

# Regression Models Project

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## Tasks

Take the *mtcars* data set and write up an analysis to answer their question using regression models and exploratory data analyses.

## Executive Summary

The data was extracted from the 1974 Motor Trend US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973–74 models).

A data frame with 32 observations on 11 (numeric) variables.

[, 1] mpg Miles/(US) gallon [, 2] cyl Number of cylinders [, 3] disp Displacement (cu.in.) [, 4] hp Gross horsepower [, 5] drat Rear axle ratio [, 6] wt Weight (1000 lbs) [, 7] qsec 1/4 mile time [, 8] vs Engine (0 = V-shaped, 1 = straight) [, 9] am Transmission (0 = automatic, 1 = manual) [,10] gear Number of forward gears [,11] carb Number of carburetors

Loading the dataset:

```
data(mtcars)
summary(mtcars)
```

##	mpg	cyl	disp	hp
##	Min. :10.40	Min. :4.000	Min. : 71.1	Min. : 52.0
##	1st Qu.:15.43	1st Qu.:4.000	1st Qu.:120.8	1st Qu.: 96.5
##	Median :19.20	Median :6.000	Median :196.3	Median :123.0
##	Mean :20.09	Mean :6.188	Mean :230.7	Mean :146.7
##	3rd Qu.:22.80	3rd Qu.:8.000	3rd Qu.:326.0	3rd Qu.:180.0
##	Max. :33.90	Max. :8.000	Max. :472.0	Max. :335.0
##	drat	wt	qsec	vs
##	Min. :2.760	Min. :1.513	Min. :14.50	Min. :0.0000
##	1st Qu.:3.080	1st Qu.:2.581	1st Qu.:16.89	1st Qu.:0.0000
##	Median :3.695	Median :3.325	Median :17.71	Median :0.0000
##	Mean :3.597	Mean :3.217	Mean :17.85	Mean :0.4375
##	3rd Qu.:3.920	3rd Qu.:3.610	3rd Qu.:18.90	3rd Qu.:1.0000
##	Max. :4.930	Max. :5.424	Max. :22.90	Max. :1.0000
##	am	gear	carb	
##	Min. :0.0000	Min. :3.000	Min. :1.000	
##	1st Qu.:0.0000	1st Qu.:3.000	1st Qu.:2.000	
##	Median :0.0000	Median :4.000	Median :2.000	
##	Mean :0.4062	Mean :3.688	Mean :2.812	
##	3rd Qu.:1.0000	3rd Qu.:4.000	3rd Qu.:4.000	
##	Max. :1.0000	Max. :5.000	Max. :8.000	

```
mtcars$drat <- factor(mtcars$drat)
mtcars$cyl <- factor(mtcars$cyl)
mtcars$vs <- factor(mtcars$vs)
mtcars$gear <- factor(mtcars$gear)
mtcars$carb <- factor(mtcars$carb)
mtcars$am <- factor(mtcars$am, labels=c('Automatic', 'Manual'))
```

## Regression Model

```
full.model <- lm(mpg ~ ., data = mtcars)
best.model <- step(full.model, direction = "backward")
```

```
## Start: AIC=25.34
## mpg ~ cyl + disp + hp + drat + wt + qsec + vs + am + gear + carb
##
##
## Step: AIC=25.34
## mpg ~ cyl + disp + hp + drat + wt + qsec + vs + am + gear
##
##
## Step: AIC=25.34
## mpg ~ cyl + disp + hp + drat + wt + qsec + vs + gear
##
##
## Step: AIC=25.34
## mpg ~ cyl + disp + hp + drat + wt + qsec + gear
##
##      Df Sum of Sq    RSS   AIC
## - qsec  1      0.083 11.615 23.571
## <none>                11.532 25.340
## - wt    1      2.963 14.495 30.658
## - disp  1      4.773 16.305 34.423
## - hp    1      5.044 16.576 34.951
## - gear  1      5.984 17.516 36.715
## - cyl   2      9.582 21.113 40.694
## - drat 20     135.570 147.102 66.812
##
## Step: AIC=23.57
## mpg ~ cyl + disp + hp + drat + wt + gear
##
##      Df Sum of Sq    RSS   AIC
## <none>                11.615 23.571
## - wt    1      3.569 15.184 30.144
## - disp  1      4.873 16.489 32.782
## - hp    1      5.169 16.784 33.350
## - gear  1      6.222 17.838 35.299
## - cyl   2     12.344 23.959 42.740
## - drat 20     139.637 151.253 65.703
```

```
summary(best.model)
```

```
##
## Call:
## lm(formula = mpg ~ cyl + disp + hp + drat + wt + gear, data = mtcars)
##
## Residuals:
```

