Data Analytics 101 Course Project: Car Price Predictor

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Brief introduction of the project: This project aims to build predictive models for car prices using two datasets: Cars93 and CarPrice_Assignment

Load both cars data

```
cars93 <- read.csv("Cars93.csv")
cars_assign = read.csv("CarPrice_Assignment.csv")
```

Standard deviations for cars_assign

```
sd(cars_assign$enginesize)
```

```
## [1] 41.64269
```

```
sd(cars_assign$horsepower)
```

```
## [1] 39.54417
```

```
sd(cars_assign$curbweight)
```

```
## [1] 520.6802
```

```
sd(cars_assign$price)
```

```
## [1] 7988.852
```

Standard deviations for cars93

```
sd(cars93$EngineSize)
```

```
## [1] 1.037363
```

```
sd(cars93$Horsepower)
```

```
## [1] 52.37441
```

```r
sd(cars93$Weight)
```

```
## [1] 589.8965
```

```r
knitr::opts_chunk$set(echo = TRUE)
library(ggplot2)  # Ensure ggplot2 is loaded
```

Dataset 1 Summary

```r
summary(cars_assign)
```

```
##      car_ID      symboling         CarName            fueltype
##  Min.   :  1   Min.   :-2.0000   Length:205         Length:205
##  1st Qu.: 52   1st Qu.: 0.0000   Class :character   Class :character
##  Median :103   Median : 1.0000   Mode  :character   Mode  :character
##  Mean   :103   Mean   : 0.8341
##  3rd Qu.:154   3rd Qu.: 2.0000
##  Max.   :205   Max.   : 3.0000
##   aspiration         doornumber          carbody           drivewheel
##  Length:205         Length:205         Length:205         Length:205
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##  enginelocation       wheelbase        carlength        carwidth
##  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
##    carheight       curbweight    enginetype        cylindernumber
##  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
##    enginesize     fuelsystem          boreratio        stroke
##  Min.   : 61.0   Length:205         Min.   :2.54   Min.   :2.070
##  1st Qu.: 97.0   Class :character   1st Qu.:3.15   1st Qu.:3.110
##  Median :120.0   Mode  :character   Median :3.31   Median :3.290
##  Mean   :126.9                      Mean   :3.33   Mean   :3.255
##  3rd Qu.:141.0                      3rd Qu.:3.58   3rd Qu.:3.410
##  Max.   :326.0                      Max.   :3.94   Max.   :4.170
##  compressionratio   horsepower       peakrpm        citympg
##  Min.   : 7.00    Min.   : 48.0   Min.   :4150   Min.   :13.00
##  1st Qu.: 8.60    1st Qu.: 70.0   1st Qu.:4800   1st Qu.:19.00
##  Median : 9.00    Median : 95.0   Median :5200   Median :24.00
##  Mean   :10.14    Mean   :104.1   Mean   :5125   Mean   :25.22
##  3rd Qu.: 9.40    3rd Qu.:116.0   3rd Qu.:5500   3rd Qu.:30.00
```

```
##  Max.   :23.00    Max.   :288.0   Max.   :6600   Max.   :49.00
##    highwaympg        price
##  Min.   :16.00   Min.   : 5118
##  1st Qu.:25.00   1st Qu.: 7788
##  Median :30.00   Median :10295
##  Mean   :30.75   Mean   :13277
##  3rd Qu.:34.00   3rd Qu.:16503
##  Max.   :54.00   Max.   :45400
```

Dataset 2 Summary

```
summary(cars93)
```

```
##        id     Manufacturer          Model               Type
##  Min.   : 1   Length:93          Length:93          Length:93
##  1st Qu.:24   Class :character   Class :character   Class :character
##  Median :47   Mode  :character   Mode  :character   Mode  :character
##  Mean   :47
##  3rd Qu.:70
##  Max.   :93
##
##    Min.Price         Price          Max.Price       MPG.city      MPG.highway
##  Min.   : 6.70   Min.   : 7.40   Min.   : 7.9   Min.   :15.00   Min.   :20.00
##  1st Qu.:10.80   1st Qu.:12.20   1st Qu.:14.7   1st Qu.:18.00   1st Qu.:26.00
##  Median :14.70   Median :17.70   Median :19.6   Median :21.00   Median :28.00
##  Mean   :17.13   Mean   :19.51   Mean   :21.9   Mean   :22.37   Mean   :29.09
##  3rd Qu.:20.30   3rd Qu.:23.30   3rd Qu.:25.3   3rd Qu.:25.00   3rd Qu.:31.00
##  Max.   :45.40   Max.   :61.90   Max.   :80.0   Max.   :46.00   Max.   :50.00
##
##    AirBags           DriveTrain         Cylinders           EngineSize
##  Length:93          Length:93          Length:93          Min.   :1.000
##  Class :character   Class :character   Class :character   1st Qu.:1.800
##  Mode  :character   Mode  :character   Mode  :character   Median :2.400
##                                                           Mean   :2.668
##                                                           3rd Qu.:3.300
##                                                           Max.   :5.700
##
##    Horsepower         RPM        Rev.per.mile  Man.trans.avail
##  Min.   : 55.0   Min.   :3800   Min.   :1320   Length:93
##  1st Qu.:103.0   1st Qu.:4800   1st Qu.:1985   Class :character
##  Median :140.0   Median :5200   Median :2340   Mode  :character
##  Mean   :143.8   Mean   :5281   Mean   :2332
##  3rd Qu.:170.0   3rd Qu.:5750   3rd Qu.:2565
##  Max.   :300.0   Max.   :6500   Max.   :3755
##
##  Fuel.tank.capacity   Passengers        Length        Wheelbase
##  Min.   : 9.20      Min.   :2.000   Min.   :141.0   Min.   : 90.0
##  1st Qu.:14.50      1st Qu.:4.000   1st Qu.:174.0   1st Qu.: 98.0
##  Median :16.40      Median :5.000   Median :183.0   Median :103.0
##  Mean   :16.66      Mean   :5.086   Mean   :183.2   Mean   :103.9
##  3rd Qu.:18.80      3rd Qu.:6.000   3rd Qu.:192.0   3rd Qu.:110.0
##  Max.   :27.00      Max.   :8.000   Max.   :219.0   Max.   :119.0
##
```

```
##      Width        Turn.circle    Rear.seat.room   Luggage.room       Weight
##  Min.   :60.00   Min.   :32.00   Min.   :19.00   Min.   : 6.00   Min.   :1695
##  1st Qu.:67.00   1st Qu.:37.00   1st Qu.:26.00   1st Qu.:12.00   1st Qu.:2620
##  Median :69.00   Median :39.00   Median :27.50   Median :14.00   Median :3040
##  Mean   :69.38   Mean   :38.96   Mean   :27.83   Mean   :13.89   Mean   :3073
##  3rd Qu.:72.00   3rd Qu.:41.00   3rd Qu.:30.00   3rd Qu.:15.00   3rd Qu.:3525
##  Max.   :78.00   Max.   :45.00   Max.   :36.00   Max.   :22.00   Max.   :4105
##                                  NA's   :2       NA's   :11
##     Origin              Make
##  Length:93          Length:93
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
##
```

Scatter

```
cars93$Passengers
```

```
##  [1] 5 5 5 6 4 6 6 6 5 6 5 5 5 4 6 7 8 6 2 6 6 6 5 5 6 7 6 4 5 6 4 5 5 4 4 7 5 6
## [39] 4 4 4 4 4 5 5 4 5 5 5 4 6 6 4 5 5 7 2 5 5 4 5 5 5 5 5 7 5 5 5 7 6 4 4 5 4 5
## [77] 6 5 5 4 5 5 4 5 4 5 7 4 7 5 4 5 5
```

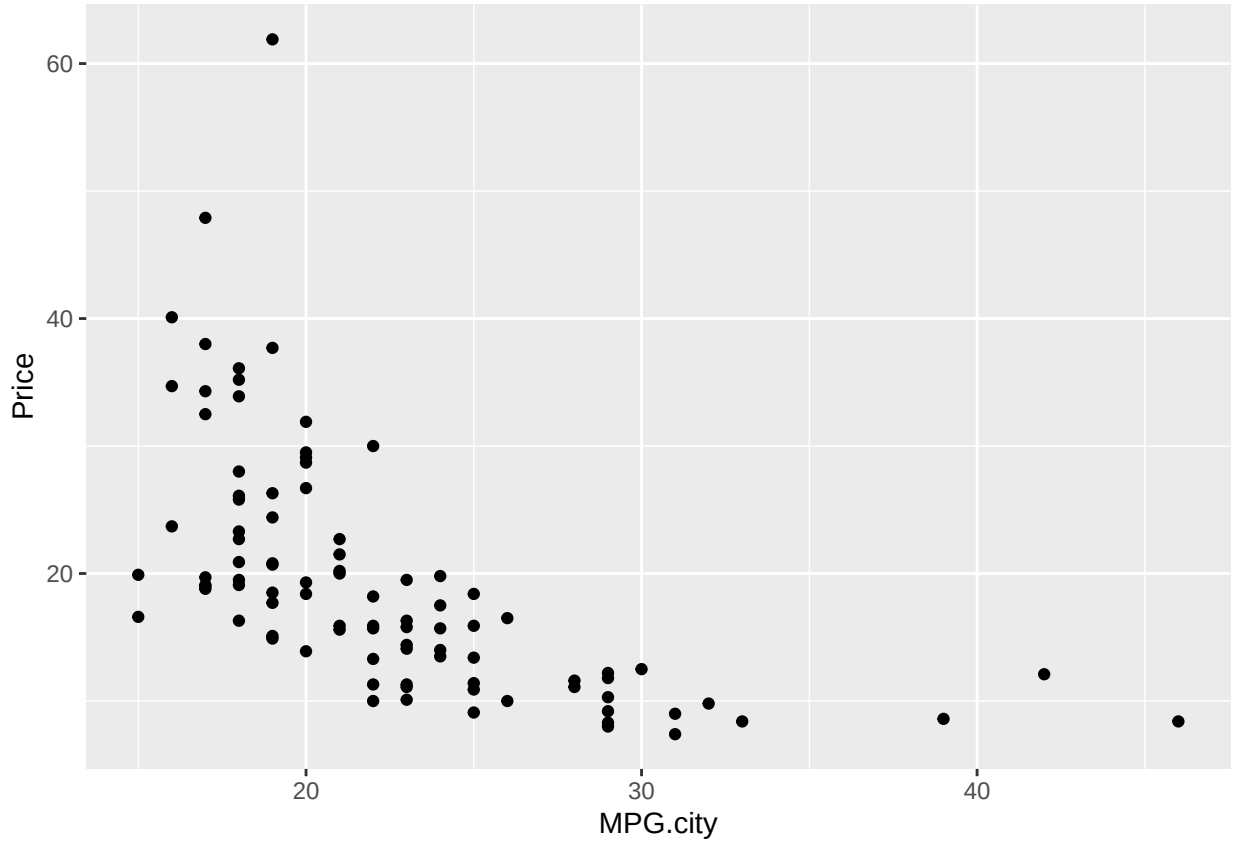
```
cars93$Cylinders
```

```
##  [1] "4"      "6"      "6"      "6"      "4"      "4"      "6"      "6"
##  [9] "6"      "8"      "8"      "4"      "4"      "6"      "4"      "6"
## [17] "6"      "8"      "8"      "6"      "4"      "6"      "4"      "4"
## [25] "4"      "6"      "4"      "6"      "4"      "6"      "4"      "4"
## [33] "4"      "4"      "4"      "6"      "6"      "8"      "3"      "4"
## [41] "4"      "4"      "4"      "4"      "4"      "4"      "4"      "8"
## [49] "6"      "6"      "6"      "8"      "4"      "4"      "4"      "6"
## [57] "rotary" "4"      "6"      "4"      "6"      "4"      "6"      "4"
## [65] "4"      "6"      "6"      "4"      "4"      "6"      "6"      "4"
## [73] "4"      "4"      "6"      "6"      "6"      "4"      "4"      "3"
## [81] "4"      "4"      "3"      "4"      "4"      "4"      "4"      "4"
## [89] "5"      "4"      "6"      "4"      "5"
```

```
columns93 <- c("MPG.city", "MPG.highway", "EngineSize", "Horsepower", "RPM", "Rev.per.mile", "Fuel.tank

length(columns93)
```

```
## [1] 13
```

```
ggplot(cars93, aes(x = MPG.city, y = Price)) +
  geom_point()
```




```
cars93[]
```

```
##    id  Manufacturer          Model    Type Min.Price Price Max.Price MPG.city
## 1   1         Acura        Integra   Small      12.9  15.9      18.8       25
## 2   2         Acura         Legend Midsize      29.2  33.9      38.7       18
## 3   3          Audi             90 Compact      25.9  29.1      32.3       20
## 4   4          Audi            100 Midsize      30.8  37.7      44.6       19
## 5   5           BMW           535i Midsize      23.7  30.0      36.2       22
## 6   6         Buick        Century Midsize      14.2  15.7      17.3       22
## 7   7         Buick        LeSabre   Large      19.9  20.8      21.7       19
## 8   8         Buick     Roadmaster   Large      22.6  23.7      24.9       16
## 9   9         Buick        Riviera Midsize      26.3  26.3      26.3       19
## 10 10      Cadillac        DeVille   Large      33.0  34.7      36.3       16
## 11 11      Cadillac        Seville Midsize      37.5  40.1      42.7       16
## 12 12     Chevrolet       Cavalier Compact       8.5  13.4      18.3       25
## 13 13     Chevrolet        Corsica Compact      11.4  11.4      11.4       25
## 14 14     Chevrolet         Camaro  Sporty      13.4  15.1      16.8       19
## 15 15     Chevrolet         Lumina Midsize      13.4  15.9      18.4       21
## 16 16     Chevrolet     Lumina_APV     Van      14.7  16.3      18.0       18
## 17 17     Chevrolet          Astro     Van      14.7  16.6      18.6       15
## 18 18     Chevrolet        Caprice   Large      18.0  18.8      19.6       17
## 19 19     Chevrolet       Corvette  Sporty      34.6  38.0      41.5       17
## 20 20      Chrylser       Concorde   Large      18.4  18.4      18.4       20
## 21 21      Chrysler        LeBaron Compact      14.5  15.8      17.1       23
## 22 22      Chrysler       Imperial   Large      29.5  29.5      29.5       20
## 23 23         Dodge           Colt   Small       7.9   9.2      10.6       29
```

```
## 24 24         Dodge         Shadow   Small       8.4  11.3      14.2       23
## 25 25         Dodge         Spirit Compact      11.9  13.3      14.7       22
## 26 26         Dodge        Caravan     Van      13.6  19.0      24.4       17
## 27 27         Dodge        Dynasty Midsize      14.8  15.6      16.4       21
## 28 28         Dodge        Stealth  Sporty      18.5  25.8      33.1       18
## 29 29         Eagle         Summit   Small       7.9  12.2      16.5       29
## 30 30         Eagle         Vision   Large      17.5  19.3      21.2       20
## 31 31          Ford        Festiva   Small       6.9   7.4       7.9       31
## 32 32          Ford         Escort   Small       8.4  10.1      11.9       23
## 33 33          Ford          Tempo Compact      10.4  11.3      12.2       22
## 34 34          Ford        Mustang  Sporty      10.8  15.9      21.0       22
## 35 35          Ford          Probe  Sporty      12.8  14.0      15.2       24
## 36 36          Ford       Aerostar     Van      14.5  19.9      25.3       15
## 37 37          Ford         Taurus Midsize      15.6  20.2      24.8       21
## 38 38          Ford Crown_Victoria   Large      20.1  20.9      21.7       18
## 39 39           Geo          Metro   Small       6.7   8.4      10.0       46
## 40 40           Geo          Storm  Sporty      11.5  12.5      13.5       30
## 41 41         Honda        Prelude  Sporty      17.0  19.8      22.7       24
## 42 42         Honda          Civic   Small       8.4  12.1      15.8       42
## 43 43         Honda         Accord Compact      13.8  17.5      21.2       24
## 44 44       Hyundai          Excel   Small       6.8   8.0       9.2       29
## 45 45       Hyundai        Elantra   Small       9.0  10.0      11.0       22
## 46 46       Hyundai         Scoupe  Sporty       9.1  10.0      11.0       26
## 47 47       Hyundai         Sonata Midsize      12.4  13.9      15.3       20
## 48 48      Infiniti            Q45 Midsize      45.4  47.9      50.4       17
## 49 49         Lexus          ES300 Midsize      27.5  28.0      28.4       18
## 50 50         Lexus          SC300 Midsize      34.7  35.2      35.6       18
## 51 51       Lincoln    Continental Midsize      33.3  34.3      35.3       17
## 52 52       Lincoln       Town_Car   Large      34.4  36.1      37.8       18
## 53 53         Mazda            323   Small       7.4   8.3       9.1       29
## 54 54         Mazda        Protege   Small      10.9  11.6      12.3       28
## 55 55         Mazda            626 Compact      14.3  16.5      18.7       26
## 56 56         Mazda            MPV     Van      16.6  19.1      21.7       18
## 57 57         Mazda           RX-7  Sporty      32.5  32.5      32.5       17
## 58 58 Mercedes-Benz           190E Compact      29.0  31.9      34.9       20
## 59 59 Mercedes-Benz           300E Midsize      43.8  61.9      80.0       19
## 60 60       Mercury          Capri  Sporty      13.3  14.1      15.0       23
## 61 61       Mercury         Cougar Midsize      14.9  14.9      14.9       19
## 62 62    Mitsubishi         Mirage   Small       7.7  10.3      12.9       29
## 63 63    Mitsubishi       Diamante Midsize      22.4  26.1      29.9       18
## 64 64        Nissan         Sentra   Small       8.7  11.8      14.9       29
## 65 65        Nissan         Altima Compact      13.0  15.7      18.3       24
## 66 66        Nissan          Quest     Van      16.7  19.1      21.5       17
## 67 67        Nissan         Maxima Midsize      21.0  21.5      22.0       21
## 68 68    Oldsmobile        Achieva Compact      13.0  13.5      14.0       24
## 69 69    Oldsmobile  Cutlass_Ciera Midsize      14.2  16.3      18.4       23
## 70 70    Oldsmobile     Silhouette     Van      19.5  19.5      19.5       18
## 71 71    Oldsmobile   Eighty-Eight   Large      19.5  20.7      21.9       19
## 72 72      Plymouth          Laser  Sporty      11.4  14.4      17.4       23
## 73 73       Pontiac         LeMans   Small       8.2   9.0       9.9       31
## 74 74       Pontiac        Sunbird Compact       9.4  11.1      12.8       23
## 75 75       Pontiac       Firebird  Sporty      14.0  17.7      21.4       19
## 76 76       Pontiac     Grand_Prix Midsize      15.4  18.5      21.6       19
## 77 77       Pontiac     Bonneville   Large      19.4  24.4      29.4       19
```

```
## 78 78          Saab            900 Compact      20.3  28.7      37.1       20
## 79 79        Saturn             SL   Small       9.2  11.1      12.9       28
## 80 80        Subaru          Justy   Small       7.3   8.4       9.5       33
## 81 81        Subaru         Loyale   Small      10.5  10.9      11.3       25
## 82 82        Subaru         Legacy Compact      16.3  19.5      22.7       23
## 83 83        Suzuki          Swift   Small       7.3   8.6      10.0       39
## 84 84        Toyota         Tercel   Small       7.8   9.8      11.8       32
## 85 85        Toyota         Celica  Sporty      14.2  18.4      22.6       25
## 86 86        Toyota          Camry Midsize      15.2  18.2      21.2       22
## 87 87        Toyota         Previa     Van      18.9  22.7      26.6       18
## 88 88    Volkswagen            Fox   Small       8.7   9.1       9.5       25
## 89 89    Volkswagen        Eurovan     Van      16.6  19.7      22.7       17
## 90 90    Volkswagen         Passat Compact      17.6  20.0      22.4       21
## 91 91    Volkswagen        Corrado  Sporty      22.9  23.3      23.7       18
## 92 92         Volvo            240 Compact      21.8  22.7      23.5       21
## 93 93         Volvo            850 Midsize      24.8  26.7      28.5       20
##    MPG.highway            AirBags DriveTrain Cylinders EngineSize Horsepower
## 1           31               None      Front         4        1.8        140
## 2           25 Driver & Passenger      Front         6        3.2        200
## 3           26        Driver only      Front         6        2.8        172
## 4           26                         Front         6        2.8        172
## 5           30        Driver only       Rear         4        3.5        208
## 6           31        Driver only      Front         4        2.2        110
## 7           28        Driver only      Front         6        3.8        170
## 8           25        Driver only       Rear         6        5.7        180
## 9           27        Driver only      Front         6        3.8        170
## 10          25        Driver only      Front         8        4.9        200
## 11          25 Driver & Passenger      Front         8        4.6        295
## 12          36               None      Front         4        2.2        110
## 13          34        Driver only      Front         4        2.2        110
## 14          28 Driver & Passenger       Rear         6        3.4        160
## 15          29               None      Front         4        2.2        110
## 16          23               None      Front         6        3.8        170
## 17          20               None        4WD         6        4.3        165
## 18          26        Driver only       Rear         8        5.0        170
## 19          25        Driver only       Rear         8        5.7        300
## 20          28 Driver & Passenger      Front         6        3.3        153
## 21          28 Driver & Passenger      Front         4        3.0        141
## 22          26                         Front         6        3.3        147
## 23          33               None      Front         4        1.5         92
## 24          29        Driver only      Front         4        2.2         93
## 25          27        Driver only      Front         4        2.5        100
## 26          21        Driver only        4WD         6        3.0        142
## 27          27        Driver only      Front         4        2.5        100
## 28          24        Driver only        4WD         6        3.0        300
## 29          33               None      Front         4        1.5         92
## 30          28 Driver & Passenger      Front         6        3.5        214
## 31          33               None      Front         4        1.3         63
## 32          30               None      Front         4        1.8        127
## 33          27               None      Front         4        2.3         96
## 34          29        Driver only       Rear         4        2.3        105
## 35          30        Driver only      Front         4        2.0        115
## 36          20        Driver only        4WD         6        3.0        145
## 37          30        Driver only      Front         6        3.0        140
```

```
## 38          26         Driver only        Rear         8        4.6         190
## 39          50                None       Front         3        1.0          55
## 40          36         Driver only       Front         4        1.6          90
## 41          31 Driver & Passenger       Front         4        2.3         160
## 42          46         Driver only       Front         4        1.5         102
## 43          31 Driver & Passenger       Front         4        2.2         140
## 44          33                None       Front         4        1.5          81
## 45          29                None       Front         4        1.8         124
## 46          34                           Front         4        1.5          92
## 47          27                None       Front         4        2.0         128
## 48          22         Driver only        Rear         8        4.5         278
## 49          24         Driver only       Front         6        3.0         185
## 50          23 Driver & Passenger        Rear         6        3.0         225
## 51          26 Driver & Passenger       Front         6        3.8         160
## 52          26                           Rear         8        4.6         210
## 53          37                None       Front         4        1.6          82
## 54          36                None       Front         4        1.8         103
## 55          34         Driver only       Front         4        2.5         164
## 56          24                None         4WD         6        3.0         155
## 57          25         Driver only        Rear      rotary      1.3         255
## 58          29         Driver only        Rear         4        2.3         130
## 59          25 Driver & Passenger        Rear         6        3.2         217
## 60          26         Driver only       Front         4        1.6         100
## 61          26                None        Rear         6        3.8         140
## 62          33                None       Front         4        1.5          92
## 63          24         Driver only       Front         6        3.0         202
## 64          33         Driver only       Front         4        1.6         110
## 65          30         Driver only       Front         4        2.4         150
## 66          23                None       Front         6        3.0         151
## 67          26         Driver only       Front         6        3.0         160
## 68          31                None       Front         4        2.3         155
## 69          31         Driver only       Front         4        2.2         110
## 70          23                None       Front         6        3.8         170
## 71          28         Driver only       Front         6        3.8         170
## 72          30                None         4WD         4        1.8          92
## 73          41                None       Front         4        1.6          74
## 74          31                None       Front         4        2.0         110
## 75          28 Driver & Passenger        Rear         6        3.4         160
## 76          27                None       Front         6        3.4         200
## 77          28 Driver & Passenger       Front         6        3.8         170
## 78          26         Driver only       Front         4        2.1         140
## 79          38         Driver only       Front         4        1.9          85
## 80          37                None         4WD         3        1.2          73
## 81          30                None         4WD         4        1.8          90
## 82          30         Driver only         4WD         4        2.2         130
## 83          43                None       Front         3        1.3          70
## 84          37         Driver only       Front         4        1.5          82
## 85          32         Driver only       Front         4        2.2         135
## 86          29         Driver only       Front         4        2.2         130
## 87          22         Driver only         4WD         4        2.4         138
## 88          33                None       Front         4        1.8          81
## 89          21                None       Front         5        2.5         109
## 90          30                None       Front         4        2.0         134
## 91          25                None       Front         6        2.8         178
```

```
## 92          28        Driver only       Rear         4        2.3        114
## 93          28 Driver & Passenger      Front         5        2.4        168
##     RPM Rev.per.mile Man.trans.avail Fuel.tank.capacity Passengers Length
## 1  6300         2890             Yes               13.2          5    177
## 2  5500         2335             Yes               18.0          5    195
## 3  5500         2280             Yes               16.9          5    180
## 4  5500         2535             Yes               21.1          6    193
## 5  5700         2545             Yes               21.1          4    186
## 6  5200         2565              No               16.4          6    189
## 7  4800         1570              No               18.0          6    200
## 8  4000         1320              No               23.0          6    216
## 9  4800         1690              No               18.8          5    198
## 10 4100         1510              No               18.0          6    206
## 11 6000         1985              No               20.0          5    204
## 12 5200         2380             Yes               15.2          5    182
## 13 5200         2665             Yes               15.6          5    184
## 14 4600         1805             Yes               15.5          4    193
## 15 5200         2595              No               16.5          6    198
## 16 4800         1690              No               20.0          7    178
## 17 4000         1790              No               27.0          8    194
## 18 4200         1350              No               23.0          6    214
## 19 5000         1450             Yes               20.0          2    179
## 20 5300         1990              No               18.0          6    203
## 21 5000         2090              No               16.0          6    183
## 22 4800         1785              No               16.0          6    203
## 23 6000         3285             Yes               13.2          5    174
## 24 4800         2595             Yes               14.0          5    172
## 25 4800         2535             Yes               16.0          6    181
## 26 5000         1970              No               20.0          7    175
## 27 4800         2465              No               16.0          6    192
## 28 6000         2120             Yes               19.8          4    180
## 29 6000         2505             Yes               13.2          5    174
## 30 5800         1980              No               18.0          6    202
## 31 5000         3150             Yes               10.0          4    141
## 32 6500         2410             Yes               13.2          5    171
## 33 4200         2805             Yes               15.9          5    177
## 34 4600         2285             Yes               15.4          4    180
## 35 5500         2340             Yes               15.5          4    179
## 36 4800         2080             Yes               21.0          7    176
## 37 4800         1885              No               16.0          5    192
## 38 4200         1415              No               20.0          6    212
## 39 5700         3755             Yes               10.6          4    151
## 40 5400         3250             Yes               12.4          4    164
## 41 5800         2855             Yes               15.9          4    175
## 42 5900         2650             Yes               11.9          4    173
## 43 5600         2610             Yes               17.0          4    185
## 44 5500         2710             Yes               11.9          5    168
## 45 6000         2745             Yes               13.7          5    172
## 46 5550         2540             Yes               11.9          4    166
## 47 6000         2335             Yes               17.2          5    184
## 48 6000         1955              No               22.5          5    200
## 49 5200         2325             Yes               18.5          5    188
## 50 6000         2510             Yes               20.6          4    191
## 51 4400         1835              No               18.4          6    205
```

```
## 52 4600         1840              No              20.0          6    219
## 53 5000         2370             Yes              13.2          4    164
## 54 5500         2220             Yes              14.5          5    172
## 55 5600         2505             Yes              15.5          5    184
## 56 5000         2240              No              19.6          7    190
## 57 6500         2325             Yes              20.0          2    169
## 58 5100         2425             Yes              14.5          5    175
## 59 5500         2220              No              18.5          5    187
## 60 5750         2475             Yes              11.1          4    166
## 61 3800         1730              No              18.0          5    199
## 62 6000         2505             Yes              13.2          5    172
## 63 6000         2210              No              19.0          5    190
## 64 6000         2435             Yes              13.2          5    170
## 65 5600         2130             Yes              15.9          5    181
## 66 4800         2065              No              20.0          7    190
## 67 5200         2045              No              18.5          5    188
## 68 6000         2380              No              15.2          5    188
## 69 5200         2565              No              16.5          5    190
## 70 4800         1690              No              20.0          7    194
## 71 4800         1570              No              18.0          6    201
## 72 5000         2360             Yes              15.9          4    173
## 73 5600         3130             Yes              13.2          4    177
## 74 5200         2665             Yes              15.2          5    181
## 75 4600         1805             Yes              15.5          4    196
## 76 5000         1890             Yes              16.5          5    195
## 77 4800         1565              No              18.0          6    177
## 78 6000         2910             Yes              18.0          5    184
## 79 5000         2145             Yes              12.8          5    176
## 80 5600         2875             Yes               9.2          4    146
## 81 5200         3375             Yes              15.9          5    175
## 82 5600         2330             Yes              15.9          5    179
## 83 6000         3360             Yes              10.6          4    161
## 84 5200         3505             Yes              11.9          5    162
## 85 5400         2405             Yes              15.9          4    174
## 86 5400         2340             Yes              18.5          5    188
## 87 5000         2515             Yes              19.8          7    187
## 88 5500         2550             Yes              12.4          4    163
## 89 4500         2915             Yes              21.1          7    187
## 90 5800         2685             Yes              18.5          5    180
## 91 5800         2385             Yes              18.5          4    159
## 92 5400         2215             Yes              15.8          5    190
## 93 6200         2310             Yes              19.3          5    184
##    Wheelbase Width Turn.circle Rear.seat.room Luggage.room Weight  Origin
## 1        102    68          37           26.5           11   2705 non-USA
## 2        115    71          38           30.0           15   3560 non-USA
## 3        102    67          37           28.0           14   3375 non-USA
## 4        106    70          37           31.0           17   3405 non-USA
## 5        109    69          39           27.0           13   3640 non-USA
## 6        105    69          41           28.0           16   2880     USA
## 7        111    74          42           30.5           17   3470     USA
## 8        116    78          45           30.5           21   4105     USA
## 9        108    73          41           26.5           14   3495     USA
## 10       114    73          43           35.0           18   3620     USA
## 11       111    74          44           31.0           14   3935     USA
```

```
## 12      101    66          38          25.0          13   2490     USA
## 13      103    68          39          26.0          14   2785     USA
## 14      101    74          43          25.0          13   3240     USA
## 15      108    71          40          28.5          16   3195     USA
## 16      110    74          44          30.5          NA   3715     USA
## 17      111    78          42          33.5          NA   4025     USA
## 18      116    77          42          29.5          20   3910     USA
## 19       96    74          43            NA          NA   3380     USA
## 20      113    74          40          31.0          15   3515     USA
## 21      104    68          41          30.5          14   3085     USA
## 22      110    69          44          36.0          17   3570     USA
## 23       98    66          32          26.5          11   2270     USA
## 24       97    67          38          26.5          13   2670     USA
## 25      104    68          39          30.5          14   2970     USA
## 26      112    72          42          26.5          NA   3705     USA
## 27      105    69          42          30.5          16   3080     USA
## 28       97    72          40          20.0          11   3805     USA
## 29       98    66          36          26.5          11   2295     USA
## 30      113    74          40          30.0          15   3490     USA
## 31       90    63          33          26.0          12   1845     USA
## 32       98    67          36          28.0          12   2530     USA
## 33      100    68          39          27.5          13   2690     USA
## 34      101    68          40          24.0          12   2850     USA
## 35      103    70          38          23.0          18   2710     USA
## 36      119    72          45          30.0          NA   3735     USA
## 37      106    71          40          27.5          18   3325     USA
## 38      114    78          43          30.0          21   3950     USA
## 39       93    63          34          27.5          10   1695 non-USA
## 40       97    67          37          24.5          11   2475 non-USA
## 41      100    70          39          23.5           8   2865 non-USA
## 42      103    67          36          28.0          12   2350 non-USA
## 43      107    67          41          28.0          14   3040 non-USA
## 44       94    63          35          26.0          11   2345 non-USA
## 45       98    66          36          28.0          12   2620 non-USA
## 46       94    64          34          23.5           9   2285 non-USA
## 47      104    69          41          31.0          14   2885 non-USA
## 48      113    72          42          29.0          15   4000 non-USA
## 49      103    70          40          27.5          14   3510 non-USA
## 50      106    71          39          25.0           9   3515 non-USA
## 51      109    73          42          30.0          19   3695     USA
## 52      117    77          45          31.5          22   4055     USA
## 53       97    66          34          27.0          16   2325 non-USA
## 54       98    66          36          26.5          13   2440 non-USA
## 55      103    69          40          29.5          14   2970 non-USA
## 56      110    72          39          27.5          NA   3735 non-USA
## 57       96    69          37            NA          NA   2895 non-USA
## 58      105    67          34          26.0          12   2920 non-USA
## 59      110    69          37          27.0          15   3525 non-USA
## 60       95    65          36          19.0           6   2450     USA
## 61      113    73          38          28.0          15   3610     USA
## 62       98    67          36          26.0          11   2295 non-USA
## 63      107    70          43          27.5          14   3730 non-USA
## 64       96    66          33          26.0          12   2545 non-USA
## 65      103    67          40          28.5          14   3050 non-USA
```

```
## 66       112    74           41            27.0           NA   4100 non-USA
## 67       104    69           41            28.5           14   3200 non-USA
## 68       103    67           39            28.0           14   2910     USA
## 69       105    70           42            28.0           16   2890     USA
## 70       110    74           44            30.5           NA   3715     USA
## 71       111    74           42            31.5           17   3470     USA
## 72        97    67           39            24.5            8   2640     USA
## 73        99    66           35            25.5           17   2350     USA
## 74       101    66           39            25.0           13   2575     USA
## 75       101    75           43            25.0           13   3240     USA
## 76       108    72           41            28.5           16   3450     USA
## 77       111    74           43            30.5           18   3495     USA
## 78        99    67           37            26.5           14   2775 non-USA
## 79       102    68           40            26.5           12   2495     USA
## 80        90    60           32            23.5           10   2045 non-USA
## 81        97    65           35            27.5           15   2490 non-USA
## 82       102    67           37            27.0           14   3085 non-USA
## 83        93    63           34            27.5           10   1965 non-USA
## 84        94    65           36            24.0           11   2055 non-USA
## 85        99    69           39            23.0           13   2950 non-USA
## 86       103    70           38            28.5           15   3030 non-USA
## 87       113    71           41            35.0           NA   3785 non-USA
## 88        93    63           34            26.0           10   2240 non-USA
## 89       115    72           38            34.0           NA   3960 non-USA
## 90       103    67           35            31.5           14   2985 non-USA
## 91        97    66           36            26.0           15   2810 non-USA
## 92       104    67           37            29.5           14   2985 non-USA
## 93       105    69           38            30.0           15   3245 non-USA
##                        Make
## 1              Acura Integra
## 2               Acura Legend
## 3                    Audi 90
## 4                   Audi 100
## 5                   BMW 535i
## 6              Buick Century
## 7              Buick LeSabre
## 8            Buick Roadmaster
## 9              Buick Riviera
## 10           Cadillac DeVille
## 11           Cadillac Seville
## 12         Chevrolet Cavalier
## 13          Chevrolet Corsica
## 14           Chevrolet Camaro
## 15           Chevrolet Lumina
## 16     Chevrolet Lumina_APV
## 17          Chevrolet Astro
## 18          Chevrolet Caprice
## 19         Chevrolet Corvette
## 20          Chrylser Concorde
## 21           Chrysler LeBaron
## 22          Chrysler Imperial
## 23                 Dodge Colt
## 24              Dodge Shadow
## 25              Dodge Spirit
```

```
## 26            Dodge Caravan
## 27            Dodge Dynasty
## 28            Dodge Stealth
## 29             Eagle Summit
## 30             Eagle Vision
## 31             Ford Festiva
## 32              Ford Escort
## 33                Ford Tempo
## 34             Ford Mustang
## 35                Ford Probe
## 36            Ford Aerostar
## 37              Ford Taurus
## 38      Ford Crown_Victoria
## 39                 Geo Metro
## 40                 Geo Storm
## 41            Honda Prelude
## 42              Honda Civic
## 43             Honda Accord
## 44            Hyundai Excel
## 45          Hyundai Elantra
## 46           Hyundai Scoupe
## 47           Hyundai Sonata
## 48             Infiniti Q45
## 49              Lexus ES300
## 50              Lexus SC300
## 51      Lincoln Continental
## 52         Lincoln Town_Car
## 53                Mazda 323
## 54            Mazda Protege
## 55                Mazda 626
## 56                Mazda MPV
## 57               Mazda RX-7
## 58       Mercedes-Benz 190E
## 59       Mercedes-Benz 300E
## 60            Mercury Capri
## 61           Mercury Cougar
## 62        Mitsubishi Mirage
## 63      Mitsubishi Diamante
## 64            Nissan Sentra
## 65            Nissan Altima
## 66             Nissan Quest
## 67            Nissan Maxima
## 68       Oldsmobile Achieva
## 69 Oldsmobile Cutlass_Ciera
## 70    Oldsmobile Silhouette
## 71  Oldsmobile Eighty-Eight
## 72           Plymouth Laser
## 73           Pontiac LeMans
## 74          Pontiac Sunbird
## 75         Pontiac Firebird
## 76       Pontiac Grand_Prix
## 77       Pontiac Bonneville
## 78                 Saab 900
## 79                Saturn SL
```

