ISQS 6350 Project

A Study of the Factors Affecting Car Fuel Efficiency

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INTRODUCTION

This paper sets out to identify the factors that affect the Fuel Economy of Cars. This topic is very relevant given the increasingly Global call for reduction in green-house gas emission of which petroleum products such as fuel is a major source of it. Fuel economy, a measure of energy efficiency in vehicle (thereafter "Car"), plays a vital role in reducing consumption of traditional fuel and thereby also ultimately reducing green-house emissions. We will be using Miles per Gallon (thereafter "MPG") as our measure of fuel efficiency because of the comprehensive nature of what goes into calculating this measure. Using the MPG as a guideline, a higher MPG number implies the Car is more fuel-efficient, while a lower number implies the Car is less fuel-efficient.

A Car has several components or variables contributing to its speed, fuel efficiency and overall value. These attributes can be represented numerically and can provide an insight into how the combinations of these attributes affect the vehicles performance. In this project, we will examine how the relationship of several vehicle variables affects its fuel efficiency and ultimately the environmental footprint. In particular, how does the other variables effect the MPG rating of a car. The dataset that will be used is for Cars manufactured from the 70s and 80s by European, American and Japanese car manufacturers. This dataset has three (3) multivalued discrete variable, five (5) continuous variables and a string variable representing the car name.

Data Dictionary:

We retrieved two datasets from the UC Irvine Machine Learning Repository, i.e. the modified and the original versions. However, for the purpose of this project we will concentrate on the original dataset. The modified dataset unlike the original omitted eight of the original instances had unknown values for the "MPG" attribute. Because of risks of bias, filling the unknown "MPG" attribute will be utilized instead. Also, both datasets have six missing values for the "horsepower" attribute making a total of 14 missing values. The original dataset has 406 observations and 9 variables or attributes. All but one of the

attributes is not numerical. All unknown or missing values will be filled to maintain data integrity.

We will further describe the attributes of each variable in Table 1 below. Also, the direct link to the website from which the dataset was sourced is:

https://archive.ics.uci.edu/ml/datasets/Auto+MPG

Table 1: Data Dictionary for Car Mpg Data:

Column	Column Label	Types of Variable	Explanation	Numerical Units
1	MPG	continuous	Miles per gallon for car	mpg
2	Cylinders	multi-valued discrete	Name of Cylinders	String
3	Displacement	continuous	Engine displacement	cu. inches
4	Horsepower	continuous	maximum power a car engine can put out	hp
5	Weight	continuous	vehicle weight	lbs.
6	Acceleration	continuous	time to accelerate from 0 to 60 mph	sec.
7	Model Year	multi-valued discrete	model year the car manufactured	unique for each instance
8	Origin	multi-valued discrete	origin of car	1 = American, 2 = European, 3 = Japanese.
9	Car Name	string	model names for each car	unique for each instance

Source: UCI Machine Learning Repository

Citation::Quinlan, R. "Auto MPG Data Set ." *UCI Machine Learning Repository: Auto MPG Data Set*, 7 July 1993, archive.ics.uci.edu/ml/datasets/Auto+MPG.

DATA CLEANING AND VISUALIZATION

In this section we aim to prepare the data for our analysis. Primarily, we will ensure there are no Null observations and most importantly scale our Data to normalized it as our variables have different measurement standards.

The original data started with 406 observations across 9 variables identified in Table 1. We removed the 3 non-numeric variables namely column 7, 8, 9 to enable us carry out numeric calculations. Empty observations (NA's) were filled using median to fill these missing variables (column). "Car names" was used as our row names. Because of the restrictions on duplicate row names (which is 94 in our dataset), we exported the dataset in Python. In Python, we made "Car names" our row names and removed duplicates and imported it in R, resulting to only 312 rows. The modified data was imported back to R and it is saved in a CSV file named original. For Scaling, we used the scale function in R- this normalizes the data.

The first Six data from our Dataset are identified below:

```
head(original)

##                            mpg cylinders displacement horsepower weight
## chevrolet chevelle malibu  18          8          307        130   3504
## buick skylark 320          15          8          350        165   3693
## plymouth satellite         18          8          318        150   3436
## amc rebel sst              16          8          304        150   3433
## ford torino                17          8          302        140   3449
## ford galaxie 500           15          8          429        198   4341
##                            acceleration model.year origin
## chevrolet chevelle malibu         12.0         70      1
## buick skylark 320                 11.5         70      1
## plymouth satellite                11.0         70      1
## amc rebel sst                     12.0         70      1
## ford torino                       10.5         70      1
## ford galaxie 500                  10.0         70      1
```

To gain useful insights into our dataset and further understand the correlation between our MPG and the other variables, we plotted a scatterplot of the variables with MPG.
The results are presented below:

Fig1: Scatterplot for MPG vs Cylinders

Fig2: Scatterplot for MPG vs displacement

Fig3: Scatterplot for MPG vs horsepower

Fig4: Scatterplot for MPG vs weight

Fig5: Scatterplot for MPG vs acceleration
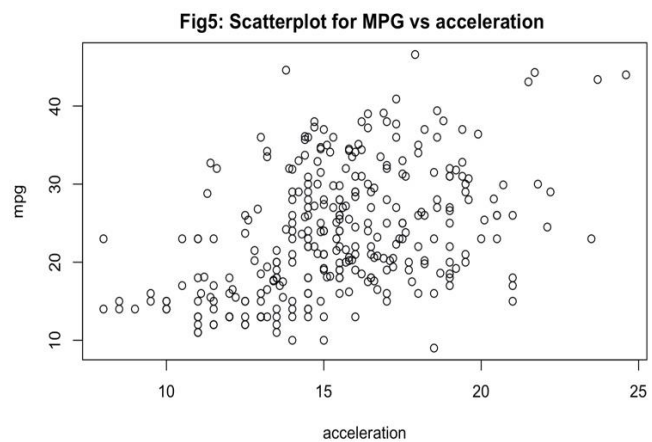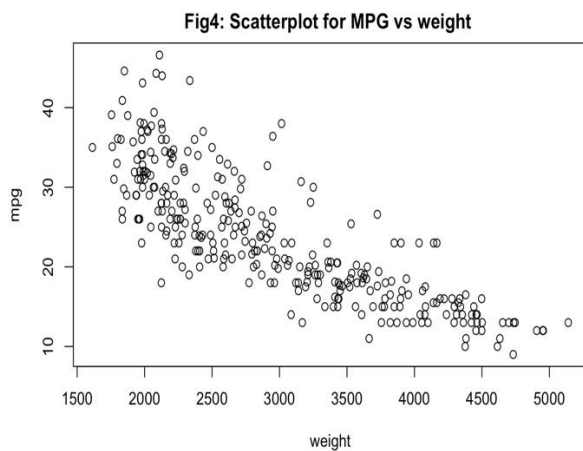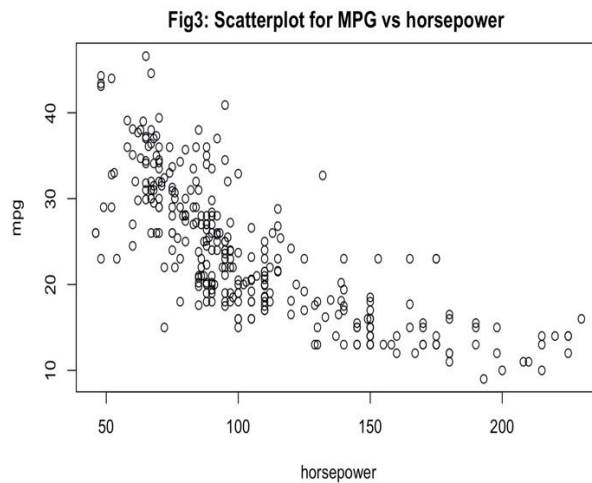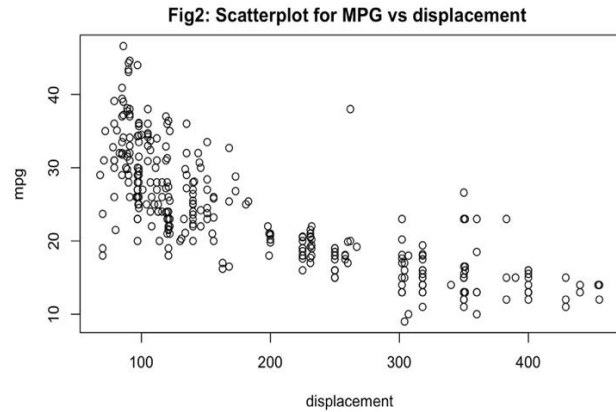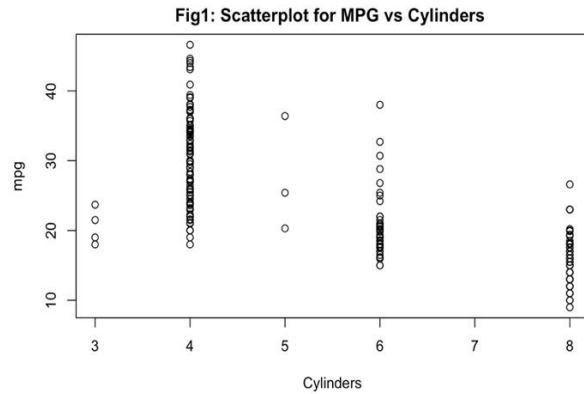
Findings:

- Negative correlation- the lower the displacement, the higher the MPG
- Negative correlation- the lower the horsepower, the higher the MPG
- Negative correlation- the lower the car weight, the higher the MPG
- Positive correlation- the higher the acceleration, the higher the MPG
- Cylinder seems undefined as this is directly related to the standard cylinders of cars; it shows that higher the cylinder the lower the MPG

DIMENSION REDUCTION ANALYSIS

We will be using 2 main Dimension Reduction techniques here, namely Principal Component Analysis ("PCA") and Exploratory Factor Analysis("EFA"). Another type of factor analysis, the Confirmatory Factor Analysis ("CFA") will be discussed in a later section.

(i)   Principal Component Analysis ("PCA"):

We used PCA to summarize the information in our dataset described by the multiple variables by reducing the dimension of these variables into principal components which explains most of the variation in the data. We only used the Numeric variables in our dataset for this analysis

From our analysis, the first **2 principal components account for 79.0% of the variances of the dataset. PCI** explains the largest variation at **67.2%,** followed by **PC2, at 11.8%**. From this result, we can infer that the PCA has done a good job in summarizing the variability in our dataset from just 2 principal components.

```
pc_data <- princomp(data_scale, cor = T)
summary(pc_data, loadings = T)

## Importance of components:
##                           Comp.1    Comp.2     Comp.3     Comp.4
Comp.5
## Standard deviation      2.3182420 0.9733912 0.88280233 0.68586609
0.46963247
## Proportion of Variance 0.6717808 0.1184363 0.09741749 0.05880154
0.02756933
## Cumulative Proportion  0.6717808 0.7902171 0.88763458 0.94643611
0.97400545
##                           Comp.6     Comp.7     Comp.8
## Standard deviation      0.34689306 0.237055569 0.177274624
## Proportion of Variance 0.01504185 0.007024418 0.003928287
## Cumulative Proportion  0.98904730 0.996071713 1.000000000
```

Plotting the PCA Biplot:

We will use the Biplot to visualize our principal components. From the biplot, we see that car origin, acceleration contributes more to PC1, while horsepower, cylinder, weight contributes to PC2.

PCA summary:

From the Biplot, we can infer that diesel cars are more fuel efficient given their proximity to the MPG axis. We also note that American cars are near the weight axis. This makes senses as our dataset is from the 70s and 80s, a period when American cars were mainly defined by

their weight and not necessary their fuel efficiency- the literature on fuel efficiency attributes the weight of the car as one of the components contributing the most to low MPG.

(ii)   Exploratory Factor Analysis("EFA"):

To get a good understanding of what factors we believe to be the latent variables inherent in our dataset that influence MPG, we will be running an EFA analysis using the factanal function in R using its inherent rotation model of Varimax.

Assumptions:

- We will be working with the assumptions of 2 factors
- For better visibility, we used a latent loading cut-off criterion of greater than 0.5 to be the benchmark to qualify for use in our analysis.

To further validate the model, we found p-value which is very low and close to 0 at 1.15e-45

Naming the Factors:

From our loading factors based on our assumptions we will identify the latent factors explaining the MPG as below:

- Factor 1 seem to explain the size of the car
- Factor 2 seem to explain the performance of the car

The EFA analysis output is presented below:

```
mpg.efa <- factanal(auto_original2, factors = 2)
mpg.efa

##
## Call:
## factanal(x = auto_original2, factors = 2)
##
## Uniquenesses:
##           mpg   cylinders displacement   horsepower       weight
acceleration
##         0.355       0.079        0.019        0.005        0.115
0.461
##    model.year       origin
##         0.817        0.571
##
## Loadings:
##              Factor1 Factor2
## mpg           -0.602  -0.531
## cylinders      0.821   0.497
## displacement   0.811   0.569
## horsepower     0.503   0.862
## weight         0.759   0.555
## acceleration  -0.216  -0.702
## model.year    -0.202  -0.377
## origin        -0.637  -0.153
```

```
##                Factor1 Factor2
## SS loadings      3.017   2.563
## Proportion Var   0.377   0.320
## Cumulative Var   0.377   0.697
##
## Test of the hypothesis that 2 factors are sufficient.
## The chi square statistic is 248.78 on 13 degrees of freedom.
## The p-value is 1.15e-45
```

EFA summary:

Our EFA model was well specified and identified our latent factors influencing MPG to be

the **size of the car** and the **performance of the car**, which is line with what happens in reality

 Size- cars with more cylinders and larger cars like trucks have low MPG, while,

Performance- Cars that have higher horsepower accelerates better and have higher MPG.

CLUSTER ANALYSIS

We will be using cluster analysis to get insights into the number of similar groups (clusters) in our dataset. We will work with the 3 main clustering algorithm – K-means, Hierarchical and Model-based clustering and we will summarize our findings at the end of the clustering section

(I)   K-Means Clustering:

To gain insight into the clusters in our dataset, we used K-Mean Clustering and based on the Elbow test of our Scree plot, we settled on 3 Clusters as the appropriate number of Clusters for the dataset we are working with.

Fig6: Scree Plot for data_scale
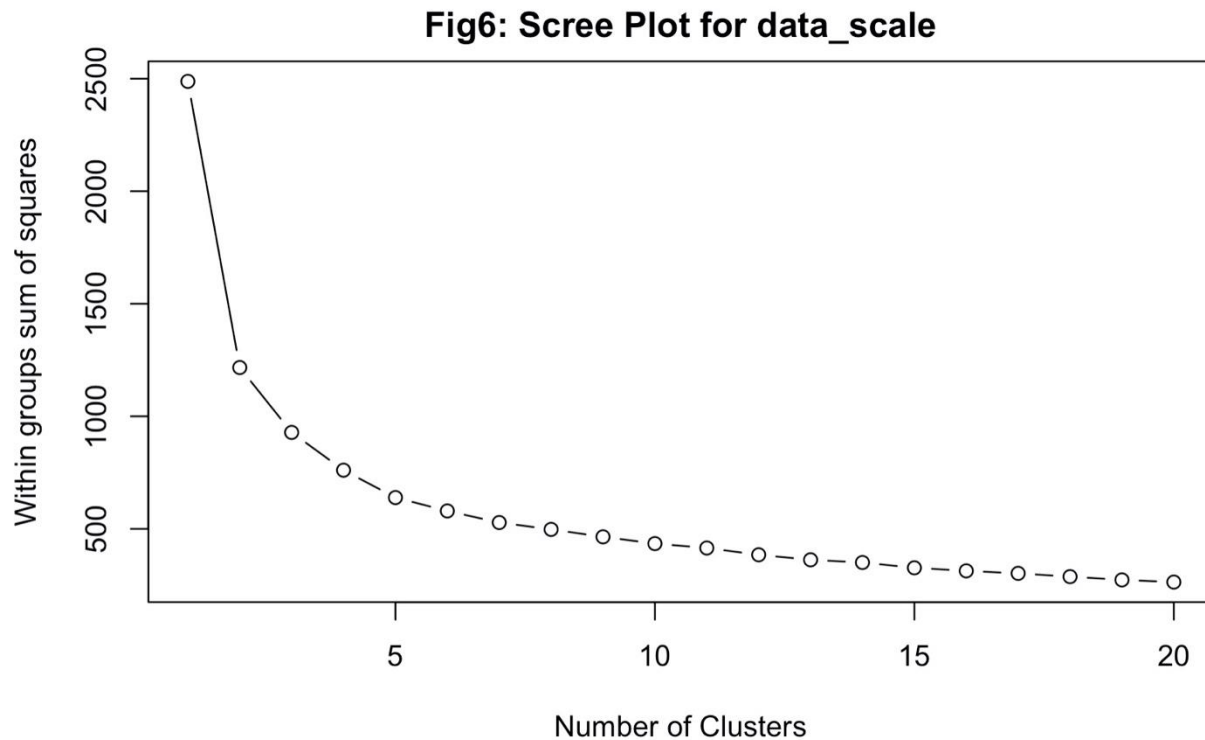
This is further confirmed with the *Kim Clusters function* in R. The 3 Clusters do show adequate amount allocated to these Clusters hence making them adequate for any decision-making purposes we wish to take on them.

This is presented below:

```
k_meansc <- kmeans(data_scale, centers = 3) # Applying kmeans for k=3
clusters table(km$cluster)
table(k_meansc$cluster)

##
##   1   2   3
## 105  82 125
```

To gain further insight to what variables accounts for each cluster, we used the K*M Centers function in R,* from this we can infer that:

```
km2$centers

##           mpg  cylinders displacement horsepower      weight acceleration
## 1 -1.0935807  1.4573326   1.45399524  1.4516537  1.32425981   -1.0899659
## 2  0.8700165 -0.8040804  -0.84609983 -0.7082716 -0.86709709    0.3191979
## 3 -0.2402492 -0.1248567  -0.06963826 -0.2404394  0.05742466    0.4468034
##   model.year     origin
## 1 -0.6800046 -0.7307683
## 2  0.3021310  0.9194930
## 3  0.1497618 -0.5840110
```

K-means Clustering summary:
- **Cluster 1:** is a diversified cluster but primarily focused on cylinder size, displacement and horsepower
- **Cluster 2:** is also diversified and primarily focused on the country of Car origin.
- **Cluster 3:** Is focused on acceleration

(II) Model Based (Mclust):

For our model-based clustering, we will be using the Mclust library in R.

For our data, we selected a model with the identified 3 Clusters from our K means analysis. The optimal selected model name is **VEV(Variable equal Variable** model. The summary showing the number of observations in each cluster is presented below:

```
mcl <- Mclust(data_scale,3)
summary(mcl)

## ----------------------------------------------------
## Gaussian finite mixture model fitted by EM algorithm
## ----------------------------------------------------
##
## Mclust VEV (ellipsoidal, equal shape) model with 3 components:
##
##  log-likelihood   n  df      BIC       ICL
##       -1088.475 312 120 -2866.11 -2866.179
##
## Clustering table:
##    1   2   3
## 84 178  50

mcct <- table(mcl$classification) /
plot(mcl, what = "classification", cex = 0.4)
```

Visualizing our Model-based Clustering Result:

The plot of the model-based clustering as well as the plot of the BIC is presented below
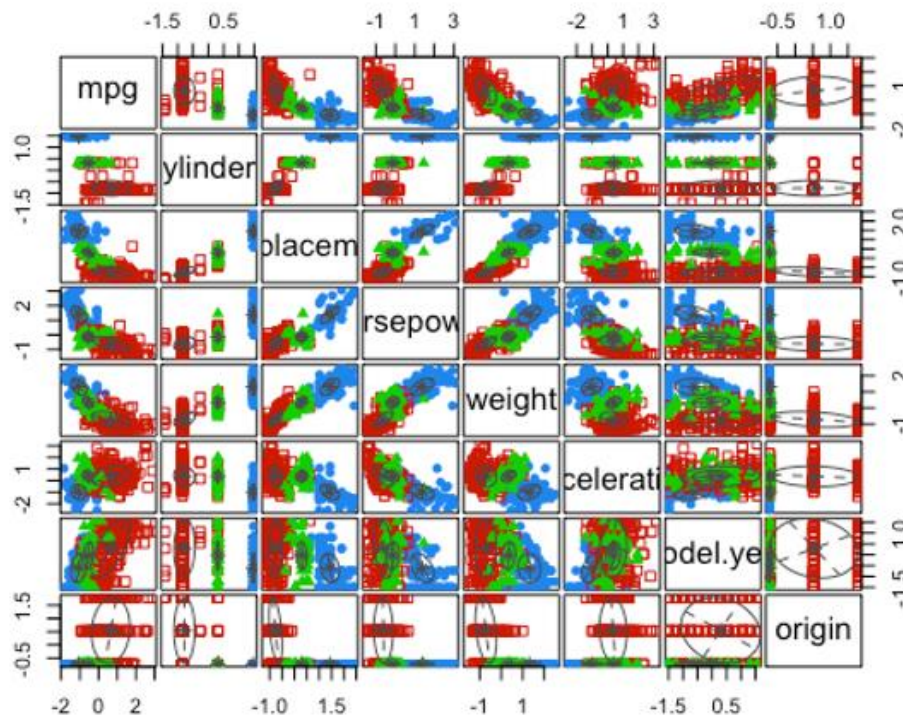
The best model is selected using the Bayesian Information Criterion or BIC. A large BIC score indicates strong evidence for the corresponding model in our case is the VEV model
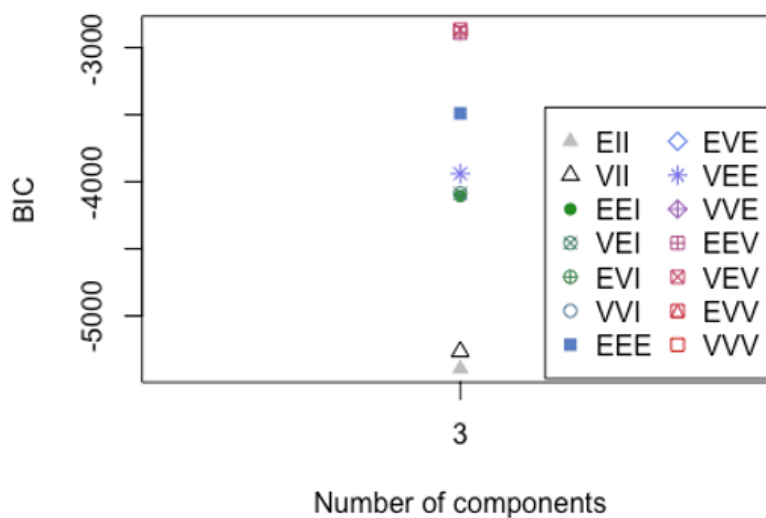
We have selected two variables for further insights namely weight and acceleration and we can see that the European and Japanese Cars fair better with higher MPG compared to their American counterparts.
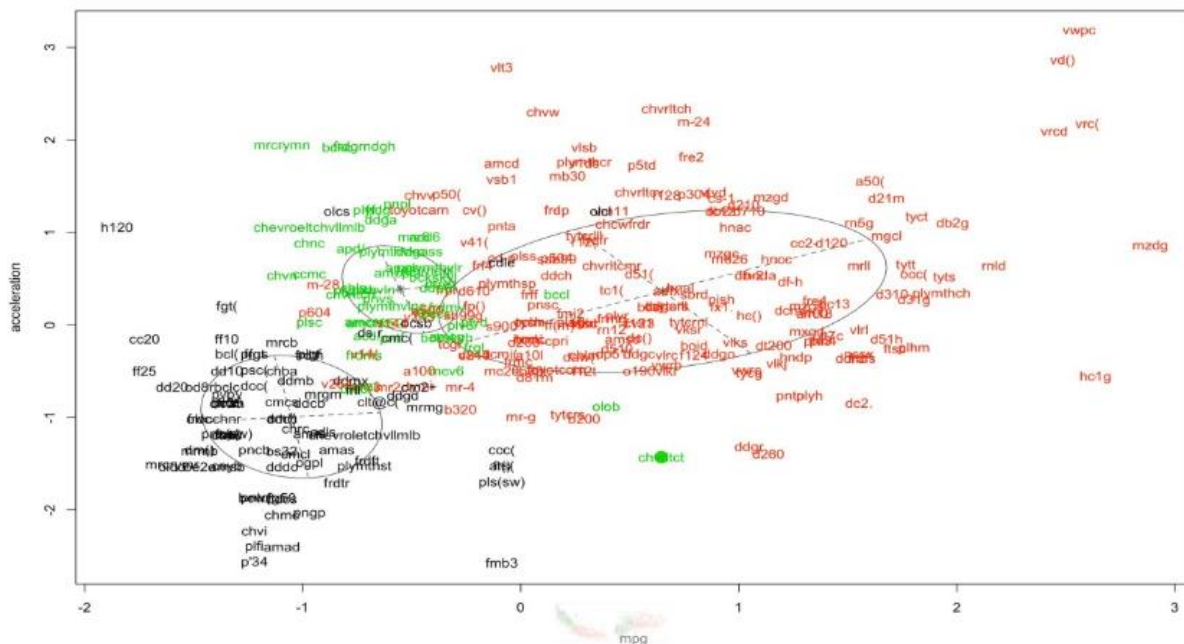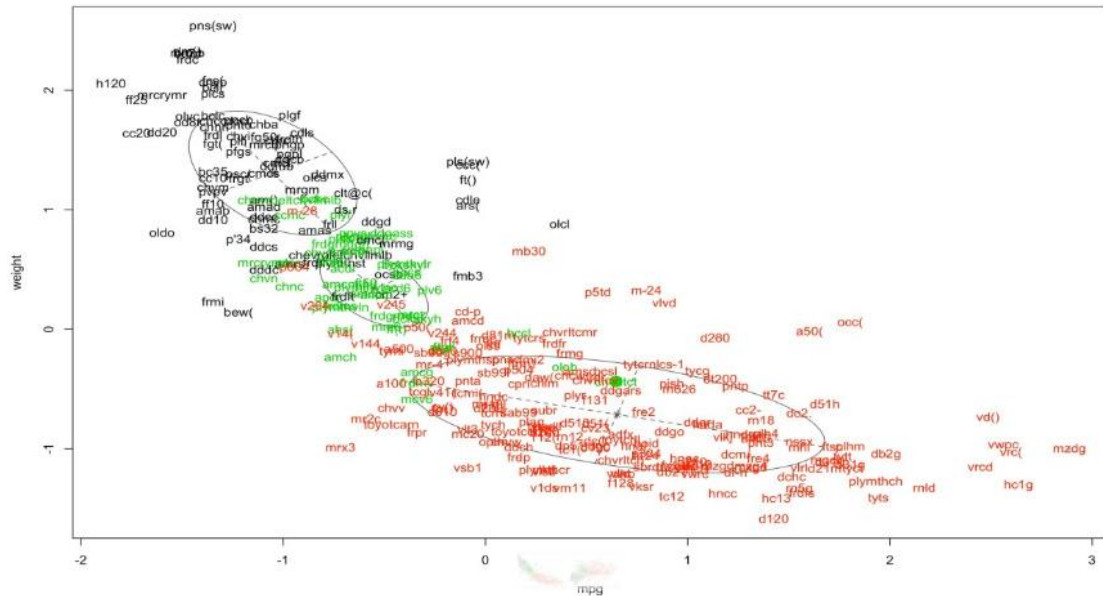
(III) Hierarchical Clustering:

We created a Euclidean distance metric to use for this method. The resulting dendrogram is

presented below:

Fig. 7: Complete Linkage HC Dendogram
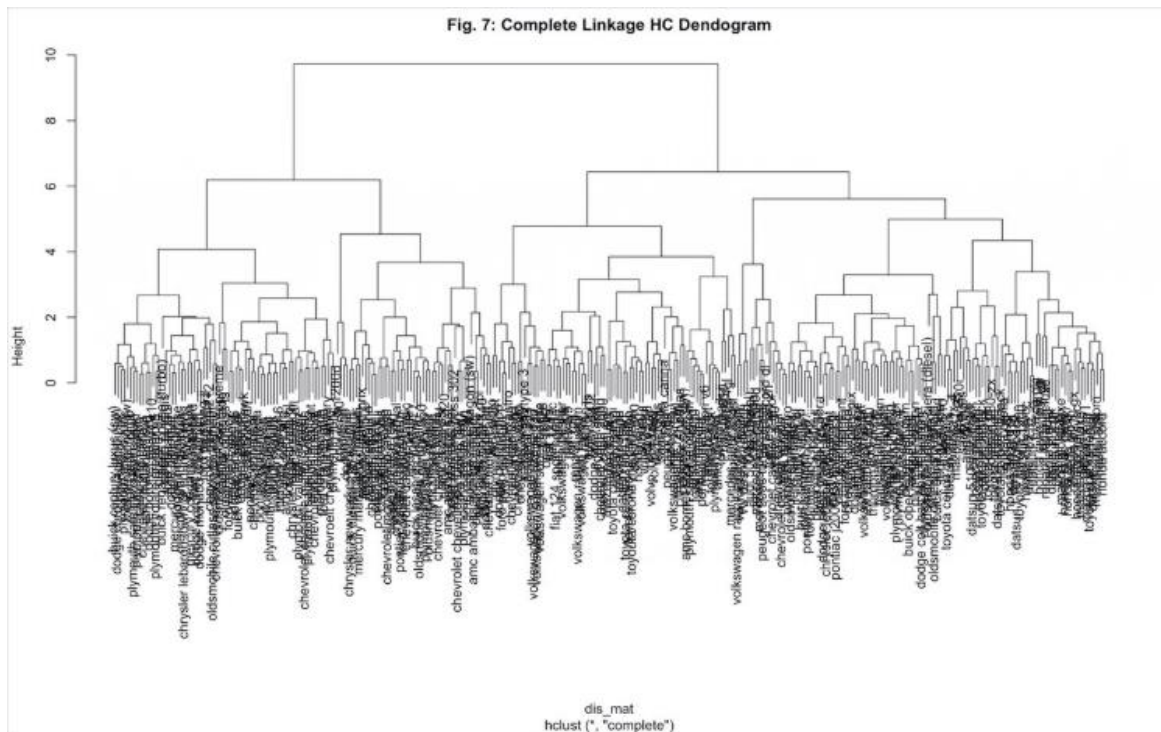
From the dendrogram, it is easy to see that this is difficult to interpret as the hierarchical

clustering algorithm doesn't work well with a large dataset such as ours- this is exactly what we

expected given our large dataset of 406 observations

Clustering Section Summary:

We employed 3 clustering techniques and all except the hierarchical clustering which was not

suitable for our dataset found Clusters to be primarily centered around Car weight, Country of

Origin and Speed related variables.

