Deliverable 2

PCA, CA and Clustering

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Contents

#Set up

```
# Clear plots
if(!is.null(dev.list())) dev.off()
# Clean workspace
rm(list=ls())
#Set working directory
setwd("C:/Users/renzo/Documents/ADEI")
filepath<-"C:/Users/renzo/Documents/ADEI/"
```

##Loading Required Packages for this deliverable

```
options(contrasts=c("contr.treatment","contr.treatment"))

requiredPackages <- c("effects","FactoMineR","car","missMDA","mvoutlier","chemometrics", "factoextra","F

package.check <- lapply(requiredPackages, FUN = function(x) {
  if (!require(x, character.only = TRUE)) {
    install.packages(x, dependencies = TRUE)
    library(x, character.only = TRUE)
  }
})

search()
```

0.1 Load processed data from first deliverable

```
load(paste0(filepath,"Deliverable1_Result_Data.RData"))
```

---

1 Principal Component Analysis (PCA)

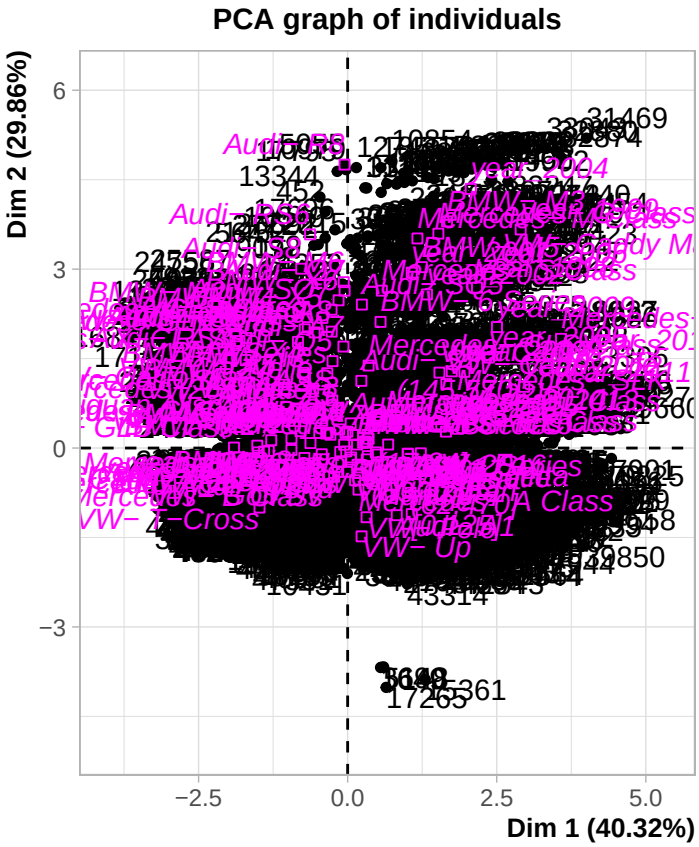
```
names(df[,c(1:17)])
```

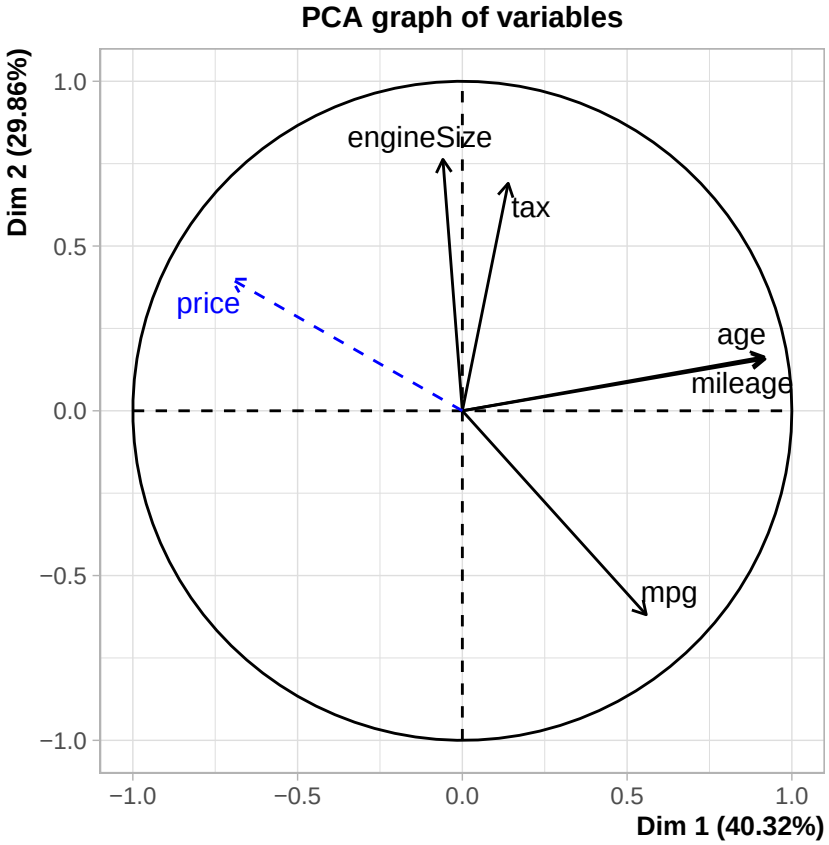
```
##  [1] "model"        "year"         "price"        "transmission" "mileage"
##  [6] "fuelType"     "tax"          "mpg"          "engineSize"   "manufacturer"
## [11] "age"          "auxPrice"     "auxTax"       "auxMileage"   "auxMpg"
## [16] "auxAge"       "Audi"
```

```
vars_con<-names(df)[c(5,7,8,9,11)]
vars_dis<-names(df)[c(1,2,4,6,10,12:16)]
vars_res<-names(df)[c(3,17)]
```

We have already seen profiling in the first deliverable. Now we are gonna look at the main components.

```
library(FactoMineR)
res.pca <- PCA(df[,c(vars_res, vars_dis, vars_con)],quali.sup=c("Audi",vars_dis),quanti.sup= c(1))
```





As we know variables that have a 90 degrees angle, are not related.

1.1 Multivariant outliers should be included as supplementary observations

Since the data set we have is pretty good, we considered that we don't have multivariate outliers

1.2 Eigenvalues and dominant axes analysis

Eigenvalues correspond to the amount of the variation explained by each principal component (PC). Eigenvalues are large for the first PC and small for the subsequent PCs.

1.2.1 How many axes we have to interpret according to Kaiser?

A PC with an eigenvalue > 1 indicates that the PC accounts for more variance than accounted by one of the original variables in standardized data. This is commonly used as a cutoff point to determine the number of PCs to retain, using the Kaiser criteria.

```
eigenvalues <- res.pca$eig
head(eigenvalues)
```

```
##        eigenvalue percentage of variance cumulative percentage of variance
## comp 1  2.0160220              40.320439                           40.32044
## comp 2  1.4931210              29.862419                           70.18286
## comp 3  0.7815661              15.631323                           85.81418
## comp 4  0.5188779              10.377558                           96.19174
## comp 5  0.1904130               3.808261                          100.00000
```

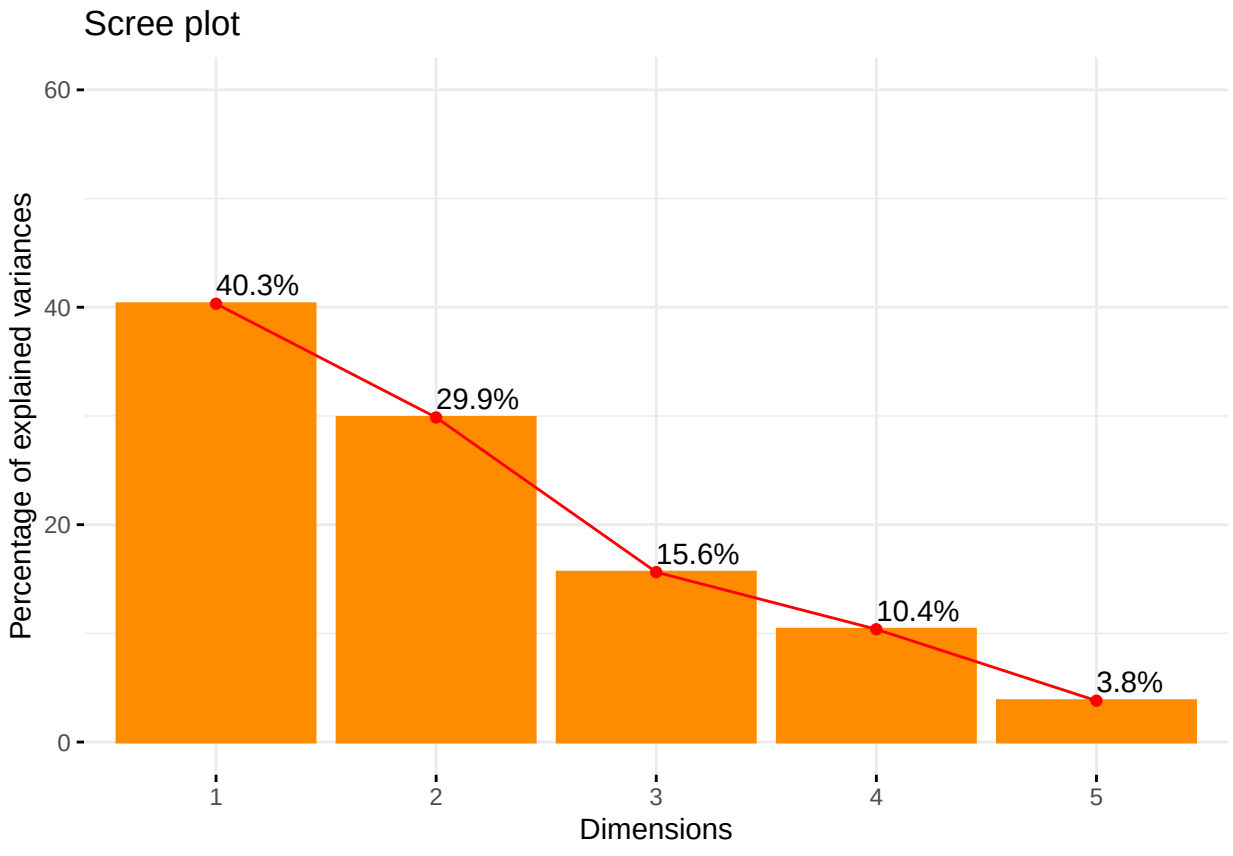
In this case we will use dimensions one and two, which explain 70.18% of the inertia.

1.2.2 How many axes we have to interpret according to Elbow's rule?

As a brief definition, we would say that Elbow's rule is based on selecting dimensions until the difference in variance of that of the next factorial plane is almost the same as that of the current plane.

So let's look at exactly where we have this minimal difference:

```
fviz_screeplot(res.pca,addlabels=TRUE,ylim=c(0,60),barfill="darkorange",barcolor="darkorange",linecolor
```

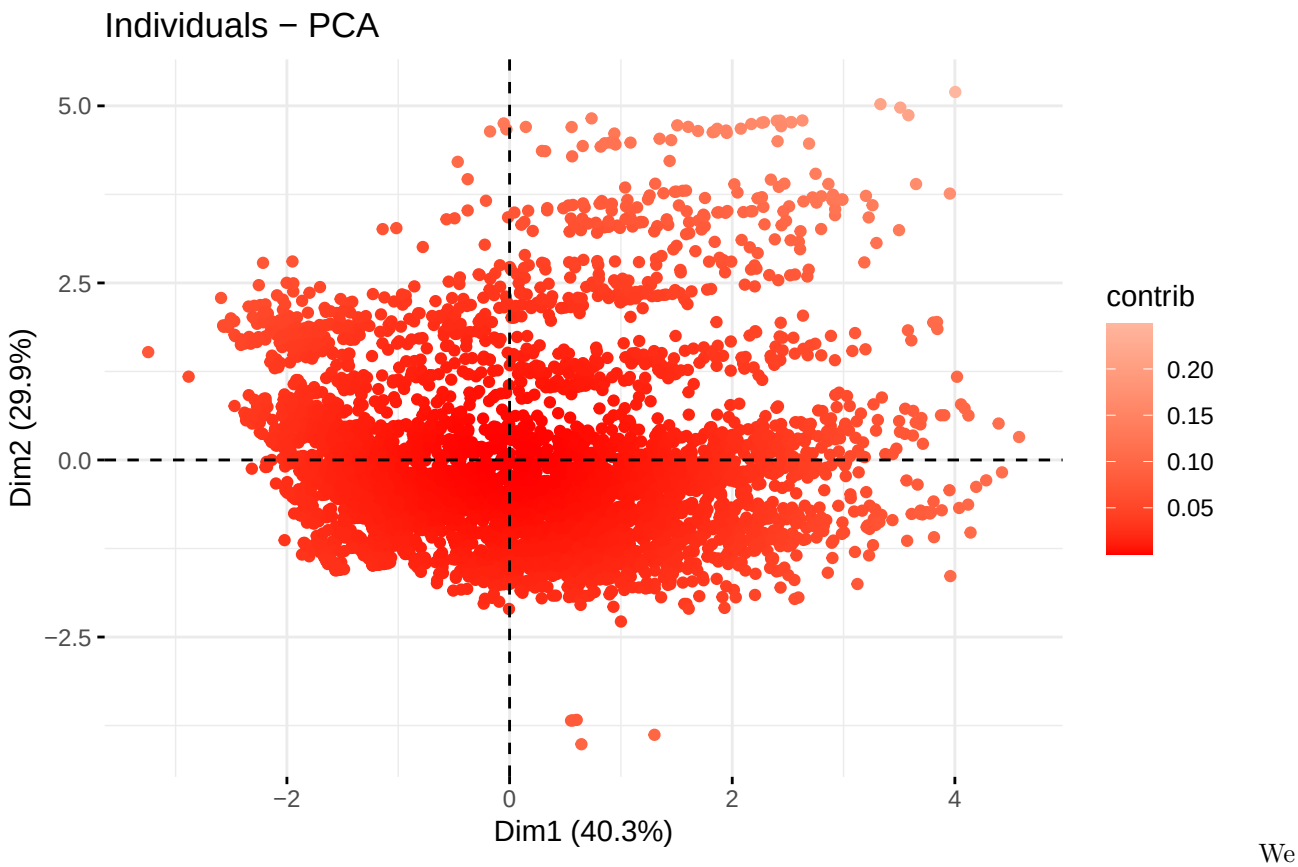


We arrive to the same conclusion as with Kaiser.

1.3 Individuals point of view

1.3.1 Contribution

```
fviz_pca_ind(res.pca, col.ind="contrib", geom = "point") + scale_color_gradient2(low="red", mid="white",
```

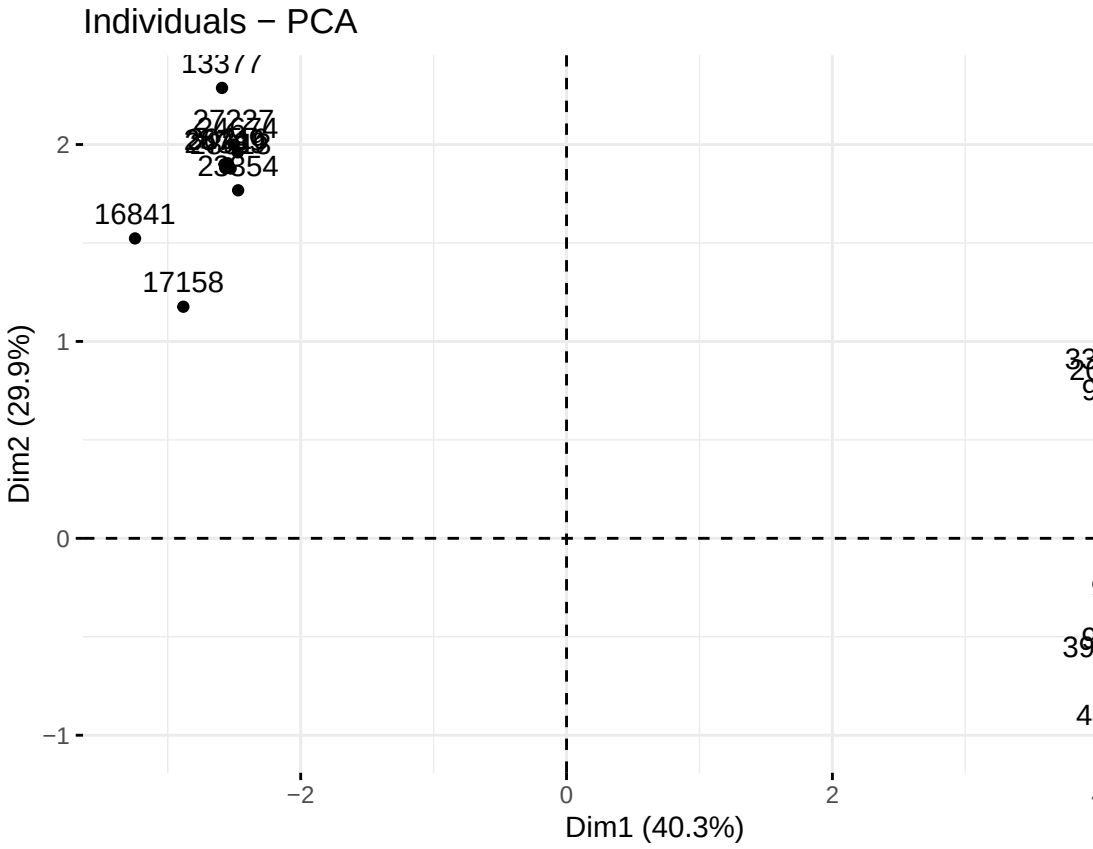


We can see that there are some individuals that are too contributive. Let's try to understand them better with extreme individuals.

1.3.2 Extreme individuals

```
rang<-order(res.pca$ind$coord[,1])
contrib.extremes<-c(row.names(df)[rang[1]], row.names(df)[rang[length(rang)]])

contrib.extremes<-c(row.names(df)[rang[1:10]], row.names(df)[rang[(length(rang)-10):length(rang)]])
fviz_pca_ind(res.pca, select.ind = list(names=contrib.extremes))
```



1.3.2.1 In dimension 1:

We can now have a look at them:

```
df[which(row.names(df) %in% row.names(df)[rang[length(rang)]]), 1:16]
```

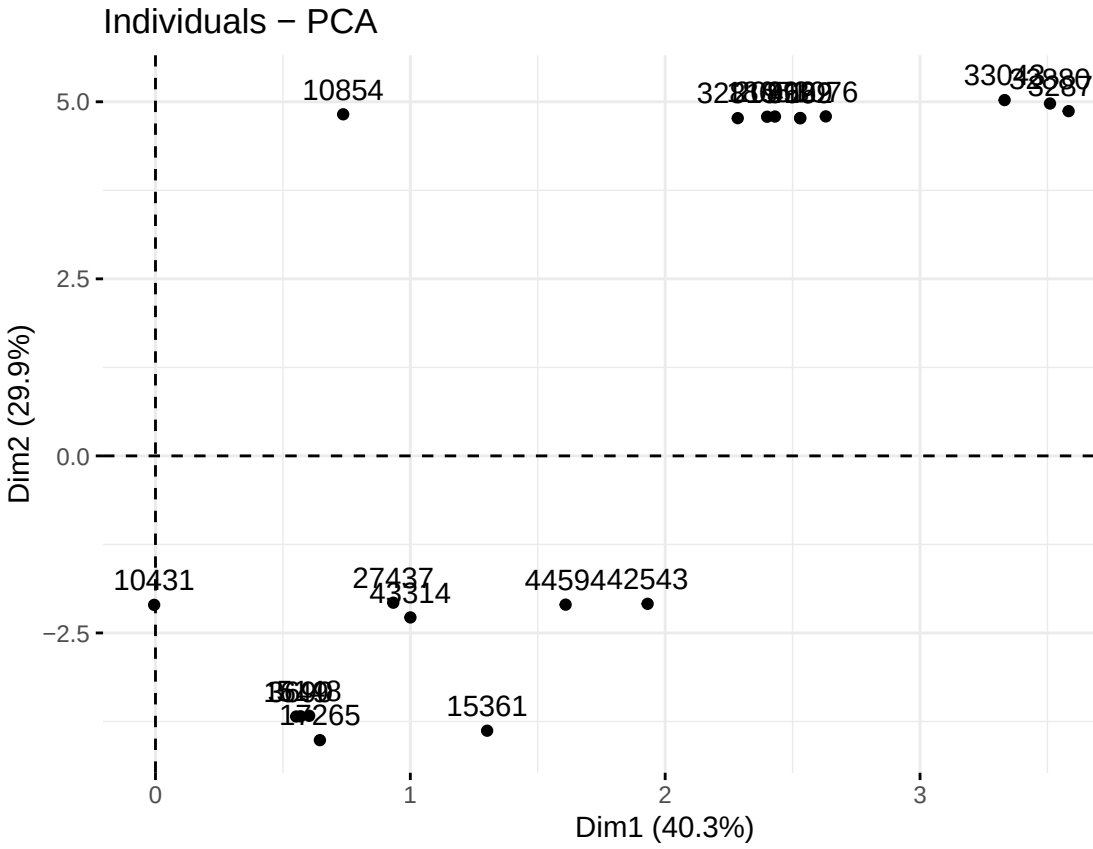
```
##          model year price transmission  mileage fuelType      tax  mpg
## 39660 VW- Golf 2010  2775       Manual 74035.11   Diesel 151.8763 62.8
##       engineSize manufacturer age auxPrice    auxTax auxMileage   auxMpg auxAge
## 39660        1.6           VW  10   [0,15] (145,570]   (34,153] (62,470] (4,22]
```

```
df[which(row.names(df) %in% row.names(df)[rang[1]]),1:16]
```

```
##         model year price transmission mileage fuelType tax mpg engineSize
## 16841 BMW- X3 2020 42990     SemiAuto    3245   Hybrid 140 5.5          2
##       manufacturer age auxPrice    auxTax auxMileage auxMpg auxAge
## 16841          BMW   0  (26,90] (125,145]      [0,6] [5,45]  [0,1]
```

```
rang<-order(res.pca$ind$coord[,2])
contrib.extremes<-c(row.names(df)[rang[1]], row.names(df)[rang[length(rang)]])

contrib.extremes<-c(row.names(df)[rang[1:10]], row.names(df)[rang[(length(rang)-10):length(rang)]])
fviz_pca_ind(res.pca, select.ind = list(names=contrib.extremes))
```



1.3.2.2 In dimension 2:

We can now have a look at them:

```
df[which(row.names(df) %in% row.names(df)[rang[length(rang)]]), 1:16]
```

```
##                   model year price transmission mileage fuelType tax  mpg
## 31469 Mercedes- E Class 2010  8850    Automatic   64723   Diesel 200 45.6
##       engineSize manufacturer age auxPrice    auxTax auxMileage  auxMpg auxAge
## 31469          3     Mercedes  10   [0,15] (145,570]   (34,153] (45,53] (4,22]
```

```
df[which(row.names(df) %in% row.names(df)[rang[1]]),1:16]
```

```
##               model year price transmission mileage fuelType tax mpg engineSize
## 17265 BMW- 2 Series 2019 26994    Automatic      13   Hybrid 135 113        1.5
##       manufacturer age auxPrice    auxTax auxMileage   auxMpg auxAge
## 17265          BMW   1  (26,90] (125,145]      [0,6] (62,470]  [0,1]
```

1.3.3 Detection of multivariant outliers and influent data.

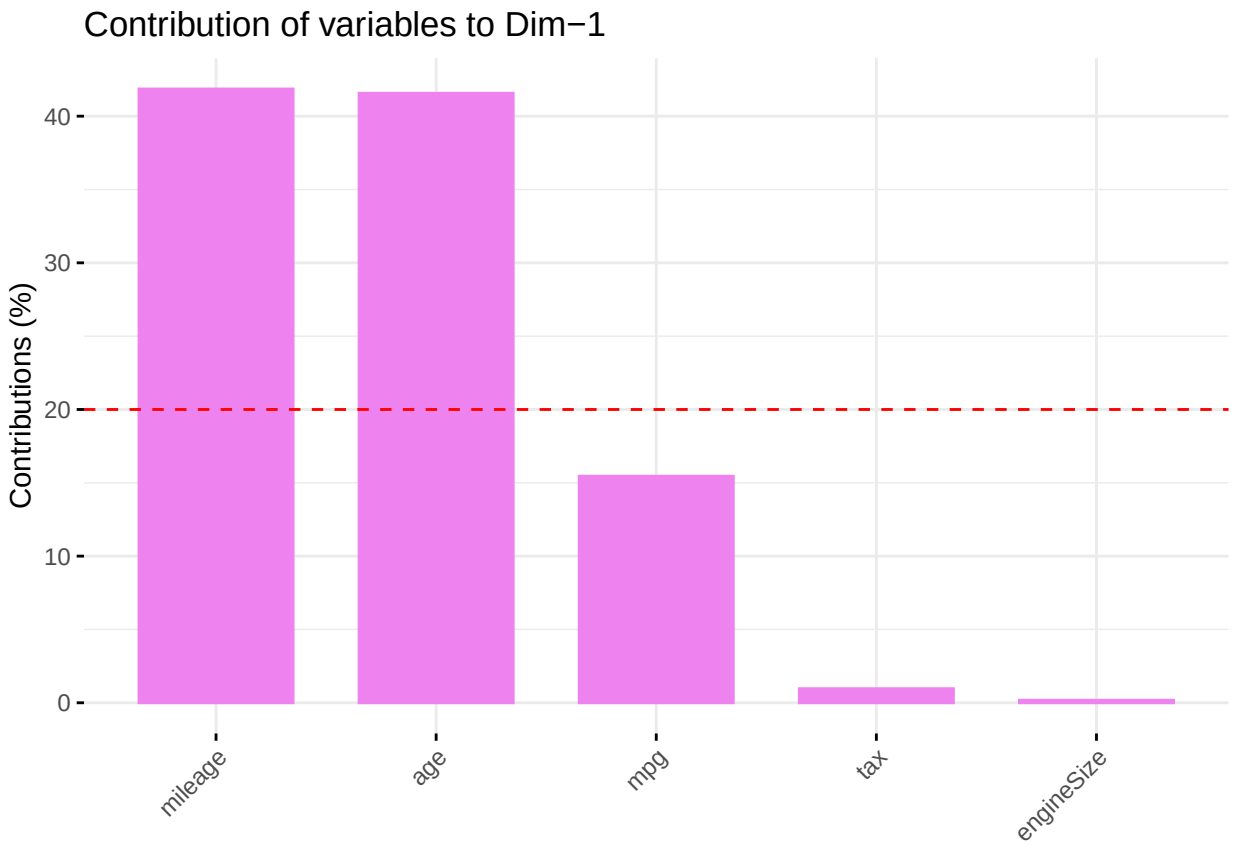
As explained before we do not have multivariate outliers.

