Regression Models Project - Motor Trend Data 'mtcars' Miles Per Gallon Analysis

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I. Executive Summary:

```
## Add after completing analysis
NOTE: include some info on cor, confint, ChisSq?, VIF
```

II. Problem Statement & Questions to Answer:

```
## Q1 "Is an automatic or manual transmission better for 'mpg'"
## Q2 "Quantify the MPG difference between automatic and manual transmissions"
```

Grading - Criteria (remove on completion)!!!

???? Did the report include an executive summary?
???? Did the student answer the questions of interest or detail why the question(s) is (are) not answerable?
???? Did the student quantify the uncertainty in their conclusions and/or perform an inference correctly?
???? Was the report brief (about 2 pages long) for the main body of the report and no longer than 5 with supporting appendix of figures?

YES!!!! Did the student interpret the coefficients correctly?
YES!!!! Did the student do some exploratory data analyses?
YES!!!! Did the student fit multiple models and detail their strategy for model selection?
YES!!!! Did the student do a residual plot and some diagnostics?
YES!!!! Was the report done in Rmd (knitr) with pdf output?

III. Analysis Considerations:

```
Descriptive - (dim, mean, sd, sigma^2, str & summary) statistics

Exploratory - pairs, histograms, QQ, fitted, residualplots, boxplots
& (multiple plots); T-Test

Analysis -  OLS, simple linear regression, statistical linear regression,
multivariate regression & model selection, logistic regression, pValues,
adjustments, residuals, residual fit, predict fit, hatvalues, variance, & dfbetas, R^2,
diagnostics; ANOVA, coeficients, confint, correlation, covariance, variance inflation
```

