mtcars

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Executive Summary

Given the data provided in 'mtcars', a linear regression model was calculated using correlation, analysis of predictor variance, and significant linear regression coefficients.

The final resultant model found transmission type to be an insignificant predictor for MPG, therefore no confident conclusions can be made regarding transmission type's correlation with MPG, nor could quantified relationships between the two variables be calculated.

Instead, the only statistically significant parameters – given the provided data – were found to be 'number of cylinders' and 'weight', by which the formula holds true:

```
mpg = 39.6863 + (-1.5078)cyl + (-3.1910)wt
```

Exploratory Analysis

We're interested in how data variables affect MPG. That said, let's take a quick look at the data & the correlations between the other varables and MPG:

```
##     cyl    disp      hp    drat      wt    qsec      vs      am    gear
## -0.8522 -0.8476 -0.7762  0.6812 -0.8677  0.4187  0.6640  0.5998  0.4803
##    carb
## -0.5509
```

Number of cylinders, displacement, and weight have the strongest correlations with MPG. Let's quantify those relationships further.

Analysis of the Variance of the Predictors

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## cyl          1    818     818  116.42  5e-10 ***
## disp         1     38      38    5.35 0.0309 *
## hp           1      9       9    1.33 0.2610
## drat         1     16      16    2.34 0.1406
## wt           1     77      77   11.03 0.0032 **
## qsec         1      4       4    0.56 0.4617
## vs           1      0       0    0.02 0.8932
## am           1     14      14    2.06 0.1659
## gear         1      1       1    0.14 0.7137
## carb         1      0       0    0.06 0.8122
## Residuals   21    147       7
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Analysis of the variance of the predictors as they relate to MPG further identifies engine configuration (vs) as the relatively least significant regressor. Let's remove it and reassess our pending model. We'll iteratively continue this until all predictors are significant. Then, we'll calculate coefficients.

Linear Regression Model

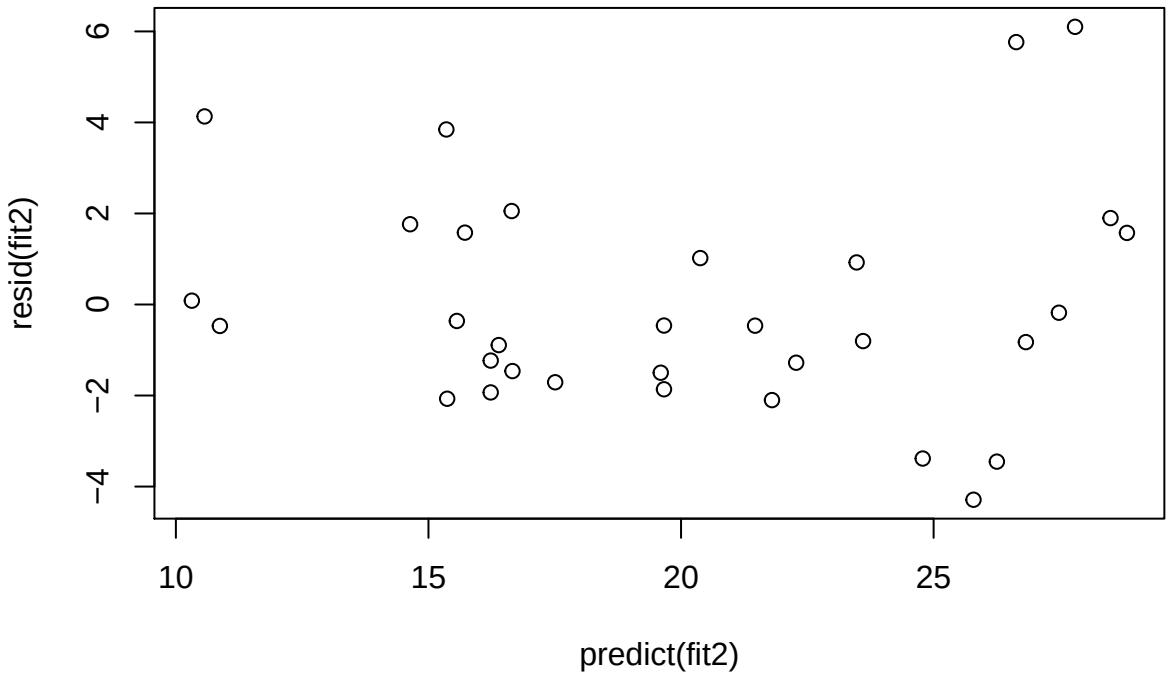
```
##              Estimate Std. Error t value  Pr(>|t|)
## (Intercept) 41.107678    2.84243 14.4622 1.620e-14
## cyl         -1.784944    0.60711 -2.9401 6.512e-03
## disp         0.007473    0.01184  0.6309 5.332e-01
## wt          -3.635677    1.04014 -3.4954 1.596e-03
```