CONFIRMATORY FACTOR ANALYSIS ("CFA")

We will employ the results of our EFA in Dimension Reduction section for our CFA. We will however limit our variable to the true six numerical variables, excluding car year and country of origin. As we identified, we will be working with the latent factors:

Size- cars with more cylinders and larger cars like trucks have low MPG, while,

Performance- Cars that have higher horsepower accelerates better and have higher MPG.

Resulting output is as below:

```
data_cfa <- auto_original2[c(1:6)] # includes only numerical variables


data_cfa2 <- factanal(data_cfa, factors = 2)

faLR2 <- data_cfa2$loadings[,1:2]
faLR2

##                   Factor1    Factor2
## mpg           -0.7723358 -0.2350562
## cylinders      0.9035034  0.3094037
## displacement   0.9245564  0.3452408
## horsepower     0.7805426  0.5193699
## weight         0.9322156  0.2052535
## acceleration  -0.2765709 -0.9583911
```

```
print(data_cfa2$loadings, cut = 0.5)

##
## Loadings:
##              Factor1 Factor2
## mpg          -0.772
## cylinders     0.904
## displacement  0.925
## horsepower    0.781   0.519
## weight        0.932
## acceleration         -0.958
##
##              Factor1 Factor2
## SS loadings    3.822   1.501
## Proportion Var 0.637   0.250
## Cumulative Var 0.637   0.887
```

To carry out our CFA, we will be employing the SEM function in R using the txt file

`data_cfamodel`   we creating based on the identified latent variable

The output of the SEM is presented below

```r
library("sem")

data_cfamodel <- specifyModel(text = "
Size      -> mpg, lambda1, NA
Size      -> cylinders, lambda2, NA
Size      -> displacement, lambda3, NA
Size      -> weight, lambda4, NA
Perf      -> horsepower, lambda5, NA
Perf   -> acceleration, lambda6, NA
Size      <-> Perf, rho, NA
mpg <-> mpg, theta1, NA
cylinders <-> cylinders, theta2, NA
displacement <-> displacement, theta3, NA
weight <-> weight, theta4, NA
horsepower <-> horsepower, theta5, NA
acceleration <-> acceleration, theta6, NA

Size <-> Size, NA, 1
Perf <-> Perf, NA, 1 ")

## NOTE: it is generally simpler to use specifyEquations() or cfa()
##       see ?specifyEquations

cfamodel_sem <- sem(data_cfamodel, cor(data_cfa), nrow(data_cfa))
```

```
summary(cfamodel_sem)
```

```
##
##   Model Chisquare =   136.8738    Df =  8 Pr(>Chisq) = 1.059545e-25
##   AIC =   162.8738
##   BIC =   90.9298
##
##   Normalized Residuals
##        Min.     1st Qu.      Median        Mean     3rd Qu.        Max.
## -0.8894278  -0.2703812   0.0000001  -0.0282552   0.0671064   1.3601900
##
##   R-square for Endogenous Variables
##          mpg    cylinders displacement        weight    horsepower
acceleration
##       0.6413       0.9147       0.9789        0.8883        1.1231
0.4538
##
##   Parameter Estimates
##           Estimate    Std Error   z value    Pr(>|z|)
## lambda1 -0.80080847 0.046924879 -17.065755  2.669182e-65
## lambda2  0.95641975 0.041854794  22.850901 1.431549e-115
## lambda3  0.98939488 0.040595403  24.372092 3.381485e-131
## lambda4  0.94251838 0.042366363  22.246856 1.209815e-109
## lambda5  1.05975276 0.040972354  25.865069 1.646971e-147
## lambda6 -0.67362297 0.050936678 -13.224714  6.317748e-40
```

```
## rho      0.85365831 0.020628049  41.383376  0.000000e+00
## theta1   0.35870580 0.029536856  12.144346  6.147215e-34
## theta2   0.08526125 0.008513186  10.015199  1.306983e-23
## theta3   0.02109783 0.005265699   4.006654  6.158499e-05
## theta4   0.11165910 0.010365908  10.771763  4.679537e-27
## theta5  -0.12307574 0.036129441  -3.406522  6.579619e-04
## theta6   0.54623212 0.045999641  11.874704  1.602000e-32
##
## lambda1 mpg <--- Size
## lambda2 cylinders <--- Size
## lambda3 displacement <--- Size
## lambda4 weight <--- Size
## lambda5 horsepower <--- Perf
## lambda6 acceleration <--- Perf
## rho        Perf <--> Size
## theta1   mpg <--> mpg
## theta2   cylinders <--> cylinders
## theta3   displacement <--> displacement
## theta4   weight <--> weight
## theta5   horsepower <--> horsepower
## theta6   acceleration <--> acceleration
##
##   Iterations =  41
```

Output Findings

From the summary SEM results, we do see that our model seems **well specified** as:

- Standard Errors are low- all less than 0.05

- P-values are all significant

- The Uniqueness, theta are all relatively low

- The correlation between the specified factors, rho is high at 0.85

- The RMSE is relatively low at `0.03`, which is relatively lower than the 0.05 benchmark

Visualizing the SEM Path:

The path diagram shows a path visualization of what was specified in our CFA text file. Our Path diagram shows we have 2 factors namely SIZE and PERFORMANCE and the corresponding relation. The red lines show the inequality constraint as these loadings were negative
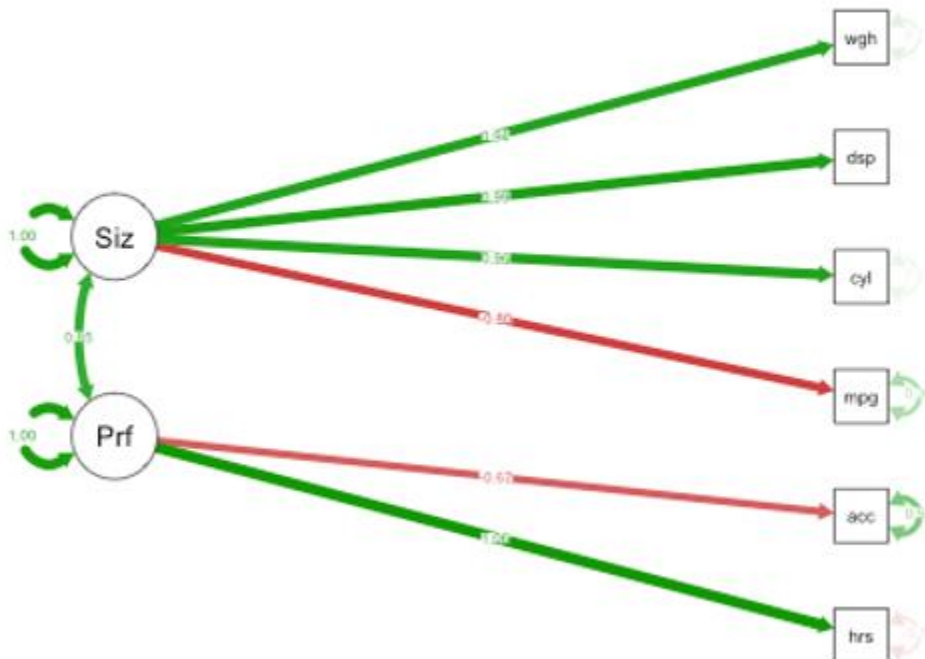
Testing our Model:

The results obtained from our calculation of SRMR, GFI and AGFI, shows that our RMSE is relatively low but that the fit model criteria of AGFI and GFI are lower than the benchmark of 0.95. Despite this low value, which is likely because items within the factors are more related to each other, we are confident of the model specified as it holds with entails in reality and the parameter estimates also confirms that:

```
options(fit.indices = c("SRMR", "GFI", "AGFI")) # Some fit indices
criteria = summary(cfamodel_sem)
criteria$SRMR

## [1] 0.02668518

criteria$GFI

## [1] 0.8669881

criteria$AGFI

## [1] 0.6508438

criteria$SRMR < 0.05

## [1] TRUE

criteria$GFI > 0.95

## [1] FALSE

criteria$AGFI > 0.95

## [1] FALSE
```

Hypothesis Testing:

The CFA model 95% confidence interval for the correlation between the specified factors range from 0.30 to 0.42. This is quite narrow and again speaks to the fact that we have iterated earlier that the model is well specified and suitable for analysis which we aim to do with it.

CFA summary:

Based on the result we are quite confident that our identified factors of Car Size and Car Performance are the factors that mostly affect the determination of the MPG of a Car

```
parameters$coeff[7,]$Estimate
```

```
## [1] 0.8536583
```

```
coef.Lower = parameters$coeff[8,]$Estimate - 1.96 * parameters$coeff[8,]$`Std
Error`
coef.Upper = parameters$coeff[8,]$Estimate + 1.96 * parameters$coeff[8,]$`Std
Error`
coef.Lower
```

```
## [1] 0.3008136
```

```
coef.Upper
```

```
## [1] 0.416598
```

CONCLUSION

In identifying the factors affecting the MPG of a car, we have employed various multivariate analysis methods namely Principal Component Analysis, Exploratory Factor Analysis, Clustering and Confirmatory Factor Analysis and which have found that the weight of the Car and the speed related variables have a higher impact on the MPG of a Car.

This is in line with what we were expecting and what literature has stated- larger Cars particularly, American Cars are expected to have low MPG. Given our dataset were focused Cars in the 70s and 80s, it is interesting to see that the Car in the present period have less weight, even the newer American Cars models are lighter and continue to market themselves are being more fuel efficient given the fierce competition they have received from their foreign counterpart, who have been ahead of this MPG train.

With all being said, the customers focus remains the same- they need a fuel-efficient Car which is environmentally friendly and will not add to Green-House emission.

PARTICIPATION:

- Introduction, The Problem Context was written by Egbearung Ojong
- Data cleaning and visualization was written by Biram Nicol
- Dimension Reduction Analysis was written by Modupe Azeez and Biram Nicol
- Cluster Analysis was written by Modupe Azeez
- Confirmatory Factor Analysis by Modupe Azeez and Egbearung Ojong
- Conclusion was written by Biram Nicol

LITERATURE USED:

What Factors Affect Average Fuel Economy of US Passenger Vehicles? Suman Gautam Illinois Wesleyan University, sgautam@iwu.edu
https://digitalcommons.iwu.edu/cgi/viewcontent.cgi?article=1103&context=econ_honproj
Want Your MPG? 10 Factors That Affect Fuel Economy, Newgate School
https://www.newgateschool.org/blog/entry/want-your-mpg-10-factors-that-affect-fuel-economy

APPENDIX

Biram Nicol, Modupe Azeez, Egbearung Ojong

11/5/2019

```
auto_original.mpg <- read.table("~/Desktop/TTU/ISQS 6350/R Project/auto-mpg.d
ata-original", quote = "\"", comment.char = "")
dim(auto_original.mpg)
```

```
## [1] 406    9
```

```
head(auto_original.mpg)
```

```
##    V1 V2  V3  V4   V5   V6 V7 V8                        V9
## 1 18   8 307 130 3504 12.0 70  1 chevrolet chevelle malibu
## 2 15   8 350 165 3693 11.5 70  1         buick skylark 320
## 3 18   8 318 150 3436 11.0 70  1        plymouth satellite
## 4 16   8 304 150 3433 12.0 70  1               amc rebel sst
## 5 17   8 302 140 3449 10.5 70  1                ford torino
## 6 15   8 429 198 4341 10.0 70  1          ford galaxie 500
```

```
# Renaming all column names to their respective variable names.
names(auto_original.mpg)
```

```
## [1] "V1" "V2" "V3" "V4" "V5" "V6" "V7" "V8" "V9"
```

```
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V1"] <- "mpg"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V2"] <- "cylinder
s"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V3"] <- "displace
ment"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V4"] <- "horsepow
er"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V5"] <- "weight"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V6"] <- "accelera
tion"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V7"] <- "model ye
ar"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V8"] <- "origin"
colnames(auto_original.mpg)[colnames(auto_original.mpg) == "V9"] <- "car name
"
```

```
head(auto_original.mpg)
```

```
##   mpg cylinders displacement horsepower weight acceleration model year ori
gin
## 1  18         8          307        130   3504         12.0         70
1
## 2  15         8          350        165   3693         11.5         70
```

```
1
## 3   18           8           318       150   3436         11.0           70
1
## 4   16           8           304       150   3433         12.0           70
1
## 5   17           8           302       140   3449         10.5           70
1
## 6   15           8           429       198   4341         10.0           70
1
##                  car name
## 1 chevrolet chevelle malibu
## 2         buick skylark 320
## 3       plymouth satellite
## 4             amc rebel sst
## 5               ford torino
## 6          ford galaxie 500
```

```r
# Converting auto_original.mpg to a CSV file
write.csv(auto_original.mpg,'auto_original.mpg.csv')
autooriginalmpg <- read.csv("auto_original.mpg.csv")
head(autooriginalmpg)
```

```
##   X mpg cylinders displacement horsepower weight acceleration model.year o
rigin
## 1 1  18           8           307       130   3504         12.0           70
1
## 2 2  15           8           350       165   3693         11.5           70
1
## 3 3  18           8           318       150   3436         11.0           70
1
## 4 4  16           8           304       150   3433         12.0           70
1
## 5 5  17           8           302       140   3449         10.5           70
1
## 6 6  15           8           429       198   4341         10.0           70
1
##                  car.name
## 1 chevrolet chevelle malibu
## 2         buick skylark 320
## 3       plymouth satellite
## 4             amc rebel sst
## 5               ford torino
## 6          ford galaxie 500
```

```r
# autooriginalmpg Exported to be modified in python in order to get row names
write.csv(autooriginalmpg, "~/Desktop/TTU/ISQS 6350/R Project/autooriginalmpg
.csv")

# Data imported with row names as original_mpg
original <- read.csv("~/Desktop/TTU/ISQS 6350/R Project/original.csv", row.na
```

```
mes = 1)

head(original)

##                              mpg cylinders displacement horsepower weight
## chevrolet chevelle malibu    18         8          307        130   3504
## buick skylark 320            15         8          350        165   3693
## plymouth satellite           18         8          318        150   3436
## amc rebel sst                16         8          304        150   3433
## ford torino                  17         8          302        140   3449
## ford galaxie 500             15         8          429        198   4341
##                              acceleration model.year origin
## chevrolet chevelle malibu           12.0         70      1
## buick skylark 320                   11.5         70      1
## plymouth satellite                  11.0         70      1
## amc rebel sst                       12.0         70      1
## ford torino                         10.5         70      1
## ford galaxie 500                    10.0         70      1

# not including car.name because it is a string because we are findind correl
ation
ori_data <- original[,c(1:6)]
rownames(ori_data) <- NULL
head(ori_data)

##   mpg cylinders displacement horsepower weight acceleration
## 1  18         8          307        130   3504         12.0
## 2  15         8          350        165   3693         11.5
## 3  18         8          318        150   3436         11.0
## 4  16         8          304        150   3433         12.0
## 5  17         8          302        140   3449         10.5
## 6  15         8          429        198   4341         10.0

corr <- cor(scale(ori_data)) #correlation matrix
corr

##               mpg  cylinders displacement horsepower     weight acceleratio
n
## mpg             1         NA           NA         NA         NA            N
A
## cylinders      NA  1.0000000    0.9515157         NA  0.8926808   -0.546549
4
## displacement   NA  0.9515157    1.0000000         NA  0.9289649   -0.586585
1
## horsepower     NA         NA           NA          1         NA            N
A
## weight         NA  0.8926808    0.9289649         NA  1.0000000   -0.454260
0
## acceleration   NA -0.5465494   -0.5865851         NA -0.4542600    1.000000
0
```

```
ori_data2 <- ori_data
for(q in 1:ncol(ori_data2)){
ori_data2[is.na(ori_data2[, q]), q] <- median(ori_data2[, q], na.rm = TRUE)
}

corr2 <- cor(scale(ori_data2)) # Correlation matrix
corr2
```

```
##                      mpg  cylinders displacement horsepower      weight
## mpg            1.0000000 -0.7520473   -0.7793115 -0.7608196 -0.8179651
## cylinders     -0.7520473  1.0000000    0.9515157  0.8408101  0.8926808
## displacement  -0.7793115  0.9515157    1.0000000  0.8976494  0.9289649
## horsepower    -0.7608196  0.8408101    0.8976494  1.0000000  0.8612004
## weight        -0.8179651  0.8926808    0.9289649  0.8612004  1.0000000
## acceleration   0.4389192 -0.5465494   -0.5865851 -0.7138737 -0.4542600
##              acceleration
## mpg             0.4389192
## cylinders      -0.5465494
## displacement   -0.5865851
## horsepower     -0.7138737
## weight         -0.4542600
## acceleration    1.0000000
```

```
summary(ori_data2)
```

```
##       mpg           cylinders      displacement      horsepower
##  Min.   : 9.00   Min.   :3.000   Min.   : 68.0   Min.   : 46.00
##  1st Qu.:17.57   1st Qu.:4.000   1st Qu.: 99.5   1st Qu.: 76.75
##  Median :23.00   Median :4.000   Median :142.5   Median : 95.00
##  Mean   :23.69   Mean   :5.458   Mean   :194.2   Mean   :106.24
##  3rd Qu.:29.00   3rd Qu.:8.000   3rd Qu.:302.0   3rd Qu.:130.00
##  Max.   :46.60   Max.   :8.000   Max.   :455.0   Max.   :230.00
##      weight      acceleration
##  Min.   :1613   Min.   : 8.00
##  1st Qu.:2214   1st Qu.:13.50
##  Median :2804   Median :15.40
##  Mean   :2969   Mean   :15.44
##  3rd Qu.:3615   3rd Qu.:17.30
##  Max.   :5140   Max.   :24.60
```

The scatter plot below shows lower the cylinders in a car, the higher the mpg.

```
plot(ori_data2$cylinders, ori_data2$mpg,
     main = "Fig1: Scatterplot for MPG vs Cylinders ",
     xlab = "Cylinders", ylab = "mpg")
```

Fig1: Scatterplot for MPG vs Cylinders
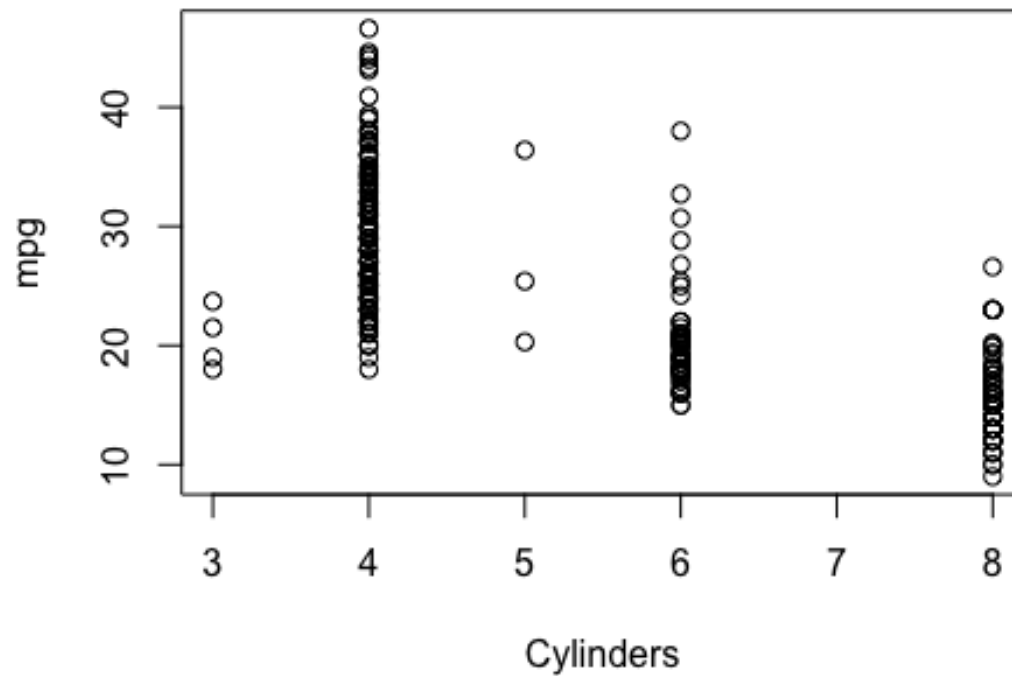
The scatter plot below shows the lower the displacement in a car, the higher the mpg.

```
plot(ori_data2$displacement, ori_data2$mpg,
     main = "Fig2: Scatterplot for MPG vs displacement ",
     xlab = "displacement" , ylab = "mpg")
```

Fig2: Scatterplot for MPG vs displacement
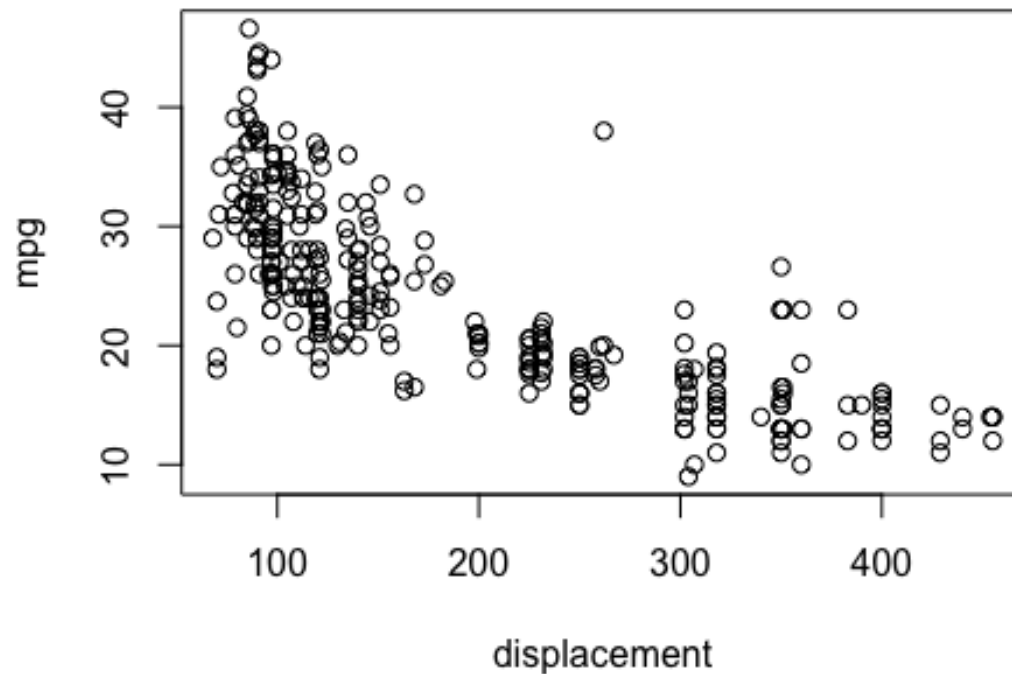
The scatter plot below shows the lower the horsepower in a car, the higher the mpg.

```
plot(ori_data2$horsepower, ori_data2$mpg,
    main = "Fig3: Scatterplot for MPG vs horsepower ",
    xlab = "horsepower" , ylab = "mpg")
```

Fig3: Scatterplot for MPG vs horsepower
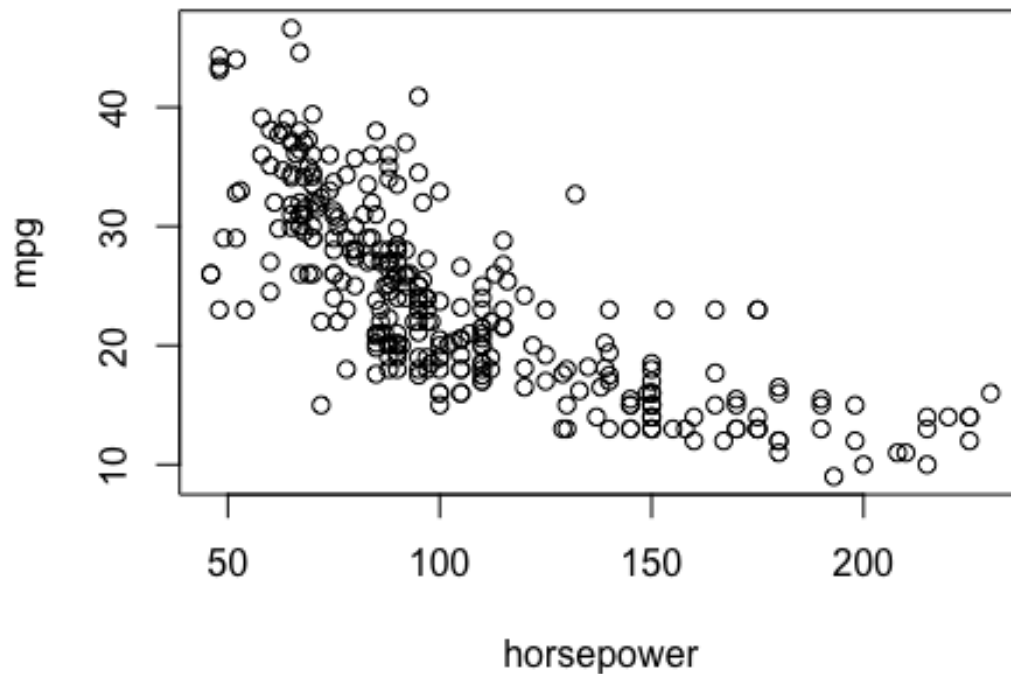
The scatter plot below shows the lower the weight the higher in a car, the higher the mpg.

```
plot(ori_data2$weight, ori_data2$mpg,
    main = "Fig4: Scatterplot for MPG vs weight ",
    xlab = "weight", ylab = "mpg")
```