1.4 Interpreting the axes: Variables point of view coordinates, quality of representation, contribution of the variables

```
res.des <- dimdesc(res.pca)
```

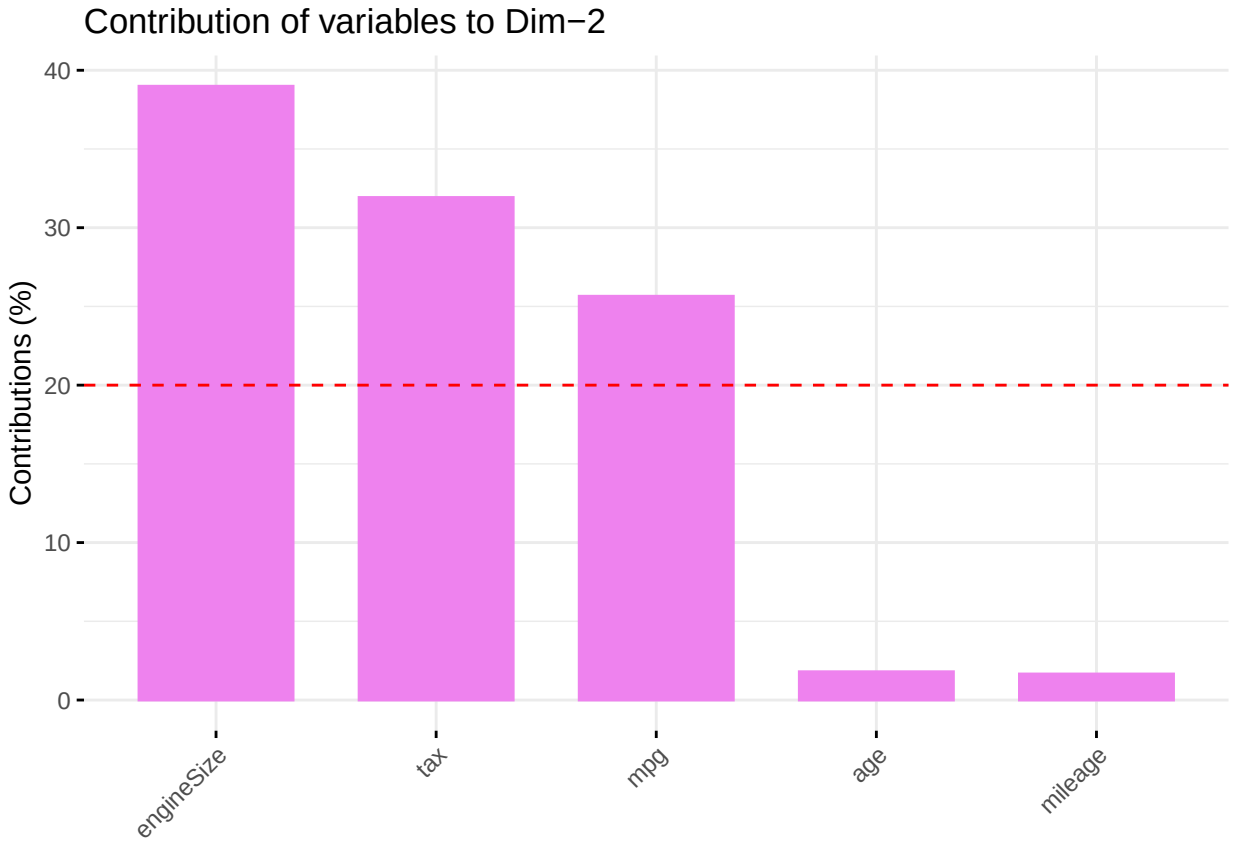
1.4.1 First dimension

```
#Contributions of variables to PC1
fviz_contrib(res.pca, fill = "violet", color = "violet", choice = "var", axes = 1, top = 5)
```



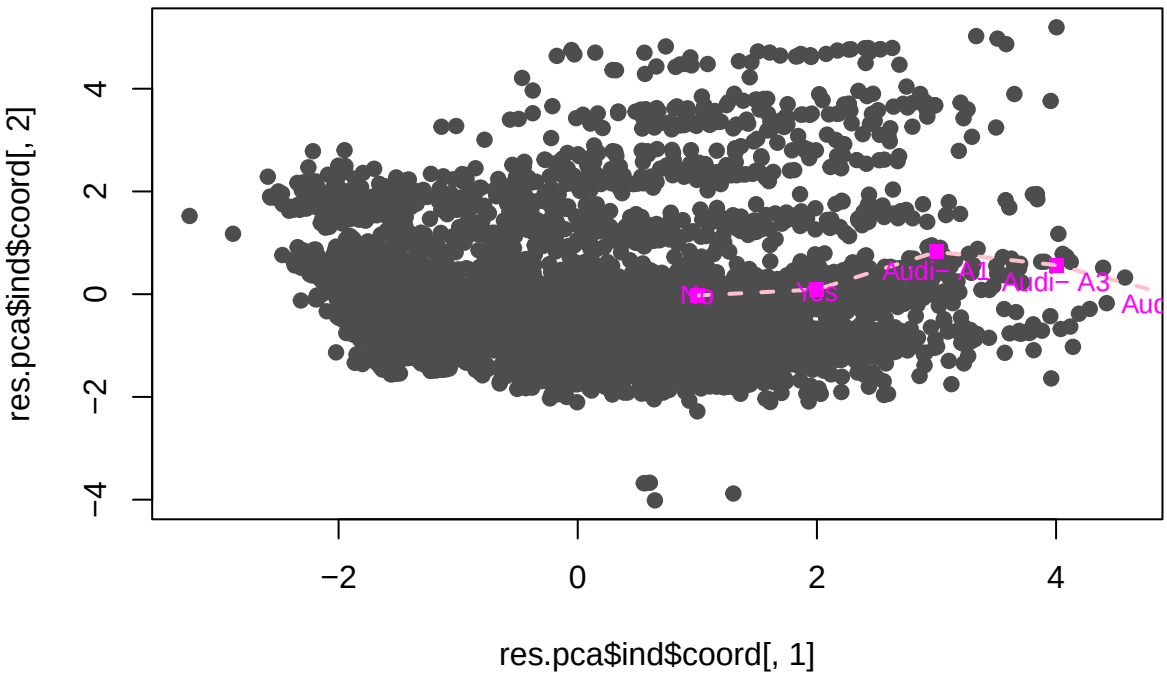
1.4.2 Second dimension

```
#Contributions of variables to PC2
fviz_contrib(res.pca, fill = "violet", color = "violet", choice = "var", axes = 2, top = 5)
```



1.5 Perform a PCA taking into account also supplementary variables the supplementary variables can be quantitative and/or categorical

```
# Manually producing the plot
plot(res.pca$ind$coord[,1],res.pca$ind$coord[,2],pch=19,col="grey30")
points(res.pca$quali.sup$coord[,1],pch=15,col="magenta")
lines(res.pca$quali.sup$coord[,1],lwd=2,lty=2,col="pink")
text(res.pca$quali.sup$coord[,3],labels=names(res.pca$quali.sup$coord[,5]),col="magenta",cex=0.8)
```



---

2 K-Means Classification

2.1 Description of clusters

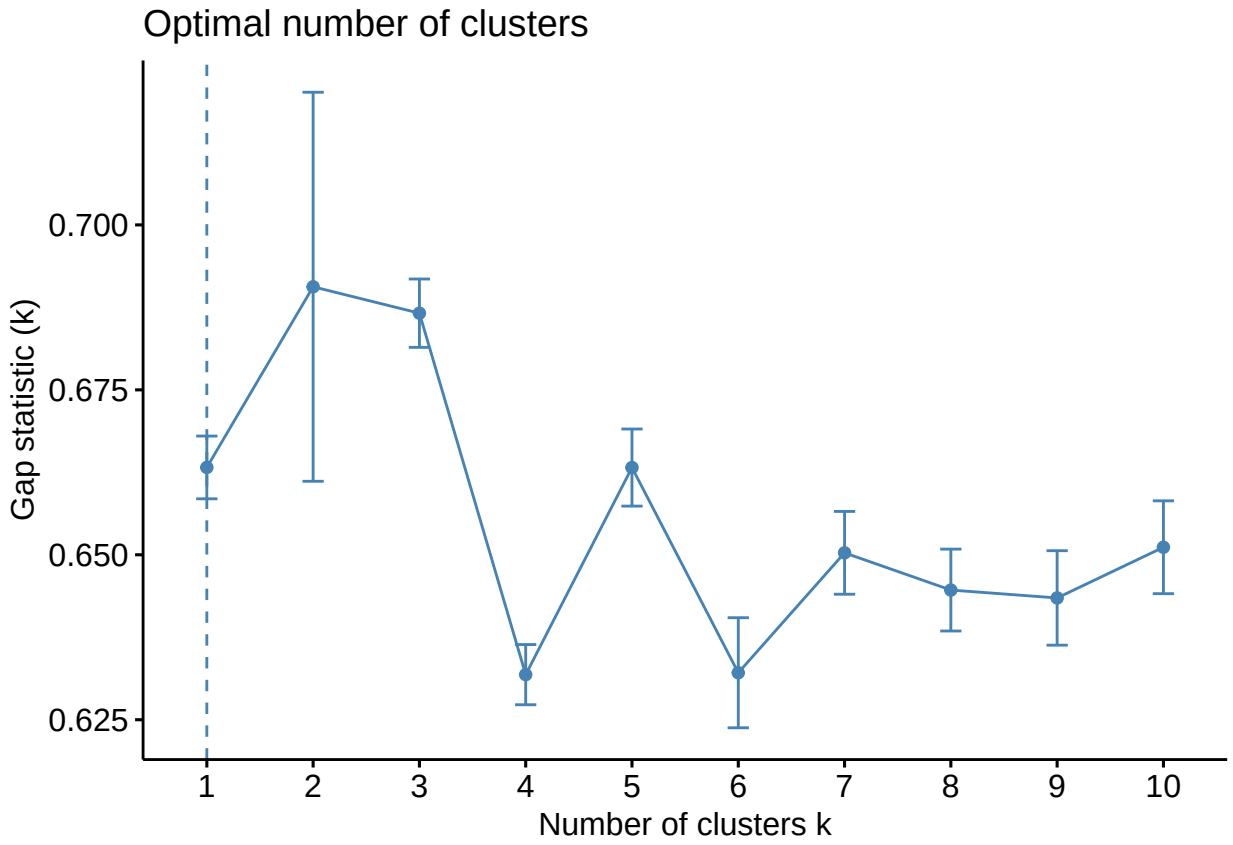
```
res.pca <- PCA(df[,c(vars_res, vars_dis, vars_con)],quali.sup=c("Audi",vars_dis),quanti.sup=c(1),ncp=5,g
ppcc<-res.pca$ind$coord[,1:2] # 2 components principals (kaiser)
dim(ppcc)
```

```
## [1] 4940    2
```

2.1.1 Optimal number of clusters

```
library("factoextra")
fviz_nbclust(ppcc, kmeans, method = "gap_stat")
```

```
## Warning: did not converge in 10 iterations
```



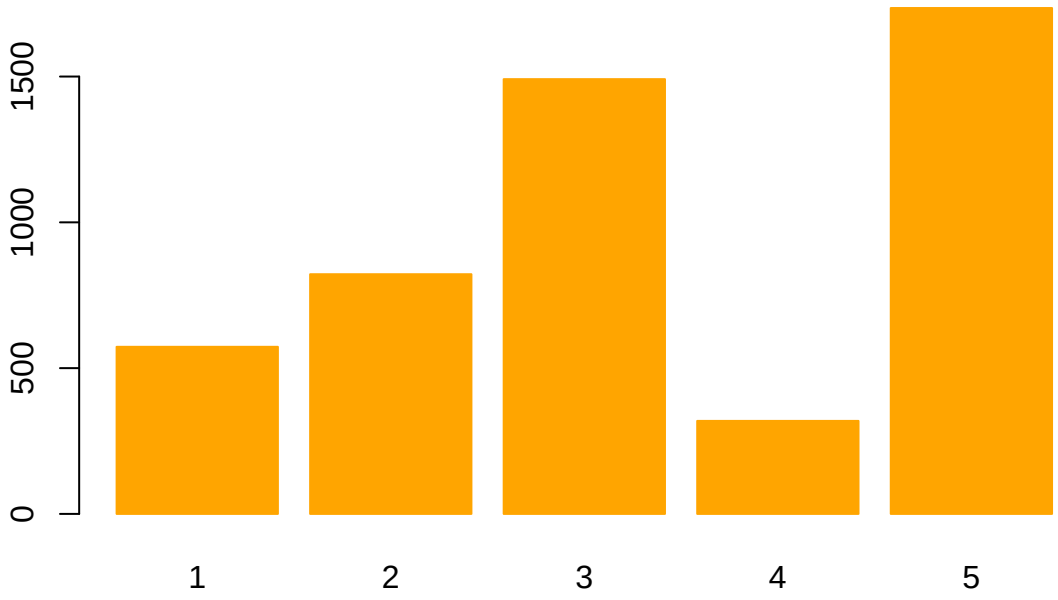
According to the previous plot, the optimal number of clusters per k-means is 2.

2.2 Classification

```
dist<-dist(ppcc)
kc<-kmeans(dist, 5, iter.max=30, trace=TRUE) #Annex K-means Classification
```

Converged in 4 iterations.

```
df$claKM<-0
df$claKM<-kc$cluster
df$claKM<-factor(df$claKM)
barplot(table(df$claKM),col="orange",border="orange",main="[k-means]#observations/cluster")
```



2.2.1 Gain in inertia (in %)

```
100*(kc$betweenss/kc$totss)
```

```
## [1] 77.62806
```

2.2.2 k-means clusters characteristics

If we want to know the characteristics of each cluster we need to execute a catdes to obtain these characteristics. In the following output we get them.

```
dim(df)
res.cat <- catdes(df,18)
res.cat #annex k-means res.cat
```

We proceed to explain the data obtained.

2.2.3 The description of the clusters by the variables

We start by the description of categorical variables that have greater influence on our clusters. We can see that **transmission**,**auxTax**, **fuelType**, **manufacturer** and **Audi** are the variables that have a greater effect on our clusters because of their small p-value.

For each cluster which are their categories.

- Cluster 1:
  - One of the first things we notice is that individuals of this cluster have a high MPG and price value since 78.70% of the observations are in **auxMpg=[5,45]** and **auxPrice=(26,89]**, we can also see that 61.08% of the observations use a **SemiAuto Transmission** and 65.09% are highly taxed.
- Cluster 2:

  - This cluster is for younger, less used cars. We can see that 85.76% of observations are **auxAge=[0,1]** also with a low mileage but high tax.

- Cluster 3:
  - The first thing we see is that individuals in this cluster have a high tax with 94.98% of the observations in **auxTax=[145,570]**, also have a higher age and mileage. The most predominant fuel type is Diesel.
- Cluster 4:
  - We notice that most of the observations of this cluster have a high mileage and age, as well as the predominant type of fuel being Diesel, like the previous cluster. But also a high value of mpg with the predominant transmission being Manual.
- Cluster 5:
  - We see that 67.77% of **auxMileage=(17,34]** observations on the Model are in this cluster, also include young cars with the year 2017.

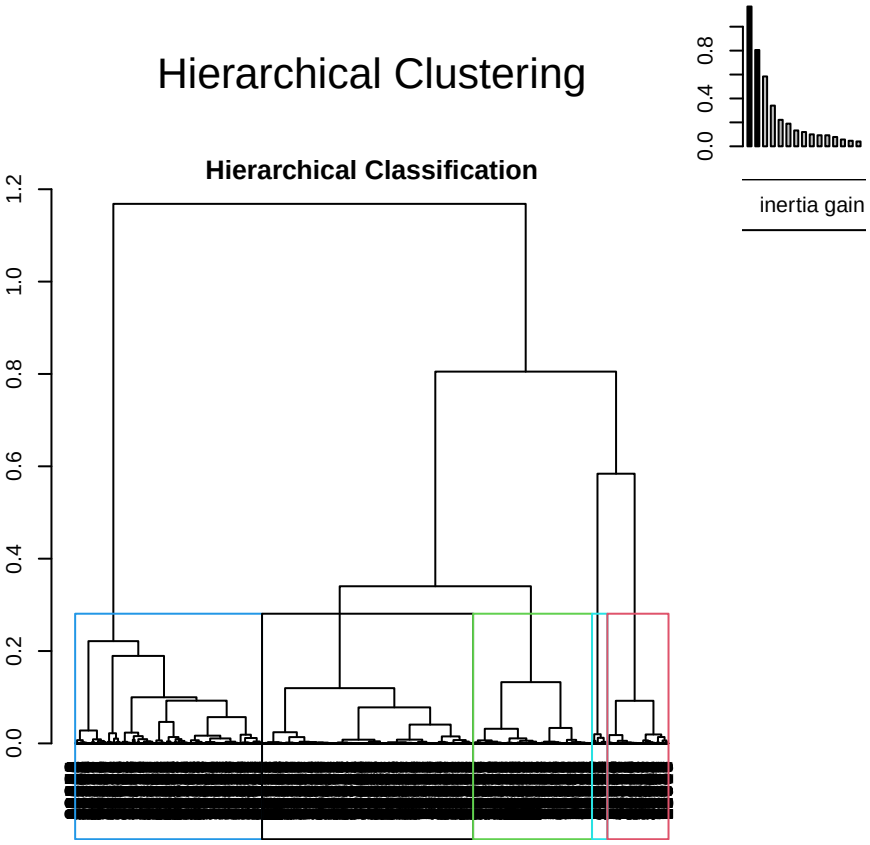
We now proceed to see the quantitative variables that characterizes the clusters. We can observe that all variables are a little over represented. **age** being the most represented with 0.708 units over the global mean, then **mileage* with 0.704.

- Cluster 1:
  - We notice that **engineSize**, **price** and **tax** are over the overall mean.
- Cluster 2:
  - Only **price** and **mpg** are over the overall mean.
- Cluster 3:
  - Only **price** and **mpg** are under the overall mean.
- Cluster 4:
  - We notice that **engineSize**, **price** and **tax** are under the overall mean.
- Cluster 5:
  - The same observation as in Cluster 4.

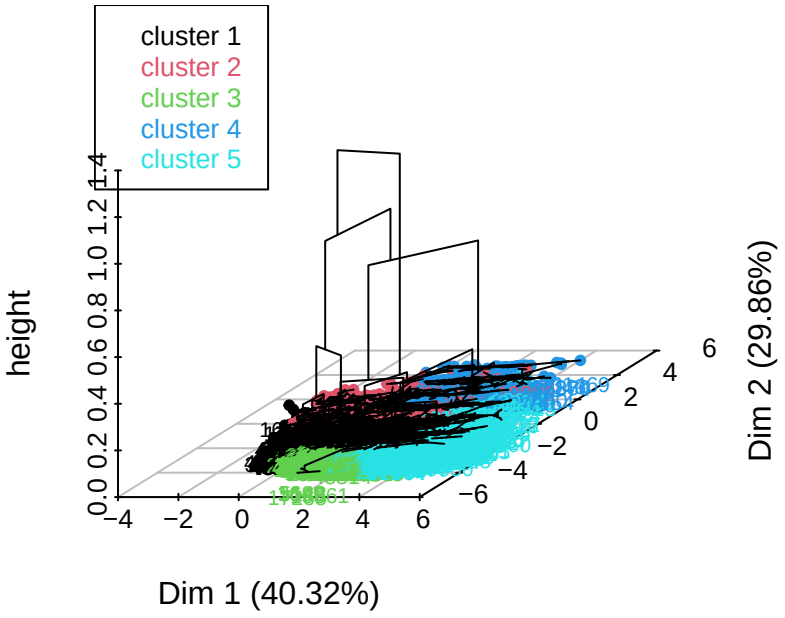
#Hierarchical Clustering

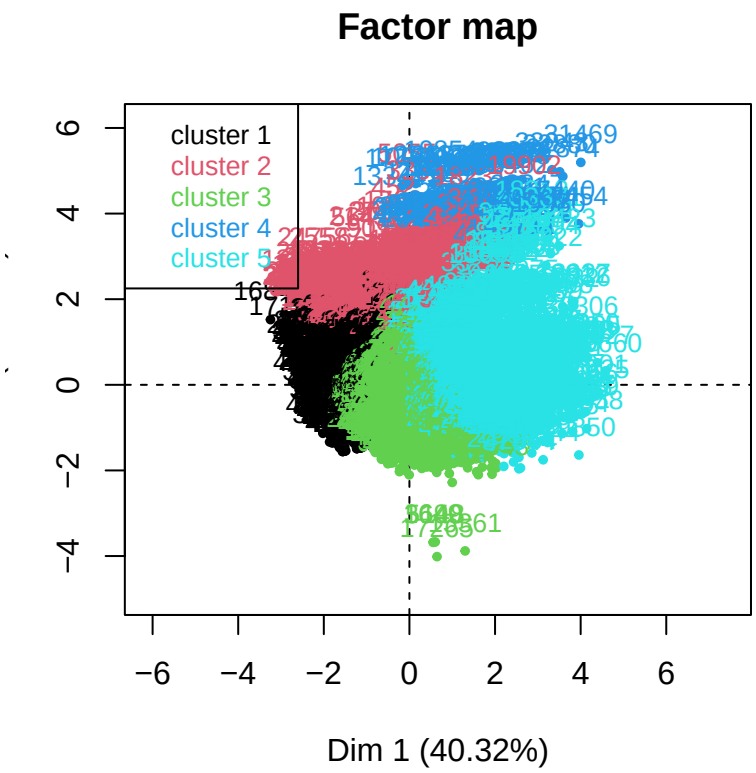
After having performed a PCA, we are going to perform a Hierarchical Clustering analysis on the same data set. We created 5 clusters and sorted by size.

```
res.hcpc <- HCPC(res.pca,nb.clust = 5, order = TRUE)
```



Hierarchical clustering on the factor map





We have chosen 5 clusters because it is the limit at which visually they can be clearly distinguished.

2.3 Description of clusters

Observations for each cluster

```
table(res.hcpc$data.clust$clust)
```

```
##
##    1    2    3    4    5
## 1698  553 1549  131 1009
```

```
barplot(table(res.hcpc$data.clust$clust), col="darkorange", border="darkorange", main="observations/clus
```

2.4 Interpret the results of the classification

2.4.1 The description of the clusters by the variables

```
names(res.hcpc$desc.var)
```

```
## [1] "test.chi2"  "category"   "quanti.var" "quanti"     "call"
```

```
res.hcpc$desc.var$test.chi2
```

```
##                     p.value  df
## model          0.000000e+00 360
## year           0.000000e+00  80
## auxPrice       0.000000e+00  12
## auxMileage     0.000000e+00  12
## auxMpg         0.000000e+00  12
## auxAge         0.000000e+00  12
## auxTax        6.196947e-289   8
## transmission 7.589330e-119   8
## fuelType       4.815342e-77   8
## manufacturer   2.871328e-48  12
## Audi           2.755174e-10   4
```

A small p value (close to zero) indicates that there is a significant association between the variable and the clusters. In this case the variables that affect more to the clustering are model, year, auxPrice, auxMileage, auxMpg and auxAge.

```
res.hcpc$desc.var$category #annex res.hcpc$desc.var$category
```

- Cluster 1:

  - It seems like this cluster appears to be associated with newer vehicles (especially year 2019), which in this cluster is 85,68% of observations. A variable that also indicates this is auxMileage[0,6], where the 78,7% of the observations are in this cluster. The 100% of observations of VW Arteon or VW T-Cross are in this cluster. Another characteristic of this cluster is that practically 50% of the observations correspond to SemiAuto Transmission.

- Cluster 2:
  - In this second cluster we can see that observations with fuel efficiency (auxMpg) in the range of 5 to 45 are strongly associated with this group (30.95%). Vehicles with auxprice(26,90) are strongly representated in this cluster. VW Touareg model is also strongly representated in this cluster, where the 97.22% of the observations are in this cluster. Almost every observations in this cluster referring to the transmission are Semiauto(57.5% of this cluster) and automatic (41.05% of this cluster).

- Cluster 3:
  - This cluster seems to be represented by observations with an age between 1 and 3 years. Observations with a range of 17.000 to 34.000 are strongly represented in this cluster (66,6% of this observations are here). This cluster is also associated with vehicles that have high miles per gallon, in the range of 62 to 470 MPG. This may indicate the presence of highly efficient cars or hybrid vehicles. We can see that this cluster seems to represent cheap cars (auxprice[0,15] is 37,7% of observations and auxPrice[15,20] is 35,95% of observations). In general, this cluster appears to focus on characteristics related to vehicle use, such as mileage, fuel efficiency, and age, as well as specific characteristics of the model and year of manufacture. These patterns can be valuable in understanding consumer preferences and trends in the vehicle market.