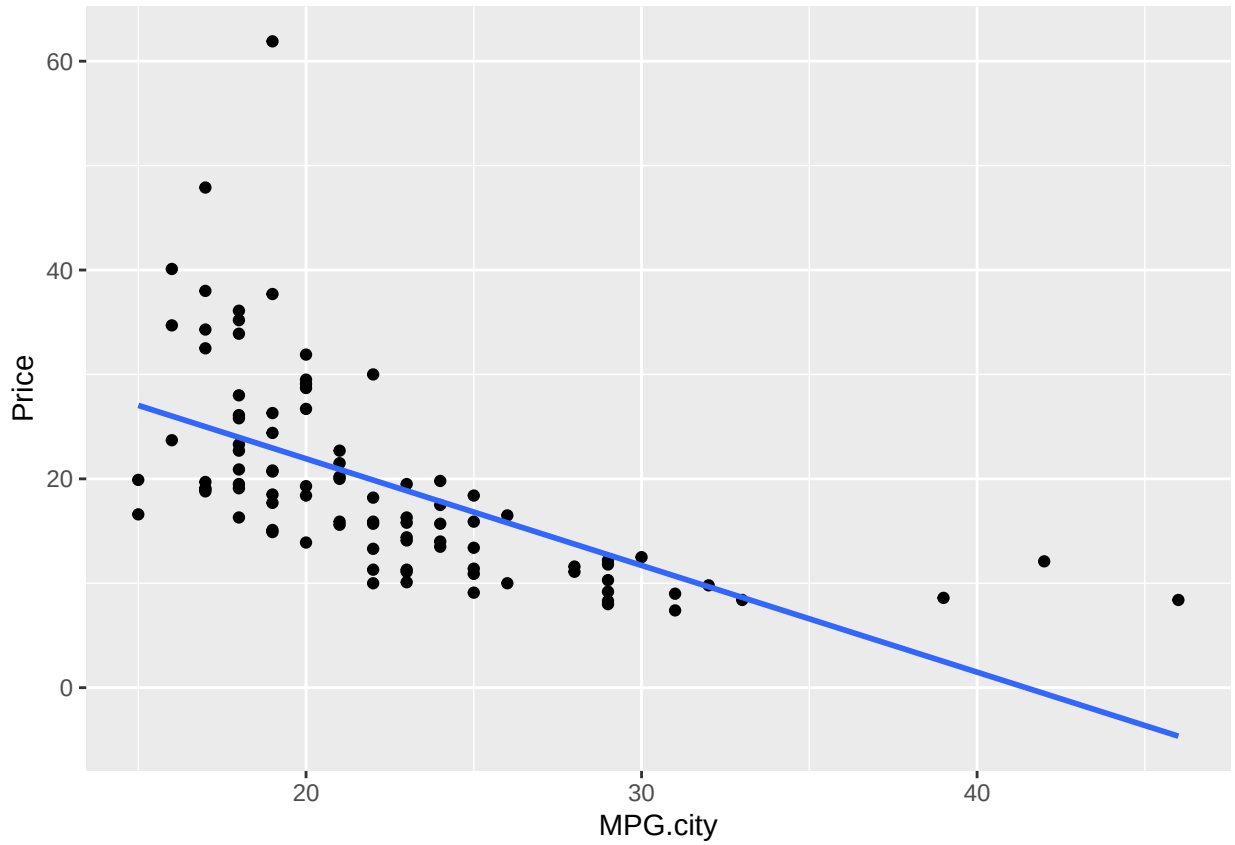
```
## 80             Subaru Justy
## 81            Subaru Loyale
## 82            Subaru Legacy
## 83             Suzuki Swift
## 84            Toyota Tercel
## 85            Toyota Celica
## 86             Toyota Camry
## 87            Toyota Previa
## 88           Volkswagen Fox
## 89       Volkswagen Eurovan
## 90        Volkswagen Passat
## 91       Volkswagen Corrado
## 92                Volvo 240
## 93                Volvo 850
```

```
for (var in columns93)
{
  print(var);
  p <- ggplot(cars93, aes_string(x = var, y = "Price")) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE);
  print(p);
  correlation <- cor(cars93$Price, cars93[[var]]);
  print(correlation)
}
```

```
## [1] "MPG.city"
```

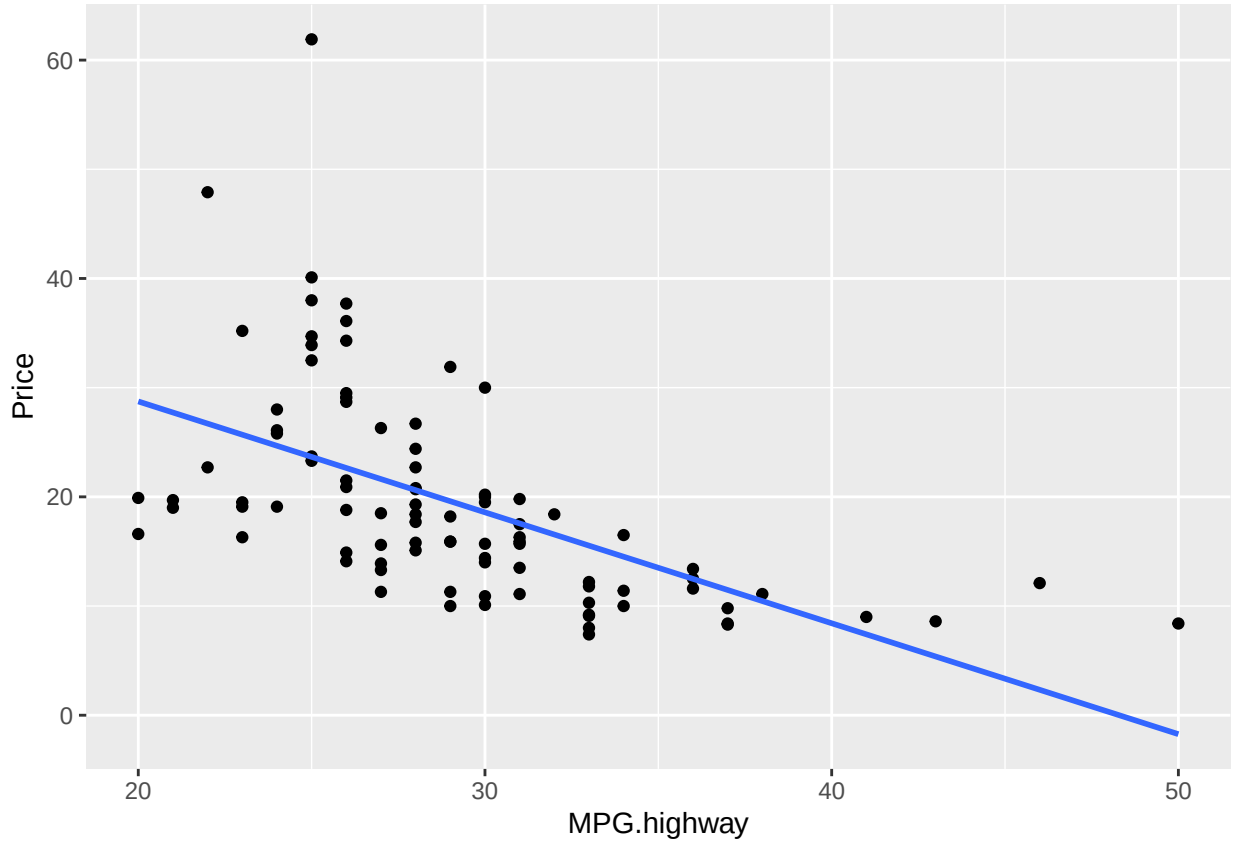
```
## Warning: `aes_string()` was deprecated in ggplot2 3.0.0.
## i Please use tidy evaluation idioms with `aes()`.
## i See also `vignette("ggplot2-in-packages")` for more information.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

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



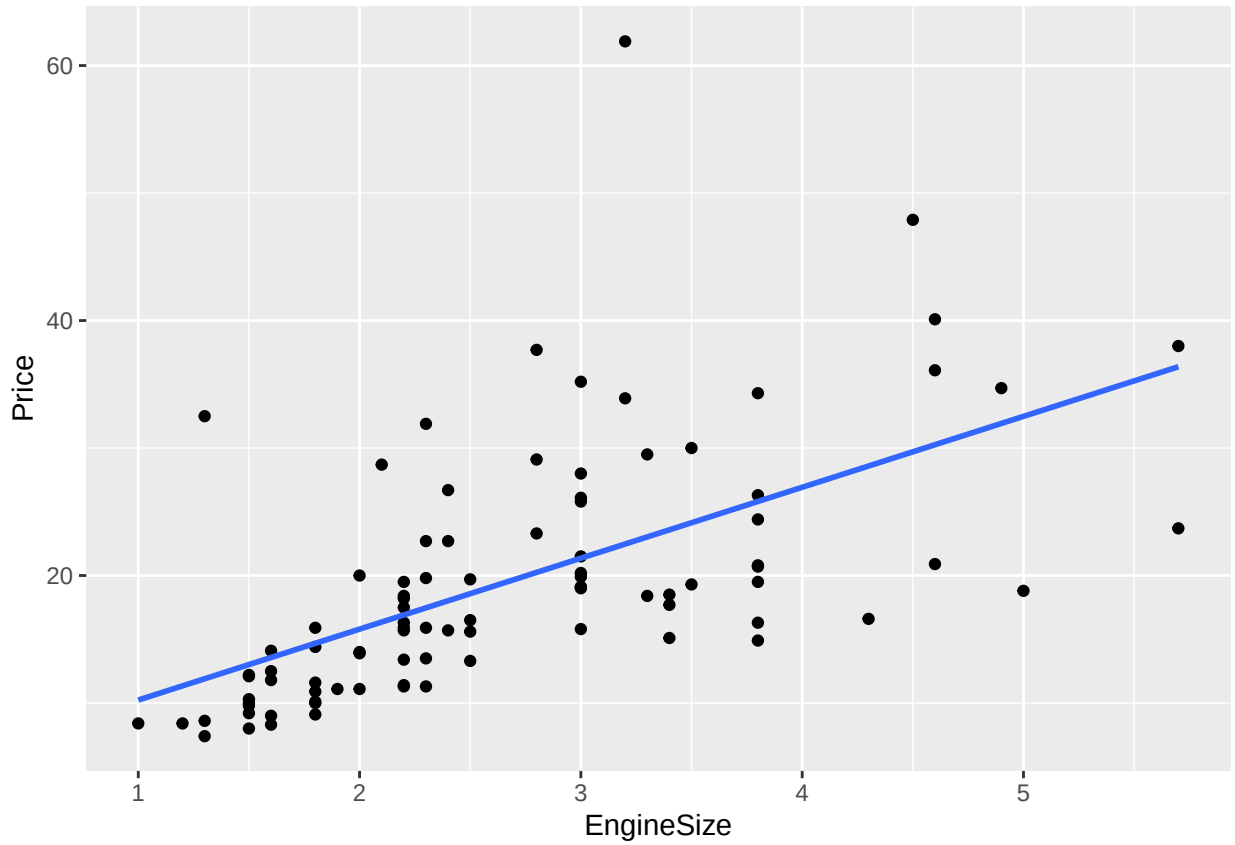

```
## [1] -0.5945622
## [1] "MPG.highway"
```

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



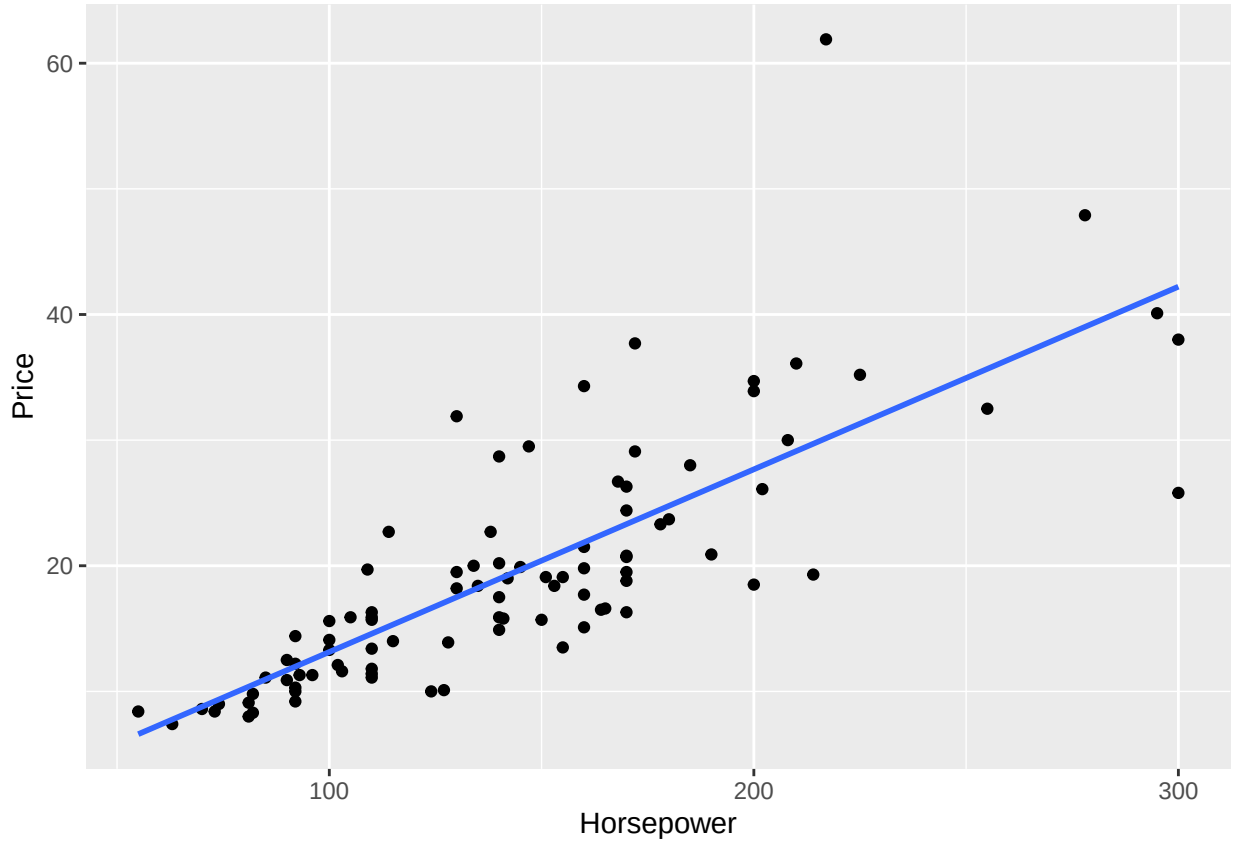

```
## [1] -0.5606804
## [1] "EngineSize"
```

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



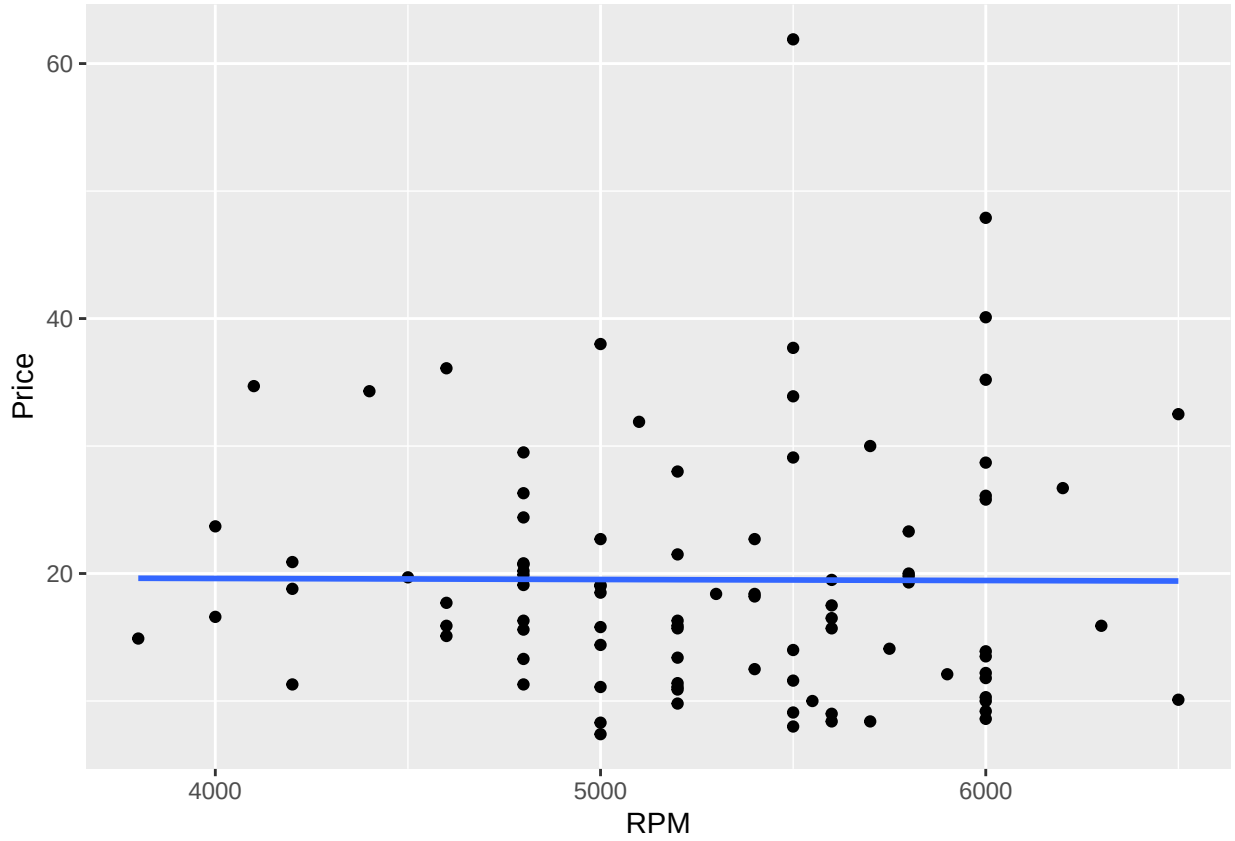

```
## [1] 0.5974254
## [1] "Horsepower"
```

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



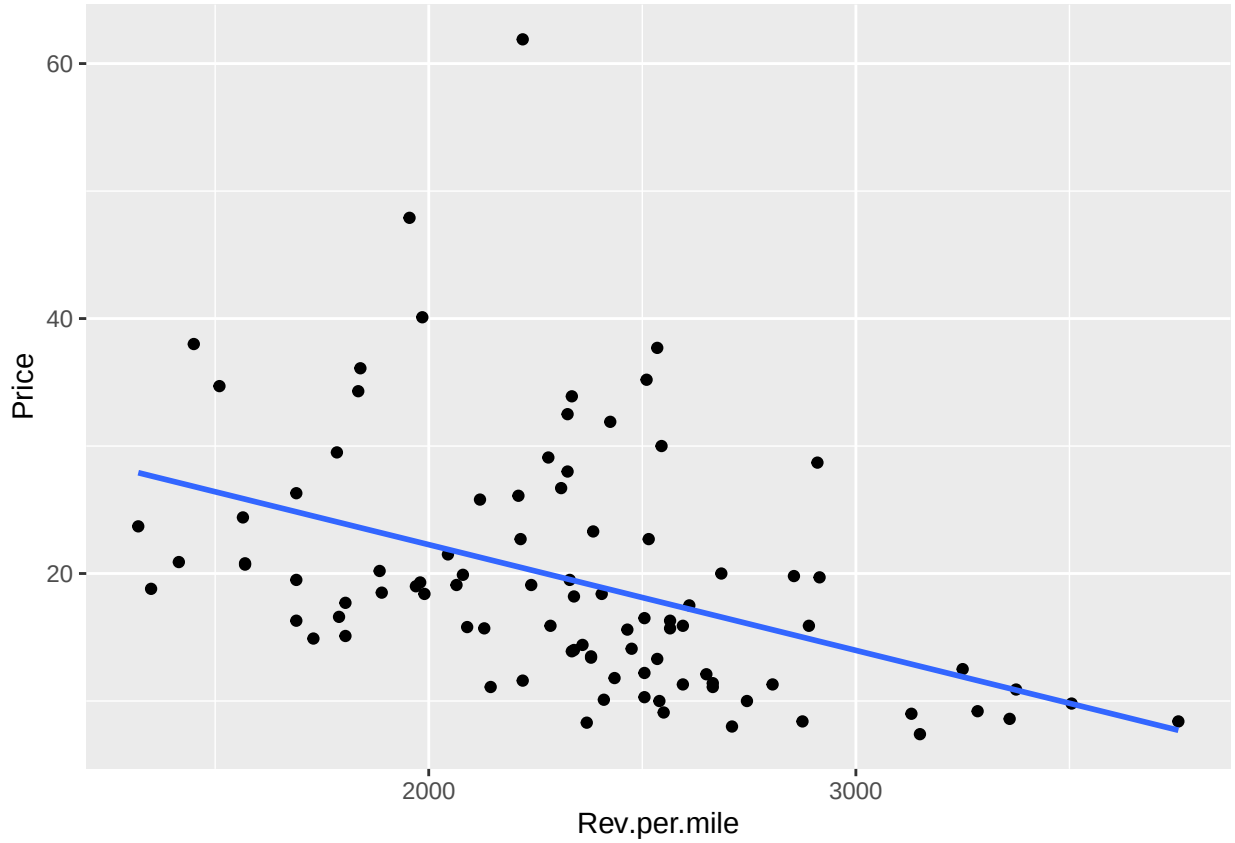

```
## [1] 0.7882176
## [1] "RPM"
```

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



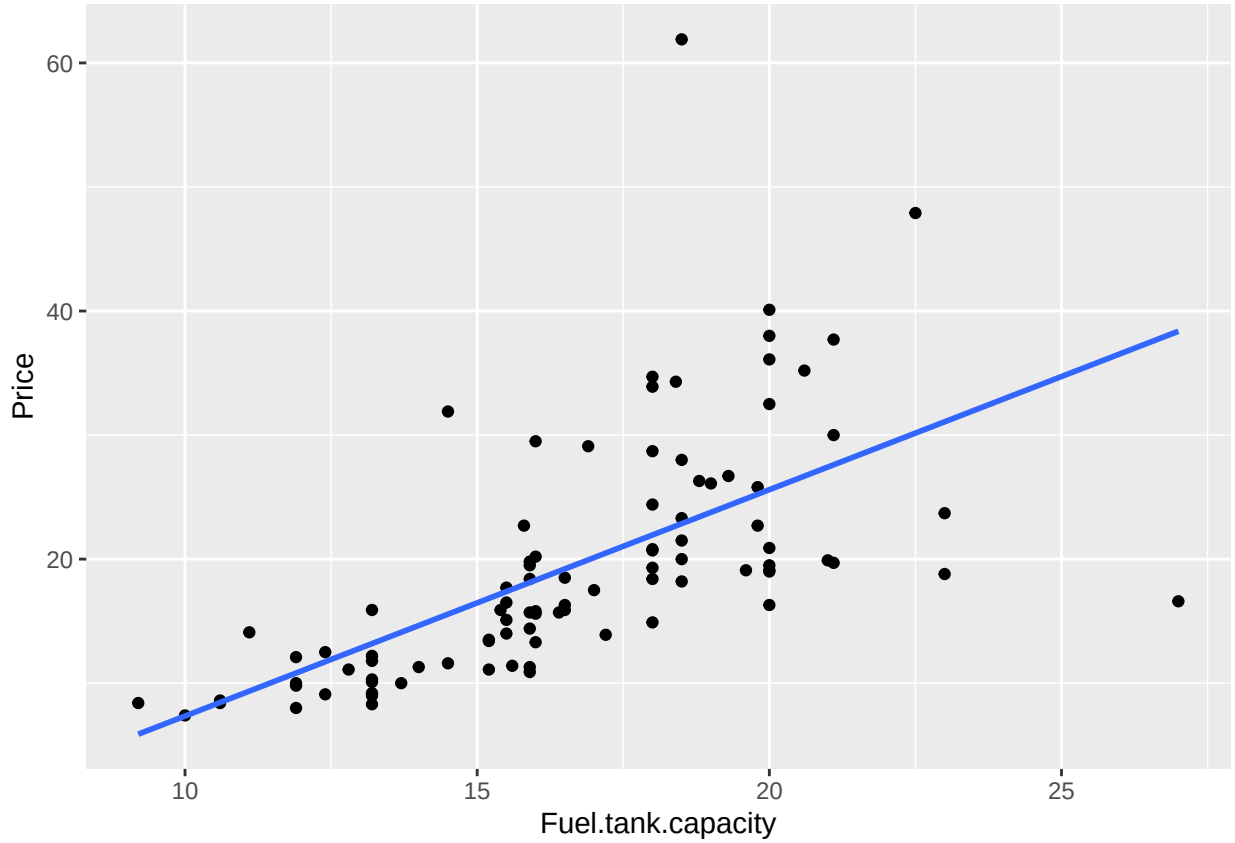

```
## [1] -0.004954931
## [1] "Rev.per.mile"
```

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



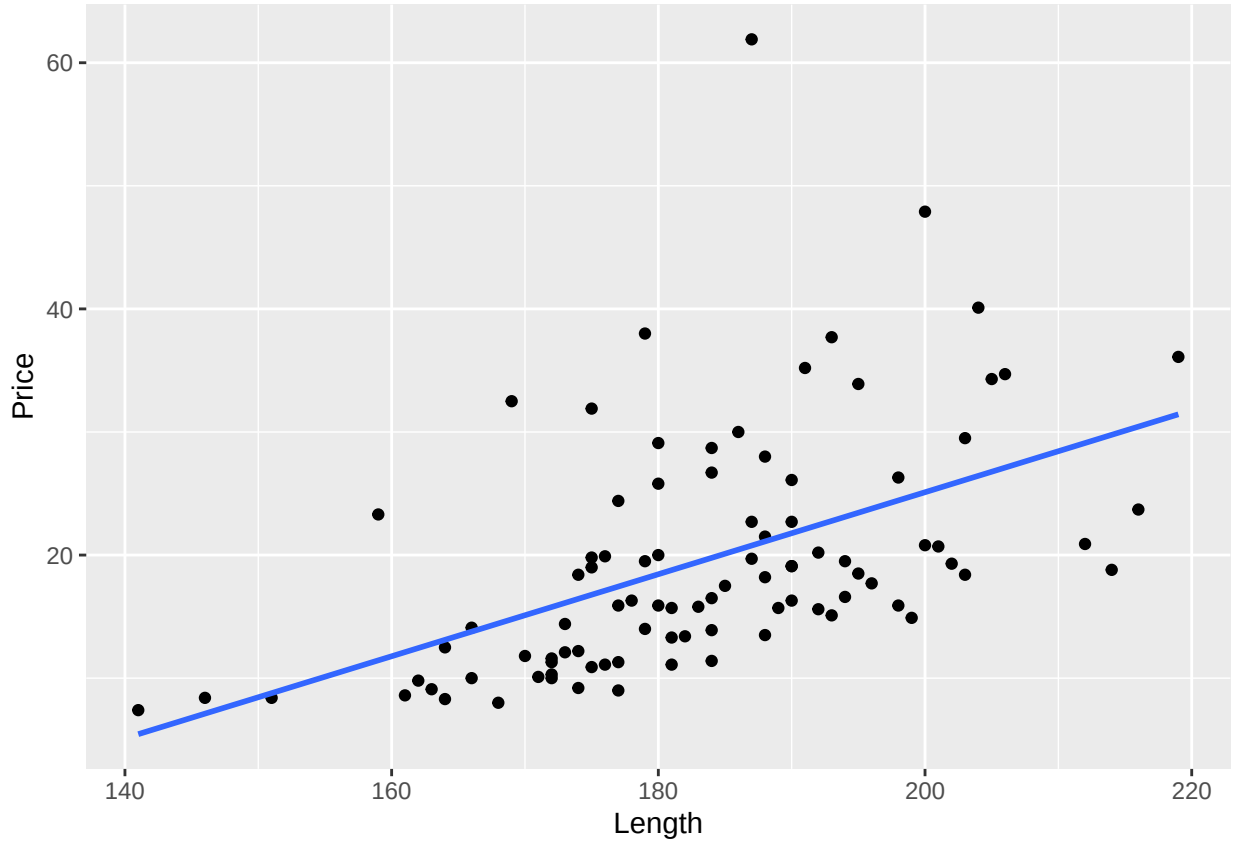

```
## [1] -0.4263951
## [1] "Fuel.tank.capacity"
```

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



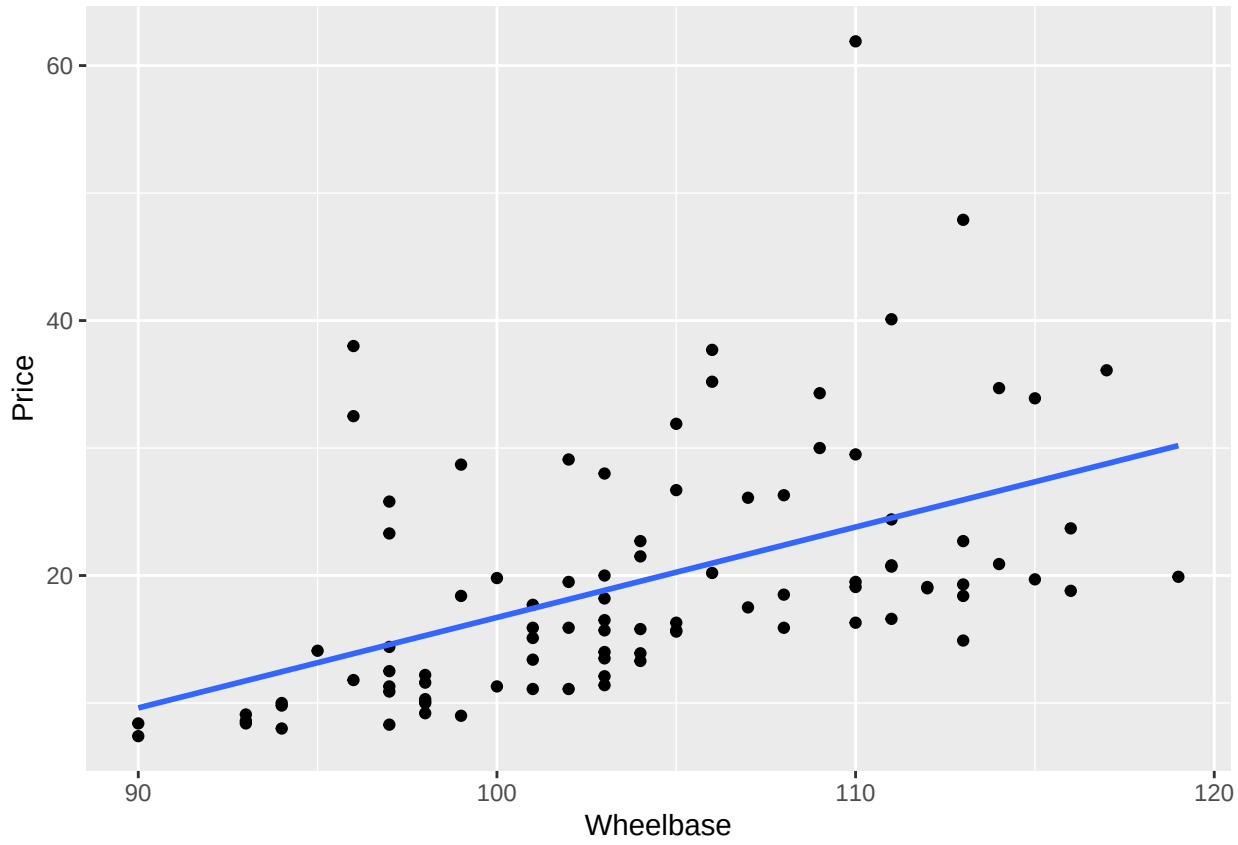