Fig4: Scatterplot for MPG vs weight
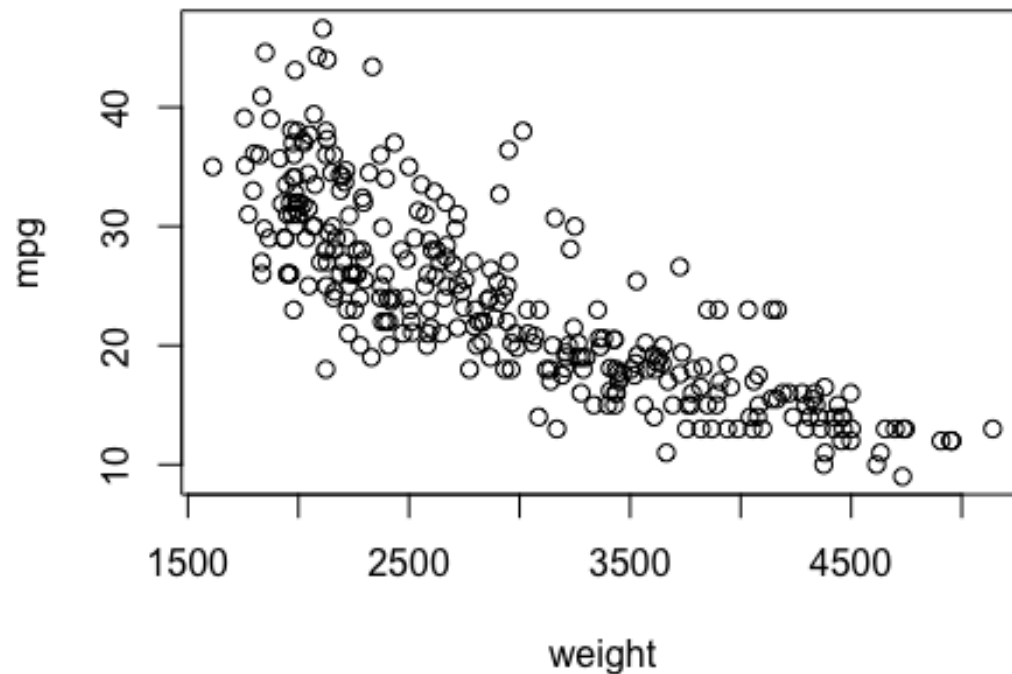
The scatter plot below shows the higher the acceleration in a car (optimal around 15 to 25), the higher the mpg.

```
plot(ori_data2$acceleration, ori_data2$mpg,
     main = "Fig5: Scatterplot for MPG vs acceleration ",
     xlab = "acceleration", ylab = "mpg")
```

Fig5: Scatterplot for MPG vs acceleration
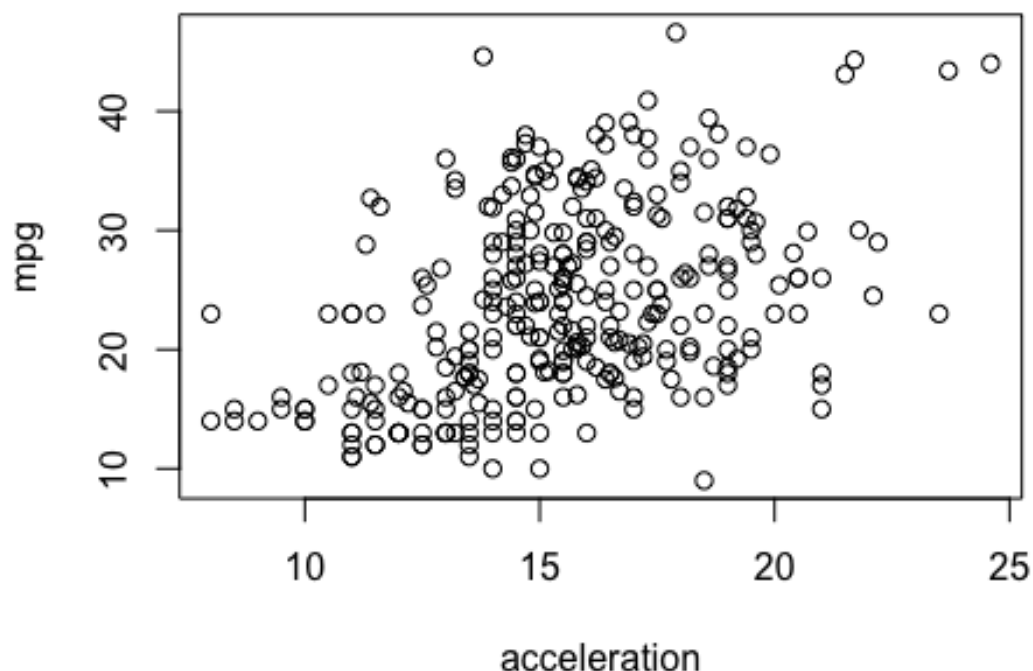

```
auto_original2 <- (original[,c(1:8)])
for(q in 1:ncol(auto_original2)){
auto_original2[is.na(auto_original2[, q]), q] <- median(auto_original2[, q],
na.rm = TRUE)
}

data_scale <- scale(auto_original2[,c(1:8)])
head(data_scale)

##                                  mpg cylinders displacement horsepower
## chevrolet chevelle malibu -0.7165936  1.471809    1.0459272  0.5876525
## buick skylark 320         -1.0946835  1.471809    1.4444945  1.4531994
## plymouth satellite        -0.7165936  1.471809    1.1478863  1.0822507
## amc rebel sst             -0.9686535  1.471809    1.0181202  1.0822507
## ford torino               -0.8426235  1.471809    0.9995822  0.8349516
## ford galaxie 500          -1.0946835  1.471809    2.1767460  2.2692865
##                             weight acceleration model.year     origin
## chevrolet chevelle malibu 0.6243706    -1.187973  -1.495422 -0.7307683
## buick skylark 320         0.8450656    -1.360672  -1.495422 -0.7307683
## plymouth satellite        0.5449671    -1.533372  -1.495422 -0.7307683
## amc rebel sst             0.5414640    -1.187973  -1.495422 -0.7307683
## ford torino               0.5601472    -1.706071  -1.495422 -0.7307683
## ford galaxie 500          1.6017341    -1.878771  -1.495422 -0.7307683
```

```
pc_data <- princomp(data_scale, cor = T)
summary(pc_data, loadings = T)

## Importance of components:
##                            Comp.1    Comp.2     Comp.3     Comp.4     Comp.
5
## Standard deviation      2.3182420 0.9733912 0.88280233 0.68586609 0.4696324
7
## Proportion of Variance 0.6717808 0.1184363 0.09741749 0.05880154 0.0275693
3
## Cumulative Proportion  0.6717808 0.7902171 0.88763458 0.94643611 0.9740054
5
##                            Comp.6      Comp.7      Comp.8
## Standard deviation      0.34689306 0.237055569 0.177274624
## Proportion of Variance 0.01504185 0.007024418 0.003928287
## Cumulative Proportion  0.98904730 0.996071713 1.000000000
##
## Loadings:
##              Comp.1 Comp.2 Comp.3 Comp.4 Comp.5 Comp.6 Comp.7 Comp.8
## mpg           0.377         0.305  0.159  0.768  0.315  0.183
## cylinders    -0.403  0.127        -0.201  0.442 -0.563 -0.285  0.429
## displacement -0.417  0.118        -0.125  0.302               -0.835
## horsepower   -0.402 -0.103  0.235 -0.101         0.680 -0.526  0.147
## weight       -0.401  0.202        -0.344         0.250  0.731  0.282
## acceleration  0.281  0.347 -0.649 -0.506  0.163  0.201 -0.237
## model.year    0.214  0.715  0.548 -0.161 -0.304        -0.124
## origin        0.273 -0.528  0.347 -0.713        -0.105

biplot(pc_data, cex = 0.9)
```
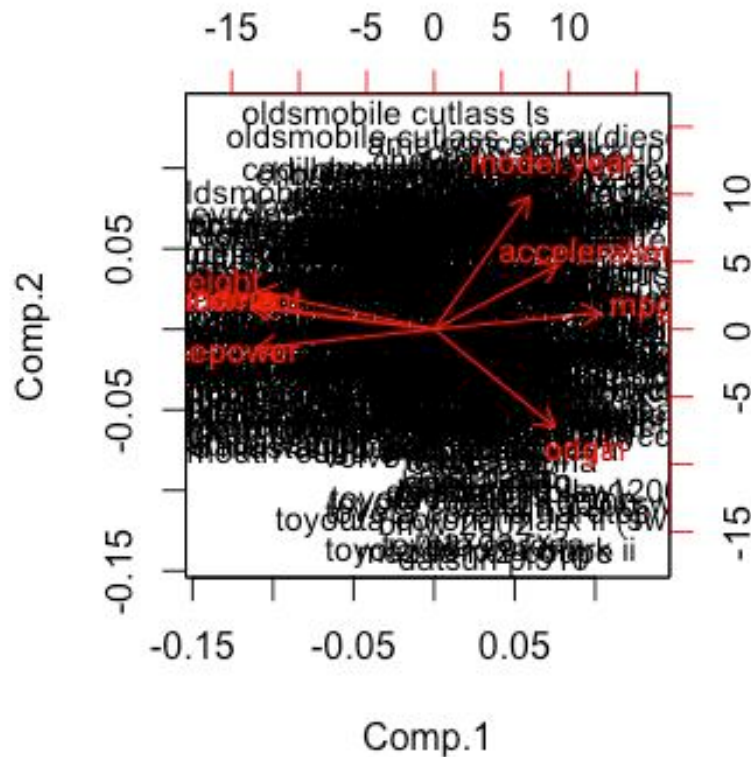
```r
k_meansc <- kmeans(data_scale, centers = 3) # Applying kmeans for k=3 cluster
s table(km$cluster)
table(k_meansc$cluster)

##
##    1    2    3
##   77  165   70

plot.wgss = function(data_scale, maxc) {
  wss = numeric(maxc)
  for (i in 1:maxc)
    wss[i] = kmeans(data_scale, centers = i, nstart = 10)$tot.withinss
  plot(1:maxc, wss, type = "b", xlab = "Number of Clusters", ylab = "Within g
roups sum of squares", main = "Fig6: Scree Plot for data_scale")
}
plot.wgss(data_scale, 20) # Elbow test.
```

Fig6: Scree Plot for data_scale
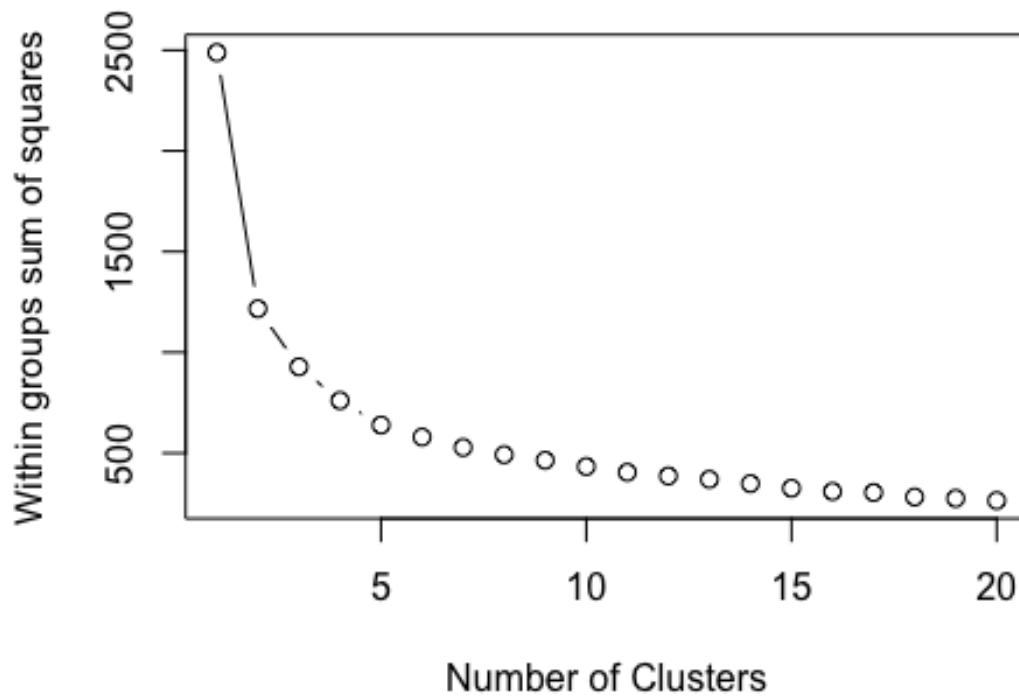

```
km2 <- kmeans(data_scale,centers = 3,nstart = 10)
table(km2$cluster)

##
##   1   2   3
##  80 103 129

# group

km2$centers

##           mpg  cylinders displacement horsepower      weight acceleration
## 1 -1.0935807  1.4573326   1.45399524  1.4516537  1.32425981   -1.0899659
## 2 -0.2402492 -0.1248567  -0.06963826 -0.2404394  0.05742466    0.4468034
## 3  0.8700165 -0.8040804  -0.84609983 -0.7082716 -0.86709709    0.3191979
##    model.year      origin
## 1 -0.6800046 -0.7307683
## 2  0.1497618 -0.5840110
## 3  0.3021310  0.9194930

tab <- km2$cluster
```

```
grt <- data.frame(tab)

subset(data_scale,tab = 3, nstart = 10)

##                                     mpg  cylinders displacement
## chevrolet chevelle malibu     -0.716593550  1.4718094   1.04592721
## buick skylark 320             -1.094683496  1.4718094   1.44449451
## plymouth satellite            -0.716593550  1.4718094   1.14788629
## amc rebel sst                 -0.968653514  1.4718094   1.01812019
## ford torino                   -0.842623532  1.4718094   0.99958218
## ford galaxie 500              -1.094683496  1.4718094   2.17674605
## chevrolet impala              -1.220713478  1.4718094   2.40847122
## plymouth fury iii             -1.220713478  1.4718094   2.27870513
## pontiac catalina              -1.220713478  1.4718094   2.41774023
## amc ambassador dpl            -1.094683496  1.4718094   1.81525478
## citroen ds-21 pallas          -0.086443641 -0.8444808  -0.56687998
## chevrolet chevelle concours (sw) -0.086443641  1.4718094   1.44449451
## ford torino (sw)              -0.086443641  1.4718094   1.45376351
## plymouth satellite (sw)       -0.086443641  1.4718094   1.75037173
## amc rebel sst (sw)            -0.086443641  1.4718094   1.53718458
## dodge challenger se           -1.094683496  1.4718094   1.75037173
## plymouth 'cuda 340            -1.220713478  1.4718094   1.35180444
## ford mustang boss 302         -0.086443641  1.4718094   0.99958218
## chevrolet monte carlo         -1.094683496  1.4718094   1.90794485
## buick estate wagon (sw)       -1.220713478  1.4718094   2.41774023
## toyota corona mark ii          0.039586340 -0.8444808  -0.75226012
## plymouth duster               -0.212473623  0.3136643   0.03560546
## amc hornet                    -0.716593550  0.3136643   0.04487447
## ford maverick                 -0.338503605  0.3136643   0.05414348
## datsun pl510                   0.417676286 -0.8444808  -0.90056423
## volkswagen 1131 deluxe sedan   0.291646304 -0.8444808  -0.90056423
## peugeot 504                    0.165616322 -0.8444808  -0.78006714
## audi 100 ls                    0.039586340 -0.8444808  -0.80787416
## saab 99e                       0.165616322 -0.8444808  -0.83568118
## bmw 2002                       0.291646304 -0.8444808  -0.67810806
## amc gremlin                   -0.338503605  0.3136643   0.04487447
## ford f250                     -1.724833405  1.4718094   1.53718458
## chevy c20                     -1.724833405  1.4718094   1.04592721
## dodge d200                    -1.598803423  1.4718094   1.14788629
## hi 1200d                      -1.850863387  1.4718094   1.01812019
## chevrolet vega 2300            0.543706268 -0.8444808  -0.50199693
## toyota corona                  0.165616322 -0.8444808  -0.75226012
## ford pinto                     0.165616322 -0.8444808  -0.89129522
## volkswagen super beetle 117   -0.086443641 -0.8444808  -0.90056423
## plymouth satellite custom     -0.968653514  0.3136643   0.28586865
## ford torino 500               -0.590563569  0.3136643   0.51759382
## amc matador                   -0.716593550  0.3136643   0.35075170
## pontiac catalina brougham     -1.220713478  1.4718094   1.90794485
## dodge monaco (sw)             -1.472773441  1.4718094   1.75037173
```

```
## ford country squire (sw)          -1.346743459   1.4718094    1.90794485
## pontiac safari (sw)                -1.346743459   1.4718094    1.90794485
## amc hornet sportabout (sw)         -0.716593550   0.3136643    0.59174588
## chevrolet vega (sw)                -0.212473623  -0.8444808   -0.50199693
## pontiac firebird                   -0.590563569   0.3136643    0.51759382
## ford mustang                       -0.716593550   0.3136643    0.51759382
## mercury capri 2000                 -0.086443641  -0.8444808   -0.66883906
## opel 1900                           0.543706268  -0.8444808   -0.72445310
## peugeot 304                         0.795766231  -0.8444808   -1.06740635
## fiat 124b                           0.795766231  -0.8444808   -0.98398529
## toyota corolla 1200                 0.921796213  -0.8444808   -1.14155841
## datsun 1200                         1.425916140  -0.8444808   -1.13228940
## volkswagen model 111                0.417676286  -0.8444808   -0.90056423
## plymouth cricket                    0.291646304  -0.8444808   -0.95617827
## toyota corona hardtop               0.039586340  -0.8444808   -0.75226012
## dodge colt hardtop                  0.165616322  -0.8444808   -0.89592973
## volkswagen type 3                  -0.086443641  -0.8444808   -0.90056423
## chevrolet vega                     -0.464533587  -0.8444808   -0.50199693
## ford pinto runabout                -0.338503605  -0.8444808   -0.66883906
## amc ambassador sst                 -0.842623532   1.4718094    1.01812019
## mercury marquis                    -1.598803423   1.4718094    2.17674605
## buick lesabre custom               -1.346743459   1.4718094    1.44449451
## oldsmobile delta 88 royale         -1.472773441   1.4718094    1.44449451
## chrysler newport royal             -1.346743459   1.4718094    1.90794485
## mazda rx2 coupe                    -0.590563569  -1.4235534   -1.15082741
## amc matador (sw)                   -1.094683496   1.4718094    1.01812019
## ford gran torino (sw)              -1.346743459   1.4718094    0.99958218
## plymouth satellite custom (sw)     -1.220713478   1.4718094    1.14788629
## volvo 145e (sw)                    -0.716593550  -0.8444808   -0.67810806
## volkswagen 411 (sw)                -0.212473623  -0.8444808   -0.67810806
## peugeot 504 (sw)                   -0.338503605  -0.8444808   -0.68737707
## renault 12 (sw)                     0.291646304  -0.8444808   -0.90983324
## ford pinto (sw)                    -0.212473623  -0.8444808   -0.66883906
## datsun 510 (sw)                     0.543706268  -0.8444808   -0.90056423
## toyouta corona mark ii (sw)        -0.086443641  -0.8444808   -0.68737707
## dodge colt (sw)                     0.543706268  -0.8444808   -0.89129522
## toyota corolla 1600 (sw)            0.417676286  -0.8444808   -0.90056423
## buick century 350                  -1.346743459   1.4718094    1.44449451
## chevrolet malibu                   -1.346743459   1.4718094    1.44449451
## ford gran torino                   -1.220713478   1.4718094    0.99958218
## dodge coronet custom               -1.094683496   1.4718094    1.14788629
## mercury marquis brougham           -1.472773441   1.4718094    2.17674605
## chevrolet caprice classic          -1.346743459   1.4718094    1.90794485
## ford ltd                           -1.346743459   1.4718094    1.45376351
## plymouth fury gran sedan           -1.220713478   1.4718094    1.14788629
## chrysler new yorker brougham       -1.346743459   1.4718094    2.27870513
## buick electra 225 custom           -1.472773441   1.4718094    2.41774023
## amc ambassador brougham            -1.346743459   1.4718094    1.53718458
## plymouth valiant                   -0.716593550   0.3136643    0.28586865
```

```
## chevrolet nova custom                -0.968653514  0.3136643   0.51759382
## volkswagen super beetle               0.291646304 -0.8444808  -0.90056423
## ford country                         -1.472773441  1.4718094   1.90794485
## plymouth custom suburb               -1.346743459  1.4718094   1.53718458
## oldsmobile vista cruiser             -1.472773441  1.4718094   1.44449451
## toyota carina                        -0.464533587 -0.8444808  -0.90056423
## datsun 610                           -0.212473623 -0.8444808  -0.79860515
## maxda rx3                            -0.716593550 -1.4235534  -1.15082741
## mercury capri v6                     -0.338503605  0.3136643  -0.36296183
## fiat 124 sport coupe                  0.291646304 -0.8444808  -0.89129522
## chevrolet monte carlo s              -1.094683496  1.4718094   1.44449451
## pontiac grand prix                   -0.968653514  1.4718094   1.90794485
## fiat 128                              0.669736249 -0.8444808  -1.16936543
## opel manta                            0.039586340 -0.8444808  -0.72445310
## audi 100ls                           -0.464533587 -0.8444808  -0.74299111
## volvo 144ea                          -0.590563569 -0.8444808  -0.67810806
## dodge dart custom                    -1.094683496  1.4718094   1.14788629
## saab 99le                             0.039586340 -0.8444808  -0.67810806
## toyota mark ii                       -0.464533587  0.3136643  -0.35369282
## oldsmobile omega                     -1.598803423  1.4718094   1.44449451
## chevrolet nova                       -1.094683496  0.3136643   0.51759382
## datsun b210                           0.921796213 -0.8444808  -1.06740635
## chevrolet chevelle malibu classic    -0.968653514  0.3136643   0.51759382
## plymouth satellite sebring           -0.716593550  0.3136643   0.28586865
## buick century luxus (sw)             -1.346743459  1.4718094   1.44449451
## dodge coronet custom (sw)            -1.220713478  1.4718094   1.14788629
## audi fox                              0.669736249 -0.8444808  -0.89129522
## volkswagen dasher                     0.291646304 -0.8444808  -1.06740635
## datsun 710                            1.047826195 -0.8444808  -1.03033033
## dodge colt                            0.543706268 -0.8444808  -0.96544728
## fiat 124 tc                           0.291646304 -0.8444808  -0.72445310
## honda civic                           0.039586340 -0.8444808  -0.68737707
## subaru                                0.291646304 -0.8444808  -0.79860515
## fiat x1.9                             0.921796213 -0.8444808  -1.06740635
## plymouth valiant custom              -0.590563569  0.3136643   0.28586865
## mercury monarch                      -1.094683496  0.3136643   0.51759382
## chevrolet bel air                    -1.094683496  1.4718094   1.44449451
## plymouth grand fury                  -0.968653514  1.4718094   1.14788629
## buick century                        -0.842623532  0.3136643   0.34148269
## chevroelt chevelle malibu            -0.968653514  0.3136643   0.51759382
## plymouth fury                        -0.716593550  0.3136643   0.28586865
## buick skyhawk                        -0.338503605  0.3136643   0.34148269
## chevrolet monza 2+2                  -0.464533587  1.4718094   0.62882190
## ford mustang ii                      -1.346743459  1.4718094   0.99958218
## toyota corolla                        0.669736249 -0.8444808  -0.90056423
## pontiac astro                        -0.086443641 -0.8444808  -0.50199693
## volkswagen rabbit                     0.669736249 -0.8444808  -0.96544728
## amc pacer                            -0.590563569  0.3136643   0.35075170
## volvo 244dl                          -0.212473623 -0.8444808  -0.67810806
```