IV. Software Environment: & System - session Info:

Set the Working Directory then get System & Session Info

V. Accessing Data & Raw Data Overview: Motor Trend 'mtcars' data set:

Clean up the work space & get the data:

```
rm(list=ls());library(car);library(dplyr); data("mtcars");any(is.na(mtcars));data(mtcars)
```

```
##
## Attaching package: 'dplyr'

## The following object is masked from 'package:car':
##
##     recode

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

A data frame with 32 observations on 11 variables.

[, 1] mpg Miles/(US) gallon
[, 2] cyl Number of cylinders (4,6,8) [, 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 V/S (V = vee-block, S = straight-block) [, 9] am Transmission (0 = automatic, 1 = manual)
[,10] gear Number of forward gears (3,4,5) [,11] carb Number of carburetors (1,2,3,4,6,8)

VI. Process Data: Cconvert columns 2 & 8:11 (cyl=(4,6,8), vs = engine block shape (0=V, 1=S), am into transmission type (0=automatic & 1=manual), gear=(3:5) & carb=(1,2,3,4,6,8) factor levels

VII. Descriptive Statistics (view first & last three rows)

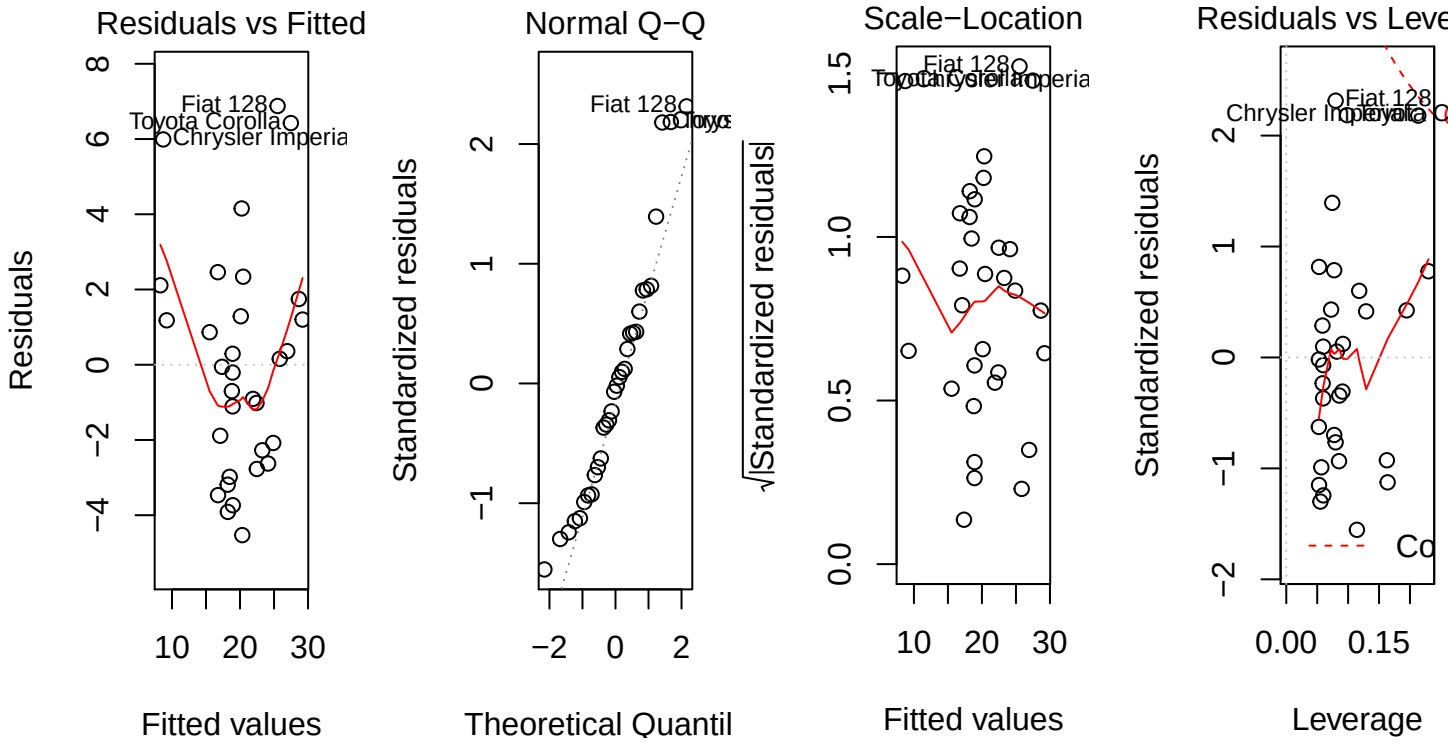
VIII. Exploratory Analysis:

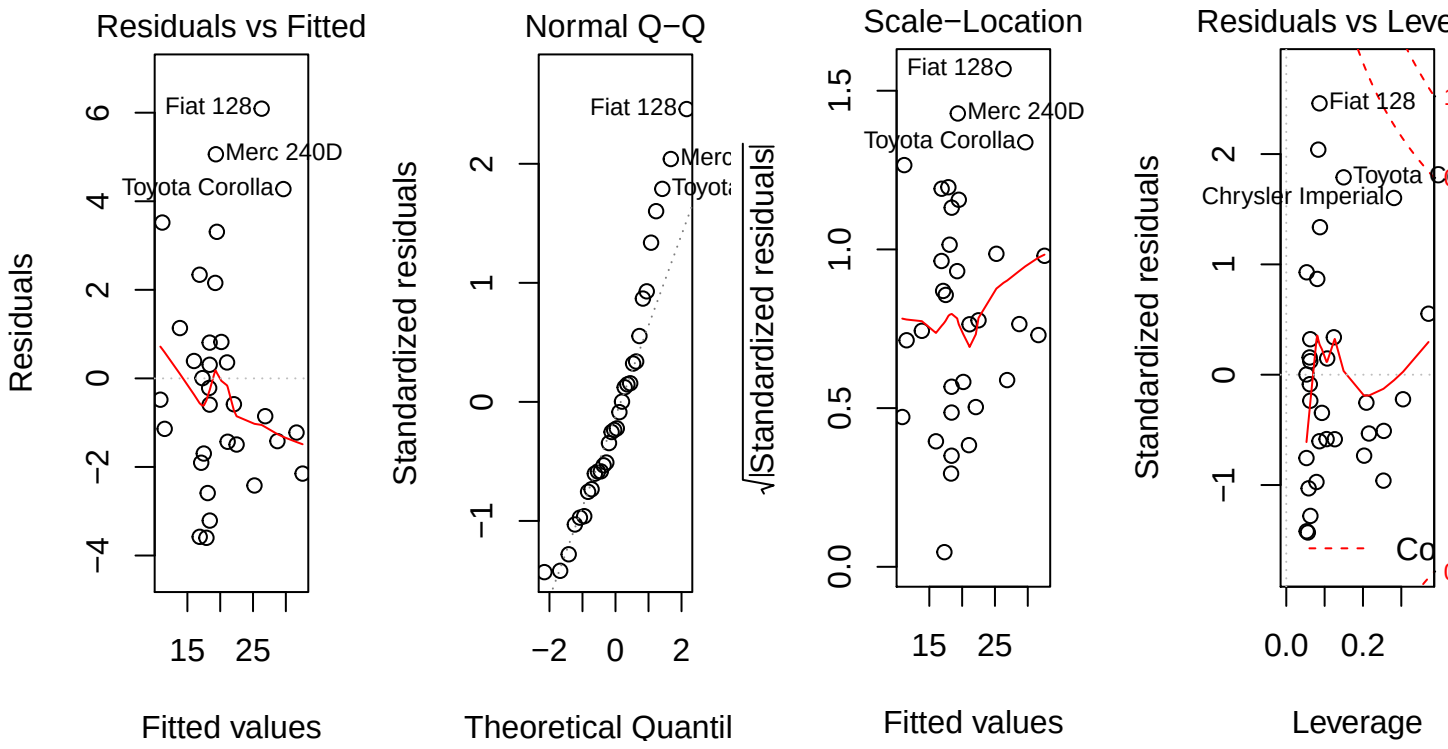
See Appendix A, Figures 1:4
Add narrative here!!

IX. Statistical Modeling, Regression & Model Fit:

