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

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Executive Summary:

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Using a broad range of linear regression model variations including the step function to gauge
model fit we idendified a model with (wt + qsec + am) that provides an 84.966 R^2 value
inidicating a reasonalby good and closeley matched a slightly different fit devloped using the
manual nested approach followed by and anova table test to check for multicollinearity which
also produced a reasonably good fit with an R^2 value of 85.13%. It must also be noted that
vehicle weight is highly correlated (-86.77%) with mpg ratings and transmission type is
relatively highly correlated with vehicle wieght at (69%).

Problem Statement:
        Backround information, problem statement & questions of interest:
        Background situation:
                As a member of a team of data analysts for the Motor Trend Magazine we have been giv
                a data set called "mtcars" and asked to answer some questions of interest concernin
                differences between automatic and  manual transmissoin types in regards to associat
                mpg or miles per gallon ratings in this data set.
        Assumptions:
                The given data set (a sample of a unknown larger population) for this analysis consi
                of (iid) independent and identically distrubuted random varialbles for 32 subjects
                (vehicles) of 11 observations or variables.

                Questions of interest for Motor Trend Magazine:

                Q1 "Is an automatic or manual transmission better for 'mpg'"
                        or which type of transmission is associated with better mpg or gas mileage i

                        A1. The mean "mpg" rating of all vehicle models including both transmission
                        is 20.09 mpg with a 95% confidence interval of 17.92 mpg to 22.26 mpg.

                Q2 "Quantify the mpg difference between automatic and manual transmissions"
                        What is the expected difference in mpg rating and how accurate
                        is this estimate based on the given data?

                        A2. The mean "mpg" of models with automatic transmisions is 17.15 mpg, with
                        confidence interval of between 14.85 mpg to 19.44 mpg and vehicles with manu
                        transmisions have a mean of 24.39 mpg for a difference of 7.24 mpg with a 95
                        confidence interval of between 18.49 mpg and 30.29 mpg
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Analysis Considerations:
Descriptive - any(is.na()), str() & summary(), Exploratory - pairsPlots(), histograms(), boxPlots(), barPlots() QQ_Plots & multiple plots Regression Models Analysis - SLR, BiVariate Regression, Multivariate Linear Regression, model selection, adjustments, residuals (predict fit, residual fit (-1)), coeficients, correlation, confidence intervals, influence & leverage, Diagnostics See section on Diagnostics Final Model Selection

strategy Beginning with the simmple linear regression using just one predictor (am), Use a bivariate model, Use a multivariate model, Use an intercept adjusted multivariate model Use a multivariate model removing a suspected key regressor, Use the nested multivariate process Use the step(function) both directions process, Usee different combinations and leave out from
the results of the step(function), Choose the best fit which is understandable and easy to explian

Technical Environment:
System - session Info; Set the Working Directory; Record the System & Session Info; Check for required packages

Raw Data:
Clean up work space, import the data & check for missing values Overview: Motor Trend 'mtcars' data set:

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 (0 = vee-block, 1 = straight-block) [, 9] am Transmission (0 = automatic, 1 = manual) [,10] gear Number of forward gears (3:5) [,11] carb Number of carburetors (1:4,6,8)

Processed Data:
Factor columns 2 & 8:11 (cyl,vs,am,gear,carb) so there values can be used as levels

Descriptive Statistics:

Exploratory Analysis:
See Appendix A. Figures (pairs-plot, histogram, box-plot)

Statistical Modeling:
Multivarite Linear Model Finding Best Fit with Step function:

```
library(stats);library(MASS)
fstp <- lm(mpg ~ ., data = mtcars)
stp <- step(fstp, trace = FALSE)
table(coef(summary(stp)))
summary(stp)$r.squared
```

Preliminary findings: # Quesions of interest: & interpretation of results: A Revisit the Question - Considering all regressors: A. Is an automatic or manual transmission better for mpg The results of using multiple linear regression techniques
sugggest that manual transmissions are associated with better mpg ratings than automatic transmissions B. Quantify the MPG difference between automatic and manual transmissions On average manual transmissions provides 24.39 mpg which is 7.24 mpg more than the 17.15 mpg average of the automatic transmission models B Primary result A. Are any other regressors significantly correlated with mpg rating? a. model fnm6 = factor(am) + cyl + disp + hp + drat + wt this model has an R^2 value of 85.13% B. Further testing a. using the step function in both directions selects wt, qsec and am as good predictors with an 84.96% R^2 value indicating very good predictability using this set of regresssors

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C Direction, Magnitude, Uncertainty
        A.
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Multivarite Linear Model Finding Best Fit with Step function:

```
library(stats);library(MASS);library(ggplot2)
fstp <- lm(mpg ~ ., data = mtcars)
stp <- step(fstp, trace = FALSE)
coef(summary(stp))
```