- Cluster 4:
  - This cluster is associated with vehicles 4 to 22 years old. The relationship is significant, suggesting that the age of the vehicle affects the characteristics of the model.The 100% of the observations of this cluster are in the range of 145 to 570 monetary units of taxing. 39% of observations are audi, mostly Q5, which may affect taxes, age and fuel efficiency observations of this cluster. Overall, this cluster appears to highlight the importance of taxes and fees, as well as fuel efficiency and certain brands and models in consumer decision making. The age of the vehicle also emerges as a distinguishing factor in this context.

- Cluster 5:
  - It seems like more than 75% of the observations of this cluster are vehicles that use Diesel as a fuel. Also manual transmission observations are very represented in this cluster. Near the 90% of the observations have a mileage between 34.000 to 153.000 miles which suggests that are old vehicles. This also affects the price because the 72% of observations are in a price range between 0 to 15.000. Most of year_2015, 2014, 2013, 2012 and olders are in this cluster. In summary, this cluster is characterized by older vehicles with lower prices, higher mileage, specific tax rates, efficient fuel performance, and a distinctive presence of manual transmissions and diesel fuel types. The Audi brand and the models associated with it are not as predominant in this group.

Quantitative variables that represent the clusters

```
res.hcpc$desc.var$quanti.var
```

```
##                 Eta2 P-value
## price      0.4883890       0
## mileage    0.6858642       0
## tax        0.6651754       0
## mpg        0.5344250       0
## engineSize 0.5611917       0
## age        0.6304414       0
```

As we can see with this output, all the variables are quite represented in the clusters in a way that is quite similar to each other. Those that most affect the variability of the data would be mileage (68,58%), tax (66,5%) and age (63%). These results suggest that these variables are important to characterize and distinguish the different groups in your clustering analysis.

Which variables are associated with the quantitative variables.

```
res.hcpc$desc.var$quanti #description of each cluster by the quantitative variables #annex res.hcpc$desc
```

- Cluster 1:
  - The average price in this cluster (25561.61) is significantly higher than the general average (21176.74).It may be because the cars in this cluster are much newer (mean of 1.04 years) than the average (2.75 years) and have less mileage (mean of 6537 vs 22024 overall mean).
- Cluster 2:
  - The engine size in this cluster is larger than the overall. This may explain that the mean price of this cluster is 50% more than the overall price of observations and the mpg are minor than the overall mean.
- Cluster 3:
  - Miles per gallon performance in this cluster is significantly higher than the overall average. Also price and engineSize are quite minor than the overall mean.
- Cluster 4:
  - Taxes in this cluster are significantly higher than the general average. Mean Age (5) in this cluster is higher than overall mean (2.7) and mileage is also significantly higher. Nevertheless the mean price of this cluster is not very minor from the overall mean. This may be because the mean engineSize of this cluster is much higher than the overall mean.
- Cluster 5:
  - This cluster represents old cars. The average mileage of this cluster (49.750) is much higher than the overall mean (22024). Also the age is much higher (5.18 years vs 2.75). Therefore, the average price of this cluster is much minor thant the overall mean.

2.4.2 The description of the clusters by the individuals

```
res.hcpc$desc.ind$para
```

```
## Cluster: 1
##      5144     37453     28473     25548      5457
## 0.2920410 0.2938912 0.3284662 0.3364906 0.3507131
## ------------------------------------------------------------
## Cluster: 2
##      5433     20573     11156     14466     10245
## 0.2618110 0.2837205 0.3180882 0.3420619 0.3615287
## ------------------------------------------------------------
## Cluster: 3
##     36079       481     36428      6990     39445
## 0.2834354 0.3005953 0.3194460 0.3414961 0.3991843
## ------------------------------------------------------------
## Cluster: 4
##     24171     39018     39014     35741     35696
## 0.6359730 0.7352745 0.7468148 0.7510087 0.7733787
## ------------------------------------------------------------
## Cluster: 5
##     39281     10773      7462     14766     14790
## 0.4574059 0.4838015 0.4870607 0.4878817 0.5022145
```

This result gives detailed information about how the individuals in each cluster are distributed in terms of the variables used in the analysis.

```
res.hcpc$desc.ind$dist
```

```
## Cluster: 1
##    16841    17158    24334    22992    21870
## 3.953078 3.747495 3.337248 3.331538 3.293036
```

```
## --------------------------------------------------------
## Cluster: 2
##     5055    33314      452    19902    17696
## 5.483902 5.109611 4.818035 4.771590 4.315787
## --------------------------------------------------------
## Cluster: 3
##     1649     3690     5148    17265    15361
## 6.295718 6.285699 6.265942 5.876822 5.497321
## --------------------------------------------------------
## Cluster: 4
##    31469     7454    33043     9169     7440
## 6.253451 6.009047 6.008367 5.733848 5.580431
## --------------------------------------------------------
## Cluster: 5
##    44558    30932     9656    43994    21391
## 5.235095 5.078231 5.033298 4.955282 4.828727
```

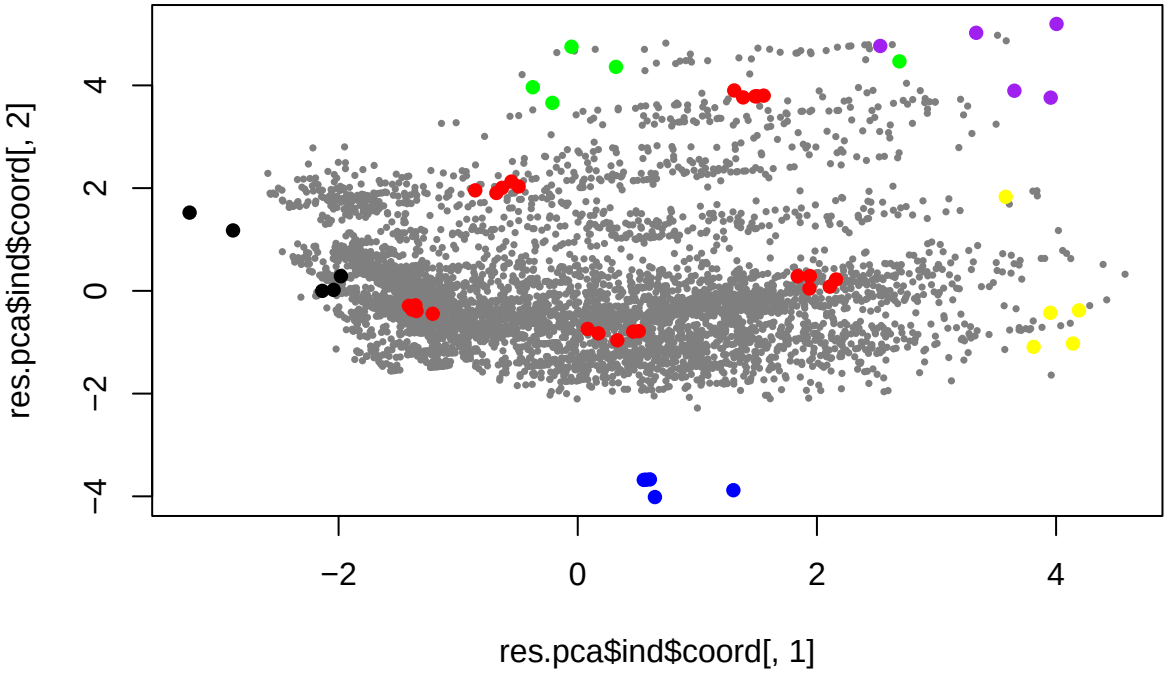
This output allows us to see how individuals are distributed relative to the clusters and how far individuals are from their nearest cluster. Is useful to evaluate the quality and consistency of the assignment of individuals to clusters. Smaller distances indicate better assignment.

2.4.2.1 Examine the values of individuals that characterize classes For each cluster, characteristic individuals (para) and distant individuals (dist) are identified using the information provided by the result of the cluster analysis (res.hcpc). The names of the individuals are used in PCA to identify the indices of these individuals in the principal coordinates.

Then, we create the scatter plot, where individuals characteristic of each cluster are highlighted in red.

```
para1<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$para[[1]]))
dist1<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$dist[[1]]))
para2<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$para[[2]]))
dist2<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$dist[[2]]))
para3<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$para[[3]]))
dist3<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$dist[[3]]))
para4<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$para[[4]]))
dist4<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$dist[[4]]))
para5<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$para[[5]]))
dist5<-which(rownames(res.pca$ind$coord)%in%names(res.hcpc$desc.ind$dist[[5]]))

plot(res.pca$ind$coord[,1],res.pca$ind$coord[,2],col="grey50",cex=0.5,pch=16)
points(res.pca$ind$coord[para1,1],res.pca$ind$coord[para1,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist1,1],res.pca$ind$coord[dist1,2],col="black",cex=1,pch=16)
points(res.pca$ind$coord[para2,1],res.pca$ind$coord[para2,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist2,1],res.pca$ind$coord[dist2,2],col="green",cex=1,pch=16)
points(res.pca$ind$coord[para3,1],res.pca$ind$coord[para3,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist3,1],res.pca$ind$coord[dist3,2],col="blue",cex=1,pch=16)
points(res.pca$ind$coord[para4,1],res.pca$ind$coord[para4,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist4,1],res.pca$ind$coord[dist4,2],col="purple",cex=1,pch=16)
points(res.pca$ind$coord[para5,1],res.pca$ind$coord[para5,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist5,1],res.pca$ind$coord[dist5,2],col="yellow",cex=1,pch=16)
```



2.4.3 Partition quality

```
((res.hcpc$call$t$within[1]-res.hcpc$call$t$within[5])/res.hcpc$call$t$within[1])*100
```

2.4.3.1 Gain in inertia (in %)

```
## [1] 57.95468
```

The quality of this reduction is 57.95%.

If we want to achieve more than 80% of representativeness in clustering, we would need 15 clusters.

```
((res.hcpc$call$t$within[1]-res.hcpc$call$t$within[15])/res.hcpc$call$t$within[1])*100
```

```
## [1] 80.5347
```

2.4.4 Save the results into dataframe

```
res.hcpc$call$t$inert.gain[1:5]
```

```
## [1] 1.1683749 0.8050985 0.5840068 0.3402535 0.2214134
```

```
df$hcpck<-res.hcpc$data.clust$clust
```

---

3 CA analysis

3.1 Are there any row categories that can be combined/avoided to explain the discretization of the numeric target.

3.1.1 CA analysis for your data should contain your factor version of the numeric target (previous) in K= 7 (maximum 10) levels and 2 factors.

The first thing we need to do is re-factor our numeric target variable in 7 levels.

```
df$f.price<-factor(cut(df$price/1000,breaks=c(0,10,15,20,26,35,90),include.lowest = T ))
table(df$f.price)
```

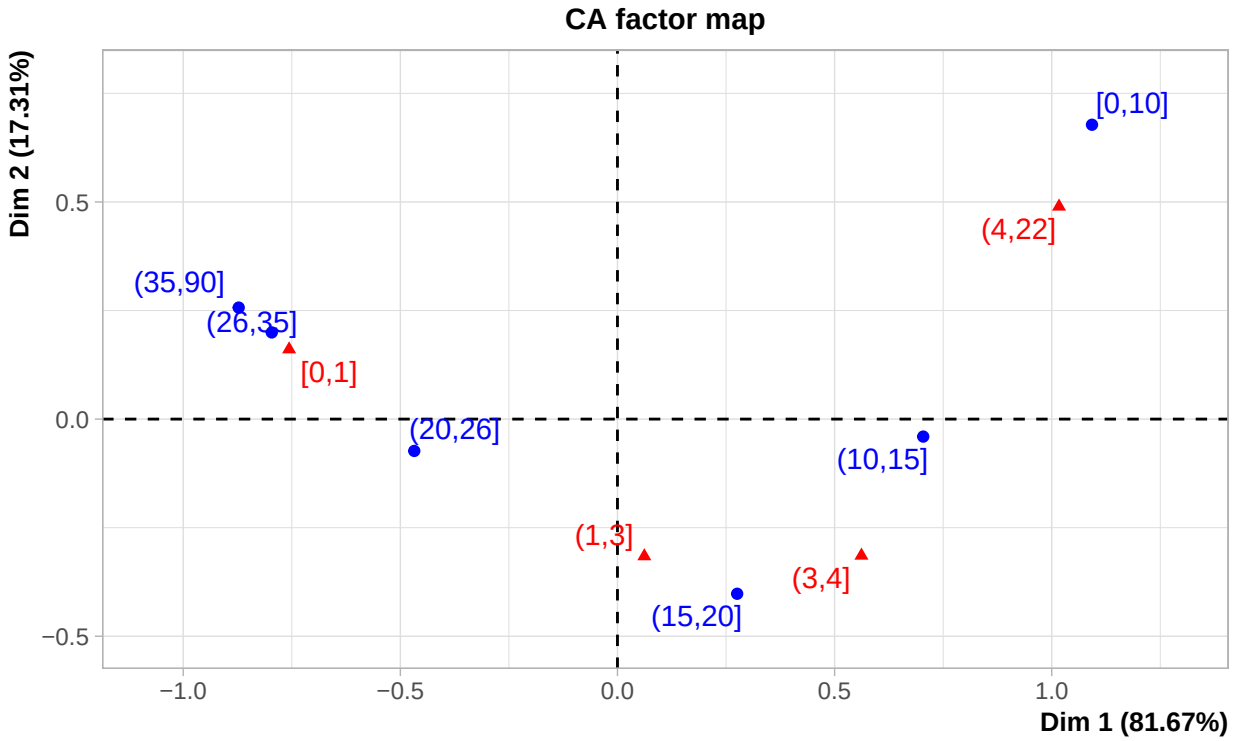
```
##
##  [0,10] (10,15] (15,20] (20,26] (26,35] (35,90]
##     464     993    1160    1081     832     410
```

Once we have the new factor we create a variable that associates price with age.

```
tt<-table(df[,c("f.price","auxAge")])
chisq.test(tt)
```

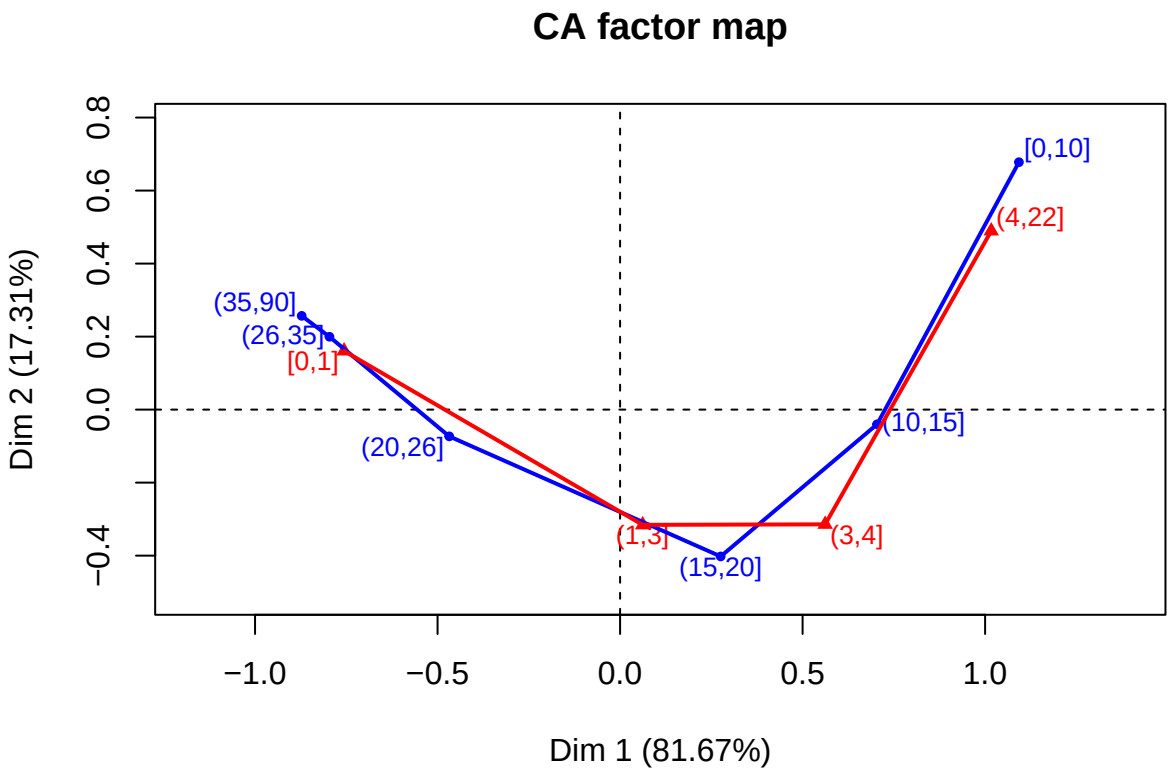
```
##
##  Pearson's Chi-squared test
##
## data:  tt
## X-squared = 2706.4, df = 15, p-value < 2.2e-16
```

```
res.ca <- CA(tt)
```



Since we get a p-value smaller than 0.05 we can say that there is a dependence between price and age.

```r
plot( res.ca, cex=0.8, graph.type = "classic" )
lines( res.ca$row$coord[,1], res.ca$row$coord[,2], col="blue", lwd = 2 )
lines( res.ca$col$coord[,1], res.ca$col$coord[,2], col="red", lwd = 2 )
```



3.2 Eigenvalues and dominant axes analysis. How many axes we have to consider?

```r
mean(res.ca$eig[,1])
```

```
## [1] 0.1826173
```

Following the kaiser criteria and the value of the output, we should retain dimensions with a variance higher than 0.1826173. In this case the first dimensions fulfills this because it's variance is higher but we will need more dimensions in order to work with the data.

---

4 MCA analysis

First, we load the libraries we'll use:

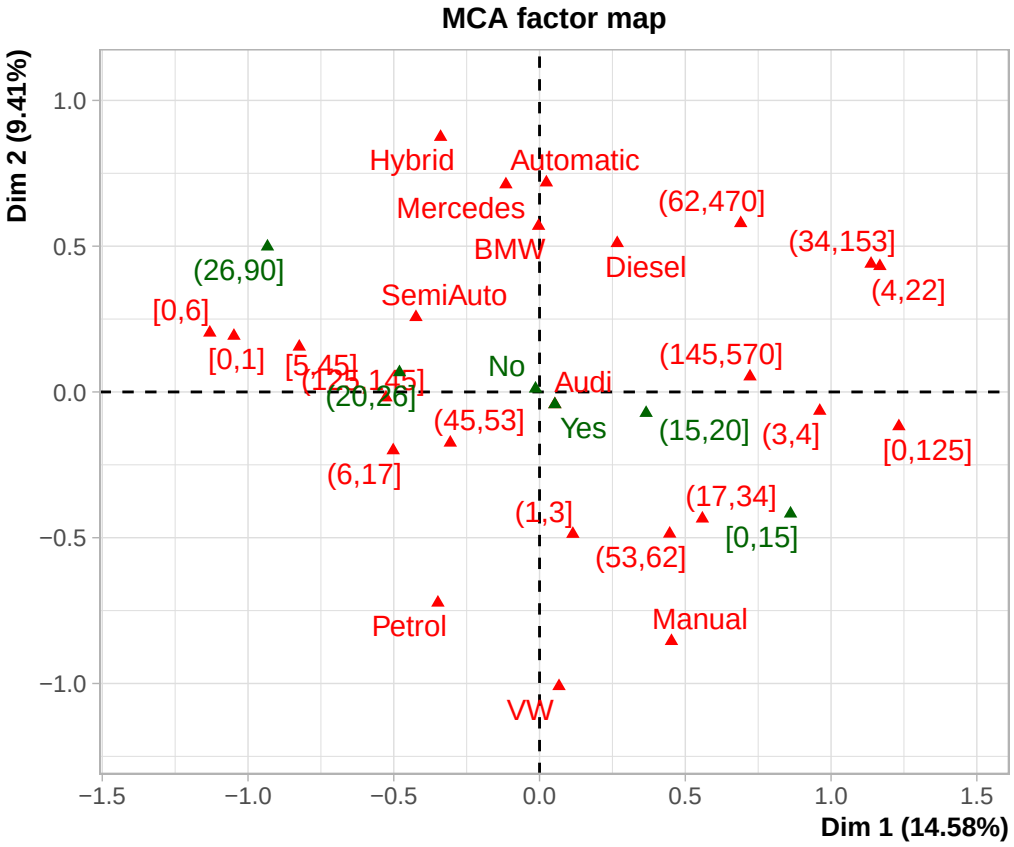
```r
library(FactoMineR)
library(factoextra)
```

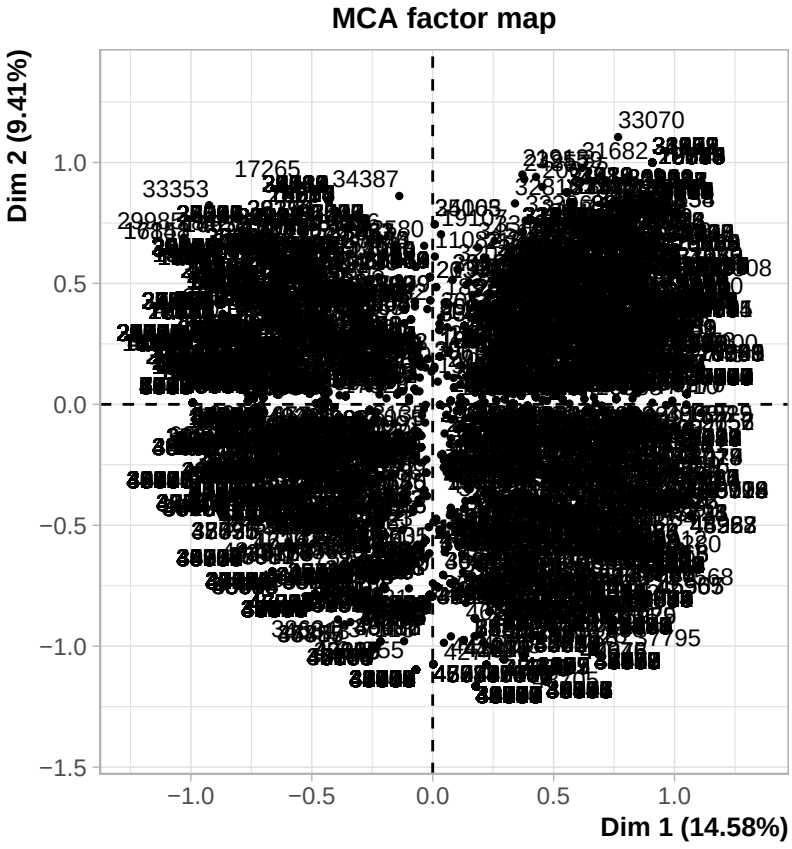
Now, we can start computing the MCA for our categorical variables:

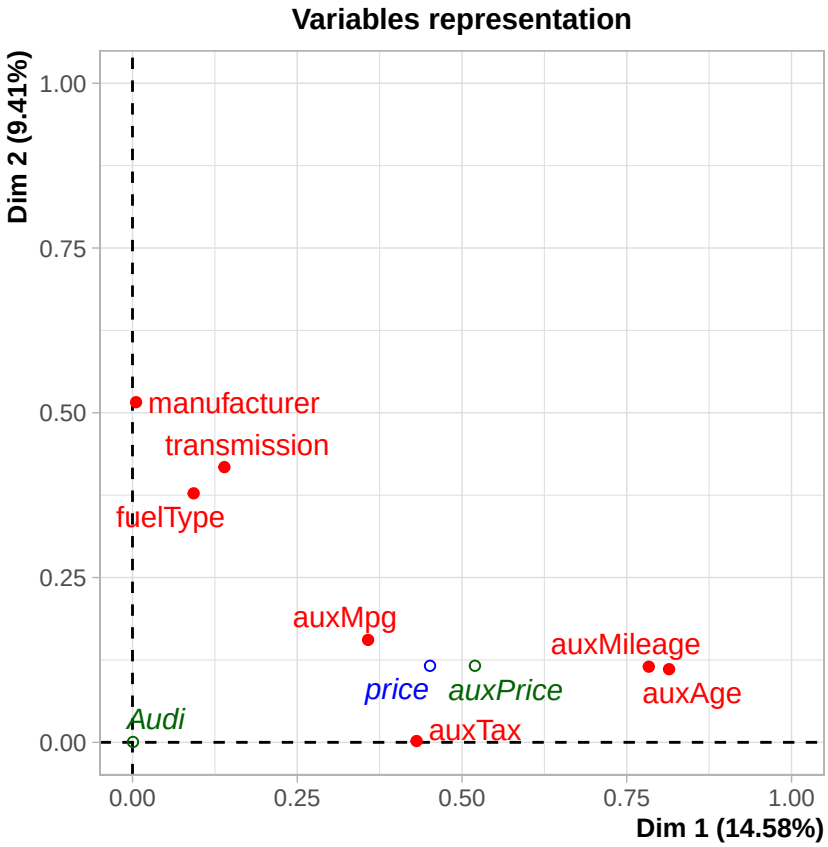
```r
names(df[,c("auxPrice","Audi",vars_dis[c(3:5,7:10)],"price")])
```

