Research Project

Alan Liu

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Introduction

```
# Load library
library(tidyverse)

## -- Attaching packages ----------------------------------------------------
-----------------------------------------------------------------------------
---------------- tidyverse 1.3.0 --

## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.3     v dplyr   1.0.2
## v tidyr   1.1.1     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0

## Warning: package 'ggplot2' was built under R version 4.0.3

## -- Conflicts -------------------------------------------------------------
-----------------------------------------------------------------------------
---------- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

# install.packages(readr)
library(readr)

# install.packages(car) on a separate R script
library(car)

## Warning: package 'car' was built under R version 4.0.3

## Loading required package: carData

## Warning: package 'carData' was built under R version 4.0.3

##
## Attaching package: 'car'

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

## The following object is masked from 'package:purrr':
##
##     some
```

```
# install.packages(psych) on a separate R script
library(psych)

##
## Attaching package: 'psych'

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

## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha

# install.packages('readr'leaps')
library(leaps)

# Import data
cpudata <- read_csv("researchproject_data.csv")

## Parsed with column specification:
## cols(
##   MSRP = col_double(),
##   Year = col_double(),
##   Benchmark_Result = col_double(),
##   Brand = col_character(),
##   Processor = col_character(),
##   Chipset = col_character()
## )
```

Variables

MSRP - Currency, numerical variable that displays the original price a chip was marketed for

Year - Date, numerical variable that is the original year of release for the chip

Benchmark_Result - Rating, numerical variable that calculates the performance of a chip

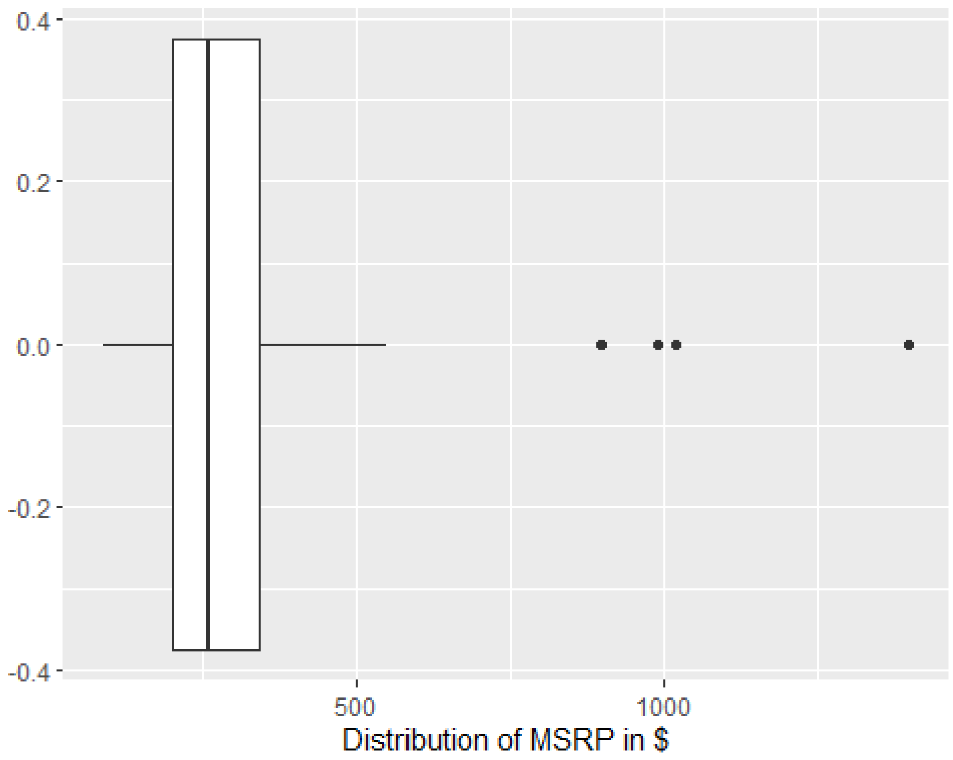
Brand - Name, categorical variable that displays the branding of a chip

Processor - Name, categorical variable that displays the associated chip

Chipset - Name, categorical variable that displays the chipset the processor was built on