```
## [1] 0.61948
## [1] "Length"
```

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



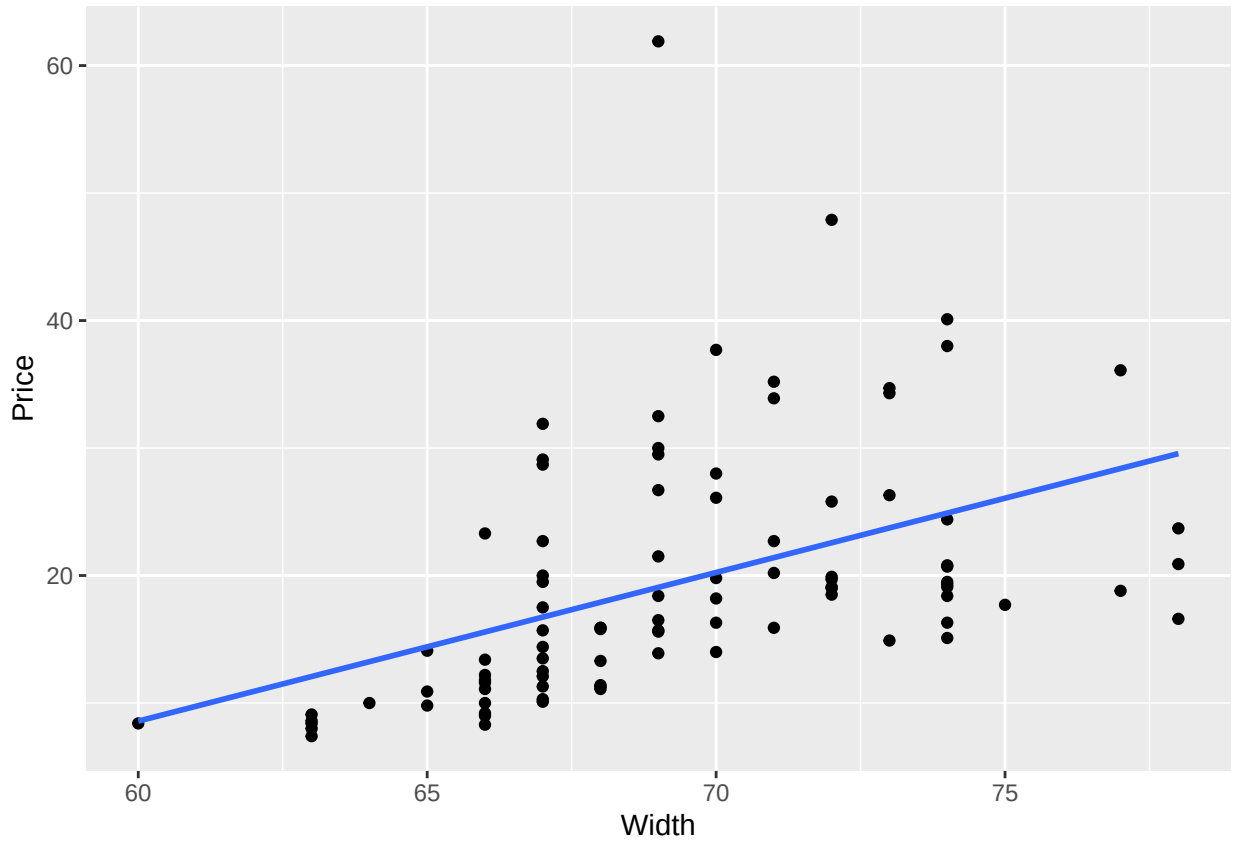

```
## [1] 0.5036284
## [1] "Wheelbase"
```

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




```
## [1] 0.5008642
## [1] "Width"
```

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

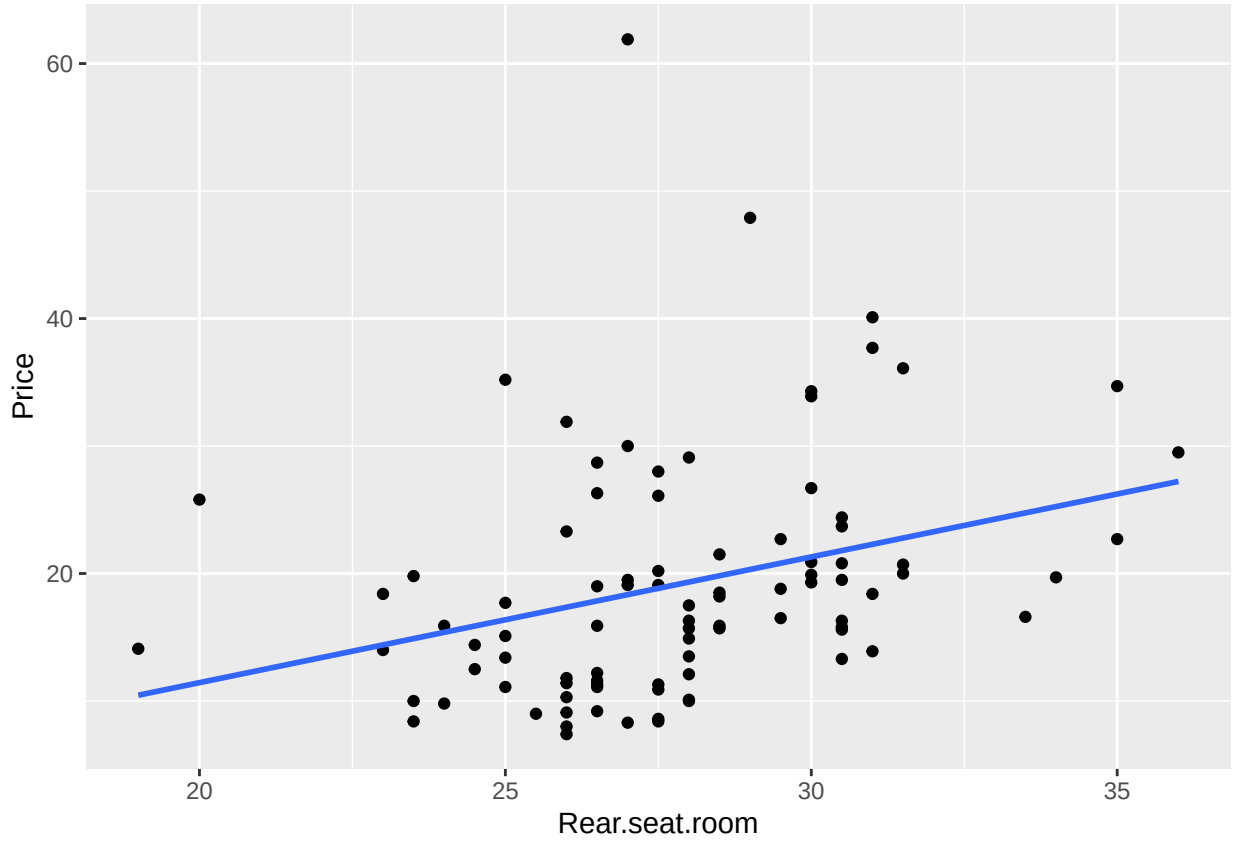



```
## [1] 0.4560279
## [1] "Rear.seat.room"
```

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

```
## Warning: Removed 2 rows containing non-finite outside the scale range
## (`stat_smooth()`).
```

```
## Warning: Removed 2 rows containing missing values or values outside the scale range
## (`geom_point()`).
```

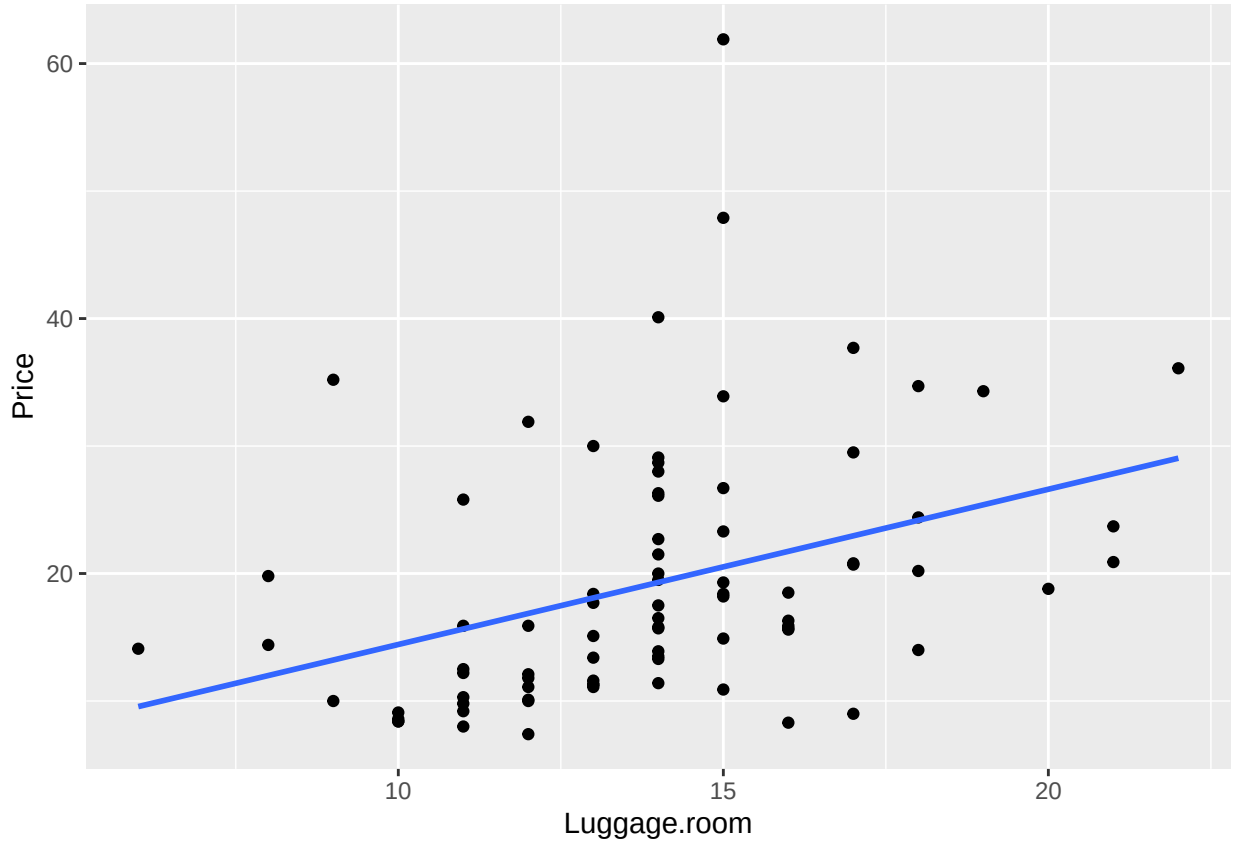



```
## [1] NA
## [1] "Luggage.room"
```

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

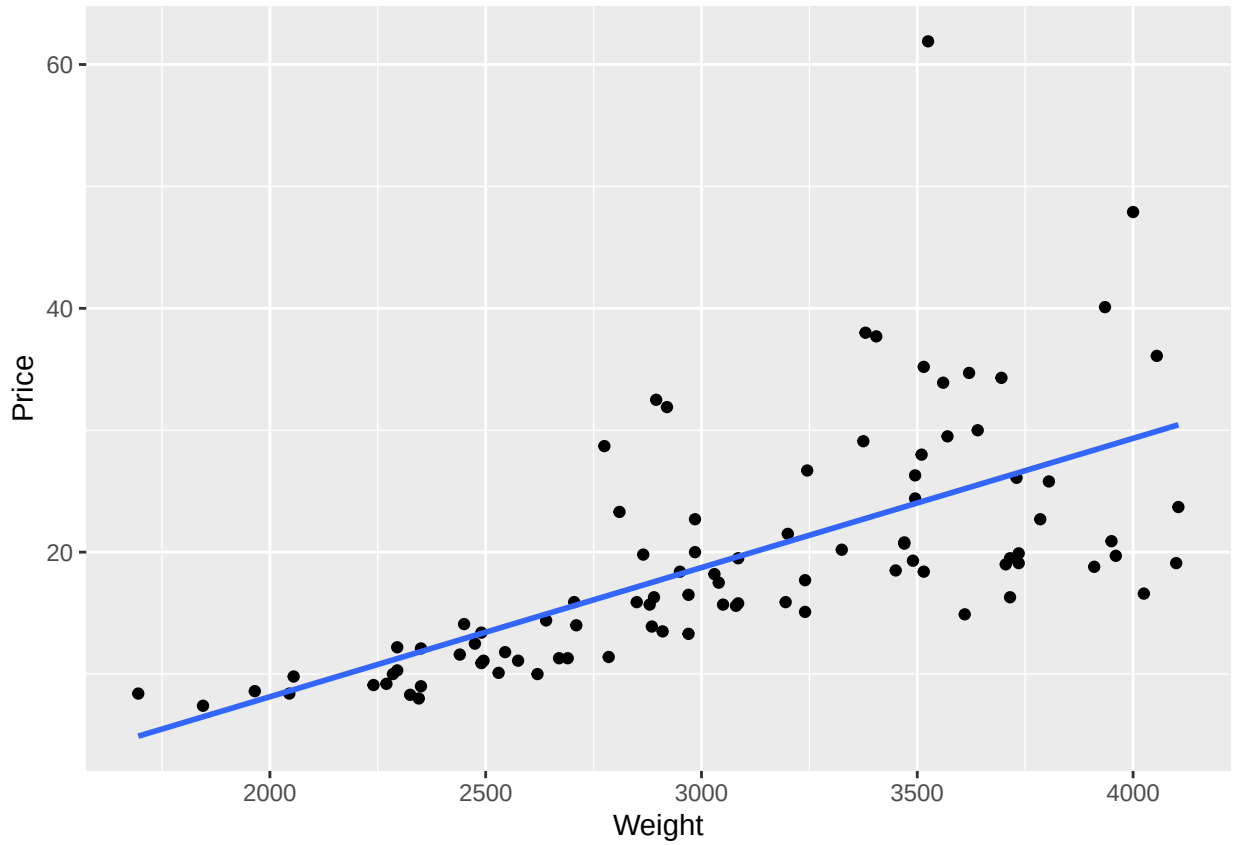
```
## Warning: Removed 11 rows containing non-finite outside the scale range
## (`stat_smooth()`).
```

```
## Warning: Removed 11 rows containing missing values or values outside the scale range
## (`geom_point()`).
```




```
## [1] NA
## [1] "Weight"
```

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



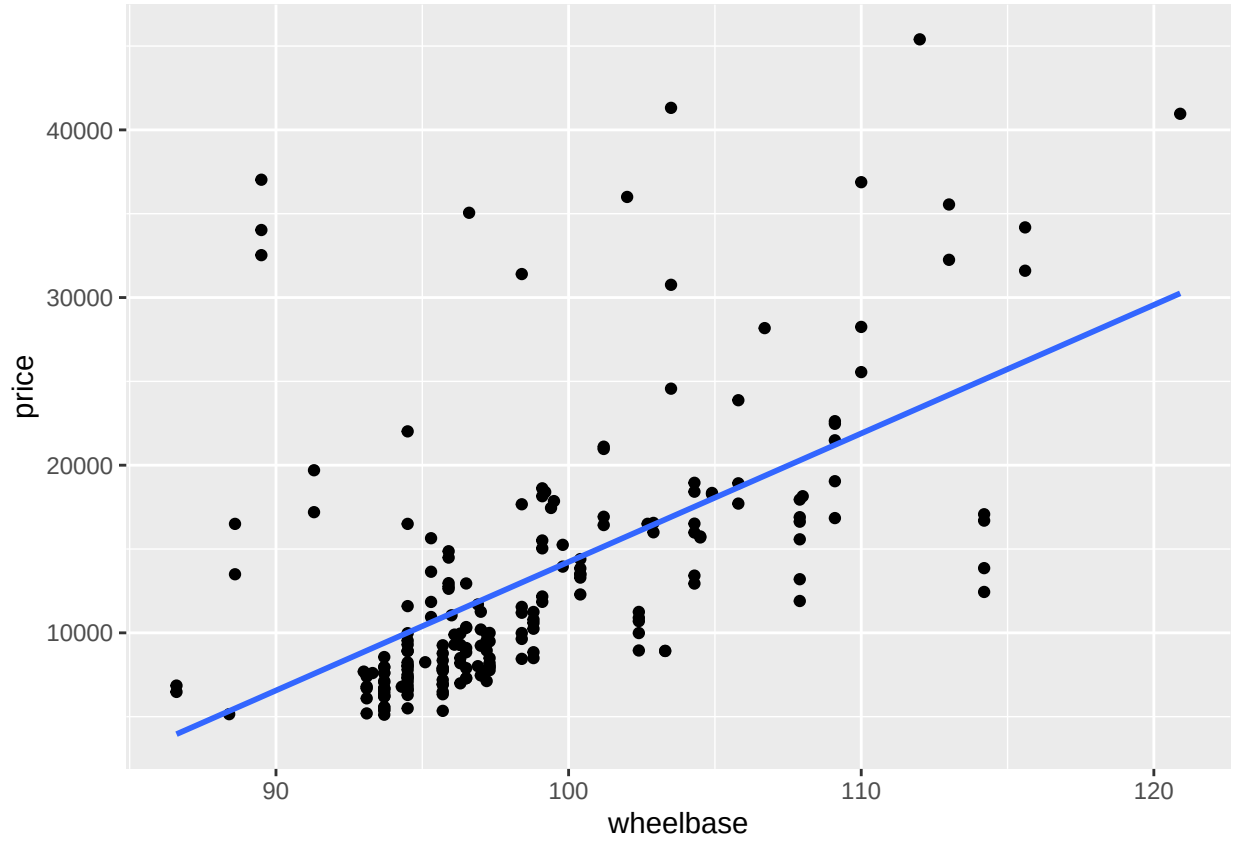

```
## [1] 0.647179
```

```
columns_assign <- c("wheelbase", "carlength", "carwidth", "carheight", "curbweight", "enginesize", "hors
```

```
for (var in columns_assign)
{
  print(var);
  p <- ggplot(cars_assign, aes_string(x = var, y = "price")) +
   geom_point() +
  geom_smooth(method = "lm", se = FALSE);
  print(p);
  correlation <- cor(cars_assign$price, cars_assign[[var]]);
  print(correlation)
}
```

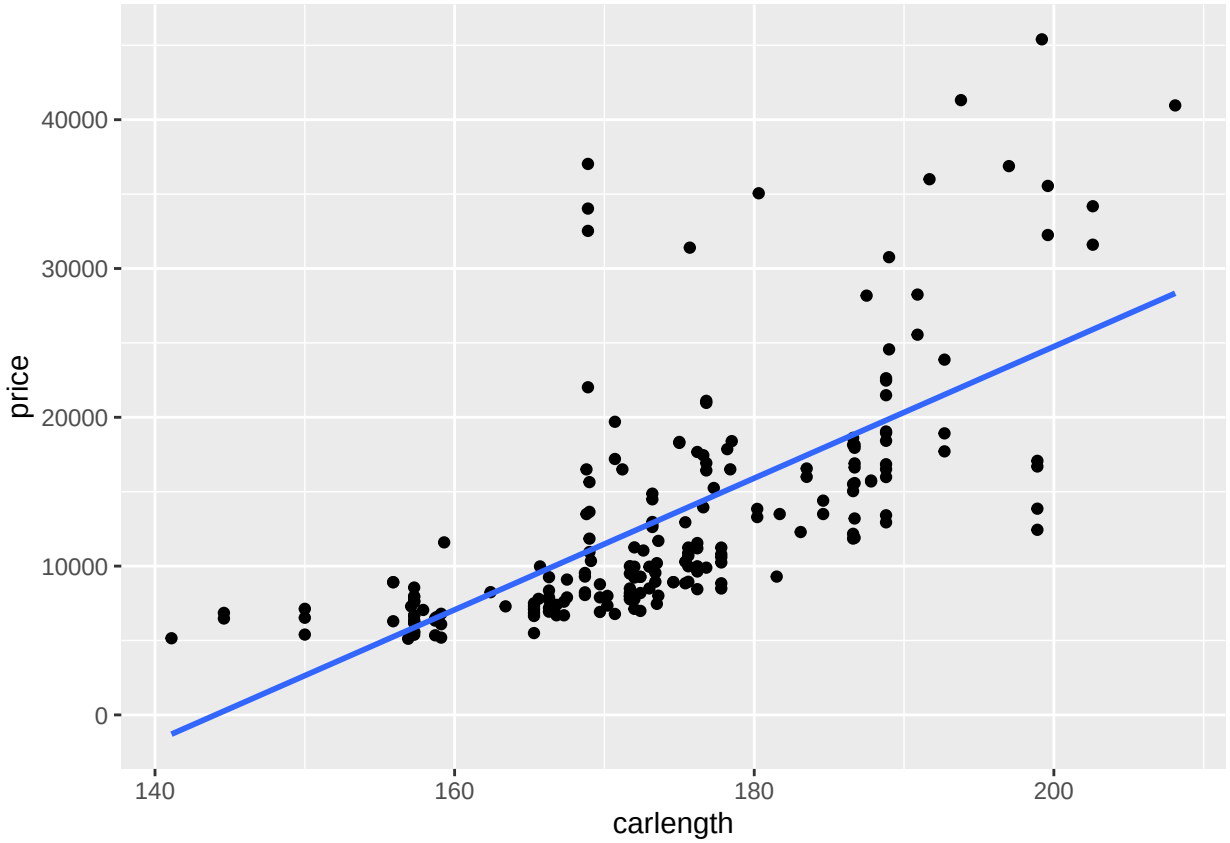
```
## [1] "wheelbase"
```

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



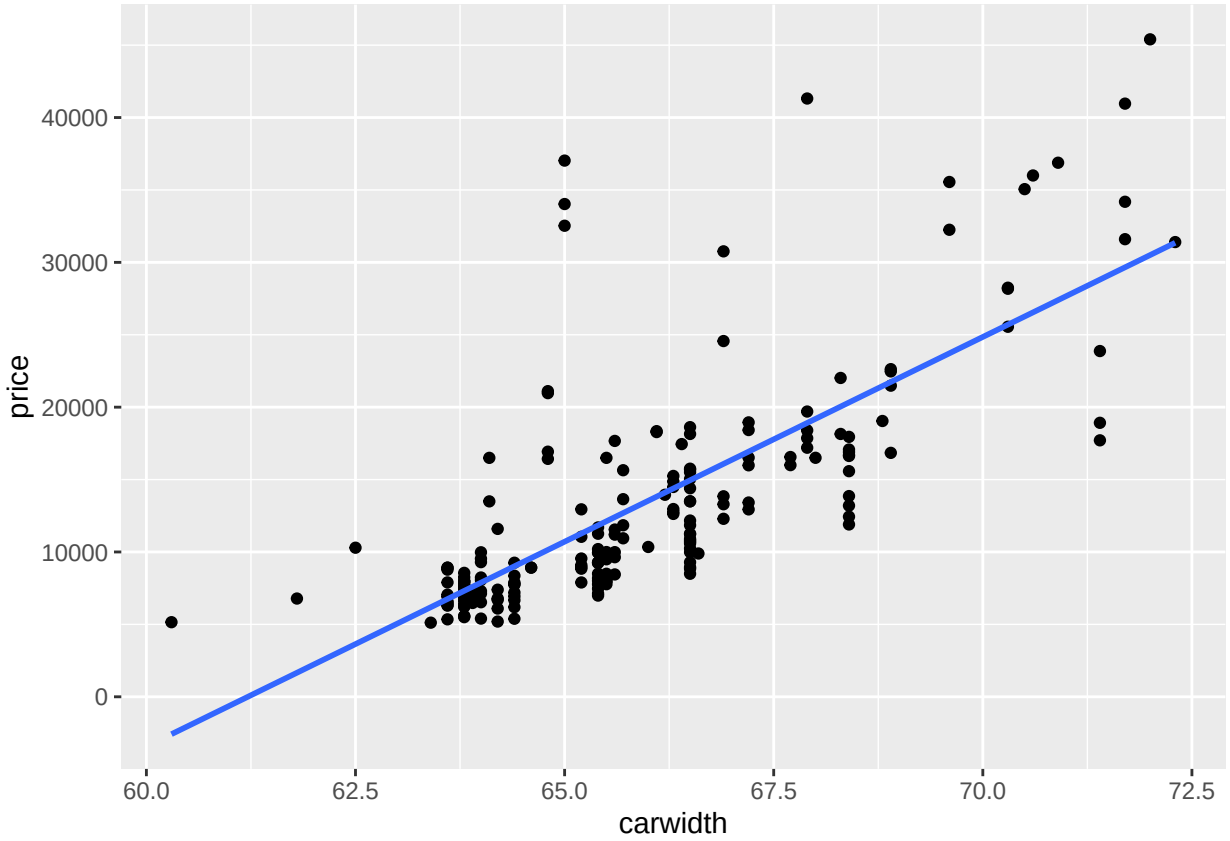

```
## [1] 0.5778156
## [1] "carlength"
```

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

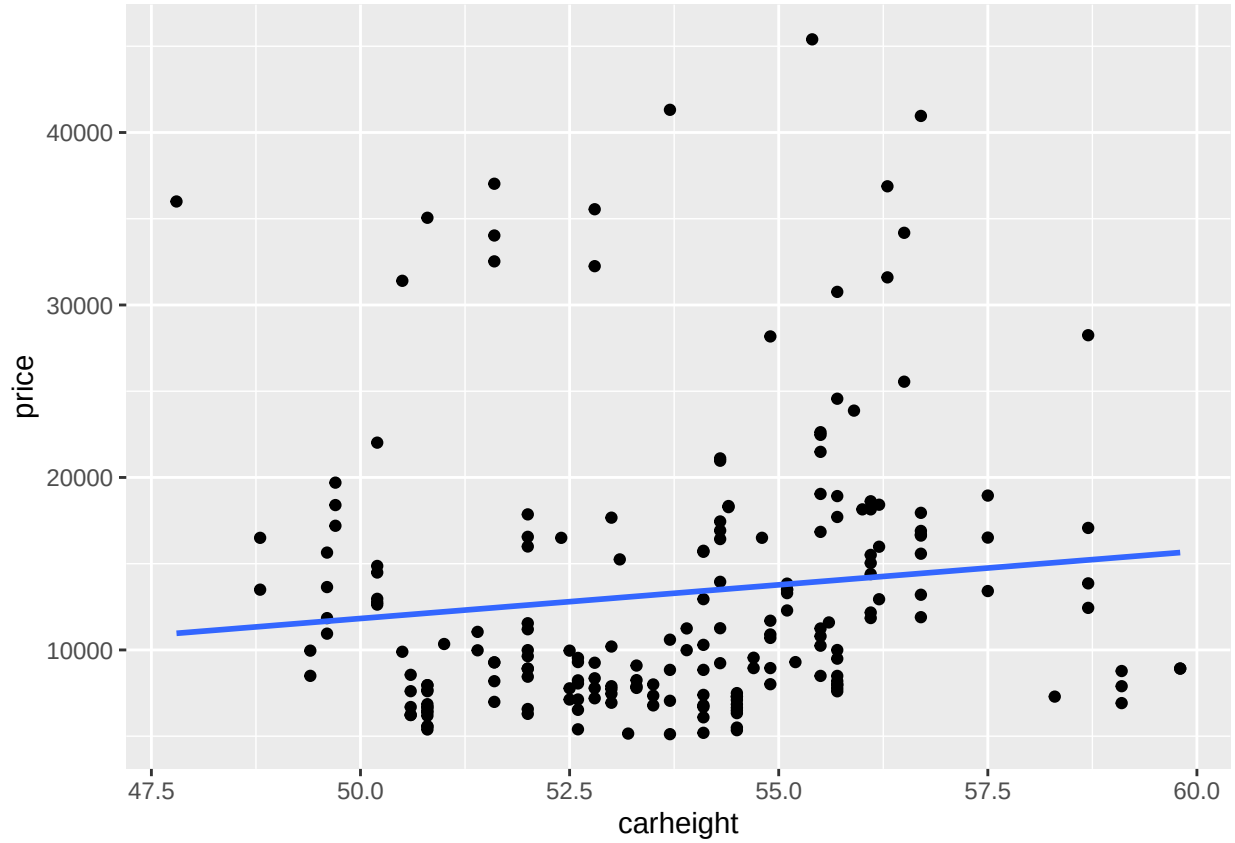



```
## [1] 0.68292
## [1] "carwidth"
```

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

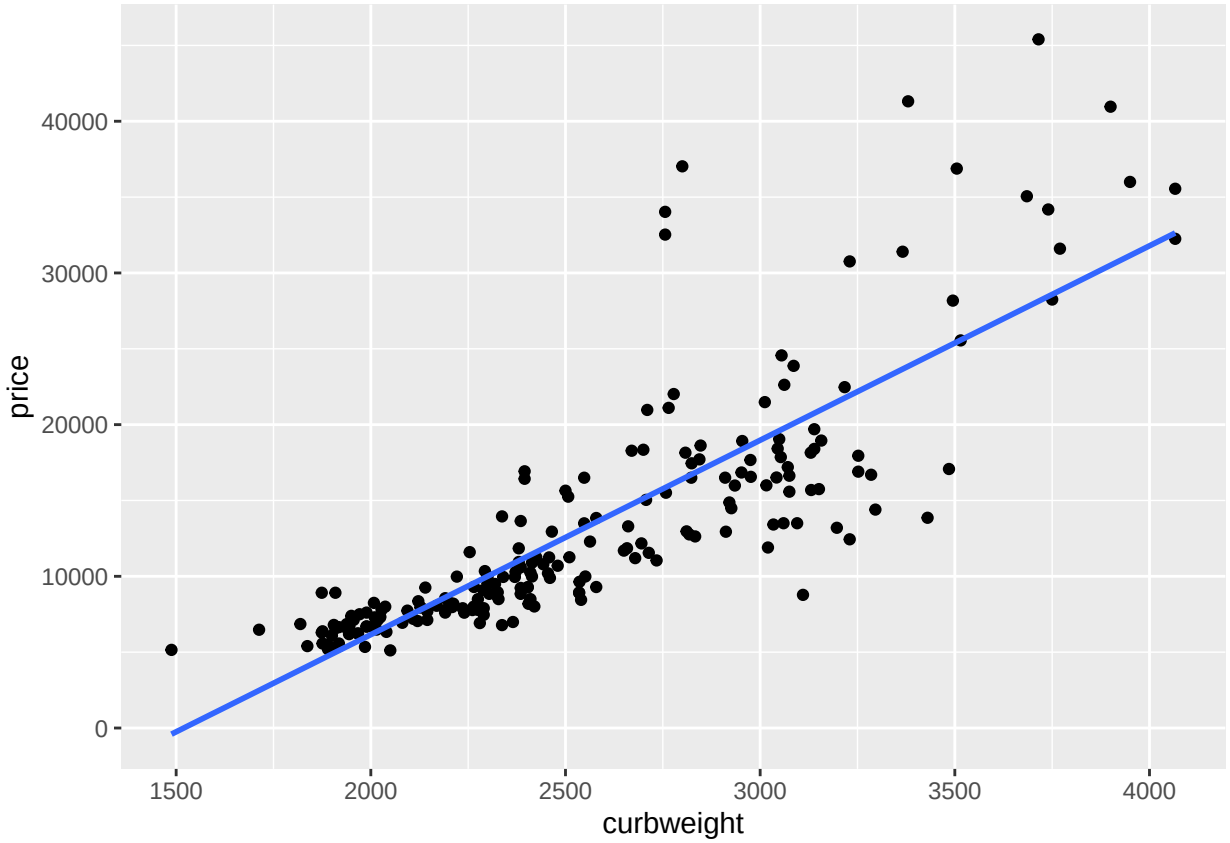



```
## [1] 0.7593253
## [1] "carheight"

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



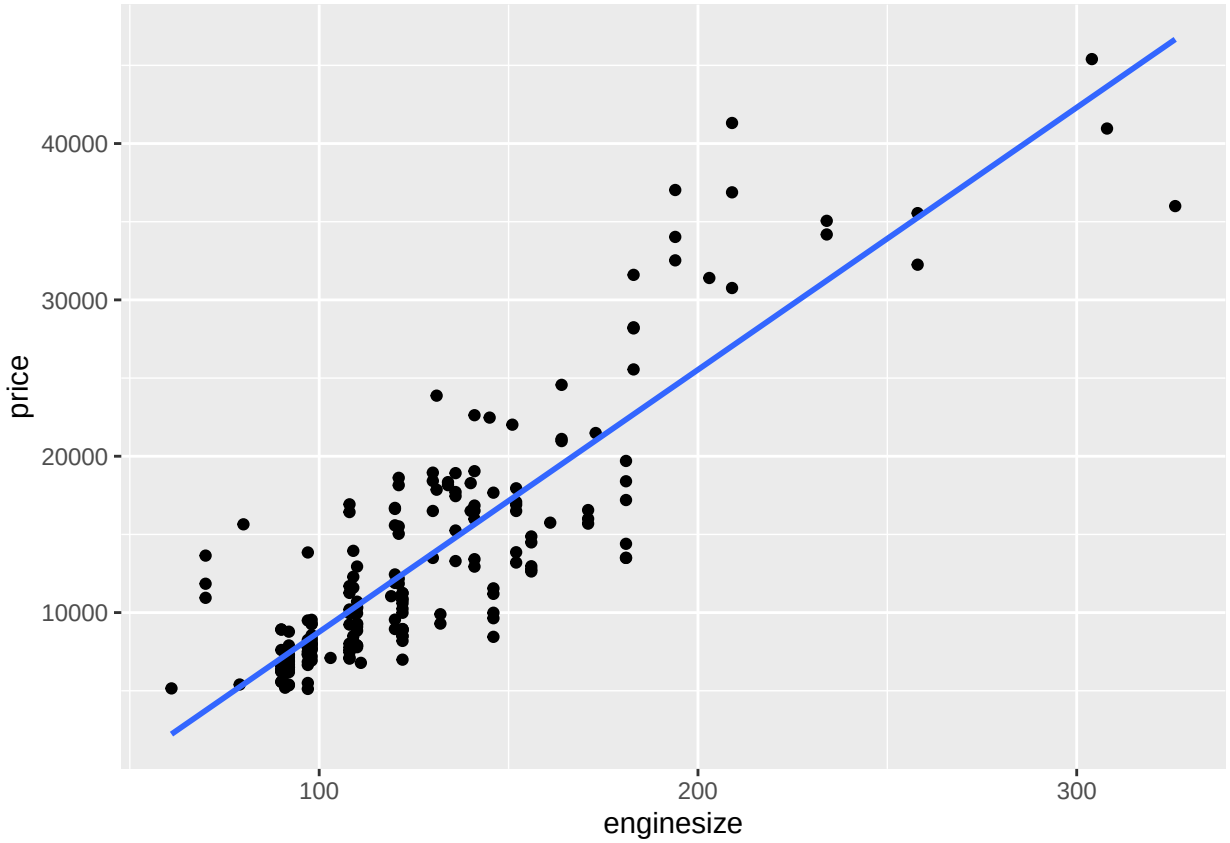

```
## [1] 0.1193362
## [1] "curbweight"
```