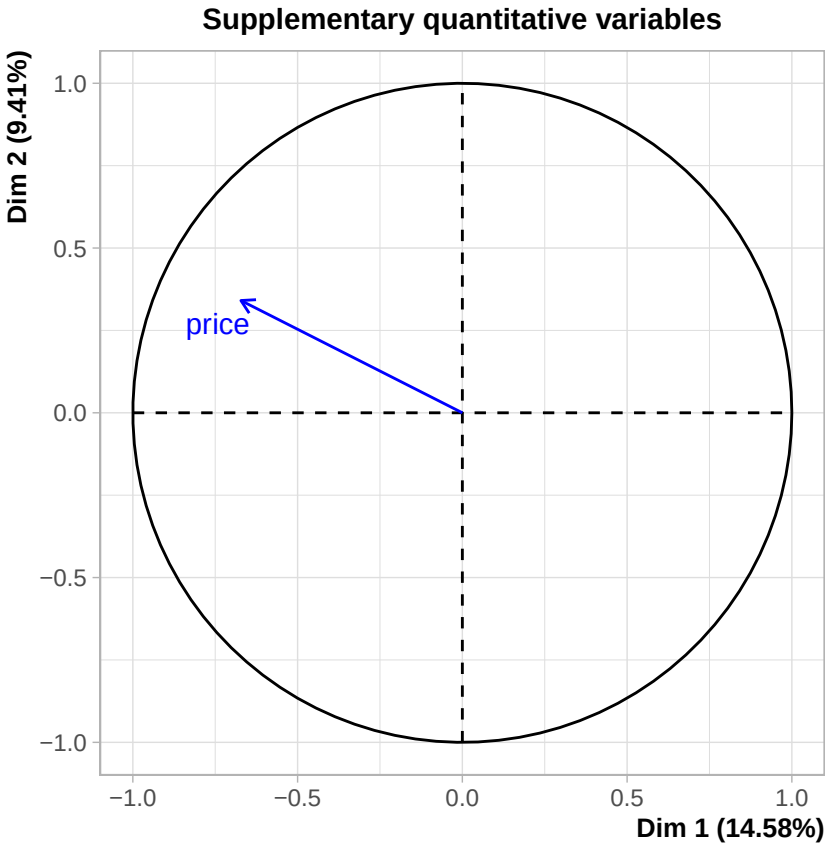
```
##  [1] "auxPrice"     "Audi"         "transmission" "fuelType"     "manufacturer"
##  [6] "auxTax"       "auxMileage"   "auxMpg"       "auxAge"       "price"
```

```
res.mca<-MCA(df[,c("auxPrice","Audi",vars_dis[c(3:5,7:10)],"price")],quali.sup=c(1,2),quanti.sup=10)
```



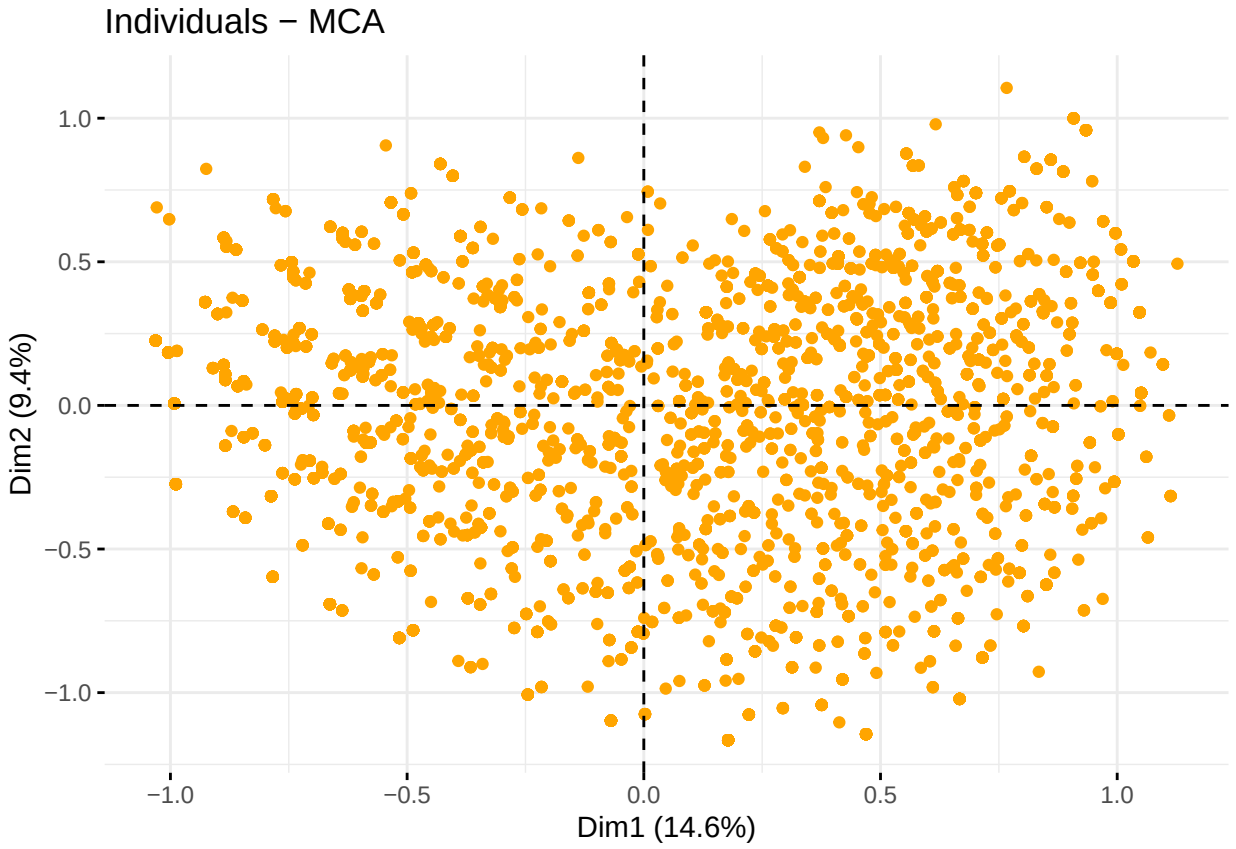






Cloud of individuals:

```
fviz_mca_ind(res.mca,geom=c("point"),col.ind="orange")
```



4.1 Eigenvalues and dominant axes analysis

How many axes we have to consider for next Hierarchical Classification stage?

We consider, according to the generalized Kaiser theorem, all those dimensions such that their eigenvalue is greater than the mean.

```
mean(res.mca$eig[,1])
```

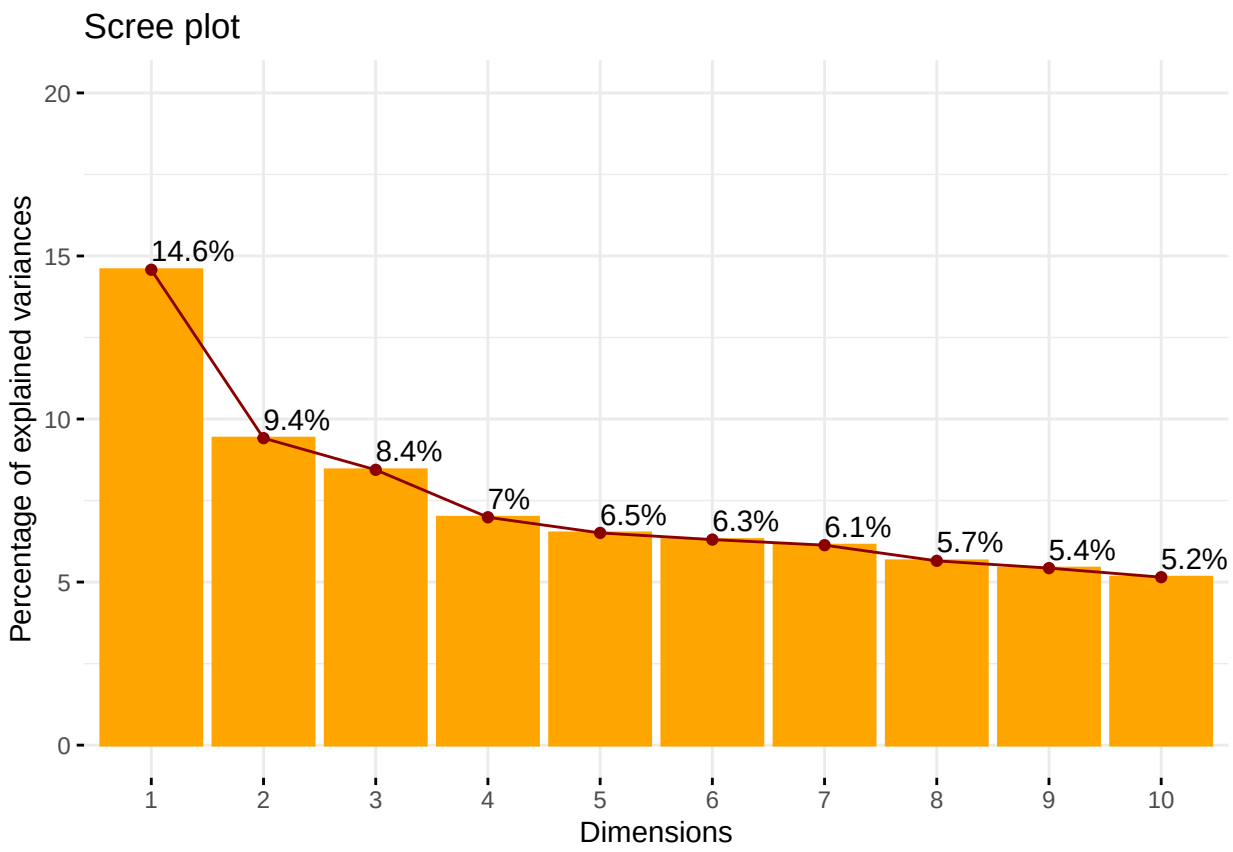
```
## [1] 0.1428571
```

```
head(get_eigenvalue(res.mca), 10)
```

```
##        eigenvalue variance.percent cumulative.variance.percent
## Dim.1   0.3748376        14.577018                    14.57702
## Dim.2   0.2420781         9.414147                    23.99117
## Dim.3   0.2170884         8.442326                    32.43349
## Dim.4   0.1796756         6.987385                    39.42088
## Dim.5   0.1673362         6.507521                    45.92840
## Dim.6   0.1620861         6.303350                    52.23175
## Dim.7   0.1576848         6.132188                    58.36394
## Dim.8   0.1453314         5.651778                    64.01571
## Dim.9   0.1395946         5.428677                    69.44439
## Dim.10  0.1324390         5.150406                    74.59480
```

We see that the average gives us 0.1428571. Therefore, we will take up to dimension 8, which represents the 64.01% of the sample. If we wanted to arrive to the 80% of inertia we would need to take 12 dimensions. We can also visualize the percentages of inertia explained by each MCA dimensions:

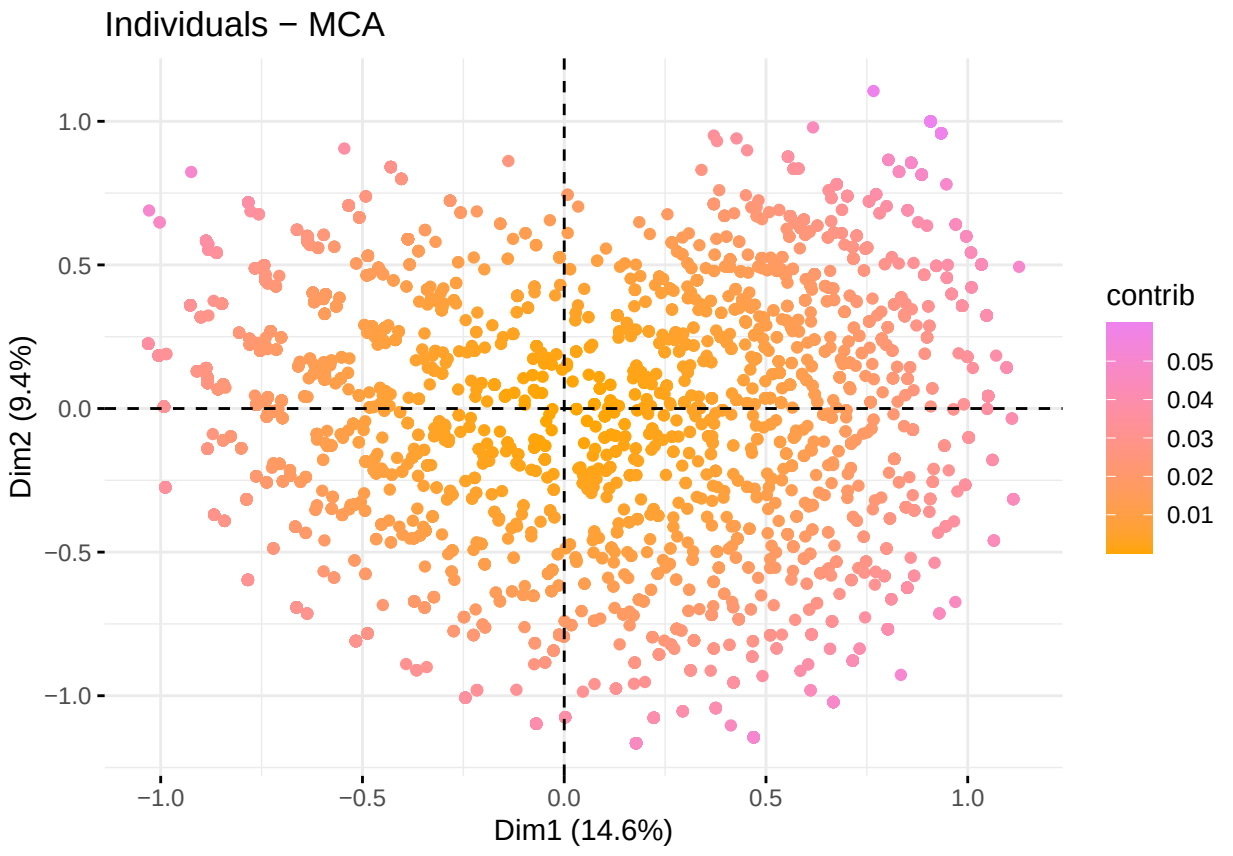
```
fviz_screeplot(res.mca,addlabels=TRUE,ylim=c(0,20),barfill="orange",barcolor="orange",linecolor="darkred
```



4.2 Individuals point of view

Are they any individuals "too contributive"?

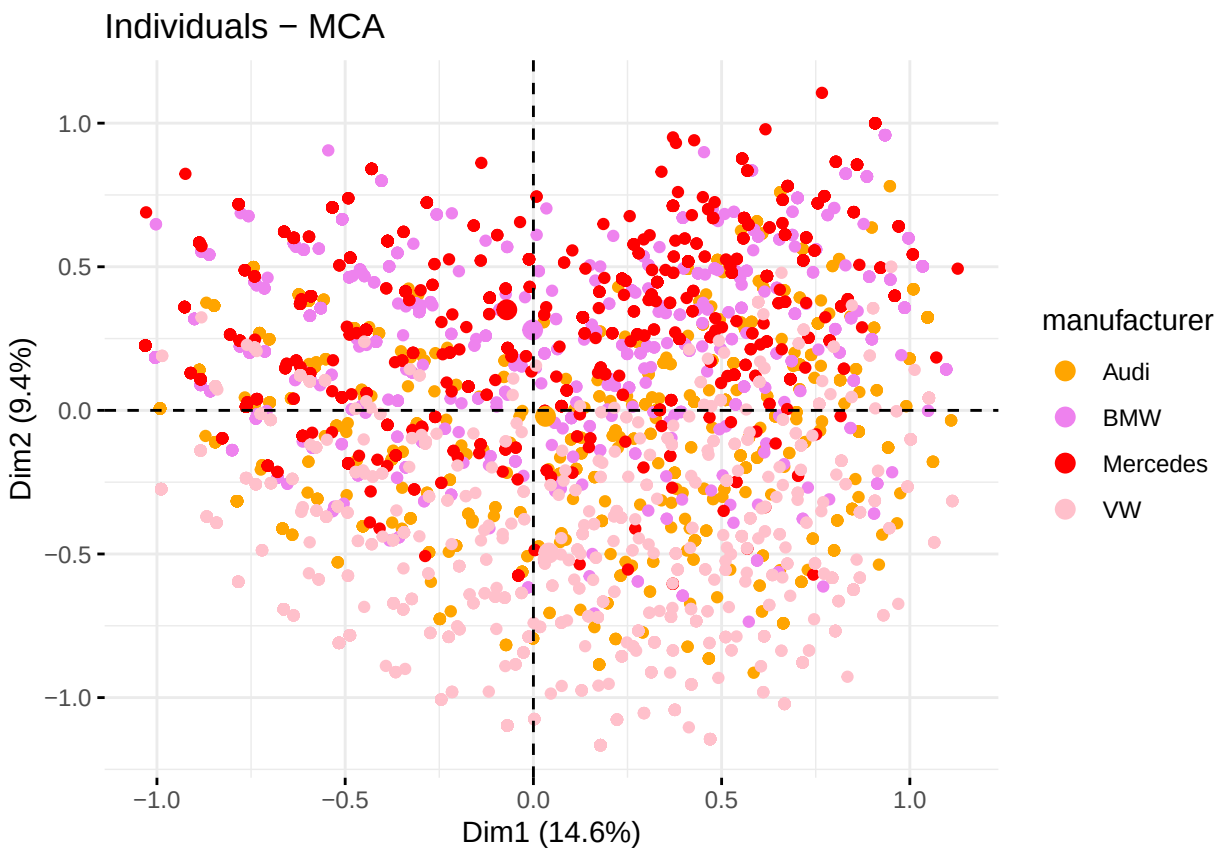
```
fviz_mca_ind(res.mca, geom=c("point"),col.ind="contrib", gradient.cols=c("orange", "violet"))
```



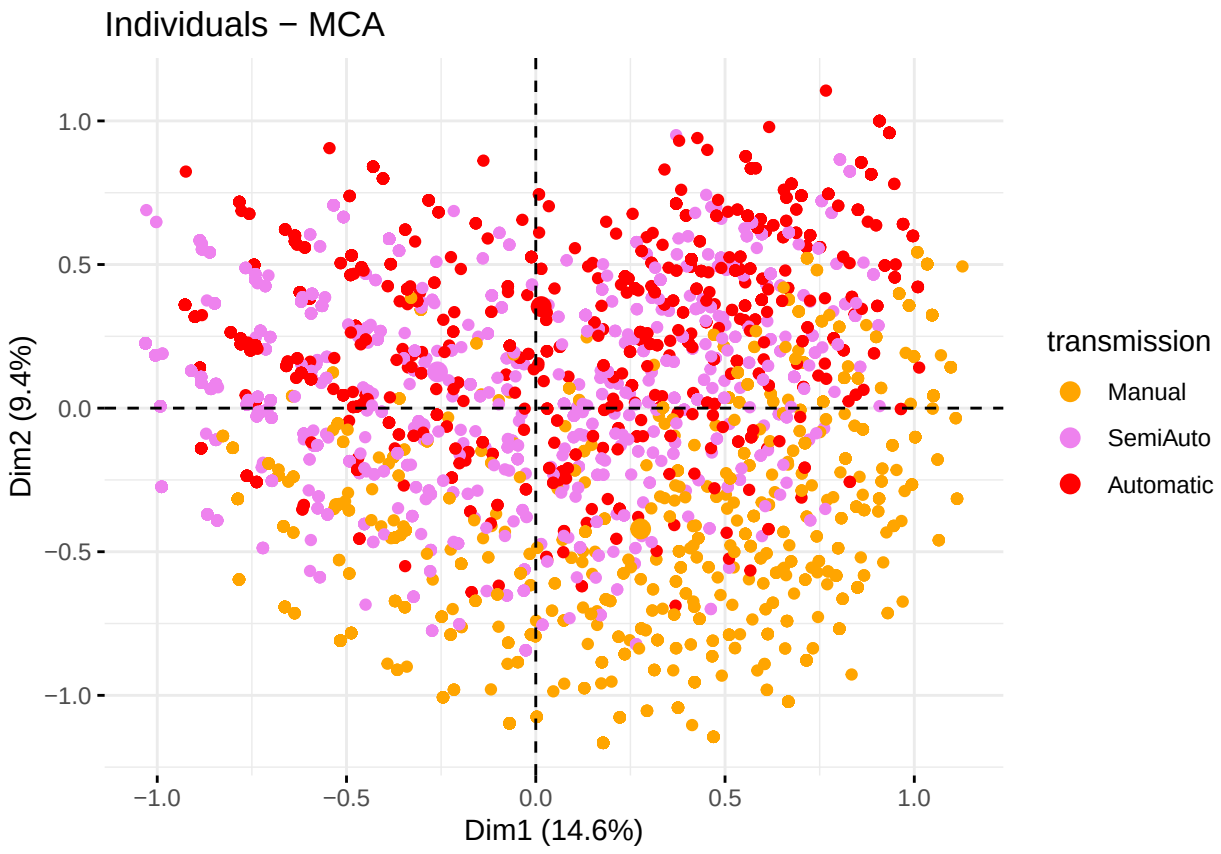
We can see there are some individuals that are more contributive than others.

Are there any groups?

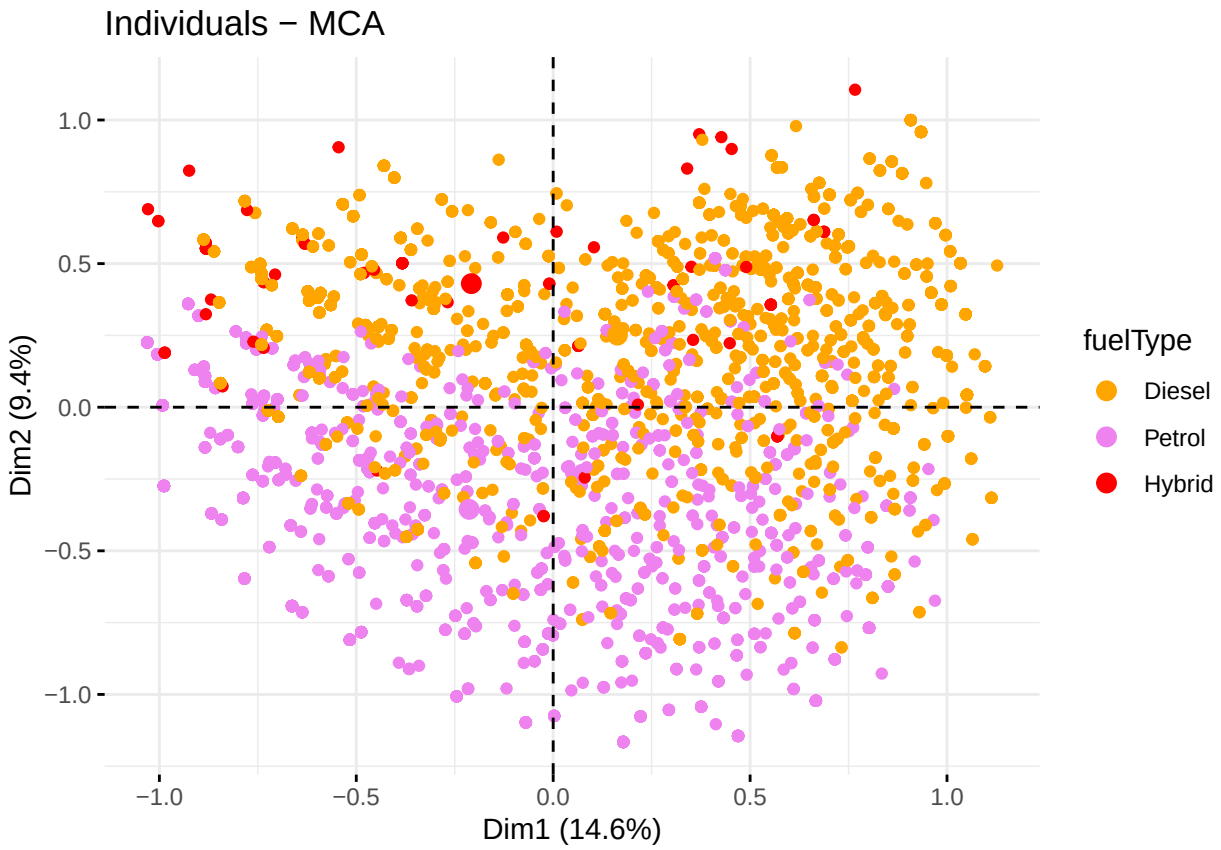
```
fviz_mca_ind(res.mca, label="none", habillage="manufacturer", palette=c("orange", "violet","red","pink"))
```




```
fviz_mca_ind(res.mca, label="none", habillage="transmission", palette=c("orange", "violet","red"))
```



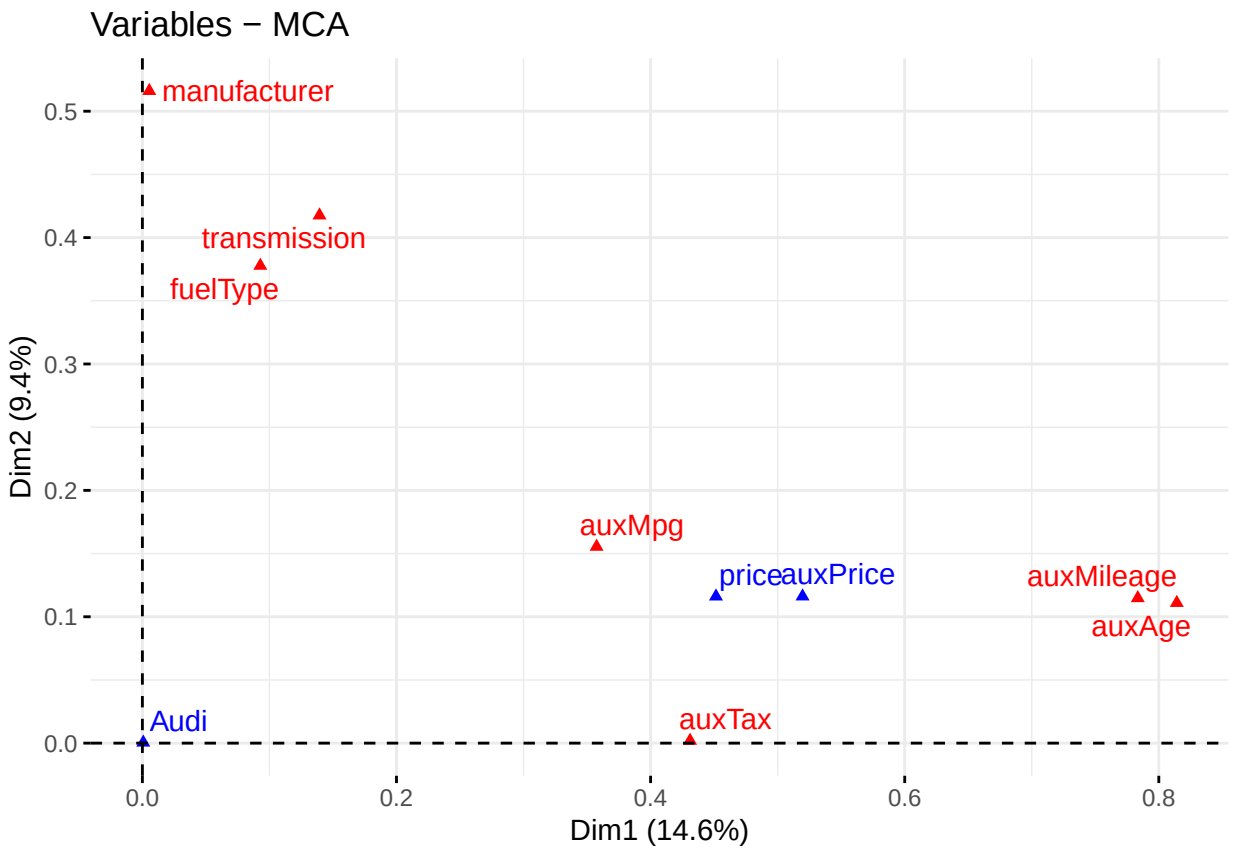
```
fviz_mca_ind(res.mca, label="none", habillage="fuelType", palette=c("orange", "violet","red"))
```



We can see there don't seem to be any clear groups but some tendencies exists.

