Imports

```
source("preprocess.R")
```

Load Data and Format

```
# Load data
data <- read.csv("car details v4.csv")
nrow(data)
```

```
## [1] 2059
```

```
df <- data
df <- remove_null(df)
df <- df[!duplicated(df), ]
nrow(df)
```

```
## [1] 1874
```

```
# Drop unwanted columns
df <- remove_cols(df, c("Model"))

# Remove the " cc" suffix from Engine
df$Engine <- as.numeric(gsub("[^0-9]", "", df$Engine)) # Convert to numbers, ex. "123 cc" -> 123

# Split max torque and the RPM at which max torque occurs
df <- tidyr::separate(df, Max.Torque, into = c("Max.Torque.Value", "Max.Torque.RPM"), sep = "@")
df$Max.Torque.Value <- as.numeric(gsub("[^0-9]", "", df$Max.Torque.Value))
df$Max.Torque.RPM <- as.numeric(gsub("[^0-9]", "", df$Max.Torque.RPM))

# Include RPM and torque interaction
df$Torque.RPM <- df$Max.Torque.Value * df$Max.Torque.RPM

# Split the max horsepower and the RPM at which max horsepower occurs
df <- tidyr::separate(df, Max.Power, into = c("Max.Power.Value", "Max.Power.RPM"), sep = "@")
df$Max.Power.Value <- as.numeric(gsub("[^0-9]", "", df$Max.Power.Value))
df$Max.Power.RPM <- as.numeric(gsub("[^0-9]", "", df$Max.Power.RPM))

colnames(df)
```

```
##  [1] "Make"               "Price"              "Year"
##  [4] "Kilometer"          "Fuel.Type"          "Transmission"
##  [7] "Location"           "Color"              "Owner"
## [10] "Seller.Type"        "Engine"             "Max.Power.Value"
## [13] "Max.Power.RPM"      "Max.Torque.Value"   "Max.Torque.RPM"
## [16] "Drivetrain"         "Length"             "Width"
## [19] "Height"             "Seating.Capacity"   "Fuel.Tank.Capacity"
## [22] "Torque.RPM"
```