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



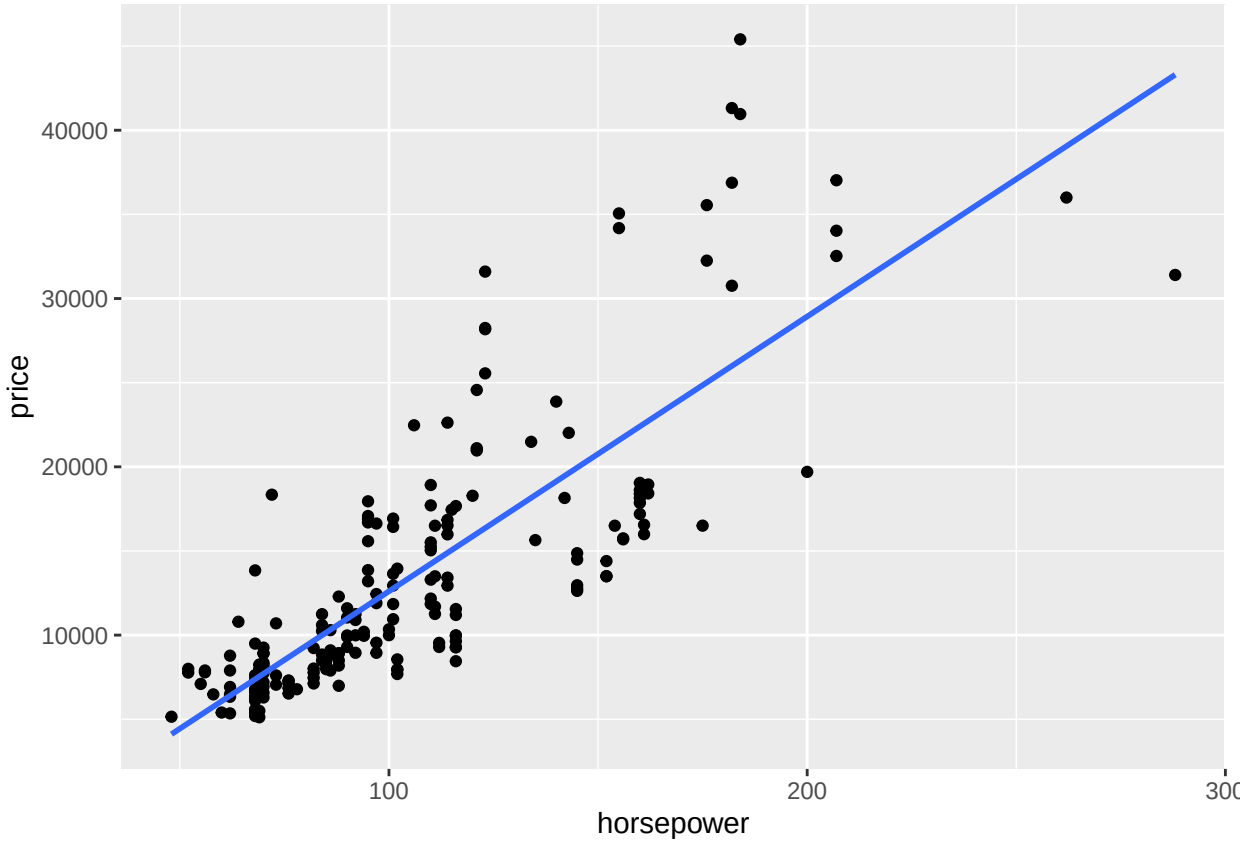

```
## [1] 0.8353049
## [1] "enginesize"
```

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



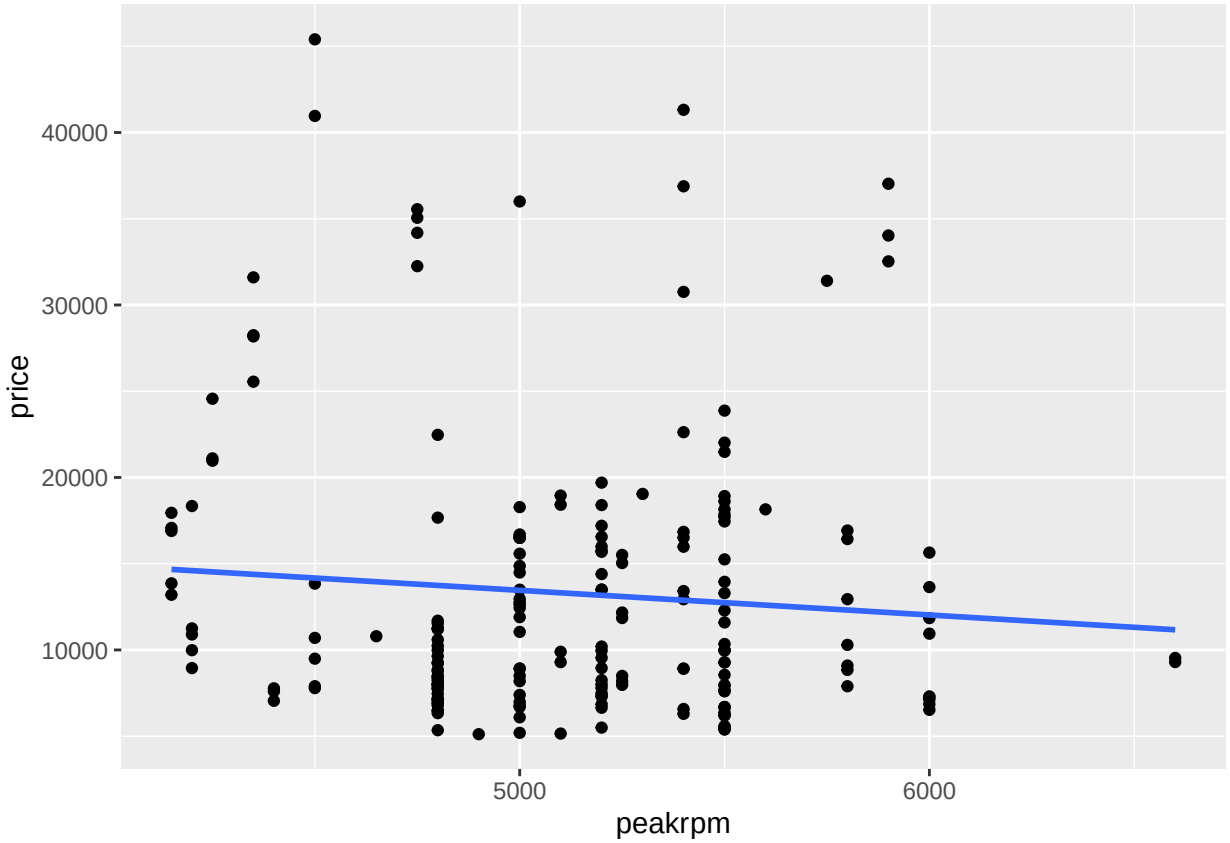

```
## [1] 0.8741448
## [1] "horsepower"
```

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



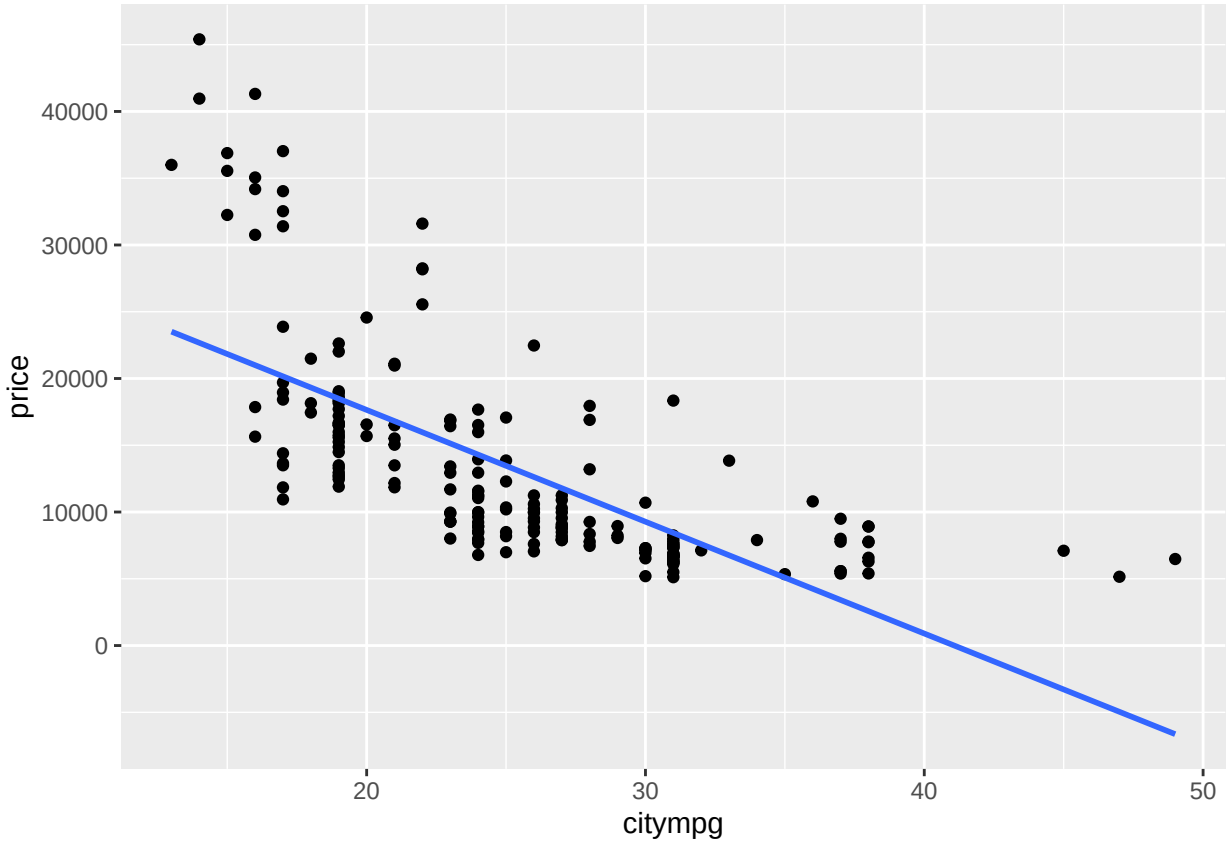

```
## [1] 0.8081388
## [1] "peakrpm"
```

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



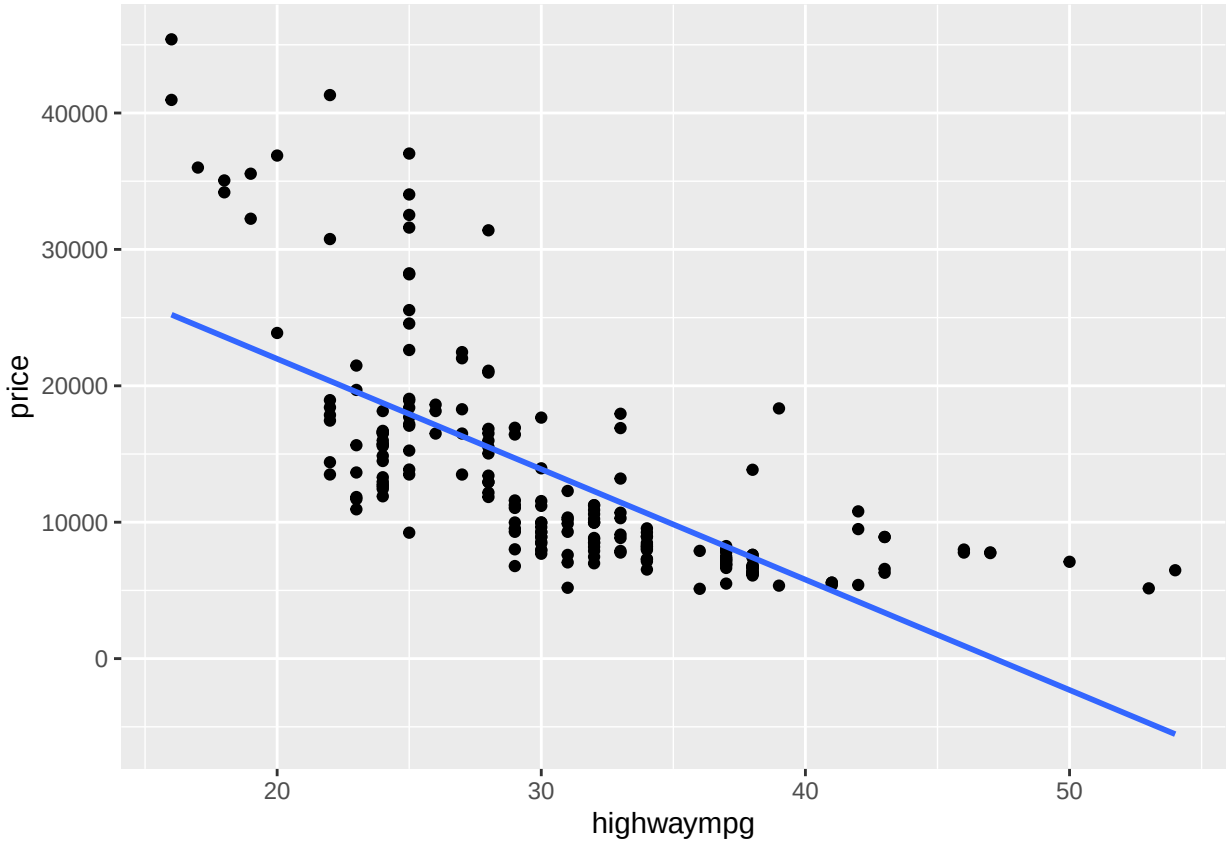

```
## [1] -0.08526715
## [1] "citympg"
```

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



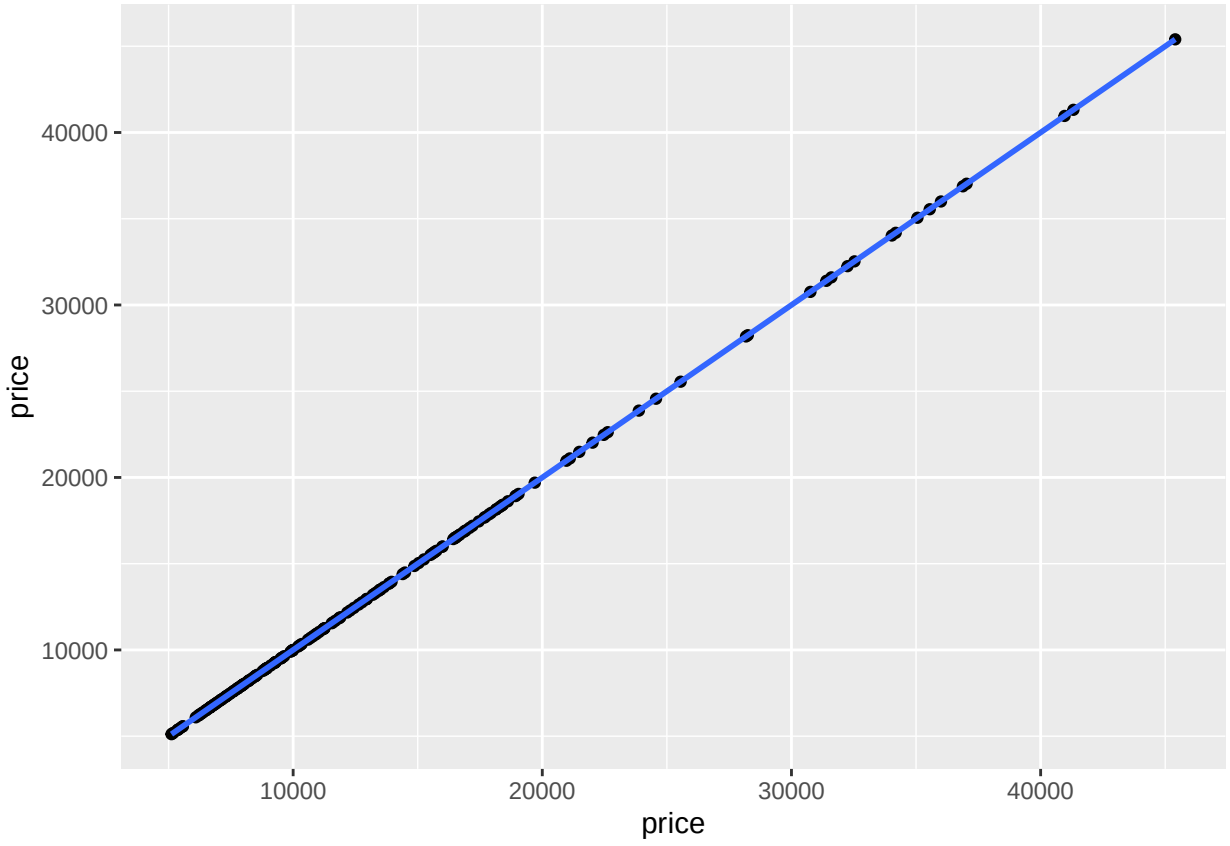

```
## [1] -0.6857513
## [1] "highwaympg"
```

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




```
## [1] -0.6975991
## [1] "price"
```

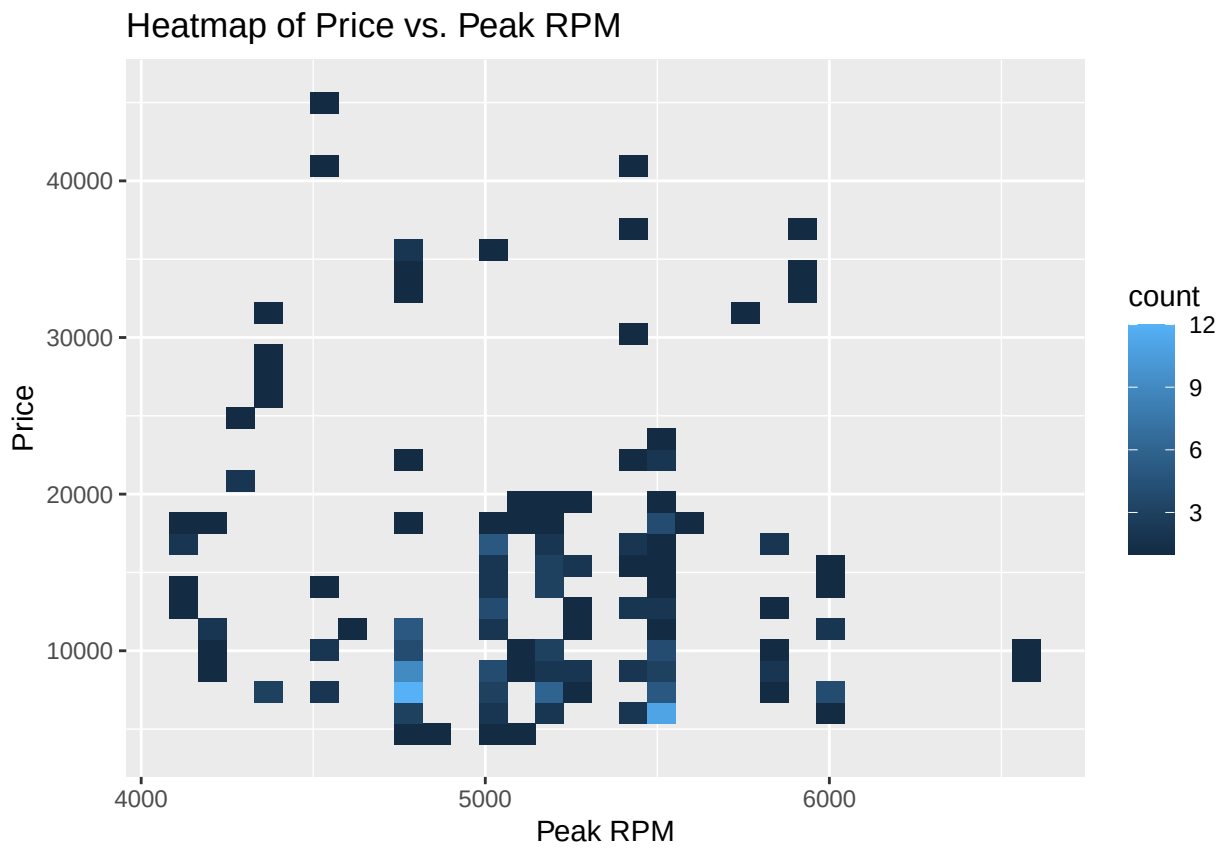
```
## `geom_smooth()` using formula = 'y ~ x'
```




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

Heatmap visualization

```
ggplot(cars_assign, aes(x = peakrpm, y = price)) +
  geom_bin2d() +
  labs(x = "Peak RPM", y = "Price", title = "Heatmap of Price vs. Peak RPM")
```



Cars93 linear regression model

```
model93 <- lm(Price ~ MPG.city + EngineSize + Horsepower + Fuel.tank.capacity + Weight, data = cars93)
summary(model93)
```

```
##
## Call:
## lm(formula = Price ~ MPG.city + EngineSize + Horsepower + Fuel.tank.capacity +
##     Weight, data = cars93)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -15.824  -2.713  -0.456   1.444  31.936
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -3.509880  11.026931  -0.318    0.751
## MPG.city           -0.078651   0.215438  -0.365    0.716
## EngineSize         -0.797961   1.187025  -0.672    0.503
## Horsepower          0.128456   0.019018   6.754 1.55e-09 ***
## Fuel.tank.capacity  0.040706   0.445052   0.091    0.927
## Weight              0.002523   0.003136   0.805    0.423
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.015 on 87 degrees of freedom
```

```
## Multiple R-squared:  0.6333, Adjusted R-squared:  0.6122
## F-statistic: 30.05 on 5 and 87 DF,  p-value: < 2.2e-16
```

cars_assignment linear regression model

```
model_assign <- lm(price ~ carwidth + curbweight + enginesize + horsepower + citympg, data = cars_assig
summary(model_assign)
```

```
##
## Call:
## lm(formula = price ~ carwidth + curbweight + enginesize + horsepower +
##     citympg, data = cars_assign)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8184.4 -1715.3   -91.6  1339.2 14273.7
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -47388.322  13175.253  -3.597 0.000406 ***
## carwidth       574.857    225.058   2.554 0.011390 *
## curbweight       2.378      1.324   1.795 0.074101 .
## enginesize      82.921     13.342   6.215 2.95e-09 ***
## horsepower      52.703     13.280   3.968 0.000101 ***
## citympg         27.400     70.724   0.387 0.698860
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3432 on 199 degrees of freedom
## Multiple R-squared:  0.8199, Adjusted R-squared:  0.8154
## F-statistic: 181.2 on 5 and 199 DF,  p-value: < 2.2e-16
```

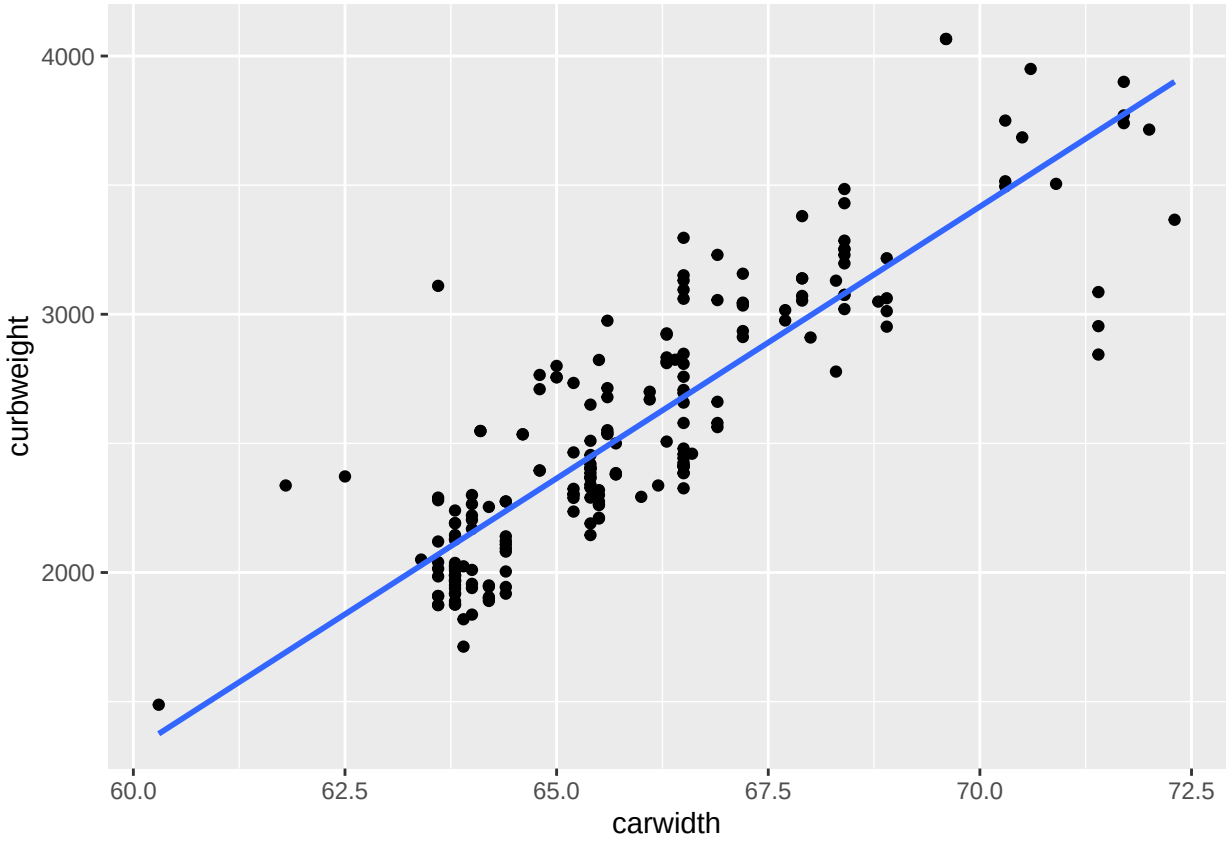
mpgcity+highway horsepower enginesize weight

cars_assign - Correlation between pairs of variables except price

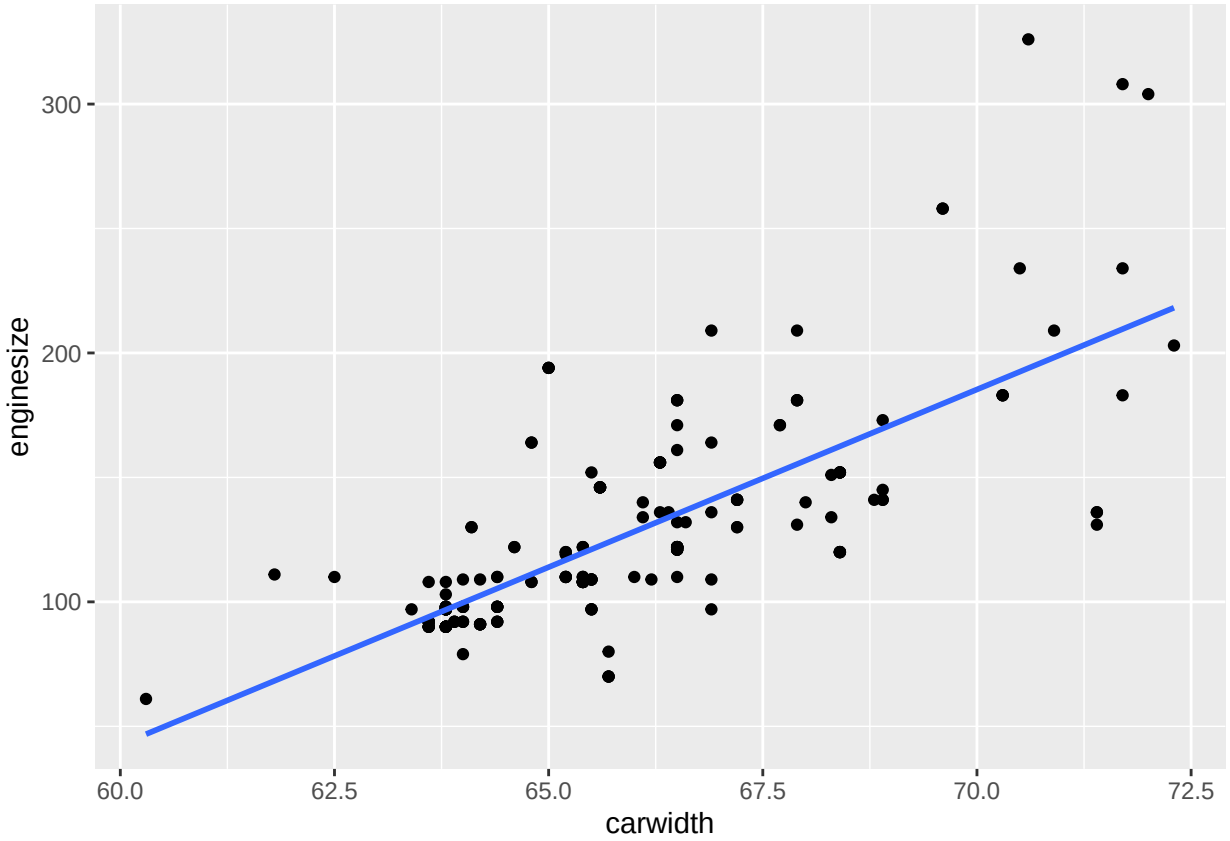
```
for (var in c("carwidth", "curbweight", "enginesize", "horsepower", "citympg")) {
  for (var1 in c("carwidth", "curbweight", "enginesize", "horsepower", "citympg")) {

    if (var != var1) {
      print(paste("x =", var, ", y =", var1))

      p <- ggplot(cars_assign, aes_string(x = var, y = var1)) +
        geom_point() +
        geom_smooth(method = "lm", se = FALSE)
      print(p)

      correlation <- cor(cars_assign[[var1]], cars_assign[[var]])
      print(paste("Correlation between", var, "and", var1, ":", correlation))
    }
  }
}
```

```
## [1] "x = carwidth , y = curbweight"
```

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

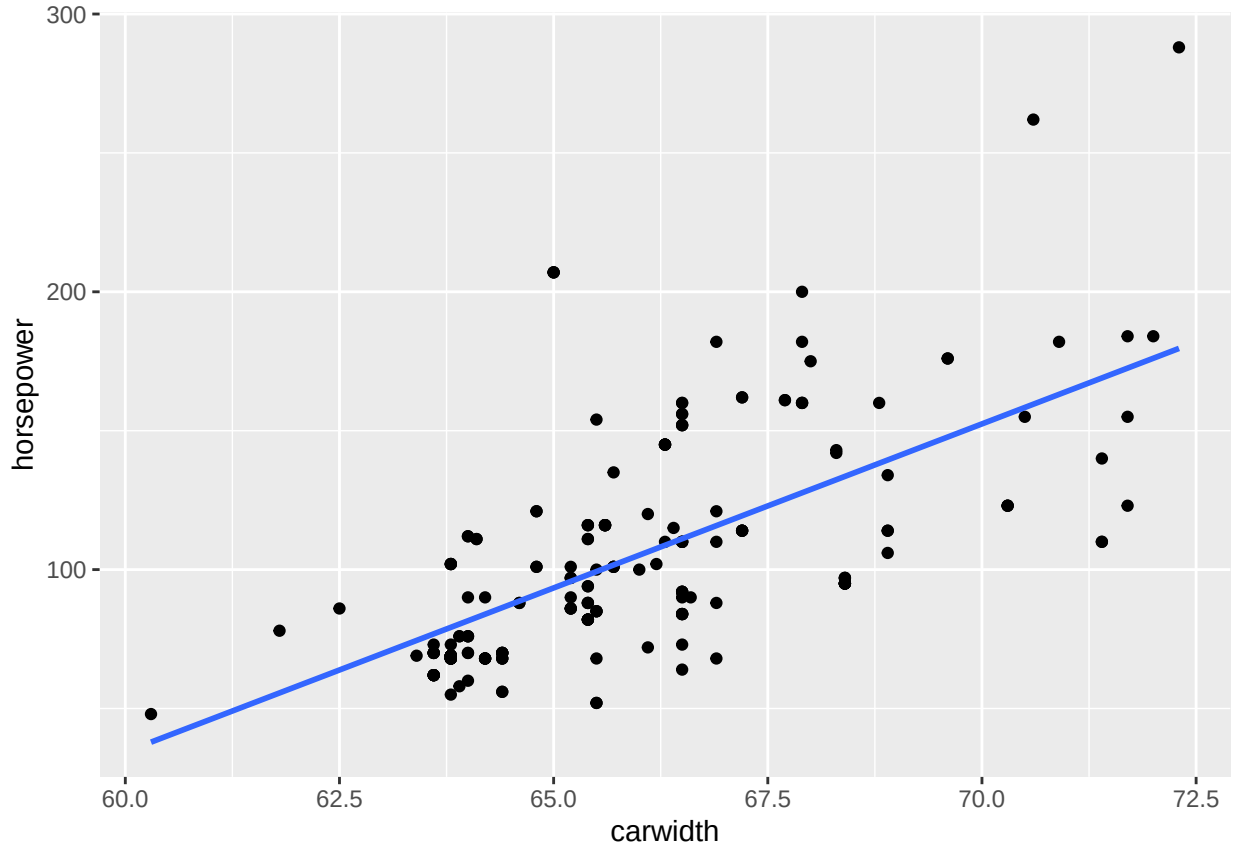



```
## [1] "Correlation between carwidth and curbweight : 0.867032464679123"
## [1] "x = carwidth , y = enginesize"

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



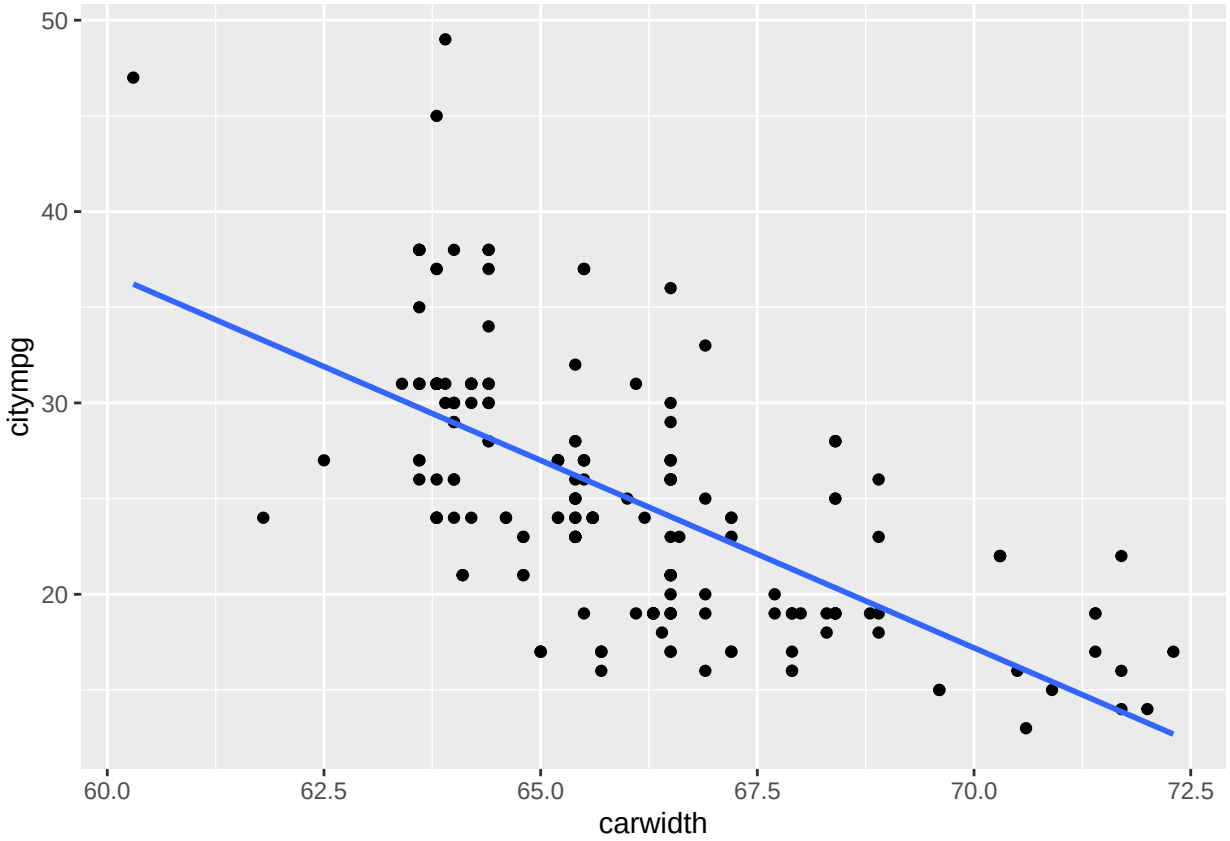