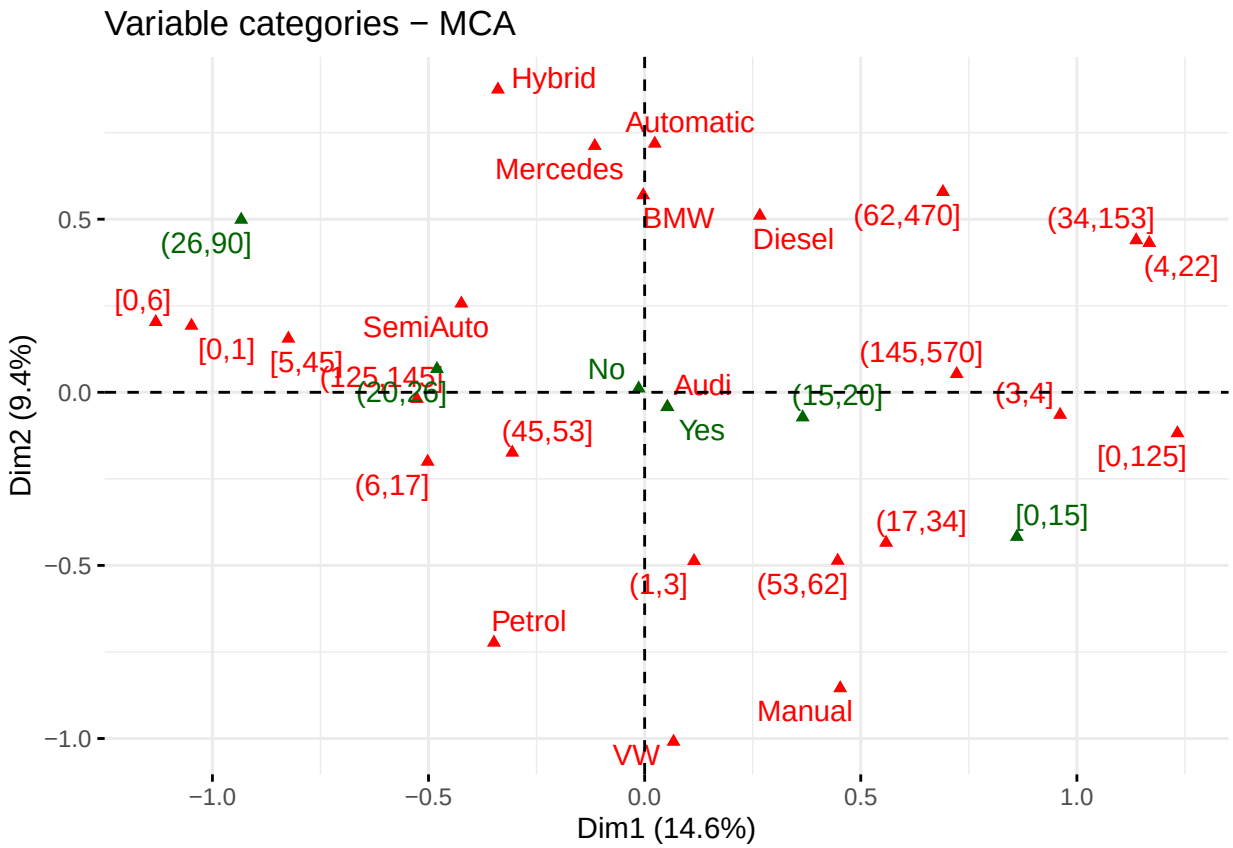
4.3 Interpreting map of categories: average profile versus extreme profiles (rare categories)

```
fviz_mca_var(res.mca, choice="mca.cor", repel=TRUE)
```



Now, let's analyze the categories.

```
fviz_mca_var(res.mca, repel=TRUE)
```



4.4 Interpreting the axes association to factor map

```
res.desc <- dimdesc(res.mca, axes = c(1,2))
```

4.4.1 Description of dimension 1

```
res.desc[[1]] #annex res.desc[[1]]mca
```

There is no information for the quantitative variables in the first dimension. We can see that the most positively related qualitative variables are **auxAge** and **auxMileage**. For the categories the most related is **auxMileage=(34,153]** ### Description of dimension 2

```
res.desc[[2]] #annex res.desc[[2]]mca
```

There is no information for the quantitative variables in the second dimension. We can see that the most positively related qualitative variables are **manufacturer** and **transmission**. For the categories the most positively related is **transmission=Automatic** and negatively **manufacturer=VW**.

4.5 Perform a MCA taking into account also supplementary variables (use all numeric variables) quantitative and/or categorical. How supplementary variables enhance the axis interpretation?

```
res.mca <- MCA(df[,c(3:17)],quanti.sup=c("price",vars_con),quali.sup=c(10,15),graph=FALSE)
```

4.5.1 Description of dimension 1

```
res.desc <- dimdesc(res.mca, axes = c(1,2))
res.desc[[1]] #annex res.desc[[1]]mca2
```

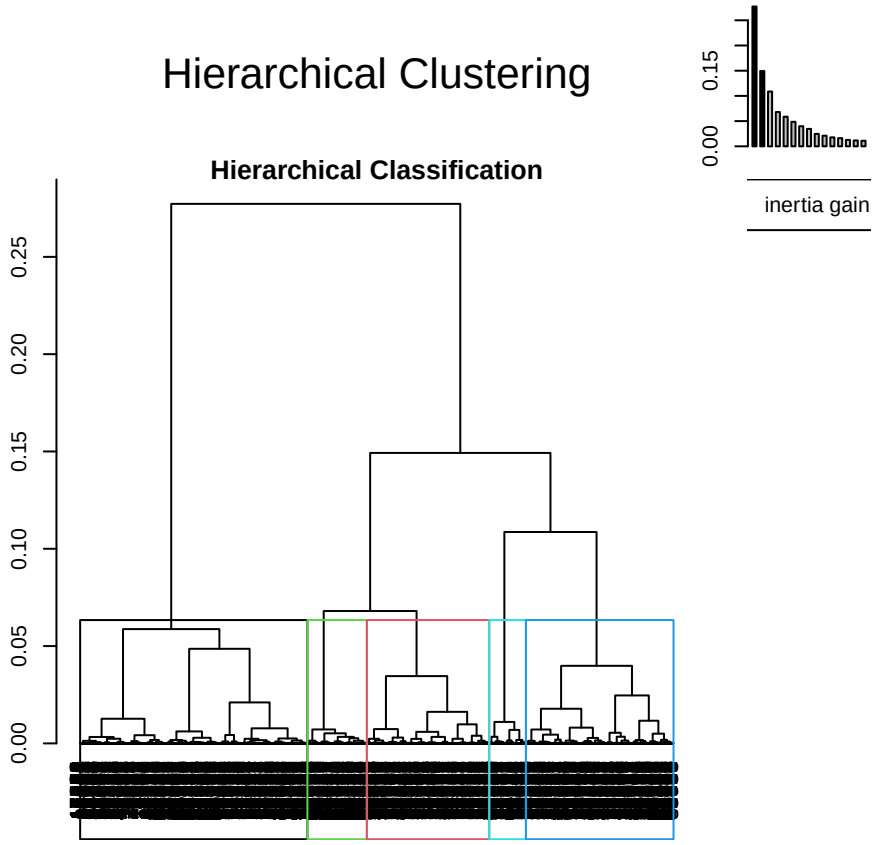
Now that we take into account quantitative variables we have information on them. In this first dimension the most positevely related are **age** and **mileage**. There are some slight chances in the relationships of qualitative variables and categories. ### Description of dimension 2

```
res.desc[[2]] #annex res.desc[[2]]mca2
```

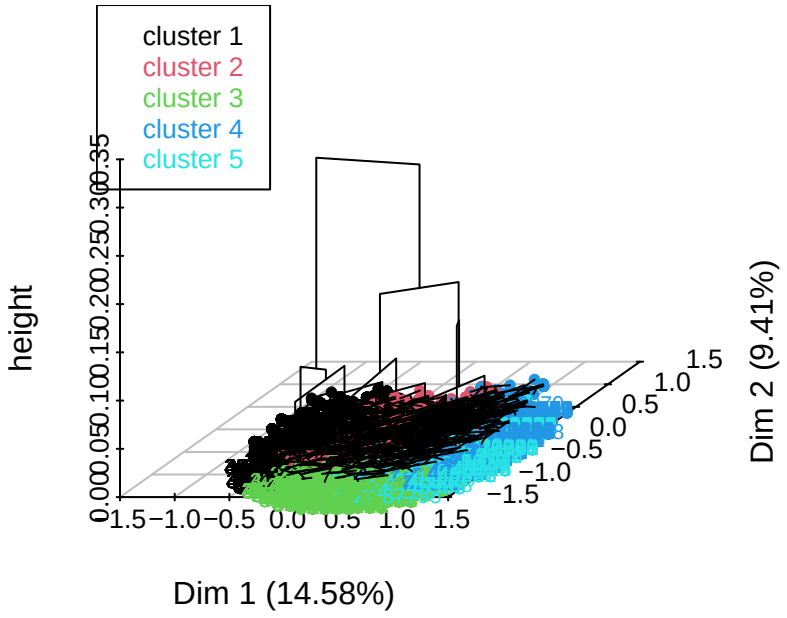
In this second dimension the most positevely related quantitative variable is **engineSize**. There are some slight chances in the relationships of qualitative variables and categories.

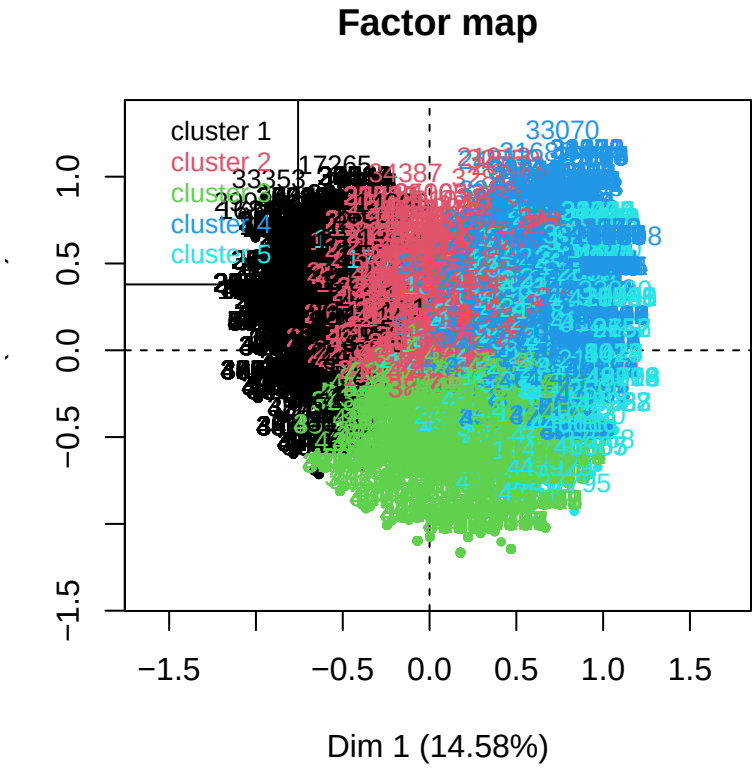
5 Hierarchical Clustering (from MCA)

```
res.hcpcMCA <- HCPC(res.mca,nb.clust = 5, order = TRUE)
```



Hierarchical clustering on the factor map





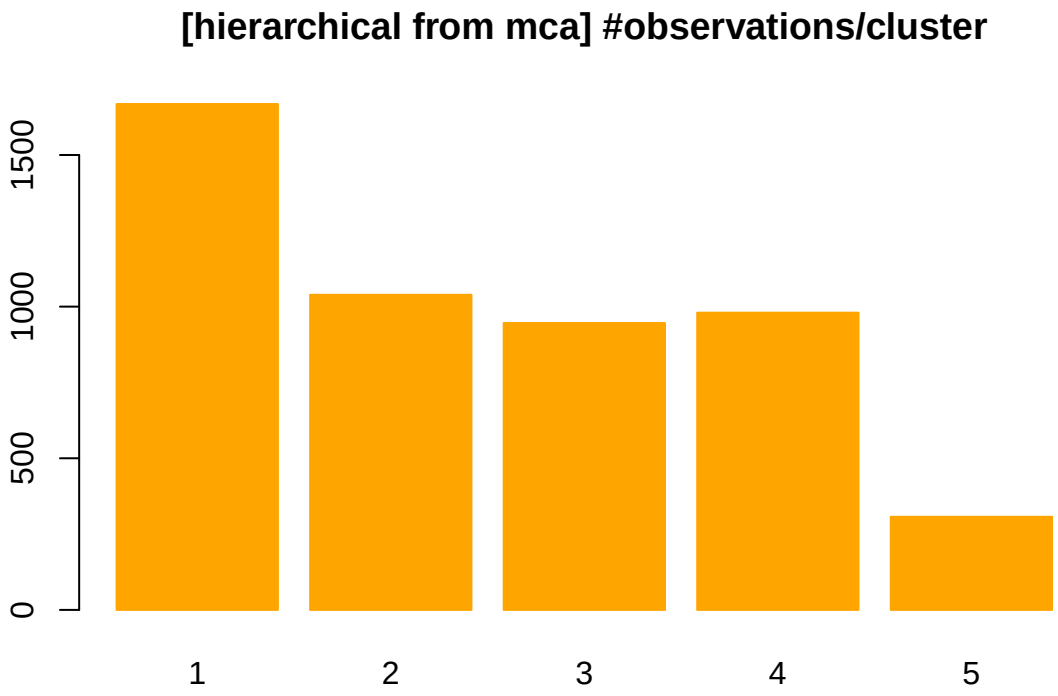
5.1 Description of clusters

Number of observations in each cluster:

```
table(res.hcpcMCA$data.clust$clust)
```

```
##
##    1    2    3    4    5
## 1668 1039  946  980  307
```

```
barplot(table(res.hcpcMCA$data.clust$clust), col="orange", border="orange", main="[hierarchical from mca
```



5.2 Interpret the results of the classification

5.2.1 The description of the clusters by the variables

```
names(res.hcpcMCA$desc.var)
```

```
## [1] "test.chi2"  "category"   "quanti.var" "quanti"     "call"
```

```
res.hcpcMCA$desc.var$test.chi2   # categorical variables which characterizes the clusters
```

```
##                    p.value df
## manufacturer  0.000000e+00 12
## auxPrice      0.000000e+00 12
## auxTax        0.000000e+00  8
## auxMileage    0.000000e+00 12
## auxMpg        0.000000e+00 12
## auxAge        0.000000e+00 12
## transmission 2.038717e-298  8
## fuelType     8.301857e-244  8
## Audi          9.613419e-30  4
```

A small p value (close to zero) indicates that there is a significant association between the variable and the clusters. In this case the variables that affect more to the clustering are manufacturer, auxPrice, auxTax, auxMileage, auxMpg and auxAge.

```
res.hcpcMCA$desc.var$category #description of each cluster by the categories #annex res.hcpcMCA$desc.va
```

- Cluster 1: +This first cluster seems to have younger cars with 96.34% of observation being of category **auxAge=[0,1]** and 93.92 of observations of **auxMileage=[0,6]** being in this cluster.
- Cluster 2: +We notice that 81.71% observations of this cluster are **fuelType=Diesel** and 69% are of **auxTax=(125,145]**.

- Cluster 3: +We can see that **manufacturer=VW** has 76.84% of the observations in this cluster also 79.38% are of **fuelType=Petrol**.
- Cluster 4: +We observe that 85.30% of observations of this cluster are **auxMileage=(34,153]**, also 81.32% are **auxTax=(145,570]** and finally 78.16% are **fuelType=Diesel**.
- Cluster 5: +In this final cluster we see that almost all observations of **auxTax=[0,125]** (98.20%) are in this cluster and 77.85% of the observations in this cluster are of category **auxMpg=(53,62]**.

We now proceed to see the quantitative variables that characterizes the clusters.

```
res.hcpcMCA$desc.var$quanti.var  # quantitative variables which characterizes the clusters
```

```
##                  Eta2       P-value
## price       0.4499508  0.000000e+00
## mileage     0.6726980  0.000000e+00
## tax         0.3085065  0.000000e+00
## age         0.7109479  0.000000e+00
## mpg         0.2375306 1.420959e-288
## engineSize 0.1999311 4.580315e-237
```

We can see that all quantitative variables are overrepresented. We want to know now which variables are associated with the quantitative variables.

```
res.hcpcMCA$desc.var$quanti #description of each cluster by the quantitative variables
#annex res.hcpcMCA$desc.var$quanti
```

5.2.2 Partition quality

We are going to evaluate the partition quality.

```
((res.hcpcMCA$call$t$within[1]-res.hcpcMCA$call$t$within[5])/res.hcpcMCA$call$t$within[1])*100
```

5.2.2.1 Gain in inertia (in %)

```
## [1] 51.06823
```

The quality of this reduction if of 51.06%.

In case we wanted to achieve an 80% of the clustering representativeness we would need 22 clusters.

```
((res.hcpcMCA$call$t$within[1]-res.hcpcMCA$call$t$within[22])/res.hcpcMCA$call$t$within[1])*100
```

```
## [1] 80.19945
```

5.3 Parangons and class-specific individuals.

5.3.1 The description of the clusters by the individuals

```
res.hcpcMCA$desc.ind$para  # representative individuals of each cluster
```

```
## Cluster: 1
##     23427     24338     40410     45120     45297
## 0.2033380 0.2033380 0.2266262 0.2266262 0.2266262
## ------------------------------------------------------------
## Cluster: 2
```

```
##     23031     25391     27224     22003     22010
## 0.1653288 0.1653288 0.1653288 0.3046122 0.3046122
## ------------------------------------------------------------
## Cluster: 3
##     16748     16983     18842      1183     14139
## 0.2493155 0.2493155 0.2493155 0.2651314 0.2731218
## ------------------------------------------------------------
## Cluster: 4
##      3042      8174      9169      9852       384
## 0.3156060 0.3156060 0.3156060 0.3156060 0.3217222
## ------------------------------------------------------------
## Cluster: 5
##      8240     29798      1399      4842      7817
## 0.2224384 0.3240772 0.3399463 0.3399463 0.3399463
```

What we obtain are the more representative individuals, paragons, for each cluster. We get the rownames of each paragon in every single cluster.

```
res.hcpcMCA$desc.ind$dist  # individuals distant from each cluster
```

```
## Cluster: 1
##    18427    16841    17158      348      696
## 1.686617 1.661347 1.661347 1.661321 1.661321
## ------------------------------------------------------------
## Cluster: 2
##    22079    27109    21485    21902    22821
## 1.666508 1.666508 1.511530 1.511530 1.511530
## ------------------------------------------------------------
## Cluster: 3
##      326     3242     3427     9715    36125
## 1.552028 1.552028 1.552028 1.552028 1.463114
## ------------------------------------------------------------
## Cluster: 4
##     2415     7983     8916     9734     9880
## 1.763676 1.763676 1.763676 1.763676 1.763676
## ------------------------------------------------------------
## Cluster: 5
##    10681    10768    18397    20134    20970
## 1.879565 1.879565 1.879565 1.879565 1.879565
```

What we acquire are the individuals within each cluster that are significantly distant from the rest of the individuals within the same cluster. Additionally, we retrieve the row names of each individual with a greater distance compared to the others in the cluster.

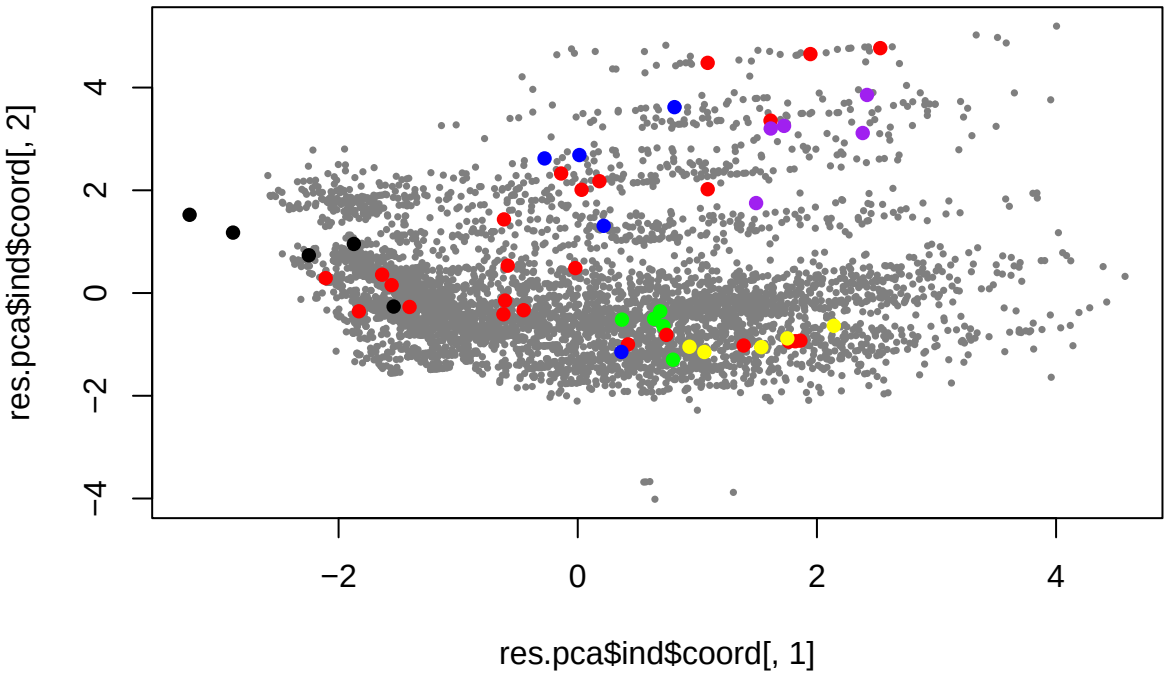
5.3.1.1 Examine the values of individuals that characterize classes

We get the graphical representation for the individuals that characterize classes (para and dist).

```
para1<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$para[[1]]))
dist1<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$dist[[1]]))
para2<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$para[[2]]))
dist2<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$dist[[2]]))
para3<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$para[[3]]))
dist3<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$dist[[3]]))
para4<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$para[[4]]))
dist4<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$dist[[4]]))
para5<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$para[[5]]))
dist5<-which(rownames(res.mca$ind$coord)%in%names(res.hcpcMCA$desc.ind$dist[[5]]))

plot(res.pca$ind$coord[,1],res.pca$ind$coord[,2],col="grey50",cex=0.5,pch=16)
points(res.pca$ind$coord[para1,1],res.pca$ind$coord[para1,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist1,1],res.pca$ind$coord[dist1,2],col="black",cex=1,pch=16)
points(res.pca$ind$coord[para2,1],res.pca$ind$coord[para2,2],col="red",cex=1,pch=16)
```

```
points(res.pca$ind$coord[dist2,1],res.pca$ind$coord[dist2,2],col="green",cex=1,pch=16)
points(res.pca$ind$coord[para3,1],res.pca$ind$coord[para3,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist3,1],res.pca$ind$coord[dist3,2],col="blue",cex=1,pch=16)
points(res.pca$ind$coord[para4,1],res.pca$ind$coord[para4,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist4,1],res.pca$ind$coord[dist4,2],col="purple",cex=1,pch=16)
points(res.pca$ind$coord[para5,1],res.pca$ind$coord[para5,2],col="red",cex=1,pch=16)
points(res.pca$ind$coord[dist5,1],res.pca$ind$coord[dist5,2],col="yellow",cex=1,pch=16)
```



5.4 Comparison of clusters obtained after K-Means (based on PCA) and/or Hierarchical Clustering (based on PCA)

5.4.1 Comparison of clusters (confusion table)

We want to compare the hierarchical clustering, previously done, and the k-means clustering, so proceed to do the following.

```
table(df$hcpck,df$claKM)
```

```
##
##        1    2    3    4    5
##   1  122    0   26    0 1550
##   2  439    6   15   87    6
##   3    6   95 1267    2  179
##   4    0    0    0  131    0
##   5    6  721  183   99    0
```

```
df$hcpck<-factor(df$hcpck,labels=c("kHP-1","kHP-2","kHP-3","kHP-4","kHP-5"))
df$claKM<-factor(df$claKM,levels=c(3,5,2,1,4),labels=c("kKM-3","kKM-5","kKM-2","kKM-1","kKM-4"))
tt<-table(df$hcpck,df$claKM); tt
```

```
##
##         kKM-3 kKM-5 kKM-2 kKM-1 kKM-4
```

```
##   kHP-1    26  1550     0   122     0
##   kHP-2    15     6     6   439    87
##   kHP-3  1267   179    95     6     2
##   kHP-4     0     0     0     0   131
##   kHP-5   183     0   721     6    99
```

```
100*sum(diag(tt)/sum(tt))
```

```
## [1] 4.574899
```

```
df$hcpckMCA<-res.hcpcMCA$data.clust$clust

# With Hierarchical Clustering (PCA)
table(df$hcpck,df$hcpckMCA)
```

```
##
##            1    2    3    4    5
##   kHP-1 1331  133  232    1    1
##   kHP-2  245  185   13  108    2
##   kHP-3   89  621  614   91  134
##   kHP-4    0   29   13   89    0
##   kHP-5    3   71   74  691  170
```

```
df$hcpckMCA_hcpck<-factor(
  df$hcpckMCA,
  levels=c(4,3,2,1,5),
  labels=c("kHPmca-4","kHPmca-3","kHPmca-2","kHPmca-1","kHPmca-5")
)
tt1<-table(df$hcpck,df$hcpckMCA_hcpck); tt
```

```
##
##         kKM-3 kKM-5 kKM-2 kKM-1 kKM-4
##   kHP-1    26  1550     0   122     0
##   kHP-2    15     6     6   439    87
##   kHP-3  1267   179    95     6     2
##   kHP-4     0     0     0     0   131
##   kHP-5   183     0   721     6    99
```

```
100*sum(diag(tt1)/sum(tt1))
```

```
## [1] 16.29555
```

We have a concordance of the 16.29% so we can say that they are different, if we had a greater concordance, this would mean that they would be more similar.

```
# With k-means (PCA)
table(df$claKM, df$hcpckMCA)
```

```
##
##            1    2    3    4    5
##   kKM-3    6  545  631  110  199
##   kKM-5 1304  204  225    0    2
##   kKM-2    3   83   59  576  101
##   kKM-1  353  173   17   30    0
##   kKM-4    2   34   14  264    5
```

```
df$hcpckMCA_claKM<-factor(
  df$hcpckMCA,
  levels=c(2,3,1,4,5),
  labels=c("kHPmca-2","kHPmca-3","kHPmca-1","kHPmca-4","kHPmca-5")
)
tt2<-table(df$claKM,df$hcpckMCA_claKM); tt2
```

```
##
##         kHPmca-2 kHPmca-3 kHPmca-1 kHPmca-4 kHPmca-5
##   kKM-3      545      631        6      110      199
##   kKM-5      204      225     1304        0        2
##   kKM-2       83       59        3      576      101
##   kKM-1      173       17      353       30        0
##   kKM-4       34       14        2      264        5
```

```
100*sum(diag(tt2)/sum(tt2))
```

```
## [1] 16.35628
```

Concordance of the 23.17%.