```
# remove nulls again in case the power and torque columns are malformed
df <- remove_null(df)

# Include power and RPM interaction
df$Power.RPM <- df$Max.Power.Value * df$Max.Power.RPM

# Numerical and categorical regressors
```

```r
# Note that Seating.Capacity was omitted to exempt it from 1.5 IQR
numerical <- c(
  "Price", "Year", "Kilometer", "Engine",
  "Max.Power.Value", "Max.Power.RPM", "Max.Torque.Value", "Max.Torque.RPM",
  "Length", "Width", "Height", "Fuel.Tank.Capacity",
  "Torque.RPM", "Power.RPM"
)
categorical <- c(
  "Make", "Fuel.Type", "Transmission", "Location", "Color",
  "Owner", "Seller.Type", "Drivetrain"
)

# Outliers for numerical regressors
df <- remove_outliers(df, numerical)
nrow(df)
```

```
## [1] 1434
```

```r
# Convert categorical data to factors
res <- convert_categorical(df, categorical)
design <- as.data.frame(res$dummy)
ncol(design)
```

```
## [1] 138
```

```r
# Remove columns with only one observation and affected rows
singles <- c()
bad_idx <- c()
for (col in colnames(design)) {
  if (sum(design[, col] != 0) <= 1) {
    singles <- c(singles, col)
    bad_idx <- c(bad_idx, which(design[, col] != 0))
  }
}
singles
```

```
##  [1] "MakeFiat"              "MakeLexus"             "Fuel.TypePetrol + CNG"
##  [4] "LocationDak. Kannada"  "LocationFaizabad"      "LocationGorakhpur"
##  [7] "LocationMirzapur"      "LocationPurnea"        "LocationRohtak"
## [10] "LocationRudrapur"      "LocationSamastipur"    "LocationValsad"
```