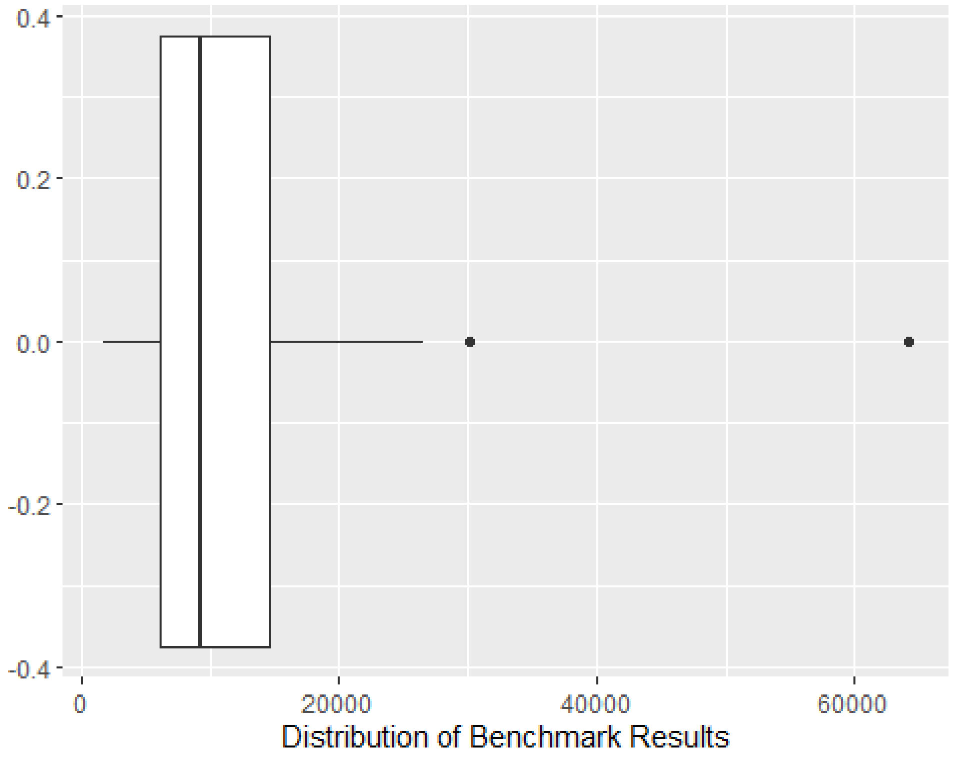
##Variable Regression Analysis

```
# Visualize the predictor variable
# Creates the box plot for MSRP
ggplot(cpudata, aes(y=MSRP)) +
  geom_boxplot() + coord_flip() +
  labs(y = "Distribution of MSRP in $")
```