```
## [1] "Correlation between carwidth and enginesize : 0.735433404779637"
## [1] "x = carwidth , y = horsepower"
```

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



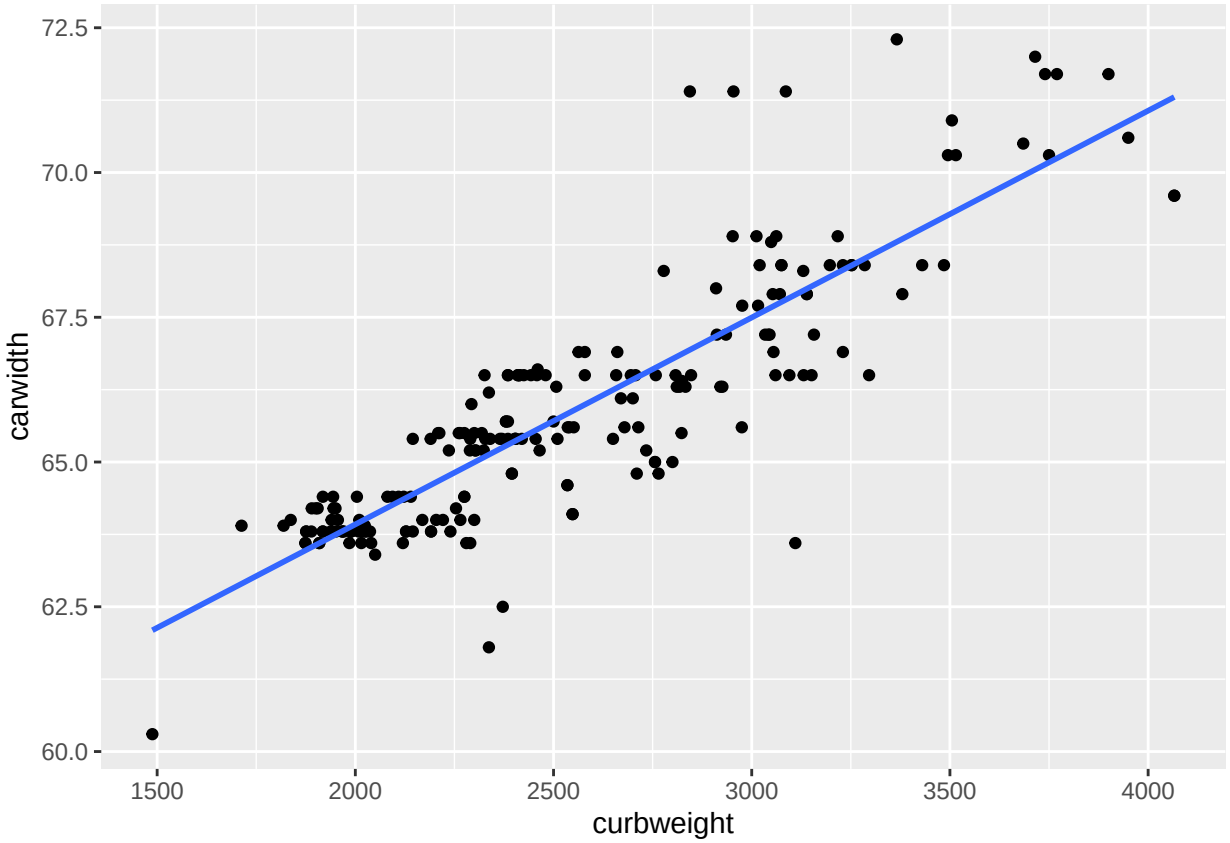

```
## [1] "Correlation between carwidth and horsepower : 0.640732075572292"
## [1] "x = carwidth , y = citympg"
```

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



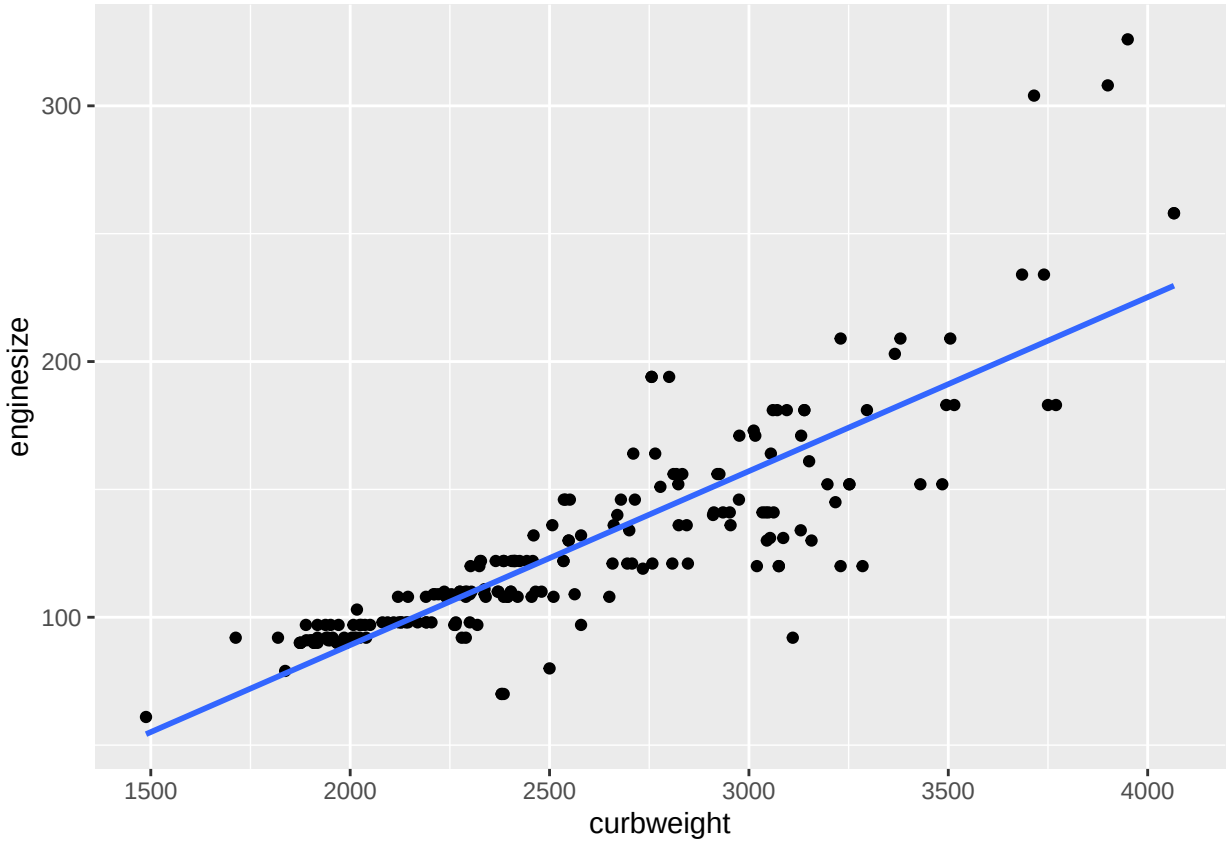

```
## [1] "Correlation between carwidth and citympg : -0.642704340710898"
## [1] "x = curbweight , y = carwidth"
```

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



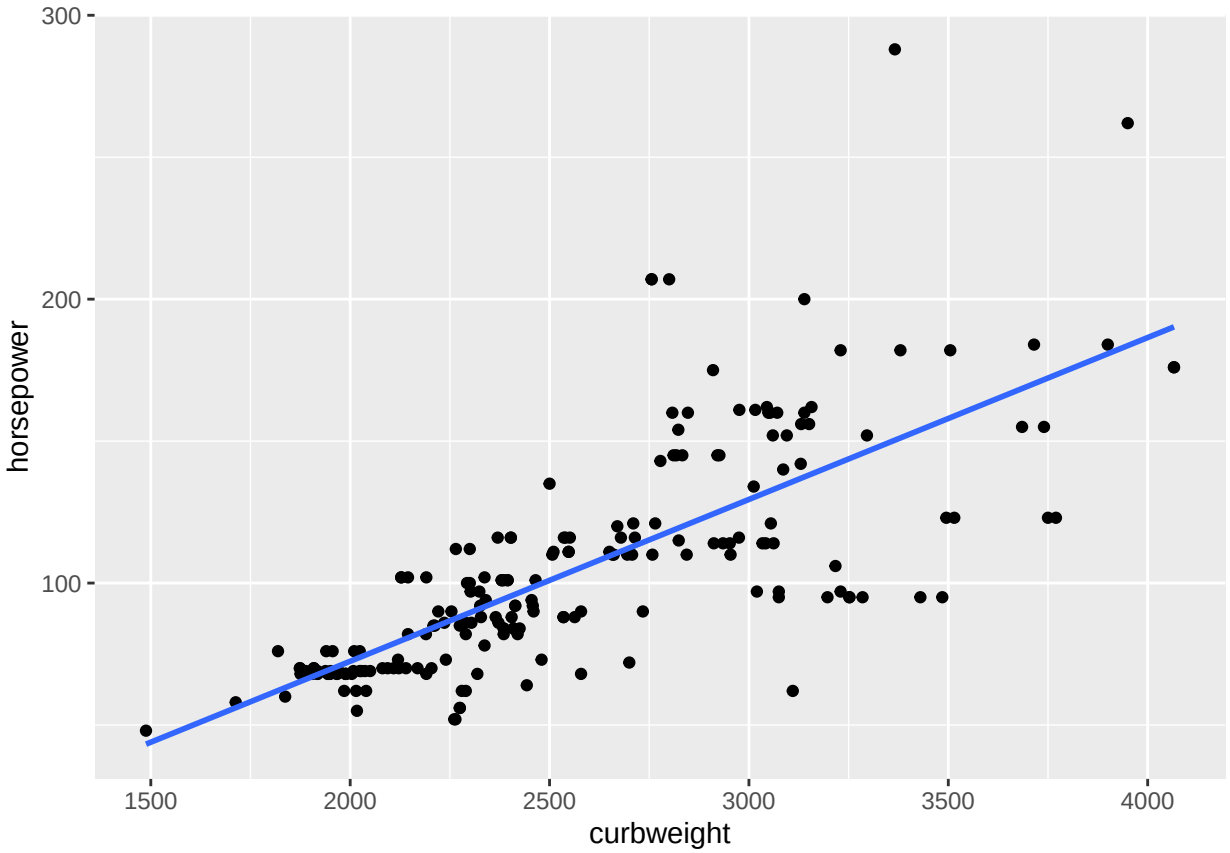

```
## [1] "Correlation between curbweight and carwidth : 0.867032464679123"
## [1] "x = curbweight , y = enginesize"
```

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



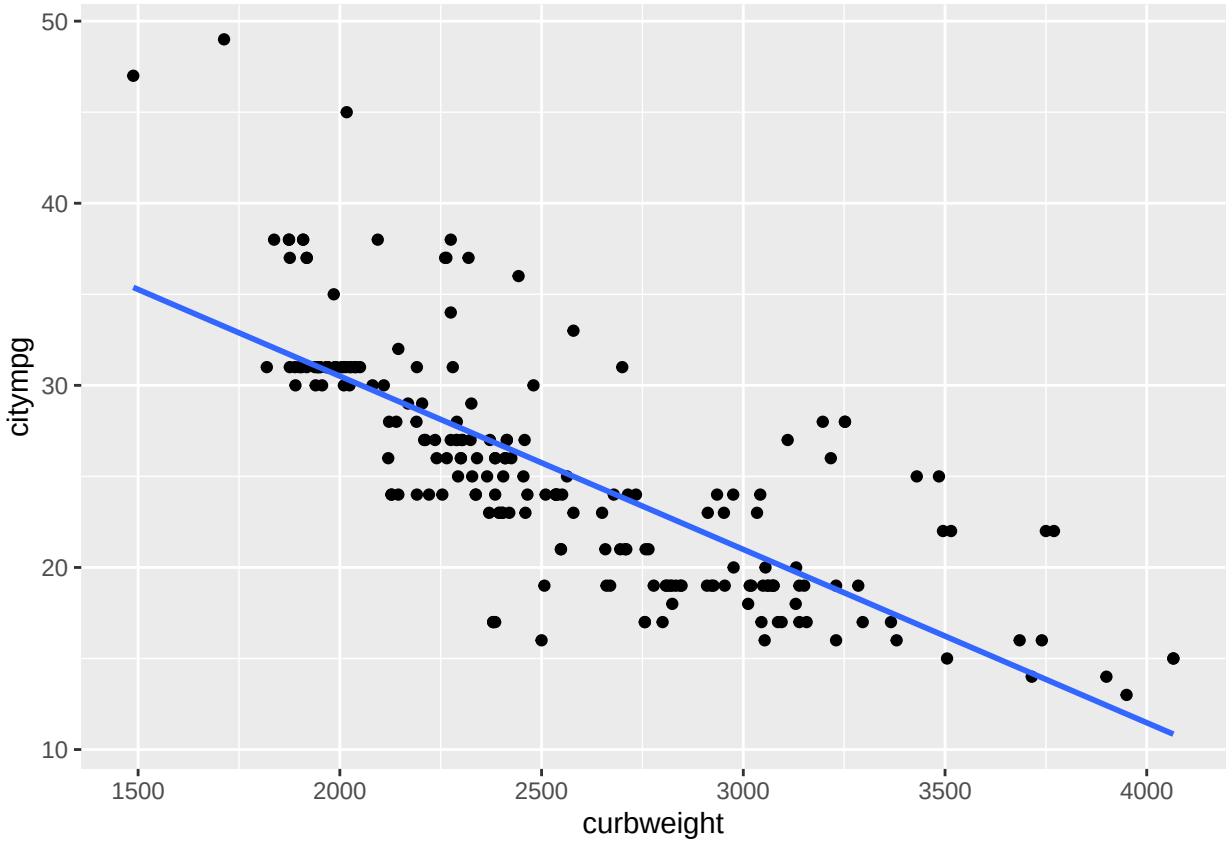

```
## [1] "Correlation between curbweight and enginesize : 0.850594073426277"
## [1] "x = curbweight , y = horsepower"
```

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



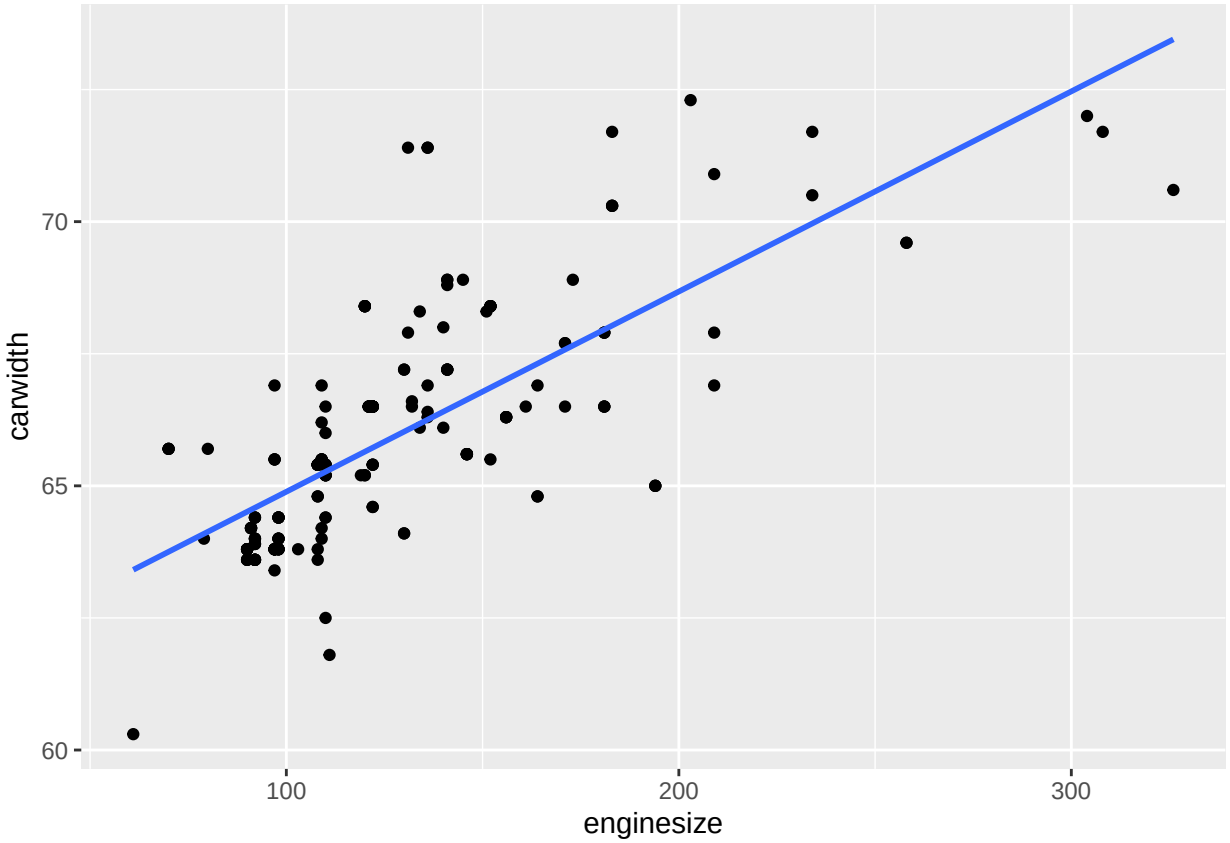

```
## [1] "Correlation between curbweight and horsepower : 0.750739251443481"
## [1] "x = curbweight , y = citympg"
```

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



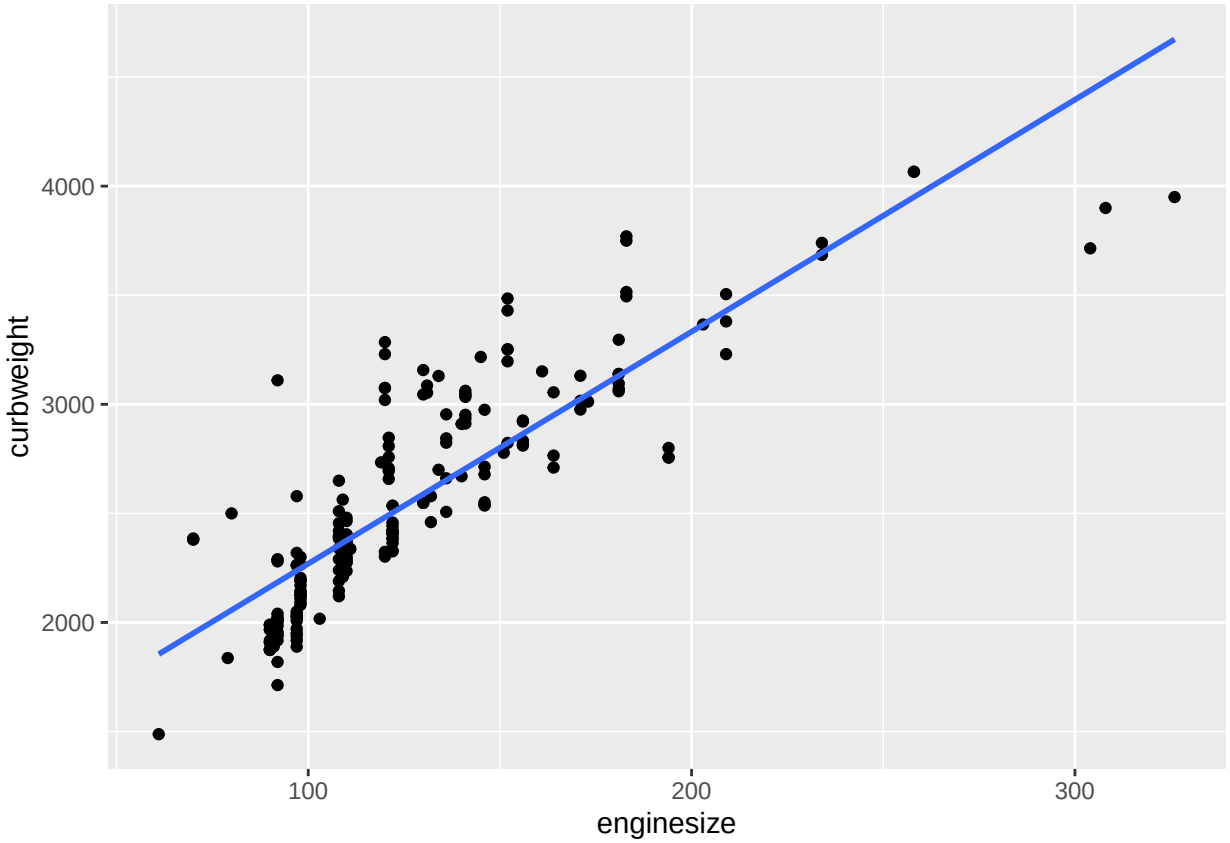

```
## [1] "Correlation between curbweight and citympg : -0.757413784505601"
## [1] "x = enginesize , y = carwidth"
```

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



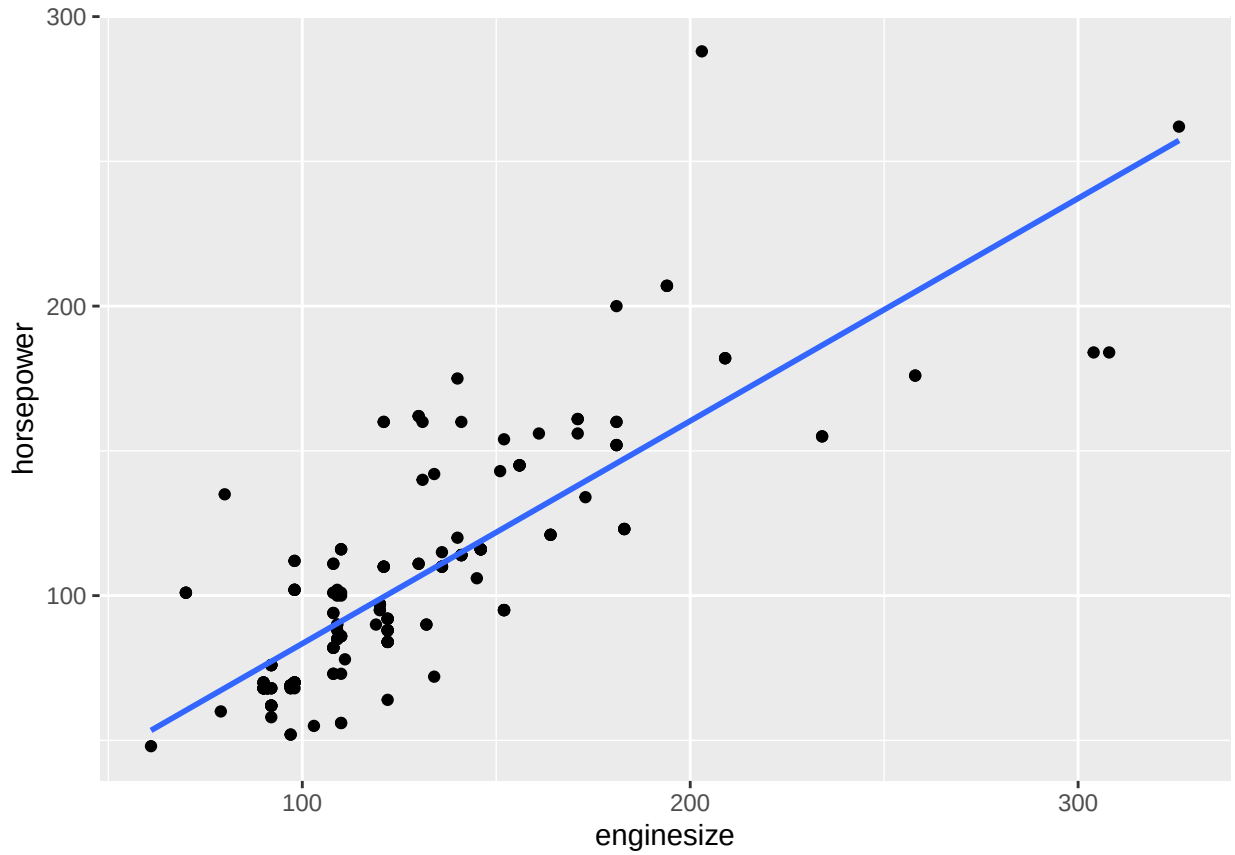

```
## [1] "Correlation between enginesize and carwidth : 0.735433404779637"
## [1] "x = enginesize , y = curbweight"
```

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



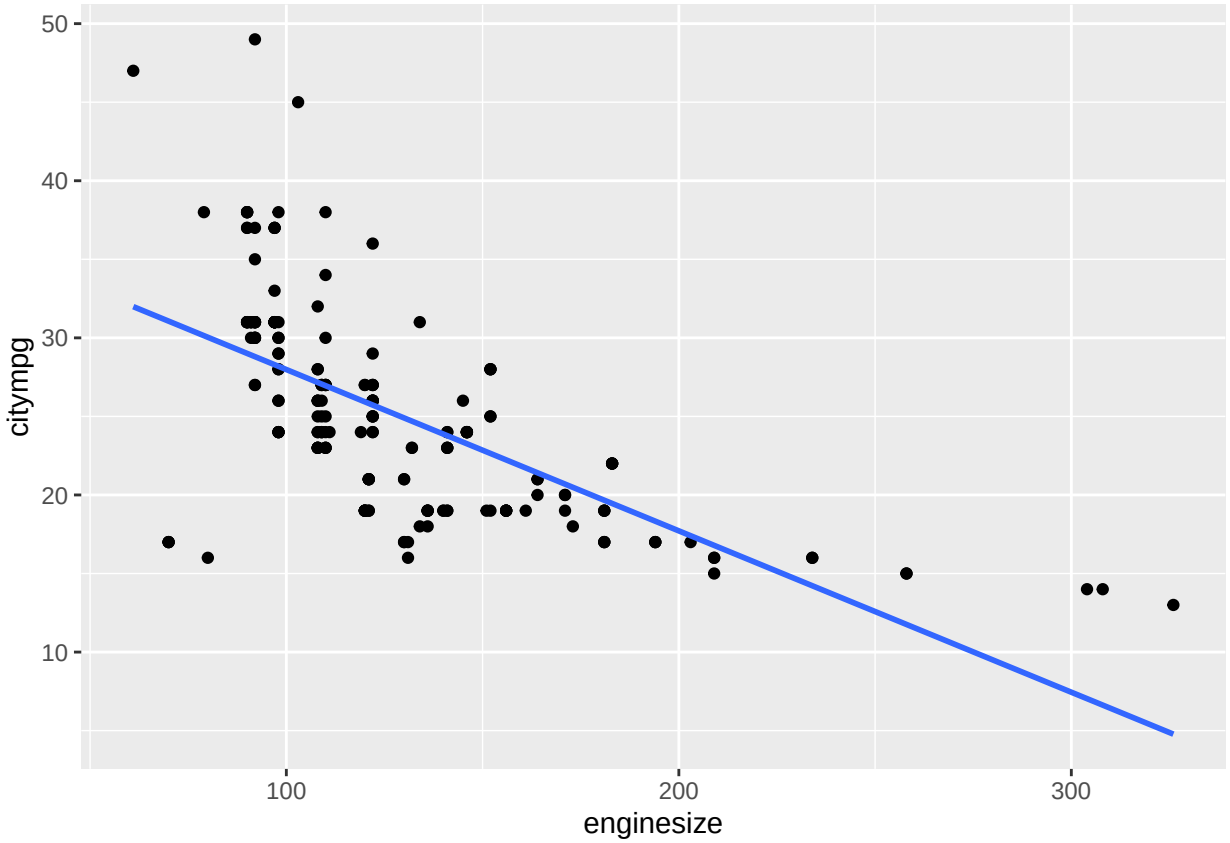

```
## [1] "Correlation between enginesize and curbweight : 0.850594073426277"
## [1] "x = enginesize , y = horsepower"
```

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



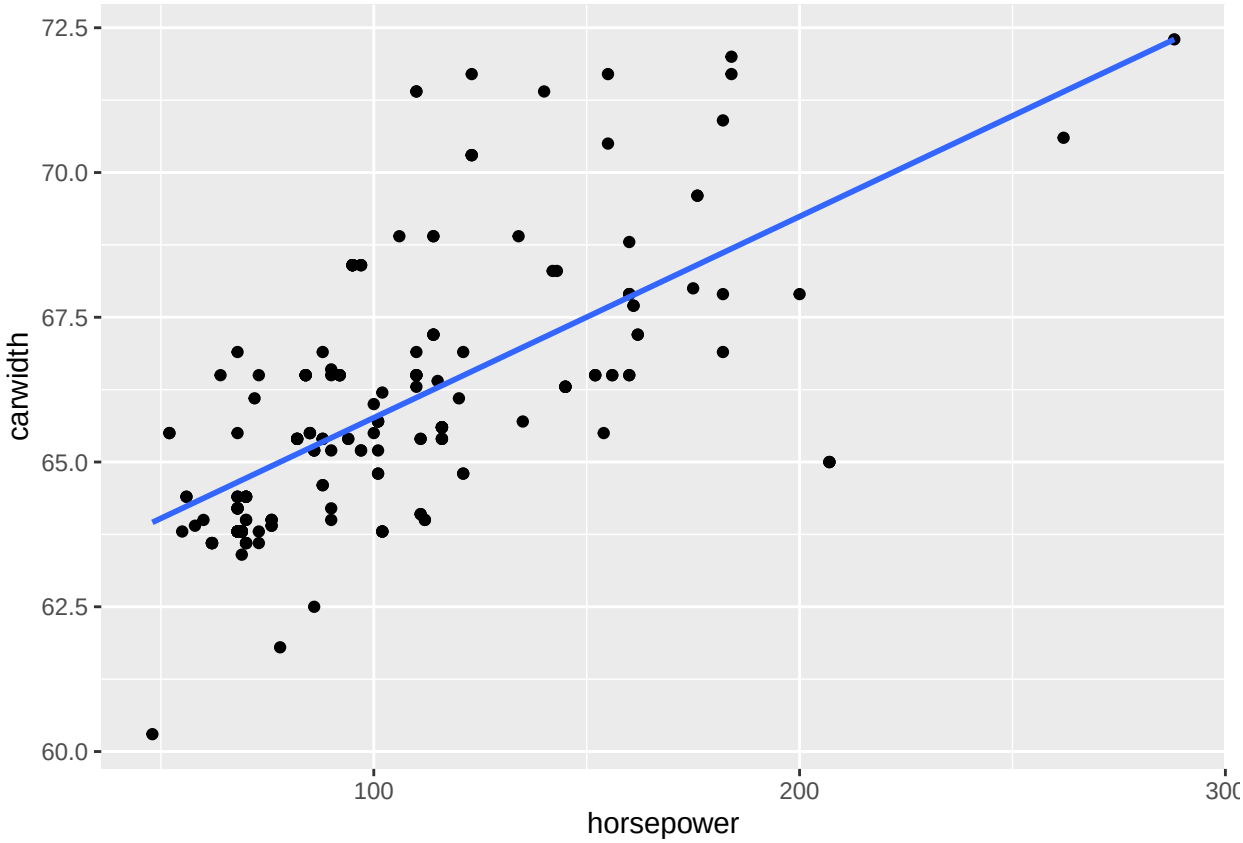

