Multi linear Regression Report on fuel efficiency of Automobile

Issues :

Our data collection includes numerical data on various vehicle characteristics such as weight, engine performance, displacement, acceleration, and miles per gallon (mpg). We can utilize the mpg metric to investigate the relationships between different vehicle parts and build a predictive model for a car's fuel efficiency based on multiple variables.

To achieve this, we need to answer three important questions:

1.Are one or more predictors useful in predicting the response variable?

2.Do all predictors contribute to explaining the response, or only a subset of predictors is useful?

3.How well does the model fit the data, and how accurate is our prediction given a set of predictor values?

Findings:

Based on the analysis, acceleration is the only variable that has a positive relationship with mpg, while displacement, horsepower, and weight have a negative relationship. The p-values indicate that among the variables of horsepower, acceleration, displacement, and weight, only weight is a statistically significant factor in relation to mpg.

Discussions:

Our analysis involved studying the dataset provided to determine the relationship between the five variables, using the 377 samples that were part of the dataset. To identify the significant variables, we examined the correlation matrix. We also assessed the fit of the model by considering the P-value. Based on our analysis, we can conclude that the model is a good fit for the sample.

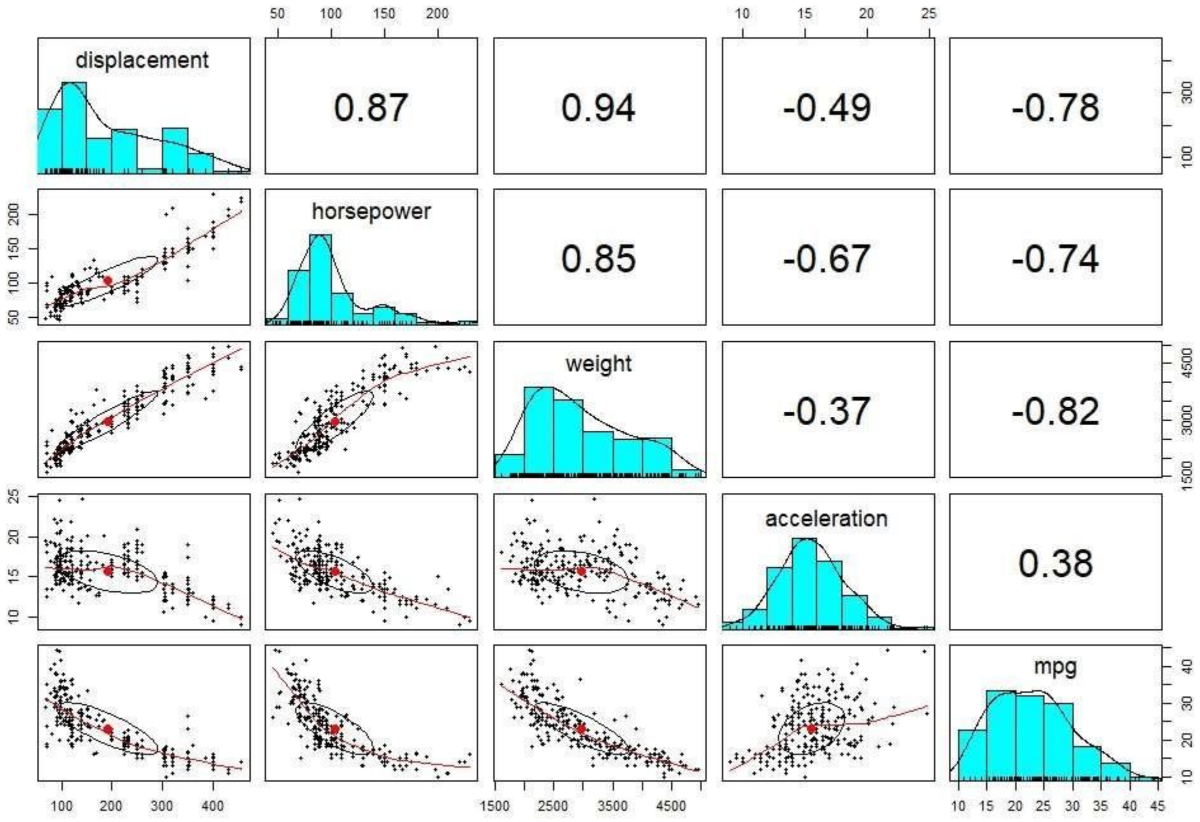
Appendix A: Method

To explore the relationship between fuel efficiency and various factors like horsepower, acceleration, weight, and displacement, we used multiple linear regression analysis since we had multiple predictor variables. We imported the data from a .csv file into R Studio and conducted the analysis. The car's fuel efficiency was represented by miles per gallon (MPG), while horsepower indicated the engine's power. Acceleration referred to how quickly the car could change speed, weight represented the car's total weight, and displacement measured the cylinder volume swept. To analyze the correlation between variables and determine the significance of each variable on the dependent variable, we utilized several statistical tools such as correlation scatter plots, linear model plots, and Pearson's method.