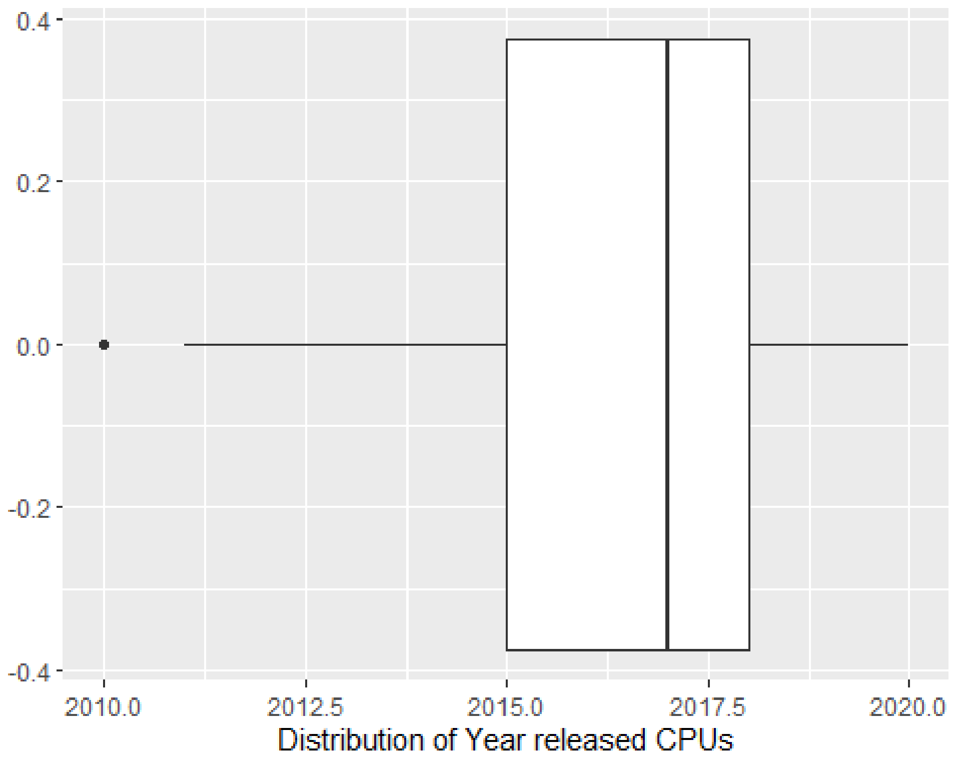
This box plot shows a distribution of the MSRP across the 60 CPUs in the data.

```r
# Visualize the predictor variable
# Creates the box plot for Benchmark_Results
ggplot(cpudata, aes(y=Benchmark_Result)) + geom_boxplot() + coord_flip() +
  labs(y = "Distribution of Benchmark Results")
```



This box plot shows a distribution of the Benchmark Results for all the CPUs. The higher the score, the better performance the CPU has.

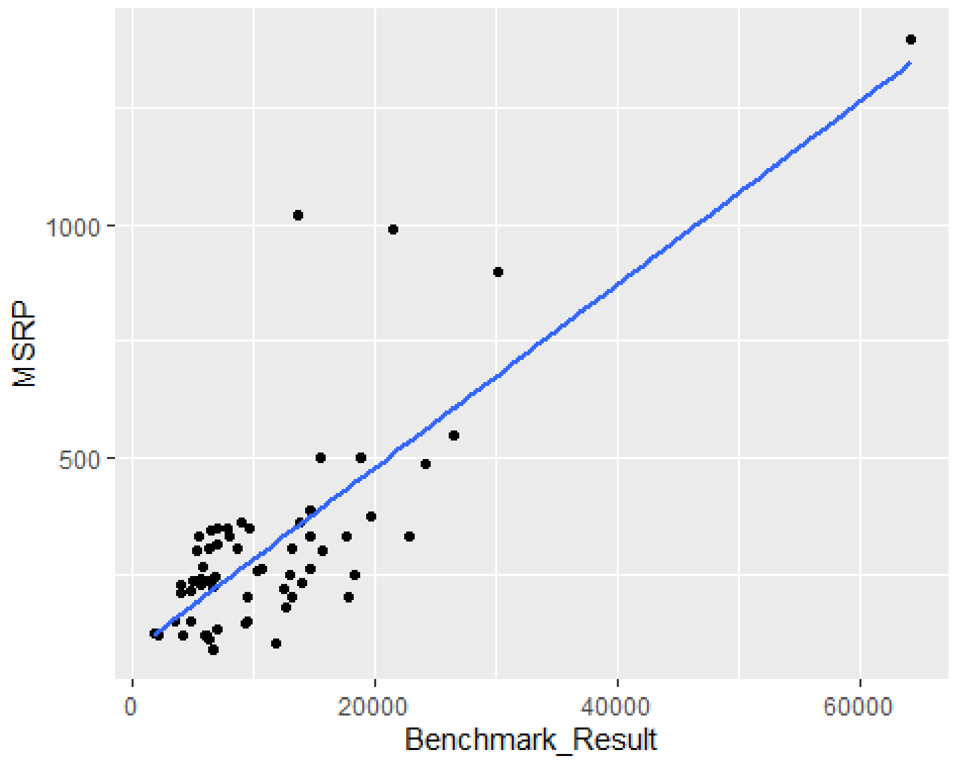
```r
# Visualize the predictor variable
# Creates the box plot for Year
ggplot(cpudata, aes(y=Year)) + geom_boxplot() + coord_flip() +
  labs(y = "Distribution of Year released CPUs")
```