```
## [1] "Correlation between enginesize and horsepower : 0.80976865453773"
## [1] "x = enginesize , y = citympg"
```

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

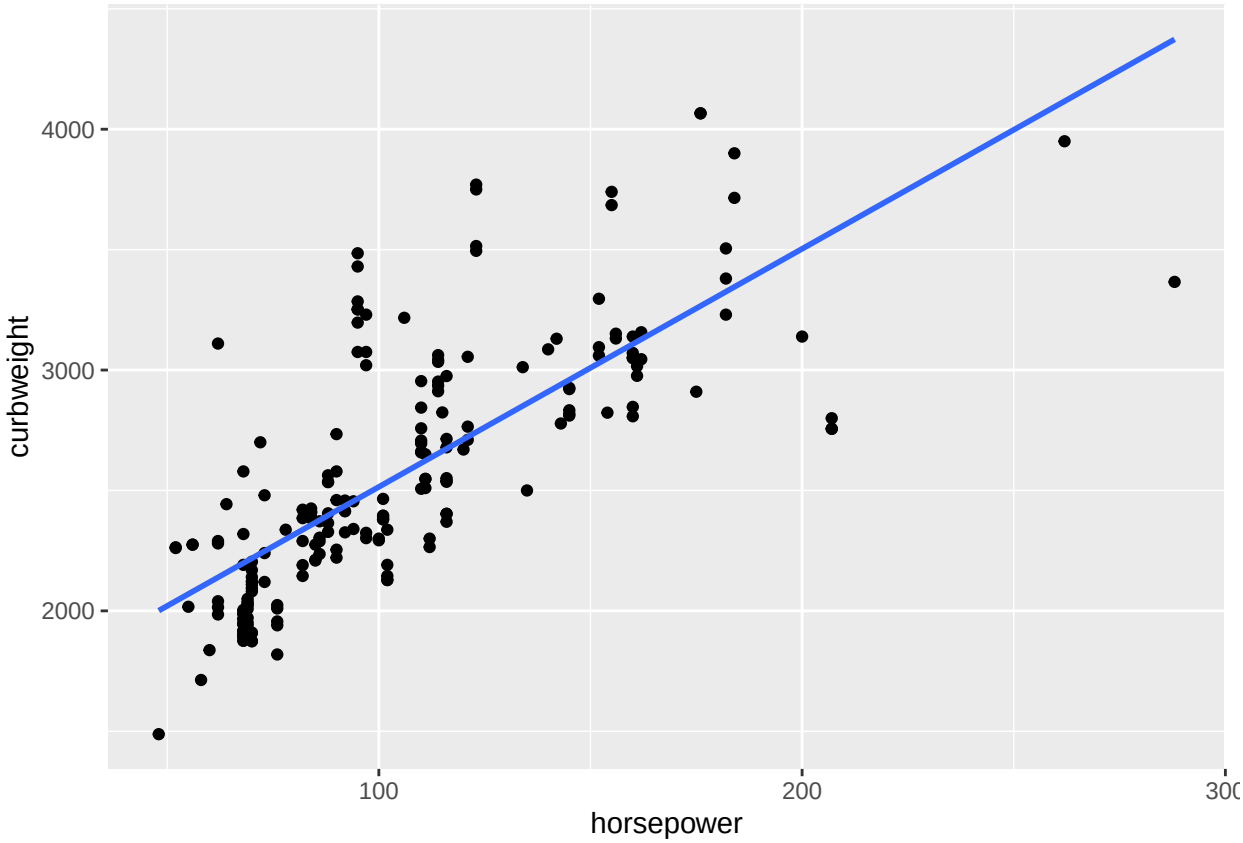



```
## [1] "Correlation between enginesize and citympg : -0.65365791631142"
## [1] "x = horsepower , y = carwidth"
```

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

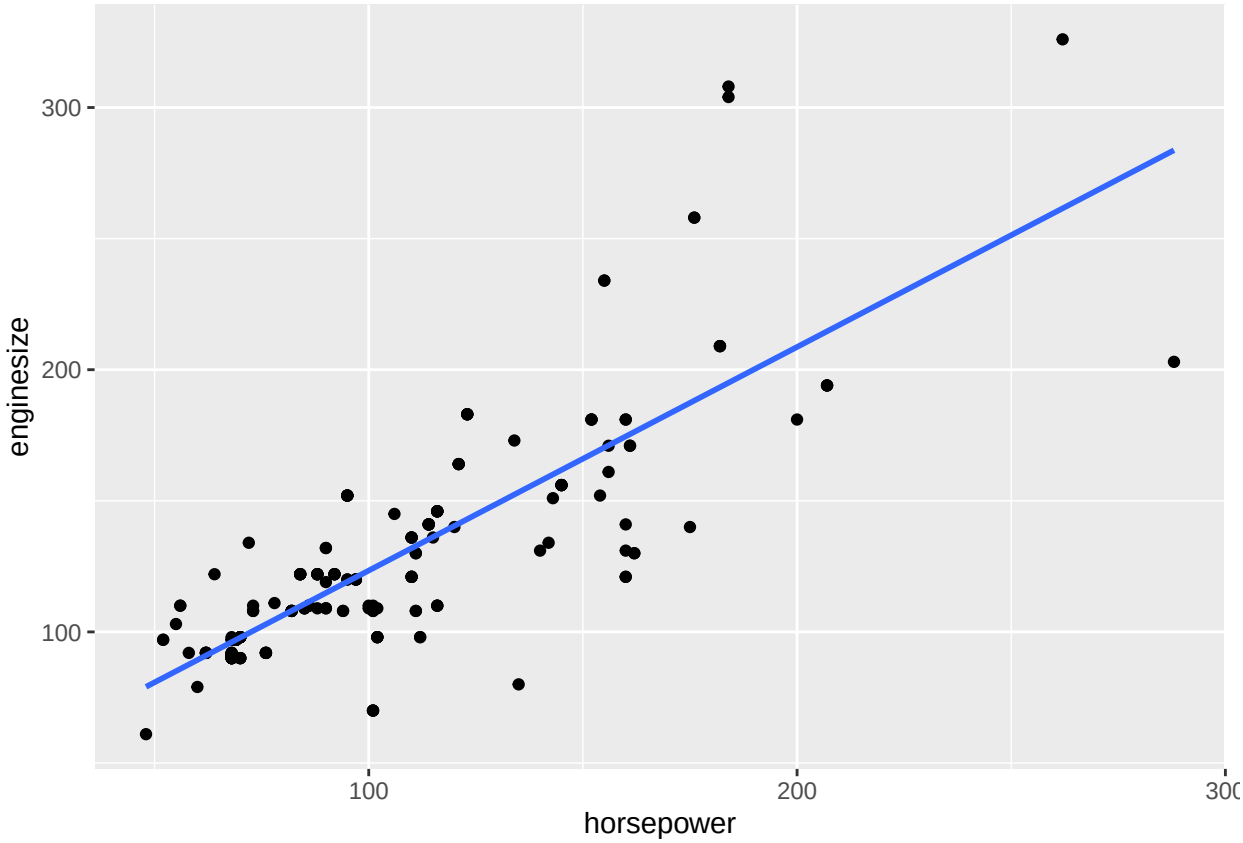



```
## [1] "Correlation between horsepower and carwidth : 0.640732075572292"
## [1] "x = horsepower , y = curbweight"

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



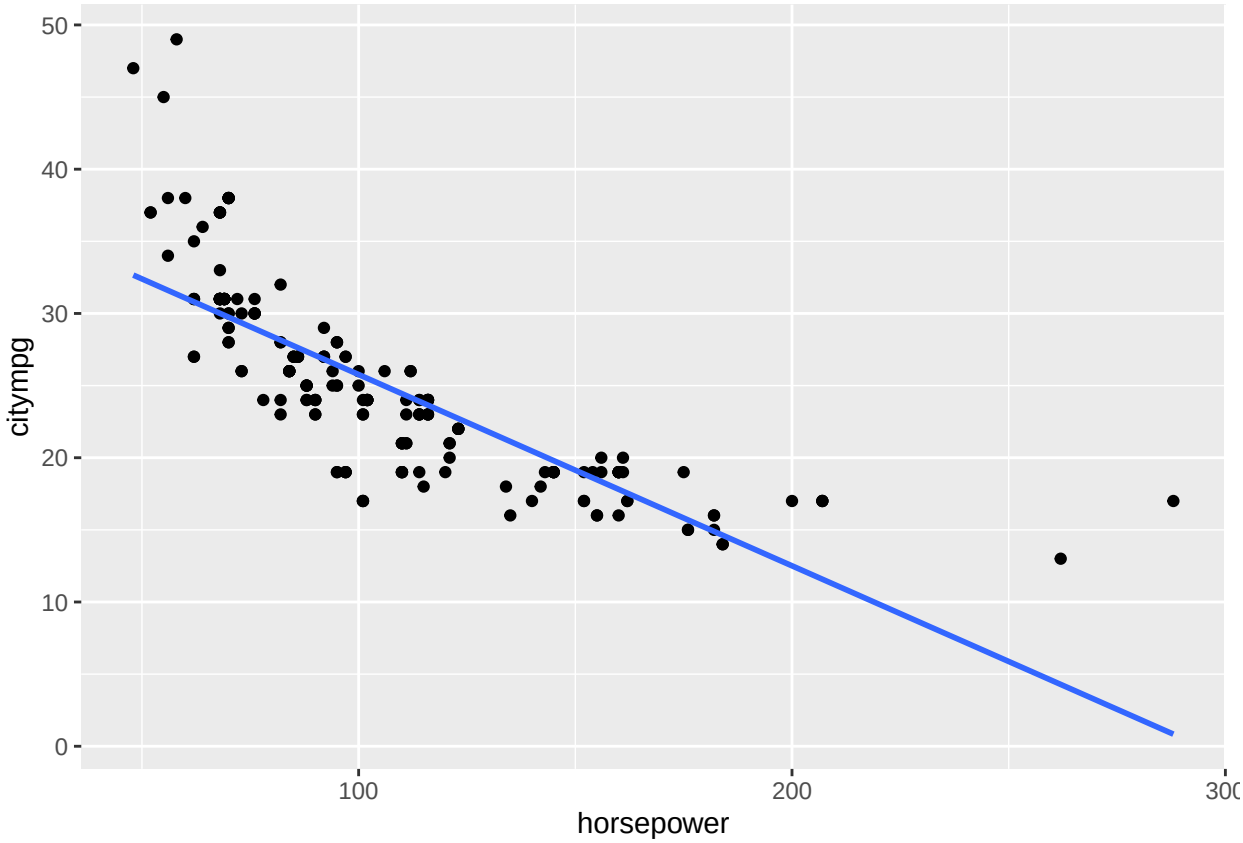

```
## [1] "Correlation between horsepower and curbweight : 0.750739251443481"
## [1] "x = horsepower , y = enginesize"
```

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



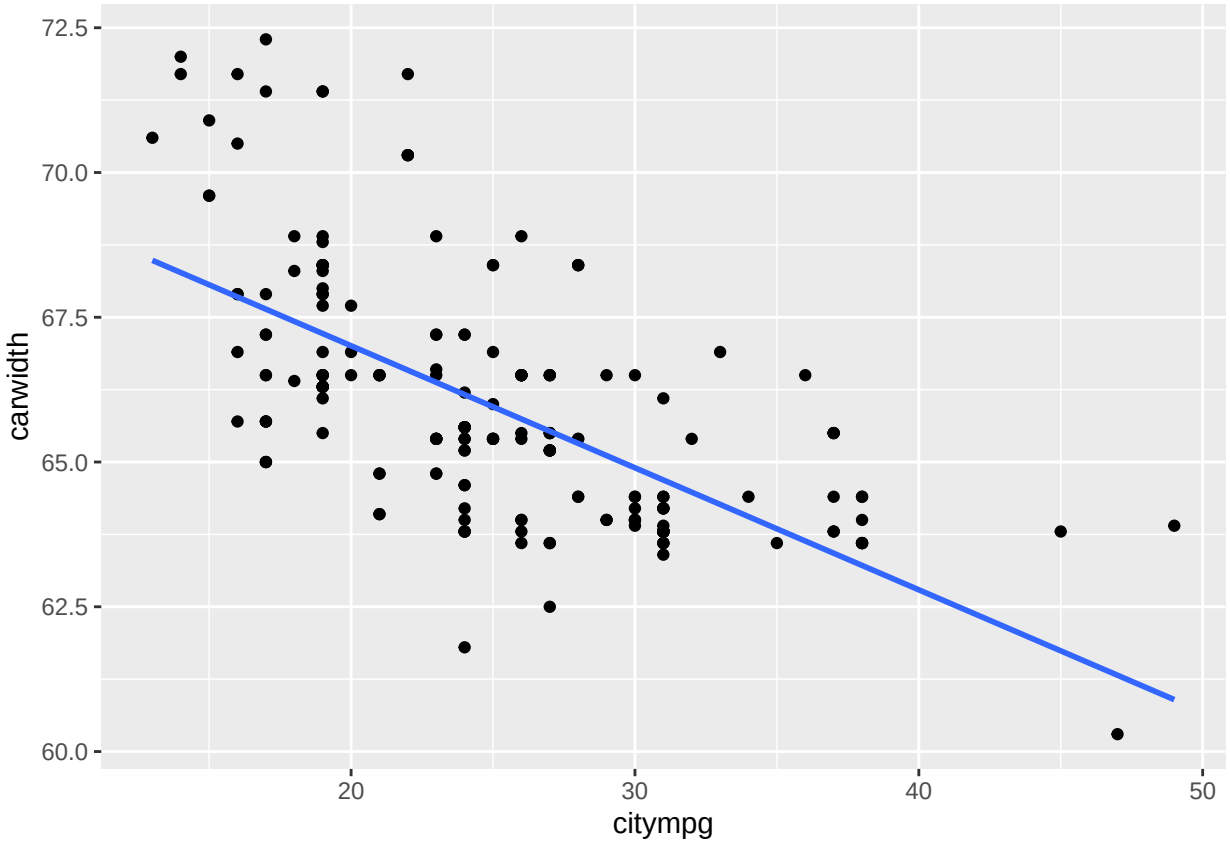

```
## [1] "Correlation between horsepower and enginesize : 0.80976865453773"
## [1] "x = horsepower , y = citympg"
```

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

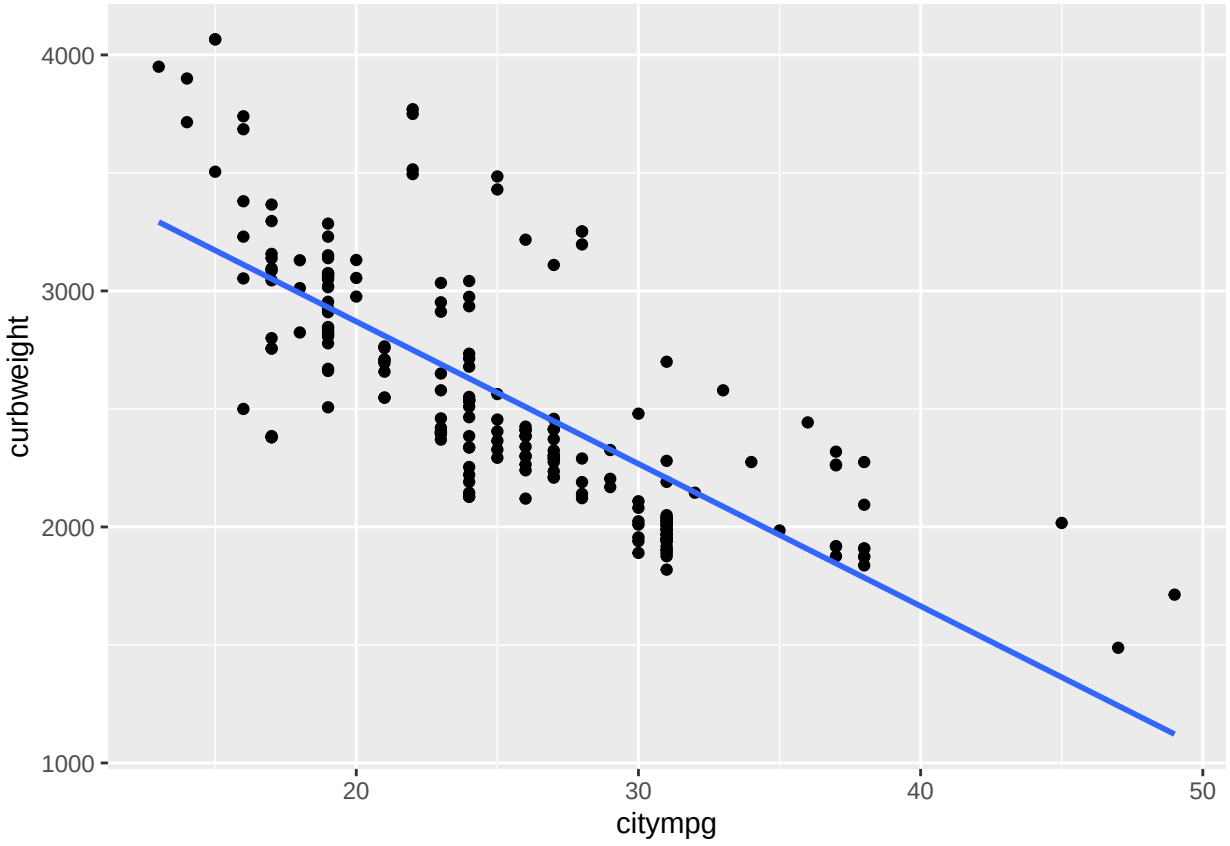



```
## [1] "Correlation between horsepower and citympg : -0.80145617566627"
## [1] "x = citympg , y = carwidth"
```

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

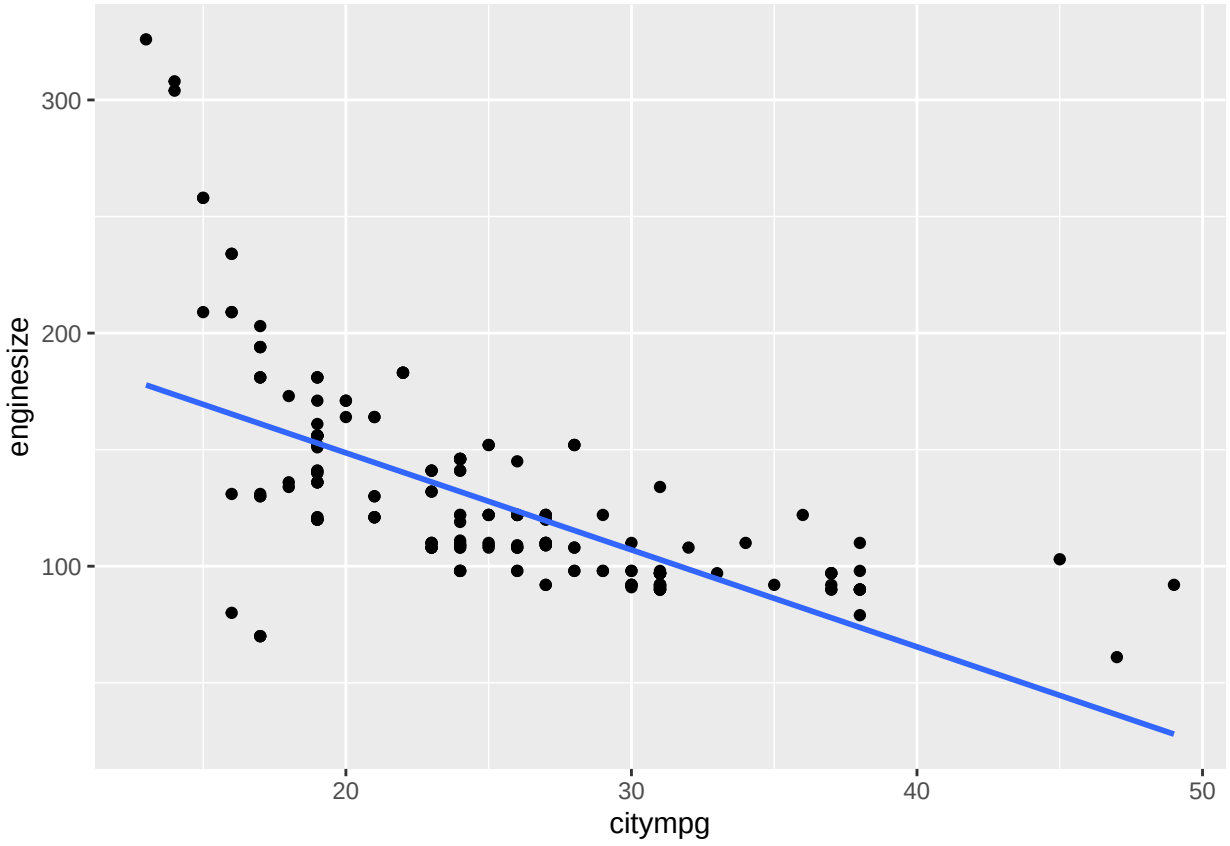



```
## [1] "Correlation between citympg and carwidth : -0.642704340710898"
## [1] "x = citympg , y = curbweight"

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



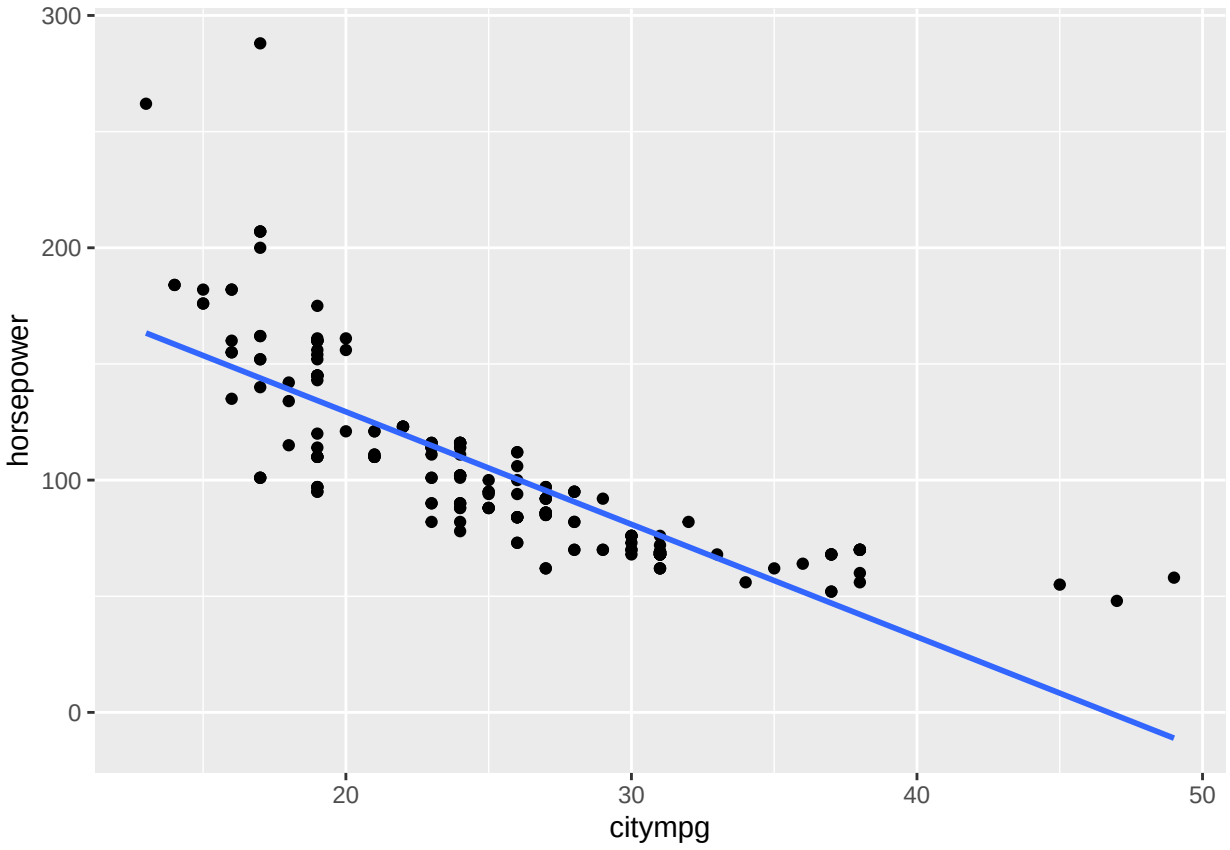

```
## [1] "Correlation between citympg and curbweight : -0.757413784505601"
## [1] "x = citympg , y = enginesize"
```

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




```
## [1] "Correlation between citympg and enginesize : -0.65365791631142"
## [1] "x = citympg , y = horsepower"
```

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



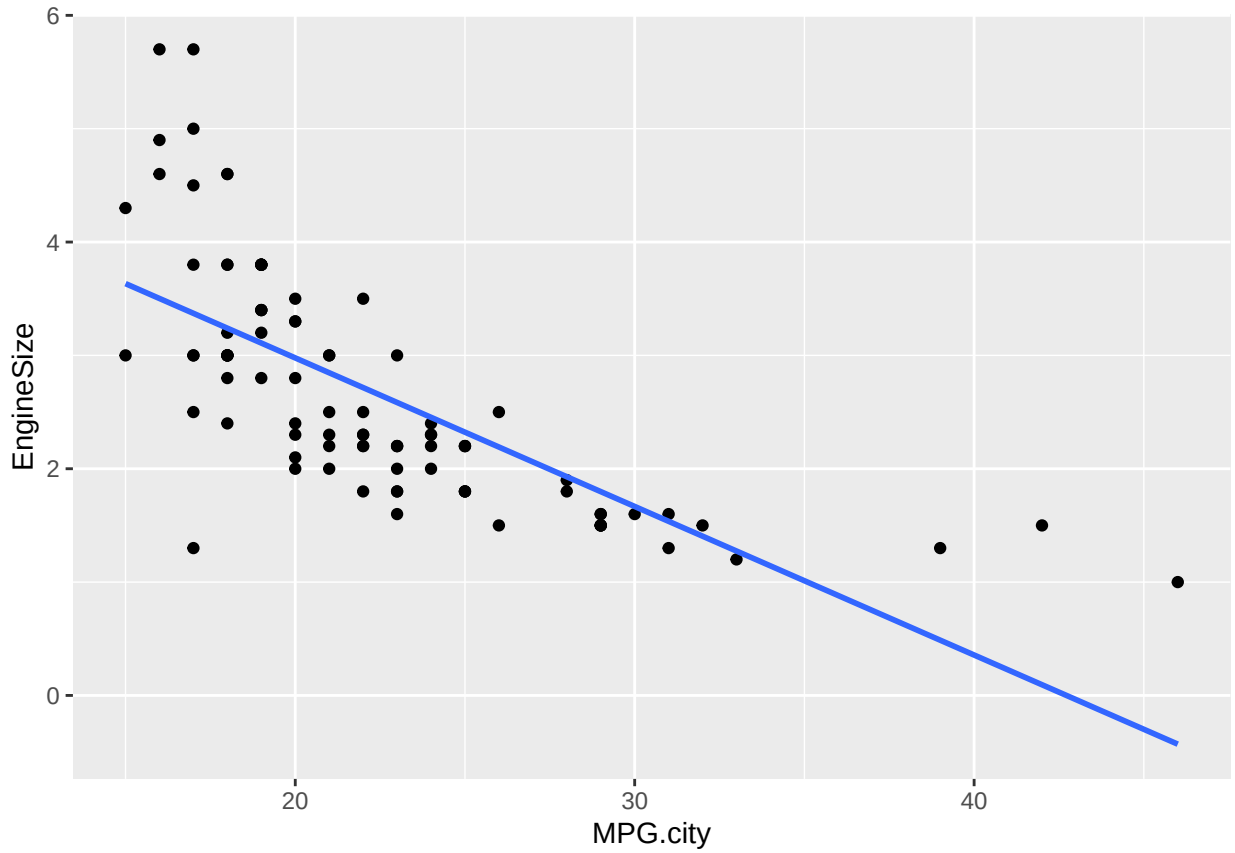

```
## [1] "Correlation between citympg and horsepower : -0.80145617566627"
```

cars93 - Correlation between pairs of variables except price

```
for (var in c("MPG.city", "EngineSize", "Horsepower", "Fuel.tank.capacity", "Weight")) {
  for (var1 in c("MPG.city", "EngineSize", "Horsepower", "Fuel.tank.capacity", "Weight")) {

    if (var != var1) {
      print(paste("x =", var, ", y =", var1))

      p <- ggplot(cars93, aes_string(x = var, y = var1)) +
        geom_point() +
        geom_smooth(method = "lm", se = FALSE)
      print(p)

      correlation <- cor(cars93[[var1]], cars93[[var]])
      print(paste("Correlation between", var, "and", var1, ":", correlation))
    }
  }
}
```

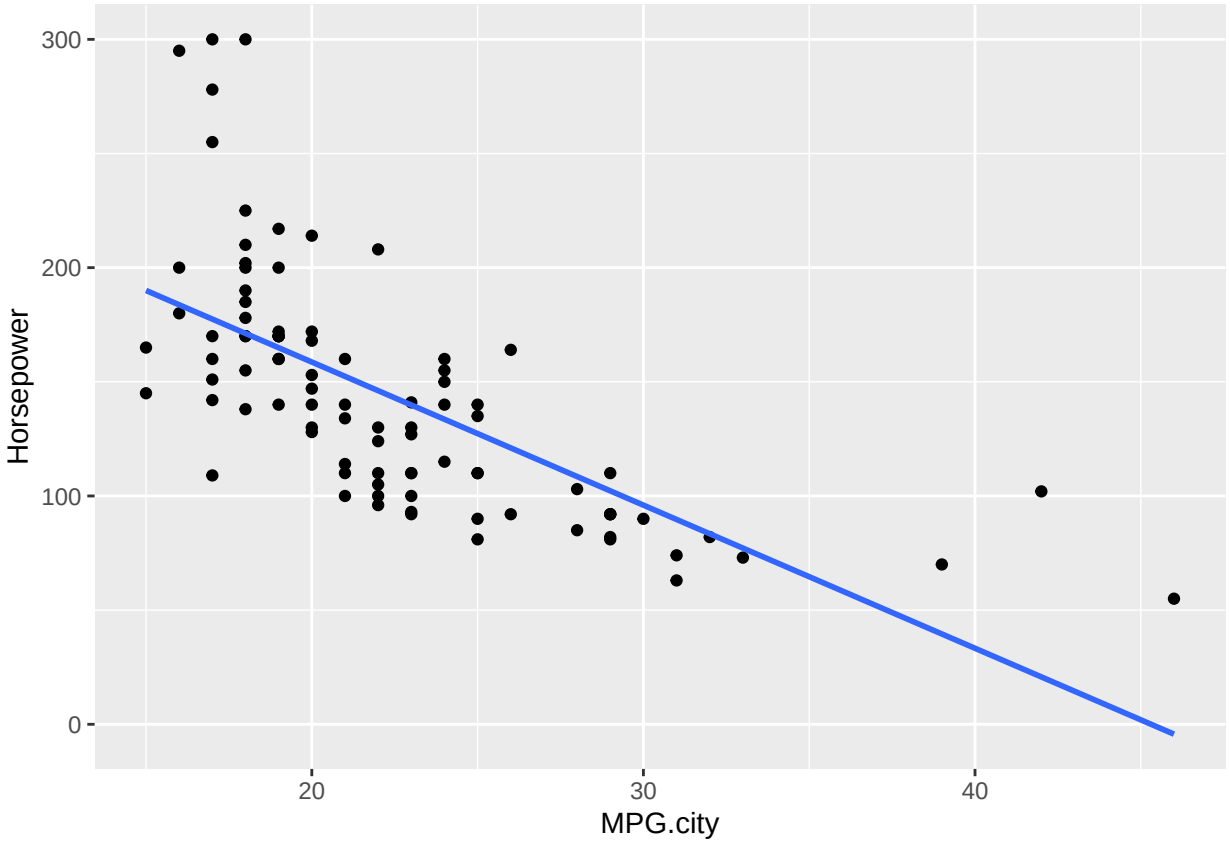
```
## [1] "x = MPG.city , y = EngineSize"
```

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

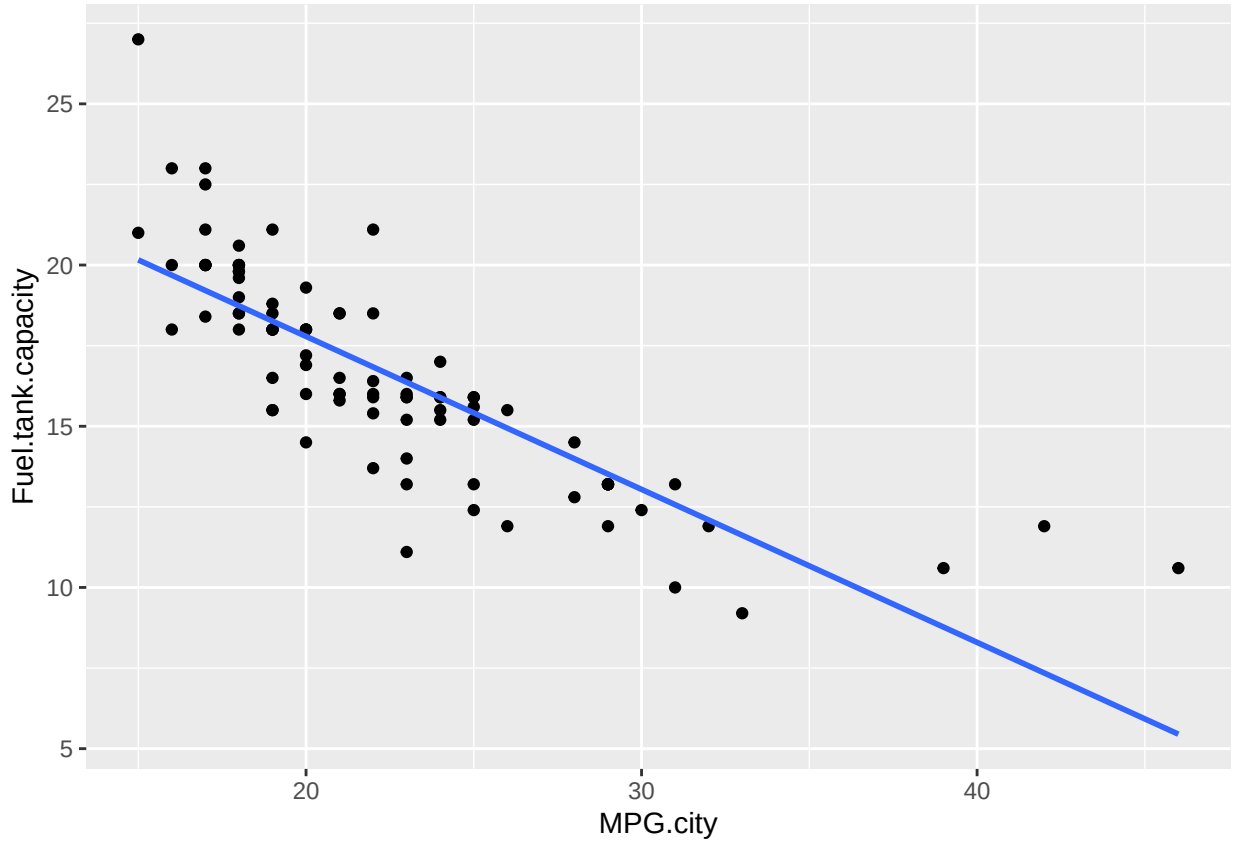