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## honda civic cvcc                      1.173856177 -0.8444808  -0.95617827
## fiat 131                              0.543706268 -0.8444808  -0.80787416
## capri ii                              0.165616322 -0.8444808  -0.50199693
## renault 12tl                          0.417676286 -0.8444808  -0.86348820
## dodge coronet brougham               -0.968653514  1.4718094   1.14788629
## chevrolet chevette                    0.669736249 -0.8444808  -1.01179231
## chevrolet woody                       0.102601331 -0.8444808  -0.89129522
## vw rabbit                             0.669736249 -0.8444808  -0.96544728
## dodge aspen se                       -0.464533587  0.3136643   0.28586865
## ford granada ghia                    -0.716593550  0.3136643   0.51759382
## pontiac ventura sj                   -0.653578559  0.3136643   0.51759382
## amc pacer d/l                        -0.779608541  0.3136643   0.59174588
## datsun b-210                          1.047826195 -0.8444808  -1.01179231
## volvo 245                            -0.464533587 -0.8444808  -0.59468700
## plymouth volare premier v8           -1.346743459  1.4718094   1.14788629
## mercedes-benz 280s                   -0.905638523  0.3136643  -0.24246474
## cadillac seville                     -0.905638523  1.4718094   1.44449451
## chevy c10                            -1.346743459  1.4718094   1.44449451
## ford f108                            -1.346743459  1.4718094   0.99958218
## dodge d100                           -1.346743459  1.4718094   1.14788629
## honda accord cvcc                     0.984811204 -0.8444808  -0.89129522
## buick opel isuzu deluxe               0.795766231 -0.8444808  -0.77079813
## renault 5 gtl                         1.551946122 -0.8444808  -1.06740635
## plymouth arrow gs                     0.228631313 -0.8444808  -0.66883906
## datsun f-10 hatchback                 1.236871168 -0.8444808  -1.01179231
## oldsmobile cutlass supreme           -0.842623532  1.4718094   0.61028389
## dodge monaco brougham                -1.031668505  1.4718094   1.14788629
## mercury cougar brougham              -1.094683496  1.4718094   0.99958218
## chevrolet concours                   -0.779608541  0.3136643   0.51759382
## buick skylark                        -0.401518596  0.3136643   0.34148269
## plymouth volare custom               -0.590563569  0.3136643   0.28586865
## ford granada                         -0.653578559  0.3136643   0.51759382
## pontiac grand prix lj                -0.968653514  1.4718094   1.90794485
## chevrolet monte carlo landau         -1.031668505  1.4718094   1.44449451
## chrysler cordoba                     -1.031668505  1.4718094   1.90794485
## ford thunderbird                     -0.968653514  1.4718094   1.45376351
## volkswagen rabbit custom              0.669736249 -0.8444808  -0.90056423
## pontiac sunbird coupe                 0.102601331 -0.8444808  -0.40003786
## toyota corolla liftback               0.291646304 -0.8444808  -0.90056423
## ford mustang ii 2+2                   0.228631313 -0.8444808  -0.50199693
## dodge colt m/m                        1.236871168 -0.8444808  -0.89129522
## subaru dl                             0.795766231 -0.8444808  -0.90056423
## datsun 810                           -0.212473623  0.3136643  -0.44638289
## bmw 320i                             -0.275488614 -0.8444808  -0.67810806
## mazda rx-4                           -0.275488614 -1.4235534  -1.05813735
## volkswagen rabbit custom diesel       2.446758993 -0.8444808  -0.96544728
## ford fiesta                           1.564549120 -0.8444808  -0.89129522
## mazda glc deluxe                      1.148650180 -0.8444808  -1.07667536
## datsun b210 gx                        1.980448060 -0.8444808  -1.01179231
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## oldsmobile cutlass salon brougham       -0.477136585   1.4718094    0.61028389
## dodge diplomat                          -0.540151576   1.4718094    1.14788629
## mercury monarch ghia                    -0.439327590   1.4718094    0.99958218
## pontiac phoenix lj                      -0.565357572   0.3136643    0.34148269
## ford fairmont (auto)                    -0.439327590   0.3136643    0.05414348
## ford fairmont (man)                      0.178219320  -0.8444808   -0.50199693
## plymouth volare                         -0.401518596   0.3136643    0.28586865
## amc concord                             -0.540151576   0.3136643    0.35075170
## buick century special                   -0.388915598   0.3136643    0.34148269
## mercury zephyr                          -0.363709601   0.3136643    0.05414348
## dodge aspen                             -0.640975561   0.3136643    0.28586865
## amc concord d/l                         -0.703990552   0.3136643    0.59174588
## buick regal sport coupe (turbo)         -0.754402545   0.3136643    0.34148269
## ford futura                             -0.703990552   1.4718094    0.99958218
## dodge magnum xe                         -0.779608541   1.4718094    1.14788629
## datsun 510                               0.442882282  -0.8444808   -0.69664608
## dodge omni                               0.909193215  -0.8444808   -0.82641217
## toyota celica gt liftback               -0.325900607  -0.8444808   -0.55761098
## plymouth sapporo                        -0.061237645  -0.8444808   -0.35369282
## oldsmobile starfire sx                   0.014380344  -0.8444808   -0.40003786
## datsun 200-sx                            0.026983342  -0.8444808   -0.69664608
## audi 5000                               -0.426724592  -0.2654083   -0.58541800
## volvo 264gl                             -0.842623532   0.3136643   -0.28880978
## saab 99gle                              -0.262885616  -0.8444808   -0.67810806
## peugeot 604sl                           -0.943447518   0.3136643   -0.28880978
## volkswagen scirocco                      0.984811204  -0.8444808   -0.97471628
## honda accord lx                          0.732751240  -0.8444808   -0.89129522
## pontiac lemans v6                       -0.275488614   0.3136643    0.34148269
## mercury zephyr 6                        -0.489739583   0.3136643    0.05414348
## ford fairmont 4                         -0.174664629  -0.8444808   -0.50199693
## amc concord dl 6                        -0.439327590   0.3136643    0.35075170
## dodge aspen 6                           -0.388915598   0.3136643    0.28586865
## ford ltd landau                         -0.767005543   1.4718094    0.99958218
## mercury grand marquis                   -0.905638523   1.4718094    1.45376351
## dodge st. regis                         -0.691387554   1.4718094    1.14788629
## chevrolet malibu classic (sw)           -0.565357572   1.4718094    0.67516694
## chrysler lebaron town @ country (sw)    -0.653578559   1.4718094    1.53718458
## vw rabbit custom                         1.035223197  -0.8444808   -0.97471628
## maxda glc deluxe                         1.312489157  -0.8444808   -1.00252330
## dodge colt hatchback custom              1.514137127  -0.8444808   -0.89129522
## amc spirit dl                            0.468088279  -0.8444808   -0.67810806
## mercedes benz 300d                       0.216028315  -0.2654083   -0.10342964
## cadillac eldorado                       -0.086443641   1.4718094    1.44449451
## plymouth horizon                         1.325092155  -0.8444808   -0.82641217
## plymouth horizon tc3                     1.362901149  -0.8444808   -0.82641217
## datsun 210                               1.022620198  -0.8444808   -1.01179231
## fiat strada custom                       1.715785098  -0.8444808   -0.95617827
## buick skylark limited                    0.594118260  -0.8444808   -0.40003786
## chevrolet citation                       0.644530253   0.3136643   -0.19611971
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## oldsmobile omega brougham              0.392470289  0.3136643  -0.19611971
## pontiac phoenix                         1.236871168 -0.8444808  -0.40003786
## toyota corolla tercel                   1.816609084 -0.8444808  -0.97471628
## datsun 310                              1.703182100 -0.8444808  -1.00252330
## ford fairmont                           0.342058297 -0.8444808  -0.50199693
## audi 4000                               1.337695153 -0.8444808  -0.90056423
## toyota corona liftback                  0.770560235 -0.8444808  -0.55761098
## mazda 626                               0.959605208 -0.8444808  -0.68737707
## datsun 510 hatchback                    1.677976104 -0.8444808  -0.69664608
## mazda glc                               2.887863929 -0.8444808  -1.00252330
## vw rabbit c (diesel)                    2.597994971 -0.8444808  -0.96544728
## vw dasher (diesel)                      2.484567987 -0.8444808  -0.96544728
## audi 5000s (diesel)                     1.602358115 -0.2654083  -0.67810806
## mercedes-benz 240d                      0.795766231 -0.8444808  -0.44638289
## honda civic 1500 gl                     2.635803965 -0.8444808  -0.95617827
## renault lecar deluxe                    2.169493033 -0.8444808  -1.01179231
## vokswagen rabbit                        0.770560235 -0.8444808  -0.97471628
## datsun 280-zx                           1.136047182  0.3136643  -0.24246474
## mazda rx-7 gs                           0.001777346 -1.4235534  -1.15082741
## triumph tr7 coupe                       1.425916140 -0.8444808  -0.66883906
## ford mustang cobra                     -0.010825652 -0.8444808  -0.50199693
## honda accord                            1.098238188 -0.8444808  -0.80787416
## plymouth reliant                        0.442882282 -0.8444808  -0.54834197
## dodge aries wagon (sw)                  0.266440308 -0.8444808  -0.35369282
## toyota starlet                          1.942639066 -0.8444808  -1.06740635
## plymouth champ                          1.930036067 -0.8444808  -1.00252330
## honda civic 1300                        1.438519138 -0.8444808  -1.04886834
## datsun 210 mpg                          1.677976104 -0.8444808  -1.01179231
## toyota tercel                           1.766197091 -0.8444808  -0.97471628
## mazda glc 4                             1.312489157 -0.8444808  -0.95617827
## plymouth horizon 4                      1.388107146 -0.8444808  -0.82641217
## ford escort 4w                          1.350298151 -0.8444808  -0.89129522
## ford escort 2h                          0.783163233 -0.8444808  -0.89129522
## volkswagen jetta                        1.173856177 -0.8444808  -0.82641217
## renault 18i                             1.362901149 -0.8444808  -0.87275721
## honda prelude                           1.262077164 -0.8444808  -0.80787416
## datsun 200sx                            1.161253178 -0.8444808  -0.69664608
## peugeot 505s turbo diesel               0.556309266 -0.8444808  -0.49272793
## saab 900s                              -0.086443641 -0.8444808  -0.67810806
## volvo diesel                            0.883987218  0.3136643  -0.45565190
## toyota cressida                         0.216028315  0.3136643  -0.24246474
## datsun 810 maxima                       0.064792337  0.3136643  -0.44638289
## oldsmobile cutlass ls                   0.367264293  1.4718094   1.44449451
## ford granada gl                        -0.439327590  0.3136643   0.05414348
## chrysler lebaron salon                 -0.767005543  0.3136643   0.28586865
## chevrolet cavalier                      0.543706268 -0.8444808  -0.76152913
## chevrolet cavalier wagon                0.417676286 -0.8444808  -0.76152913
## chevrolet cavalier 2-door               1.299886158 -0.8444808  -0.76152913
## pontiac j2000 se hatchback              0.921796213 -0.8444808  -0.76152913
```

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## dodge aries se                           0.669736249 -0.8444808  -0.54834197
## ford fairmont futura                     0.039586340 -0.8444808  -0.50199693
## amc concord dl                          -0.086443641 -0.8444808  -0.40003786
## volkswagen rabbit l                      1.551946122 -0.8444808  -0.82641217
## mazda glc custom l                       1.677976104 -0.8444808  -0.95617827
## mazda glc custom                         0.921796213 -0.8444808  -0.95617827
## plymouth horizon miser                   1.804006086 -0.8444808  -0.82641217
## mercury lynx l                           1.551946122 -0.8444808  -0.89129522
## nissan stanza xe                         1.551946122 -0.8444808  -0.68737707
## honda civic (auto)                       1.047826195 -0.8444808  -0.95617827
## datsun 310 gx                            1.804006086 -0.8444808  -0.95617827
## buick century limited                    0.165616322  0.3136643  -0.12196765
## oldsmobile cutlass ciera (diesel)        1.804006086  0.3136643   0.62882190
## chrysler lebaron medallion               0.291646304 -0.8444808  -0.35369282
## ford granada l                          -0.212473623  0.3136643   0.35075170
## toyota celica gt                         1.047826195 -0.8444808  -0.46492091
## dodge charger 2.2                        1.551946122 -0.8444808  -0.54834197
## chevrolet camaro                         0.417676286 -0.8444808  -0.40003786
## ford mustang gl                          0.417676286 -0.8444808  -0.50199693
## vw pickup                                2.560185976 -0.8444808  -0.90056423
## dodge rampage                            1.047826195 -0.8444808  -0.54834197
## ford ranger                              0.543706268 -0.8444808  -0.68737707
## chevy s-10                               0.921796213 -0.8444808  -0.69664608
##                                          horsepower      weight acceleration
## chevrolet chevelle malibu                0.58765246  0.624370579  -1.18797285
## buick skylark 320                        1.45319937  0.845065577  -1.36067229
## plymouth satellite                       1.08225069  0.544967088  -1.53337173
## amc rebel sst                            1.08225069  0.541463993  -1.18797285
## ford torino                              0.83495157  0.560147167  -1.70607116
## ford galaxie 500                         2.26928646  1.601734139  -1.87877060
## chevrolet impala                         2.81334452  1.616914218  -2.22416947
## plymouth fury iii                        2.68969496  1.567870885  -2.39686891
## pontiac catalina                         2.93699408  1.699820804  -1.87877060
## amc ambassador dpl                       2.07144716  1.028394225  -2.39686891
## citroen ds-21 pallas                     0.21670378  0.140943442   0.71172095
## chevrolet chevelle concours (sw)         1.45319937  1.369362158  -1.36067229
## ford torino (sw)                         1.15644043  1.243250731  -1.53337173
## plymouth satellite (sw)                  1.70049849  1.397386919  -1.70607116
## amc rebel sst (sw)                       1.70049849  1.028394225  -1.53337173
## dodge challenger se                      1.57684893  0.693264785  -1.87877060
## plymouth 'cuda 340                       1.32954981  0.746978911  -2.56956834
## ford mustang boss 302                    0.83495157  0.448048121  -2.56956834
## chevrolet monte carlo                    1.08225069  0.924469068  -2.05147004
## buick estate wagon (sw)                  2.93699408  0.136272649  -1.87877060
## toyota corona mark ii                   -0.27789446 -0.697464008  -0.15177624
## plymouth duster                         -0.27789446 -0.159155046   0.02092320
## amc hornet                              -0.22843463 -0.228049252   0.02092320
## ford maverick                           -0.52519358 -0.446408852   0.19362264
## datsun pl510                            -0.45100384 -0.980047020  -0.32447567
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## volkswagen 1131 deluxe sedan          -1.48966014 -1.324518048   1.74791756
## peugeot 504                           -0.47573375 -0.347154488   0.71172095
## audi 100 ls                           -0.40154402 -0.629737501  -0.32447567
## saab 99e                              -0.27789446 -0.693960913   0.71172095
## bmw 2002                               0.16724395 -0.858606387  -1.01527342
## amc gremlin                           -0.40154402 -0.375179250  -0.15177624
## ford f250                              2.68969496  1.921683500  -0.49717511
## chevy c20                              2.31874628  1.642603583  -0.15177624
## dodge d200                             2.56604540  1.649609773  -0.66987454
## hi 1200d                               2.14563690  2.058304213   1.05711982
## chevrolet vega 2300                   -0.40154402 -0.823575435   0.02092320
## toyota corona                         -0.27789446 -0.865612577  -0.49717511
## ford pinto                            -0.27789446 -1.078133686   1.22981926
## volkswagen super beetle 117           -1.44020031 -1.157537177   1.57521813
## plymouth satellite custom             -0.03059534  0.548470183   0.02092320
## ford torino 500                       -0.45100384  0.388495503   0.02092320
## amc matador                           -0.15424490  0.372147725   0.02092320
## pontiac catalina brougham              1.70049849  1.745361042  -1.36067229
## dodge monaco (sw)                      1.82414805  2.318700956  -1.36067229
## ford country squire (sw)               1.57684893  2.074651990  -1.18797285
## pontiac safari (sw)                    1.70049849  2.534725159  -1.18797285
## amc hornet sportabout (sw)             0.09305422 -0.008521953  -0.66987454
## chevrolet vega (sw)                   -0.84668243 -0.655426866   1.22981926
## pontiac firebird                      -0.15424490  0.365141535  -0.15177624
## ford mustang                          -0.45100384  0.198160664  -0.32447567
## mercury capri 2000                    -0.50046366 -0.874954164  -0.49717511
## opel 1900                             -0.40154402 -0.988220909  -0.49717511
## peugeot 304                           -0.89614225 -1.045438131   1.40251869
## fiat 124b                             -0.74776278 -1.055947416  -0.32447567
## toyota corolla 1200                   -1.01979181 -1.396915349   1.22981926
## datsun 1200                           -0.92087216 -1.583747092   0.88442038
## volkswagen model 111                  -1.14344137 -1.325685746   1.22981926
## plymouth cricket                      -0.89614225 -1.184394240   1.74791756
## toyota corona hardtop                 -0.27789446 -0.807227657   0.02092320
## dodge colt hardtop                    -0.64884313 -0.984717814   0.53902151
## volkswagen type 3                     -1.29182084 -0.835252419   2.78411418
## chevrolet vega                        -0.40154402 -0.655426866   1.40251869
## ford pinto runabout                   -0.50046366 -0.867947974   0.36632207
## amc ambassador sst                     1.08225069  0.820543910  -1.36067229
## mercury marquis                        2.51658558  1.942702071  -1.53337173
## buick lesabre custom                   1.20590025  1.789733581  -0.66987454
## oldsmobile delta 88 royale             1.32954981  1.736019455  -0.66987454
## chrysler newport royal                 2.07144716  1.696317709  -1.01527342
## mazda rx2 coupe                       -0.22843463 -0.746507341  -0.66987454
## amc matador (sw)                       1.08225069  1.077437558  -1.01527342
## ford gran torino (sw)                  0.83495157  1.546852314   0.19362264
## plymouth satellite custom (sw)         1.08225069  1.293461762  -0.49717511
## volvo 145e (sw)                        0.14251404 -0.042385206  -0.32447567
## volkswagen 411 (sw)                   -0.74776278 -0.535153931   0.88442038
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## peugeot 504 (sw)                      -0.47573375  0.011328920   1.40251869
## renault 12 (sw)                       -0.92087216 -0.911152815   0.88442038
## ford pinto (sw)                       -0.50046366 -0.670606945   0.19362264
## datsun 510 (sw)                       -0.35208419 -0.795550673   0.53902151
## toyouta corona mark ii (sw)           -0.22843463 -0.540992422  -0.32447567
## dodge colt (sw)                       -0.64884313 -0.940345275  -0.15177624
## toyota corolla 1600 (sw)              -0.45100384 -1.015077972   0.36632207
## buick century 350                      1.70049849  1.320318825  -0.84257398
## chevrolet malibu                       0.95860113  1.189536604  -0.84257398
## ford gran torino                       0.76076184  1.252592318  -0.32447567
## dodge coronet custom                   1.08225069  0.943152242  -1.01527342
## mercury marquis brougham               2.26928646  2.315197860  -1.36067229
## chevrolet caprice classic              1.08225069  1.745361042  -1.18797285
## ford ltd                               1.28008999  1.627423504  -0.84257398
## plymouth fury gran sedan               1.08225069  1.480293505  -0.32447567
## chrysler new yorker brougham           2.68969496  2.061807308  -1.53337173
## buick electra 225 custom               2.93699408  2.314030162  -1.53337173
## amc ambassador brougham                1.70049849  0.994530972  -1.53337173
## plymouth valiant                      -0.03059534  0.177142093   0.36632207
## chevrolet nova custom                 -0.15424490  0.360470741   0.88442038
## volkswagen super beetle               -1.48966014 -1.190232732   1.92061700
## ford country                           1.50265919  2.261483734  -1.01527342
## plymouth custom suburb                 1.57684893  1.967223738  -0.84257398
## oldsmobile vista cruiser               1.82414805  1.786230486  -1.01527342
## toyota carina                         -0.45100384 -0.806059959   1.22981926
## datsun 610                            -0.30262437 -0.689290119   0.36632207
## maxda rx3                             -0.40154402 -0.987053211  -0.66987454
## mercury capri v6                       0.01886448 -0.580694168  -0.49717511
## fiat 124 sport coupe                  -0.40154402 -0.822407737   0.02092320
## chevrolet monte carlo s                0.95860113  1.299300254  -0.84257398
## pontiac grand prix                     3.06064364  1.528169140  -2.05147004
## fiat 128                              -1.41547040 -1.287151699   1.40251869
## opel manta                            -0.77249269 -0.947351465   0.02092320
## audi 100ls                            -0.37681410 -0.452247344  -0.49717511
## volvo 144ea                            0.14251404 -0.118285602   0.02092320
## dodge dart custom                      1.08225069  0.501762247  -1.53337173
## saab 99le                              0.09305422 -0.361166869  -0.49717511
## toyota mark ii                         0.38981316 -0.189515205  -0.66987454
## oldsmobile omega                       1.82414805  0.811202323  -1.53337173
## chevrolet nova                        -0.15424490  0.428197248   0.53902151
## datsun b210                           -0.97033199 -1.190232732   1.22981926
## chevrolet chevelle malibu classic     -0.15424490  0.947823036   0.53902151
## plymouth satellite sebring            -0.03059534  0.751649705   0.36632207
## buick century luxus (sw)               1.08225069  2.019770166  -0.32447567
## dodge coronet custom (sw)              1.08225069  1.737187153  -0.66987454
## audi fox                              -0.57465340 -0.876121863   0.36632207
## volkswagen dasher                     -0.97033199 -1.175052653   0.02092320
## datsun 710                            -1.11871146 -1.128344717   1.22981926
## dodge colt                            -0.77249269 -0.985885512  -0.32447567
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## fiat 124 tc                        -0.77249269 -0.844594006 -0.49717511
## honda civic                        -0.22843463 -0.560843295 -0.15177624
## subaru                             -0.32735428 -0.675277738  0.02092320
## fiat x1.9                          -0.97033199 -1.131847812  0.19362264
## plymouth valiant custom            -0.27789446  0.344122964  0.19362264
## mercury monarch                    -0.84668243  0.540296295  1.92061700
## chevrolet bel air                   0.95860113  1.717336280 -0.49717511
## plymouth grand fury                 1.08225069  1.785062788 -0.32447567
## buick century                       0.09305422  1.094953034  1.92061700
## chevroelt chevelle malibu          -0.03059534  1.083276050  1.05711982
## plymouth fury                      -0.27789446  0.952493829  1.22981926
## buick skyhawk                       0.09305422  0.081390824 -0.15177624
## chevrolet monza 2+2                 0.09305422  0.293911932 -0.66987454
## ford mustang ii                     0.56292254  0.233191616 -1.18797285
## toyota corolla                     -0.77249269 -0.932171386  0.19362264
## pontiac astro                      -0.69830296 -0.440570360  1.05711982
## volkswagen rabbit                  -0.89614225 -1.205412811 -0.49717511
## amc pacer                          -0.40154402  0.282234949  0.53902151
## volvo 244dl                        -0.20370472 -0.028372826 -0.32447567
## honda civic cvcc                   -1.31655075 -1.371225984  0.71172095
## fiat 131                           -0.50046366 -0.590035755  0.02092320
## capri ii                           -0.35208419 -0.463924328 -0.18631612
## renault 12tl                       -0.57465340 -0.895972736 -0.04815657
## dodge coronet brougham              1.08225069  1.425411681 -0.84257398
## chevrolet chevette                 -1.34128067 -1.090978368  2.33509565
## chevrolet woody                    -1.14344137 -0.940345275  2.30055576
## vw rabbit                          -0.89614225 -1.205412811 -0.42809533
## dodge aspen se                     -0.15424490  0.796022244  0.78080072
## ford granada ghia                  -0.69830296  0.706109467  1.92061700
## pontiac ventura sj                  0.09305422  0.789016054  0.26270241
## amc pacer d/l                      -0.27789446  0.261216377  0.81534061
## datsun b-210                       -0.89614225 -1.143524796  0.53902151
## volvo 245                          -0.10478508  0.211005346  0.09000298
## plymouth volare premier v8          1.08225069  1.133487081 -0.77349421
## mercedes-benz 280s                  0.34035334  0.993363273  0.43540185
## cadillac seville                    1.82414805  1.647274376 -1.15343297
## chevy c10                           0.95860113  1.267772397 -1.18797285
## ford f108                           0.58765246  1.051748193 -0.15177624
## dodge d100                          1.08225069  0.917462877 -0.49717511
## honda accord cvcc                  -0.94560208 -1.079301384  1.05711982
## buick opel isuzu deluxe            -0.64884313 -0.950854560 -0.22085601
## renault 5 gtl                      -1.19290119 -1.336195032  1.09165971
## plymouth arrow gs                  -0.25316455 -0.781538293  0.02092320
## datsun f-10 hatchback              -0.89614225 -1.196071224  0.46994174
## oldsmobile cutlass supreme          0.09305422  1.273610889  1.22981926
## dodge monaco brougham               0.95860113  1.367026761 -0.60079477
## mercury cougar brougham             0.58765246  1.548020013 -0.18631612
## chevrolet concours                  0.09305422  0.643053754  0.33178219
## buick skylark                      -0.03059534  0.532122406  0.50448162
```