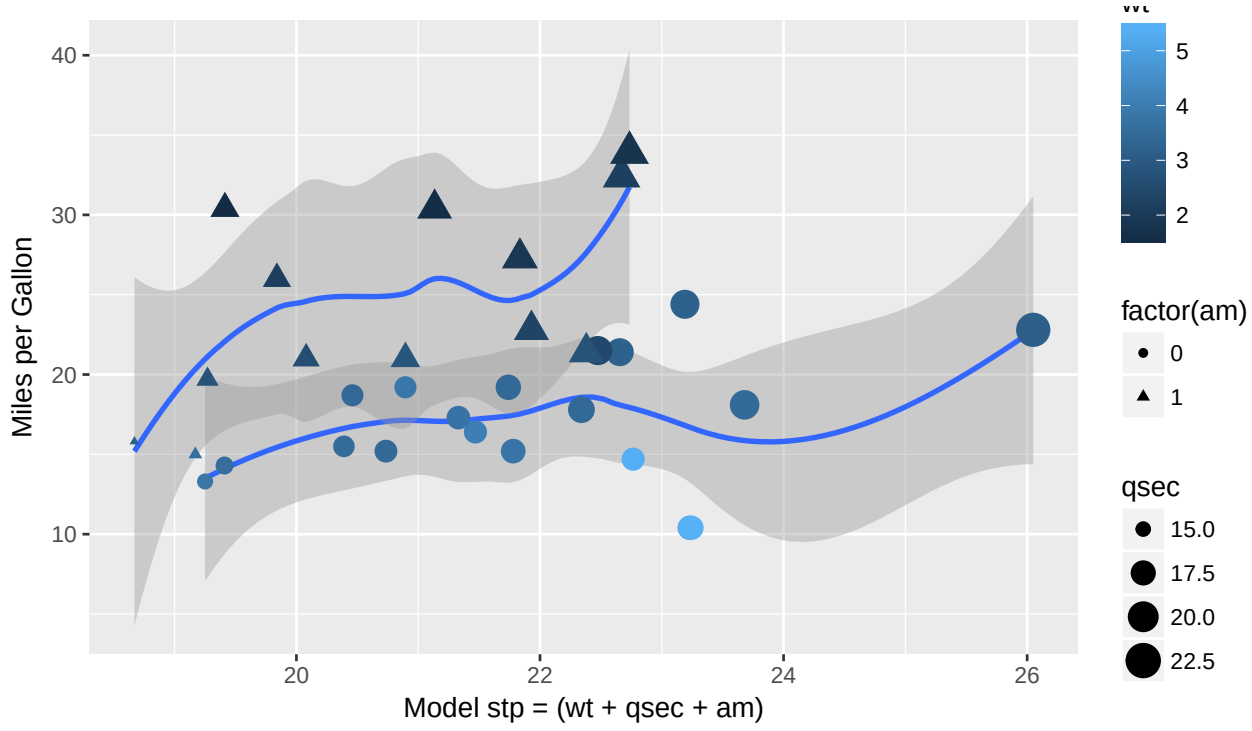
```
            Estimate Std. Error    t value     Pr(>|t|)
```

(Intercept) 9.617781 6.9595930 1.381946 1.779152e-01 wt -3.916504 0.7112016 -5.506882 6.952711e-06 qsec 1.225886 0.2886696 4.246676 2.161737e-04 am 2.935837 1.4109045 2.080819 4.671551e-02

```
summary(stp)$r.squared
```

[1] 0.8496636

```
par(mfrow = c(1, 1), mar = c(4,4,4,2))
g <- ggplot(mtcars, aes(x = (wt + qsec + am), y = mpg),)
g <- g + xlab("Model stp = (wt + qsec + am)")
g <- g + ylab("Miles per Gallon")
g <- g + geom_smooth(aes(method = "lm", shape = factor(am)))
g <- g + geom_point(aes(shape = factor(am), size=qsec, colour=wt))
g
```



D Context A. It should be noted that vehicle weight has a strong negative correlation to mpg ratings (-86.76%) and the weight of vehicle models with manual transmissions
range from 1.513tons to 3.570 tons and the weight of vehicles with automatic
transmissions range from 2.465 tons to 5.424 tons

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E Implications - Congruence with existing knowledge?
        A. Sedan, Sports, Luxury
        Generally accepted expectations of mpg ratings are that sports and luxury models
        typically will have lower mpg ratings than sedans
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Diagnostics:
Diagnostic tests were conducted on model results in accordance with the plan for analysis considerations. Besides several vehicle models exhibiting leverage on the model fit at the high end of the qsec, and weight scales results were generally as expected with faster and or heavier vehilces of both manual and automatic transmissoin types getting lower mpg ratings and slower lighter vehicle models of both transmission types exhibiting better or higher mpg ratings.

Hypothesis Test: ? H0 = mean(automatic transmission)mpg = mean(manual transmission)mpg Ha = mean(automatic transmission)mpg != mean(manual transmission)mpg

Inference & Prediction: ?

Interpretation of Results: #

Appendix A. Figures: need to review again possibly condense to one plot