```
Assumptions:
        A A correlation to mpg ratings may exist among multiple variables
        B
```

Bivariate Linear Model





Multivariate LM (all vars) Fitted Plot

Multivariate LM (all vars) Fitted & Adjusted

(Note: the variable qsec appears to be significant at this point)

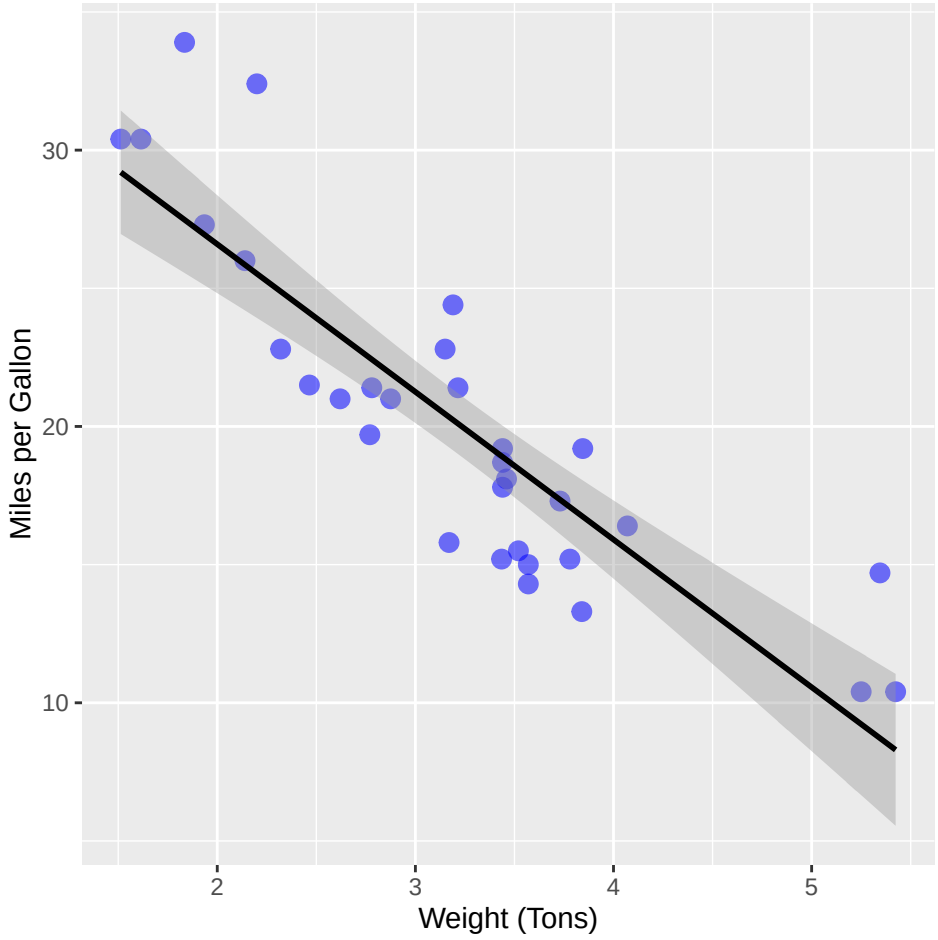
MultivariateLM(allvars)VIF(varianceInflationFactor)

(Note: at this point qsec no longer appears significant; but drat now appears to be instead, and notice the variance inflation figures of the other varables now seem to warrant removing them from the model)

Multivariate LM Nested & ANOVA table (Note: here that with the nested model approach that models 2 & 4 are indicated to be significant)

Best Fit Modeling (Note: comparing the models above and using anova table we find that models fm2 & fm4 are significant exhibiting low pValues, therefore discard two variables in model three from model four as the bestfit models)

Comparing variations of the best two models from the first MVLM Nested ANOVA table we find that model fbf3 has the lowest Variance Inflation results of the possible models tested > lm(mpg ~ factor(am) + cyl + wt, data = mtcars)



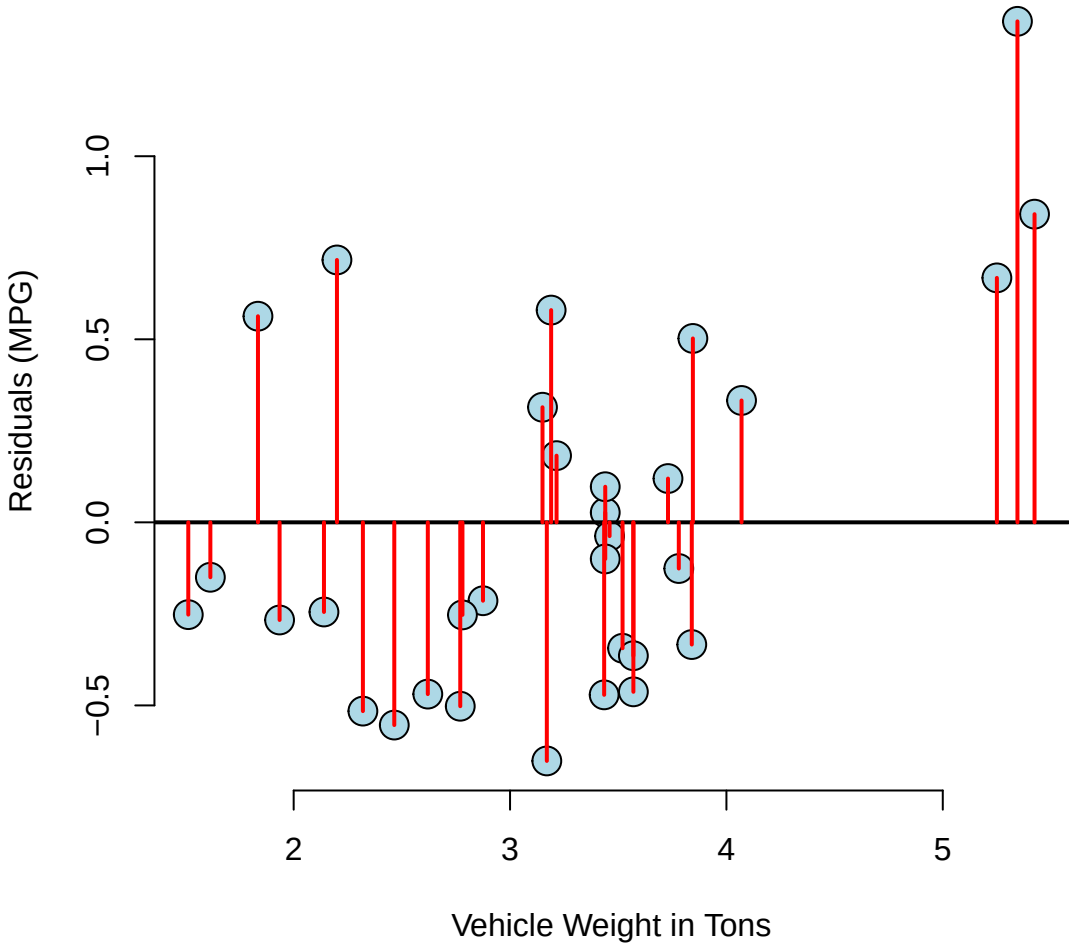

```
##
##  Pearson's product-moment correlation
##
## data:  mtcars$am and mtcars$cyl
## t = -3.3574, df = 30, p-value = 0.002151
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.7369979 -0.2126675
## sample estimates:
##       cor
```