```
## [1] "Correlation between MPG.city and EngineSize : -0.710003161620369"
## [1] "x = MPG.city , y = Horsepower"
```

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

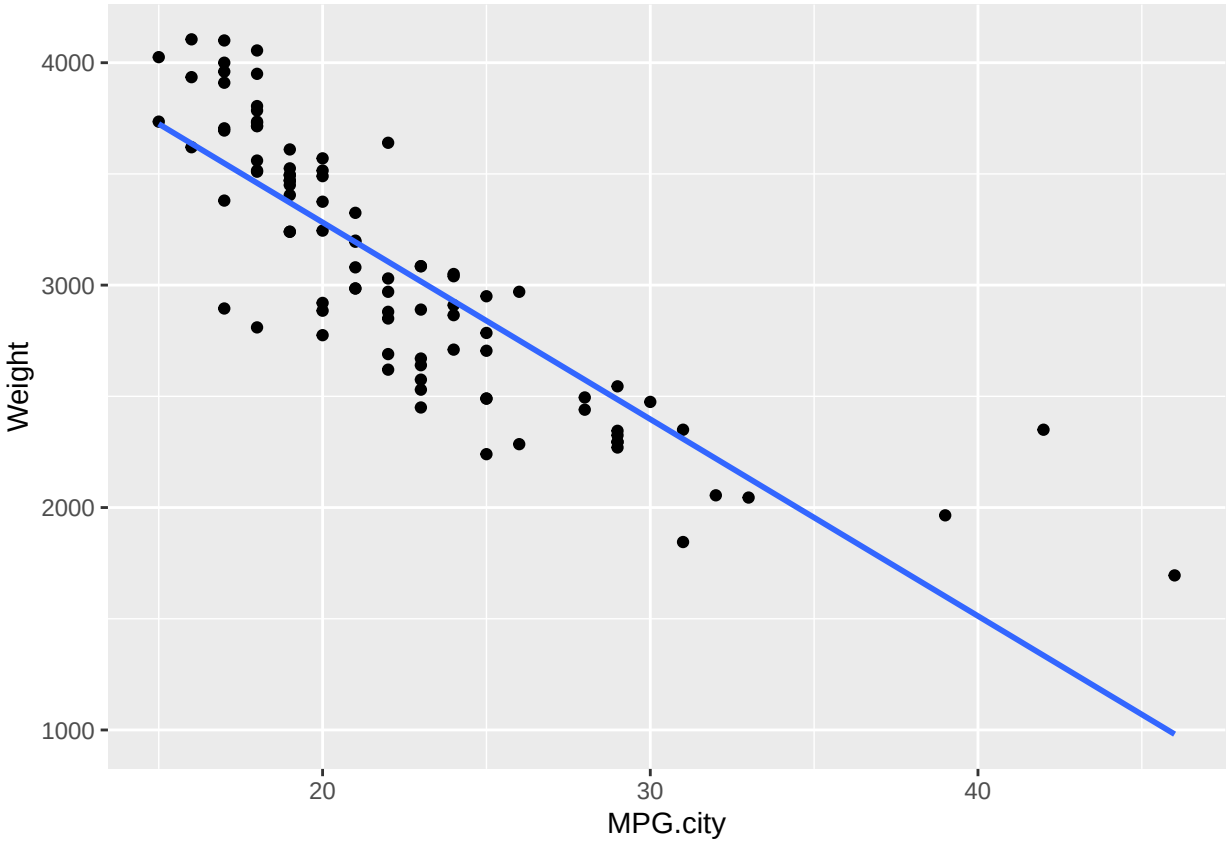



```
## [1] "Correlation between MPG.city and Horsepower : -0.672636150795724"
## [1] "x = MPG.city , y = Fuel.tank.capacity"

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



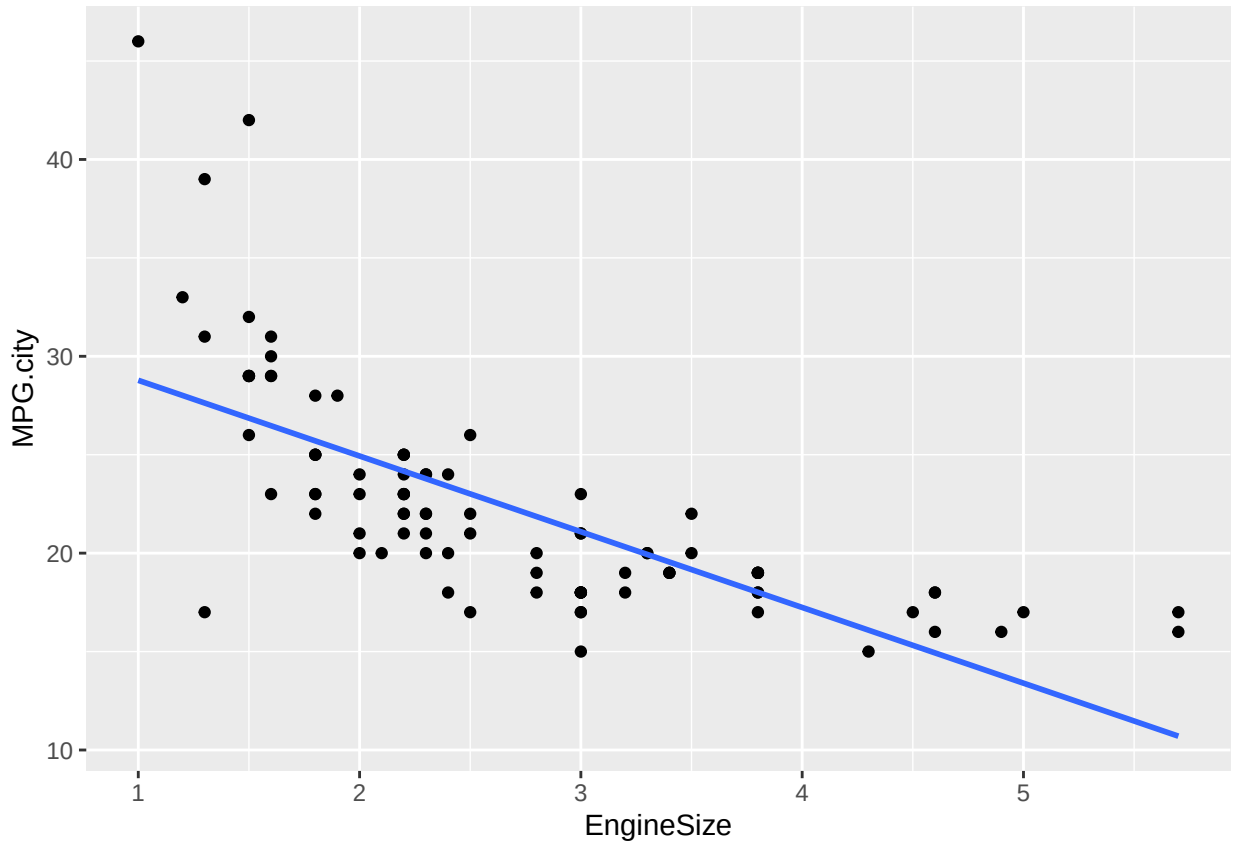

```
## [1] "Correlation between MPG.city and Fuel.tank.capacity : -0.813144416992242"
## [1] "x = MPG.city , y = Weight"
```

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



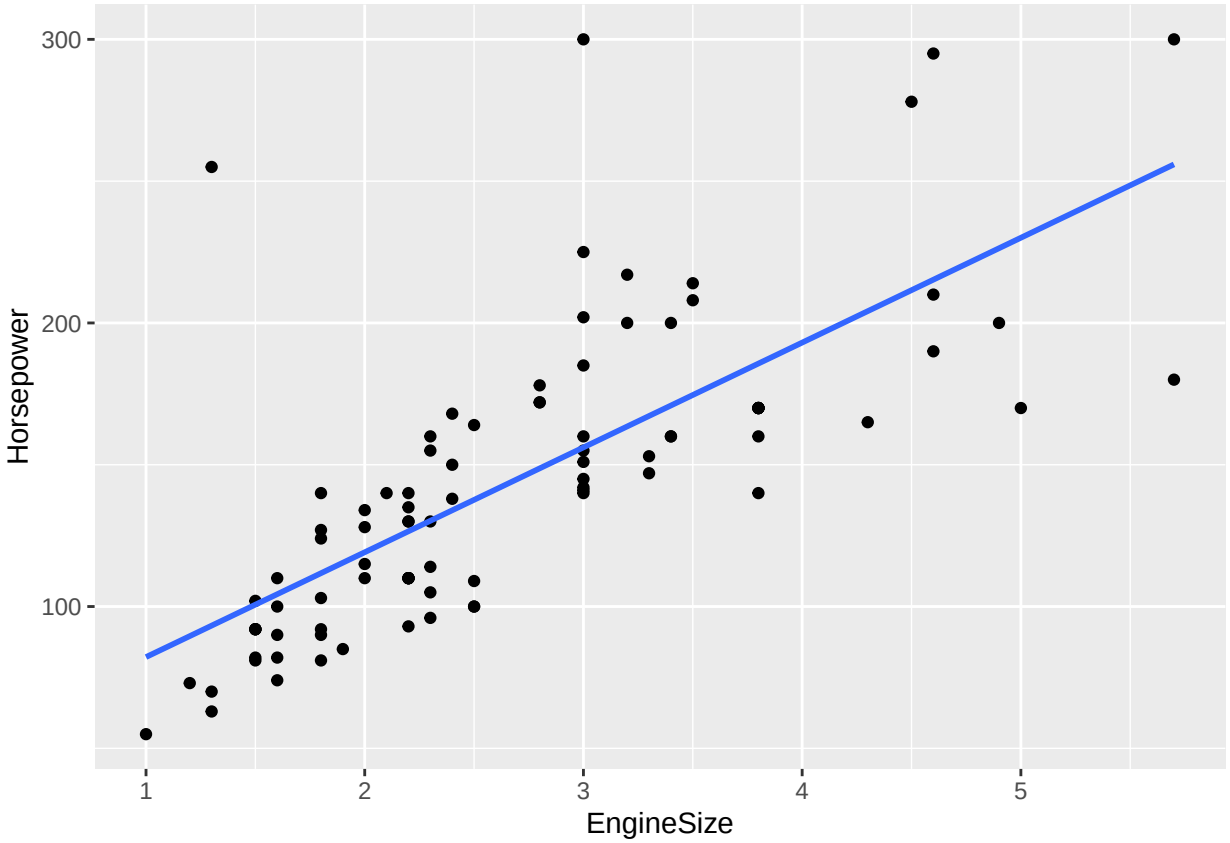

```
## [1] "Correlation between MPG.city and Weight : -0.84313854799682"
## [1] "x = EngineSize , y = MPG.city"
```

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



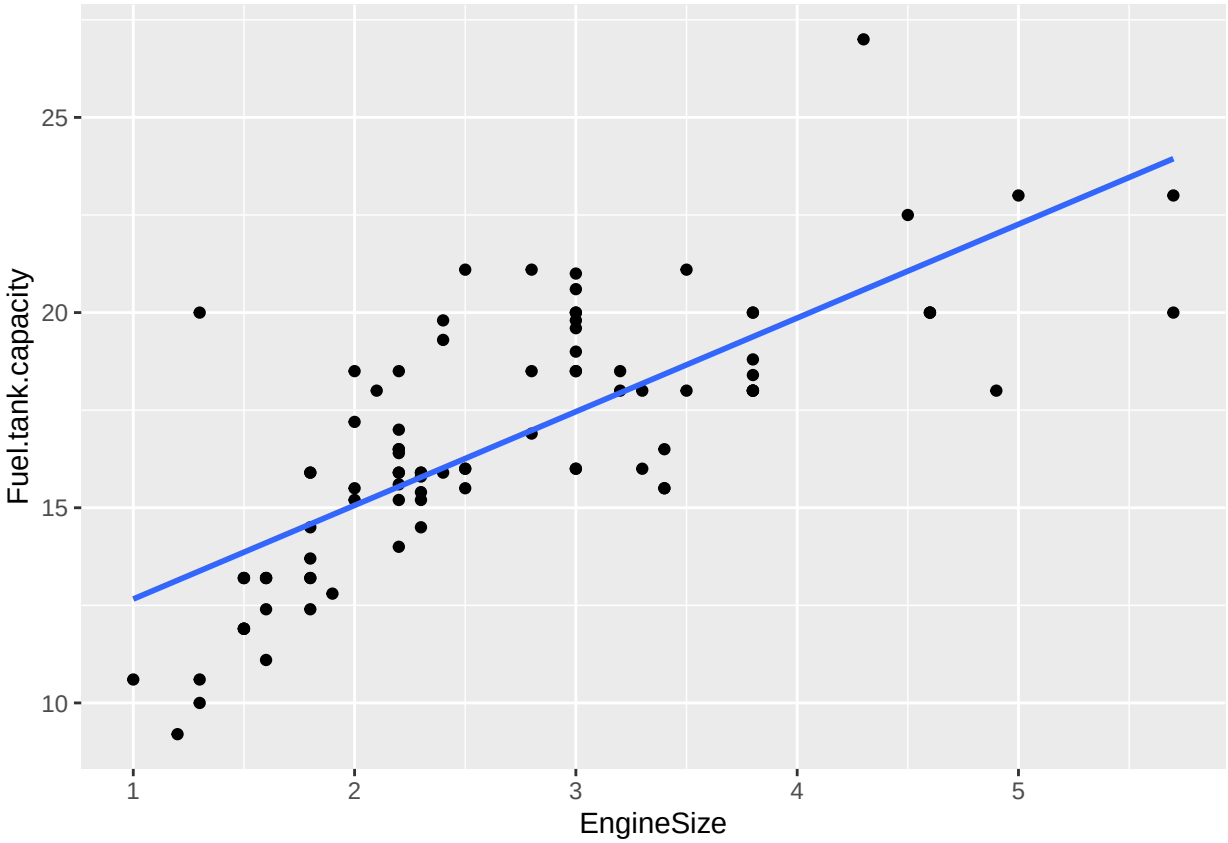

```
## [1] "Correlation between EngineSize and MPG.city : -0.710003161620369"
## [1] "x = EngineSize , y = Horsepower"
```

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



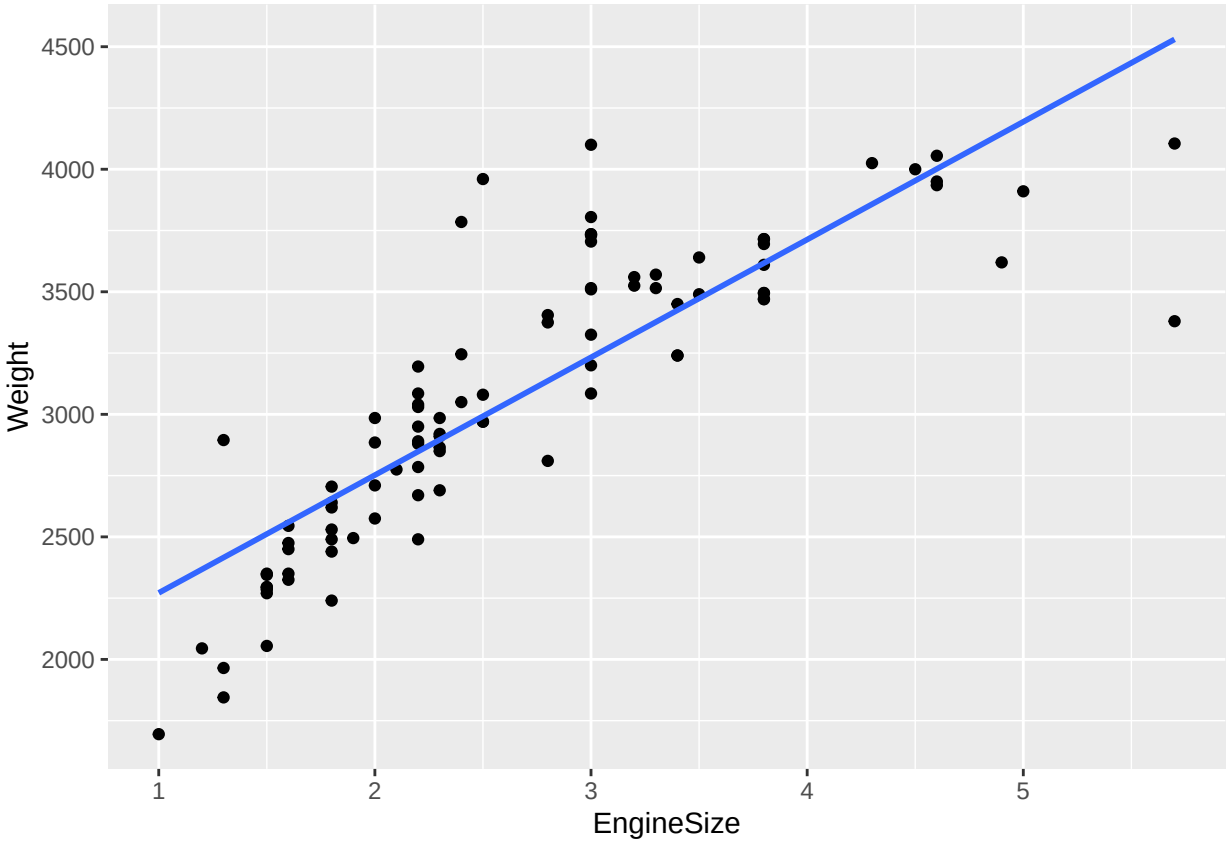

```
## [1] "Correlation between EngineSize and Horsepower : 0.732119730417387"
## [1] "x = EngineSize , y = Fuel.tank.capacity"
```

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



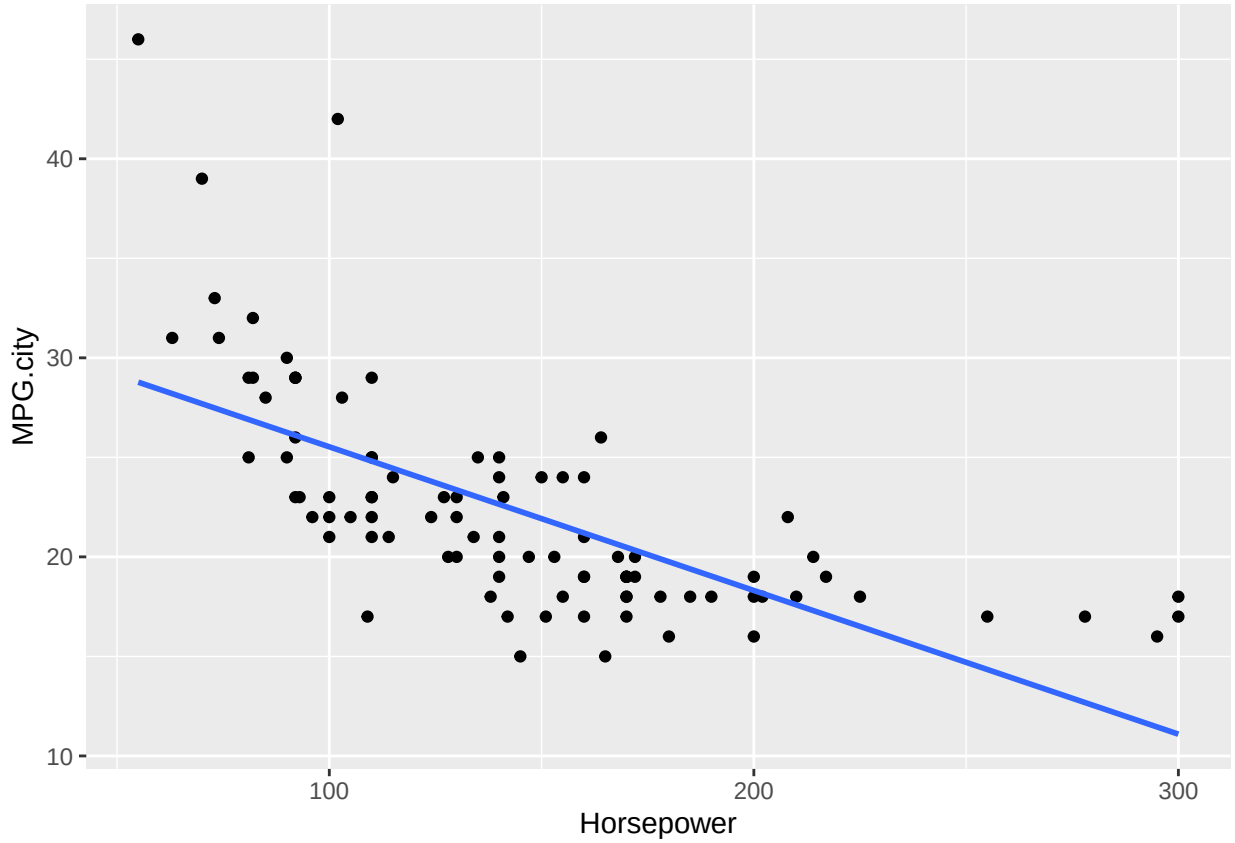

```
## [1] "Correlation between EngineSize and Fuel.tank.capacity : 0.759306224903401"
## [1] "x = EngineSize , y = Weight"
```

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



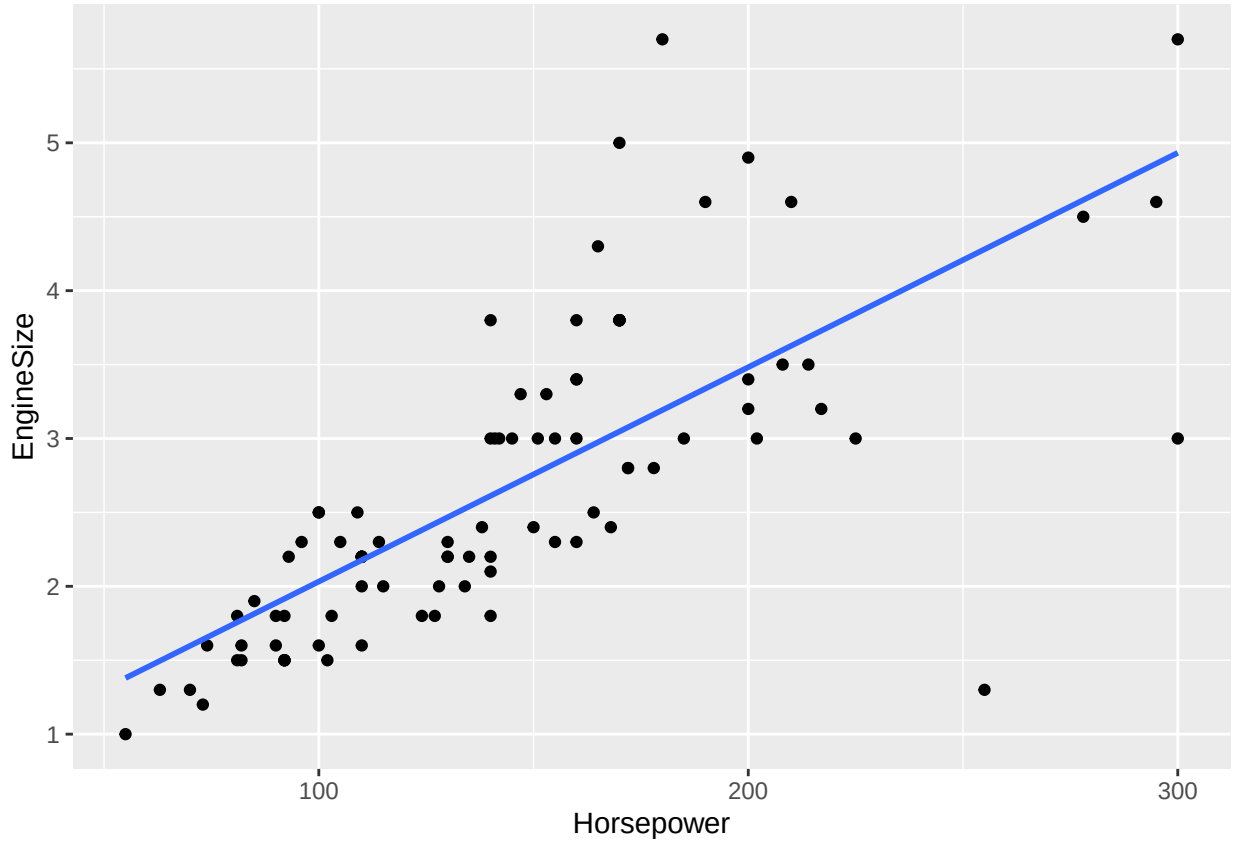

```
## [1] "Correlation between EngineSize and Weight : 0.845075335037262"
## [1] "x = Horsepower , y = MPG.city"
```

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

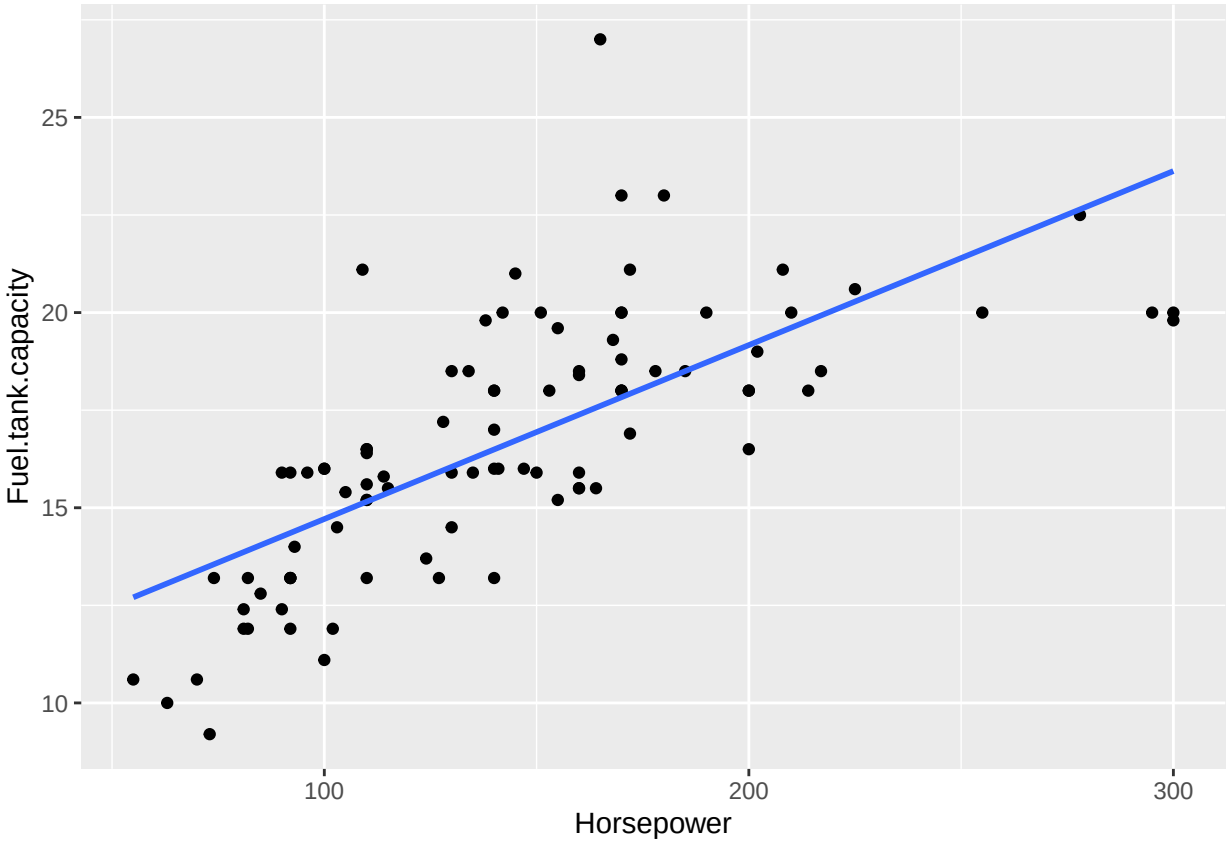



```
## [1] "Correlation between Horsepower and MPG.city : -0.672636150795724"
## [1] "x = Horsepower , y = EngineSize"
```

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

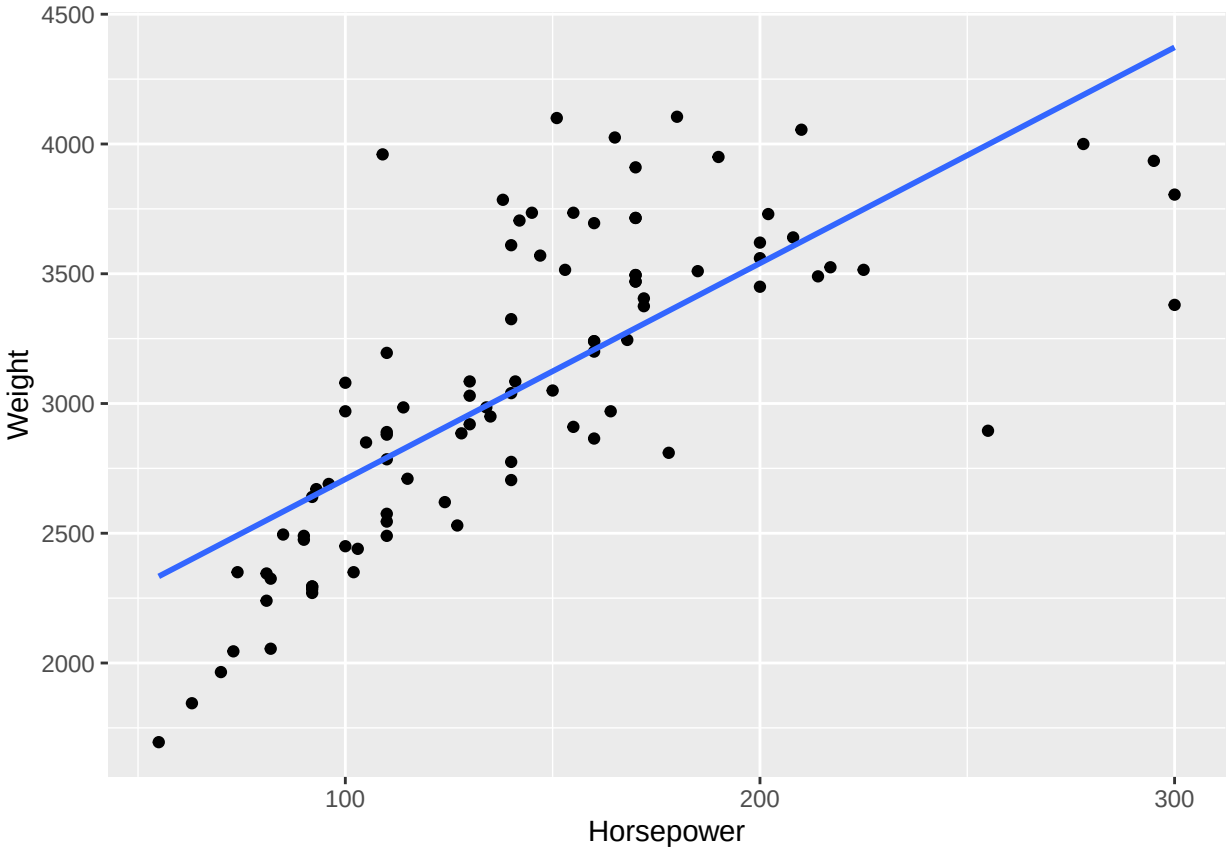



```
## [1] "Correlation between Horsepower and EngineSize : 0.732119730417387"
## [1] "x = Horsepower , y = Fuel.tank.capacity"

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



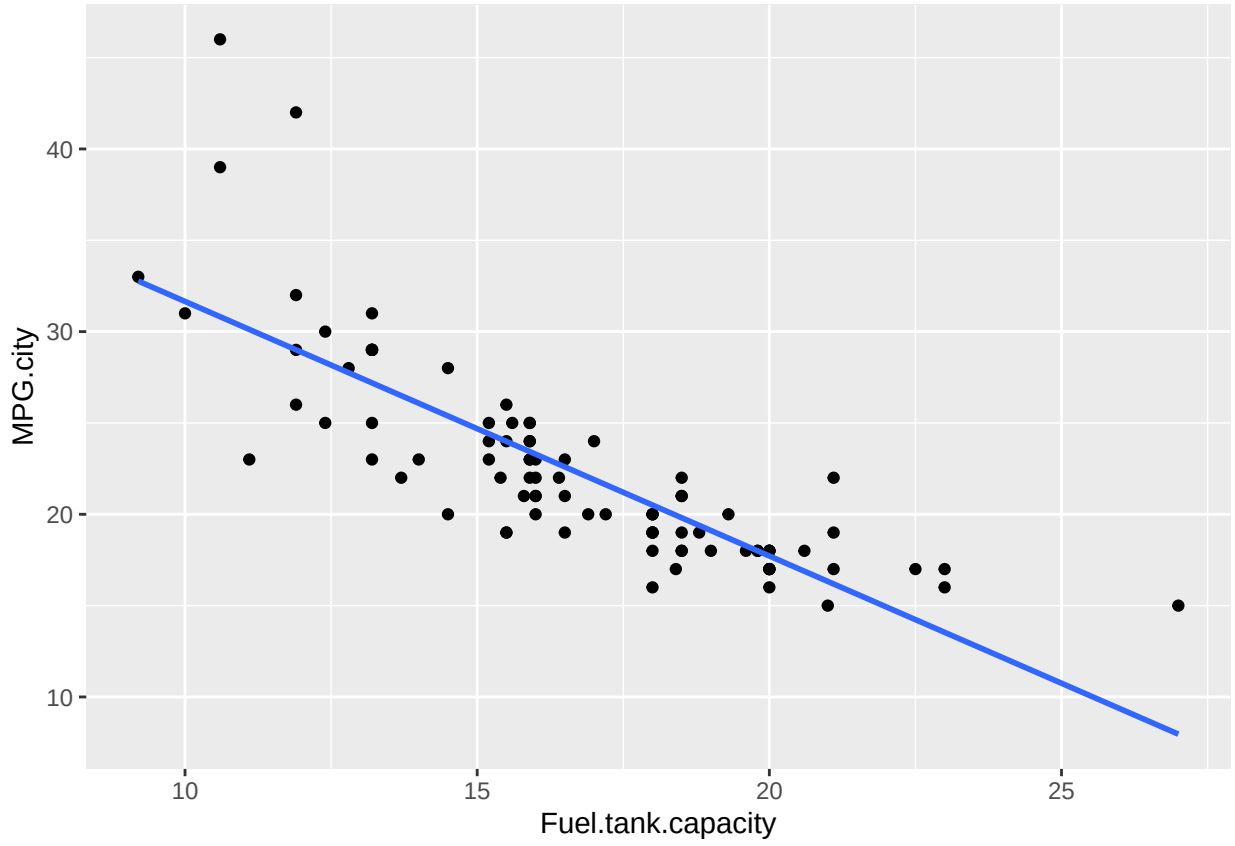