5.4.2 Quantitative target (price)

- hcpc

```
#res.hcpc$desc.var$quanti.var  # quantitative variables which characterizes the clusters
# #               Eta2       P-value
# # price      0.4883890       0
```

- kmeans

```
#res.cat
#Link between the cluster variable and the quantitative variables
#=================================================================
#                Eta2 P-value
#price      0.5341522       0
```

- hcpc_mca

```
#res.hcpcMCA$desc.var$quanti.var  # quantitative variables which characterizes the clusters
#               Eta2       P-value
#price      0.4499508  0.000000e+00
```

5.4.2.1 Comment To compare the variable Total_amount in the three different classifications, we will look at Eta2:

- The closer to 1 is eta2 for a variable, the better the variance between groups is explained by this variable.
- We can see that, in descending order, we have:
  - k-means (0.53)
  - hcpc (0.48)
  - hcpc_mca (0.44)

5.4.3 Binary target (Audi)

```
#res.hcpc$desc.var$category    # description of each cluster by the categories
# # $`1`
# # There's nothing in this cluster.
# #
# # $`2`
# # There's nothing in this cluster.
# #
# # $`3`
```

```
# #                                Cla/Mod    Mod/Cla    Global
# # Audi=Yes                    24.9272551 16.5913493 20.8704453
# # Audi=No                     33.0519314 83.4086507 79.1295547
# #
# # $`4`
# #                                Cla/Mod   Mod/Cla    Global
# # Audi=Yes                     4.9466537  38.9312977 20.87044534
# # Audi=No                      2.0465592  61.0687023 79.12955466
# #
# # $`5`
# #                                Cla/Mod   Mod/Cla    Global
# # Audi=Yes                    23.1813773 23.68681863 20.87044534
# # Audi=No                     19.6981325 76.31318137 79.12955466
```

5.4.3.1 hcpc

```
# res.cat
# #
# # Description of each cluster by the categories
# # ============================================
# # $`1`
# # There's nothing in this cluster.
# #
# # $`2`
# #                                Cla/Mod    Mod/Cla    Global
# # Audi=Yes                     9.89330747 33.0097087 20.87044534
# # Audi=No                      5.29547199 66.9902913 79.12955466
# #
# # $`3`
# #                               Cla/Mod     Mod/Cla     Global
# # Audi=Yes                    26.576140 18.43876178 20.8704453
# # Audi=No                     31.005372 81.56123822 79.1295547
# #
# # $`4`
# #                                Cla/Mod    Mod/Cla     Global
# # Audi=Yes                    30.4558681 18.05635423 20.8704453
# # Audi=No                     36.4543361 81.94364577 79.1295547
# #
# # $`5`
# #                                Cla/Mod     Mod/Cla     Global
# # Audi=Yes                    14.0640155 24.9140893 20.87044534
# # Audi=No                     11.1793298 75.0859107 79.12955466
```

5.4.3.2 kmeans

```
#res.hcpcMCA$desc.var$category    # description of each cluster by the categories
# # $`1`
# #                              Cla/Mod   Mod/Cla     Global
# # Audi=Yes                 36.5664403 22.6019185 20.870445
# # Audi=No                  33.0263494 77.3980815 79.129555
# #
# # $`2`
# #                              Cla/Mod   Mod/Cla   Global
# # Audi=Yes                 11.057226 10.972089 20.870445
# # Audi=No                  23.663341 89.027911 79.129555
# #
# # $`3`
```

```
# # There's nothing in this cluster.
# #
# # $`4`
# #                            Cla/Mod   Mod/Cla     Global
# # Audi=Yes                30.0678952 31.6326531 20.870445
# # Audi=No                 17.1399335 68.3673469 79.129555
# #
# # $`5`
# #                            Cla/Mod   Mod/Cla    Global
# # Audi=Yes                 4.2677013 14.3322476 20.870445
# # Audi=No                  6.7280634 85.6677524 79.129555
```

5.4.3.3 hcpc_mca

5.4.3.4 Comment To compare the variable Audi in the three different classifications, we will look at Cla / Mod, Mod / Cla and Global.

6 Annex

6.1 K-means Classification

```
kc<-kmeans(dist, 5, iter.max=30, trace=TRUE)
```

```
## KMNS(*, k=5): iter=  1, indx=0
##  QTRAN(): istep=4940, icoun=2
##  QTRAN(): istep=9880, icoun=38
##  QTRAN(): istep=14820, icoun=16
##  QTRAN(): istep=19760, icoun=38
##  QTRAN(): istep=24700, icoun=375
##  QTRAN(): istep=29640, icoun=79
##  QTRAN(): istep=34580, icoun=146
##  QTRAN(): istep=39520, icoun=539
## KMNS(*, k=5): iter=  2, indx=9
##  QTRAN(): istep=4940, icoun=29
##  QTRAN(): istep=9880, icoun=7
##  QTRAN(): istep=14820, icoun=209
##  QTRAN(): istep=19760, icoun=0
##  QTRAN(): istep=24700, icoun=81
##  QTRAN(): istep=29640, icoun=111
##  QTRAN(): istep=34580, icoun=176
##  QTRAN(): istep=39520, icoun=186
##  QTRAN(): istep=44460, icoun=75
##  QTRAN(): istep=49400, icoun=1204
##  QTRAN(): istep=54340, icoun=2545
## KMNS(*, k=5): iter=  3, indx=417
##  QTRAN(): istep=4940, icoun=1115
##  QTRAN(): istep=9880, icoun=1747
## KMNS(*, k=5): iter=  4, indx=4940
```