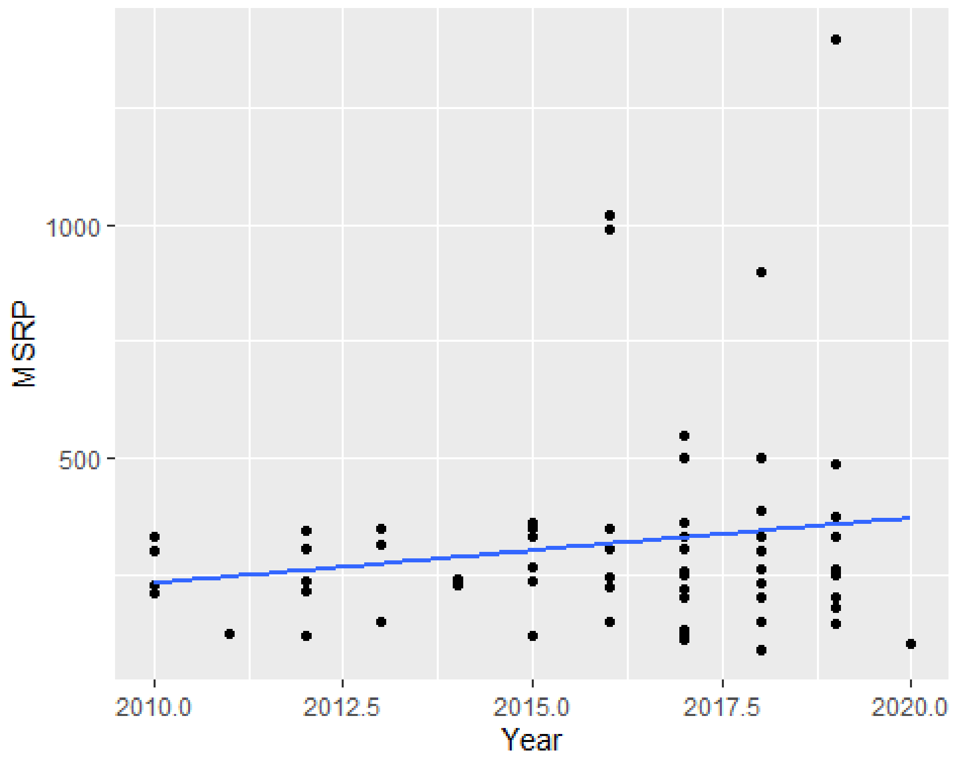
This box plot shows a distribution of the years released for all the CPUs.

```
# Visualize the data with the regression line
# Creates the scatterplot for MSRP
ggplot(cpudata, aes(x=Benchmark_Result, y=MSRP)) +
  geom_point() +
  geom_smooth(method='lm', se = FALSE)
```

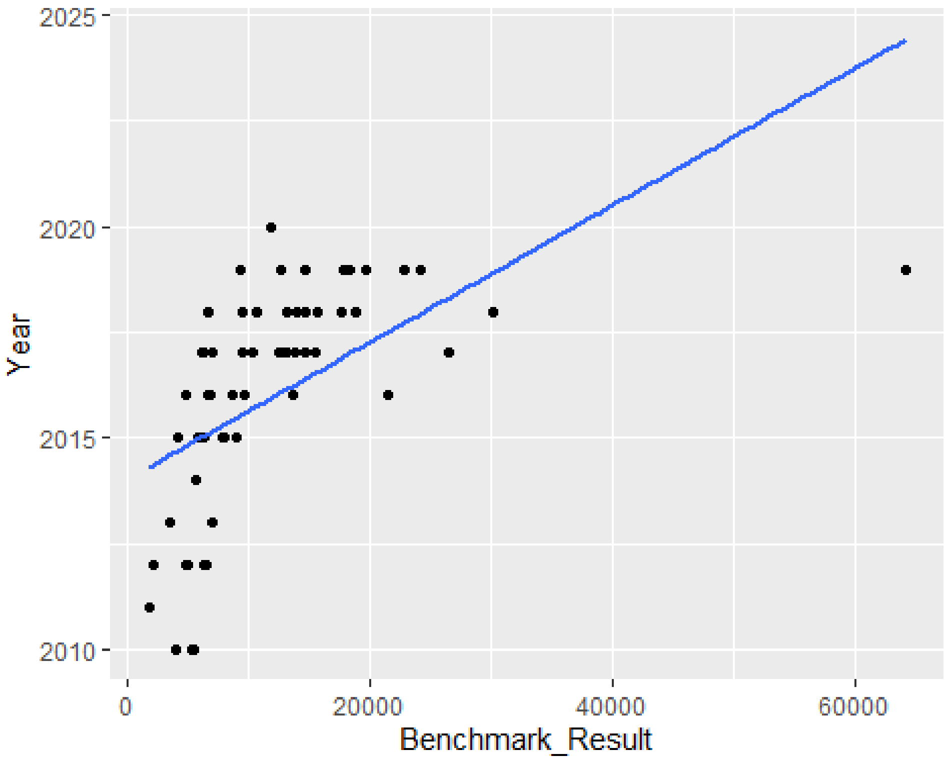
```
## `geom_smooth()` using formula 'y ~ x'
```