```
## [1] "Correlation between Horsepower and Fuel.tank.capacity : 0.711790317259719"
## [1] "x = Horsepower , y = Weight"
```

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



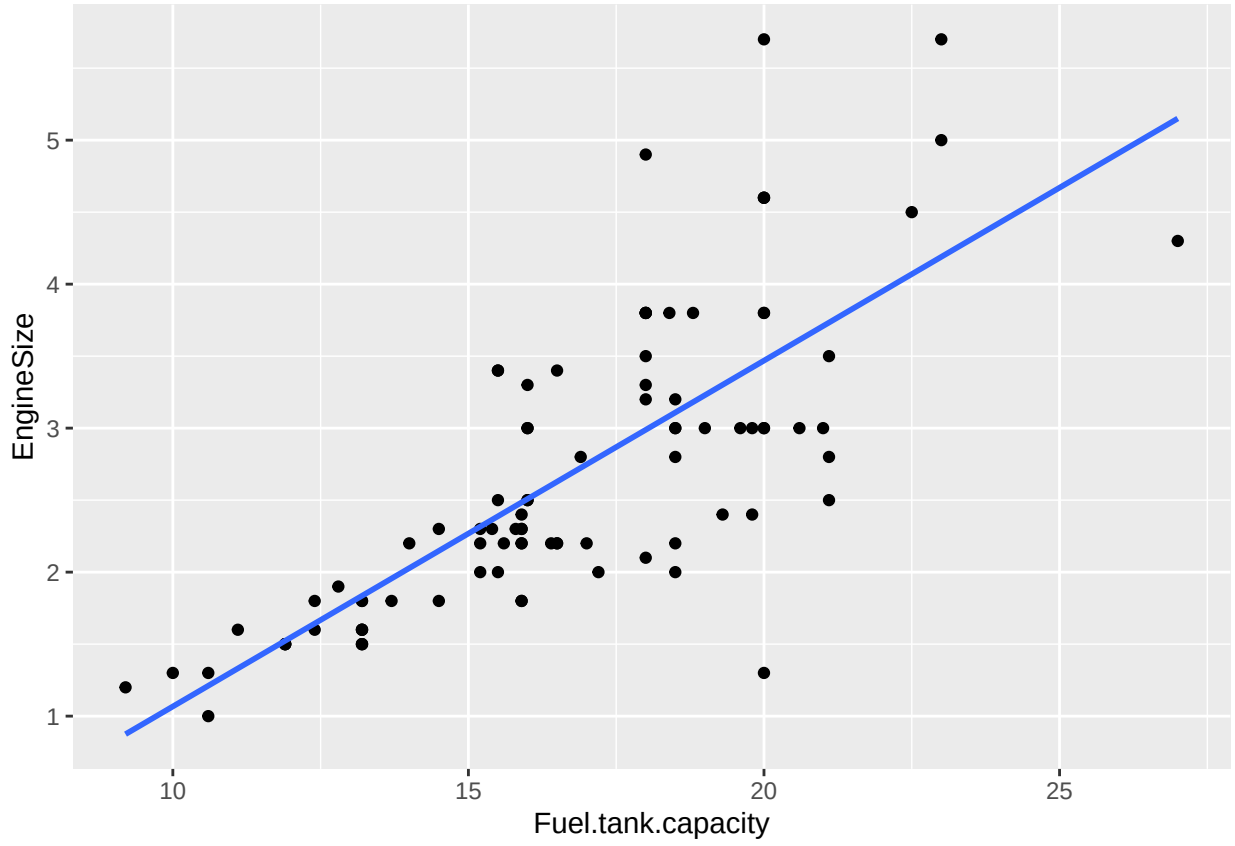

```
## [1] "Correlation between Horsepower and Weight : 0.738797515540372"
## [1] "x = Fuel.tank.capacity , y = MPG.city"
```

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

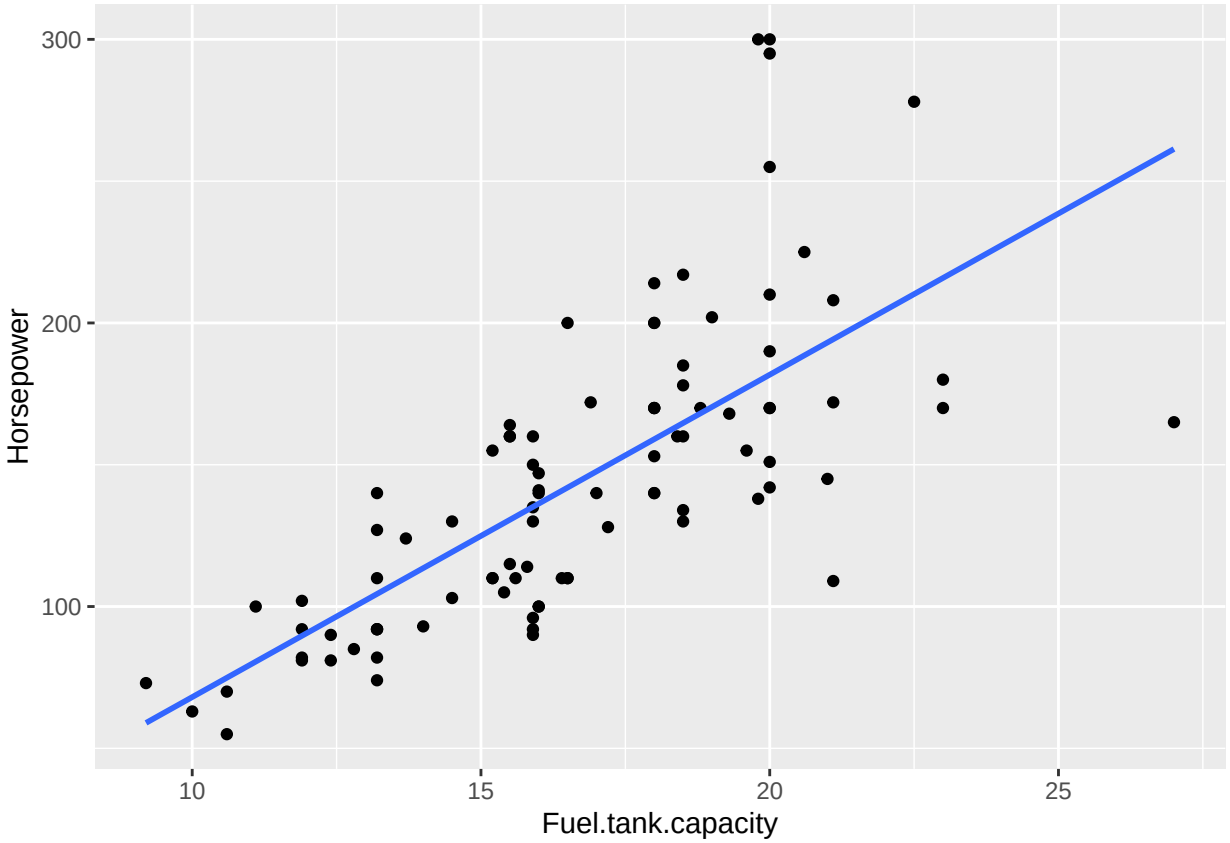



```
## [1] "Correlation between Fuel.tank.capacity and MPG.city : -0.813144416992242"
## [1] "x = Fuel.tank.capacity , y = EngineSize"
```

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

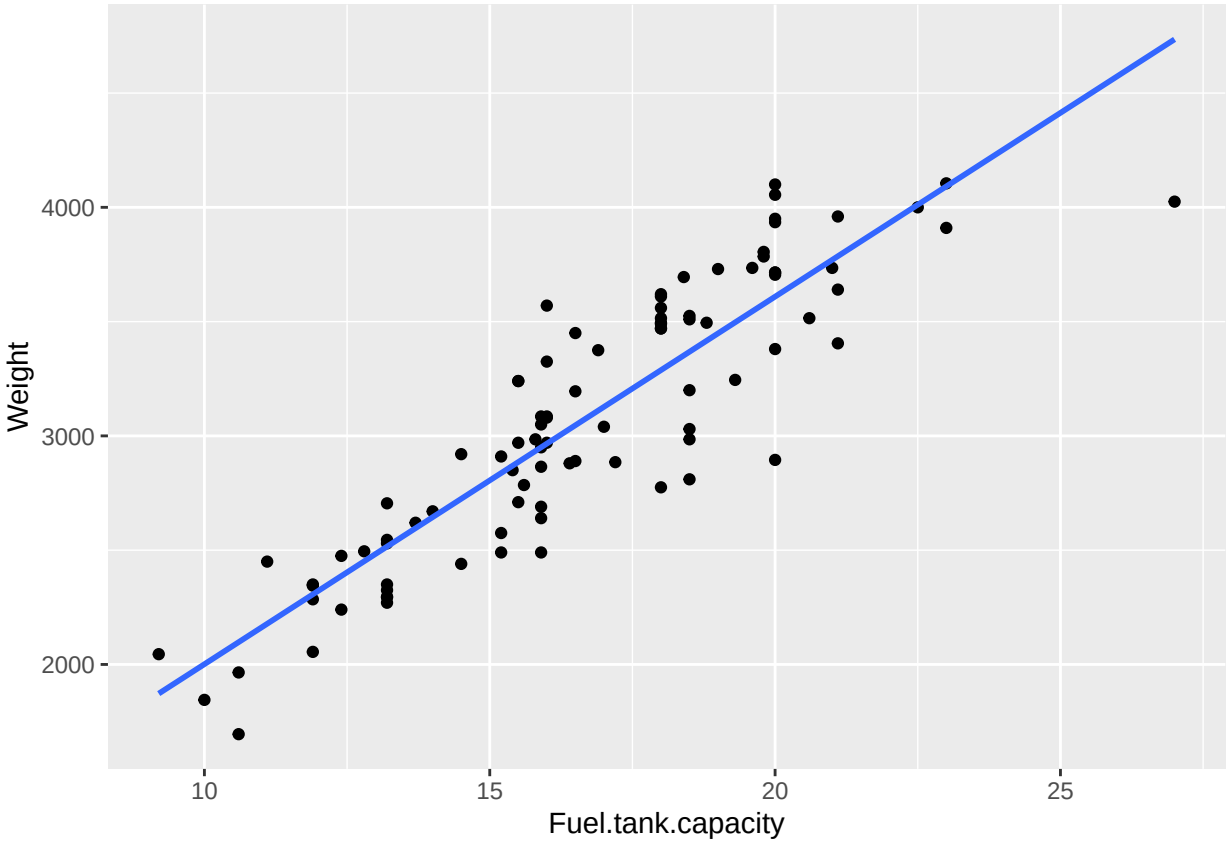



```
## [1] "Correlation between Fuel.tank.capacity and EngineSize : 0.759306224903401"
## [1] "x = Fuel.tank.capacity , y = Horsepower"

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

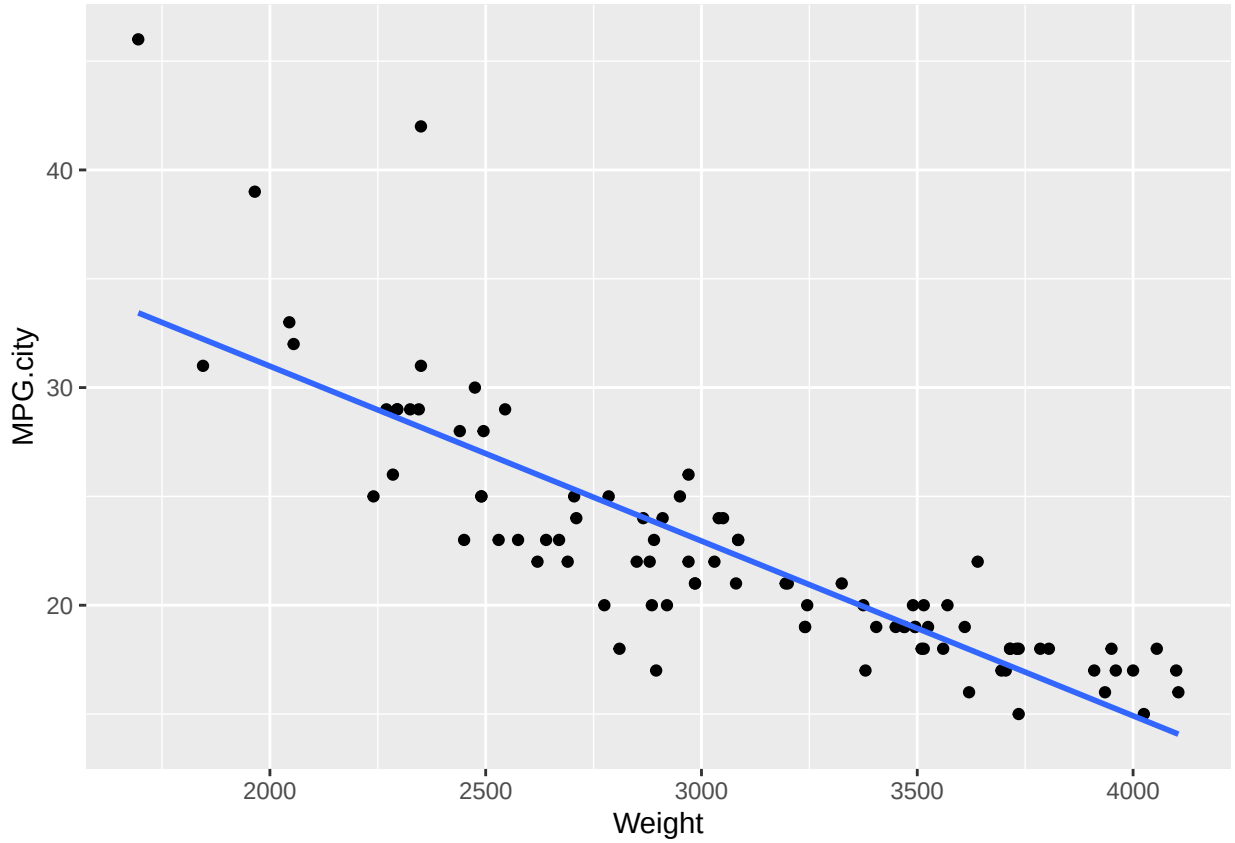



```
## [1] "Correlation between Fuel.tank.capacity and Horsepower : 0.711790317259719"
## [1] "x = Fuel.tank.capacity , y = Weight"
```

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

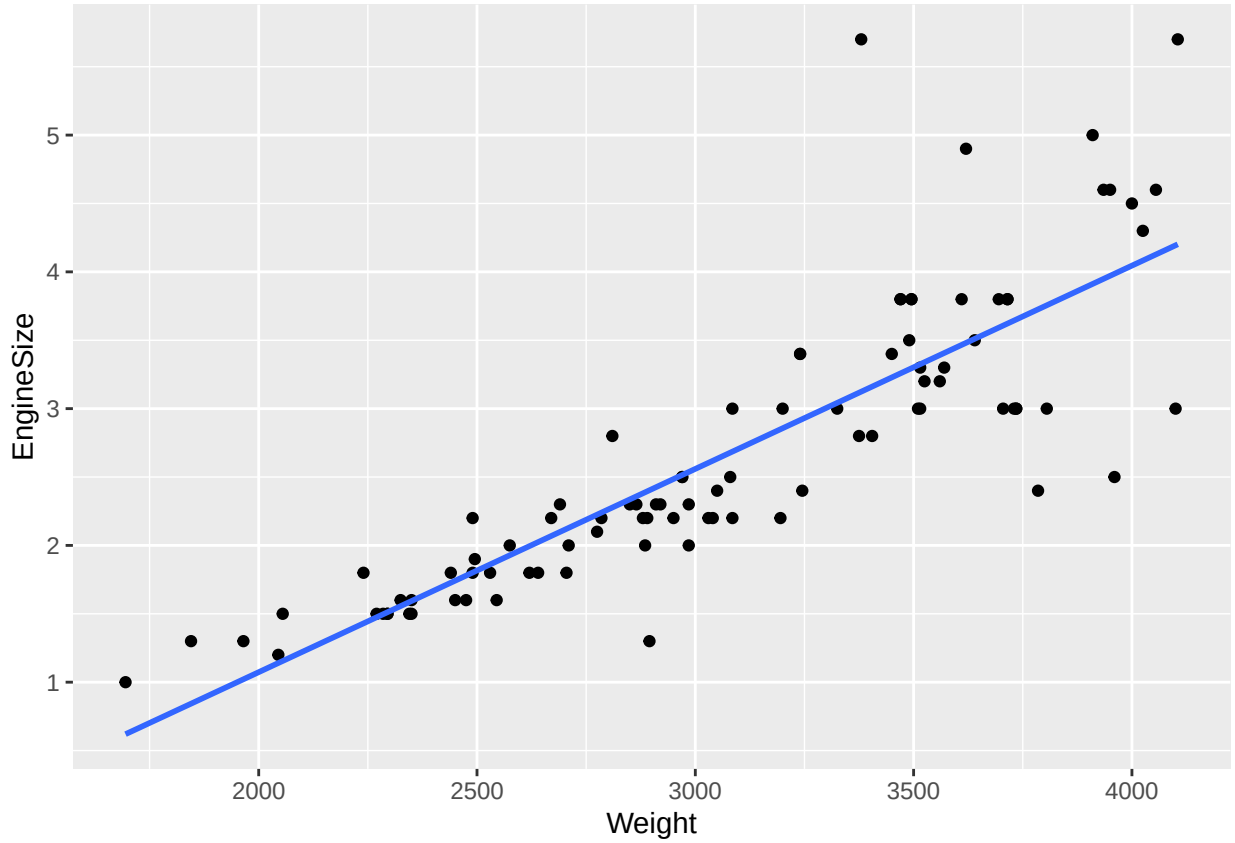



```
## [1] "Correlation between Fuel.tank.capacity and Weight : 0.894018054491314"
## [1] "x = Weight , y = MPG.city"

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

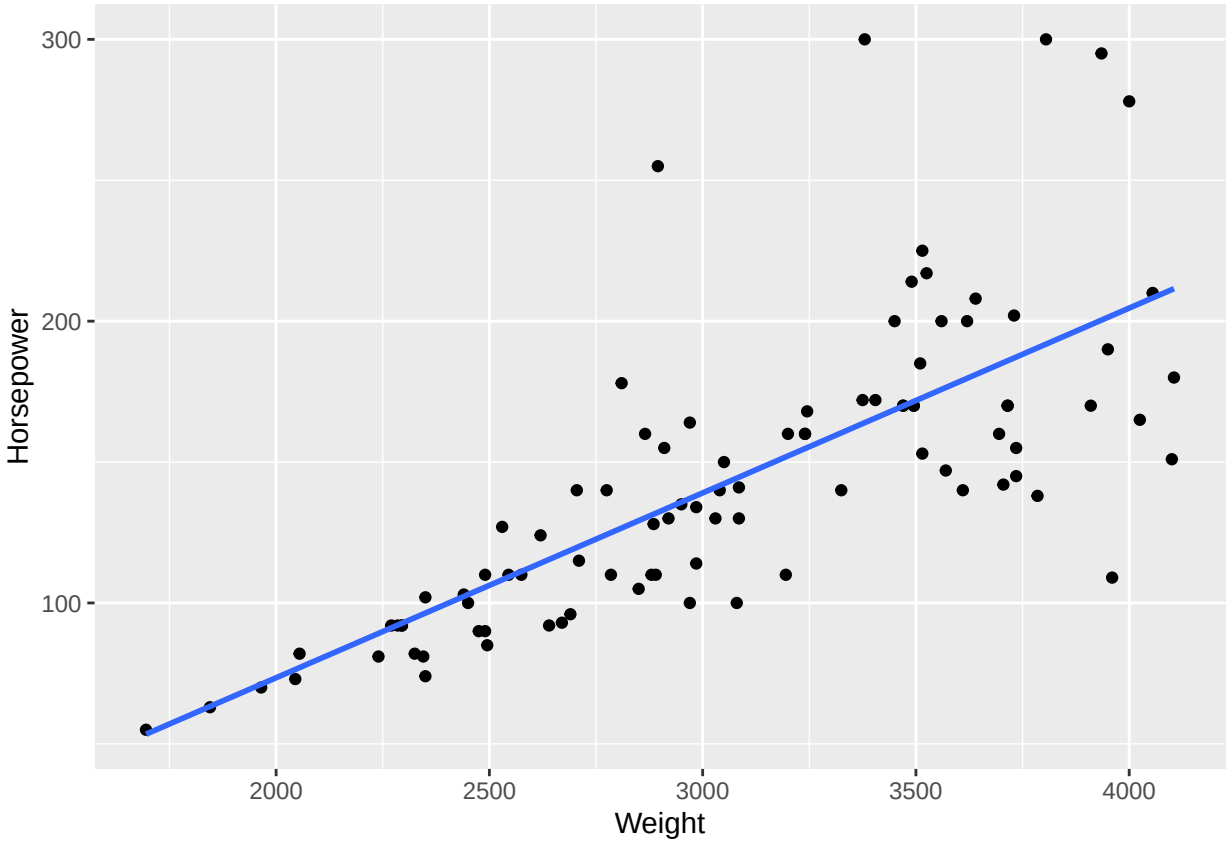



```
## [1] "Correlation between Weight and MPG.city : -0.84313854799682"
## [1] "x = Weight , y = EngineSize"
```

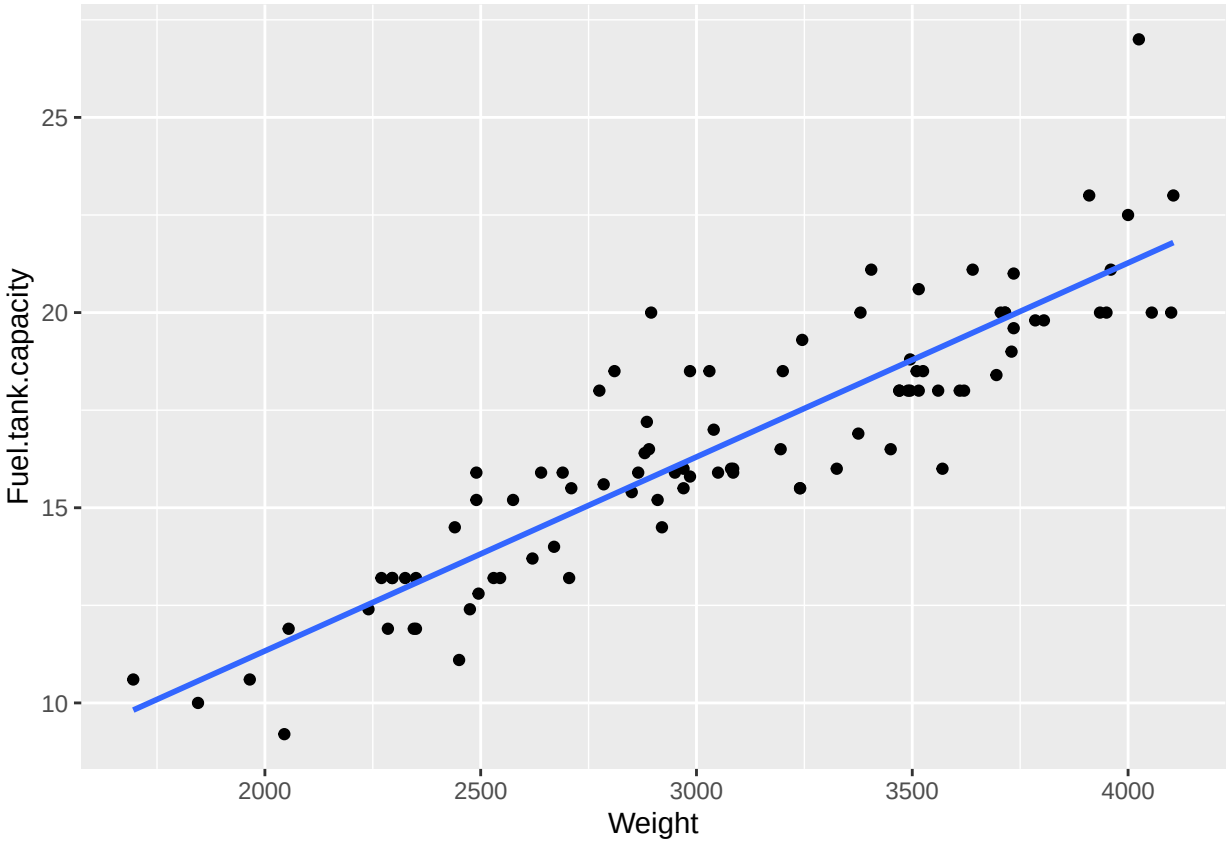
```
## `geom_smooth()` using formula = 'y ~ x'
```




```
## [1] "Correlation between Weight and EngineSize : 0.845075335037262"
## [1] "x = Weight , y = Horsepower"

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




```
## [1] "Correlation between Weight and Horsepower : 0.738797515540372"
## [1] "x = Weight , y = Fuel.tank.capacity"

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




```
## [1] "Correlation between Weight and Fuel.tank.capacity : 0.894018054491314"
```

Linear regression model using common columns: mpgcity+highway, horsepower, enginesize, weight

```
model_assign2 <- lm(price ~ citympg + highwaympg + curbweight + enginesize + horsepower, data = cars_ass
summary(model_assign2)
```

```
##
## Call:
## lm(formula = price ~ citympg + highwaympg + curbweight + enginesize +
##     horsepower, data = cars_assign)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8942.7 -1685.5   -35.5  1322.6 13679.1
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -15803.388   4053.921  -3.898 0.000132 ***
## citympg        -40.841    177.895  -0.230 0.818657
## highwaympg      75.944    167.738   0.453 0.651218
## curbweight       4.654      1.101   4.226 3.63e-05 ***
## enginesize      83.295     13.586   6.131 4.61e-09 ***
## horsepower      51.005     13.878   3.675 0.000305 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3486 on 199 degrees of freedom
## Multiple R-squared:  0.8142, Adjusted R-squared:  0.8095
## F-statistic: 174.4 on 5 and 199 DF,  p-value: < 2.2e-16
```

```
summary(model_assign2)
```

```
##
## Call:
## lm(formula = price ~ citympg + highwaympg + curbweight + enginesize +
##     horsepower, data = cars_assign)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8942.7 -1685.5   -35.5  1322.6 13679.1
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -15803.388   4053.921  -3.898 0.000132 ***
## citympg        -40.841    177.895  -0.230 0.818657
## highwaympg      75.944    167.738   0.453 0.651218
## curbweight       4.654      1.101   4.226 3.63e-05 ***
## enginesize      83.295     13.586   6.131 4.61e-09 ***
## horsepower      51.005     13.878   3.675 0.000305 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3486 on 199 degrees of freedom
## Multiple R-squared:  0.8142, Adjusted R-squared:  0.8095
## F-statistic: 174.4 on 5 and 199 DF,  p-value: < 2.2e-16
```

The main model

```
model_assign3 <- lm(price ~ curbweight + enginesize + horsepower, data = cars_assign)
summary(model_assign3)
```

```
##
## Call:
## lm(formula = price ~ curbweight + enginesize + horsepower, data = cars_assign)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -9003  -1701    -24   1340  13760
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.346e+04  1.333e+03 -10.100  < 2e-16 ***
## curbweight   4.263e+00  9.065e-01   4.702 4.78e-06 ***
## enginesize   8.488e+01  1.276e+01   6.651 2.69e-10 ***
## horsepower   4.875e+01  1.070e+01   4.557 8.99e-06 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3473 on 201 degrees of freedom
## Multiple R-squared:  0.8138, Adjusted R-squared:  0.811
## F-statistic: 292.9 on 3 and 201 DF,  p-value: < 2.2e-16
```

```
model_assign_all <- lm(price ~ wheelbase + carlength + carwidth + carheight + curbweight + enginesize +
summary(model_assign_all)
```

```
##
## Call:
## lm(formula = price ~ wheelbase + carlength + carwidth + carheight +
##     curbweight + enginesize + horsepower + peakrpm + citympg +
##     highwaympg, data = cars_assign)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8806.6 -1643.9  -146.4  1355.1 13900.7
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -6.787e+04  1.486e+04  -4.566 8.82e-06 ***
## wheelbase    4.487e+01  1.046e+02   0.429  0.66844
## carlength   -8.311e+01  5.812e+01  -1.430  0.15433
## carwidth     6.069e+02  2.567e+02   2.365  0.01904 *
## carheight    2.369e+02  1.413e+02   1.677  0.09524 .
## curbweight   3.916e+00  1.670e+00   2.345  0.02004 *
## enginesize   1.009e+02  1.413e+01   7.142 1.80e-11 ***
## horsepower   3.305e+01  1.658e+01   1.994  0.04756 *
## peakrpm      2.020e+00  6.713e-01   3.008  0.00297 **
## citympg     -1.202e+02  1.813e+02  -0.663  0.50822
## highwaympg   1.585e+02  1.672e+02   0.948  0.34449
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3364 on 194 degrees of freedom
## Multiple R-squared:  0.8314, Adjusted R-squared:  0.8227
## F-statistic: 95.68 on 10 and 194 DF,  p-value: < 2.2e-16
```

```
any(is.na(cars93))
```

```
## [1] TRUE
```

```
custom_model <- lm(price ~ enginesize, data = cars_assign)
summary(custom_model)
```

```
##
## Call:
## lm(formula = price ~ enginesize, data = cars_assign)
##
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -10664.2  -2225.0   -482.4   1588.0  14271.5
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -8005.446    873.221  -9.168   <2e-16 ***
## enginesize    167.698      6.539  25.645   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3889 on 203 degrees of freedom
## Multiple R-squared:  0.7641, Adjusted R-squared:  0.763
## F-statistic: 657.6 on 1 and 203 DF,  p-value: < 2.2e-16
```

Data Cleaning: Clean Cars93.csv, use it to validate model.

```
price_prediction_assign <- model_assign3
```

Get the columns needed to validate from cars 93, three needed columns

```
cars93_clean <- cars93[, c("Weight", "EngineSize", "Horsepower")]
```

Convert EngineSize to cubic centiliters

```
cars93_clean$EngineSize <- cars93_clean$EngineSize * 100
```

Change the column names to reflect that of cars_assign

```
colnames(cars93_clean) <- c("curbweight", "enginesize", "horsepower")
```

Check for null rows

```
anyNA(cars93_clean)
```

```
## [1] FALSE
```

Check cars 93 for NA. Should be True

```
anyNA(cars93)
```

```
## [1] TRUE
```

Predict for first row

```
first_row = cars93_clean[1, ]
```

```
predicted_price <- predict(price_prediction_assign, first_row)
print(predicted_price)
```

```
##        1
## 20169.36
```

Predict for all in cars93

```
predicted_prices_assign <- predict(price_prediction_assign, cars93_clean)
print(predicted_prices_assign[1:10])
```

```
##        1        2        3        4        5        6        7        8
## 20169.36 38621.83 33073.15 33201.02 41899.20 22848.08 41868.56 61189.88
##        9       10
## 41975.12 53307.12
```

Calculate Error of cars_assign prediction model, comparing the cars93$Max.Price

```
# First multiply cars 93 prices by 1000
cars93_prices = cars93$Max.Price * 1000

mse_assign = mean((cars93_prices - predicted_prices_assign)^2)
rmse_assign = sqrt(mse_assign)
mae_assign = mean(abs(cars93_prices - predicted_prices_assign))


print(paste("Mean Squared Error =", mse_assign
            , ", Root Mean Squared Error =", rmse_assign
            , ", Mean Absolute Error =", mae_assign))
```

```
## [1] "Mean Squared Error = 165852816.56787 , Root Mean Squared Error = 12878.385635159 , Mean Absolut
```

Values seem large: Check differences.

```
abs(cars93_prices - predicted_prices_assign)[1:10]
```

```
##           1           2           3           4           5           6
##  1369.36297    78.17167   773.14781 11398.97564  5699.19943  5548.07689
##           7           8           9          10
## 20168.55870 36289.88123 15675.12248 17007.11853
```

```
# Some differences are really low... but some are pretty high :(
```

Get percentage of standard errors and predicted_prices_assign

```
mean_predicted_price <- mean(predicted_prices_assign)
print(mean_predicted_price)
```

```
## [1] 29289.53
```

```
print(rmse_assign / mean_predicted_price)
```

```
## [1] 0.4396924
```

```
print(mae_assign / mean_predicted_price)
```

```
## [1] 0.3236962
```

Make a model with cars 93 using the same variables

```r
cars93_1000 = read.csv("Cars93.csv")
cars93_1000$Max.Price = cars93_1000$Max.Price * 1000
price_model93 <- lm(Max.Price ~ Weight + EngineSize + Horsepower, data = cars93_1000)
summary(price_model93)
```

```
##
## Call:
## lm(formula = Max.Price ~ Weight + EngineSize + Horsepower, data = cars93_1000)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -14421  -3471   -514   1658  46325
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -8032.427   4868.375  -1.650   0.1025
## Weight          4.529      2.577   1.758   0.0822 .
## EngineSize  -1917.945   1449.811  -1.323   0.1893
## Horsepower    146.908     22.781   6.449 5.69e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7360 on 89 degrees of freedom
## Multiple R-squared:  0.5694, Adjusted R-squared:  0.5548
## F-statistic: 39.22 on 3 and 89 DF,  p-value: 3.017e-16
```

Test the model on cars_assign

```r
# Get necessary columns
cars_assign_clean = cars_assign[, c("curbweight", "enginesize", "horsepower")]

# Rename columns to fit model
colnames(cars_assign_clean) <- c("Weight", "EngineSize", "Horsepower")


predicted_prices93 = predict(price_model93, cars_assign_clean)
predicted_prices93[1:10]
```

```
##         1         2         3         4         5         6         7         8
## -229517.6 -229517.6 -264149.8 -191518.6 -239187.5 -241357.9 -239831.5 -239333.2
##         9        10
## -224738.4 -221949.7
```

Turns out that cars 93 model is really bad. We can manage cars_assign model.

Conclusion and Insights: The project successfully demonstrated the process of predicting car prices using linear regression model on two distinct datasets. By exploring various predictors, such as engine size, horsepower, and weight, we identified key factors influencing car prices. The analysis revealed: **Strong predictors:** Variables like horsepower and curb weight consistently showed a significant impact on car prices across both datasets. **Model performance:** Both models achieved reasonable accuracy, with R-squared values indicating a good fit. However, there is room for improvement in capturing price variability. **Dataset differences:** The comparison between the Cars93 and CarPrice_Assignment datasets highlighted differences in market segments and vehicle specifications. These findings provide valuable insights into how

car features affect pricing, which could benefit both consumers and manufacturers. Future work could explore more advanced models or incorporate additional data to improve predictive power and better account for market dynamics.