```
## -0.522607

##
##  Pearson's product-moment correlation
##
## data:  mtcars$am and mtcars$disp
## t = -4.0152, df = 30, p-value = 0.0003662
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.7792690 -0.3055178
## sample estimates:
##       cor
## -0.591227

##
##  Pearson's product-moment correlation
##
## data:  mtcars$am and mtcars$wt
## t = -5.2576, df = 30, p-value = 1.125e-05
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.8386752 -0.4532461
## sample estimates:
##        cor
## -0.6924953

##
##  Pearson's product-moment correlation
##
## data:  mtcars$cyl and mtcars$disp
## t = 11.445, df = 30, p-value = 1.803e-12
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.8072442 0.9514607
## sample estimates:
##       cor
## 0.9020329

##
##  Pearson's product-moment correlation
##
## data:  mtcars$cyl and mtcars$disp
## t = 11.445, df = 30, p-value = 1.803e-12
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.8072442 0.9514607
## sample estimates:
##       cor
## 0.9020329

##
##  Pearson's product-moment correlation
##
```

```
## data:  mtcars$cyl and mtcars$wt
## t = 6.8833, df = 30, p-value = 1.218e-07
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.5965795 0.8887052
## sample estimates:
##       cor
## 0.7824958


##
##  Pearson's product-moment correlation
##
## data:  mtcars$disp and mtcars$wt
## t = 10.576, df = 30, p-value = 1.222e-11
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.7811586 0.9442902
## sample estimates:
##       cor
## 0.8879799
```

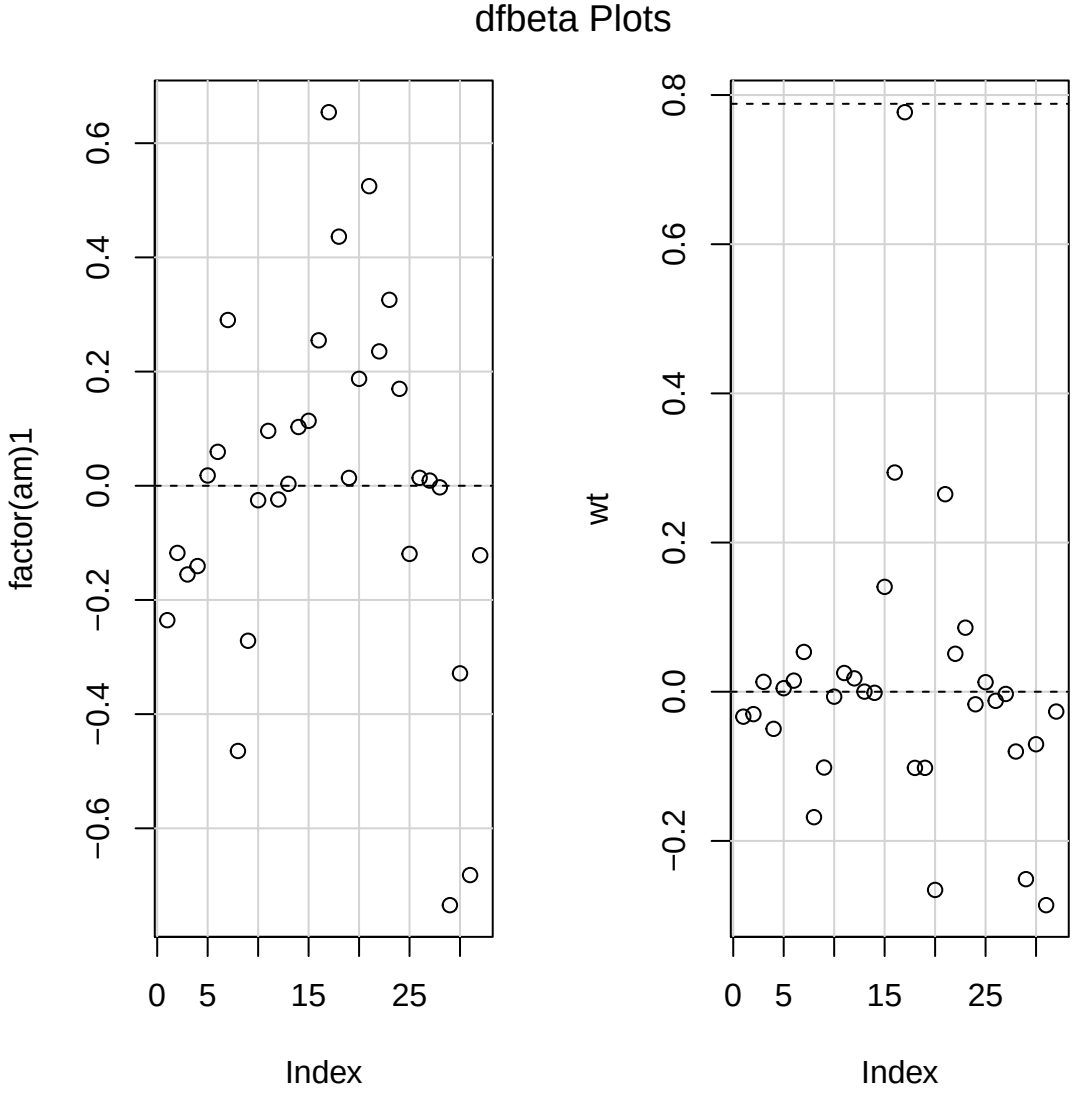
NEXT PROCESS TO CHECK!!!!! IS RESIDUALS TO IDENTIFY POOR MODEL FIT??

```r
y <- mtcars$mpg
x <- mtcars$wt
n <- length(y)
fw <- lm(x ~ y, data = mtcars)
e <- resid(fw)# ;e;plot(e);sum(e)
plot(x,e,
     xlab = "Vehicle Weight in Tons",
     ylab = "Residuals (MPG)",
     bg = "lightblue",
     col = "black", cex = 2, pch = 21, frame = FALSE)
abline(h = 0, lwd = 2)
for(i in 1:n)
        lines(c(x[i], x[i]), c(e[i], 0), col = "red", lwd = 2)
```



NEXT PROCESS: R^2 the percentage of total variability explained by the linear relationship with the predictor !!!!