```r
bad_idx
```

```
##  [1]  654  996 1153 1063  770  563  765  719  242  505  261  159
```

```r
design <- remove_cols(design, singles)
design <- design[-bad_idx, ]

nrow(design)
```

```
## [1] 1422
```

```r
ncol(design)
```

```
## [1] 126
```

Multicollinearity

```
x <- design
model <- lm(log(Price) ~., data = x)
removed <- c()

finished <- F
while(!finished) {
  temp <- car::vif(model)
  worst <- names(which.max(temp))
  if (temp[worst] > 5) {
    x <- remove_cols(x, c(gsub("^`|`$", "", worst)))
    model <- lm(log(Price) ~., data = x)

    removed <- c(removed, worst)
  } else {
    finished <- T
  }
}

removed
```

```
##  [1] "Max.Power.Value"       "ColorWhite"            "Max.Torque.RPM"
##  [4] "Max.Power.RPM"         "Fuel.TypeDiesel"       "Max.Torque.Value"
##  [7] "LocationMumbai"        "Seller.TypeIndividual" "Engine"
## [10] "`MakeMaruti Suzuki`"   "Length"                "Fuel.Tank.Capacity"
```

Leverage Points

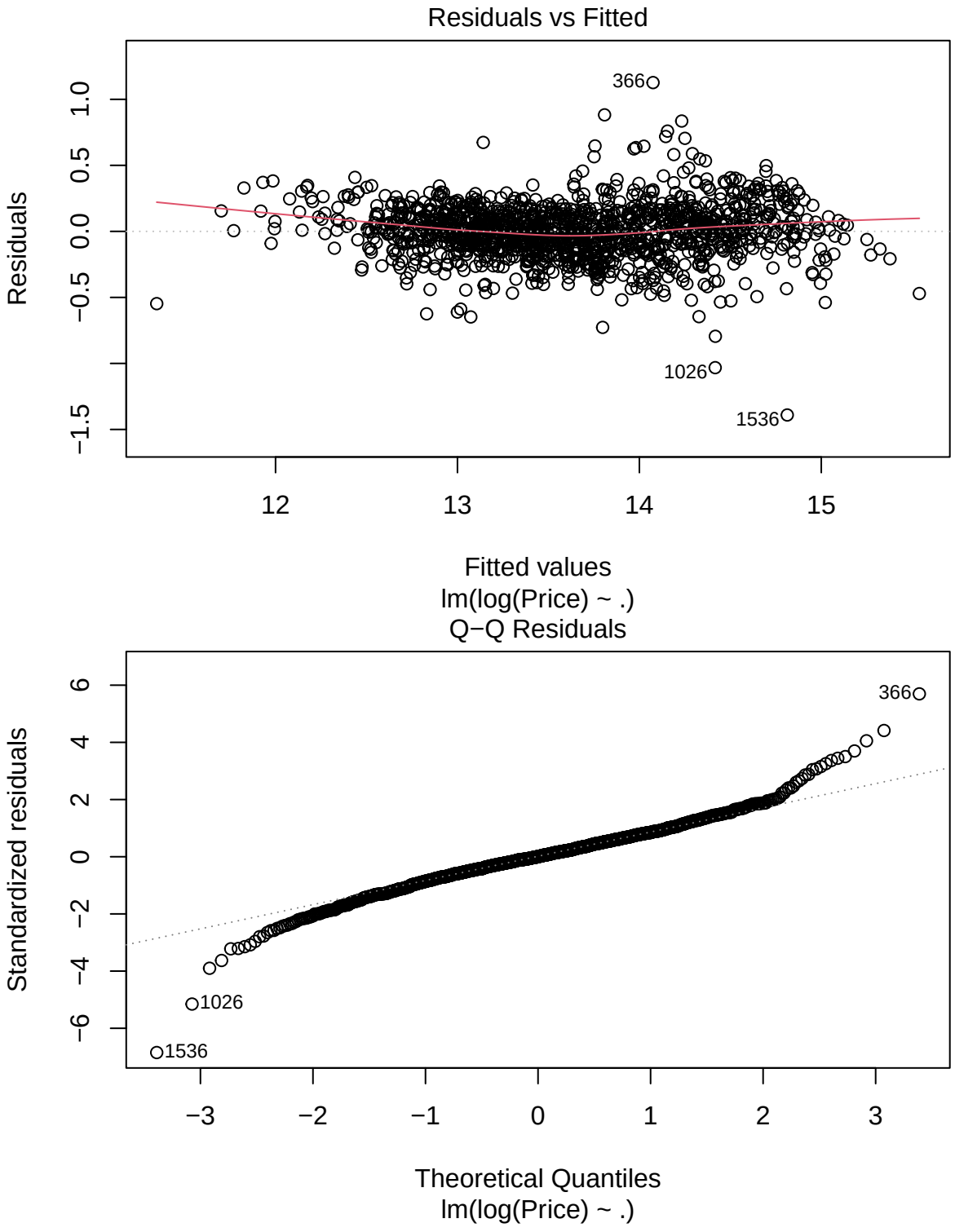
```
which(abs(rstudent(model)) > 4)
```

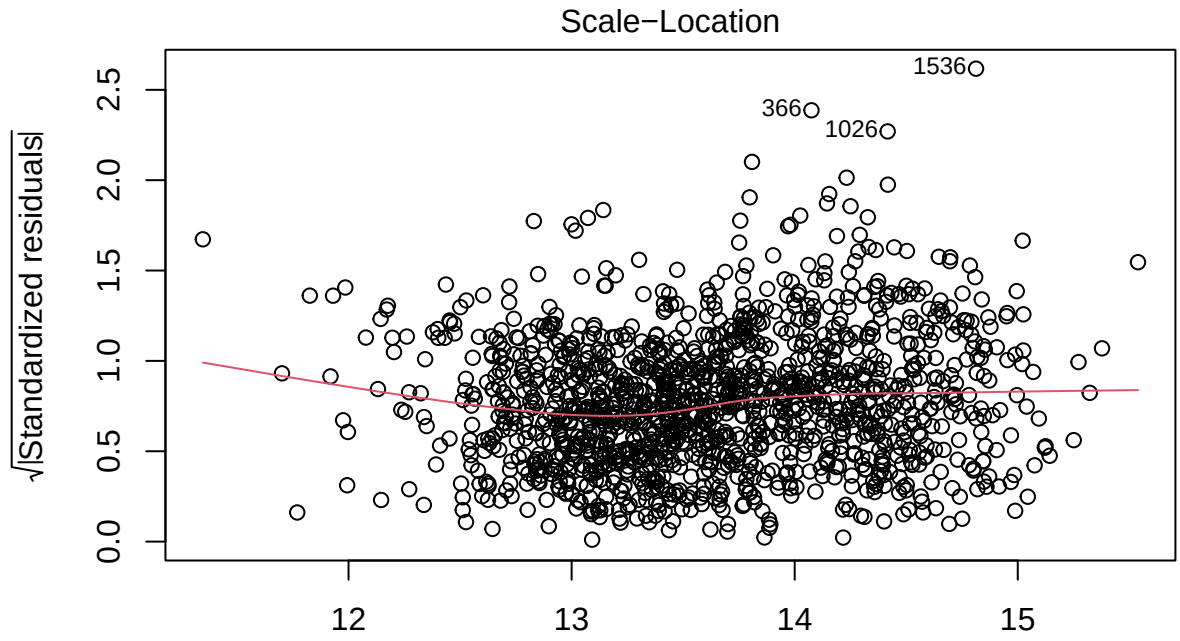
```
##   44  366  610 1026 1536
##   39  265  426  712 1056
```

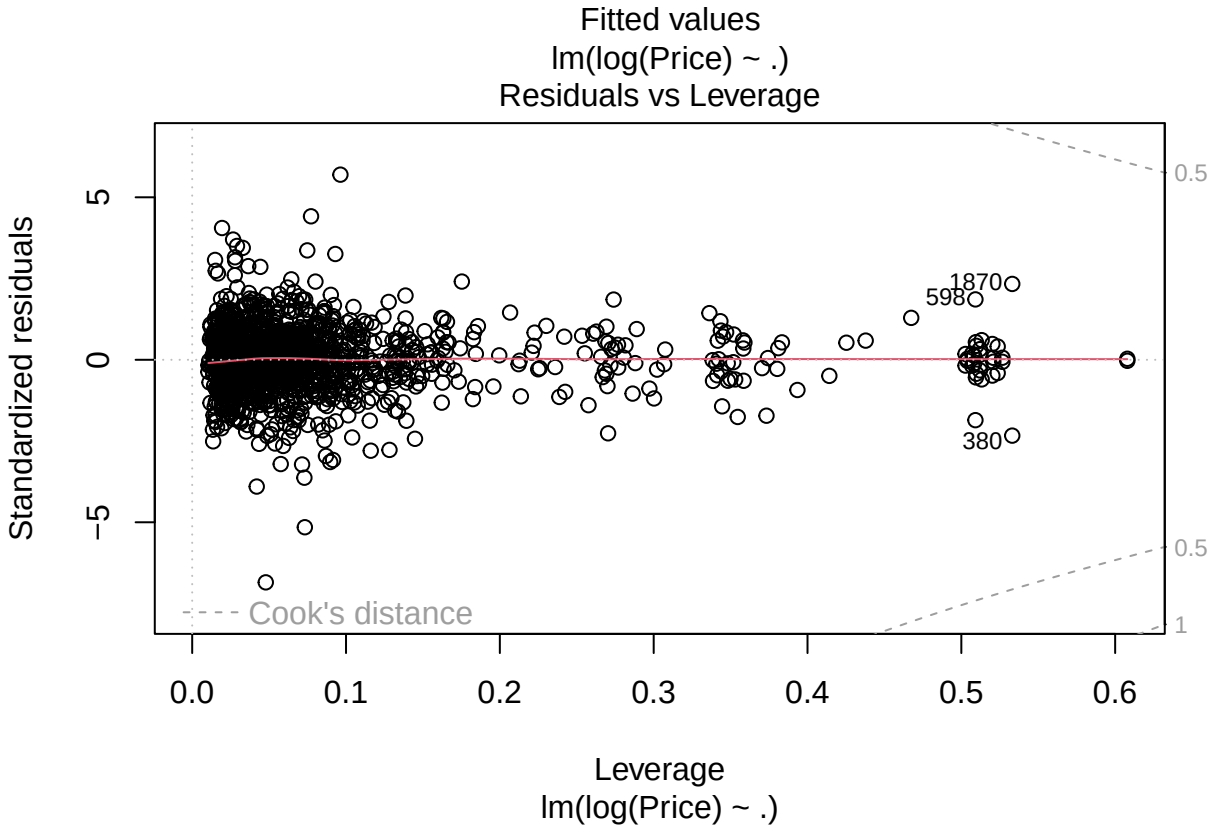
```
# all of these points were manually inspected, and were not suspected to be clerical errors.
```

Diagnostics

```
plot(model)
```


Residuals vs Fitted
Residuals
366
1026
1536
1.0
0.5
0.0
−0.5
−1.5
12
13
14
15
Fitted values
lm(log(Price) ~ .)
Q−Q Residuals
Standardized residuals
366
1026
1536
6
4
2
0
−2
−4
−6
−3
−2
−1
0
1
2
3
Theoretical Quantiles
lm(log(Price) ~ .)