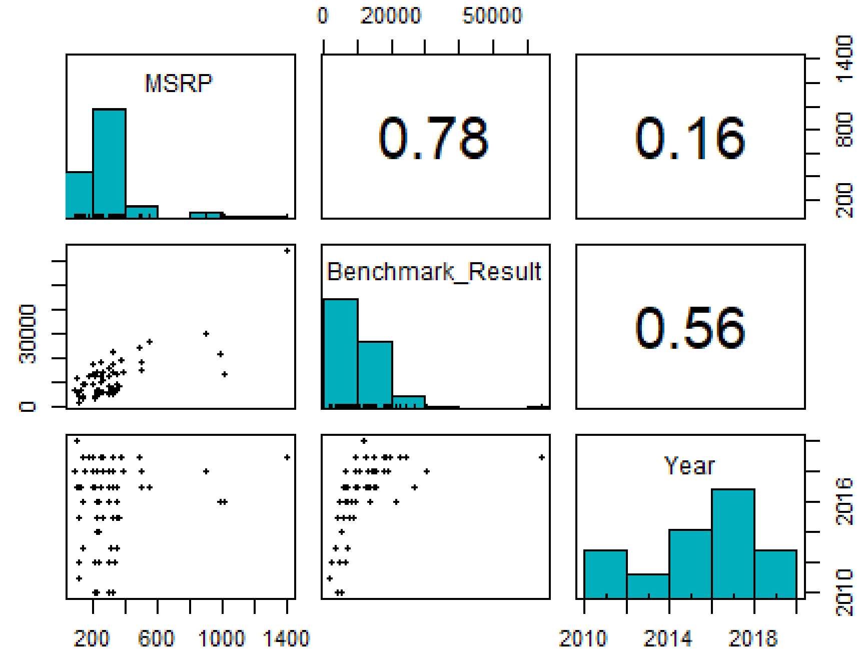
```
# Summary statistics : Correlation coefficient
# Calculates the correlation coefficient for Air Permeability
cor(cpudata$MSRP,cpudata$Benchmark_Result)

## [1] 0.7791367

# Visualize the data with the regression line
# Creates the scatterplot for Year
ggplot(cpudata, aes(x=Year, y=MSRP)) +
  geom_point() +
  geom_smooth(method='lm', se = FALSE)

## `geom_smooth()` using formula 'y ~ x'
```



```
# Summary statistics : Correlation coefficient
# Calculates the correlation coefficient for Air Permeability
cor(cpudata$MSRP,cpudata$Year)

## [1] 0.1625529

# Visualize the data with the regression line
# Creates the scatterplot for Predictors
ggplot(cpudata, aes(x=Benchmark_Result, y=Year)) +
  geom_point() +
  geom_smooth(method='lm', se = FALSE)

## `geom_smooth()` using formula 'y ~ x'
```



```
# Summary statistics : Correlation coefficient
# Calculates the correlation coefficient for Air Permeability
cor(cpudata$Year,cpudata$Benchmark_Result)

## [1] 0.5551998

# A fancy scatterplot matrix
pairs.panels(cpudata[c("MSRP","Benchmark_Result","Year")],
method = "pearson", # correlation method
hist.col = "#00AFBB", # color of histogram
smooth = FALSE, density = FALSE, ellipses = FALSE)
```



Graphs indicate the correlation coefficients among all three variables and provide various plots that indicate point distributions (via histograms and scatterplots).