With this model, disp becomes insignificant once again, therefore we reduce the data again and reevaluate:

```
##             Estimate Std. Error t value  Pr(>|t|)
## (Intercept)   39.686     1.7150  23.141 3.043e-20
## cyl           -1.508     0.4147  -3.636 1.064e-03
## wt            -3.191     0.7569  -4.216 2.220e-04
```

Residuals

Plotting the residuals produces no obvious patterns:



Therefore, we have a linear model to help answer the pending questions:

1. Is an automatic or manual transmission better for MPG?

Given the transmission type does not have a significant impact on MPG.

2. Quantify the MPG difference between automatic and manual transmissions?

Unable to quantify this regressors impact because it's insignificant by the calculated model

Appendix A

Original context:

You work for Motor Trend, a magazine about the automobile industry. Looking at a data set of a collection of cars, they are interested in exploring the relationship between a set of variables and miles per gallon (MPG) (outcome). They are particularly interested in the following two questions:

1. Is an automatic or manual transmission better for MPG?
2. Quantify the MPG difference between automatic and manual transmissions?

Appendix B

Ouput of summary data:

```
summary(mtcars)
```

```
##       mpg             cyl             disp             hp       
##  Min.   :10.4   Min.   :4.00   Min.   : 71.1   Min.   : 52.0  
##  1st Qu.:15.4   1st Qu.:4.00   1st Qu.:120.8   1st Qu.: 96.5  
##  Median :19.2   Median :6.00   Median :196.3   Median :123.0  
##  Mean   :20.1   Mean   :6.19   Mean   :230.7   Mean   :146.7  
##  3rd Qu.:22.8   3rd Qu.:8.00   3rd Qu.:326.0   3rd Qu.:180.0  
##  Max.   :33.9   Max.   :8.00   Max.   :472.0   Max.   :335.0  
##       drat             wt             qsec             vs        
##  Min.   :2.76   Min.   :1.51   Min.   :14.5   Min.   :0.000  
##  1st Qu.:3.08   1st Qu.:2.58   1st Qu.:16.9   1st Qu.:0.000  
##  Median :3.69   Median :3.33   Median :17.7   Median :0.000  
##  Mean   :3.60   Mean   :3.22   Mean   :17.8   Mean   :0.438  
##  3rd Qu.:3.92   3rd Qu.:3.61   3rd Qu.:18.9   3rd Qu.:1.000  
##  Max.   :4.93   Max.   :5.42   Max.   :22.9   Max.   :1.000  
##        am              gear            carb      
##  Min.   :0.000   Min.   :3.00   Min.   :1.00  
##  1st Qu.:0.000   1st Qu.:3.00   1st Qu.:2.00  
##  Median :0.000   Median :4.00   Median :2.00  
##  Mean   :0.406   Mean   :3.69   Mean   :2.81  
##  3rd Qu.:1.000   3rd Qu.:4.00   3rd Qu.:4.00  
##  Max.   :1.000   Max.   :5.00   Max.   :8.00
```

Appendix C

All code used in this report:

```
library(datasets)
data(mtcars)
cor(mtcars, mtcars$mpg)[-1,]
summary(aov(mpg ~ ., data=mtcars))
...
fit1 <- lm(mtcars$mpg ~ cyl + disp + wt, data=subset(mtcars, select=c(cyl, disp, wt)))
summary(fit1)$coefficients
...
fit2 <- lm(mtcars$mpg ~ cyl + wt, data=subset(mtcars, select=c(cyl, wt)))
summary(fit2)$coefficients
plot(resid(fit2) ~ predict(fit2))
```

Appendix D

Confidence interval example:

```
coef <- summary(fit2)$coefficients
int95cyl <- (coef['cyl', 1] + c(-1, 1) * qt(0.975, df=fit2$df) * coef['cyl', 2]) * 2
int95wt <- coef['wt', 1] + c(-1, 1) * qt(0.975, df=fit2$df) * coef['wt', 2]
```

At 95% confidence, for each increase in cylinders (by 2), we find between 1.32 and 4.71 decrease in MPG.

At 95% confidence, for each 1000lb increase weight, we find between 1.64 and 4.74 decrease in MPG.