```
## Warning: In lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...) :
##  extra argument 'family' will be disregarded
```



ISSUE NEEDS RESOLUTION

```
##                Estimate Std. Error     t value     Pr(>|t|)
## (Intercept) 37.32155131  3.0546385 12.21799285 5.843477e-13
## am          -0.02361522  1.5456453 -0.01527855 9.879146e-01
## wt          -5.35281145  0.7882438 -6.79080719 1.867415e-07
```

```
## [1] 31.07411 43.56899
```

```
## [1] -3.184815  3.137584
```

Find something with levels

X. Preliminary Findings:

Questions of Interest:

A What other regressors if any correlated with mpg rating and transmission type?

```
        B
Interpretation of Results:
        A Using ANOVA table with Nested Multivariate Regression fit it is clear that the variable w
        B Based on the
        C
```

XI. Inference:

```
Hypothesis':
        A H0 = The difference between Automatic and Manual transmission MPG = 0
        B Ha = The difference between Automatic and Manual transmission MPG != 0
        C Desired confidence interval = .95 (one sided) ??
```

XII. Conclusions / Recommendations:

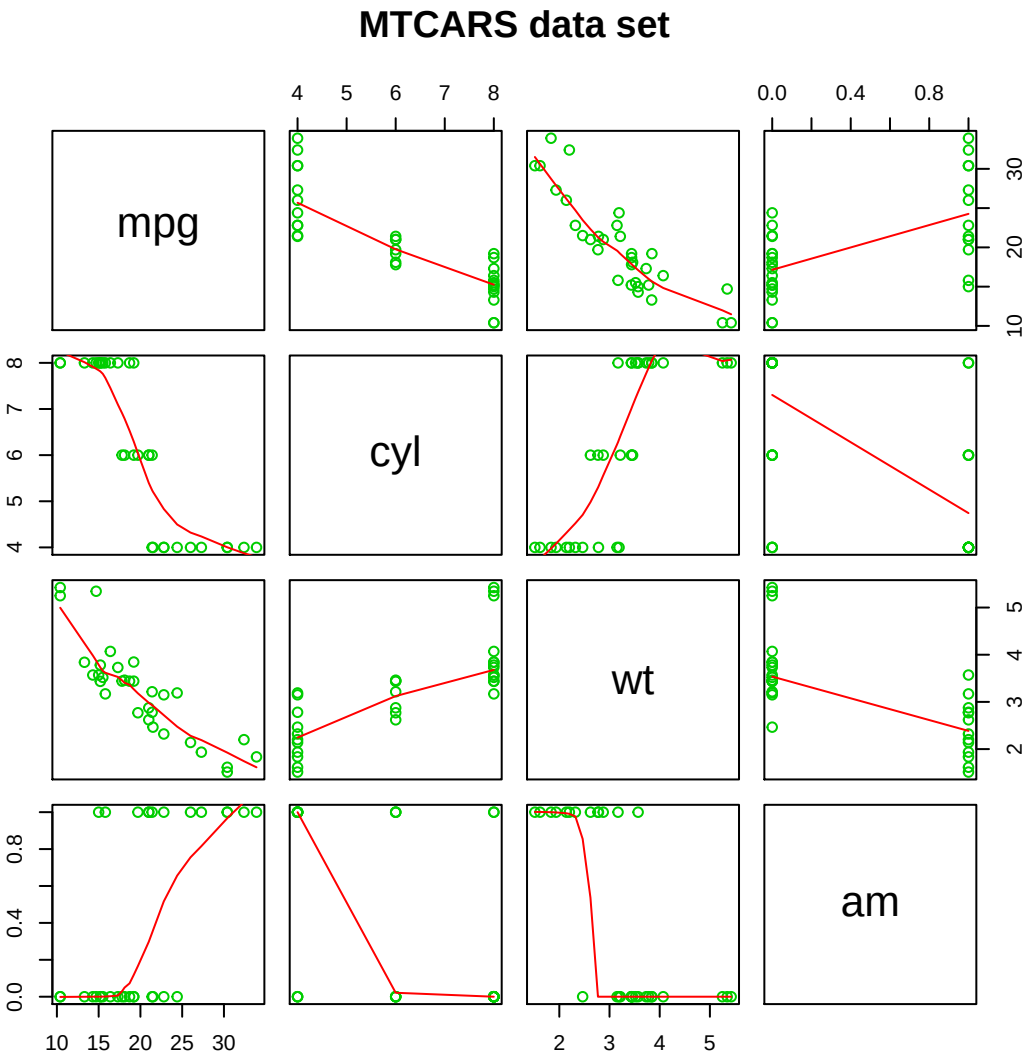
```
A
B
```

XIII. Are there other alternative analyses?