Model Building Strategy

```
# Fit the regression model with 1 predictor, Benchmark Results
reg <- lm(MSRP ~ Benchmark_Result + Year, cpudata)

# Display the summary table for the regression model
summary(reg)

## 
## Call:
## lm(formula = MSRP ~ Benchmark_Result + Year, data = cpudata)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -166.93  -63.79  -23.16   40.69  658.42 
## 
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)    
## (Intercept)       6.805e+04  1.474e+04   4.617 2.21e-05 ***
## Benchmark_Result  2.517e-02  2.140e-03  11.763  < 2e-16 ***
## Year             -3.374e+01  7.318e+00  -4.611 2.25e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
```

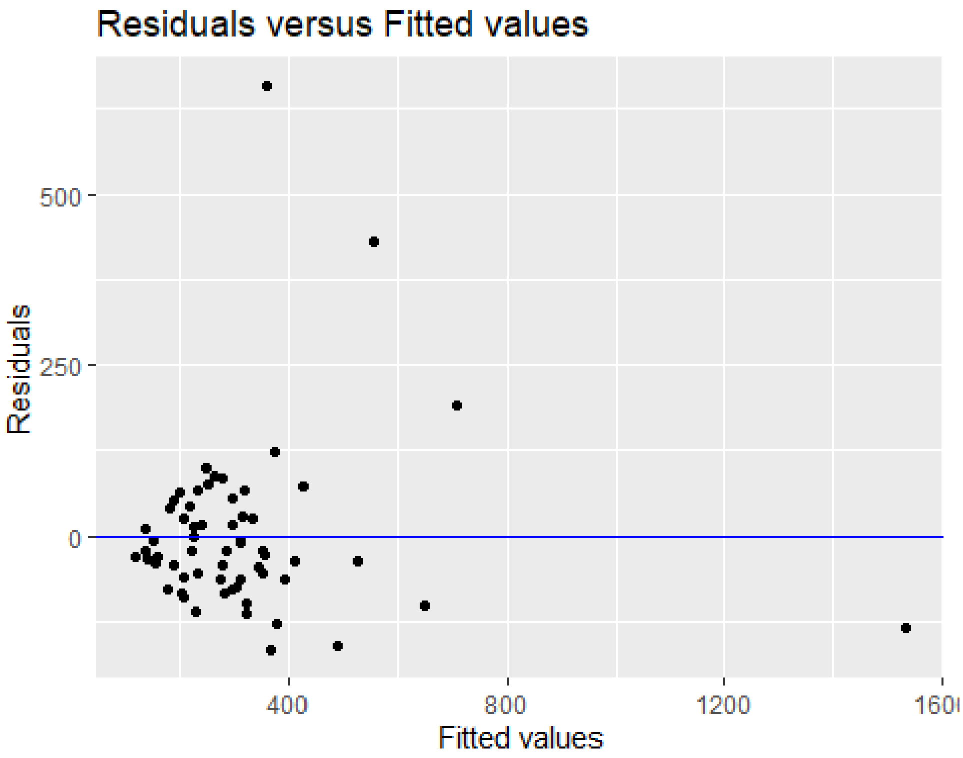
```
## Residual standard error: 127.6 on 58 degrees of freedom
## Multiple R-squared:  0.7125, Adjusted R-squared:  0.7025
## F-statistic: 71.85 on 2 and 58 DF,  p-value: < 2.2e-16
```

```
# Display the correlation coefficient
coefficients(reg)
```

