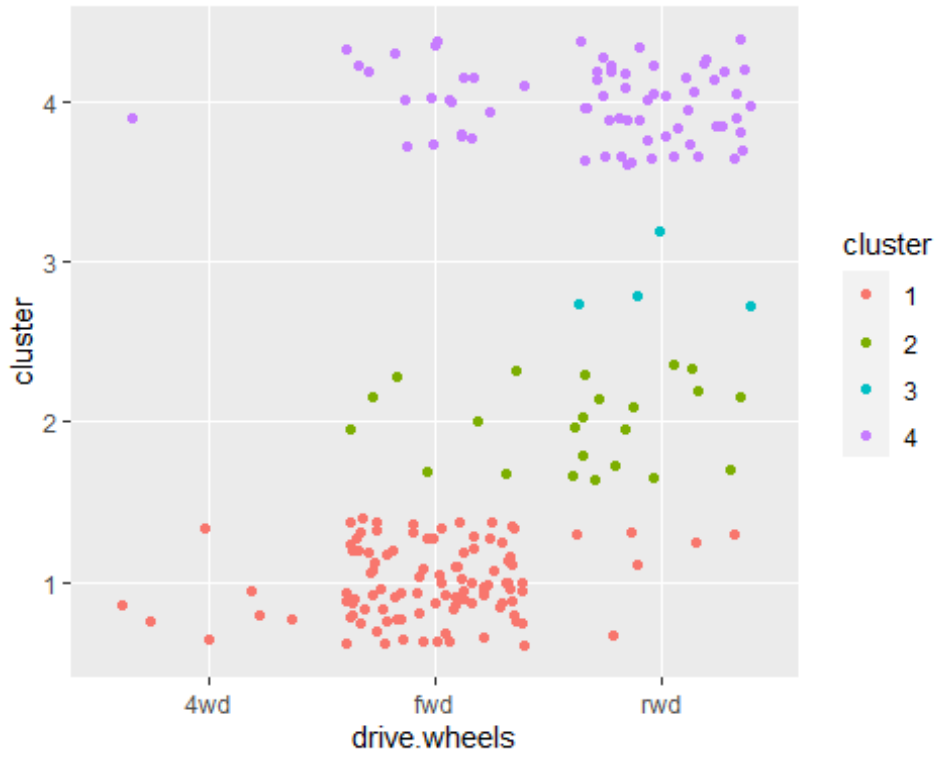

```
u <- ggplot(dataset, aes(num.of.doors,cluster,color=cluster))
u + geom_jitter()
```



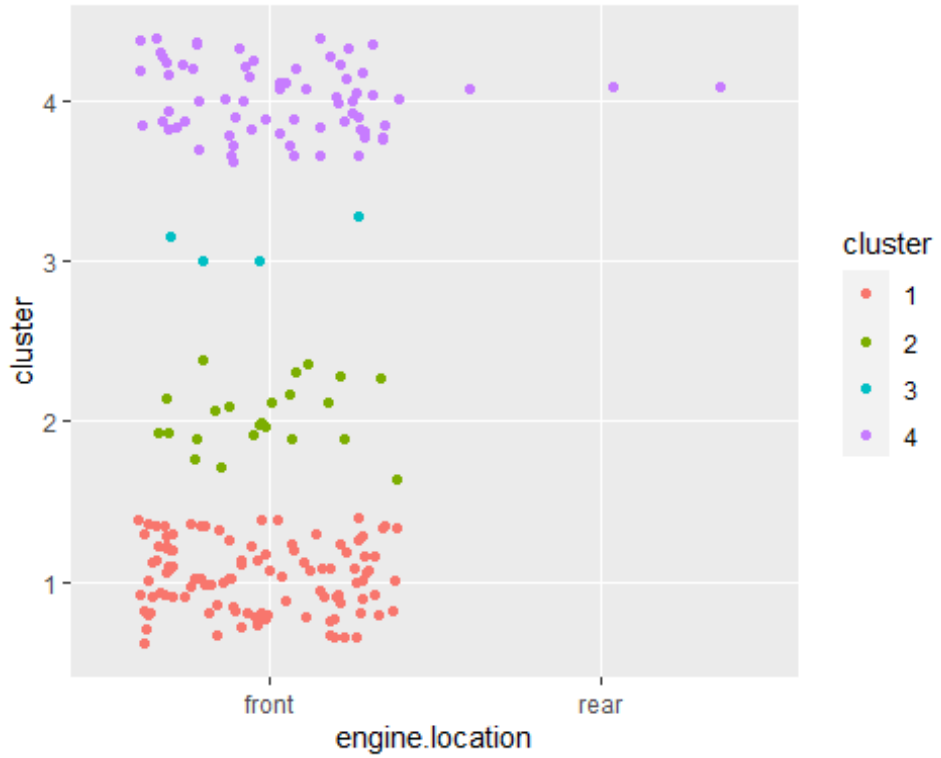
```
v <- ggplot(dataset, aes(body.style,cluster,color=cluster))
v + geom_jitter()
```



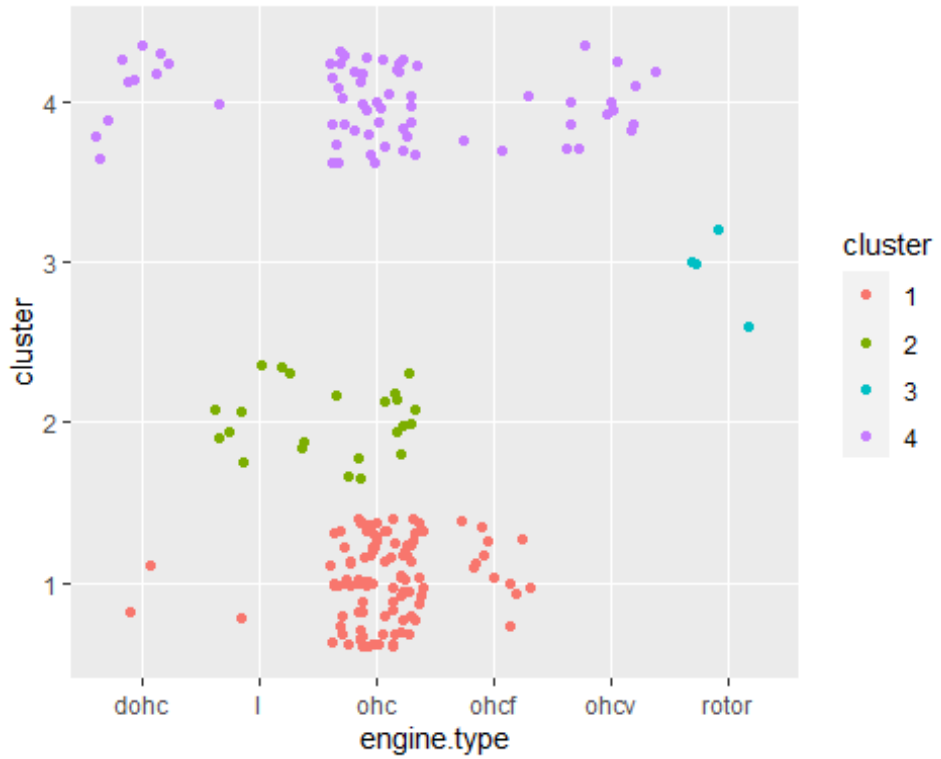

```