```
summary(model)
```

```
##
## Call:
## lm(formula = log(Price) ~ ., data = x)
##
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -1.39045 -0.10899  0.00104  0.11573  1.12668
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)              -1.918e+02  5.543e+00 -34.603  < 2e-16 ***
## MakeBMW                   1.250e-01  4.830e-02   2.588 0.009760 **
## MakeChevrolet            -3.156e-01  1.064e-01  -2.966 0.003070 **
## MakeDatsun               -3.711e-01  7.722e-02  -4.806 1.72e-06 ***
## MakeFord                 -1.870e-01  3.726e-02  -5.017 5.96e-07 ***
## MakeHonda                -7.359e-02  2.305e-02  -3.193 0.001442 **
## MakeHyundai              -7.965e-02  1.706e-02  -4.670 3.32e-06 ***
## MakeIsuzu                -1.894e-02  1.543e-01  -0.123 0.902303
## MakeJaguar               -1.504e-02  1.294e-01  -0.116 0.907468
## MakeJeep                 -5.365e-02  5.786e-02  -0.927 0.353997
## MakeKia                  -5.703e-02  4.777e-02  -1.194 0.232764
## `MakeLand Rover`          4.689e-01  1.525e-01   3.076 0.002144 **
## MakeMahindra             -2.820e-01  3.357e-02  -8.401  < 2e-16 ***
## `MakeMercedes-Benz`       4.437e-01  3.884e-02  11.424  < 2e-16 ***
## MakeMG                   -4.836e-02  6.330e-02  -0.764 0.445001
## MakeMINI                  8.575e-01  9.425e-02   9.099  < 2e-16 ***
## MakeMitsubishi           -3.443e-02  1.358e-01  -0.253 0.799942
## MakeNissan               -1.973e-01  5.793e-02  -3.406 0.000680 ***
## MakeRenault              -2.086e-01  3.627e-02  -5.752 1.09e-08 ***
## MakeSkoda                 1.371e-02  3.925e-02   0.349 0.726908
## MakeTata                 -3.098e-01  3.599e-02  -8.606  < 2e-16 ***
## MakeToyota                1.807e-01  2.902e-02   6.225 6.46e-10 ***
## MakeVolkswagen            4.132e-02  3.631e-02   1.138 0.255320
## MakeVolvo                 2.774e-01  6.614e-02   4.194 2.93e-05 ***
## Year                      1.000e-01  2.769e-03  36.117  < 2e-16 ***
## Kilometer                -2.047e-06  2.929e-07  -6.988 4.44e-12 ***
## Fuel.TypePetrol          -4.260e-01  1.870e-02 -22.781  < 2e-16 ***
## TransmissionManual       -2.075e-01  1.507e-02 -13.770  < 2e-16 ***
## LocationAhmedabad        -8.261e-03  3.286e-02  -0.251 0.801561
## LocationAllahabad        -2.148e-01  1.217e-01  -1.765 0.077786 .
## `LocationAmbala Cantt`   -2.767e-01  6.958e-02  -3.976 7.40e-05 ***
## LocationAmritsar         -2.675e-03  1.077e-01  -0.025 0.980188
## LocationAurangabad        2.100e-01  1.221e-01   1.720 0.085686 .
## LocationBangalore         1.480e-01  2.550e-02   5.804 8.13e-09 ***
## LocationBhopal           -1.442e-02  1.225e-01  -0.118 0.906344
## LocationBhubaneswar      -3.519e-02  1.275e-01  -0.276 0.782525
## LocationBulandshahar     -3.404e-01  1.521e-01  -2.238 0.025399 *
## LocationChandigarh        3.165e-02  5.737e-02   0.552 0.581233
## LocationChennai           1.786e-01  3.788e-02   4.716 2.67e-06 ***
## LocationCoimbatore        2.046e-01  5.222e-02   3.918 9.40e-05 ***
## LocationDehradun          4.099e-02  5.110e-02   0.802 0.422598
## LocationDelhi            -2.179e-02  1.991e-02  -1.094 0.273962
## LocationDharwad           2.544e-02  1.487e-01   0.171 0.864154
## LocationErnakulam         1.505e-01  1.491e-01   1.009 0.313137
## LocationFaridabad        -9.745e-02  4.748e-02  -2.052 0.040337 *
## LocationGhaziabad         6.304e-02  1.533e-01   0.411 0.680959
## LocationGoa               5.127e-01  1.072e-01   4.782 1.93e-06 ***
## LocationGurgaon          -1.652e-02  4.702e-02  -0.351 0.725427
## LocationGuwahati          5.416e-02  9.683e-02   0.559 0.576013
```