6.2 K-means res.cat

```
res.cat
```

```
##
## Link between the cluster variable and the categorical variables (chi-square test)
## ================================================================================
##                    p.value  df
```

```
## model         0.000000e+00 360
## year          0.000000e+00  80
## auxPrice      0.000000e+00  12
## auxMileage    0.000000e+00  12
## auxMpg        0.000000e+00  12
## auxAge        0.000000e+00  12
## auxTax       9.791087e-318   8
## transmission 1.041560e-140   8
## fuelType      1.746898e-46   8
## manufacturer  1.104923e-36  12
## Audi          3.577801e-10   4
##
## Description of each cluster by the categories
## =============================================
## $`1`
##                                Cla/Mod    Mod/Cla      Global       p.value
## auxMpg=[5,45]               36.6368806 78.7085515 24.91902834 1.224385e-187
## auxPrice=(26,90]            36.3123994 78.7085515 25.14170040 1.245201e-185
## transmission=SemiAuto       18.5185185 61.0820244 38.25910931  6.649093e-32
## model=VW- Touareg           83.3333333  5.2356021  0.72874494  4.369791e-23
## auxAge=[0,1]                17.3148641 56.7190227 37.99595142  4.628755e-22
## model=Mercedes- GLE Class   63.7931034  6.4572426  1.17408907  2.828617e-21
## auxMileage=[0,6]            18.3898974 40.6631763 25.64777328  4.982243e-17
## model=BMW- X5               59.4594595  3.8394415  0.74898785  3.371622e-12
## model=Audi- Q7              59.4594595  3.8394415  0.74898785  3.371622e-12
## model=Mercedes- GLS Class  100.0000000  1.7452007  0.20242915  4.110914e-10
## model=Audi- A8              76.4705882  2.2687609  0.34412955  9.622431e-10
## year=2020                   23.5294118 12.5654450  6.19433198  1.267485e-09
## year=2019                   15.6749840 42.7574171 31.63967611  2.656193e-09
## manufacturer=BMW            16.6969147 32.1116928 22.30769231  7.760343e-09
## transmission=Automatic      16.0118606 37.6963351 27.30769231  7.983770e-09
## model=Mercedes- X-CLASS    100.0000000  1.3961606  0.16194332  3.137393e-08
## model=BMW- X6               68.7500000  1.9197208  0.32388664  1.244174e-07
## model=BMW- M4               88.8888889  1.3961606  0.18218623  2.572064e-07
## model=VW- Amarok            87.5000000  1.2216405  0.16194332  1.999284e-06
## model=BMW- i3              100.0000000  1.0471204  0.12145749  2.379467e-06
## model=Mercedes- CLS Class   45.8333333  1.9197208  0.48582996  3.190976e-05
## model=BMW- 4 Series         26.3157895  4.3630017  1.92307692  6.807755e-05
## model=BMW- 7 Series         66.6666667  1.0471204  0.18218623  1.545083e-04
## model=Audi- Q8             100.0000000  0.6980803  0.08097166  1.793418e-04
## model=Audi- A7              53.8461538  1.2216405  0.26315789  2.730284e-04
## model=BMW- X3               26.4705882  3.1413613  1.37651822  6.992215e-04
## fuelType=Petrol             13.3591481 48.1675393 41.82186235  1.123929e-03
## model=BMW- X4               43.7500000  1.2216405  0.32388664  1.387006e-03
## auxMileage=(6,17]           14.0549273 30.3664921 25.06072874  2.195732e-03
## model=Mercedes- S Class     46.1538462  1.0471204  0.26315789  2.235167e-03
## model=BMW- 6 Series         50.0000000  0.8726003  0.20242915  3.487078e-03
## model=Audi- Q5              21.0526316  3.4904014  1.92307692  7.743516e-03
## auxTax=(125,145]            12.5589226 65.0959860 60.12145749  9.344175e-03
## model=VW- Caravelle         50.0000000  0.6980803  0.16194332  9.402927e-03
## model=BMW- 8 Series        100.0000000  0.3490401  0.04048583  1.343336e-02
## model=Audi- SQ7            100.0000000  0.3490401  0.04048583  1.343336e-02
## model=Audi- RS5            100.0000000  0.3490401  0.04048583  1.343336e-02
## model=Audi- RS3            100.0000000  0.3490401  0.04048583  1.343336e-02
## model=Mercedes- E Class     17.1428571  6.2827225  4.25101215  1.492195e-02
## auxAge=(1,3]                13.3677991 31.5881326 27.40890688  1.837847e-02
## Audi=Yes                    13.6760427 24.6073298 20.87044534  2.119000e-02
## manufacturer=Audi           13.6760427 24.6073298 20.87044534  2.119000e-02
## model=Audi- SQ5             66.6666667  0.3490401  0.06072874  3.874673e-02
## model=Audi- TT              25.0000000  1.2216405  0.56680162  4.837493e-02
## model=VW- Golf SV            0.0000000  0.0000000  0.52631579  4.018829e-02
## model=VW- Sharan             0.0000000  0.0000000  0.62753036  2.161504e-02
## Audi=No                     11.0514198 75.3926702 79.12955466  2.119000e-02
## model=Mercedes- C Class      7.9787234  5.2356021  7.61133603  1.818560e-02
```

```
## year=2012                   0.0000000  0.0000000  0.66801619  1.686307e-02
## model=VW- Touran            0.0000000  0.0000000  0.70850202  1.315439e-02
## model=BMW- 5 Series         4.5454545  0.8726003  2.22672065  1.132554e-02
## model=VW- Tiguan            5.8139535  1.7452007  3.48178138  1.011095e-02
## model=Mercedes- B Class     0.0000000  0.0000000  0.85020243  5.510242e-03
## fuelType=Diesel            10.3251161 50.4363002 56.65991903  1.453995e-03
## auxMpg=(45,53]              9.0538336 19.3717277 24.81781377  1.054786e-03
## model=Mercedes- CL Class    0.0000000  0.0000000  1.15384615  8.500502e-04
## model=VW- Passat            1.1904762  0.1745201  1.70040486  3.831391e-04
## model=Mercedes- GLA Class   0.0000000  0.0000000  1.57894737  6.145475e-05
## auxPrice=(20,26]            8.2331175 15.5322862 21.88259109  5.474930e-05
## model=VW- Up                0.0000000  0.0000000  2.10526316  2.337389e-06
## model=Audi- A3              2.0000000  0.6980803  4.04858300  3.452217e-07
## model=Audi- A1              0.0000000  0.0000000  2.53036437  1.644365e-07
## year=2013                   0.0000000  0.0000000  2.87449393  1.900647e-08
## model=Mercedes- A Class     1.6129032  0.6980803  5.02024291  1.619509e-09
## year=2015                   3.0470914  1.9197208  7.30769231  1.576061e-09
## year=2014                   0.9523810  0.3490401  4.25101215  1.486619e-09
## year=2016                   5.9954751  9.2495637 17.89473684  8.602445e-10
## auxAge=(3,4]                5.8823529  9.0750436 17.89473684  3.636040e-10
## model=VW- Golf              3.5343035  2.9668412  9.73684211  5.056064e-11
## auxTax=[0,125]              0.0000000  0.0000000  5.64777328  3.937094e-16
## model=VW- Polo              0.0000000  0.0000000  6.45748988  2.023942e-18
## manufacturer=VW             5.4666667 14.3106457 30.36437247  3.935192e-21
## auxAge=(4,22]               1.8181818  2.6178010 16.70040486  1.211333e-29
## auxMileage=(34,153]         2.5000000  5.2356021 24.29149798  8.235350e-38
## auxPrice=(15,20]            2.2413793  4.5375218 23.48178138  7.218912e-39
## auxMpg=(53,62]              0.8283133  1.9197208 26.88259109  9.983147e-66
## auxMpg=(62,470]             0.0000000  0.0000000 23.38056680  7.835933e-72
## auxPrice=[0,15]             0.4804393  1.2216405 29.49392713  7.467267e-81
## transmission=Manual         0.4115226  1.2216405 34.43319838 6.191702e-100
##                               v.test
## auxMpg=[5,45]              29.215725
## auxPrice=(26,90]           29.057278
## transmission=SemiAuto      11.755089
## model=VW- Touareg           9.895144
## auxAge=[0,1]                9.656163
## model=Mercedes- GLE Class   9.468879
## auxMileage=[0,6]            8.387113
## model=BMW- X5               6.961294
## model=Audi- Q7              6.961294
## model=Mercedes- GLS Class   6.249757
## model=Audi- A8              6.115550
## year=2020                   6.071465
## year=2019                   5.951547
## manufacturer=BMW            5.773583
## transmission=Automatic      5.768801
## model=Mercedes- X-CLASS     5.533591
## model=BMW- X6               5.286884
## model=BMW- M4               5.152376
## model=VW- Amarok            4.753497
## model=BMW- i3               4.718195
## model=Mercedes- CLS Class   4.159391
## model=BMW- 4 Series         3.982906
## model=BMW- 7 Series         3.783709
## model=Audi- Q8              3.746468
## model=Audi- A7              3.639632
## model=BMW- X3               3.389884
## fuelType=Petrol             3.257514
## model=BMW- X4               3.197342
## auxMileage=(6,17]           3.062395
## model=Mercedes- S Class     3.057064
## model=BMW- 6 Series         2.921180
## model=Audi- Q5              2.663053
```

```
## auxTax=(125,145]            2.599198
## model=VW- Caravelle         2.597046
## model=BMW- 8 Series         2.472069
## model=Audi- SQ7             2.472069
## model=Audi- RS5             2.472069
## model=Audi- RS3             2.472069
## model=Mercedes- E Class     2.434268
## auxAge=(1,3]                2.357903
## Audi=Yes                    2.304582
## manufacturer=Audi           2.304582
## model=Audi- SQ5             2.066867
## model=Audi- TT              1.974060
## model=VW- Golf SV          -2.051808
## model=VW- Sharan           -2.297065
## Audi=No                    -2.304582
## model=Mercedes- C Class    -2.361817
## year=2012                  -2.389680
## model=VW- Touran           -2.479562
## model=BMW- 5 Series        -2.532491
## model=VW- Tiguan           -2.572011
## model=Mercedes- B Class    -2.775585
## fuelType=Diesel            -3.183712
## auxMpg=(45,53]             -3.275491
## model=Mercedes- CL Class   -3.335961
## model=VW- Passat           -3.551433
## model=Mercedes- GLA Class  -4.007154
## auxPrice=(20,26]           -4.034369
## model=VW- Up               -4.721824
## model=Audi- A3             -5.096921
## model=Audi- A1             -5.235615
## year=2013                  -5.620810
## model=Mercedes- A Class    -6.031992
## year=2015                  -6.036384
## year=2014                  -6.045809
## year=2016                  -6.133393
## auxAge=(3,4]               -6.268902
## model=VW- Golf             -6.569276
## auxTax=[0,125]             -8.140481
## model=VW- Polo             -8.755948
## manufacturer=VW            -9.434325
## auxAge=(4,22]             -11.307021
## auxMileage=(34,153]       -12.853360
## auxPrice=(15,20]          -13.040282
## auxMpg=(53,62]            -17.123091
## auxMpg=(62,470]           -17.922748
## auxPrice=[0,15]           -19.043299
## transmission=Manual       -21.220383
##
## $`2`
##                             Cla/Mod    Mod/Cla     Global       p.value
## auxMileage=(34,153]       58.1666667 84.9148418 24.2914980  0.000000e+00
## auxPrice=[0,15]           44.9553878 79.6836983 29.4939271 2.703915e-241
## auxAge=(4,22]             60.0000000 60.2189781 16.7004049 9.244897e-231
## auxMpg=(62,470]           40.0865801 56.3260341 23.3805668 1.792555e-114
## year=2015                 59.5567867 26.1557178  7.3076923  7.391593e-84
## year=2014                 70.0000000 17.8832117  4.2510121  6.169984e-70
## fuelType=Diesel           22.6866738 77.2506083 56.6599190  3.921676e-41
## auxTax=(145,570]          26.7297457 54.9878345 34.2307692  5.580512e-41
## year=2013                 64.7887324 11.1922141  2.8744939  6.168282e-39
## transmission=Manual       26.3962375 54.6228710 34.4331984  8.104409e-39
## auxAge=(3,4]              29.6380090 31.8734793 17.8947368  4.424578e-27
## year=2016                 29.6380090 31.8734793 17.8947368  4.424578e-27
## auxTax=[0,125]            32.9749104 11.1922141  5.6477733  5.522718e-12
## model=Audi- A1            36.0000000  5.4744526  2.5303644  1.219865e-07
```

```
## model=Audi- A3            29.5000000  7.1776156  4.0485830  3.858033e-06
## year=2012                 45.4545455  1.8248175  0.6680162  1.187173e-04
## auxMpg=(53,62]            20.0301205 32.3600973 26.8825911  1.329031e-04
## model=VW- Passat          33.3333333  3.4063260  1.7004049  1.688110e-04
## model=BMW- 1 Series       27.0408163  6.4476886  3.9676113  1.814554e-04
## model=BMW- 3 Series       25.3846154  8.0291971  5.2631579  2.282562e-04
## year=2008                 61.5384615  0.9732360  0.2631579  3.692237e-04
## model=VW- CC              52.9411765  1.0948905  0.3441296  7.368251e-04
## model=Mercedes- A Class   24.5967742  7.4209246  5.0202429  1.016715e-03
## model=Mercedes- SLK       53.8461538  0.8515815  0.2631579  2.673942e-03
## year=2011                 42.8571429  1.0948905  0.4251012  5.046852e-03
## year=2007                 57.1428571  0.4866180  0.1417004  1.942780e-02
## model=VW- Up              25.0000000  3.1630170  2.1052632  2.787723e-02
## model=Audi- A6            26.2500000  2.5547445  1.6194332  2.816132e-02
## Audi=Yes                  18.9136760 23.7226277 20.8704453  2.927031e-02
## manufacturer=Audi         18.9136760 23.7226277 20.8704453  2.927031e-02
## model=Mercedes- SL CLASS   3.5714286  0.1216545  0.5668016  4.597267e-02
## model=Audi- A8             0.0000000  0.0000000  0.3441296  4.507308e-02
## manufacturer=Mercedes     14.8431523 23.6009732 26.4574899  4.067979e-02
## model=Mercedes- V Class    0.0000000  0.0000000  0.3643725  3.754716e-02
## Audi=No                   16.0399079 76.2773723 79.1295547  2.927031e-02
## model=VW- T-Cross          0.0000000  0.0000000  0.4655870  1.505259e-02
## model=VW- Arteon           0.0000000  0.0000000  0.5060729  1.044001e-02
## model=BMW- 2 Series        7.5630252  1.0948905  2.4089069  3.867050e-03
## model=VW- Sharan           0.0000000  0.0000000  0.6275304  3.479717e-03
## model=Audi- Q5             6.3157895  0.7299270  1.9230769  2.996803e-03
## model=VW- Touareg          0.0000000  0.0000000  0.7287449  1.391310e-03
## model=BMW- X2              0.0000000  0.0000000  0.7489879  1.158101e-03
## model=Audi- Q7             0.0000000  0.0000000  0.7489879  1.158101e-03
## auxPrice=(15,20]          13.1034483 18.4914842 23.4817814  1.638212e-04
## model=Audi- Q2             1.3888889  0.1216545  1.4574899  3.051267e-05
## model=Mercedes- GLC Class  3.0927835  0.3649635  1.9635628  2.994270e-05
## model=Mercedes- GLE Class  0.0000000  0.0000000  1.1740891  2.434372e-05
## model=VW- Tiguan           5.8139535  1.2165450  3.4817814  1.710519e-05
## model=VW- T-Roc            0.0000000  0.0000000  1.3967611  3.195992e-06
## auxMileage=(17,34]         9.3927126 14.1119221 25.0000000  1.172162e-16
## year=2017                  7.1925754  7.5425791 17.4493927  7.262422e-19
## year=2020                  0.9803922  0.3649635  6.1943320  4.660564e-21
## auxMpg=(45,53]             5.5464927  8.2725061 24.8178138  1.428228e-39
## transmission=SemiAuto      7.8835979 18.1265207 38.2591093  4.650495e-42
## fuelType=Petrol            8.4220716 21.1678832 41.8218623  4.069832e-42
## year=2018                  0.0000000  0.0000000 10.0809717  1.954594e-42
## auxAge=(1,3]               4.5790251  7.5425791 27.4089069  8.412928e-54
## auxTax=(125,145]           9.3602694 33.8199513 60.1214575  1.231886e-62
## auxMpg=[5,45]              2.0308692  3.0413625 24.9190283  3.329873e-76
## auxPrice=(20,26]           0.9250694  1.2165450 21.8825911  2.422352e-80
## auxMileage=(6,17]          0.4038772  0.6082725 25.0607287 1.764419e-104
## auxPrice=(26,90]           0.4025765  0.6082725 25.1417004 6.609962e-105
## auxMileage=[0,6]           0.2367798  0.3649635 25.6477733 2.093853e-111
## year=2019                  0.0000000  0.0000000 31.6396761 1.794355e-152
## auxAge=[0,1]               0.1598295  0.3649635 37.9959514 5.747722e-185
##                               v.test
## auxMileage=(34,153]              Inf
## auxPrice=[0,15]            33.172274
## auxAge=(4,22]              32.433537
## auxMpg=(62,470]            22.740238
## year=2015                  19.402216
## year=2014                  17.678233
## fuelType=Diesel            13.432093
## auxTax=(145,570]           13.405949
## year=2013                  13.052269
## transmission=Manual        13.031458
## auxAge=(3,4]               10.776919
## year=2016                  10.776919
```

```
## auxTax=[0,125]              6.891448
## model=Audi- A1              5.290494
## model=Audi- A3              4.618887
## year=2012                   3.848760
## auxMpg=(53,62]              3.821016
## model=VW- Passat            3.761628
## model=BMW- 1 Series         3.743527
## model=BMW- 3 Series         3.685498
## year=2008                   3.561157
## model=VW- CC                3.375497
## model=Mercedes- A Class     3.285860
## model=Mercedes- SLK         3.002930
## year=2011                   2.804028
## year=2007                   2.337219
## model=VW- Up                2.199010
## model=Audi- A6              2.195032
## Audi=Yes                    2.179827
## manufacturer=Audi           2.179827
## model=Mercedes- SL CLASS   -1.995644
## model=Audi- A8             -2.003972
## manufacturer=Mercedes      -2.046779
## model=Mercedes- V Class    -2.079764
## Audi=No                    -2.179827
## model=VW- T-Cross          -2.431111
## model=VW- Arteon           -2.560904
## model=BMW- 2 Series        -2.888808
## model=VW- Sharan           -2.921839
## model=Audi- Q5             -2.968066
## model=VW- Touareg          -3.196448
## model=BMW- X2              -3.249003
## model=Audi- Q7             -3.249003
## auxPrice=(15,20]           -3.769124
## model=Audi- Q2             -4.169606
## model=Mercedes- GLC Class  -4.173902
## model=Mercedes- GLE Class  -4.220800
## model=VW- Tiguan           -4.299671
## model=VW- T-Roc            -4.657805
## auxMileage=(17,34]         -8.285903
## year=2017                  -8.870797
## year=2020                  -9.416572
## auxMpg=(45,53]            -13.163242
## transmission=SemiAuto     -13.589054
## fuelType=Petrol           -13.598813
## year=2018                 -13.652355
## auxAge=(1,3]              -15.442974
## auxTax=(125,145]          -16.703698
## auxMpg=[5,45]             -18.474223
## auxPrice=(20,26]          -18.981573
## auxMileage=(6,17]         -21.706934
## auxPrice=(26,90]          -21.752023
## auxMileage=[0,6]          -22.428101
## year=2019                 -26.302524
## auxAge=[0,1]              -29.004655
##
## $`3`
##                             Cla/Mod     Mod/Cla     Global       p.value
## auxMileage=(17,34]        67.773279 56.13682093 25.0000000 6.890516e-229
## auxAge=(1,3]              62.703102 56.94164990 27.4089069 1.019049e-195
## year=2017                 71.345708 41.24748491 17.4493927 2.986075e-170
## auxMpg=(53,62]            53.463855 47.61904762 26.8825911  1.519903e-98
## auxPrice=(15,20]          54.827586 42.65593561 23.4817814  2.204327e-91
## auxAge=(3,4]              55.769231 33.06505701 17.8947368  1.875731e-69
## year=2016                 55.769231 33.06505701 17.8947368  1.875731e-69
## auxMpg=(62,470]           47.186147 36.55264923 23.3805668  1.217576e-44
```

```
## auxTax=[0,125]            65.232975 12.20657277  5.6477733  1.632662e-35
## model=VW- Polo            60.501567 12.94433266  6.4574899  4.722172e-31
## transmission=Manual       40.623163 46.34473508 34.4331984  2.163466e-30
## auxPrice=[0,15]           39.190117 38.29644534 29.4939271  1.330540e-18
## year=2018                 46.987952 15.69416499 10.0809717  8.700537e-17
## manufacturer=VW           37.466667 37.69282361 30.3643725  3.203447e-13
## model=VW- Scirocco        70.833333  1.14017438  0.4858300  5.315007e-05
## model=Mercedes- E Class   42.380952  5.96914822  4.2510121  1.335376e-04
## model=Mercedes- A Class   39.516129  6.57276995  5.0202429  1.328323e-03
## model=VW- Golf            36.590437 11.80415828  9.7368421  1.510001e-03
## model=VW- Tiguan          40.116279  4.62776660  3.4817814  4.843070e-03
## Audi=No                   31.082118 81.48893360 79.1295547  6.919391e-03
## model=VW- Up              41.346154  2.88397049  2.1052632  1.483562e-02
## model=Audi- A1            38.400000  3.21931590  2.5303644  4.703317e-02
## model=BMW- 3 Series       24.615385  4.29242119  5.2631579  4.214926e-02
## model=Audi- A5            20.000000  1.07310530  1.6194332  4.109984e-02
## model=BMW- X3             19.117647  0.87189805  1.3765182  4.063111e-02
## model=Audi- A4            22.047244  1.87793427  2.5708502  3.957094e-02
## model=BMW- M4              0.000000  0.00000000  0.1821862  3.929399e-02
## model=BMW- Z4              6.666667  0.06706908  0.3036437  3.850082e-02
## year=2009                  0.000000  0.00000000  0.2024291  2.741256e-02
## model=Mercedes- GLS Class  0.000000  0.00000000  0.2024291  2.741256e-02
## model=BMW- 6 Series        0.000000  0.00000000  0.2024291  2.741256e-02
## model=BMW- 5 Series       20.000000  1.47551979  2.2267206  1.579728e-02
## model=Mercedes- V Class    5.555556  0.06706908  0.3643725  1.505460e-02
## model=BMW- 4 Series       18.947368  1.20724346  1.9230769  1.314814e-02
## year=2010                  0.000000  0.00000000  0.2631579  9.302308e-03
## year=2008                  0.000000  0.00000000  0.2631579  9.302308e-03
## model=Mercedes- S Class    0.000000  0.00000000  0.2631579  9.302308e-03
## Audi=Yes                  26.770126 18.51106640 20.8704453  6.919391e-03
## manufacturer=Audi         26.770126 18.51106640 20.8704453  6.919391e-03
## model=VW- Passat          16.666667  0.93896714  1.7004049  4.629574e-03
## model=BMW- X6              0.000000  0.00000000  0.3238866  3.154189e-03
## model=Audi- A8             0.000000  0.00000000  0.3441296  2.199092e-03
## year=2011                  0.000000  0.00000000  0.4251012  5.191384e-04
## model=Mercedes- GLE Class 10.344828  0.40241449  1.1740891  3.651736e-04
## model=VW- T-Roc           11.594203  0.53655265  1.3967611  2.878156e-04
## model=VW- T-Cross          0.000000  0.00000000  0.4655870  2.520999e-04
## model=VW- Arteon           0.000000  0.00000000  0.5060729  1.223795e-04
## model=BMW- X5              2.702703  0.06706908  0.7489879  2.887310e-05
## model=BMW- X2              2.702703  0.06706908  0.7489879  2.887310e-05
## year=2012                  0.000000  0.00000000  0.6680162  6.771918e-06
## model=VW- Touareg          0.000000  0.00000000  0.7287449  2.284027e-06
## model=Audi- Q7             0.000000  0.00000000  0.7489879  1.589597e-06
## year=2015                 19.390582  4.69483568  7.3076923  1.542057e-06
## auxPrice=(20,26]          23.219241 16.83433937 21.8825911  9.472150e-09
## transmission=SemiAuto     25.343915 32.12608987 38.2591093  4.400786e-09
## transmission=Automatic    23.795404 21.52917505 27.3076923  1.231755e-09
## manufacturer=BMW          22.232305 16.43192488 22.3076923  2.834240e-11
## model=Audi- Q5             3.157895  0.20120724  1.9230769  1.410496e-11
## auxTax=(125,145]          26.397306 52.58215962 60.1214575  1.426614e-12
## year=2014                  6.666667  0.93896714  4.2510121  1.332582e-17
## year=2013                  2.112676  0.20120724  2.8744939  1.331505e-18
## auxMileage=(34,153]       19.500000 15.69416499 24.2914980  1.544587e-21
## auxMpg=(45,53]            17.944535 14.75519785 24.8178138  8.391048e-29
## auxAge=(4,22]             10.787879  5.96914822 16.7004049  1.068149e-46
## year=2020                  0.000000  0.00000000  6.1943320  2.431303e-50
## auxPrice=(26,90]           2.657005  2.21327968 25.1417004 1.692632e-172
## auxMileage=[0,6]           2.525651  2.14621060 25.6477733 4.547201e-179
## auxMpg=[5,45]              1.299756  1.07310530 24.9190283 6.825171e-196
## year=2019                  3.838772  4.02414487 31.6396761 8.353123e-206
## auxAge=[0,1]               3.196590  4.02414487 37.9959514 3.239855e-281
##                               v.test
## auxMileage=(17,34]         32.300465
```

```
## auxAge=(1,3]               29.845009
## year=2017                  27.813411
## auxMpg=(53,62]             21.069354
## auxPrice=(15,20]           20.273495
## auxAge=(3,4]               17.615426
## year=2016                  17.615426
## auxMpg=(62,470]            14.017543
## auxTax=[0,125]             12.437635
## model=VW- Polo             11.588336
## transmission=Manual        11.457221
## auxPrice=[0,15]             8.803129
## year=2018                   8.321298
## manufacturer=VW             7.285557
## model=VW- Scirocco          4.041325
## model=Mercedes- E Class     3.819841
## model=Mercedes- A Class     3.209789
## model=VW- Golf              3.172755
## model=VW- Tiguan            2.817291
## Audi=No                     2.700699
## model=VW- Up                2.436367
## model=Audi- A1              1.986001
## model=BMW- 3 Series        -2.032043
## model=Audi- A5             -2.042521
## model=BMW- X3              -2.047275
## model=Audi- A4             -2.058200
## model=BMW- M4              -2.061095
## model=BMW- Z4              -2.069483
## year=2009                  -2.205592
## model=Mercedes- GLS Class  -2.205592
## model=BMW- 6 Series        -2.205592
## model=BMW- 5 Series        -2.413566
## model=Mercedes- V Class    -2.431063
## model=BMW- 4 Series        -2.479731
## year=2010                  -2.600739
## year=2008                  -2.600739
## model=Mercedes- S Class    -2.600739
## Audi=Yes                   -2.700699
## manufacturer=Audi          -2.700699
## model=VW- Passat           -2.831738
## model=BMW- X6              -2.952298
## model=Audi- A8             -3.061938
## year=2011                  -3.470682
## model=Mercedes- GLE Class  -3.564052
## model=VW- T-Roc            -3.626027
## model=VW- T-Cross          -3.660117
## model=VW- Arteon           -3.841310
## model=BMW- X5              -4.182177
## model=BMW- X2              -4.182177
## year=2012                  -4.500734
## model=VW- Touareg          -4.726518
## model=Audi- Q7             -4.799629
## year=2015                  -4.805707
## auxPrice=(20,26]           -5.739920
## transmission=SemiAuto      -5.868378
## transmission=Automatic     -6.076055
## manufacturer=BMW           -6.654936
## model=Audi- Q5             -6.756824
## auxTax=(125,145]           -7.081443
## year=2014                  -8.540833
## year=2013                  -8.803047
## auxMileage=(34,153]        -9.531881
## auxMpg=(45,53]            -11.135882
## auxAge=(4,22]             -14.349819
## year=2020                 -14.920313
```

```
## auxPrice=(26,90]          -27.998541
## auxMileage=[0,6]          -28.533143
## auxMpg=[5,45]             -29.858422
## year=2019                 -30.612469
## auxAge=[0,1]              -35.834213
##
## $`4`
##                                Cla/Mod    Mod/Cla      Global       p.value
## auxTax=(145,570]           17.91839148 94.9843260 34.23076923 4.271740e-126
## auxAge=(4,22]              27.39393939 70.8463950 16.70040486 4.086588e-112
## auxMileage=(34,153]        19.83333333 74.6081505 24.29149798  2.855678e-86
## year=2013                  33.09859155 14.7335423  2.87449393  2.203868e-22
## year=2010                 100.00000000  4.0752351  0.26315789  2.692066e-16
## model=Audi- Q5             33.68421053 10.0313480  1.92307692  1.019837e-15
## year=2015                  18.00554017 20.3761755  7.30769231  3.794396e-15
## auxMpg=[5,45]              11.45410236 44.2006270 24.91902834  8.208787e-15
## year=2014                  22.38095238 14.7335423  4.25101215  9.796516e-15
## auxMpg=(45,53]             11.25611746 43.2601881 24.81781377  9.538272e-14
## year=2012                  54.54545455  5.6426332  0.66801619  1.074279e-13
## transmission=Automatic     10.82283173 45.7680251 27.30769231  3.081172e-13
## year=2011                  57.14285714  3.7617555  0.42510121  7.797401e-10
## model=Audi- Q7             40.54054054  4.7021944  0.74898785  2.849379e-09
## Audi=Yes                   10.18428710 32.9153605 20.87044534  2.088442e-07
## manufacturer=Audi          10.18428710 32.9153605 20.87044534  2.088442e-07
## model=Mercedes- S Class    53.84615385  2.1943574  0.26315789  5.638430e-06
## year=2009                  60.00000000  1.8808777  0.20242915  1.209752e-05
## model=BMW- X5              29.72972973  3.4482759  0.74898785  1.465281e-05
## model=BMW- M3             100.00000000  1.2539185  0.08097166  1.708378e-05
## fuelType=Diesel             7.75276885 68.0250784 56.65991903  1.828838e-05
## year=2006                  80.00000000  1.2539185  0.10121457  8.214820e-05
## model=BMW- 6 Series        50.00000000  1.5673981  0.20242915  2.210490e-04
## model=Mercedes- M Class   100.00000000  0.9404389  0.06072874  2.669070e-04
## model=Audi- RS6           100.00000000  0.9404389  0.06072874  2.669070e-04
## auxPrice=[0,15]             8.23610158 37.6175549 29.49392713  1.278418e-03
## model=BMW- X6              31.25000000  1.5673981  0.32388664  2.945860e-03
## manufacturer=BMW            8.43920145 29.1536050 22.30769231  3.165303e-03
## year=2004                 100.00000000  0.6269592  0.04048583  4.157687e-03
## year=2008                  30.76923077  1.2539185  0.26315789  8.563100e-03
## model=Mercedes- SLK        30.76923077  1.2539185  0.26315789  8.563100e-03
## model=Audi- A7             30.76923077  1.2539185  0.26315789  8.563100e-03
## year=2002                  66.66666667  0.6269592  0.06072874  1.220616e-02
## year=2001                  66.66666667  0.6269592  0.06072874  1.220616e-02
## model=BMW- M6              66.66666667  0.6269592  0.06072874  1.220616e-02
## model=Mercedes- CLS Class  20.83333333  1.5673981  0.48582996  2.014943e-02
## model=Audi- A8             23.52941176  1.2539185  0.34412955  2.429006e-02
## auxAge=(3,4]                8.14479638 22.5705329 17.89473684  2.805867e-02
## year=2016                   8.14479638 22.5705329 17.89473684  2.805867e-02
## model=VW- Touareg          16.66666667  1.8808777  0.72874494  3.318464e-02
## model=Mercedes- GLE Class  13.79310345  2.5078370  1.17408907  4.255702e-02
## transmission=SemiAuto       5.39682540 31.9749216 38.25910931  1.613996e-02
## model=VW- Tiguan            2.32558140  1.2539185  3.48178138  1.417722e-02
## model=Mercedes- GLC Class   1.03092784  0.3134796  1.96356275  1.275254e-02
## model=VW- T-Roc             0.00000000  0.0000000  1.39676113  9.666005e-03
## model=Audi- Q2              0.00000000  0.0000000  1.45748988  7.888249e-03
## model=Mercedes- A Class     2.41935484  1.8808777  5.02024291  3.493638e-03
## model=VW- Up                0.00000000  0.0000000  2.10526316  8.952728e-04
## auxTax=[0,125]              1.79211470  1.5673981  5.64777328  2.109302e-04
## fuelType=Petrol             4.84027106 31.3479624 41.82186235  7.202815e-05
## model=Mercedes- C Class     1.86170213  2.1943574  7.61133603  1.838518e-05
## auxPrice=(26,90]            3.70370370 14.4200627 25.14170040  1.588452e-06
## transmission=Manual         4.17401529 22.2570533 34.43319838  1.070923e-06
## Audi=No                     5.47454592 67.0846395 79.12955466  2.088442e-07
## model=VW- Polo              0.62695925  0.6269592  6.45748988  8.797242e-08
## year=2020                   0.00000000  0.0000000  6.19433198  6.805549e-10
```

```
## year=2017                   2.20417633  5.9561129 17.44939271  4.781766e-10
## manufacturer=VW             3.20000000 15.0470219 30.36437247  7.251838e-11
## auxMpg=(62,470]             2.42424242  8.7774295 23.38056680  2.940650e-12
## year=2018                   0.20080321  0.3134796 10.08097166  2.304157e-14
## auxAge=(1,3]                1.47710487  6.2695925 27.40890688  4.731650e-23
## auxMileage=(6,17]           0.88852989  3.4482759 25.06072874  3.813181e-27
## auxMpg=(53,62]              0.90361446  3.7617555 26.88259109  3.080308e-29
## auxMileage=[0,6]            0.15785320  0.6269592 25.64777328  1.569037e-39
## year=2019                   0.06397953  0.3134796 31.63967611  2.187132e-53
## auxAge=[0,1]                0.05327651  0.3134796 37.99595142  1.690853e-67
## auxTax=(125,145]            0.37037037  3.4482759 60.12145749 1.041310e-112
##                               v.test
## auxTax=(145,570]           23.886099
## auxAge=(4,22]              22.500690
## auxMileage=(34,153]        19.685769
## year=2013                   9.731923
## year=2010                   8.186377
## model=Audi- Q5              8.024448
## year=2015                   7.861540
## auxMpg=[5,45]               7.764315
## year=2014                   7.741870
## auxMpg=(45,53]              7.447144
## year=2012                   7.431432
## transmission=Automatic      7.290801
## year=2011                   6.148998
## model=Audi- Q7              5.940048
## Audi=Yes                    5.191288
## manufacturer=Audi           5.191288
## model=Mercedes- S Class     4.539513
## year=2009                   4.375823
## model=BMW- X5               4.333844
## model=BMW- M3               4.299949
## fuelType=Diesel             4.284824
## year=2006                   3.938045
## model=BMW- 6 Series         3.693660
## model=Mercedes- M Class     3.645467
## model=Audi- RS6             3.645467
## auxPrice=[0,15]             3.220781
## model=BMW- X6               2.973332
## manufacturer=BMW            2.951211
## year=2004                   2.865943
## year=2008                   2.629021
## model=Mercedes- SLK         2.629021
## model=Audi- A7              2.629021
## year=2002                   2.506128
## year=2001                   2.506128
## model=BMW- M6               2.506128
## model=Mercedes- CLS Class   2.323554
## model=Audi- A8              2.252510
## auxAge=(3,4]                2.196465
## year=2016                   2.196465
## model=VW- Touareg           2.129842
## model=Mercedes- GLE Class   2.028032
## transmission=SemiAuto      -2.405735
## model=VW- Tiguan           -2.452741
## model=Mercedes- GLC Class  -2.490606
## model=VW- T-Roc            -2.587554
## model=Audi- Q2             -2.656816
## model=Mercedes- A Class    -2.920595
## model=VW- Up               -3.321524
## auxTax=[0,125]             -3.705553
## fuelType=Petrol            -3.969485
## model=Mercedes- C Class    -4.283650
## auxPrice=(26,90]           -4.799774
```

```
## transmission=Manual        -4.878138
## Audi=No                    -5.191288
## model=VW- Polo             -5.349963
## year=2020                  -6.170544
## year=2017                  -6.226104
## manufacturer=VW            -6.515354
## auxMpg=(62,470]            -6.980532
## year=2018                  -7.632404
## auxAge=(1,3]               -9.887181
## auxMileage=(6,17]         -10.790594
## auxMpg=(53,62]            -11.224815
## auxMileage=[0,6]          -13.156138
## year=2019                 -15.381242
## auxAge=[0,1]              -17.358847
## auxTax=(125,145]          -22.561253
##
## $`5`
##                              Cla/Mod     Mod/Cla     Global       p.value
## auxAge=[0,1]               79.2754395 85.76368876 37.9959514  0.000000e+00
## year=2019                  80.4222649 72.44956772 31.6396761  0.000000e+00
## auxMileage=[0,6]           78.6898185 57.46397695 25.6477733 2.023457e-307
## auxTax=(125,145]           51.3131313 87.83861671 60.1214575 7.439654e-208
## auxPrice=(20,26]           61.0545791 38.04034582 21.8825911  2.362534e-87
## auxPrice=(26,90]           56.9243156 40.74927954 25.1417004  9.531997e-75
## auxMpg=(45,53]             56.1990212 39.71181556 24.8178138  8.571327e-69
## auxMileage=(6,17]          53.3117932 38.04034582 25.0607287  1.897434e-52
## year=2020                  75.4901961 13.31412104  6.1943320  4.431365e-50
## auxMpg=[5,45]              48.5783916 34.46685879 24.9190283  2.152884e-29
## fuelType=Petrol            42.9332043 51.12391931 41.8218623  2.372681e-22
## transmission=SemiAuto      42.8571429 46.68587896 38.2591093  4.470582e-19
## model=VW- T-Roc            79.7101449  3.17002882  1.3967611  3.145985e-14
## model=VW- T-Cross         100.0000000  1.32564841  0.4655870  3.212472e-11
## model=BMW- X2              83.7837838  1.78674352  0.7489879  1.501578e-09
## model=VW- Arteon           92.0000000  1.32564841  0.5060729  4.466596e-09
## model=Mercedes- C Class    48.1382979 10.43227666  7.6113360  7.018345e-08
## model=BMW- 2 Series        57.1428571  3.91930836  2.4089069  7.908516e-07
## model=VW- Sharan           70.9677419  1.26801153  0.6275304  5.916980e-05
## model=Mercedes- B Class    64.2857143  1.55619597  0.8502024  1.336981e-04
## model=Mercedes- V Class    77.7777778  0.80691643  0.3643725  3.031600e-04
## Audi=No                    36.3520082 81.90201729 79.1295547  3.811480e-04
## model=Audi- Q2             54.1666667  2.24783862  1.4574899  9.468580e-04
## model=VW- Tiguan           45.9302326  4.55331412  3.4817814  3.018032e-03
## model=VW- Tiguan Allspace  77.7777778  0.40345821  0.1821862  1.277781e-02
## model=VW- Golf SV          57.6923077  0.86455331  0.5263158  2.052183e-02
## model=Mercedes- GLC Class  46.3917526  2.59365994  1.9635628  2.141906e-02
## manufacturer=VW            37.4666667 32.39193084 30.3643725  2.295989e-02
## model=BMW- 5 Series        45.4545455  2.88184438  2.2267206  2.425438e-02
## model=Mercedes- GLA Class  47.4358974  2.13256484  1.5789474  2.477972e-02
## model=VW- Passat           46.4285714  2.24783862  1.7004049  3.201964e-02
## year=2007                   0.0000000  0.00000000  0.1417004  4.827331e-02
## transmission=Automatic     32.7650111 25.47550432 27.3076923  3.308521e-02
## year=2008                   7.6923077  0.05763689  0.2631579  3.242714e-02
## model=Audi- A7              7.6923077  0.05763689  0.2631579  3.242714e-02
## model=VW- Amarok            0.0000000  0.00000000  0.1619433  3.129496e-02
## model=Mercedes- X-CLASS     0.0000000  0.00000000  0.1619433  3.129496e-02
## model=VW- Beetle            0.0000000  0.00000000  0.1821862  2.028589e-02
## model=BMW- M4               0.0000000  0.00000000  0.1821862  2.028589e-02
## model=BMW- 7 Series         0.0000000  0.00000000  0.1821862  2.028589e-02
## model=Mercedes- CLS Class  12.5000000  0.17291066  0.4858300  1.558507e-02
## year=2009                   0.0000000  0.00000000  0.2024291  1.314818e-02
## model=Mercedes- GLS Class   0.0000000  0.00000000  0.2024291  1.314818e-02
## model=BMW- 6 Series         0.0000000  0.00000000  0.2024291  1.314818e-02
## model=VW- CC                5.8823529  0.05763689  0.3441296  7.085016e-03
## model=BMW- 1 Series        26.0204082  2.93948127  3.9676113  5.599812e-03
```

```
## year=2010                   0.0000000  0.00000000  0.2631579  3.577618e-03
## model=Mercedes- SLK         0.0000000  0.00000000  0.2631579  3.577618e-03
## model=Mercedes- S Class     0.0000000  0.00000000  0.2631579  3.577618e-03
## model=BMW- X6               0.0000000  0.00000000  0.3238866  9.725035e-04
## model=Audi- A8              0.0000000  0.00000000  0.3441296  6.298362e-04
## Audi=Yes                   30.4558681 18.09798271 20.8704453  3.811480e-04
## manufacturer=Audi          30.4558681 18.09798271 20.8704453  3.811480e-04
## model=Audi- A1             20.0000000  1.44092219  2.5303644  1.996277e-04
## year=2011                   0.0000000  0.00000000  0.4251012  1.106862e-04
## model=Mercedes- GLE Class  12.0689655  0.40345821  1.1740891  7.737050e-05
## model=VW- Scirocco          0.0000000  0.00000000  0.4858300  3.000804e-05
## year=2012                   0.0000000  0.00000000  0.6680162  5.943833e-07
## model=VW- Touareg           0.0000000  0.00000000  0.7287449  1.604991e-07
## model=BMW- X5               0.0000000  0.00000000  0.7489879  1.037157e-07
## model=Audi- Q7              0.0000000  0.00000000  0.7489879  1.037157e-07
## model=VW- Polo             21.6300940  3.97694524  6.4574899  6.789858e-08
## model=Mercedes- E Class    17.1428571  2.07492795  4.2510121  4.372165e-09
## transmission=Manual        28.3950617 27.83861671 34.4331984  4.641313e-13
## auxMpg=(53,62]             24.7740964 18.96253602 26.8825911  5.186414e-21
## fuelType=Diesel            29.2604502 47.20461095 56.6599190  7.022252e-23
## auxPrice=(15,20]           22.7586207 15.21613833 23.4817814  4.934724e-25
## year=2013                   0.0000000  0.00000000  2.8744939  6.761225e-28
## year=2014                   0.0000000  0.00000000  4.2510121  2.868816e-41
## auxTax=[0,125]              0.0000000  0.00000000  5.6477733  4.338168e-55
## auxAge=(1,3]               17.8729690 13.94812680 27.4089069  6.067338e-59
## year=2015                   0.0000000  0.00000000  7.3076923  7.416653e-72
## auxMpg=(62,470]            10.3030303  6.85878963 23.3805668 1.932925e-104
## year=2017                   5.8004640  2.88184438 17.4493927 7.803878e-109
## auxTax=(145,570]           12.4778238 12.16138329 34.2307692 5.714629e-141
## auxMileage=(17,34]          6.3157895  4.49567723 25.0000000 6.695568e-160
## auxAge=(4,22]               0.0000000  0.00000000 16.7004049 1.178684e-174
## auxAge=(3,4]                0.5656109  0.28818444 17.8947368 8.430271e-177
## year=2016                   0.4524887  0.23054755 17.8947368 6.416614e-179
## auxPrice=[0,15]             7.1379547  5.99423631 29.4939271 1.890191e-184
## auxMileage=(34,153]         0.0000000  0.00000000 24.2914980 1.022379e-269
##                               v.test
## auxAge=[0,1]                     Inf
## year=2019                        Inf
## auxMileage=[0,6]           37.479022
## auxTax=(125,145]           30.766138
## auxPrice=(20,26]           19.811642
## auxPrice=(26,90]           18.292293
## auxMpg=(45,53]             17.529236
## auxMileage=(6,17]          15.240728
## year=2020                  14.880205
## auxMpg=[5,45]              11.256437
## fuelType=Petrol             9.724414
## transmission=SemiAuto       8.924663
## model=VW- T-Roc             7.592167
## model=VW- T-Cross           6.636487
## model=BMW- X2               6.044195
## model=VW- Arteon            5.865916
## model=Mercedes- C Class     5.390701
## model=BMW- 2 Series         4.937612
## model=VW- Sharan            4.016097
## model=Mercedes- B Class     3.819545
## model=Mercedes- V Class     3.612585
## Audi=No                     3.552804
## model=Audi- Q2              3.305859
## model=VW- Tiguan            2.965895
## model=VW- Tiguan Allspace   2.489903
## model=VW- Golf SV           2.316668
## model=Mercedes- GLC Class   2.300515
## manufacturer=VW             2.274101
```

```
## model=BMW- 5 Series         2.253076
## model=Mercedes- GLA Class   2.244819
## model=VW- Passat            2.144165
## year=2007                  -1.974955
## transmission=Automatic     -2.131048
## year=2008                  -2.139105
## model=Audi- A7             -2.139105
## model=VW- Amarok           -2.153302
## model=Mercedes- X-CLASS    -2.153302
## model=VW- Beetle           -2.321018
## model=BMW- M4              -2.321018
## model=BMW- 7 Series        -2.321018
## model=Mercedes- CLS Class  -2.418490
## year=2009                  -2.479730
## model=Mercedes- GLS Class  -2.479730
## model=BMW- 6 Series        -2.479730
## model=VW- CC               -2.692822
## model=BMW- 1 Series        -2.770338
## year=2010                  -2.913186
## model=Mercedes- SLK        -2.913186
## model=Mercedes- S Class    -2.913186
## model=BMW- X6              -3.298363
## model=Audi- A8             -3.418430
## Audi=Yes                   -3.552804
## manufacturer=Audi          -3.552804
## model=Audi- A1             -3.719487
## year=2011                  -3.865887
## model=Mercedes- GLE Class  -3.952402
## model=VW- Scirocco         -4.173405
## year=2012                  -4.993033
## model=VW- Touareg          -5.240089
## model=BMW- X5              -5.320090
## model=Audi- Q7             -5.320090
## model=VW- Polo             -5.396645
## model=Mercedes- E Class    -5.869460
## transmission=Manual        -7.235408
## auxMpg=(53,62]             -9.405336
## fuelType=Diesel            -9.847568
## auxPrice=(15,20]          -10.334208
## year=2013                 -10.948426
## year=2014                 -13.455221
## auxTax=[0,125]            -15.633010
## auxAge=(1,3]              -16.188621
## year=2015                 -17.925807
## auxMpg=(62,470]           -21.702741
## year=2017                 -22.163073
## auxTax=(145,570]          -25.277034
## auxMileage=(17,34]        -26.944062
## auxAge=(4,22]             -28.175164
## auxAge=(3,4]              -28.349747
## year=2016                 -28.521086
## auxPrice=[0,15]           -28.963631
## auxMileage=(34,153]       -35.088140
##
##
## Link between the cluster variable and the quantitative variables
## ================================================================
##                 Eta2 P-value
## price      0.5358447       0
## mileage    0.7047220       0
## tax        0.4453052       0
## mpg        0.5039535       0
## engineSize 0.4464596       0
## age        0.7083933       0
```

```
##
## Description of each cluster by quantitative variables
## ======================================================
## $`1`
##                v.test Mean in category Overall mean sd in category   Overall sd
## engineSize  40.238982         2.749746     1.908200   4.371789e-01 5.323977e-01
## price       38.530443     35993.237347 21176.744332   1.090242e+04 9.789187e+03
## tax          2.870866       148.041050   146.831552   5.010900e+00 1.072500e+01
## age        -13.023756         1.763283     2.754676   1.295469e+00 1.937826e+00
## mileage    -13.106361     12189.312979 22024.672986   1.130566e+04 1.910352e+04
## mpg        -32.801991        38.191798    53.007951   7.579385e+00 1.149848e+01
##                 p.value
## engineSize  0.000000e+00
## price       0.000000e+00
## tax         4.093497e-03
## age         8.965015e-39
## mileage     3.027820e-39
## mpg        5.515481e-236
##
## $`2`
##                v.test Mean in category Overall mean sd in category   Overall sd
## mileage     42.443633     47848.087359 22024.672986   1.312689e+04 1.910352e+04
## age         36.898414         5.031923     2.754676   1.302798e+00 1.937826e+00
## mpg         27.153370        62.951741    53.007951   9.289650e+00 1.149848e+01
## engineSize  -6.567755         1.796837     1.908200   3.693747e-01 5.323977e-01
## tax         -7.310395       144.334509   146.831552   7.901703e+00 1.072500e+01
## price      -28.751936     12212.751825 21176.744332   4.286467e+03 9.789187e+03
##                 p.value
## mileage     0.000000e+00
## age        4.899809e-298
## mpg        2.310342e-162
## engineSize  5.107945e-11
## tax         2.663582e-13
## price      8.566617e-182
##
## $`3`
##                  v.test Mean in category Overall mean sd in category   Overall sd
## mpg           27.82481        59.932012    53.007951   6.952170e+00 1.149848e+01
## age           11.23926         3.226023     2.754676   9.525405e-01 1.937826e+00
## mileage        4.32520     23812.839133 22024.672986   1.008972e+04 1.910352e+04
## tax          -14.03483       143.573988   146.831552   7.523726e+00 1.072500e+01
## engineSize   -17.86618         1.702347     1.908200   4.002697e-01 5.323977e-01
## price        -21.89544     16538.126761 21176.744332   4.658666e+03 9.789187e+03
##                   p.value
## mpg        2.173730e-170
## age         2.615606e-29
## mileage     1.523932e-05
## tax         9.542453e-45
## engineSize  2.162904e-71
## price      2.871238e-106
##
## $`4`
##                v.test Mean in category Overall mean sd in category   Overall sd
## tax         46.044137       173.575466   146.831552   2.228487e+01 1.072500e+01
## age         28.746304         5.771499     2.754676   1.804211e+00 1.937826e+00
## mileage     26.573613     49517.355039 22024.672986   1.916797e+04 1.910352e+04
## engineSize  19.894891         2.481829     1.908200   5.726047e-01 5.323977e-01
## price       -5.912085     18042.445141 21176.744332   9.699362e+03 9.789187e+03
## mpg        -11.374571        45.924765    53.007951   1.169801e+01 1.149848e+01
##                 p.value
## tax         0.000000e+00
## age        1.007429e-181
## mileage    1.370401e-155
## engineSize  4.505878e-88
```

```
## price       3.378039e-09
## mpg         5.597746e-30
##
## $`5`
##                v.test Mean in category Overall mean sd in category   Overall sd
## price       20.685746     25092.923919 21176.744332   6537.2027757 9.789187e+03
## tax         -6.432252       145.497400   146.831552      1.9594476 1.072500e+01
## engineSize -14.930917         1.754467     1.908200      0.3478571 5.323977e-01
## mpg        -20.082889        48.542026    53.007951      7.7577947 1.149848e+01
## mileage    -42.164638      6446.859366 22024.672986   5284.9797739 1.910352e+04
## age        -45.661213         1.043451     2.754676      0.6174349 1.937826e+00
##                    p.value
## price      4.655157e-95
## tax        1.257274e-10
## engineSize 2.073943e-50
## mpg        1.041574e-89
## mileage    0.000000e+00
## age        0.000000e+00
```