w <- ggplot(dataset, aes(drive.wheels,cluster,color=cluster))
w + geom_jitter()
```



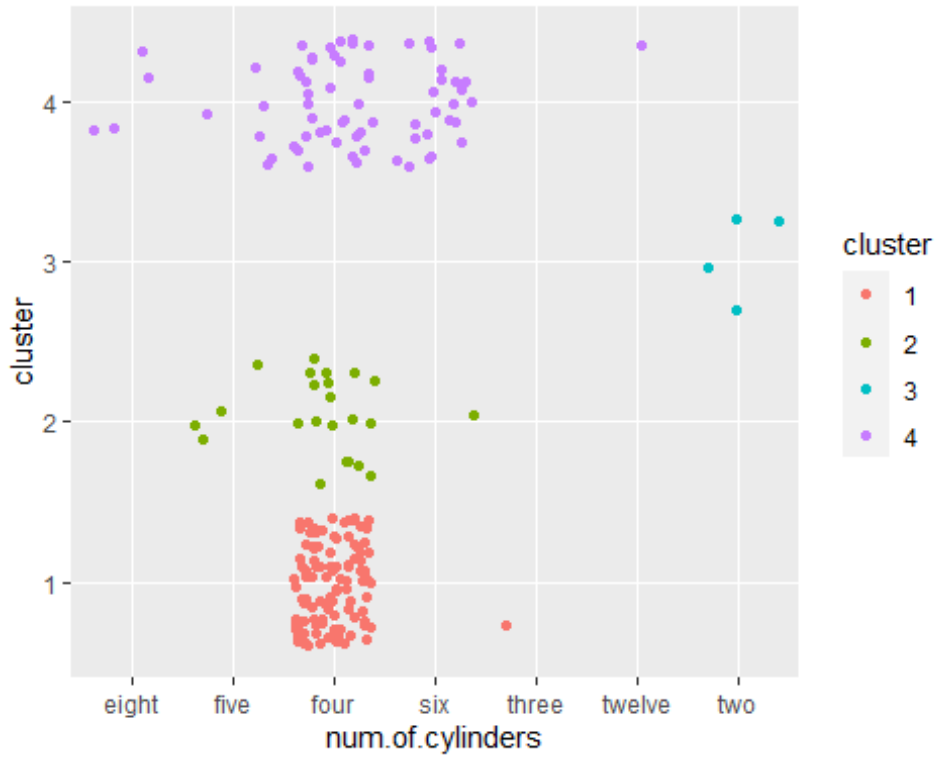

```
x <- ggplot(dataset, aes(engine.location,cluster,color=cluster))
x + geom_jitter()
```



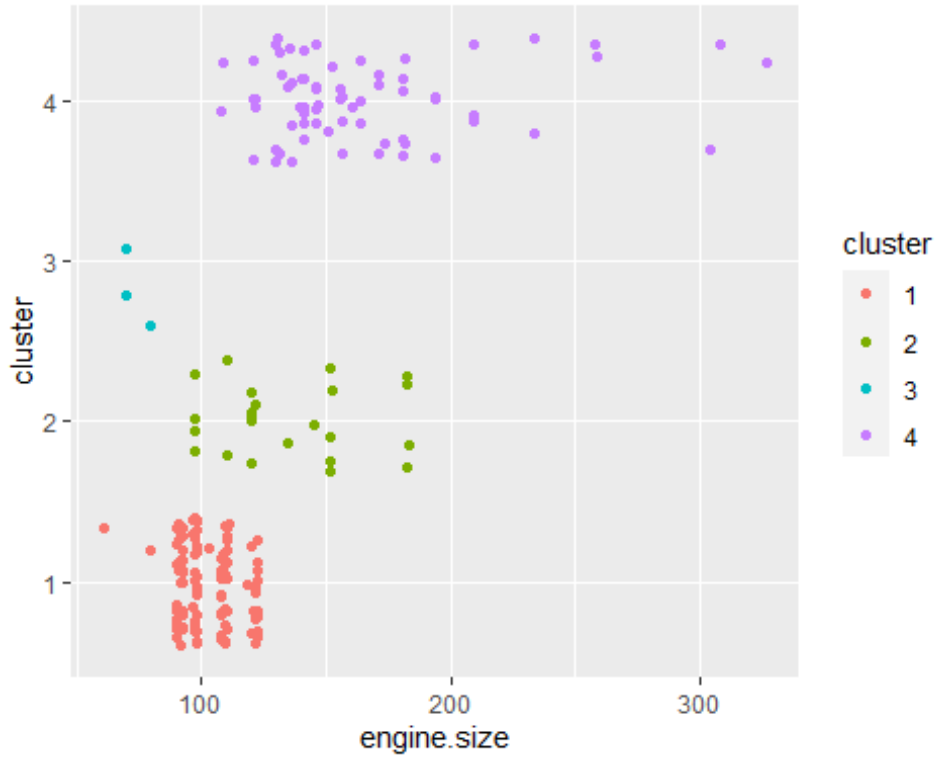
```
y <- ggplot(dataset, aes(engine.type,cluster,color=cluster))
y + geom_jitter()
```




```
z <- ggplot(dataset, aes(num.of.cylinders,cluster,color=cluster))
z + geom_jitter()
```




```
a <- ggplot(dataset, aes(engine.size,cluster,color=cluster))
a + geom_jitter()
```



```
b <- ggplot(dataset, aes(fuel.system,cluster,color=cluster))
b + geom_jitter()
```