```
## LocationHaldwani        -1.613e-01  1.490e-01  -1.083 0.279191
## LocationHyderabad        1.040e-01  2.783e-02   3.737 0.000195 ***
## LocationIndore           1.803e-01  1.063e-01   1.695 0.090289 .
## LocationJaipur           6.025e-02  4.579e-02   1.316 0.188470
## LocationJalandhar        4.853e-02  5.196e-02   0.934 0.350452
## LocationJamshedpur       4.408e-02  9.649e-02   0.457 0.647895
## LocationKanpur          -9.718e-02  4.008e-02  -2.425 0.015458 *
## LocationKarnal           9.823e-02  7.616e-02   1.290 0.197352
## LocationKharar          -6.913e-02  1.485e-01  -0.465 0.641698
## LocationKheda           -8.693e-02  1.490e-01  -0.583 0.559765
## LocationKolkata         -1.576e-01  3.201e-02  -4.925 9.52e-07 ***
## LocationKollam           1.506e-01  1.493e-01   1.008 0.313551
## LocationKota             1.424e-01  1.635e-01   0.871 0.383969
## LocationLucknow          1.570e-03  3.370e-02   0.047 0.962851
## LocationLudhiana        -3.600e-02  4.023e-02  -0.895 0.371021
## LocationMangalore       -5.101e-02  1.062e-01  -0.480 0.631089
## LocationMeerut           1.963e-02  7.578e-02   0.259 0.795665
## LocationMohali           5.729e-02  4.724e-02   1.213 0.225407
## LocationMuzaffurpur     -7.812e-02  1.491e-01  -0.524 0.600437
## LocationMysore           3.033e-01  8.210e-02   3.694 0.000230 ***
## LocationNagpur           1.528e-01  1.222e-01   1.250 0.211614
## LocationNashik           5.282e-02  8.081e-02   0.654 0.513441
## `LocationNavi Mumbai`    1.797e-02  6.003e-02   0.299 0.764759
## LocationNoida            4.097e-02  6.010e-02   0.682 0.495557
## LocationPanchkula       -7.015e-02  1.214e-01  -0.578 0.563431
## LocationPatna            1.440e-02  4.005e-02   0.360 0.719213
## LocationPune             7.107e-02  2.590e-02   2.744 0.006155 **
## LocationRaipur           6.231e-02  5.449e-02   1.143 0.253071
## LocationRanchi          -8.400e-02  5.459e-02  -1.539 0.124100
## `LocationRanga Reddy`   -1.628e-01  1.499e-01  -1.086 0.277577
## LocationRoorkee          1.123e-01  1.237e-01   0.907 0.364479
## LocationSalem            3.265e-01  1.502e-01   2.174 0.029904 *
## LocationSurat            3.894e-03  1.069e-01   0.036 0.970938
## LocationThane            1.182e-02  5.749e-02   0.206 0.837177
## LocationUdupi            1.007e-01  7.543e-02   1.335 0.182226
## LocationVadodara        -1.895e-01  1.218e-01  -1.556 0.119912
## LocationVaranasi        -1.597e-01  5.471e-02  -2.918 0.003581 **
## LocationWarangal        -2.123e-01  1.498e-01  -1.417 0.156649
## LocationYamunanagar     -2.660e-02  1.236e-01  -0.215 0.829635
## LocationZirakpur        -7.028e-02  5.744e-02  -1.224 0.221357
## ColorBlack              -1.737e-02  2.454e-02  -0.708 0.479223
## ColorBlue               -2.190e-02  2.306e-02  -0.950 0.342485
## ColorBronze             -4.483e-02  4.662e-02  -0.962 0.336465
## ColorBrown               2.604e-04  2.863e-02   0.009 0.992745
## ColorGold               -1.939e-02  4.761e-02  -0.407 0.683929
## ColorGreen              -5.648e-02  6.952e-02  -0.812 0.416687
## ColorGrey               -8.916e-03  1.920e-02  -0.464 0.642504
## ColorMaroon             -7.699e-02  4.646e-02  -1.657 0.097728 .