```
A VIF
B Challenge the results ?
C Measures of uncertainty 'e'
```

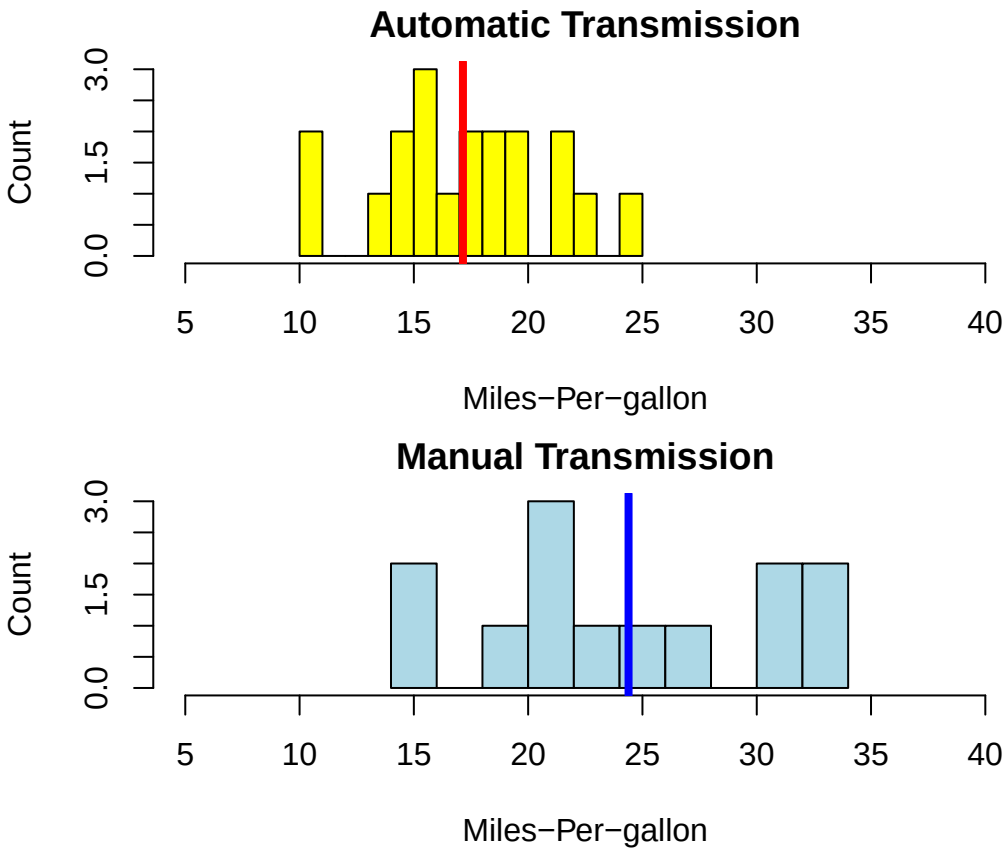
XIV. Appendix A: “Exploratory Graphical Analysis”"

Pairs Plot



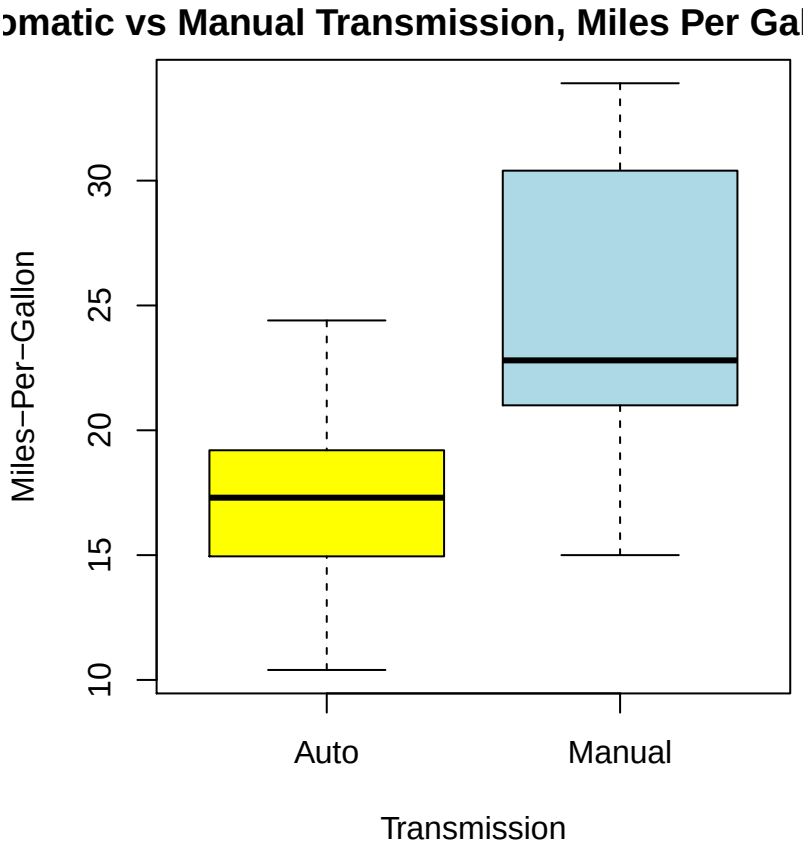
Histograms Plot

```
##                mpg cyl disp  hp drat    wt  qsec      vs     am gear carb
## Mazda RX4     21.0   6  160 110 3.90 2.620 16.46 V-block Manual    4    4
## Mazda RX4 Wag 21.0   6  160 110 3.90 2.875 17.02 V-block Manual    4    4
## Datsun 710    22.8   4  108  93 3.85 2.320 18.61 S-block Manual    4    1
```



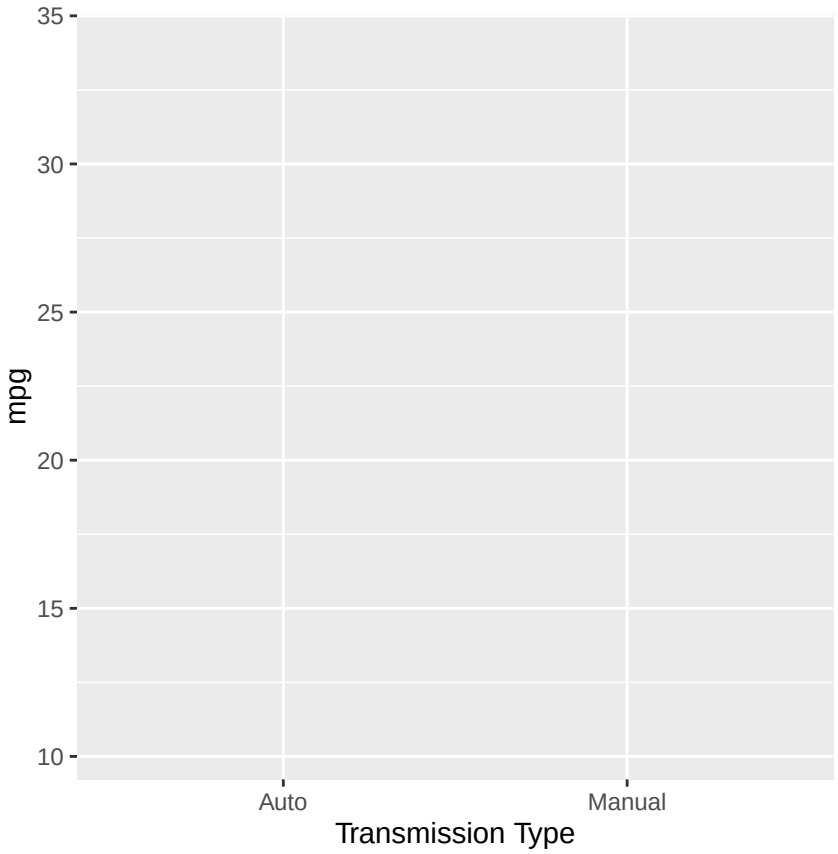
Box Plot