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## plymouth volare custom               -0.15424490  0.771500578   0.78080072
## ford granada                         -0.20370472  0.648892246   1.22981926
## pontiac grand prix lj                 1.82414805  1.460442633  -1.49883184
## chevrolet monte carlo landau          1.57684893  1.396219221  -1.39521218
## chrysler cordoba                      2.07144716  1.583050965  -1.11889308
## ford thunderbird                      1.05752078  1.594727949  -0.32447567
## volkswagen rabbit custom             -0.69830296 -1.201909716  -0.32447567
## pontiac sunbird coupe                -0.45100384 -0.267750997   0.19362264
## toyota corolla liftback              -0.77249269 -0.822407737   0.95350016
## ford mustang ii 2+2                  -0.42627393 -0.250235521   0.12454286
## dodge colt m/m                       -0.57465340 -1.044270432   0.15908275
## subaru dl                            -0.97033199 -1.149363288   0.33178219
## datsun 810                           -0.22843463 -0.180173617  -0.32447567
## bmw 320i                              0.09305422 -0.431228773  -0.91165376
## mazda rx-4                            0.09305422 -0.291104965  -0.66987454
## volkswagen rabbit custom diesel      -1.44020031 -1.149363288   2.09331644
## ford fiesta                          -0.99506190 -1.365387492  -0.35901556
## mazda glc deluxe                     -1.34128067 -1.149363288   1.36797880
## datsun b210 gx                       -0.89614225 -1.050108924   1.09165971
## oldsmobile cutlass salon brougham     0.09305422  0.462060502   0.02092320
## dodge diplomat                        0.83495157  0.894108909  -0.77349421
## mercury monarch ghia                  0.81022166  0.701438674  -0.91165376
## pontiac phoenix lj                   -0.03059534  0.660569230   1.29889903
## ford fairmont (auto)                 -0.52519358 -0.005018858   0.12454286
## ford fairmont (man)                  -0.45100384 -0.291104965  -0.01361669
## plymouth volare                      -0.15424490  0.537960898   0.60810128
## amc concord                          -0.40154402  0.281067250   0.60810128
## buick century special                -0.03059534  0.479575978   0.12454286
## mercury zephyr                       -0.52519358  0.117589474   0.43540185
## dodge aspen                           0.09305422  0.759823594   1.12619959
## amc concord d/l                       0.34035334  0.514606930  -0.11723635
## buick regal sport coupe (turbo)       1.45319937  0.555476374  -0.70441443
## ford futura                           0.81022166  0.275228758  -1.46429195
## dodge magnum xe                       0.83495157  1.296964857  -0.60079477
## datsun 510                           -0.22843463 -0.781538293  -0.25539590
## dodge omni                           -0.77249269 -0.863277181  -0.32447567
## toyota celica gt liftback            -0.27789446 -0.530483137  -0.22085601
## plymouth sapporo                     -0.03059534 -0.261912505   0.43540185
## oldsmobile starfire sx               -0.52519358 -0.133465681   0.74626083
## datsun 200-sx                        -0.22843463 -0.658929961  -0.18631612
## audi 5000                            -0.08005516 -0.162658141   0.15908275
## volvo 264gl                           0.46400290  0.199328362  -0.63533466
## saab 99gle                            0.21670378 -0.203527585   0.09000298
## peugeot 604sl                         0.66184219  0.514606930   0.12454286
## volkswagen scirocco                  -0.87141234 -1.143524796  -0.18631612
## honda accord lx                      -0.94560208 -0.974208528   0.40086196
## pontiac lemans v6                     0.21670378  0.321936694  -0.01361669
## mercury zephyr 6                     -0.52519358  0.024173602   0.95350016
## ford fairmont 4                      -0.45100384 -0.092596237   0.64264117
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## amc concord dl 6                         -0.40154402  0.345290662   0.95350016
## dodge aspen 6                             0.09305422  0.456222010   0.40086196
## ford ltd landau                           0.56292254  0.882431925  -0.70441443
## mercury grand marquis                     0.78549175  1.151002557  -0.77349421
## dodge st. regis                           0.71130201  1.005040257  -0.08269646
## chevrolet malibu classic (sw)             0.46400290  0.742308118  -0.15177624
## chrysler lebaron town @ country (sw)  1.08225069  1.133487081  -0.84257398
## vw rabbit custom                         -0.87141234 -1.219425192  -0.49717511
## maxda glc deluxe                         -1.01979181 -1.161040272  -0.08269646
## dodge colt hatchback custom              -0.64884313 -1.231102176  -0.35901556
## amc spirit dl                            -0.64884313 -0.349489885  -0.15177624
## mercedes benz 300d                       -0.72303287  0.654730738   1.60975802
## cadillac eldorado                         0.46400290  1.086779145   0.67718106
## plymouth horizon                         -0.89614225 -0.898308132  -0.77349421
## plymouth horizon tc3                     -0.89614225 -0.956693052  -0.18631612
## datsun 210                               -1.01979181 -1.108493844   1.29889903
## fiat strada custom                       -0.92087216 -0.980047020  -0.25539590
## buick skylark limited                    -0.40154402 -0.349489885   0.19362264
## chevrolet citation                        0.21670378 -0.437067265  -1.42975206
## oldsmobile omega brougham                 0.21670378 -0.314458933  -0.87711387
## pontiac phoenix                          -0.40154402 -0.482607503  -0.77349421
## toyota corolla tercel                    -1.14344137 -1.169214161   1.16073948
## datsun 310                               -1.01979181 -1.109661543   0.33178219
## ford fairmont                            -0.45100384 -0.115950205   0.91896027
## audi 4000                                -0.69830296 -0.912320513   0.12454286
## toyota corona liftback                   -0.40154402 -0.301614251   0.02092320
## mazda 626                                -0.77249269 -0.498955280   0.71172095
## datsun 510 hatchback                     -0.35208419 -0.625066707  -0.15177624
## mazda glc                                -1.01979181 -1.003400988   0.84988050
## vw rabbit c (diesel)                     -1.44020031 -1.032593448   2.16239621
## vw dasher (diesel)                       -1.44020031 -0.740668849   2.85319396
## audi 5000s (diesel)                      -0.97033199 -0.022534334   1.54067824
## mercedes-benz 240d                       -0.97033199  0.327775186   2.19693610
## honda civic 1500 gl                      -0.97033199 -1.307002572  -0.56625488
## renault lecar deluxe                     -0.27789446 -1.324518048   0.64264117
## vokswagen rabbit                         -1.09398155 -1.312841064  -0.04815657
## datsun 280-zx                             0.63711228 -0.069242269  -1.39521218
## mazda rx-7 gs                            -0.15424490 -0.641414485  -1.01527342
## triumph tr7 coupe                        -0.45100384 -0.547998613  -0.11723635
## ford mustang cobra                       -0.27789446 -0.075080761  -0.39355545
## honda accord                             -0.84668243 -0.793215277   0.53902151
## plymouth reliant                         -0.54992349 -0.559675597   0.09000298
## dodge aries wagon (sw)                   -0.35208419 -0.407874805  -0.35901556
## toyota starlet                           -1.19290119 -1.417933920   0.50448162
## plymouth champ                           -1.04452172 -1.277810112   0.33178219
## honda civic 1300                         -1.14344137 -1.412095428   0.22816252
## datsun 210 mpg                           -1.01979181 -1.161040272   1.36797880
## toyota tercel                            -1.09398155 -1.073462892   0.64264117
## mazda glc 4                              -0.94560208 -1.149363288   0.19362264
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## plymouth horizon 4                      -1.06925164 -0.880792656  -0.18631612
## ford escort 4w                          -1.01979181 -1.079301384   0.26270241
## ford escort 2h                          -1.01979181 -0.688122421   1.81699734
## volkswagen jetta                        -0.79722261 -0.909985116  -0.42809533
## renault 18i                             -0.27789446 -0.758184325   0.12454286
## honda prelude                           -0.77249269 -0.886631148  -0.35901556
## datsun 200sx                            -0.15424490 -0.413713297  -0.22085601
## peugeot 505s turbo diesel               -0.64884313  0.304421218   1.71337768
## saab 900s                                0.09305422 -0.197689093  -0.01361669
## volvo diesel                            -0.74776278  0.222682330   1.43705858
## toyota cressida                          0.24143369 -0.080919253  -0.98073353
## datsun 810 maxima                        0.34035334 -0.045888301  -0.56625488
## oldsmobile cutlass ls                   -0.03059534  0.882431925   1.22981926
## ford granada gl                         -0.45100384  0.105912490   0.57356140
## chrysler lebaron salon                  -0.52519358  0.578830342   0.40086196
## chevrolet cavalier                      -0.45100384 -0.425390281   1.43705858
## chevrolet cavalier wagon                -0.45100384 -0.384520837   1.09165971
## chevrolet cavalier 2-door               -0.45100384 -0.670606945   0.88442038
## pontiac j2000 se hatchback              -0.52519358 -0.460421233   0.26270241
## dodge aries se                          -0.54992349 -0.518806153   0.19362264
## ford fairmont futura                    -0.35208419 -0.121788697   0.33178219
## amc concord dl                          -0.27789446  0.076720030   1.74791756
## volkswagen rabbit l                     -0.79722261 -1.155201780  -0.04815657
## mazda glc custom l                      -0.94560208 -1.102655352   0.95350016
## mazda glc custom                        -0.94560208 -1.166878764   0.74626083
## plymouth horizon miser                  -1.06925164 -0.985885512  -0.25539590
## mercury lynx l                          -0.89614225 -0.985885512   0.64264117
## nissan stanza xe                        -0.45100384 -0.945016068  -0.32447567
## honda civic (auto)                      -0.97033199 -1.172717256   0.09000298
## datsun 310 gx                           -0.97033199 -1.137686304   0.26270241
## buick century limited                    0.09305422 -0.028372826   0.33178219
## oldsmobile cutlass ciera (diesel)       -0.52519358  0.053366062   0.53902151
## chrysler lebaron medallion              -0.35208419 -0.448744249  -0.32447567
## ford granada l                           0.14251404 -0.156819649  -0.25539590
## toyota celica gt                        -0.25316455 -0.355328377  -0.53171500
## dodge charger 2.2                       -0.54992349 -0.699799405  -0.84257398
## chevrolet camaro                        -0.40154402 -0.022534334   0.64264117
## ford mustang gl                         -0.50046366 -0.209366077   0.05546309
## vw pickup                               -1.34128067 -0.980047020   3.16405294
## dodge rampage                           -0.54992349 -0.787376785  -1.32613240
## ford ranger                             -0.67357305 -0.402036313   1.09165971
## chevy s-10                              -0.59938331 -0.291104965   1.36797880
##                                          model.year      origin
## chevrolet chevelle malibu               -1.49542202 -0.7307683
## buick skylark 320                       -1.49542202 -0.7307683
## plymouth satellite                      -1.49542202 -0.7307683
## amc rebel sst                           -1.49542202 -0.7307683
## ford torino                             -1.49542202 -0.7307683
## ford galaxie 500                        -1.49542202 -0.7307683
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## chevrolet impala                     -1.49542202 -0.7307683
## plymouth fury iii                     -1.49542202 -0.7307683
## pontiac catalina                      -1.49542202 -0.7307683
## amc ambassador dpl                    -1.49542202 -0.7307683
## citroen ds-21 pallas                  -1.49542202  0.5288986
## chevrolet chevelle concours (sw)      -1.49542202 -0.7307683
## ford torino (sw)                      -1.49542202 -0.7307683
## plymouth satellite (sw)               -1.49542202 -0.7307683
## amc rebel sst (sw)                    -1.49542202 -0.7307683
## dodge challenger se                   -1.49542202 -0.7307683
## plymouth 'cuda 340                    -1.49542202 -0.7307683
## ford mustang boss 302                 -1.49542202 -0.7307683
## chevrolet monte carlo                 -1.49542202 -0.7307683
## buick estate wagon (sw)               -1.49542202 -0.7307683
## toyota corona mark ii                 -1.49542202  1.7885655
## plymouth duster                       -1.49542202 -0.7307683
## amc hornet                            -1.49542202 -0.7307683
## ford maverick                         -1.49542202 -0.7307683
## datsun pl510                          -1.49542202  1.7885655
## volkswagen 1131 deluxe sedan          -1.49542202  0.5288986
## peugeot 504                           -1.49542202  0.5288986
## audi 100 ls                           -1.49542202  0.5288986
## saab 99e                              -1.49542202  0.5288986
## bmw 2002                              -1.49542202  0.5288986
## amc gremlin                           -1.49542202 -0.7307683
## ford f250                             -1.49542202 -0.7307683
## chevy c20                             -1.49542202 -0.7307683
## dodge d200                            -1.49542202 -0.7307683
## hi 1200d                              -1.49542202 -0.7307683
## chevrolet vega 2300                   -1.24060406 -0.7307683
## toyota corona                         -1.24060406  1.7885655
## ford pinto                            -1.24060406 -0.7307683
## volkswagen super beetle 117           -1.24060406  0.5288986
## plymouth satellite custom             -1.24060406 -0.7307683
## ford torino 500                       -1.24060406 -0.7307683
## amc matador                           -1.24060406 -0.7307683
## pontiac catalina brougham             -1.24060406 -0.7307683
## dodge monaco (sw)                     -1.24060406 -0.7307683
## ford country squire (sw)              -1.24060406 -0.7307683
## pontiac safari (sw)                   -1.24060406 -0.7307683
## amc hornet sportabout (sw)            -1.24060406 -0.7307683
## chevrolet vega (sw)                   -1.24060406 -0.7307683
## pontiac firebird                      -1.24060406 -0.7307683
## ford mustang                          -1.24060406 -0.7307683
## mercury capri 2000                    -1.24060406 -0.7307683
## opel 1900                             -1.24060406  0.5288986
## peugeot 304                           -1.24060406  0.5288986
## fiat 124b                             -1.24060406  0.5288986
## toyota corolla 1200                   -1.24060406  1.7885655
```

```
## datsun 1200                        -1.24060406  1.7885655
## volkswagen model 111               -1.24060406  0.5288986
## plymouth cricket                   -1.24060406 -0.7307683
## toyota corona hardtop              -0.98578611  1.7885655
## dodge colt hardtop                 -0.98578611 -0.7307683
## volkswagen type 3                  -0.98578611  0.5288986
## chevrolet vega                     -0.98578611 -0.7307683
## ford pinto runabout                -0.98578611 -0.7307683
## amc ambassador sst                 -0.98578611 -0.7307683
## mercury marquis                    -0.98578611 -0.7307683
## buick lesabre custom               -0.98578611 -0.7307683
## oldsmobile delta 88 royale         -0.98578611 -0.7307683
## chrysler newport royal             -0.98578611 -0.7307683
## mazda rx2 coupe                    -0.98578611  1.7885655
## amc matador (sw)                   -0.98578611 -0.7307683
## ford gran torino (sw)              -0.98578611 -0.7307683
## plymouth satellite custom (sw)     -0.98578611 -0.7307683
## volvo 145e (sw)                    -0.98578611  0.5288986
## volkswagen 411 (sw)                -0.98578611  0.5288986
## peugeot 504 (sw)                   -0.98578611  0.5288986
## renault 12 (sw)                    -0.98578611  0.5288986
## ford pinto (sw)                    -0.98578611 -0.7307683
## datsun 510 (sw)                    -0.98578611  1.7885655
## toyouta corona mark ii (sw)        -0.98578611  1.7885655
## dodge colt (sw)                    -0.98578611 -0.7307683
## toyota corolla 1600 (sw)           -0.98578611  1.7885655
## buick century 350                  -0.73096816 -0.7307683
## chevrolet malibu                   -0.73096816 -0.7307683
## ford gran torino                   -0.73096816 -0.7307683
## dodge coronet custom               -0.73096816 -0.7307683
## mercury marquis brougham           -0.73096816 -0.7307683
## chevrolet caprice classic          -0.73096816 -0.7307683
## ford ltd                           -0.73096816 -0.7307683
## plymouth fury gran sedan           -0.73096816 -0.7307683
## chrysler new yorker brougham       -0.73096816 -0.7307683
## buick electra 225 custom           -0.73096816 -0.7307683
## amc ambassador brougham            -0.73096816 -0.7307683
## plymouth valiant                   -0.73096816 -0.7307683
## chevrolet nova custom              -0.73096816 -0.7307683
## volkswagen super beetle            -0.73096816  0.5288986
## ford country                       -0.73096816 -0.7307683
## plymouth custom suburb             -0.73096816 -0.7307683
## oldsmobile vista cruiser           -0.73096816 -0.7307683
## toyota carina                      -0.73096816  1.7885655
## datsun 610                         -0.73096816  1.7885655
## maxda rx3                          -0.73096816  1.7885655
## mercury capri v6                   -0.73096816 -0.7307683
## fiat 124 sport coupe               -0.73096816  0.5288986
## chevrolet monte carlo s            -0.73096816 -0.7307683
```

```
## pontiac grand prix                  -0.73096816 -0.7307683
## fiat 128                            -0.73096816  0.5288986
## opel manta                          -0.73096816  0.5288986
## audi 100ls                          -0.73096816  0.5288986
## volvo 144ea                         -0.73096816  0.5288986
## dodge dart custom                   -0.73096816 -0.7307683
## saab 99le                           -0.73096816  0.5288986
## toyota mark ii                      -0.73096816  1.7885655
## oldsmobile omega                    -0.73096816 -0.7307683
## chevrolet nova                      -0.47615021 -0.7307683
## datsun b210                         -0.47615021  1.7885655
## chevrolet chevelle malibu classic   -0.47615021 -0.7307683
## plymouth satellite sebring          -0.47615021 -0.7307683
## buick century luxus (sw)            -0.47615021 -0.7307683
## dodge coronet custom (sw)           -0.47615021 -0.7307683
## audi fox                            -0.47615021  0.5288986
## volkswagen dasher                   -0.47615021  0.5288986
## datsun 710                          -0.47615021  1.7885655
## dodge colt                          -0.47615021 -0.7307683
## fiat 124 tc                         -0.47615021  0.5288986
## honda civic                         -0.47615021  1.7885655
## subaru                              -0.47615021  1.7885655
## fiat x1.9                           -0.47615021  0.5288986
## plymouth valiant custom             -0.22133226 -0.7307683
## mercury monarch                     -0.22133226 -0.7307683
## chevrolet bel air                   -0.22133226 -0.7307683
## plymouth grand fury                 -0.22133226 -0.7307683
## buick century                       -0.22133226 -0.7307683
## chevroelt chevelle malibu           -0.22133226 -0.7307683
## plymouth fury                       -0.22133226 -0.7307683
## buick skyhawk                       -0.22133226 -0.7307683
## chevrolet monza 2+2                 -0.22133226 -0.7307683
## ford mustang ii                     -0.22133226 -0.7307683
## toyota corolla                      -0.22133226  1.7885655
## pontiac astro                       -0.22133226 -0.7307683
## volkswagen rabbit                   -0.22133226  0.5288986
## amc pacer                           -0.22133226 -0.7307683
## volvo 244dl                         -0.22133226  0.5288986
## honda civic cvcc                    -0.22133226  1.7885655
## fiat 131                             0.03348569  0.5288986
## capri ii                             0.03348569 -0.7307683
## renault 12tl                         0.03348569  0.5288986
## dodge coronet brougham               0.03348569 -0.7307683
## chevrolet chevette                   0.03348569 -0.7307683
## chevrolet woody                      0.03348569 -0.7307683
## vw rabbit                            0.03348569  0.5288986
## dodge aspen se                       0.03348569 -0.7307683
## ford granada ghia                    0.03348569 -0.7307683
## pontiac ventura sj                   0.03348569 -0.7307683
```

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## amc pacer d/l                        0.03348569 -0.7307683
## datsun b-210                         0.03348569  1.7885655
## volvo 245                            0.03348569  0.5288986
## plymouth volare premier v8           0.03348569 -0.7307683
## mercedes-benz 280s                   0.03348569  0.5288986
## cadillac seville                     0.03348569 -0.7307683
## chevy c10                            0.03348569 -0.7307683
## ford f108                            0.03348569 -0.7307683
## dodge d100                           0.03348569 -0.7307683
## honda accord cvcc                    0.28830364  1.7885655
## buick opel isuzu deluxe              0.28830364 -0.7307683
## renault 5 gtl                        0.28830364  0.5288986
## plymouth arrow gs                    0.28830364 -0.7307683
## datsun f-10 hatchback                0.28830364  1.7885655
## oldsmobile cutlass supreme           0.28830364 -0.7307683
## dodge monaco brougham                0.28830364 -0.7307683
## mercury cougar brougham              0.28830364 -0.7307683
## chevrolet concours                   0.28830364 -0.7307683
## buick skylark                        0.28830364 -0.7307683
## plymouth volare custom               0.28830364 -0.7307683
## ford granada                         0.28830364 -0.7307683
## pontiac grand prix lj                0.28830364 -0.7307683
## chevrolet monte carlo landau         0.28830364 -0.7307683
## chrysler cordoba                     0.28830364 -0.7307683
## ford thunderbird                     0.28830364 -0.7307683
## volkswagen rabbit custom             0.28830364  0.5288986
## pontiac sunbird coupe                0.28830364 -0.7307683
## toyota corolla liftback              0.28830364  1.7885655
## ford mustang ii 2+2                  0.28830364 -0.7307683
## dodge colt m/m                       0.28830364 -0.7307683
## subaru dl                            0.28830364  1.7885655
## datsun 810                           0.28830364  1.7885655
## bmw 320i                             0.28830364  0.5288986
## mazda rx-4                           0.28830364  1.7885655
## volkswagen rabbit custom diesel      0.54312159  0.5288986
## ford fiesta                          0.54312159 -0.7307683
## mazda glc deluxe                     0.54312159  1.7885655
## datsun b210 gx                       0.54312159  1.7885655
## oldsmobile cutlass salon brougham    0.54312159 -0.7307683
## dodge diplomat                       0.54312159 -0.7307683
## mercury monarch ghia                 0.54312159 -0.7307683
## pontiac phoenix lj                   0.54312159 -0.7307683
## ford fairmont (auto)                 0.54312159 -0.7307683
## ford fairmont (man)                  0.54312159 -0.7307683
## plymouth volare                      0.54312159 -0.7307683
## amc concord                          0.54312159 -0.7307683
## buick century special                0.54312159 -0.7307683
## mercury zephyr                       0.54312159 -0.7307683
## dodge aspen                          0.54312159 -0.7307683
```

```
## amc concord d/l                          0.54312159 -0.7307683
## buick regal sport coupe (turbo)          0.54312159 -0.7307683
## ford futura                              0.54312159 -0.7307683
## dodge magnum xe                          0.54312159 -0.7307683
## datsun 510                               0.54312159  1.7885655
## dodge omni                               0.54312159 -0.7307683
## toyota celica gt liftback                0.54312159  1.7885655
## plymouth sapporo                         0.54312159 -0.7307683
## oldsmobile starfire sx                   0.54312159 -0.7307683
## datsun 200-sx                            0.54312159  1.7885655
## audi 5000                                0.54312159  0.5288986
## volvo 264gl                              0.54312159  0.5288986
## saab 99gle                               0.54312159  0.5288986
## peugeot 604sl                            0.54312159  0.5288986
## volkswagen scirocco                      0.54312159  0.5288986
## honda accord lx                          0.54312159  1.7885655
## pontiac lemans v6                        0.79793955 -0.7307683
## mercury zephyr 6                         0.79793955 -0.7307683
## ford fairmont 4                          0.79793955 -0.7307683
## amc concord dl 6                         0.79793955 -0.7307683
## dodge aspen 6                            0.79793955 -0.7307683
## ford ltd landau                          0.79793955 -0.7307683
## mercury grand marquis                    0.79793955 -0.7307683
## dodge st. regis                          0.79793955 -0.7307683
## chevrolet malibu classic (sw)            0.79793955 -0.7307683
## chrysler lebaron town @ country (sw)     0.79793955 -0.7307683
## vw rabbit custom                         0.79793955  0.5288986
## maxda glc deluxe                         0.79793955  1.7885655
## dodge colt hatchback custom              0.79793955 -0.7307683
## amc spirit dl                            0.79793955 -0.7307683
## mercedes benz 300d                       0.79793955  0.5288986
## cadillac eldorado                        0.79793955 -0.7307683
## plymouth horizon                         0.79793955 -0.7307683
## plymouth horizon tc3                     0.79793955 -0.7307683
## datsun 210                               0.79793955  1.7885655
## fiat strada custom                       0.79793955  0.5288986
## buick skylark limited                    0.79793955 -0.7307683
## chevrolet citation                       0.79793955 -0.7307683
## oldsmobile omega brougham                0.79793955 -0.7307683
## pontiac phoenix                          0.79793955 -0.7307683
## toyota corolla tercel                    1.05275750  1.7885655
## datsun 310                               1.05275750  1.7885655
## ford fairmont                            1.05275750 -0.7307683
## audi 4000                                1.05275750  0.5288986
## toyota corona liftback                   1.05275750  1.7885655
## mazda 626                                1.05275750  1.7885655
## datsun 510 hatchback                     1.05275750  1.7885655
## mazda glc                                1.05275750  1.7885655
## vw rabbit c (diesel)                     1.05275750  0.5288986
```

```
## vw dasher (diesel)                  1.05275750  0.5288986
## audi 5000s (diesel)                 1.05275750  0.5288986
## mercedes-benz 240d                  1.05275750  0.5288986
## honda civic 1500 gl                 1.05275750  1.7885655
## renault lecar deluxe               1.05275750  0.5288986
## vokswagen rabbit                    1.05275750  0.5288986
## datsun 280-zx                       1.05275750  1.7885655
## mazda rx-7 gs                       1.05275750  1.7885655
## triumph tr7 coupe                   1.05275750  0.5288986
## ford mustang cobra                  1.05275750 -0.7307683
## honda accord                        1.05275750  1.7885655
## plymouth reliant                    1.30757545 -0.7307683
## dodge aries wagon (sw)              1.30757545 -0.7307683
## toyota starlet                      1.30757545  1.7885655
## plymouth champ                      1.30757545 -0.7307683
## honda civic 1300                    1.30757545  1.7885655
## datsun 210 mpg                      1.30757545  1.7885655
## toyota tercel                       1.30757545  1.7885655
## mazda glc 4                         1.30757545  1.7885655
## plymouth horizon 4                  1.30757545 -0.7307683
## ford escort 4w                      1.30757545 -0.7307683
## ford escort 2h                      1.30757545 -0.7307683
## volkswagen jetta                    1.30757545  0.5288986
## renault 18i                         1.30757545  0.5288986
## honda prelude                       1.30757545  1.7885655
## datsun 200sx                        1.30757545  1.7885655
## peugeot 505s turbo diesel           1.30757545  0.5288986
## saab 900s                           1.30757545  0.5288986
## volvo diesel                        1.30757545  0.5288986
## toyota cressida                     1.30757545  1.7885655
## datsun 810 maxima                   1.30757545  1.7885655
## oldsmobile cutlass ls               1.30757545 -0.7307683
## ford granada gl                     1.30757545 -0.7307683
## chrysler lebaron salon              1.30757545 -0.7307683
## chevrolet cavalier                  1.56239340 -0.7307683
## chevrolet cavalier wagon            1.56239340 -0.7307683
## chevrolet cavalier 2-door           1.56239340 -0.7307683
## pontiac j2000 se hatchback          1.56239340 -0.7307683
## dodge aries se                      1.56239340 -0.7307683
## ford fairmont futura                1.56239340 -0.7307683
## amc concord dl                      1.56239340 -0.7307683
## volkswagen rabbit l                 1.56239340  0.5288986
## mazda glc custom l                  1.56239340  1.7885655
## mazda glc custom                    1.56239340  1.7885655
## plymouth horizon miser              1.56239340 -0.7307683
## mercury lynx l                      1.56239340 -0.7307683
## nissan stanza xe                    1.56239340  1.7885655
## honda civic (auto)                  1.56239340  1.7885655
## datsun 310 gx                       1.56239340  1.7885655
```

```
## buick century limited                1.56239340 -0.7307683
## oldsmobile cutlass ciera (diesel)    1.56239340 -0.7307683
## chrysler lebaron medallion           1.56239340 -0.7307683
## ford granada l                       1.56239340 -0.7307683
## toyota celica gt                     1.56239340  1.7885655
## dodge charger 2.2                    1.56239340 -0.7307683
## chevrolet camaro                     1.56239340 -0.7307683
## ford mustang gl                      1.56239340 -0.7307683
## vw pickup                            1.56239340  0.5288986
## dodge rampage                        1.56239340 -0.7307683
## ford ranger                          1.56239340 -0.7307683
## chevy s-10                           1.56239340 -0.7307683

data_scale2 <- data_scale
dis_mat = dist(data_scale2) # creating the distance matrix
#class(dis_mat)

#dis_mat

hhc <- hclust(dis_mat, "complete")
plot(hhc, main = "Fig. 7: Complete Linkage HC Dendogram")
```



```
library(mclust)
```

```
## Package 'mclust' version 5.4.5
## Type 'citation("mclust")' for citing this R package in publications.

mcl <- Mclust(data_scale,3)
summary(mcl)

## ----------------------------------------------------
## Gaussian finite mixture model fitted by EM algorithm
## ----------------------------------------------------
##
## Mclust VEV (ellipsoidal, equal shape) model with 3 components:
##
##  log-likelihood    n  df      BIC        ICL
##       -1088.475  312 120 -2866.11  -2866.179
##
## Clustering table:
##    1   2   3
##   84 178  50

mcct <- table(mcl$classification) ## identifies 3 groups
plot(mcl, what = "classification", cex = 0.4)
```
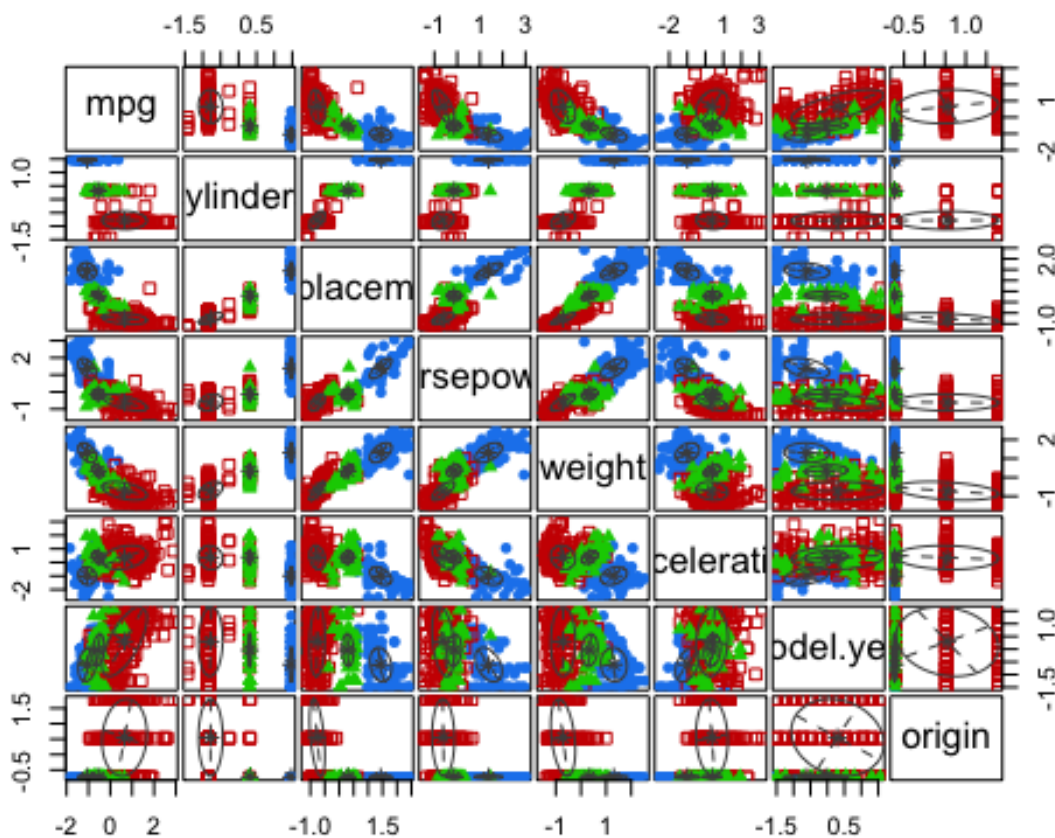


```
plot(mcl, what = "BIC")
```
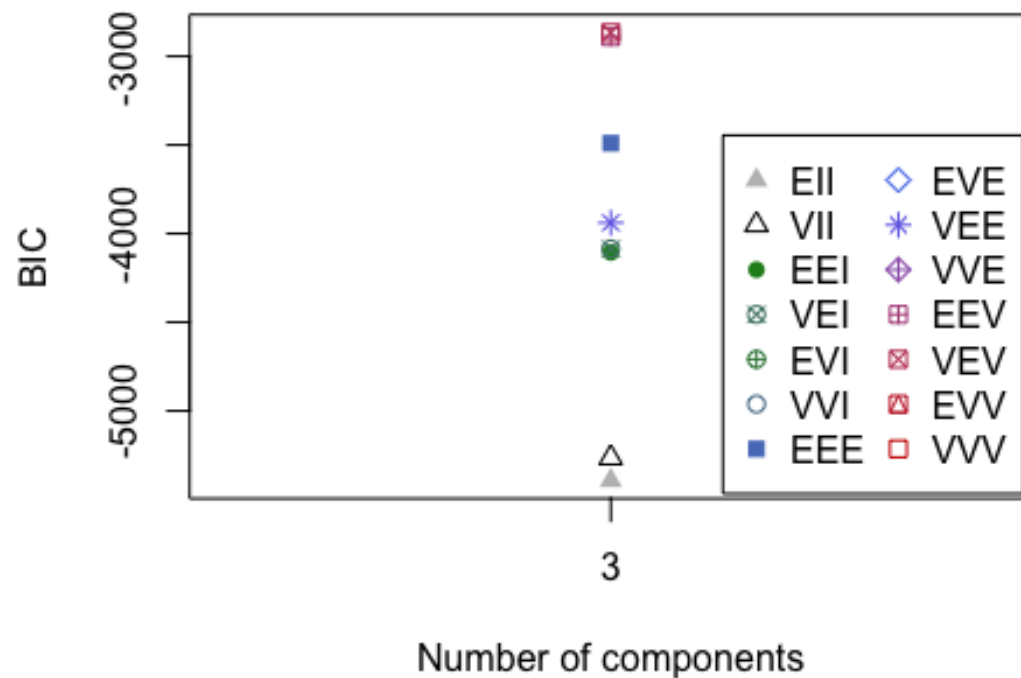
```
grm <- data.frame(mcct)
grm

##   Var1 Freq
## 1    1   84
## 2    2  178
## 3    3   50

#subset(data_scale2,grm == 1)## countries in each group

# checking for BIC plot because we have too many clusters
# Accelration  vs mpg
plot(mcl, what = "BIC")
```
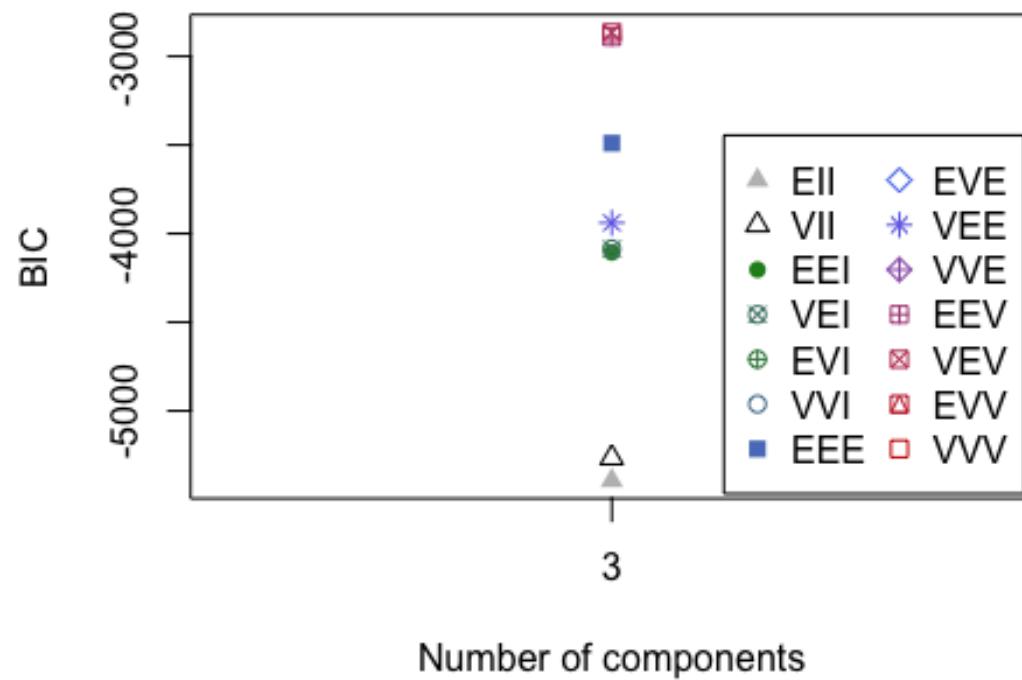
```
plot(mcl, what = "uncertainty", dimens = c(1,6)) #
text(mcl$data[,c(1,6)], labels = abbreviate(rownames(data_scale)),  col = mcl
$classification)
```

```
clust.data = cbind(rownames(data_scale), mcl$classification, mcl$uncertainty
)
clust.data[order(mcl$uncertainty),]
```

```
##                                  [,1]
## chevrolet chevelle malibu        "chevrolet chevelle malibu"
## buick skylark 320                "buick skylark 320"
## plymouth satellite               "plymouth satellite"
## amc rebel sst                    "amc rebel sst"
## ford torino                      "ford torino"
## ford galaxie 500                 "ford galaxie 500"
## chevrolet impala                 "chevrolet impala"
## plymouth fury iii                "plymouth fury iii"
## pontiac catalina                 "pontiac catalina"
## amc ambassador dpl               "amc ambassador dpl"
## citroen ds-21 pallas             "citroen ds-21 pallas"
## chevrolet chevelle concours (sw) "chevrolet chevelle concours (sw)"
## ford torino (sw)                 "ford torino (sw)"
## plymouth satellite (sw)          "plymouth satellite (sw)"
## amc rebel sst (sw)               "amc rebel sst (sw)"
## dodge challenger se              "dodge challenger se"
## plymouth 'cuda 340               "plymouth 'cuda 340"
## ford mustang boss 302            "ford mustang boss 302"
```