## ColorOrange              2.686e-02  5.866e-02   0.458 0.647088
## ColorOthers             -3.179e-02  6.603e-02  -0.481 0.630335
## ColorPurple             -5.198e-02  1.487e-01  -0.349 0.726794
## ColorRed                -1.298e-02  2.247e-02  -0.578 0.563413
## ColorSilver             -4.214e-02  1.773e-02  -2.377 0.017613 *
## ColorYellow             -4.104e-02  1.271e-01  -0.323 0.746793
```

```
## OwnerSecond             -2.712e-02  1.656e-02  -1.638 0.101685
## OwnerThird              -4.831e-02  5.886e-02  -0.821 0.411950
## `OwnerUnRegistered Car`  7.793e-02  1.117e-01   0.698 0.485480
## Seller.TypeCorporate    -9.918e-03  3.810e-02  -0.260 0.794666
## DrivetrainFWD           -2.307e-01  2.926e-02  -7.885 6.58e-15 ***
## DrivetrainRWD           -1.525e-01  3.416e-02  -4.465 8.69e-06 ***
## Width                    2.148e-03  1.120e-04  19.180  < 2e-16 ***
## Height                  -1.709e-04  9.080e-05  -1.882 0.060067 .
## Seating.Capacity         5.839e-02  1.268e-02   4.606 4.50e-06 ***
## Torque.RPM              -8.338e-08  5.825e-08  -1.431 0.152527
## Power.RPM                1.297e-06  6.875e-08  18.860  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2081 on 1308 degrees of freedom
## Multiple R-squared:  0.9172, Adjusted R-squared:  0.9101
## F-statistic: 128.3 on 113 and 1308 DF,  p-value: < 2.2e-16
```

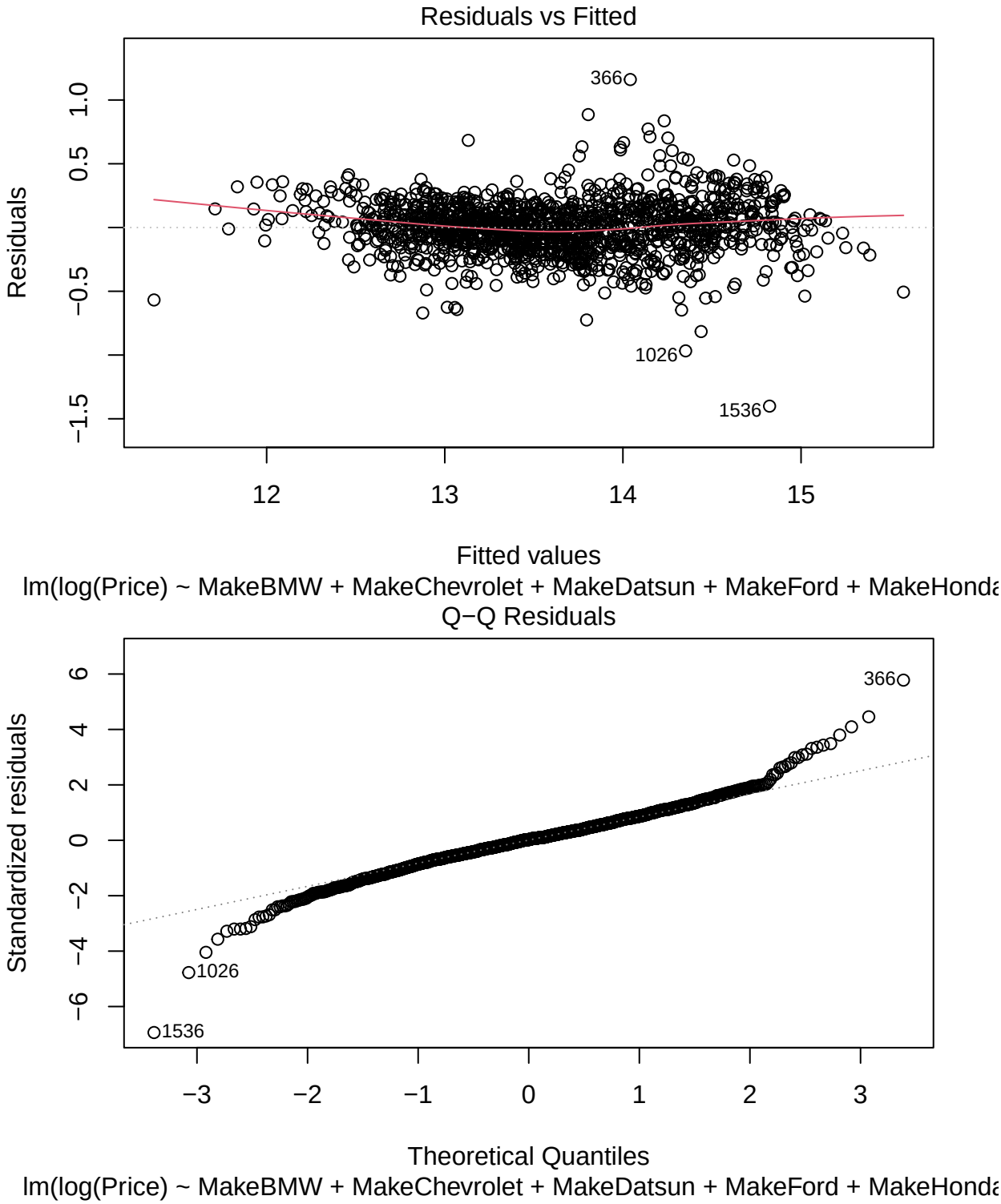
Model Reduction

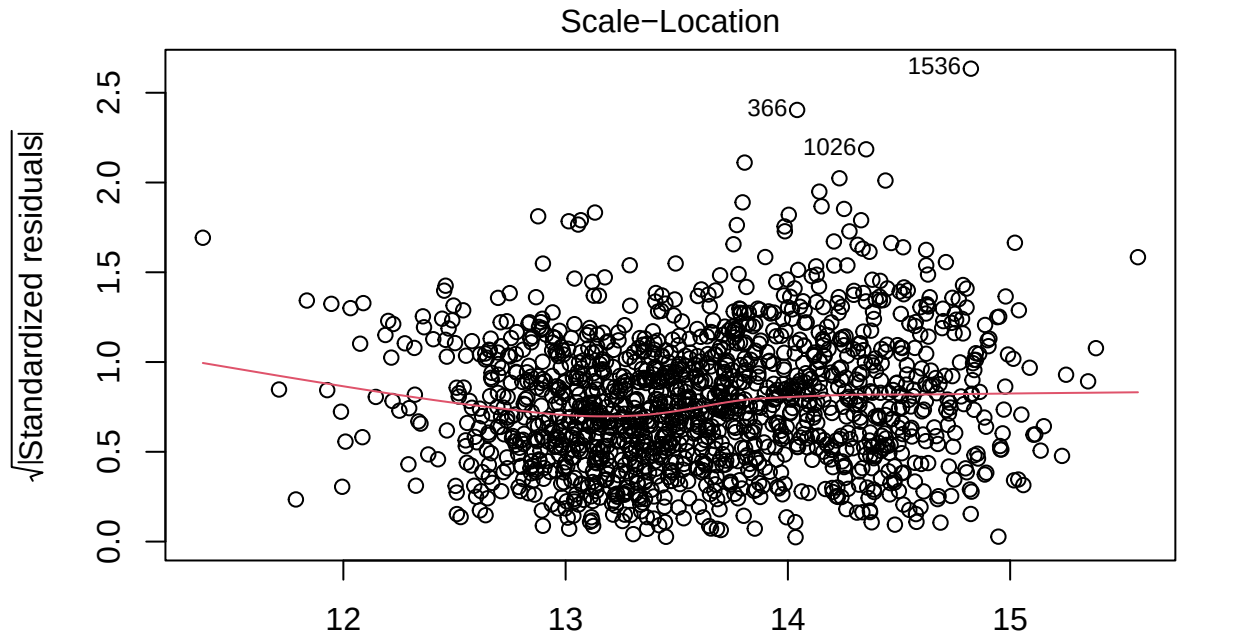
```
reduced_model <- step(model, direction = "backward", data = x, trace = 0)
old <- names(model$coefficients)
new <- names(reduced_model$coefficients)

old[!(old %in% new)]
```

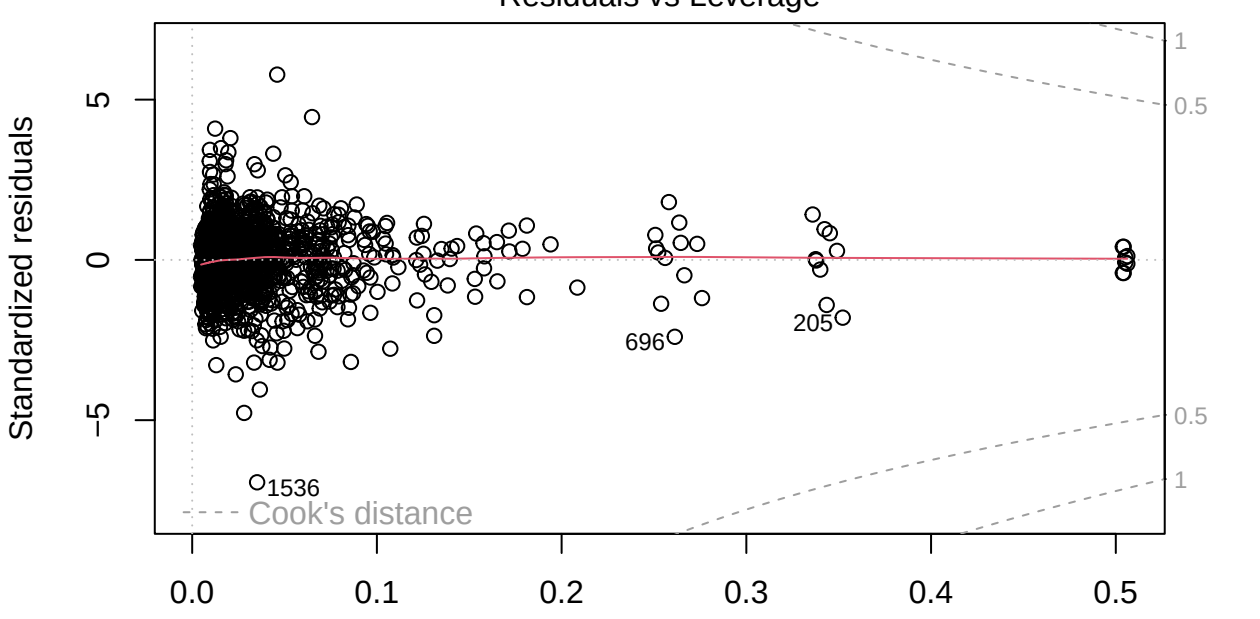
```
##   [1] "MakeIsuzu"               "MakeJaguar"
##   [3] "MakeJeep"                "MakeKia"
##   [5] "MakeMG"                  "MakeMitsubishi"
##   [7] "MakeSkoda"               "MakeVolkswagen"
##   [9] "LocationAhmedabad"       "LocationAmritsar"
##  [11] "LocationBhopal"          "LocationBhubaneswar"
##  [13] "LocationChandigarh"      "LocationDehradun"
##  [15] "LocationDharwad"         "LocationErnakulam"
##  [17] "LocationGhaziabad"       "LocationGurgaon"
##  [19] "LocationGuwahati"        "LocationHaldwani"
##  [21] "LocationJaipur"          "LocationJalandhar"
##  [23] "LocationJamshedpur"      "LocationKarnal"
##  [25] "LocationKharar"          "LocationKheda"
##  [27] "LocationKollam"          "LocationKota"
##  [29] "LocationLucknow"         "LocationMangalore"
##  [31] "LocationMeerut"          "LocationMohali"
##  [33] "LocationMuzaffurpur"     "LocationNagpur"
##  [35] "LocationNashik"          "`LocationNavi Mumbai`"
##  [37] "LocationNoida"           "LocationPanchkula"
##  [39] "LocationPatna"           "LocationRaipur"
##  [41] "`LocationRanga Reddy`"   "LocationRoorkee"
##  [43] "LocationSurat"           "LocationThane"
##  [45] "LocationUdupi"           "LocationYamunanagar"
##  [47] "ColorBlack"              "ColorBlue"
##  [49] "ColorBronze"             "ColorBrown"
##  [51] "ColorGold"               "ColorGreen"
##  [53] "ColorGrey"               "ColorOrange"
##  [55] "ColorOthers"             "ColorPurple"
```

```
## [57] "ColorRed"                 "ColorYellow"
## [59] "OwnerSecond"              "OwnerThird"
## [61] "`OwnerUnRegistered Car`" "Seller.TypeCorporate"
```

```
plot(reduced_model)
```








```
summary(reduced_model)
```

```
##
## Call:
## lm(formula = log(Price) ~ MakeBMW + MakeChevrolet + MakeDatsun +
##     MakeFord + MakeHonda + MakeHyundai + `MakeLand Rover` + MakeMahindra +
##     `MakeMercedes-Benz` + MakeMINI + MakeNissan + MakeRenault +
```

```
##     MakeTata + MakeToyota + MakeVolvo + Year + Kilometer + Fuel.TypePetrol +
##     TransmissionManual + LocationAllahabad + `LocationAmbala Cantt` +
##     LocationAurangabad + LocationBangalore + LocationBulandshahar +
##     LocationChennai + LocationCoimbatore + LocationDelhi + LocationFaridabad +
##     LocationGoa + LocationHyderabad + LocationIndore + LocationKanpur +
##     LocationKolkata + LocationLudhiana + LocationMysore + LocationPune +
##     LocationRanchi + LocationSalem + LocationVadodara + LocationVaranasi +
##     LocationWarangal + LocationZirakpur + ColorMaroon + ColorSilver +
##     DrivetrainFWD + DrivetrainRWD + Width + Height + Seating.Capacity +
##     Torque.RPM + Power.RPM, data = x)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.40073 -0.11213  0.00538  0.11549  1.16036
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)            -1.933e+02  5.133e+00 -37.656  < 2e-16 ***
## MakeBMW                 1.132e-01  4.562e-02   2.482 0.013187 *
## MakeChevrolet          -3.115e-01  1.041e-01  -2.992 0.002819 **
## MakeDatsun             -3.838e-01  7.499e-02  -5.118 3.52e-07 ***
## MakeFord               -1.771e-01  3.556e-02  -4.979 7.21e-07 ***
## MakeHonda              -7.556e-02  2.126e-02  -3.554 0.000392 ***
## MakeHyundai            -7.756e-02  1.537e-02  -5.046 5.13e-07 ***
## `MakeLand Rover`        4.537e-01  1.487e-01   3.051 0.002324 **
## MakeMahindra           -2.798e-01  3.095e-02  -9.040  < 2e-16 ***
## `MakeMercedes-Benz`     4.282e-01  3.620e-02  11.829  < 2e-16 ***
## MakeMINI                8.278e-01  8.661e-02   9.557  < 2e-16 ***
## MakeNissan             -2.085e-01  5.592e-02  -3.728 0.000200 ***
## MakeRenault            -2.088e-01  3.420e-02  -6.106 1.32e-09 ***
## MakeTata               -3.115e-01  3.385e-02  -9.200  < 2e-16 ***
## MakeToyota              1.782e-01  2.669e-02   6.674 3.60e-11 ***
## MakeVolvo               2.771e-01  6.414e-02   4.320 1.67e-05 ***
## Year                    1.008e-01  2.566e-03  39.268  < 2e-16 ***
## Kilometer              -1.954e-06  2.761e-07  -7.078 2.33e-12 ***
## Fuel.TypePetrol        -4.239e-01  1.781e-02 -23.805  < 2e-16 ***
## TransmissionManual     -2.025e-01  1.436e-02 -14.103  < 2e-16 ***
## LocationAllahabad      -2.166e-01  1.193e-01  -1.816 0.069649 .