```
##                mpg cyl disp  hp drat    wt  qsec      vs     am gear carb
## Mazda RX4     21.0   6  160 110 3.90 2.620 16.46 V-block Manual    4    4
## Mazda RX4 Wag 21.0   6  160 110 3.90 2.875 17.02 V-block Manual    4    4
## Datsun 710    22.8   4  108  93 3.85 2.320 18.61 S-block Manual    4    1
```

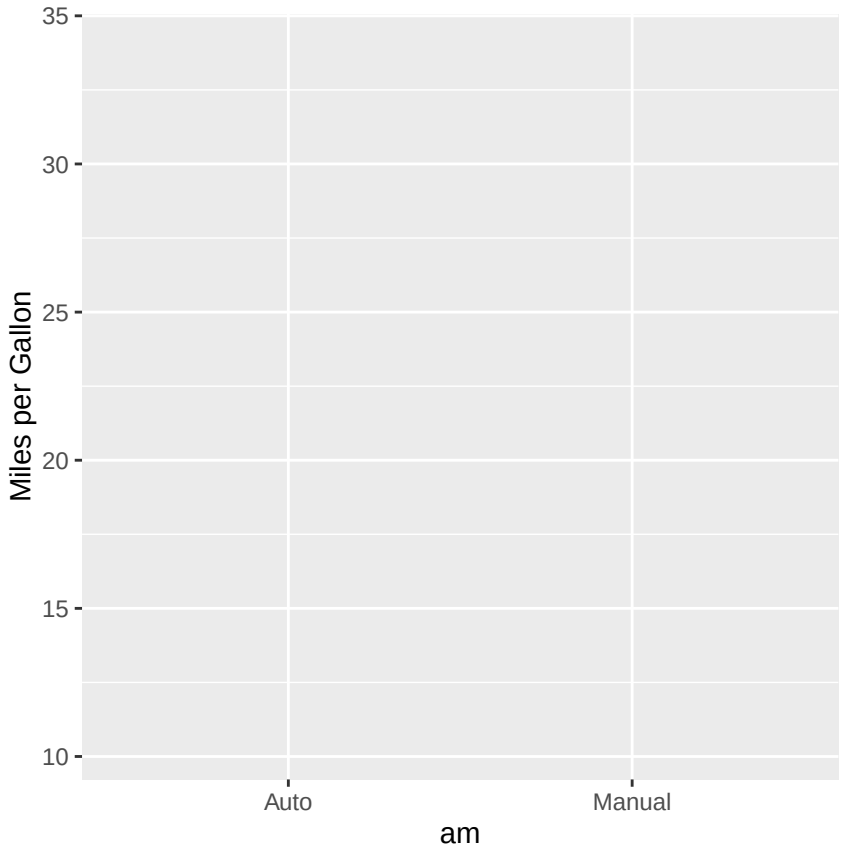


Simple Linear Regression Plot

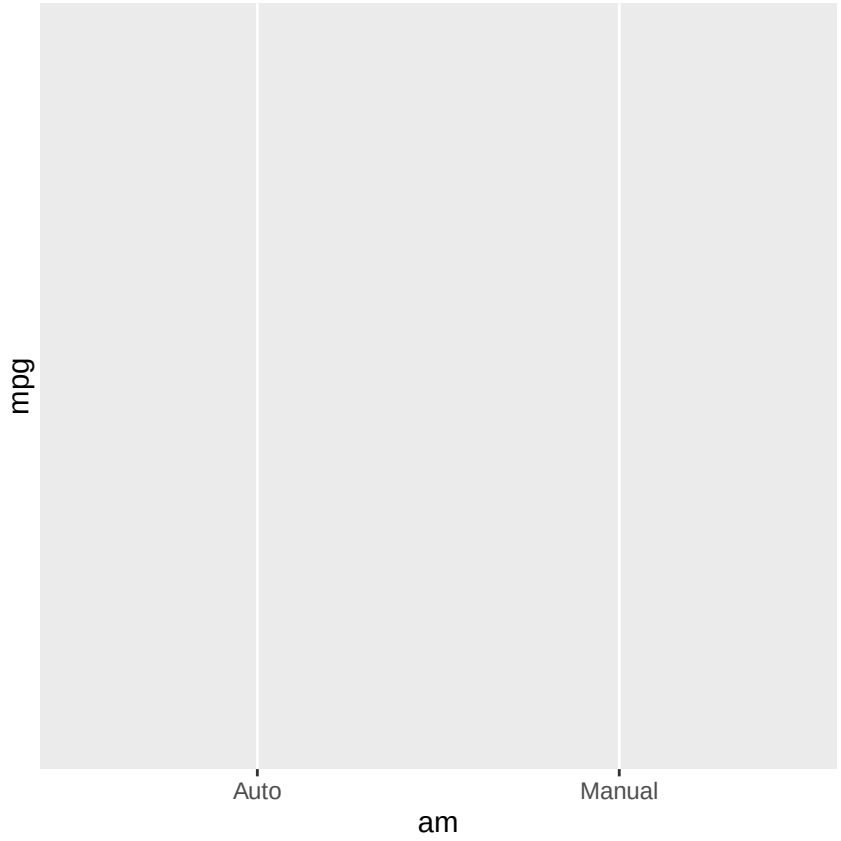
```
library(ggplot2)
fit <- lm(mpg ~ factor(am), data = mtcars)
par(mfrow = c(1,1), mar = c(4,4,2,2)) # set margin
g <- ggplot(mtcars, aes(x = am, y = mpg),)
g + xlab("Transmission Type")
```



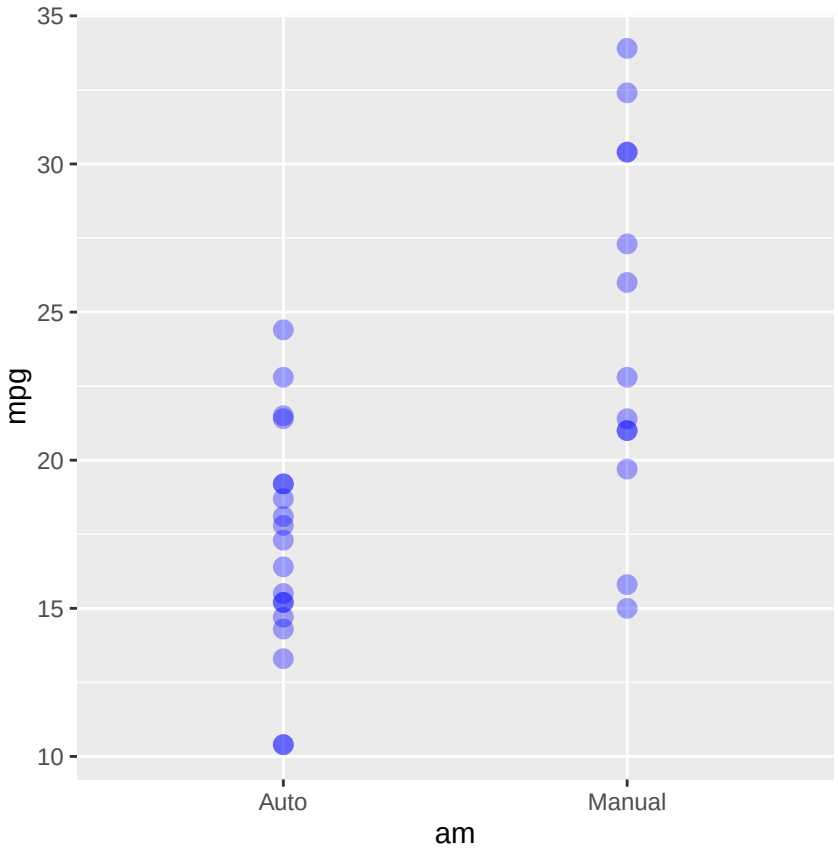

