

Motor Trend Project

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Summary

This report explores the relationship between manual and automatic transmission on the fuel efficiency. For this analysis, a dataset from Motor Trend US Magazine is used. Following questions are answered through the analysis.

1. Is an automatic or manual transmission better for MPG?
2. How different is the MPG between automatic and manual transmissions?

The result obtained for the data shows that the manual transmission presents higher average MPG value than the automatic models.

Load Data

```
library(ggplot2)
data(mtcars)
head(mtcars)
```

##	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
## Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
## Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
## Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
## Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
## Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
## Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

Exploratory Analysis

```
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"))
```

Appendix - Plot 1 below shows that Automatic Transmission has lower MPG than the Manual transmission.

Regression Analysis

```
aggregate(mpg~am, data = mtcars, mean)
```

```
##           am      mpg
## 1 Automatic 17.14737
## 2   Manual 24.39231
```

Lets do the t test now

```
automatic <- mtcars[mtcars$am == "Automatic",]
manual <- mtcars[mtcars$am == "Manual",]
t.test(automatic$mpg, manual$mpg)

##
## Welch Two Sample t-test
##
## data:  automatic$mpg and manual$mpg
## 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 of x mean of y
## 17.14737 24.39231
```

Since the p-value is 0.001374, this is very significant difference. Lets quantify this now

```
val <- lm(mpg ~ am, data = mtcars)
summary(val)

##
## Call:
## lm(formula = mpg ~ am, data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -9.3923 -3.0923 -0.2974  3.2439  9.5077
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   17.147      1.125   15.247 1.13e-15 ***
## amManual       7.245      1.764    4.106 0.000285 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.902 on 30 degrees of freedom
## Multiple R-squared:  0.3598, Adjusted R-squared:  0.3385
## F-statistic: 16.86 on 1 and 30 DF, p-value: 0.000285
```

This shows that automatic mpg is around 17.1 and manual is around 7.2. It also shows that the adjusted R square value is only around .338 and multiple R squared value is around .36, which mean only 36% of the variance can be explained. We will show now the multivariable regression model.

Multivariable Regression Model

```
data(mtcars)
multivariable_regression <- lm(mpg ~ . ,data=mtcars)
summary(multivariable_regression)

##
## Call:
## lm(formula = mpg ~ ., data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.4506 -1.6044 -0.1196  1.2193  4.6271
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.30337    18.71788   0.657   0.5181
## cyl         -0.11144     1.04502  -0.107   0.9161
## disp         0.01334     0.01786   0.747   0.4635
## hp          -0.02148     0.02177  -0.987   0.3350
## drat         0.78711     1.63537   0.481   0.6353
## wt          -3.71530     1.89441  -1.961   0.0633 .
## qsec         0.82104     0.73084   1.123   0.2739
## vs           0.31776     2.10451   0.151   0.8814
## am           2.52023     2.05665   1.225   0.2340
## gear         0.65541     1.49326   0.439   0.6652
## carb        -0.19942     0.82875  -0.241   0.8122
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.65 on 21 degrees of freedom
## Multiple R-squared:  0.869, Adjusted R-squared:  0.8066
## F-statistic: 13.93 on 10 and 21 DF, p-value: 3.793e-07
```

Correlation

```
cor(mtcars)[1,]

##      mpg      cyl      disp      hp      drat      wt
## 1.0000000 -0.8521620 -0.8475514 -0.7761684  0.6811719 -0.8676594
##      qsec      vs      am      gear      carb
## 0.4186840  0.6640389  0.5998324  0.4802848 -0.5509251
```