## `LocationAmbala Cantt` -3.052e-01  6.672e-02  -4.574 5.22e-06 ***
## LocationAurangabad      1.905e-01  1.198e-01   1.591 0.111891
## LocationBangalore       1.350e-01  2.258e-02   5.980 2.85e-09 ***
## LocationBulandshahar   -3.981e-01  1.467e-01  -2.714 0.006736 **
## LocationChennai         1.670e-01  3.574e-02   4.671 3.29e-06 ***
## LocationCoimbatore      1.868e-01  4.948e-02   3.775 0.000167 ***
## LocationDelhi          -3.239e-02  1.689e-02  -1.918 0.055365 .
## LocationFaridabad      -1.039e-01  4.518e-02  -2.299 0.021643 *
## LocationGoa             5.029e-01  1.045e-01   4.811 1.67e-06 ***
## LocationHyderabad       9.109e-02  2.473e-02   3.684 0.000239 ***
## LocationIndore          1.532e-01  1.041e-01   1.472 0.141173
## LocationKanpur         -1.146e-01  3.724e-02  -3.078 0.002124 **
## LocationKolkata        -1.773e-01  2.962e-02  -5.987 2.73e-09 ***
## LocationLudhiana       -5.805e-02  3.735e-02  -1.555 0.120295
## LocationMysore          2.719e-01  7.908e-02   3.438 0.000603 ***
## LocationPune            5.717e-02  2.346e-02   2.437 0.014940 *
```

```
## LocationRanchi         -9.385e-02  5.259e-02  -1.785 0.074541 .
## LocationSalem           2.944e-01  1.460e-01   2.016 0.043986 *
## LocationVadodara       -2.021e-01  1.197e-01  -1.689 0.091495 .
## LocationVaranasi       -1.820e-01  5.252e-02  -3.466 0.000544 ***
## LocationWarangal       -2.346e-01  1.465e-01  -1.601 0.109503
## LocationZirakpur       -8.295e-02  5.469e-02  -1.517 0.129561
## ColorMaroon            -7.123e-02  4.492e-02  -1.586 0.113003
## ColorSilver            -3.811e-02  1.567e-02  -2.433 0.015121 *
## DrivetrainFWD          -2.362e-01  2.750e-02  -8.589  < 2e-16 ***
## DrivetrainRWD          -1.486e-01  3.229e-02  -4.601 4.59e-06 ***
## Width                   2.154e-03  1.073e-04  20.067  < 2e-16 ***
## Height                 -2.229e-04  8.132e-05  -2.741 0.006209 **
## Seating.Capacity        6.032e-02  1.212e-02   4.976 7.30e-07 ***
## Torque.RPM             -7.670e-08  5.512e-08  -1.392 0.164255
## Power.RPM               1.275e-06  6.428e-08  19.841  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2055 on 1370 degrees of freedom
## Multiple R-squared:  0.9154, Adjusted R-squared:  0.9123
## F-statistic: 290.7 on 51 and 1370 DF,  p-value: < 2.2e-16
```

```
npar <- length(model$coefficients) + 1; n <- length(model$residuals)
extractAIC(model)[2] + 2*npar*(npar + 1)/(n - npar - 1)
```

```
## [1] -4335.158
```

```
npar <- length(reduced_model$coefficients) + 1; n <- length(reduced_model$residuals)
extractAIC(reduced_model)[2] + 2*npar*(npar + 1)/(n - npar - 1)
```

```
## [1] -4444.41
```

Interactions