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```
## chevrolet monte carlo              "chevrolet monte carlo"
## buick estate wagon (sw)            "buick estate wagon (sw)"
## toyota corona mark ii              "toyota corona mark ii"
## datsun pl510                       "datsun pl510"
## volkswagen 1131 deluxe sedan       "volkswagen 1131 deluxe sedan"
## peugeot 504                        "peugeot 504"
## audi 100 ls                        "audi 100 ls"
## saab 99e                           "saab 99e"
## bmw 2002                           "bmw 2002"
## ford f250                          "ford f250"
## chevy c20                          "chevy c20"
## dodge d200                         "dodge d200"
## hi 1200d                           "hi 1200d"
## chevrolet vega 2300                "chevrolet vega 2300"
## toyota corona                      "toyota corona"
## ford pinto                         "ford pinto"
## volkswagen super beetle 117        "volkswagen super beetle 117"
## pontiac catalina brougham          "pontiac catalina brougham"
## dodge monaco (sw)                  "dodge monaco (sw)"
## ford country squire (sw)           "ford country squire (sw)"
## pontiac safari (sw)                "pontiac safari (sw)"
## amc hornet sportabout (sw)         "amc hornet sportabout (sw)"
## chevrolet vega (sw)                "chevrolet vega (sw)"
## mercury capri 2000                 "mercury capri 2000"
## opel 1900                          "opel 1900"
## peugeot 304                        "peugeot 304"
## fiat 124b                          "fiat 124b"
## toyota corolla 1200                "toyota corolla 1200"
## datsun 1200                        "datsun 1200"
## volkswagen model 111               "volkswagen model 111"
## plymouth cricket                   "plymouth cricket"
## toyota corona hardtop              "toyota corona hardtop"
## dodge colt hardtop                 "dodge colt hardtop"
## volkswagen type 3                  "volkswagen type 3"
## chevrolet vega                     "chevrolet vega"
## ford pinto runabout                "ford pinto runabout"
## amc ambassador sst                 "amc ambassador sst"
## mercury marquis                    "mercury marquis"
## buick lesabre custom               "buick lesabre custom"
## oldsmobile delta 88 royale         "oldsmobile delta 88 royale"
## chrysler newport royal             "chrysler newport royal"
## mazda rx2 coupe                    "mazda rx2 coupe"
## amc matador (sw)                   "amc matador (sw)"
## plymouth satellite custom (sw)     "plymouth satellite custom (sw)"
## volvo 145e (sw)                    "volvo 145e (sw)"
## volkswagen 411 (sw)                "volkswagen 411 (sw)"
## peugeot 504 (sw)                   "peugeot 504 (sw)"
## renault 12 (sw)                    "renault 12 (sw)"
## ford pinto (sw)                    "ford pinto (sw)"
```

```
## datsun 510 (sw)                  "datsun 510 (sw)"
## toyouta corona mark ii (sw)      "toyouta corona mark ii (sw)"
## dodge colt (sw)                  "dodge colt (sw)"
## toyota corolla 1600 (sw)         "toyota corolla 1600 (sw)"
## buick century 350                "buick century 350"
## chevrolet malibu                 "chevrolet malibu"
## dodge coronet custom             "dodge coronet custom"
## mercury marquis brougham         "mercury marquis brougham"
## chevrolet caprice classic        "chevrolet caprice classic"
## ford ltd                         "ford ltd"
## plymouth fury gran sedan         "plymouth fury gran sedan"
## chrysler new yorker brougham     "chrysler new yorker brougham"
## buick electra 225 custom         "buick electra 225 custom"
## amc ambassador brougham          "amc ambassador brougham"
## volkswagen super beetle          "volkswagen super beetle"
## ford country                     "ford country"
## plymouth custom suburb           "plymouth custom suburb"
## oldsmobile vista cruiser         "oldsmobile vista cruiser"
## toyota carina                    "toyota carina"
## datsun 610                       "datsun 610"
## maxda rx3                        "maxda rx3"
## fiat 124 sport coupe             "fiat 124 sport coupe"
## chevrolet monte carlo s          "chevrolet monte carlo s"
## pontiac grand prix               "pontiac grand prix"
## fiat 128                         "fiat 128"
## opel manta                       "opel manta"
## audi 100ls                       "audi 100ls"
## volvo 144ea                      "volvo 144ea"
## dodge dart custom                "dodge dart custom"
## saab 99le                        "saab 99le"
## toyota mark ii                   "toyota mark ii"
## oldsmobile omega                 "oldsmobile omega"
## datsun b210                      "datsun b210"
## buick century luxus (sw)         "buick century luxus (sw)"
## audi fox                         "audi fox"
## volkswagen dasher                "volkswagen dasher"
## datsun 710                       "datsun 710"
## dodge colt                       "dodge colt"
## fiat 124 tc                      "fiat 124 tc"
## honda civic                      "honda civic"
## subaru                           "subaru"
## fiat x1.9                        "fiat x1.9"
## chevrolet bel air                "chevrolet bel air"
## ford mustang ii                  "ford mustang ii"
## toyota corolla                   "toyota corolla"
## pontiac astro                    "pontiac astro"
## volkswagen rabbit                "volkswagen rabbit"
## volvo 244dl                      "volvo 244dl"
## honda civic cvcc                 "honda civic cvcc"
```

```
## fiat 131                            "fiat 131"
## capri ii                            "capri ii"
## renault 12tl                        "renault 12tl"
## dodge coronet brougham              "dodge coronet brougham"
## chevrolet chevette                  "chevrolet chevette"
## chevrolet woody                     "chevrolet woody"
## vw rabbit                           "vw rabbit"
## amc pacer d/l                       "amc pacer d/l"
## datsun b-210                        "datsun b-210"
## volvo 245                           "volvo 245"
## plymouth volare premier v8          "plymouth volare premier v8"
## mercedes-benz 280s                  "mercedes-benz 280s"
## cadillac seville                    "cadillac seville"
## chevy c10                           "chevy c10"
## ford f108                           "ford f108"
## dodge d100                          "dodge d100"
## honda accord cvcc                   "honda accord cvcc"
## buick opel isuzu deluxe             "buick opel isuzu deluxe"
## renault 5 gtl                       "renault 5 gtl"
## plymouth arrow gs                   "plymouth arrow gs"
## datsun f-10 hatchback               "datsun f-10 hatchback"
## dodge monaco brougham               "dodge monaco brougham"
## pontiac grand prix lj               "pontiac grand prix lj"
## chevrolet monte carlo landau        "chevrolet monte carlo landau"
## chrysler cordoba                    "chrysler cordoba"
## ford thunderbird                    "ford thunderbird"
## volkswagen rabbit custom            "volkswagen rabbit custom"
## pontiac sunbird coupe               "pontiac sunbird coupe"
## toyota corolla liftback             "toyota corolla liftback"
## ford mustang ii 2+2                 "ford mustang ii 2+2"
## dodge colt m/m                      "dodge colt m/m"
## subaru dl                           "subaru dl"
## datsun 810                          "datsun 810"
## bmw 320i                            "bmw 320i"
## mazda rx-4                          "mazda rx-4"
## volkswagen rabbit custom diesel     "volkswagen rabbit custom diesel"
## ford fiesta                         "ford fiesta"
## mazda glc deluxe                    "mazda glc deluxe"
## datsun b210 gx                      "datsun b210 gx"
## dodge diplomat                      "dodge diplomat"
## mercury monarch ghia                "mercury monarch ghia"
## ford fairmont (man)                 "ford fairmont (man)"
## ford futura                         "ford futura"
## dodge magnum xe                     "dodge magnum xe"
## datsun 510                          "datsun 510"
## dodge omni                          "dodge omni"
## toyota celica gt liftback           "toyota celica gt liftback"
## plymouth sapporo                    "plymouth sapporo"
## oldsmobile starfire sx              "oldsmobile starfire sx"
```