Appendix B: Results

Correlation value for all factors on depending variable by using the pearson method.

```
> cor(autodata, method = "pearson")
          displacement horsepower    weight acceleration       mpg displacement
1.0000000    0.8737022   0.9361073    -0.4892218  -0.7843810  horsepower
0.8737022      1.0000000     0.8491263       -0.6663514   -0.7366148   weight
0.9361073   0.8491263   1.0000000    -0.3703465 -0.8176565 acceleration    -
0.4892218 -0.6663514 -0.3703465      1.0000000   0.3753230 mpg                -
0.7843810 -0.7366148 -0.8176565    0.3753230  1.0000000
```



Correlation plots

We used the lm function to fit the multiple linear regression and obtained results are

```
> library(psych)
> head(autodata)
  displacement horsepower weight acceleration  mpg
1          120         87   2979         19.5 21.0
2          258        110   3632         18.0 16.0
3          112         88   2395         18.0 34.0
4          225        105   3439         15.5 16.0
5          304        120   3962         13.9 15.5
6          140         89   2755         15.8 25.5
> str(autodata)
Classes ‘tbl_df’, ‘tbl’ and 'data.frame':	377 obs. of  5 variables:
 $ displacement: num  120 258 112 225 304 140 91 231 134 85 ...
 $ horsepower  : num  87 110 88 105 120 89 53 110 96 52 ...
 $ weight      : num  2979 3632 2395 3439 3962 ...
 $ acceleration: num  19.5 18 18 15.5 13.9 15.8 17.5 15 13.5 22.2 ...
 $ mpg         : num  21 16 34 16 15.5 25.5 33 21 24 29 ...
> summary(autodata)
  displacement     horsepower       weight      acceleration        mpg
 Min.   : 68.0   Min.   : 46.0   Min.   :1613   Min.   : 9.00   Min.   :10.00
 1st Qu.:110.0   1st Qu.: 79.0   1st Qu.:2278   1st Qu.:14.00   1st Qu.:17.60
 Median :141.0   Median : 92.0   Median :2789   Median :15.50   Median :23.00
 Mean   :190.5   Mean   :103.3   Mean   :2969   Mean   :15.59   Mean   :23.06
 3rd Qu.:250.0   3rd Qu.:110.0   3rd Qu.:3535   3rd Qu.:17.00   3rd Qu.:27.00
 Max.   :455.0   Max.   :230.0   Max.   :4952   Max.   :24.80   Max.   :44.30
> cor(autodata, method = "pearson")
             displacement horsepower    weight acceleration        mpg displacement
1.0000000    0.8737022   0.9361073   -0.4892218  -0.7843810  horsepower
0.8737022    1.0000000   0.8491263   -0.6663514  -0.7366148   weight
0.9361073   0.8491263   1.0000000   -0.3703465 -0.8176565 acceleration   -
0.4892218 -0.6663514 -0.3703465    1.0000000   0.3753230 mpg              -
0.7843810 -0.7366148 -0.8176565    0.3753230  1.0000000
> pairs(autodata[1:5])
> pairs.panels(autodata)
> model <- lm(autodata$mpg ~ autodata$displacement+autodata$horsepower+autodata$weight+autodata$acceleration) >
model

Call:
lm(formula = autodata$mpg ~ autodata$displacement + autodata$horsepower +      autodata$weight
+ autodata$acceleration)

Coefficients:
          (Intercept)  autodata$displacement    autodata$horsepower
            41.697484              -0.003688              -0.016883
      autodata$weight  autodata$acceleration
            -0.006012               0.106837

> summary(model)

Call:
lm(formula = autodata$mpg ~ autodata$displacement + autodata$horsepower +      autodata$weight
+ autodata$acceleration)

Residuals:
```

```
    Min       1Q   Median       3Q      Max
-10.5926  -2.4007  -0.5381   1.9056  13.9616

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)           41.6974843  2.4088016  17.310  < 2e-16 ***
autodata$displacement -0.0036878  0.0067232  -0.549    0.584
autodata$horsepower   -0.0168827  0.0159579  -1.058    0.291
autodata$weight       -0.0060121  0.0008578  -7.008 1.14e-11 ***
autodata$acceleration  0.1068368  0.1235718   0.865    0.388
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.032 on 372 degrees of freedom
Multiple R-squared:  0.6761,	Adjusted R-squared:  0.6726
F-statistic: 194.1 on 4 and 372 DF,  p-value: < 2.2e-16
```

The linear regression model shows that there is a significant relationship between the dependent variable (mpg) and the independent variables (displacement, horsepower, weight, and acceleration). The intercept value is 41.6974843, which indicates that when all independent variables are zero, the predicted value of the dependent variable is 41.6974843. The coefficients of displacement, horsepower, weight, and acceleration are -0.0036878, 0.0168827, -0.0060121, and 0.1068368, respectively. Only weight has a significant impact on the dependent variable, as evidenced by its very low pvalue of 1.14e-11. In contrast, the p-values of the other three independent variables are greater than 0.05, indicating that they are not significant predictors of the dependent variable. The R-squared value of the model is 0.6761, meaning that 67.61% of the variation in the dependent variable can be explained by the independent variables. The adjusted R-squared value of 0.6726 indicates that the model's fit is not significantly improved by adding more independent variables. The F-statistic of 194.1 with a very low p-value indicates that the model is statistically significant overall. The residual standard error is 4.032, indicating that the model has a good fit to the data.

Mpg = 41.6974-(0.003687*displacement)-(0.0168827*horsepower)

-(0.0060121*weight)+(0.1068368*acceleration)

Appendix C: Code

```
library(psych)

head(autodata)
str(autodata)
summary(autodata)

cor(autodata, method = "pearson")
pairs(autodata[1:5])
pairs.panels(autodata)

model <- lm(autodata$mpg ~ autodata$displacement +
autodata$horsepower + autodata$weight + autodata$acceleration)
summary(model)
```