Mazda RX4	Mazda RX4 Wag	Datsun 710	Hornet 4 Drive
6.305e-01	-6.305e-01	2.776e-17	-1.205e-01
Hornet Sportabout	Valiant	Duster 360	Merc 240D
-9.637e-02	1.205e-01	1.665e-16	-3.053e-16
Merc 230	Merc 280	Merc 280C	Merc 450SE
1.305e-15	7.000e-01	-7.000e-01	-9.385e-01
Merc 450SL	Merc 450SLC	Cadillac Fleetwood	Lincoln Continental
1.643e+00	-7.044e-01	2.776e-17	-5.551e-17
Chrysler Imperial	Fiat 128	Honda Civic	Toyota Corolla
0.000e+00	1.686e+00	-3.608e-16	-4.718e-16
Toyota Corona	Dodge Challenger	AMC Javelin	Camaro Z28
-1.943e-16	-1.205e-01	9.637e-02	-2.776e-16
Pontiac Firebird	Fiat X1-9	Porsche 914-2	Lotus Europa
1.205e-01	-1.686e+00	1.388e-16	0.000e+00
Ford Pantera L	Ferrari Dino	Maserati Bora	Volvo 142E
8.327e-17	0.000e+00	5.551e-17	-2.498e-16

```
##
## Coefficients: (1 not defined because of singularities)
##           Estimate Std. Error t value Pr(>|t|)
## (Intercept)  31.038    20.528   1.512  0.2051
## cyl6         -59.745    40.381  -1.480  0.2131
## cyl8        -79.839    49.838  -1.602  0.1844
## disp         -1.389     1.072  -1.295  0.2649
## hp           3.259     2.443   1.334  0.2530
## drat2.93      20.944    27.242   0.769  0.4849
## drat3        -29.174    13.566  -2.151  0.0979
## drat3.07    -157.389   119.891  -1.313  0.2595
## drat3.08      34.305    25.051   1.369  0.2427
## drat3.15    -19.546    16.086  -1.215  0.2911
## drat3.21   -252.792   187.756  -1.346  0.2494
## drat3.23   -101.149    69.620  -1.453  0.2199
## drat3.54   -627.339   470.801  -1.332  0.2535
## drat3.62   -334.116   254.614  -1.312  0.2597
## drat3.69   -225.129   157.636  -1.428  0.2264
## drat3.7     -170.968   130.460  -1.311  0.2602
## drat3.73   -269.020   199.065  -1.351  0.2479
## drat3.77   -244.231   194.278  -1.257  0.2771
## drat3.85   -377.210   272.852  -1.382  0.2390
## drat3.9    -304.535   219.304  -1.389  0.2373
## drat3.92   -342.264   244.439  -1.400  0.2340
## drat4.08   -321.424   237.585  -1.353  0.2475
## drat4.11   -414.963   299.015  -1.388  0.2375
## drat4.22   -323.732   242.931  -1.333  0.2535
## drat4.43   -145.031   114.904  -1.262  0.2755
## drat4.93   -277.391   205.793  -1.348  0.2490
## wt           4.945     4.461   1.109  0.3298
```

```
## gear4      204.483    139.689    1.464    0.2171
## gear5           NA          NA          NA          NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.704 on 4 degrees of freedom
## Multiple R-squared:  0.9897, Adjusted R-squared:  0.9201
## F-statistic: 14.21 on 27 and 4 DF,  p-value: 0.009558
```

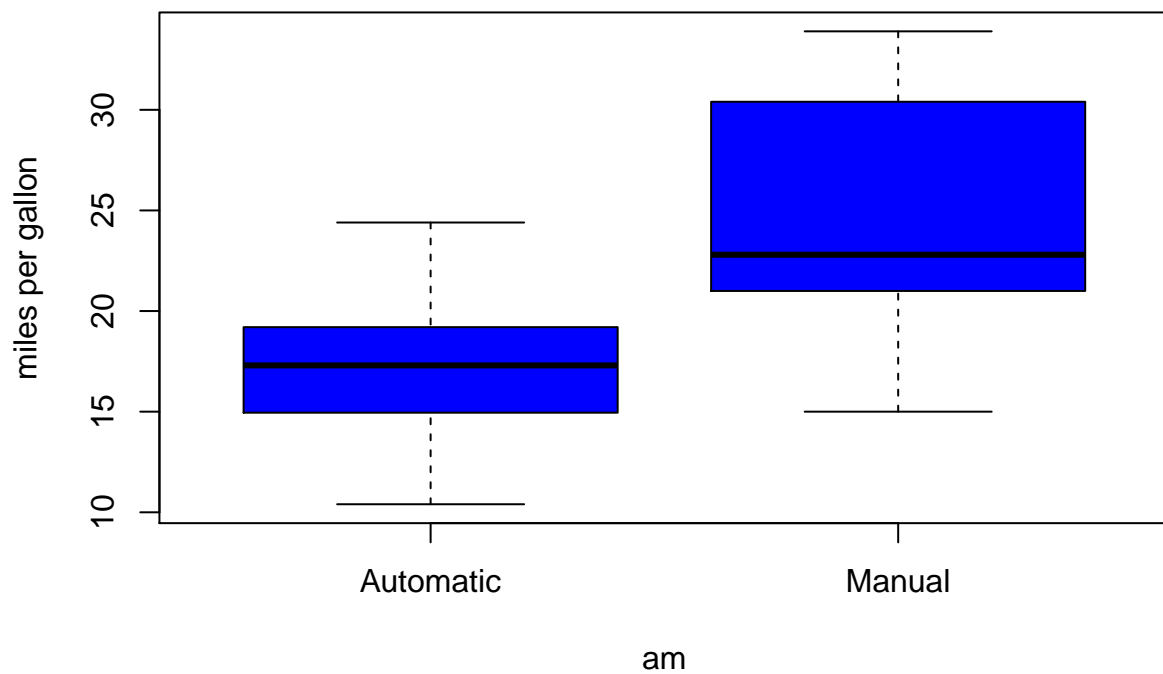
A test to determine the difference in mpg between the automatic and manual transmissions.

```
t.test(mpg ~ am, data = mtcars)
```

```
##
## Welch Two Sample t-test
##
## data:  mpg by am
## t = -3.7671, df = 18.332, p-value = 0.001374
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -11.280194  -3.209684
## sample estimates:
## mean in group Automatic    mean in group Manual
##           17.14737           24.39231
```

Boxplot for the same

```
boxplot(mpg ~ am, data = mtcars, col = "blue", ylab = "miles per gallon")
```



The boxplot confirms the result.

## Conclusion

Therefore, in conclusion, it can be state that number of cylinders and displacement are good predictors of fuel efficiency, but transmission type is not.