```
## datsun 200-sx                            "datsun 200-sx"
## audi 5000                                "audi 5000"
## volvo 264gl                              "volvo 264gl"
## saab 99gle                               "saab 99gle"
## peugeot 604sl                            "peugeot 604sl"
## volkswagen scirocco                      "volkswagen scirocco"
## honda accord lx                          "honda accord lx"
## ford fairmont 4                          "ford fairmont 4"
## ford ltd landau                          "ford ltd landau"
## mercury grand marquis                    "mercury grand marquis"
## dodge st. regis                          "dodge st. regis"
## chrysler lebaron town @ country (sw) "chrysler lebaron town @ country (sw)
"
## vw rabbit custom                         "vw rabbit custom"
## maxda glc deluxe                         "maxda glc deluxe"
## dodge colt hatchback custom              "dodge colt hatchback custom"
## amc spirit dl                            "amc spirit dl"
## mercedes benz 300d                       "mercedes benz 300d"
## cadillac eldorado                        "cadillac eldorado"
## plymouth horizon                         "plymouth horizon"
## plymouth horizon tc3                     "plymouth horizon tc3"
## datsun 210                               "datsun 210"
## fiat strada custom                       "fiat strada custom"
## buick skylark limited                    "buick skylark limited"
## pontiac phoenix                          "pontiac phoenix"
## toyota corolla tercel                    "toyota corolla tercel"
## datsun 310                               "datsun 310"
## ford fairmont                            "ford fairmont"
## audi 4000                                "audi 4000"
## toyota corona liftback                   "toyota corona liftback"
## mazda 626                                "mazda 626"
## datsun 510 hatchback                     "datsun 510 hatchback"
## mazda glc                                "mazda glc"
## vw rabbit c (diesel)                     "vw rabbit c (diesel)"
## vw dasher (diesel)                       "vw dasher (diesel)"
## audi 5000s (diesel)                      "audi 5000s (diesel)"
## mercedes-benz 240d                       "mercedes-benz 240d"
## honda civic 1500 gl                      "honda civic 1500 gl"
## renault lecar deluxe                     "renault lecar deluxe"
## vokswagen rabbit                         "vokswagen rabbit"
## datsun 280-zx                            "datsun 280-zx"
## mazda rx-7 gs                            "mazda rx-7 gs"
## triumph tr7 coupe                        "triumph tr7 coupe"
## ford mustang cobra                       "ford mustang cobra"
## honda accord                             "honda accord"
## plymouth reliant                         "plymouth reliant"
## dodge aries wagon (sw)                   "dodge aries wagon (sw)"
## toyota starlet                           "toyota starlet"
## plymouth champ                           "plymouth champ"
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## honda civic 1300                       "honda civic 1300"
## datsun 210 mpg                         "datsun 210 mpg"
## toyota tercel                          "toyota tercel"
## mazda glc 4                            "mazda glc 4"
## plymouth horizon 4                     "plymouth horizon 4"
## ford escort 4w                         "ford escort 4w"
## ford escort 2h                         "ford escort 2h"
## volkswagen jetta                       "volkswagen jetta"
## renault 18i                            "renault 18i"
## honda prelude                          "honda prelude"
## datsun 200sx                           "datsun 200sx"
## peugeot 505s turbo diesel              "peugeot 505s turbo diesel"
## saab 900s                              "saab 900s"
## volvo diesel                           "volvo diesel"
## toyota cressida                        "toyota cressida"
## datsun 810 maxima                      "datsun 810 maxima"
## oldsmobile cutlass ls                  "oldsmobile cutlass ls"
## chevrolet cavalier                     "chevrolet cavalier"
## chevrolet cavalier wagon               "chevrolet cavalier wagon"
## chevrolet cavalier 2-door              "chevrolet cavalier 2-door"
## pontiac j2000 se hatchback             "pontiac j2000 se hatchback"
## dodge aries se                         "dodge aries se"
## ford fairmont futura                   "ford fairmont futura"
## amc concord dl                         "amc concord dl"
## volkswagen rabbit l                    "volkswagen rabbit l"
## mazda glc custom l                     "mazda glc custom l"
## mazda glc custom                       "mazda glc custom"
## plymouth horizon miser                 "plymouth horizon miser"
## mercury lynx l                         "mercury lynx l"
## nissan stanza xe                       "nissan stanza xe"
## honda civic (auto)                     "honda civic (auto)"
## datsun 310 gx                          "datsun 310 gx"
## oldsmobile cutlass ciera (diesel)      "oldsmobile cutlass ciera (diesel)"
## chrysler lebaron medallion             "chrysler lebaron medallion"
## toyota celica gt                       "toyota celica gt"
## dodge charger 2.2                      "dodge charger 2.2"
## chevrolet camaro                       "chevrolet camaro"
## ford mustang gl                        "ford mustang gl"
## vw pickup                              "vw pickup"
## dodge rampage                          "dodge rampage"
## ford ranger                            "ford ranger"
## chevy s-10                             "chevy s-10"
## ford mustang                           "ford mustang"
## ford gran torino                       "ford gran torino"
## dodge coronet custom (sw)              "dodge coronet custom (sw)"
## plymouth grand fury                    "plymouth grand fury"
## mercury monarch                        "mercury monarch"
## ford torino 500                        "ford torino 500"
## mercury cougar brougham                "mercury cougar brougham"
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```
## ford gran torino (sw)                "ford gran torino (sw)"
## chevrolet monza 2+2                   "chevrolet monza 2+2"
## chevrolet nova custom                 "chevrolet nova custom"
## ford granada ghia                     "ford granada ghia"
## chevrolet nova                        "chevrolet nova"
## pontiac firebird                      "pontiac firebird"
## oldsmobile cutlass salon brougham     "oldsmobile cutlass salon brougham"
## amc concord d/l                       "amc concord d/l"
## ford granada l                        "ford granada l"
## chevrolet malibu classic (sw)         "chevrolet malibu classic (sw)"
## ford granada                          "ford granada"
## chevrolet chevelle malibu classic     "chevrolet chevelle malibu classic"
## chevrolet concours                    "chevrolet concours"
## amc pacer                             "amc pacer"
## amc concord                           "amc concord"
## oldsmobile cutlass supreme            "oldsmobile cutlass supreme"
## chevroelt chevelle malibu             "chevroelt chevelle malibu"
## pontiac ventura sj                    "pontiac ventura sj"
## buick skyhawk                         "buick skyhawk"
## amc concord dl 6                      "amc concord dl 6"
## amc matador                           "amc matador"
## buick regal sport coupe (turbo)       "buick regal sport coupe (turbo)"
## plymouth valiant                      "plymouth valiant"
## plymouth valiant custom               "plymouth valiant custom"
## pontiac lemans v6                     "pontiac lemans v6"
## buick skylark                         "buick skylark"
## buick century special                 "buick century special"
## plymouth fury                         "plymouth fury"
## pontiac phoenix lj                    "pontiac phoenix lj"
## plymouth volare                       "plymouth volare"
## dodge aspen 6                         "dodge aspen 6"
## plymouth volare custom                "plymouth volare custom"
## chrysler lebaron salon                "chrysler lebaron salon"
## dodge aspen se                        "dodge aspen se"
## ford maverick                         "ford maverick"
## plymouth satellite sebring            "plymouth satellite sebring"
## amc gremlin                           "amc gremlin"
## plymouth satellite custom             "plymouth satellite custom"
## dodge aspen                           "dodge aspen"
## mercury zephyr 6                      "mercury zephyr 6"
## mercury zephyr                        "mercury zephyr"
## ford fairmont (auto)                  "ford fairmont (auto)"
## amc hornet                            "amc hornet"
## buick century                         "buick century"
## ford granada gl                       "ford granada gl"
## plymouth duster                       "plymouth duster"
## buick century limited                 "buick century limited"
## oldsmobile omega brougham             "oldsmobile omega brougham"
## mercury capri v6                      "mercury capri v6"
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## buick skylark 320                       "1"  "0"
## plymouth satellite                      "1"  "0"
## amc rebel sst                           "1"  "0"
## ford torino                             "1"  "0"
## ford galaxie 500                        "1"  "0"
## chevrolet impala                        "1"  "0"
## plymouth fury iii                       "1"  "0"
## pontiac catalina                        "1"  "0"
## amc ambassador dpl                      "1"  "0"
## citroen ds-21 pallas                    "2"  "0"
## chevrolet chevelle concours (sw)        "1"  "0"
## ford torino (sw)                        "1"  "0"
## plymouth satellite (sw)                 "1"  "0"
## amc rebel sst (sw)                      "1"  "0"
## dodge challenger se                     "1"  "0"
## plymouth 'cuda 340                      "1"  "0"
## ford mustang boss 302                   "1"  "0"
## chevrolet monte carlo                   "1"  "0"
## buick estate wagon (sw)                 "1"  "0"
## toyota corona mark ii                   "2"  "0"
## datsun pl510                            "2"  "0"
## volkswagen 1131 deluxe sedan            "2"  "0"
## peugeot 504                             "2"  "0"
## audi 100 ls                             "2"  "0"
## saab 99e                                "2"  "0"
## bmw 2002                                "2"  "0"
## ford f250                               "1"  "0"
## chevy c20                               "1"  "0"
## dodge d200                              "1"  "0"
## hi 1200d                                "1"  "0"
## chevrolet vega 2300                     "2"  "0"
## toyota corona                           "2"  "0"
## ford pinto                              "2"  "0"
## volkswagen super beetle 117             "2"  "0"
## pontiac catalina brougham              "1"  "0"
## dodge monaco (sw)                       "1"  "0"
## ford country squire (sw)                "1"  "0"
## pontiac safari (sw)                     "1"  "0"
## amc hornet sportabout (sw)              "3"  "0"
## chevrolet vega (sw)                     "2"  "0"
## mercury capri 2000                      "2"  "0"
## opel 1900                               "2"  "0"
## peugeot 304                             "2"  "0"
## fiat 124b                               "2"  "0"
## toyota corolla 1200                     "2"  "0"
## datsun 1200                             "2"  "0"
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## volkswagen model 111              "2"   "0"
## plymouth cricket                  "2"   "0"
## toyota corona hardtop             "2"   "0"
## dodge colt hardtop                "2"   "0"
## volkswagen type 3                 "2"   "0"
## chevrolet vega                    "2"   "0"
## ford pinto runabout               "2"   "0"
## amc ambassador sst                "1"   "0"
## mercury marquis                   "1"   "0"
## buick lesabre custom              "1"   "0"
## oldsmobile delta 88 royale        "1"   "0"
## chrysler newport royal            "1"   "0"
## mazda rx2 coupe                   "2"   "0"
## amc matador (sw)                  "1"   "0"
## plymouth satellite custom (sw)    "1"   "0"
## volvo 145e (sw)                   "2"   "0"
## volkswagen 411 (sw)               "2"   "0"
## peugeot 504 (sw)                  "2"   "0"
## renault 12 (sw)                   "2"   "0"
## ford pinto (sw)                   "2"   "0"
## datsun 510 (sw)                   "2"   "0"
## toyouta corona mark ii (sw)       "2"   "0"
## dodge colt (sw)                   "2"   "0"
## toyota corolla 1600 (sw)          "2"   "0"
## buick century 350                 "1"   "0"
## chevrolet malibu                  "1"   "0"
## dodge coronet custom              "1"   "0"
## mercury marquis brougham          "1"   "0"
## chevrolet caprice classic         "1"   "0"
## ford ltd                          "1"   "0"
## plymouth fury gran sedan          "1"   "0"
## chrysler new yorker brougham      "1"   "0"
## buick electra 225 custom          "1"   "0"
## amc ambassador brougham           "1"   "0"
## volkswagen super beetle           "2"   "0"
## ford country                      "1"   "0"
## plymouth custom suburb            "1"   "0"
## oldsmobile vista cruiser          "1"   "0"
## toyota carina                     "2"   "0"
## datsun 610                        "2"   "0"
## maxda rx3                         "2"   "0"
## fiat 124 sport coupe              "2"   "0"
## chevrolet monte carlo s           "1"   "0"
## pontiac grand prix                "1"   "0"
## fiat 128                          "2"   "0"
## opel manta                        "2"   "0"
## audi 100ls                        "2"   "0"
## volvo 144ea                       "2"   "0"
## dodge dart custom                 "1"   "0"
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## toyota mark ii                     "2"  "0"
## oldsmobile omega                   "1"  "0"
## datsun b210                        "2"  "0"
## buick century luxus (sw)           "1"  "0"
## audi fox                           "2"  "0"
## volkswagen dasher                  "2"  "0"
## datsun 710                         "2"  "0"
## dodge colt                         "2"  "0"
## fiat 124 tc                        "2"  "0"
## honda civic                        "2"  "0"
## subaru                             "2"  "0"
## fiat x1.9                          "2"  "0"
## chevrolet bel air                  "1"  "0"
## ford mustang ii                    "1"  "0"
## toyota corolla                     "2"  "0"
## pontiac astro                      "2"  "0"
## volkswagen rabbit                  "2"  "0"
## volvo 244dl                        "2"  "0"
## honda civic cvcc                   "2"  "0"
## fiat 131                           "2"  "0"
## capri ii                           "2"  "0"
## renault 12tl                       "2"  "0"
## dodge coronet brougham             "1"  "0"
## chevrolet chevette                 "2"  "0"
## chevrolet woody                    "2"  "0"
## vw rabbit                          "2"  "0"
## amc pacer d/l                      "3"  "0"
## datsun b-210                       "2"  "0"
## volvo 245                          "2"  "0"
## plymouth volare premier v8         "1"  "0"
## mercedes-benz 280s                 "2"  "0"
## cadillac seville                   "1"  "0"
## chevy c10                          "1"  "0"
## ford f108                          "1"  "0"
## dodge d100                         "1"  "0"
## honda accord cvcc                  "2"  "0"
## buick opel isuzu deluxe            "2"  "0"
## renault 5 gtl                      "2"  "0"
## plymouth arrow gs                  "2"  "0"
## datsun f-10 hatchback              "2"  "0"
## dodge monaco brougham              "1"  "0"
## pontiac grand prix lj              "1"  "0"
## chevrolet monte carlo landau       "1"  "0"
## chrysler cordoba                   "1"  "0"
## ford thunderbird                   "1"  "0"
## volkswagen rabbit custom           "2"  "0"
## pontiac sunbird coupe              "2"  "0"
## toyota corolla liftback            "2"  "0"
```

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## ford mustang ii 2+2                     "2"  "0"
## dodge colt m/m                          "2"  "0"
## subaru dl                               "2"  "0"
## datsun 810                              "2"  "0"
## bmw 320i                                "2"  "0"
## mazda rx-4                              "2"  "0"
## volkswagen rabbit custom diesel         "2"  "0"
## ford fiesta                             "2"  "0"
## mazda glc deluxe                        "2"  "0"
## datsun b210 gx                          "2"  "0"
## dodge diplomat                          "1"  "0"
## mercury monarch ghia                    "1"  "0"
## ford fairmont (man)                     "2"  "0"
## ford futura                             "1"  "0"
## dodge magnum xe                         "1"  "0"
## datsun 510                              "2"  "0"
## dodge omni                              "2"  "0"
## toyota celica gt liftback               "2"  "0"
## plymouth sapporo                        "2"  "0"
## oldsmobile starfire sx                  "2"  "0"
## datsun 200-sx                           "2"  "0"
## audi 5000                               "2"  "0"
## volvo 264gl                             "2"  "0"
## saab 99gle                              "2"  "0"
## peugeot 604sl                           "2"  "0"
## volkswagen scirocco                     "2"  "0"
## honda accord lx                         "2"  "0"
## ford fairmont 4                         "2"  "0"
## ford ltd landau                         "1"  "0"
## mercury grand marquis                   "1"  "0"
## dodge st. regis                         "1"  "0"
## chrysler lebaron town @ country (sw)    "1"  "0"
## vw rabbit custom                        "2"  "0"
## maxda glc deluxe                        "2"  "0"
## dodge colt hatchback custom             "2"  "0"
## amc spirit dl                           "2"  "0"
## mercedes benz 300d                      "2"  "0"
## cadillac eldorado                       "1"  "0"
## plymouth horizon                        "2"  "0"
## plymouth horizon tc3                    "2"  "0"
## datsun 210                              "2"  "0"
## fiat strada custom                      "2"  "0"
## buick skylark limited                   "2"  "0"
## pontiac phoenix                         "2"  "0"
## toyota corolla tercel                   "2"  "0"
## datsun 310                              "2"  "0"
## ford fairmont                           "2"  "0"
## audi 4000                               "2"  "0"
## toyota corona liftback                  "2"  "0"
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## mazda 626                       "2"  "0"
## datsun 510 hatchback            "2"  "0"
## mazda glc                       "2"  "0"
## vw rabbit c (diesel)            "2"  "0"
## vw dasher (diesel)              "2"  "0"
## audi 5000s (diesel)             "2"  "0"
## mercedes-benz 240d              "2"  "0"
## honda civic 1500 gl             "2"  "0"
## renault lecar deluxe            "2"  "0"
## vokswagen rabbit                "2"  "0"
## datsun 280-zx                   "2"  "0"
## mazda rx-7 gs                   "2"  "0"
## triumph tr7 coupe               "2"  "0"
## ford mustang cobra              "2"  "0"
## honda accord                    "2"  "0"
## plymouth reliant                "2"  "0"
## dodge aries wagon (sw)          "2"  "0"
## toyota starlet                  "2"  "0"
## plymouth champ                  "2"  "0"
## honda civic 1300                "2"  "0"
## datsun 210 mpg                  "2"  "0"
## toyota tercel                   "2"  "0"
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## plymouth horizon 4              "2"  "0"
## ford escort 4w                  "2"  "0"
## ford escort 2h                  "2"  "0"
## volkswagen jetta                "2"  "0"
## renault 18i                     "2"  "0"
## honda prelude                   "2"  "0"
## datsun 200sx                    "2"  "0"
## peugeot 505s turbo diesel       "2"  "0"
## saab 900s                       "2"  "0"
## volvo diesel                    "2"  "0"
## toyota cressida                 "2"  "0"
## datsun 810 maxima               "2"  "0"
## oldsmobile cutlass ls           "1"  "0"
## chevrolet cavalier              "2"  "0"
## chevrolet cavalier wagon        "2"  "0"
## chevrolet cavalier 2-door       "2"  "0"
## pontiac j2000 se hatchback      "2"  "0"
## dodge aries se                  "2"  "0"
## ford fairmont futura            "2"  "0"
## amc concord dl                  "2"  "0"
## volkswagen rabbit l             "2"  "0"
## mazda glc custom l              "2"  "0"
## mazda glc custom                "2"  "0"
## plymouth horizon miser          "2"  "0"
## mercury lynx l                  "2"  "0"
## nissan stanza xe                "2"  "0"
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## toyota celica gt                          "2"   "0"
## dodge charger 2.2                         "2"   "0"
## chevrolet camaro                          "2"   "0"
## ford mustang gl                           "2"   "0"
## vw pickup                                 "2"   "0"
## dodge rampage                             "2"   "0"
## ford ranger                               "2"   "0"
## chevy s-10                                "2"   "0"
## ford mustang                              "3"   "2.22044604925031e-16"
## ford gran torino                          "1"   "2.22044604925031e-16"
## dodge coronet custom (sw)                 "1"   "2.22044604925031e-16"
## plymouth grand fury                       "1"   "2.22044604925031e-16"
## mercury monarch                           "3"   "4.44089209850063e-16"
## ford torino 500                           "3"   "1.33226762955019e-15"
## mercury cougar brougham                   "1"   "5.55111512312578e-15"
## ford gran torino (sw)                     "1"   "6.88338275267597e-15"
## chevrolet monza 2+2                       "1"   "1.82076576038526e-14"
## chevrolet nova custom                     "3"   "3.17523785042795e-14"
## ford granada ghia                         "3"   "8.26005930321116e-14"
## chevrolet nova                            "3"   "1.0458300891969e-13"
## pontiac firebird                          "3"   "1.21236354289067e-13"
## oldsmobile cutlass salon brougham         "1"   "3.08419956240868e-13"
## amc concord d/l                           "3"   "3.67927910360777e-13"
## ford granada l                            "3"   "1.00963681859412e-12"
## chevrolet malibu classic (sw)             "1"   "1.31761268562514e-12"
## ford granada                              "3"   "2.19957385638736e-12"
## chevrolet chevelle malibu classic         "3"   "3.80828701906921e-12"
## chevrolet concours                        "3"   "1.20345955423318e-11"
## amc pacer                                 "3"   "1.63362656735444e-11"
## amc concord                               "3"   "3.78650444332607e-11"
## oldsmobile cutlass supreme                "1"   "3.80846465475315e-11"
## chevroelt chevelle malibu                 "3"   "8.4234619279755e-11"
## pontiac ventura sj                        "3"   "9.13320530315787e-11"
## buick skyhawk                             "3"   "1.71147762628721e-10"
## amc concord dl 6                          "3"   "1.85021331589041e-10"
## amc matador                               "3"   "3.16096482322337e-10"
## buick regal sport coupe (turbo)           "3"   "3.93983290436495e-10"
## plymouth valiant                          "3"   "1.35865096950738e-09"
## plymouth valiant custom                   "3"   "1.55982493588169e-09"
## pontiac lemans v6                         "3"   "5.89257242999963e-09"
## buick skylark                             "3"   "1.03800089634731e-08"
## buick century special                     "3"   "1.38862554788233e-08"
## plymouth fury                             "3"   "1.47646939119284e-08"
## pontiac phoenix lj                        "3"   "1.88157286418189e-08"
## plymouth volare                           "3"   "3.94841781492516e-08"
```

```
## dodge aspen 6                          "3"  "5.16976514930434e-08"
## plymouth volare custom                 "3"  "5.46606823137452e-08"
## chrysler lebaron salon                  "3"  "5.48894750762585e-08"
## dodge aspen se                          "3"  "7.15596777389749e-08"
## ford maverick                           "3"  "7.32815825799094e-08"
## plymouth satellite sebring              "3"  "1.01877271396766e-07"
## amc gremlin                             "3"  "1.98765903958176e-07"
## plymouth satellite custom               "3"  "2.35351600319511e-07"
## dodge aspen                             "3"  "2.63478881712409e-07"
## mercury zephyr 6                        "3"  "5.98250061267791e-07"
## mercury zephyr                          "3"  "7.89619385876961e-07"
## ford fairmont (auto)                    "3"  "9.054251819407e-07"
## amc hornet                              "3"  "2.2288511278834e-06"
## buick century                           "3"  "3.60498058837866e-06"
## ford granada gl                         "3"  "3.98275259305692e-06"
## plymouth duster                         "3"  "4.32439353292846e-06"
## buick century limited                   "3"  "1.07244919869132e-05"
## oldsmobile omega brougham               "3"  "0.000210543572972788"
## mercury capri v6                        "3"  "0.000323378579092592"
## chevrolet citation                      "3"  "0.0334029723637843"

# checking for BIC plot because we have too many clusters
# Weight  vs mpg
plot(mcl, what = "BIC")
```
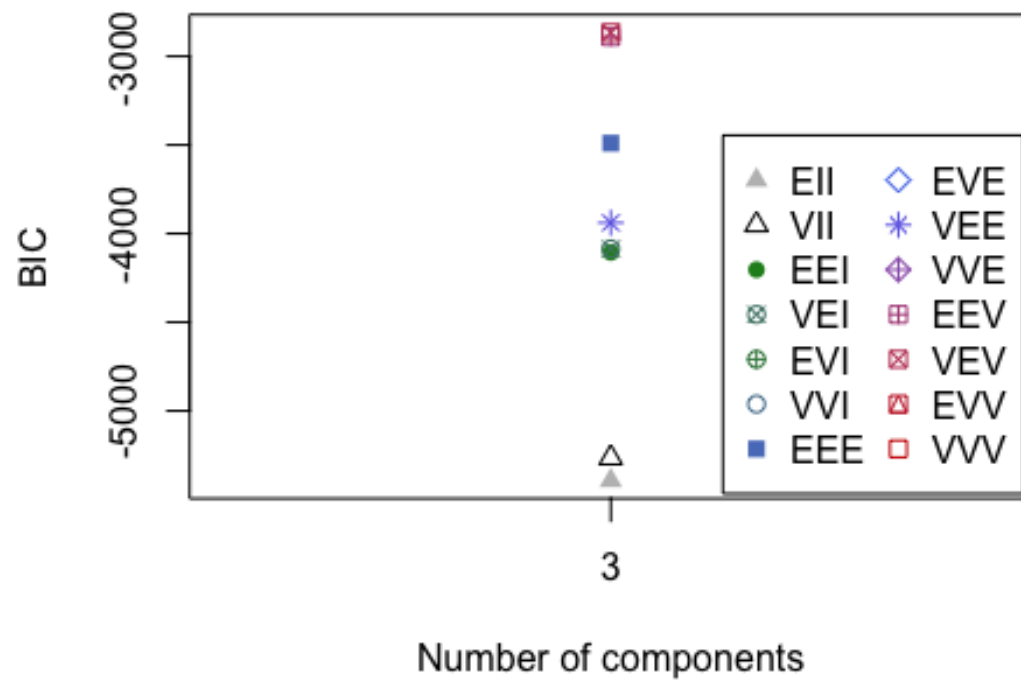
```
plot(mcl, what = "uncertainty", dimens = c(1,5)) #
text(mcl$data[,c(1,5)], labels = abbreviate(rownames(data_scale)),  col = mcl
$classification)
```

```
clust.data = cbind(rownames(data_scale), mcl$classification, mcl$uncertainty
)
clust.data[order(mcl$uncertainty),]
```

```
##                                    [,1]
## chevrolet chevelle malibu          "chevrolet chevelle malibu"
## buick skylark 320                  "buick skylark 320"
## plymouth satellite                 "plymouth satellite"
## amc rebel sst                      "amc rebel sst"
## ford torino                        "ford torino"
## ford galaxie 500                   "ford galaxie 500"
## chevrolet impala                   "chevrolet impala"
## plymouth fury iii                  "plymouth fury iii"
## pontiac catalina                   "pontiac catalina"
## amc ambassador dpl                 "amc ambassador dpl"
## citroen ds-21 pallas               "citroen ds-21 pallas"
## chevrolet chevelle concours (sw)   "chevrolet chevelle concours (sw)"
## ford torino (sw)                   "ford torino (sw)"
## plymouth satellite (sw)            "plymouth satellite (sw)"
## amc rebel sst (sw)                 "amc rebel sst (sw)"
## dodge challenger se                "dodge challenger se"
## plymouth 'cuda 340                 "plymouth 'cuda 340"
## ford mustang boss 302              "ford mustang boss 302"
```

```
## chevrolet monte carlo           "chevrolet monte carlo"
## buick estate wagon (sw)         "buick estate wagon (sw)"
## toyota corona mark ii           "toyota corona mark ii"
## datsun pl510                    "datsun pl510"
## volkswagen 1131 deluxe sedan    "volkswagen 1131 deluxe sedan"
## peugeot 504                     "peugeot 504"
## audi 100 ls                     "audi 100 ls"
## saab 99e                        "saab 99e"
## bmw 2002                        "bmw 2002"
## ford f250                       "ford f250"
## chevy c20                       "chevy c20"
## dodge d200                      "dodge d200"
## hi 1200d                        "hi 1200d"
## chevrolet vega 2300             "chevrolet vega 2300"
## toyota corona                   "toyota corona"
## ford pinto                      "ford pinto"
## volkswagen super beetle 117     "volkswagen super beetle 117"
## pontiac catalina brougham       "pontiac catalina brougham"
## dodge monaco (sw)               "dodge monaco (sw)"
## ford country squire (sw)        "ford country squire (sw)"
## pontiac safari (sw)             "pontiac safari (sw)"
## amc hornet sportabout (sw)      "amc hornet sportabout (sw)"
## chevrolet vega (sw)             "chevrolet vega (sw)"
## mercury capri 2000              "mercury capri 2000"
## opel 1900                       "opel 1900"
## peugeot 304                     "peugeot 304"
## fiat 124b                       "fiat 124b"
## toyota corolla 1200             "toyota corolla 1200"
## datsun 1200                     "datsun 1200"
## volkswagen model 111            "volkswagen model 111"
## plymouth cricket                "plymouth cricket"
## toyota corona hardtop           "toyota corona hardtop"
## dodge colt hardtop              "dodge colt hardtop"
## volkswagen type 3               "volkswagen type 3"
## chevrolet vega                  "chevrolet vega"
## ford pinto runabout             "ford pinto runabout"
## amc ambassador sst              "amc ambassador sst"
## mercury marquis                 "mercury marquis"
## buick lesabre custom            "buick lesabre custom"
## oldsmobile delta 88 royale      "oldsmobile delta 88 royale"
## chrysler newport royal          "chrysler newport royal"
## mazda rx2 coupe                 "mazda rx2 coupe"
## amc matador (sw)                "amc matador (sw)"
## plymouth satellite custom (sw)  "plymouth satellite custom (sw)"
## volvo 145e (sw)                 "volvo 145e (sw)"
## volkswagen 411 (sw)             "volkswagen 411 (sw)"
## peugeot 504 (sw)                "peugeot 504 (sw)"
## renault 12 (sw)                 "renault 12 (sw)"
## ford pinto (sw)                 "ford pinto (sw)"
```

```
## datsun 510 (sw)                    "datsun 510 (sw)"
## toyouta corona mark ii (sw)        "toyouta corona mark ii (sw)"
## dodge colt (sw)                    "dodge colt (sw)"
## toyota corolla 1600 (sw)           "toyota corolla 1600 (sw)"
## buick century 350                  "buick century 350"
## chevrolet malibu                   "chevrolet malibu"
## dodge coronet custom               "dodge coronet custom"
## mercury marquis brougham           "mercury marquis brougham"
## chevrolet caprice classic          "chevrolet caprice classic"
## ford ltd                           "ford ltd"
## plymouth fury gran sedan           "plymouth fury gran sedan"
## chrysler new yorker brougham       "chrysler new yorker brougham"
## buick electra 225 custom           "buick electra 225 custom"
## amc ambassador brougham            "amc ambassador brougham"
## volkswagen super beetle            "volkswagen super beetle"
## ford country                       "ford country"
## plymouth custom suburb             "plymouth custom suburb"
## oldsmobile vista cruiser           "oldsmobile vista cruiser"
## toyota carina                      "toyota carina"
## datsun 610                         "datsun 610"
## maxda rx3                          "maxda rx3"
## fiat 124 sport coupe               "fiat 124 sport coupe"
## chevrolet monte carlo s            "chevrolet monte carlo s"
## pontiac grand prix                 "pontiac grand prix"
## fiat 128                           "fiat 128"
## opel manta                         "opel manta"
## audi 100ls                         "audi 100ls"
## volvo 144ea                        "volvo 144ea"
## dodge dart custom                  "dodge dart custom"
## saab 99le                          "saab 99le"
## toyota mark ii                     "toyota mark ii"
## oldsmobile omega                   "oldsmobile omega"
## datsun b210                        "datsun b210"
## buick century luxus (sw)           "buick century luxus (sw)"
## audi fox                           "audi fox"
## volkswagen dasher                  "volkswagen dasher"
## datsun 710                         "datsun 710"
## dodge colt                         "dodge colt"
## fiat 124 tc                        "fiat 124 tc"
## honda civic                        "honda civic"
## subaru                             "subaru"
## fiat x1.9                          "fiat x1.9"
## chevrolet bel air                  "chevrolet bel air"
## ford mustang ii                    "ford mustang ii"
## toyota corolla                     "toyota corolla"
## pontiac astro                      "pontiac astro"
## volkswagen rabbit                  "volkswagen rabbit"
## volvo 244dl                        "volvo 244dl"
## honda civic cvcc                   "honda civic cvcc"
```

```
## fiat 131                              "fiat 131"
## capri ii                              "capri ii"
## renault 12tl                          "renault 12tl"
## dodge coronet brougham                "dodge coronet brougham"
## chevrolet chevette                    "chevrolet chevette"
## chevrolet woody                       "chevrolet woody"
## vw rabbit                             "vw rabbit"
## amc pacer d/l                         "amc pacer d/l"
## datsun b-210                          "datsun b-210"
## volvo 245                             "volvo 245"
## plymouth volare premier v8            "plymouth volare premier v8"
## mercedes-benz 280s                    "mercedes-benz 280s"
## cadillac seville                      "cadillac seville"
## chevy c10                             "chevy c10"
## ford f108                             "ford f108"
## dodge d100                            "dodge d100"
## honda accord cvcc                     "honda accord cvcc"
## buick opel isuzu deluxe               "buick opel isuzu deluxe"
## renault 5 gtl                         "renault 5 gtl"
## plymouth arrow gs                     "plymouth arrow gs"
## datsun f-10 hatchback                 "datsun f-10 hatchback"
## dodge monaco brougham                 "dodge monaco brougham"
## pontiac grand prix lj                 "pontiac grand prix lj"
## chevrolet monte carlo landau          "chevrolet monte carlo landau"
## chrysler cordoba                      "chrysler cordoba"
## ford thunderbird                      "ford thunderbird"
## volkswagen rabbit custom              "volkswagen rabbit custom"
## pontiac sunbird coupe                 "pontiac sunbird coupe"
## toyota corolla liftback               "toyota corolla liftback"
## ford mustang ii 2+2                   "ford mustang ii 2+2"
## dodge colt m/m                        "dodge colt m/m"
## subaru dl                             "subaru dl"
## datsun 810                            "datsun 810"
## bmw 320i                              "bmw 320i"
## mazda rx-4                            "mazda rx-4"
## volkswagen rabbit custom diesel       "volkswagen rabbit custom diesel"
## ford fiesta                           "ford fiesta"
## mazda glc deluxe                      "mazda glc deluxe"
## datsun b210 gx                        "datsun b210 gx"
## dodge diplomat                        "dodge diplomat"
## mercury monarch ghia                  "mercury monarch ghia"
## ford fairmont (man)                   "ford fairmont (man)"
## ford futura                           "ford futura"
## dodge magnum xe                       "dodge magnum xe"
## datsun 510                            "datsun 510"
## dodge omni                            "dodge omni"
## toyota celica gt liftback             "toyota celica gt liftback"
## plymouth sapporo                      "plymouth sapporo"
## oldsmobile starfire sx                "oldsmobile starfire sx"
```

```
## datsun 200-sx                          "datsun 200-sx"
## audi 5000                              "audi 5000"
## volvo 264gl                            "volvo 264gl"
## saab 99gle                             "saab 99gle"
## peugeot 604sl                          "peugeot 604sl"
## volkswagen scirocco                    "volkswagen scirocco"
## honda accord lx                        "honda accord lx"
## ford fairmont 4                        "ford fairmont 4"
## ford ltd landau                        "ford ltd landau"
## mercury grand marquis                  "mercury grand marquis"
## dodge st. regis                        "dodge st. regis"
## chrysler lebaron town @ country (sw) "chrysler lebaron town @ country (sw)
"
## vw rabbit custom                       "vw rabbit custom"
## maxda glc deluxe                       "maxda glc deluxe"
## dodge colt hatchback custom            "dodge colt hatchback custom"
## amc spirit dl                          "amc spirit dl"
## mercedes benz 300d                     "mercedes benz 300d"
## cadillac eldorado                      "cadillac eldorado"
## plymouth horizon                       "plymouth horizon"
## plymouth horizon tc3                   "plymouth horizon tc3"
## datsun 210                             "datsun 210"
## fiat strada custom                     "fiat strada custom"
## buick skylark limited                  "buick skylark limited"
## pontiac phoenix                        "pontiac phoenix"
## toyota corolla tercel                  "toyota corolla tercel"
## datsun 310                             "datsun 310"
## ford fairmont                          "ford fairmont"
## audi 4000                              "audi 4000"
## toyota corona liftback                 "toyota corona liftback"
## mazda 626                              "mazda 626"
## datsun 510 hatchback                   "datsun 510 hatchback"
## mazda glc                              "mazda glc"
## vw rabbit c (diesel)                   "vw rabbit c (diesel)"
## vw dasher (diesel)                     "vw dasher (diesel)"
## audi 5000s (diesel)                    "audi 5000s (diesel)"
## mercedes-benz 240d                     "mercedes-benz 240d"
## honda civic 1500 gl                    "honda civic 1500 gl"
## renault lecar deluxe                   "renault lecar deluxe"
## vokswagen rabbit                       "vokswagen rabbit"
## datsun 280-zx                          "datsun 280-zx"
## mazda rx-7 gs                          "mazda rx-7 gs"
## triumph tr7 coupe                      "triumph tr7 coupe"
## ford mustang cobra                     "ford mustang cobra"
## honda accord                           "honda accord"
## plymouth reliant                       "plymouth reliant"
## dodge aries wagon (sw)                 "dodge aries wagon (sw)"
## toyota starlet                         "toyota starlet"
## plymouth champ                         "plymouth champ"
```

```
## honda civic 1300                       "honda civic 1300"
## datsun 210 mpg                         "datsun 210 mpg"
## toyota tercel                          "toyota tercel"
## mazda glc 4                            "mazda glc 4"
## plymouth horizon 4                     "plymouth horizon 4"
## ford escort 4w                         "ford escort 4w"
## ford escort 2h                         "ford escort 2h"
## volkswagen jetta                       "volkswagen jetta"
## renault 18i                            "renault 18i"
## honda prelude                          "honda prelude"
## datsun 200sx                           "datsun 200sx"
## peugeot 505s turbo diesel              "peugeot 505s turbo diesel"
## saab 900s                              "saab 900s"
## volvo diesel                           "volvo diesel"
## toyota cressida                        "toyota cressida"
## datsun 810 maxima                      "datsun 810 maxima"
## oldsmobile cutlass ls                  "oldsmobile cutlass ls"
## chevrolet cavalier                     "chevrolet cavalier"
## chevrolet cavalier wagon               "chevrolet cavalier wagon"
## chevrolet cavalier 2-door              "chevrolet cavalier 2-door"
## pontiac j2000 se hatchback             "pontiac j2000 se hatchback"
## dodge aries se                         "dodge aries se"
## ford fairmont futura                   "ford fairmont futura"
## amc concord dl                         "amc concord dl"
## volkswagen rabbit l                    "volkswagen rabbit l"
## mazda glc custom l                     "mazda glc custom l"
## mazda glc custom                       "mazda glc custom"
## plymouth horizon miser                 "plymouth horizon miser"
## mercury lynx l                         "mercury lynx l"
## nissan stanza xe                       "nissan stanza xe"
## honda civic (auto)                     "honda civic (auto)"
## datsun 310 gx                          "datsun 310 gx"
## oldsmobile cutlass ciera (diesel)      "oldsmobile cutlass ciera (diesel)"
## chrysler lebaron medallion             "chrysler lebaron medallion"
## toyota celica gt                       "toyota celica gt"
## dodge charger 2.2                      "dodge charger 2.2"
## chevrolet camaro                       "chevrolet camaro"
## ford mustang gl                        "ford mustang gl"
## vw pickup                              "vw pickup"
## dodge rampage                          "dodge rampage"
## ford ranger                            "ford ranger"
## chevy s-10                             "chevy s-10"
## ford mustang                           "ford mustang"
## ford gran torino                       "ford gran torino"
## dodge coronet custom (sw)              "dodge coronet custom (sw)"
## plymouth grand fury                    "plymouth grand fury"
## mercury monarch                        "mercury monarch"
## ford torino 500                        "ford torino 500"
## mercury cougar brougham                "mercury cougar brougham"
```

```
## ford gran torino (sw)                "ford gran torino (sw)"
## chevrolet monza 2+2                   "chevrolet monza 2+2"
## chevrolet nova custom                 "chevrolet nova custom"
## ford granada ghia                     "ford granada ghia"
## chevrolet nova                        "chevrolet nova"
## pontiac firebird                      "pontiac firebird"
## oldsmobile cutlass salon brougham     "oldsmobile cutlass salon brougham"
## amc concord d/l                       "amc concord d/l"
## ford granada l                        "ford granada l"
## chevrolet malibu classic (sw)         "chevrolet malibu classic (sw)"
## ford granada                          "ford granada"
## chevrolet chevelle malibu classic     "chevrolet chevelle malibu classic"
## chevrolet concours                    "chevrolet concours"
## amc pacer                             "amc pacer"
## amc concord                           "amc concord"
## oldsmobile cutlass supreme            "oldsmobile cutlass supreme"
## chevroelt chevelle malibu             "chevroelt chevelle malibu"
## pontiac ventura sj                    "pontiac ventura sj"
## buick skyhawk                         "buick skyhawk"
## amc concord dl 6                      "amc concord dl 6"
## amc matador                           "amc matador"
## buick regal sport coupe (turbo)       "buick regal sport coupe (turbo)"
## plymouth valiant                      "plymouth valiant"
## plymouth valiant custom               "plymouth valiant custom"
## pontiac lemans v6                     "pontiac lemans v6"
## buick skylark                         "buick skylark"
## buick century special                 "buick century special"
## plymouth fury                         "plymouth fury"
## pontiac phoenix lj                    "pontiac phoenix lj"
## plymouth volare                       "plymouth volare"
## dodge aspen 6                         "dodge aspen 6"
## plymouth volare custom                "plymouth volare custom"
## chrysler lebaron salon                "chrysler lebaron salon"
## dodge aspen se                        "dodge aspen se"
## ford maverick                         "ford maverick"
## plymouth satellite sebring            "plymouth satellite sebring"
## amc gremlin                           "amc gremlin"
## plymouth satellite custom             "plymouth satellite custom"
## dodge aspen                           "dodge aspen"
## mercury zephyr 6                      "mercury zephyr 6"
## mercury zephyr                        "mercury zephyr"
## ford fairmont (auto)                  "ford fairmont (auto)"
## amc hornet                            "amc hornet"
## buick century                         "buick century"
## ford granada gl                       "ford granada gl"
## plymouth duster                       "plymouth duster"
## buick century limited                 "buick century limited"
## oldsmobile omega brougham             "oldsmobile omega brougham"
## mercury capri v6                      "mercury capri v6"
```

```
## chevrolet citation                    "chevrolet citation"
##                                        [,2] [,3]
## chevrolet chevelle malibu             "1"  "0"
## buick skylark 320                     "1"  "0"
## plymouth satellite                    "1"  "0"
## amc rebel sst                         "1"  "0"
## ford torino                           "1"  "0"
## ford galaxie 500                      "1"  "0"
## chevrolet impala                      "1"  "0"
## plymouth fury iii                     "1"  "0"
## pontiac catalina                      "1"  "0"
## amc ambassador dpl                    "1"  "0"
## citroen ds-21 pallas                  "2"  "0"
## chevrolet chevelle concours (sw)      "1"  "0"
## ford torino (sw)                      "1"  "0"
## plymouth satellite (sw)               "1"  "0"
## amc rebel sst (sw)                    "1"  "0"
## dodge challenger se                   "1"  "0"
## plymouth 'cuda 340                    "1"  "0"
## ford mustang boss 302                 "1"  "0"
## chevrolet monte carlo                 "1"  "0"
## buick estate wagon (sw)               "1"  "0"
## toyota corona mark ii                 "2"  "0"
## datsun pl510                          "2"  "0"
## volkswagen 1131 deluxe sedan          "2"  "0"
## peugeot 504                           "2"  "0"
## audi 100 ls                           "2"  "0"
## saab 99e                              "2"  "0"
## bmw 2002                              "2"  "0"
## ford f250                             "1"  "0"
## chevy c20                             "1"  "0"
## dodge d200                            "1"  "0"
## hi 1200d                              "1"  "0"
## chevrolet vega 2300                   "2"  "0"
## toyota corona                         "2"  "0"
## ford pinto                            "2"  "0"
## volkswagen super beetle 117           "2"  "0"
## pontiac catalina brougham             "1"  "0"
## dodge monaco (sw)                     "1"  "0"
## ford country squire (sw)              "1"  "0"
## pontiac safari (sw)                   "1"  "0"
## amc hornet sportabout (sw)            "3"  "0"
## chevrolet vega (sw)                   "2"  "0"
## mercury capri 2000                    "2"  "0"
## opel 1900                             "2"  "0"
## peugeot 304                           "2"  "0"
## fiat 124b                             "2"  "0"
## toyota corolla 1200                   "2"  "0"
## datsun 1200                           "2"  "0"
```

```
## volkswagen model 111              "2"  "0"
## plymouth cricket                  "2"  "0"
## toyota corona hardtop             "2"  "0"
## dodge colt hardtop                "2"  "0"
## volkswagen type 3                 "2"  "0"
## chevrolet vega                    "2"  "0"
## ford pinto runabout               "2"  "0"
## amc ambassador sst                "1"  "0"
## mercury marquis                   "1"  "0"
## buick lesabre custom              "1"  "0"
## oldsmobile delta 88 royale        "1"  "0"
## chrysler newport royal            "1"  "0"
## mazda rx2 coupe                   "2"  "0"
## amc matador (sw)                  "1"  "0"
## plymouth satellite custom (sw)    "1"  "0"
## volvo 145e (sw)                   "2"  "0"
## volkswagen 411 (sw)               "2"  "0"
## peugeot 504 (sw)                  "2"  "0"
## renault 12 (sw)                   "2"  "0"
## ford pinto (sw)                   "2"  "0"
## datsun 510 (sw)                   "2"  "0"
## toyouta corona mark ii (sw)       "2"  "0"
## dodge colt (sw)                   "2"  "0"
## toyota corolla 1600 (sw)          "2"  "0"
## buick century 350                 "1"  "0"
## chevrolet malibu                  "1"  "0"
## dodge coronet custom              "1"  "0"
## mercury marquis brougham          "1"  "0"
## chevrolet caprice classic         "1"  "0"
## ford ltd                          "1"  "0"
## plymouth fury gran sedan          "1"  "0"
## chrysler new yorker brougham      "1"  "0"
## buick electra 225 custom          "1"  "0"
## amc ambassador brougham           "1"  "0"
## volkswagen super beetle           "2"  "0"
## ford country                      "1"  "0"
## plymouth custom suburb            "1"  "0"
## oldsmobile vista cruiser          "1"  "0"
## toyota carina                     "2"  "0"
## datsun 610                        "2"  "0"
## maxda rx3                         "2"  "0"
## fiat 124 sport coupe              "2"  "0"
## chevrolet monte carlo s           "1"  "0"
## pontiac grand prix                "1"  "0"
## fiat 128                          "2"  "0"
## opel manta                        "2"  "0"
## audi 100ls                        "2"  "0"
## volvo 144ea                       "2"  "0"
## dodge dart custom                 "1"  "0"
```

```
## saab 99le                               "2"   "0"
## toyota mark ii                          "2"   "0"
## oldsmobile omega                        "1"   "0"
## datsun b210                             "2"   "0"
## buick century luxus (sw)                "1"   "0"
## audi fox                                "2"   "0"
## volkswagen dasher                       "2"   "0"
## datsun 710                              "2"   "0"
## dodge colt                              "2"   "0"
## fiat 124 tc                             "2"   "0"
## honda civic                             "2"   "0"
## subaru                                  "2"   "0"
## fiat x1.9                               "2"   "0"
## chevrolet bel air                       "1"   "0"
## ford mustang ii                         "1"   "0"
## toyota corolla                          "2"   "0"
## pontiac astro                           "2"   "0"
## volkswagen rabbit                       "2"   "0"
## volvo 244dl                             "2"   "0"
## honda civic cvcc                        "2"   "0"
## fiat 131                                "2"   "0"
## capri ii                                "2"   "0"
## renault 12tl                            "2"   "0"
## dodge coronet brougham                  "1"   "0"
## chevrolet chevette                      "2"   "0"
## chevrolet woody                         "2"   "0"
## vw rabbit                               "2"   "0"
## amc pacer d/l                           "3"   "0"
## datsun b-210                            "2"   "0"
## volvo 245                               "2"   "0"
## plymouth volare premier v8              "1"   "0"
## mercedes-benz 280s                      "2"   "0"
## cadillac seville                        "1"   "0"
## chevy c10                               "1"   "0"
## ford f108                               "1"   "0"
## dodge d100                              "1"   "0"
## honda accord cvcc                       "2"   "0"
## buick opel isuzu deluxe                 "2"   "0"
## renault 5 gtl                           "2"   "0"
## plymouth arrow gs                       "2"   "0"
## datsun f-10 hatchback                   "2"   "0"
## dodge monaco brougham                   "1"   "0"
## pontiac grand prix lj                   "1"   "0"
## chevrolet monte carlo landau            "1"   "0"
## chrysler cordoba                        "1"   "0"
## ford thunderbird                        "1"   "0"
## volkswagen rabbit custom                "2"   "0"
## pontiac sunbird coupe                   "2"   "0"
## toyota corolla liftback                 "2"   "0"
```

```
## ford mustang ii 2+2                      "2"   "0"
## dodge colt m/m                           "2"   "0"
## subaru dl                                "2"   "0"
## datsun 810                               "2"   "0"
## bmw 320i                                 "2"   "0"
## mazda rx-4                               "2"   "0"
## volkswagen rabbit custom diesel          "2"   "0"
## ford fiesta                              "2"   "0"
## mazda glc deluxe                         "2"   "0"
## datsun b210 gx                           "2"   "0"
## dodge diplomat                           "1"   "0"
## mercury monarch ghia                     "1"   "0"
## ford fairmont (man)                      "2"   "0"
## ford futura                              "1"   "0"
## dodge magnum xe                          "1"   "0"
## datsun 510                               "2"   "0"
## dodge omni                               "2"   "0"
## toyota celica gt liftback                "2"   "0"
## plymouth sapporo                         "2"   "0"
## oldsmobile starfire sx                   "2"   "0"
## datsun 200-sx                            "2"   "0"
## audi 5000                                "2"   "0"
## volvo 264gl                              "2"   "0"
## saab 99gle                               "2"   "0"
## peugeot 604sl                            "2"   "0"
## volkswagen scirocco                      "2"   "0"
## honda accord lx                          "2"   "0"
## ford fairmont 4                          "2"   "0"
## ford ltd landau                          "1"   "0"
## mercury grand marquis                    "1"   "0"
## dodge st. regis                          "1"   "0"
## chrysler lebaron town @ country (sw) "1"   "0"
## vw rabbit custom                         "2"   "0"
## maxda glc deluxe                         "2"   "0"
## dodge colt hatchback custom              "2"   "0"
## amc spirit dl                            "2"   "0"
## mercedes benz 300d                       "2"   "0"
## cadillac eldorado                        "1"   "0"
## plymouth horizon                         "2"   "0"
## plymouth horizon tc3                     "2"   "0"
## datsun 210                               "2"   "0"
## fiat strada custom                       "2"   "0"
## buick skylark limited                    "2"   "0"
## pontiac phoenix                          "2"   "0"
## toyota corolla tercel                    "2"   "0"
## datsun 310                               "2"   "0"
## ford fairmont                            "2"   "0"
## audi 4000                                "2"   "0"
## toyota corona liftback                   "2"   "0"
```

```
## mazda 626                         "2"   "0"
## datsun 510 hatchback              "2"   "0"
## mazda glc                         "2"   "0"
## vw rabbit c (diesel)              "2"   "0"
## vw dasher (diesel)                "2"   "0"
## audi 5000s (diesel)               "2"   "0"
## mercedes-benz 240d                "2"   "0"
## honda civic 1500 gl               "2"   "0"
## renault lecar deluxe              "2"   "0"
## vokswagen rabbit                  "2"   "0"
## datsun 280-zx                     "2"   "0"
## mazda rx-7 gs                     "2"   "0"
## triumph tr7 coupe                 "2"   "0"
## ford mustang cobra                "2"   "0"
## honda accord                      "2"   "0"
## plymouth reliant                  "2"   "0"
## dodge aries wagon (sw)            "2"   "0"
## toyota starlet                    "2"   "0"
## plymouth champ                    "2"   "0"
## honda civic 1300                  "2"   "0"
## datsun 210 mpg                    "2"   "0"
## toyota tercel                     "2"   "0"
## mazda glc 4                       "2"   "0"
## plymouth horizon 4                "2"   "0"
## ford escort 4w                    "2"   "0"
## ford escort 2h                    "2"   "0"
## volkswagen jetta                  "2"   "0"
## renault 18i                       "2"   "0"
## honda prelude                     "2"   "0"
## datsun 200sx                      "2"   "0"
## peugeot 505s turbo diesel         "2"   "0"
## saab 900s                         "2"   "0"
## volvo diesel                      "2"   "0"
## toyota cressida                   "2"   "0"
## datsun 810 maxima                 "2"   "0"
## oldsmobile cutlass ls             "1"   "0"
## chevrolet cavalier                "2"   "0"
## chevrolet cavalier wagon          "2"   "0"
## chevrolet cavalier 2-door         "2"   "0"
## pontiac j2000 se hatchback        "2"   "0"
## dodge aries se                    "2"   "0"
## ford fairmont futura              "2"   "0"
## amc concord dl                    "2"   "0"
## volkswagen rabbit l               "2"   "0"
## mazda glc custom l                "2"   "0"
## mazda glc custom                  "2"   "0"
## plymouth horizon miser            "2"   "0"
## mercury lynx l                    "2"   "0"
## nissan stanza xe                  "2"   "0"
```

```
## honda civic (auto)                      "2"   "0"
## datsun 310 gx                           "2"   "0"
## oldsmobile cutlass ciera (diesel)       "2"   "0"
## chrysler lebaron medallion              "2"   "0"
## toyota celica gt                        "2"   "0"
## dodge charger 2.2                       "2"   "0"
## chevrolet camaro                        "2"   "0"
## ford mustang gl                         "2"   "0"
## vw pickup                               "2"   "0"
## dodge rampage                           "2"   "0"
## ford ranger                             "2"   "0"
## chevy s-10                              "2"   "0"
## ford mustang                            "3"   "2.22044604925031e-16"
## ford gran torino                        "1"   "2.22044604925031e-16"
## dodge coronet custom (sw)               "1"   "2.22044604925031e-16"
## plymouth grand fury                     "1"   "2.22044604925031e-16"
## mercury monarch                         "3"   "4.44089209850063e-16"
## ford torino 500                         "3"   "1.33226762955019e-15"
## mercury cougar brougham                 "1"   "5.55111512312578e-15"
## ford gran torino (sw)                   "1"   "6.88338275267597e-15"
## chevrolet monza 2+2                     "1"   "1.82076576038526e-14"
## chevrolet nova custom                   "3"   "3.17523785042795e-14"
## ford granada ghia                       "3"   "8.26005930321116e-14"
## chevrolet nova                          "3"   "1.0458300891969e-13"
## pontiac firebird                        "3"   "1.21236354289067e-13"
## oldsmobile cutlass salon brougham       "1"   "3.08419956240868e-13"
## amc concord d/l                         "3"   "3.67927910360777e-13"
## ford granada l                          "3"   "1.00963681859412e-12"
## chevrolet malibu classic (sw)           "1"   "1.31761268562514e-12"
## ford granada                            "3"   "2.19957385638736e-12"
## chevrolet chevelle malibu classic       "3"   "3.80828701906921e-12"
## chevrolet concours                      "3"   "1.20345955423318e-11"
## amc pacer                               "3"   "1.63362656735444e-11"
## amc concord                             "3"   "3.78650444332607e-11"
## oldsmobile cutlass supreme              "1"   "3.80846465475315e-11"
## chevroelt chevelle malibu               "3"   "8.4234619279755e-11"
## pontiac ventura sj                      "3"   "9.13320530315787e-11"
## buick skyhawk                           "3"   "1.71147762628721e-10"
## amc concord dl 6                        "3"   "1.85021331589041e-10"
## amc matador                             "3"   "3.16096482322337e-10"
## buick regal sport coupe (turbo)         "3"   "3.93983290436495e-10"
## plymouth valiant                        "3"   "1.35865096950738e-09"
## plymouth valiant custom                 "3"   "1.55982493588169e-09"
## pontiac lemans v6                       "3"   "5.89257242999963e-09"
## buick skylark                           "3"   "1.03800089634731e-08"
## buick century special                   "3"   "1.38862554788233e-08"
## plymouth fury                           "3"   "1.47646939119284e-08"
## pontiac phoenix lj                      "3"   "1.88157286418189e-08"
## plymouth volare                         "3"   "3.94841781492516e-08"
```

```
## dodge aspen 6                          "3"  "5.16976514930434e-08"
## plymouth volare custom                 "3"  "5.46606823137452e-08"
## chrysler lebaron salon                 "3"  "5.48894750762585e-08"
## dodge aspen se                         "3"  "7.15596777389749e-08"
## ford maverick                          "3"  "7.32815825799094e-08"
## plymouth satellite sebring             "3"  "1.01877271396766e-07"
## amc gremlin                            "3"  "1.98765903958176e-07"
## plymouth satellite custom              "3"  "2.35351600319511e-07"
## dodge aspen                            "3"  "2.63478881712409e-07"
## mercury zephyr 6                       "3"  "5.98250061267791e-07"
## mercury zephyr                         "3"  "7.89619385876961e-07"
## ford fairmont (auto)                   "3"  "9.054251819407e-07"
## amc hornet                             "3"  "2.2288511278834e-06"
## buick century                         "3"  "3.60498058837866e-06"
## ford granada gl                        "3"  "3.98275259305692e-06"
## plymouth duster                        "3"  "4.32439353292846e-06"
## buick century limited                  "3"  "1.07244919869132e-05"
## oldsmobile omega brougham              "3"  "0.000210543572972788"
## mercury capri v6                       "3"  "0.000323378579092592"
## chevrolet citation                     "3"  "0.0334029723637843"
```

```r
# EFA (2 factors)
mpg.efa <- factanal(auto_original2, factors = 2)
mpg.efa
```

```
## 
## Call:
## factanal(x = auto_original2, factors = 2)
## 
## Uniquenesses:
##          mpg    cylinders displacement   horsepower       weight accelerat
ion
##        0.355        0.079        0.019        0.005        0.115          0.
461
##   model.year       origin
##        0.817        0.571
## 
## Loadings:
##              Factor1 Factor2
## mpg          -0.602  -0.531
## cylinders     0.821   0.497
## displacement  0.811   0.569
## horsepower    0.503   0.862
## weight        0.759   0.555
## acceleration -0.216  -0.702
## model.year   -0.202  -0.377
## origin       -0.637  -0.153
## 
##               Factor1 Factor2
## SS loadings     3.017   2.563
```

```
## Proportion Var    0.377    0.320
## Cumulative Var    0.377    0.697
##
## Test of the hypothesis that 2 factors are sufficient.
## The chi square statistic is 248.78 on 13 degrees of freedom.
## The p-value is 1.15e-45

faLR <- mpg.efa$loadings[,1:2]
faLR

##                 Factor1    Factor2
## mpg          -0.6023914 -0.5313446
## cylinders     0.8210652  0.4973348
## displacement  0.8107634  0.5689286
## horsepower    0.5026147  0.8616209
## weight        0.7591737  0.5553586
## acceleration -0.2158569 -0.7020227
## model.year   -0.2019147 -0.3774065
## origin       -0.6370344 -0.1529248

print(mpg.efa$loadings, cut = 0.5)

##
## Loadings:
##              Factor1 Factor2
## mpg           -0.602  -0.531
## cylinders      0.821
## displacement   0.811   0.569
## horsepower     0.503   0.862
## weight         0.759   0.555
## acceleration          -0.702
## model.year
## origin        -0.637
##
##                 Factor1 Factor2
## SS loadings       3.017   2.563
## Proportion Var    0.377   0.320
## Cumulative Var    0.377   0.697
```