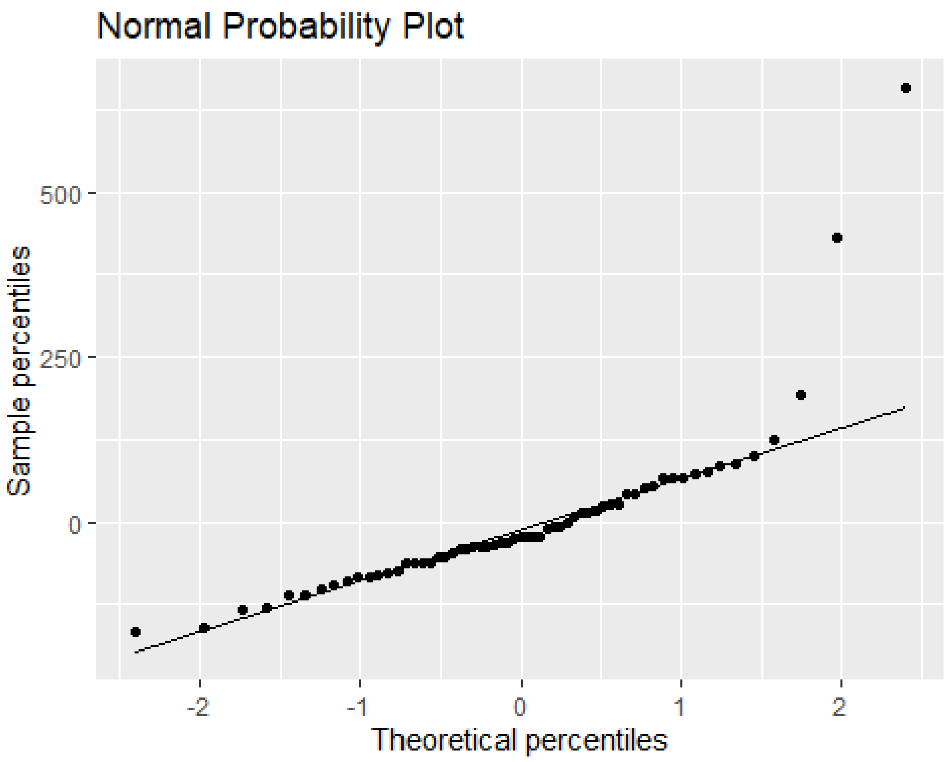
```
##      (Intercept) Benchmark_Result             Year
##     6.804720e+04     2.517316e-02    -3.374488e+01
```

Assumptions Check

```
# Residuals versus Fitted values
cpudata$resids <- residuals(reg)
cpudata$predicted <- predict(reg)
ggplot(cpudata, aes(x=predicted, y=resids)) + geom_point() +
geom_hline(yintercept=0, color = "blue") +
labs(title ="Residuals versus Fitted values", x = "Fitted values", y
="Residuals")
```



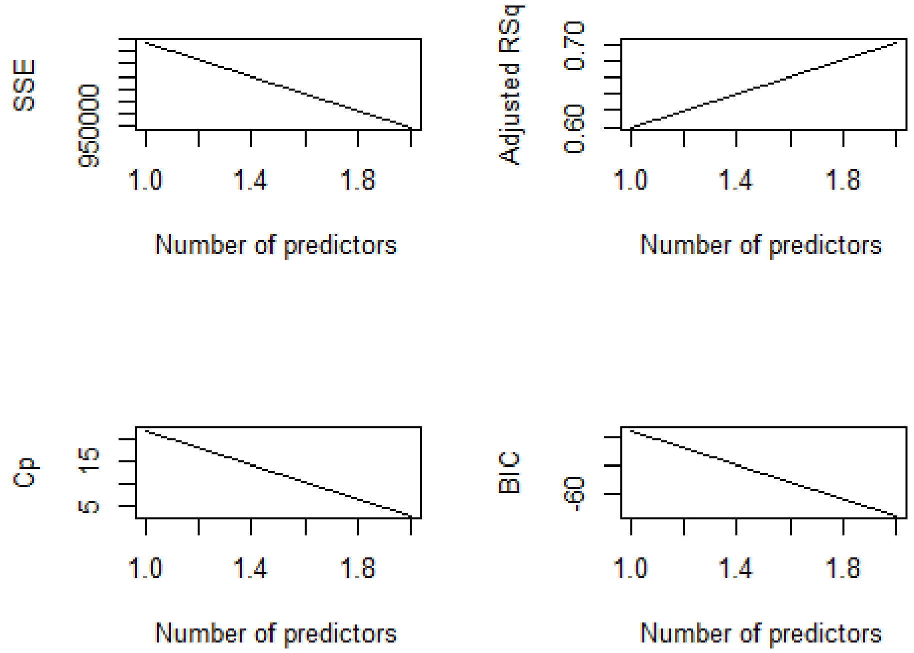
```
# Normal probability plot
ggplot(cpudata, aes(sample = resids)) + stat_qq() + stat_qq_line() +
labs(title ="Normal Probability Plot", x = "Theoretical percentiles", y =
"Sample percentiles")
```