```
g + ylab("Miles per Gallon")
```



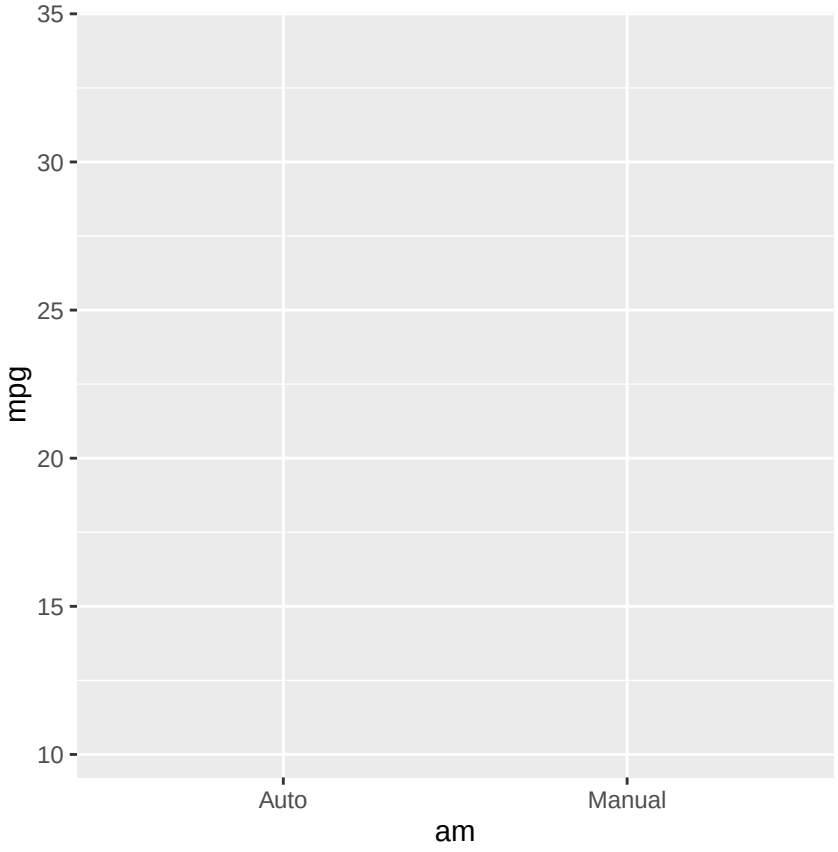

```
g + geom_smooth(method = "lm", col = "black")
```




```
g + geom_point(size = 3, col = "blue", alpha = 0.35)
```




```
g
```



NOTE: use the cut function by 3 on MPG

=== END ===