Factor 1 = Factor one portrays larger vehicle size (e.g a truck) [weight, cylinder, displacement]
Factor 2 = Factor two portrays vehicle performance.

```
# EFA for CFA insight


data_cfa <- auto_original2[c(1:6)] # includes only numerical variables


data_cfa2 <- factanal(data_cfa, factors = 2)
```

```
faLR2 <- data_cfa2$loadings[,1:2]
faLR2

##                  Factor1      Factor2
## mpg           -0.7723358 -0.2350562
## cylinders      0.9035034  0.3094037
## displacement   0.9245564  0.3452408
## horsepower     0.7805426  0.5193699
## weight         0.9322156  0.2052535
## acceleration  -0.2765709 -0.9583911

print(data_cfa2$loadings, cut = 0.5)

##
## Loadings:
##              Factor1 Factor2
## mpg          -0.772
## cylinders     0.904
## displacement  0.925
## horsepower    0.781   0.519
## weight        0.932
## acceleration         -0.958
##
##                Factor1 Factor2
## SS loadings      3.822   1.501
## Proportion Var   0.637   0.250
## Cumulative Var   0.637   0.887

# CFA
# install.packages("sem")
# install.packages("semPlot")

library("sem")

data_cfamodel <- specifyModel(text = "
Size    -> mpg, lambda1, NA
Size    -> cylinders, lambda2, NA
Size    -> displacement, lambda3, NA
Size    -> weight, lambda4, NA
Perf    -> horsepower, lambda5, NA
Perf  -> acceleration, lambda6, NA

Size    <-> Perf, rho, NA
mpg <-> mpg, theta1, NA
cylinders <-> cylinders, theta2, NA
displacement <-> displacement, theta3, NA
weight <-> weight, theta4, NA
horsepower <-> horsepower, theta5, NA
acceleration <-> acceleration, theta6, NA
```

```
Size <-> Size, NA, 1
Perf <-> Perf, NA, 1 ")
```

```
## NOTE: it is generally simpler to use specifyEquations() or cfa()
##       see ?specifyEquations
```

```
cfamodel_sem <- sem(data_cfamodel, cor(data_cfa), nrow(data_cfa))
```

```
summary(cfamodel_sem)
```

```
##
##  Model Chisquare =  136.8738   Df =  8 Pr(>Chisq) = 1.059545e-25
##  AIC =  162.8738
##  BIC =  90.9298
##
##  Normalized Residuals
##       Min.    1st Qu.    Median       Mean    3rd Qu.       Max.
## -0.8894278 -0.2703812  0.0000001 -0.0282552  0.0671064  1.3601900
##
##  R-square for Endogenous Variables
##         mpg    cylinders displacement       weight    horsepower accelerat
ion
##      0.6413       0.9147       0.9789       0.8883       1.1231        0.4
538
##
##   Parameter Estimates
##           Estimate    Std Error    z value    Pr(>|z|)
## lambda1 -0.80080847 0.046924879 -17.065755  2.669182e-65
## lambda2  0.95641975 0.041854794  22.850901 1.431549e-115
## lambda3  0.98939488 0.040595403  24.372092 3.381485e-131
## lambda4  0.94251838 0.042366363  22.246856 1.209815e-109
## lambda5  1.05975276 0.040972354  25.865069 1.646971e-147
## lambda6 -0.67362297 0.050936678 -13.224714  6.317748e-40
## rho      0.85365831 0.020628049  41.383376  0.000000e+00
## theta1   0.35870580 0.029536856  12.144346  6.147215e-34
## theta2   0.08526125 0.008513186  10.015199  1.306983e-23
## theta3   0.02109783 0.005265699   4.006654  6.158499e-05
## theta4   0.11165910 0.010365908  10.771763  4.679537e-27
## theta5  -0.12307574 0.036129441  -3.406522  6.579619e-04
## theta6   0.54623212 0.045999641  11.874704  1.602000e-32
##
## lambda1 mpg <--- Size
## lambda2 cylinders <--- Size
## lambda3 displacement <--- Size
## lambda4 weight <--- Size
## lambda5 horsepower <--- Perf
## lambda6 acceleration <--- Perf
## rho      Perf <--> Size
## theta1   mpg <--> mpg
## theta2   cylinders <--> cylinders
```
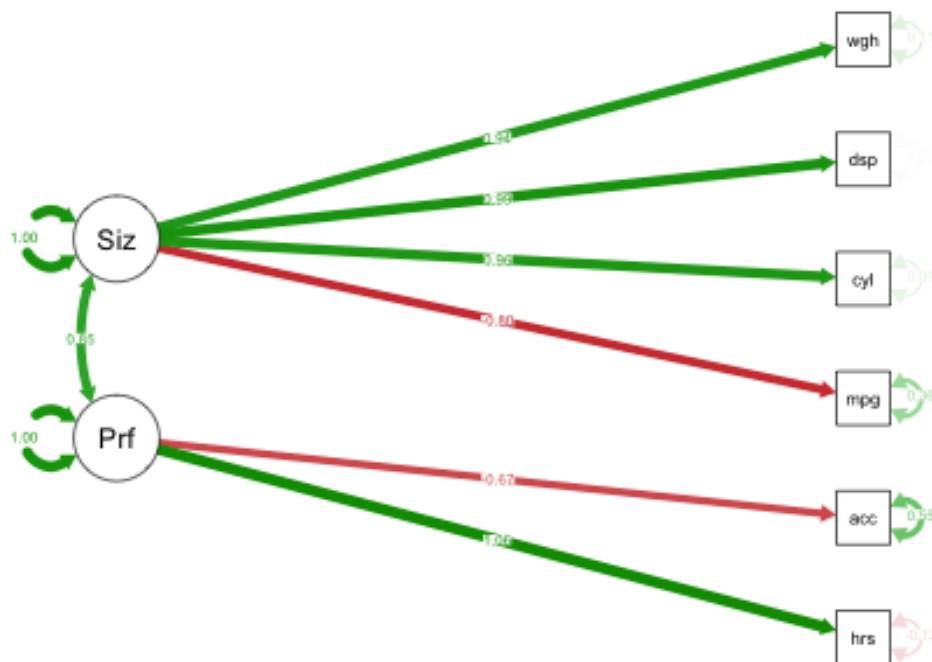
```
## theta3   displacement <--> displacement
## theta4   weight <--> weight
## theta5   horsepower <--> horsepower
## theta6   acceleration <--> acceleration
##
##   Iterations =  41

library(Rcpp)
library(DiagrammeR)
pathDiagram(cfamodel_sem)

library(semPlot)

## Registered S3 methods overwritten by 'huge':
##   method     from
##   plot.sim   BDgraph
##   print.sim  BDgraph

semPaths(cfamodel_sem, rotation = 2, 'std', 'est')
```



```
options(fit.indices = c("SRMR", "GFI", "AGFI")) # Some fit indices
criteria = summary(cfamodel_sem)
```

```
criteria$SRMR

## [1] 0.02668518

criteria$GFI

## [1] 0.8669881

criteria$AGFI

## [1] 0.6508438

criteria$SRMR < 0.05

## [1] TRUE

criteria$GFI > 0.95

## [1] FALSE

criteria$AGFI > 0.95

## [1] FALSE

parameters = summary(cfamodel_sem)
parameters$coeff

##              Estimate   Std Error    z value       Pr(>|z|)
## lambda1 -0.80080847 0.046924879 -17.065755   2.669182e-65
## lambda2  0.95641975 0.041854794  22.850901 1.431549e-115
## lambda3  0.98939488 0.040595403  24.372092 3.381485e-131
## lambda4  0.94251838 0.042366363  22.246856 1.209815e-109
## lambda5  1.05975276 0.040972354  25.865069 1.646971e-147
## lambda6 -0.67362297 0.050936678 -13.224714   6.317748e-40
## rho      0.85365831 0.020628049  41.383376   0.000000e+00
## theta1   0.35870580 0.029536856  12.144346   6.147215e-34
## theta2   0.08526125 0.008513186  10.015199   1.306983e-23
## theta3   0.02109783 0.005265699   4.006654   6.158499e-05
## theta4   0.11165910 0.010365908  10.771763   4.679537e-27
## theta5  -0.12307574 0.036129441  -3.406522   6.579619e-04
## theta6   0.54623212 0.045999641  11.874704   1.602000e-32
##
## lambda1                    mpg <--- Size
## lambda2              cylinders <--- Size
## lambda3           displacement <--- Size
## lambda4                 weight <--- Size
## lambda5             horsepower <--- Perf
## lambda6           acceleration <--- Perf
## rho                      Perf <--> Size
## theta1                    mpg <--> mpg
## theta2        cylinders <--> cylinders
```

```
## theta3  displacement <--> displacement
## theta4             weight <--> weight
## theta5      horsepower <--> horsepower
## theta6  acceleration <--> acceleration
```

```
# lets focus on Rho, the correlation between the factors
parameters$coeff[7,]$Estimate
```

```
## [1] 0.8536583
```

```
coef.Lower = parameters$coeff[8,]$Estimate - 1.96 * parameters$coeff[8,]$`Std
Error`
coef.Upper = parameters$coeff[8,]$Estimate + 1.96 * parameters$coeff[8,]$`Std
Error`
coef.Lower
```

```
## [1] 0.3008136
```

```
coef.Upper
```

```
## [1] 0.416598
```