Motor Trend Data Analysis

Regression Models Course Project

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Executive Summary

This analysis uses some data science techniques to analyze the mtcars data set, and explore the relationship between a set of variables and miles per gallon (MPG) (outcome). The key findings are:

- Manual transmission is better than automatic transmission for MPG.
- The ratio between manual and automatic transmission for MPG is 1.806099, adjusted by cyl, disp, hp, and wt.

Load required R libraries

```
library(ggplot2)
library(gridExtra)
```

Load the mtcars data and perform some basic exploratory data analysis.

```
data(mtcars)
# Convert cyl, am and gear to factors
mtcars$cyl <- as.factor(mtcars$cyl)
mtcars$am <- factor(mtcars$am, labels = c("automatic", "manual"))
mtcars$gear <- as.factor(mtcars$gear)
```

Based on Plot #1 in Appendix, we can conclude the following: Manual transmission is better than automatic transmission for MPG.

Let's try to see what other variables should be included in the model

```
anova(lm(mpg ~ ., data = mtcars))
```

```
## Analysis of Variance Table
##
## Response: mpg
##           Df Sum Sq Mean Sq F value    Pr(>F)
## cyl        2 824.78  412.39 60.2490 5.953e-09 ***
## disp       1  57.64   57.64  8.4214  0.009139 **
## hp         1  18.50   18.50  2.7031  0.116598
```

```
## drat       1  11.91   11.91  1.7407  0.202734
## wt         1  55.79   55.79  8.1503  0.010134 *
## qsec       1   1.52    1.52  0.2227  0.642342
## vs         1   0.30    0.30  0.0441  0.835841
## am         1  16.57   16.57  2.4203  0.136271
## gear       2   5.02    2.51  0.3668  0.697741
## carb       1   3.95    3.95  0.5771  0.456767
## Residuals 19 130.05    6.84
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

We can pick the variables that has a p-value close to 0.05, which are: cyl, disp, hp, wt, and am.