Will have to ejected some outliers in order to make the assumptions checks pass. Too many outliers that could lead to incorrect assumptions.

Deciding on the Best Model

```
# Find the best model for each number of predictors (with 3 predictors maximum)
models <- regsubsets(MSRP ~ Benchmark_Result + Year, cpudata, nvmax = 3)
models.sum <- summary(models)
# Create four plots within a 2x2 frame to compare the different criteria
par(mfrow = c(2,2))
# SSE
plot(models.sum$rss, xlab = "Number of predictors", ylab = "SSE", type = "l")
# R2
plot(models.sum$adjr2, xlab = "Number of predictors", ylab = "Adjusted RSq", type = "l")
# Mallow's Cp
plot(models.sum$cp, xlab = "Number of predictors", ylab = "Cp", type = "l")
# BIC
plot(models.sum$bic, xlab = "Number of predictors", ylab = "BIC", type = "l")
```



```
# Calculate the squared predictor variables to include in the model and the
interaction term:
cpudata <- cpudata %>%
mutate(bench2 = Benchmark_Result^2,
bench.year = Benchmark_Result*Year)
# Fit the polynomial regression model
reg2 <- lm(MSRP ~ Year + Benchmark_Result + bench2 + bench.year, cpudata)
# Display the summary table for the regression model
summary(reg2)

##
## Call:
## lm(formula = MSRP ~ Year + Benchmark_Result + bench2 + bench.year,
##     data = cpudata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -305.43  -43.84   -6.61   32.58  529.29
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -1.458e+04  2.344e+04  -0.622    0.537
## Year              7.194e+00  1.164e+01   0.618    0.539
## Benchmark_Result  1.582e+01  2.871e+00   5.510 9.40e-07 ***
## bench2            9.386e-08  8.796e-08   1.067    0.291
## bench.year       -7.826e-03  1.424e-03  -5.497 9.85e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 100.9 on 56 degrees of freedom
## Multiple R-squared:  0.8263, Adjusted R-squared:  0.8139
## F-statistic: 66.59 on 4 and 56 DF,  p-value: < 2.2e-16
```

Choose the best model.

```
# Display the best model (selected predictors are indicated by *) for each
number of predictors
models.sum$outmat

##          Benchmark_Result Year
## 1  ( 1 ) "*"              " "
## 2  ( 1 ) "*"              "*"
```

Creating the final model

```
# Printing the final model with the best number of predictor variables
final_model <- lm(MSRP ~ Benchmark_Result + Year, cpudata)
summary(final_model)

##
## Call:
## lm(formula = MSRP ~ Benchmark_Result + Year, data = cpudata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -166.93  -63.79  -23.16   40.69  658.42
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       6.805e+04  1.474e+04   4.617 2.21e-05 ***
## Benchmark_Result  2.517e-02  2.140e-03  11.763  < 2e-16 ***
## Year             -3.374e+01  7.318e+00  -4.611 2.25e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 127.6 on 58 degrees of freedom
## Multiple R-squared:  0.7125, Adjusted R-squared:  0.7025
## F-statistic: 71.85 on 2 and 58 DF,  p-value: < 2.2e-16
```

The equation for the final model is without outliers removed:

MSRP = 6805 + 2.517e^-2(Benchmark_Result) - 33.74(Year)

The coefficient of determination is 0.7125.