This model explains 86.9% of the variance and thus variables cyl, disp and hp shows strong correlation. Use these variables in final regression model

```
final <- lm(mpg ~ wt+hp+disp+cyl+am, data = mtcars)
summary(final)

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

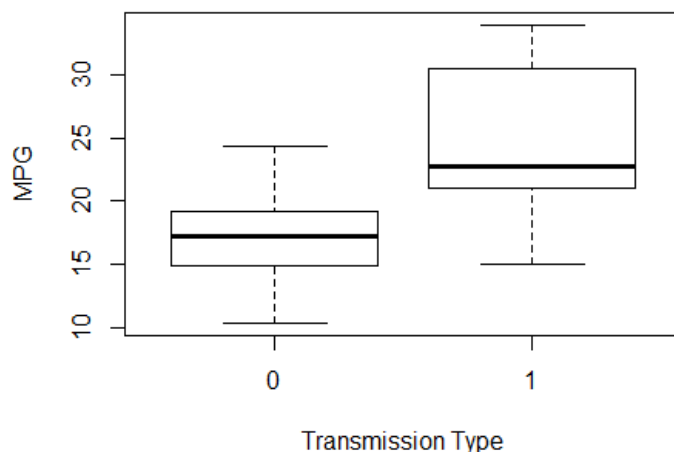
```
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3.5952 -1.5864 -0.7157  1.2821  5.5725
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  38.20280    3.66910   10.412 9.08e-11 ***
## wt           -3.30262    1.13364   -2.913  0.00726 **
## hp            -0.02796    0.01392   -2.008  0.05510 .
## disp          0.01226    0.01171    1.047  0.30472
## cyl           -1.10638    0.67636   -1.636  0.11393
## am            1.55649    1.44054    1.080  0.28984
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.505 on 26 degrees of freedom
## Multiple R-squared:  0.8551, Adjusted R-squared:  0.8273
## F-statistic: 30.7 on 5 and 26 DF, p-value: 4.029e-10
```

Thus we can say that the difference between manual and automatic transmission is 1.55 MPG.

Appendix

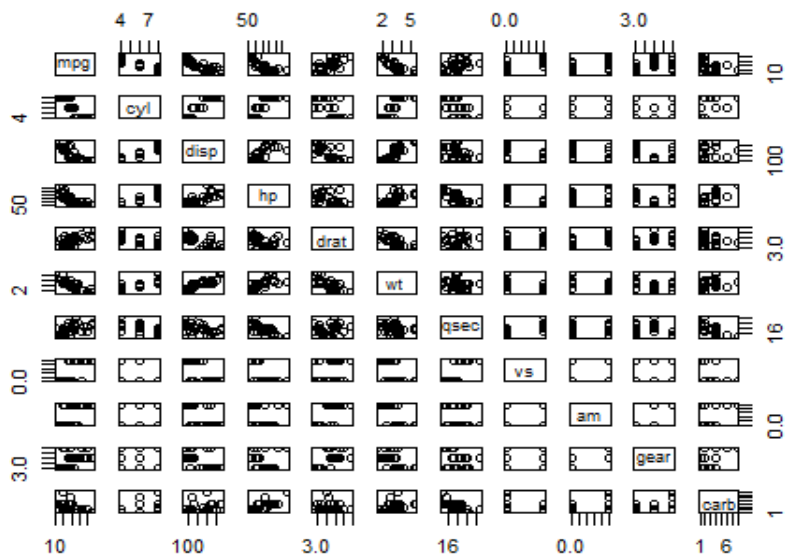
Plot 1 Boxplot of MPG

```
boxplot(mpg ~ am, data = mtcars, ylab = "MPG", xlab = "Transmission Type")
```



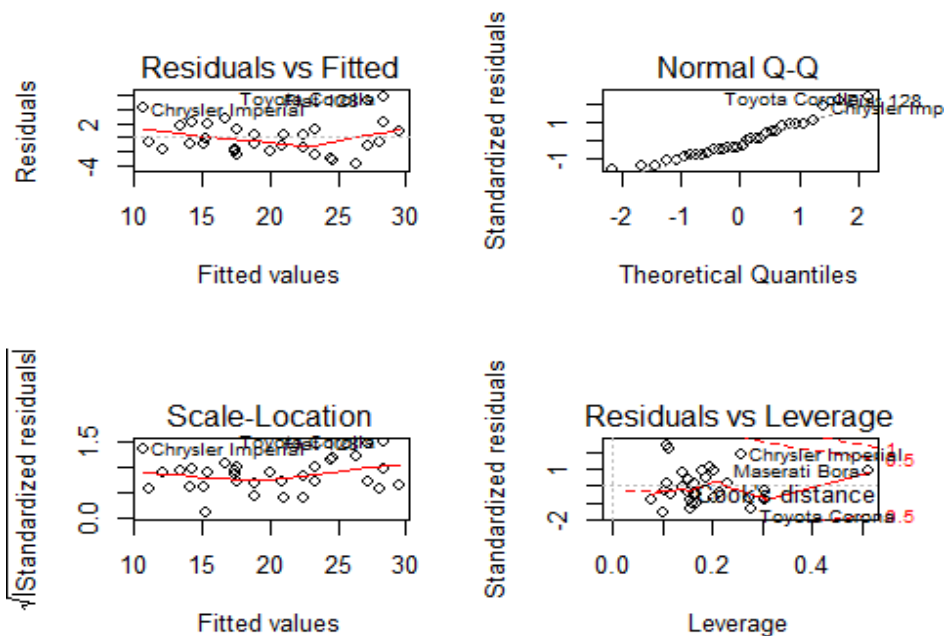
Plot 2 Pairs Plot

```
pairs(mpg ~ ., data = mtcars)
```



Plot 3 Residual Plot

```
par(mfrow = c(2,2))
plot(final)
```



So multivariable regression model shows that multiple R square value is higher at .855, where 85.5% of the regression variance can be explained by chosen variables. It concludes that wt and cyl are confounding variables in relation to am and mpg and manual transmission cars on an average have around 1.55 mpg more than that of automatic cars.