```
fit2 <- lm(mpg ~ cyl + disp + hp + wt + am, data = mtcars)
summary(fit2)
```

```
##
## Call:
## lm(formula = mpg ~ cyl + disp + hp + wt + am, data = mtcars)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.9374 -1.3347 -0.3903  1.1910  5.0757
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 33.864276   2.695416  12.564 2.67e-12 ***
## cyl6        -3.136067   1.469090  -2.135   0.0428 *
## cyl8        -2.717781   2.898149  -0.938   0.3573
## disp         0.004088   0.012767   0.320   0.7515
## hp          -0.032480   0.013983  -2.323   0.0286 *
## wt          -2.738695   1.175978  -2.329   0.0282 *
## ammanual     1.806099   1.421079   1.271   0.2155
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.453 on 25 degrees of freedom
## Multiple R-squared:  0.8664, Adjusted R-squared:  0.8344
## F-statistic: 27.03 on 6 and 25 DF,  p-value: 8.861e-10
```

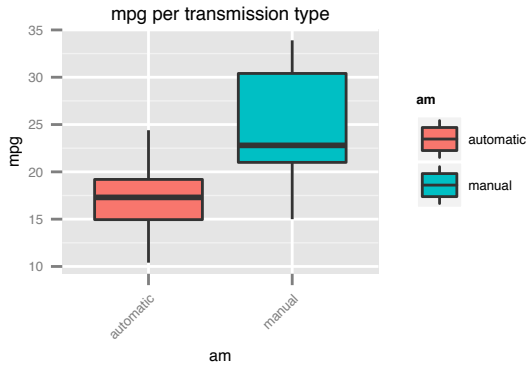
Now, the "Adjusted R-squared" is 0.8344, which we believe is a good fit model for the data.

Answer to Question #2: Cars with Manual transmission get better MPG than Automatic transmission, and the coefficient is 1.806099, adjusted by cyl, disp, hp, and wt.

Appendix: Plots for the model

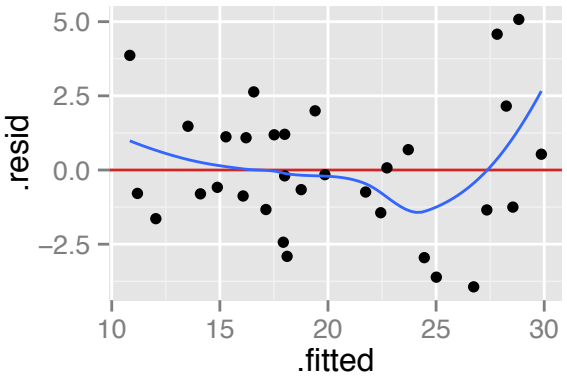
Plot to show the relationships between mpg and manual/automatic transmission.

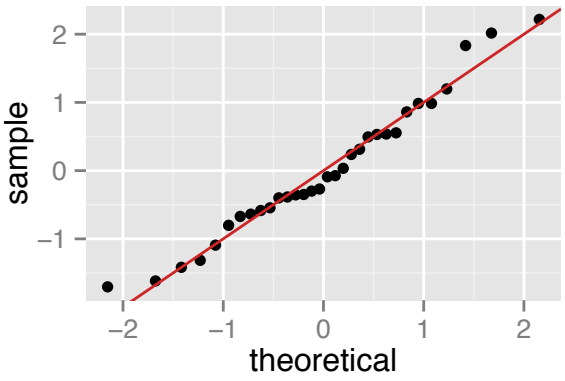
```
p <- ggplot(mtcars, aes(x = am, y = mpg)) +
    ggtitle("mpg per transmission type") +
    geom_boxplot(aes(fill = am)) +
    theme(text = element_text(size=6), axis.text.x = element_text(angle = 45, hjust = 1))
grid.arrange(p, ncol = 2, nrow = 2) # Use grid to make the plot smaller (1/4 size)
```

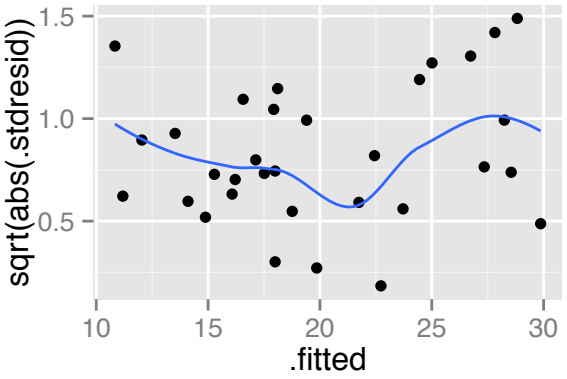


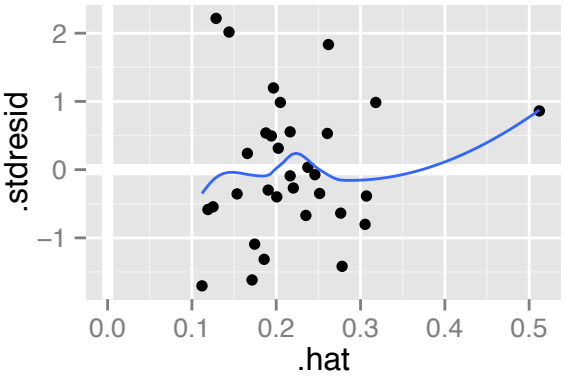
Plots for the model

```
mtcars <- fortify(fit2)
plot1 <- ggplot(data = mtcars, aes(x = .fitted, y = .resid)) +
    geom_hline(yintercept = 0, colour = "firebrick3") +
    geom_point() +
    geom_smooth(se = FALSE, method = loess)
plot2 <- ggplot(data = mtcars, aes(sample = .stdresid)) +
  stat_qq() +
  geom_abline(colour = "firebrick3")
plot3 <- ggplot(data = mtcars, aes(x = .fitted, y = sqrt(abs(.stdresid)))) +
    geom_point() +
    geom_smooth(se = FALSE, method = loess)
plot4 <- ggplot(data = mtcars, aes(.hat, .stdresid)) +
    geom_vline(size = 2, colour = "white", xintercept = 0) +
    geom_hline(size = 2, colour = "white", yintercept = 0) +
    geom_point() +
    geom_smooth(se = FALSE, method = loess)
grid.arrange(plot1, plot2, plot3, plot4, ncol = 2)
```


.resid
5.0
2.5
0.0
−2.5
10
15
20
25
30
.fitted


sample
2
1
0
−1
−2
−1
0
1
2
theoretical


sqrt(abs(.stdresid))
1.5
1.0
0.5
10
15
20
25
30
.fitted


.stdresid
2
1
0
−1
0.0
0.1
0.2
0.3
0.4
0.5
.hat