6.3 res.hcpc*desc.var*category

```
res.hcpc$desc.var$category
```

```
## $`1`
##                                Cla/Mod     Mod/Cla     Global       p.value
## auxAge=[0,1]                77.5173149 85.68904594 37.9959514  0.000000e+00
## year=year_2019              76.7114523 70.61248528 31.6396761  0.000000e+00
## auxMileage=[0,6]            78.7687451 58.77502945 25.6477733 3.853712e-321
## auxTax=(125,145]            48.7878788 85.33568905 60.1214575 3.004255e-164
## auxPrice=(26,90]            60.0644122 43.93404005 25.1417004 1.069470e-103
## auxMpg=[5,45]               58.9764419 42.75618375 24.9190283  4.009346e-94
## auxMpg=(45,53]              57.5856444 41.57832744 24.8178138  1.484498e-83
## year=year_2020              83.6601307 15.07656066  6.1943320  2.432227e-75
## fuelType=Petrol             48.4511133 58.95170789 41.8218623  1.348656e-69
## auxPrice=(20,26]            54.3940796 34.62897527 21.8825911  2.812150e-53
## auxMileage=(6,17]           47.9806139 34.98233216 25.0607287  1.824511e-30
## transmission=SemiAuto       42.1164021 46.87868080 38.2591093  2.794525e-19
## model=VW- T-Roc             85.5072464  3.47467609  1.3967611  1.479277e-18
## model=BMW- X2               94.5945946  2.06124853  0.7489879  1.428120e-14
## model=VW- Arteon           100.0000000  1.47232038  0.5060729  2.262477e-12
## model=VW- T-Cross          100.0000000  1.35453475  0.4655870  1.950410e-11
## manufacturer=VW             39.7333333 35.10011779 30.3643725  1.929057e-07
## model=VW- Tiguan            52.9069767  5.35924617  3.4817814  4.244093e-07
## model=Audi- Q2              62.5000000  2.65017668  1.4574899  1.121951e-06
## model=Mercedes- V Class     83.3333333  0.88339223  0.3643725  2.978234e-05
## model=VW- Sharan            67.7419355  1.23674912  0.6275304  1.818083e-04
## model=Mercedes- B Class     61.9047619  1.53121319  0.8502024  2.999655e-04
## model=VW- Tiguan Allspace   88.8888889  0.47114252  0.1821862  1.272364e-03
## model=BMW- 2 Series         47.8991597  3.35689046  2.4089069  2.156577e-03
## model=BMW- Z4               73.3333333  0.64782097  0.3036437  2.753047e-03
## model=Audi- Q3              45.5223881  3.59246172  2.7125506  6.979654e-03
## model=Mercedes- GLC Class   47.4226804  2.70906949  1.9635628  7.661637e-03
## model=VW- Golf SV           57.6923077  0.88339223  0.5263158  1.644251e-02
## model=VW- Passat            45.2380952  2.23792697  1.7004049  3.843076e-02
## manufacturer=BMW            31.8511797 20.67137809 22.3076923  4.500462e-02
## model=Audi- A7               7.6923077  0.05889282  0.2631579  3.670116e-02
## model=VW- Amarok             0.0000000  0.00000000  0.1619433  3.430817e-02
## model=VW- Beetle             0.0000000  0.00000000  0.1821862  2.249648e-02
## model=BMW- M4                0.0000000  0.00000000  0.1821862  2.249648e-02
## model=BMW- 7 Series          0.0000000  0.00000000  0.1821862  2.249648e-02
## year=year_2009               0.0000000  0.00000000  0.2024291  1.474977e-02
```

```
## model=Mercedes- GLS Class   0.0000000  0.00000000  0.2024291  1.474977e-02
## model=BMW- 6 Series         0.0000000  0.00000000  0.2024291  1.474977e-02
## transmission=Automatic     31.6530764 25.14723204 27.3076923  1.336775e-02
## model=VW- CC                5.8823529  0.05889282  0.3441296  8.385231e-03
## year=year_2010              0.0000000  0.00000000  0.2631579  4.154508e-03
## year=year_2008              0.0000000  0.00000000  0.2631579  4.154508e-03
## model=Mercedes- SLK         0.0000000  0.00000000  0.2631579  4.154508e-03
## model=Mercedes- S Class     0.0000000  0.00000000  0.2631579  4.154508e-03
## model=Mercedes- CLS Class   8.3333333  0.11778563  0.4858300  4.116582e-03
## model=BMW- 1 Series        23.9795918  2.76796231  3.9676113  1.385334e-03
## model=BMW- X6               0.0000000  0.00000000  0.3238866  1.169060e-03
## model=Audi- A8              0.0000000  0.00000000  0.3441296  7.659198e-04
## manufacturer=Mercedes      30.4514155 23.43934040 26.4574899  4.672501e-04
## model=Mercedes- GLE Class  13.7931034  0.47114252  1.1740891  4.477314e-04
## model=Audi- A1             19.2000000  1.41342756  2.5303644  1.697171e-04
## year=year_2011              0.0000000  0.00000000  0.4251012  1.409626e-04
## year=year_2012              0.0000000  0.00000000  0.6680162  8.697469e-07
## model=VW- Polo             21.6300940  4.06360424  6.4574899  3.079628e-07
## model=VW- Touareg           0.0000000  0.00000000  0.7287449  2.431719e-07
## model=BMW- X5               0.0000000  0.00000000  0.7489879  1.589741e-07
## model=Audi- Q7              0.0000000  0.00000000  0.7489879  1.589741e-07
## transmission=Manual        27.9247501 27.97408716 34.4331984  3.151116e-12
## model=Mercedes- E Class     9.5238095  1.17785630  4.2510121  1.750520e-17
## auxPrice=(15,20]           22.5000000 15.37102473 23.4817814  1.966114e-23
## year=year_2013              0.0000000  0.00000000  2.8744939  3.579666e-27
## year=year_2014              0.0000000  0.00000000  4.2510121  3.467620e-40
## auxMpg=(53,62]             19.1265060 14.95877503 26.8825911  2.358132e-45
## auxTax=[0,125]              0.0000000  0.00000000  5.6477733  1.235333e-53
## auxAge=(1,3]               17.2821270 13.78091873 27.4089069  1.198925e-58
## year=year_2015              0.0000000  0.00000000  7.3076923  6.004238e-70
## fuelType=Diesel            23.8656663 39.34040047 56.6599190  1.069943e-70
## year=year_2017              7.8886311  4.00471143 17.4493927  2.441735e-87
## auxTax=(145,570]           14.7250148 14.66431095 34.2307692 7.611723e-106
## auxMileage=(17,34]          8.5829960  6.24263840 25.0000000 4.249386e-126
## auxAge=(3,4]                0.9049774  0.47114252 17.8947368 7.356744e-166
## year=year_2016              0.9049774  0.47114252 17.8947368 7.356744e-166
## auxAge=(4,22]               0.1212121  0.05889282 16.7004049 3.849439e-167
## auxPrice=[0,15]             7.0693205  6.06595995 29.4939271 9.501434e-178
## auxMpg=(62,470]             1.0389610  0.70671378 23.3805668 1.470342e-223
## auxMileage=(34,153]         0.0000000  0.00000000 24.2914980 3.094389e-262
##                               v.test
## auxAge=[0,1]                     Inf
## year=year_2019                   Inf
## auxMileage=[0,6]           38.312101
## auxTax=(125,145]           27.312614
## auxPrice=(26,90]           21.623940
## auxMpg=[5,45]              20.581634
## auxMpg=(45,53]             19.366337
## year=year_2020             18.366590
## fuelType=Petrol            17.634083
## auxPrice=(20,26]           15.364959
## auxMileage=(6,17]          11.471973
## transmission=SemiAuto       8.976525
## model=VW- T-Roc             8.791233
## model=BMW- X2               7.693815
## model=VW- Arteon            7.017268
## model=VW- T-Cross           6.709688
## manufacturer=VW             5.206047
## model=VW- Tiguan            5.057670
## model=Audi- Q2              4.868946
## model=Mercedes- V Class     4.175124
## model=VW- Sharan            3.743039
## model=Mercedes- B Class     3.615330
## model=VW- Tiguan Allspace   3.222141
```

```
## model=BMW- 2 Series         3.067777
## model=BMW- Z4               2.994046
## model=Audi- Q3              2.697813
## model=Mercedes- GLC Class   2.666628
## model=VW- Golf SV           2.398942
## model=VW- Passat            2.070231
## manufacturer=BMW           -2.004611
## model=Audi- A7             -2.089073
## model=VW- Amarok           -2.116431
## model=VW- Beetle           -2.281879
## model=BMW- M4              -2.281879
## model=BMW- 7 Series        -2.281879
## year=year_2009             -2.438465
## model=Mercedes- GLS Class  -2.438465
## model=BMW- 6 Series        -2.438465
## transmission=Automatic     -2.473819
## model=VW- CC               -2.636151
## year=year_2010             -2.866185
## year=year_2008             -2.866185
## model=Mercedes- SLK        -2.866185
## model=Mercedes- S Class    -2.866185
## model=Mercedes- CLS Class  -2.869087
## model=BMW- 1 Series        -3.197689
## model=BMW- X6              -3.246323
## model=Audi- A8             -3.364826
## manufacturer=Mercedes      -3.498861
## model=Mercedes- GLE Class  -3.510223
## model=Audi- A1             -3.760289
## year=year_2011             -3.806473
## year=year_2012             -4.919029
## model=VW- Polo             -5.118508
## model=VW- Touareg          -5.162886
## model=BMW- X5              -5.241851
## model=Audi- Q7             -5.241851
## transmission=Manual        -6.970814
## model=Mercedes- E Class    -8.509257
## auxPrice=(15,20]           -9.974742
## year=year_2013            -10.796400
## year=year_2014            -13.269744
## auxMpg=(53,62]            -14.133589
## auxTax=[0,125]            -15.418182
## auxAge=(1,3]              -16.146653
## year=year_2015            -17.679768
## fuelType=Diesel           -17.776756
## year=year_2017            -19.809982
## auxTax=(145,570]          -21.850959
## auxMileage=(17,34]        -23.886318
## auxAge=(3,4]              -27.447918
## year=year_2016            -27.447918
## auxAge=(4,22]             -27.555054
## auxPrice=[0,15]           -28.426549
## auxMpg=(62,470]           -31.918679
## auxMileage=(34,153]       -34.594144
##
## $`2`
##                              Cla/Mod    Mod/Cla      Global       p.value
## auxMpg=[5,45]             30.9504468 68.8969259 24.91902834 5.468867e-121
## auxPrice=(26,90]          30.1932367 67.8119349 25.14170040 8.731196e-114
## model=VW- Touareg         97.2222222  6.3291139  0.72874494  6.320143e-33
## transmission=SemiAuto     16.8253968 57.5045208 38.25910931  2.505616e-22
## model=Mercedes- GLE Class 63.7931034  6.6907776  1.17408907  7.959976e-22
## model=Audi- Q7            78.3783784  5.2441230  0.74898785  2.260370e-21
## model=BMW- X5             70.2702703  4.7016275  0.74898785  2.986246e-17
## manufacturer=BMW          18.4210526 36.7088608 22.30769231  2.492294e-16
```

```
## transmission=Automatic     16.8272795 41.0488246 27.30769231  1.141231e-13
## model=Audi- A8              82.3529412  2.5316456  0.34412955  2.111457e-11
## model=Mercedes- GLS Class 100.0000000  1.8083183  0.20242915  2.873399e-10
## model=Mercedes- CLS Class  62.5000000  2.7124774  0.48582996  2.422890e-09
## model=BMW- M4             100.0000000  1.6274864  0.18218623  2.604546e-09
## model=BMW- 7 Series       100.0000000  1.6274864  0.18218623  2.604546e-09
## model=BMW- X6              68.7500000  1.9891501  0.32388664  8.545564e-08
## model=Audi- A7             69.2307692  1.6274864  0.26315789  1.286345e-06
## model=BMW- i3             100.0000000  1.0849910  0.12145749  1.920830e-06
## auxTax=(145,570]           13.8971023 42.4954792 34.23076923  1.833137e-05
## model=Mercedes- S Class    61.5384615  1.4466546  0.26315789  1.933982e-05
## model=BMW- 6 Series        70.0000000  1.2658228  0.20242915  1.969720e-05
## model=Mercedes- E Class    20.9523810  7.9566004  4.25101215  2.940428e-05
## model=BMW- X4              50.0000000  1.4466546  0.32388664  1.475164e-04
## model=BMW- M3             100.0000000  0.7233273  0.08097166  1.555243e-04
## model=Audi- Q8            100.0000000  0.7233273  0.08097166  1.555243e-04
## auxAge=(1,3]               13.9586411 34.1772152 27.40890688  2.044472e-04
## model=BMW- 4 Series        24.2105263  4.1591320  1.92307692  3.117048e-04
## model=VW- Amarok           62.5000000  0.9041591  0.16194332  7.685566e-04
## model=BMW- M6             100.0000000  0.5424955  0.06072874  1.396043e-03
## model=Audi- RS6           100.0000000  0.5424955  0.06072874  1.396043e-03
## fuelType=Diesel            12.3972847 62.7486438 56.65991903  2.074052e-03
## manufacturer=Mercedes      13.3894415 31.6455696 26.45748988  3.865583e-03
## year=year_2017             14.0371230 21.8806510 17.44939271  4.477153e-03
## year=year_2018             14.8594378 13.3815552 10.08097166  8.236014e-03
## model=Mercedes- SL CLASS   28.5714286  1.4466546  0.56680162  1.204097e-02
## year=year_2004            100.0000000  0.3616637  0.04048583  1.251118e-02
## model=BMW- M5             100.0000000  0.3616637  0.04048583  1.251118e-02
## model=BMW- 8 Series       100.0000000  0.3616637  0.04048583  1.251118e-02
## model=Audi- SQ7           100.0000000  0.3616637  0.04048583  1.251118e-02
## model=Audi- RS5           100.0000000  0.3616637  0.04048583  1.251118e-02
## model=Audi- RS3           100.0000000  0.3616637  0.04048583  1.251118e-02
## model=Audi- Q5             18.9473684  3.2549729  1.92307692  2.462666e-02
## model=Audi- SQ5            66.6666667  0.3616637  0.06072874  3.613749e-02
## model=VW- Golf SV           0.0000000  0.0000000  0.52631579  4.527339e-02
## model=VW- Sharan            0.0000000  0.0000000  0.62753036  2.491641e-02
## year=year_2013              5.6338028  1.4466546  2.87449393  2.373114e-02
## model=BMW- 2 Series         5.0420168  1.0849910  2.40890688  2.123905e-02
## model=VW- Touran            0.0000000  0.0000000  0.70850202  1.544534e-02
## model=Mercedes- C Class     7.4468085  5.0632911  7.61133603  1.265224e-02
## model=BMW- X2               0.0000000  0.0000000  0.74898785  1.215867e-02
## year=year_2016              8.8235294 14.1048825 17.89473684  1.178950e-02
## model=Mercedes- CL Class    1.7543860  0.1808318  1.15384615  1.025042e-02
## auxAge=(3,4]                8.7104072 13.9240506 17.89473684  8.224607e-03
## model=Mercedes- B Class     0.0000000  0.0000000  0.85020243  6.682055e-03
## fuelType=Petrol             9.6805421 36.1663653 41.82186235  4.043662e-03
## auxAge=(4,22]               8.3636364 12.4773960 16.70040486  3.696810e-03
## model=VW- Passat            1.1904762  0.1808318  1.70040486  5.456082e-04
## auxMileage=(34,153]         8.4166667 18.2640145 24.29149798  3.263813e-04
## model=VW- T-Roc             0.0000000  0.0000000  1.39676113  2.607059e-04
## model=Audi- Q2              0.0000000  0.0000000  1.45748988  1.815976e-04
## model=Mercedes- GLA Class   0.0000000  0.0000000  1.57894737  8.804806e-05
## model=BMW- X1               0.0000000  0.0000000  1.72064777  3.779285e-05
## model=VW- Up                0.0000000  0.0000000  2.10526316  3.780770e-06
## model=Audi- Q3              0.7462687  0.1808318  2.71255061  1.899341e-06
## model=Audi- A1              0.0000000  0.0000000  2.53036437  2.935184e-07
## model=VW- Tiguan            0.5813953  0.1808318  3.48178138  2.264354e-08
## model=Audi- A3              0.5000000  0.1808318  4.04858300  8.213672e-10
## model=Mercedes- A Class     0.8064516  0.3616637  5.02024291  4.458693e-11
## auxTax=[0,125]              0.7168459  0.3616637  5.64777328  1.143466e-12
## auxPrice=(15,20]            4.8275862 10.1265823 23.48178138  2.070613e-17
## model=VW- Polo              0.0000000  0.0000000  6.45748988  9.192031e-18
## model=VW- Golf              0.2079002  0.1808318  9.73684211  4.684057e-25
## auxMpg=(53,62]              2.6355422  6.3291139 26.88259109  1.151703e-38
```

```
## manufacturer=VW             2.9333333  7.9566004 30.36437247  2.233044e-41
## auxMpg=(62,470]             0.0000000  0.0000000 23.38056680  3.587250e-69
## auxPrice=[0,15]             0.6863418  1.8083183 29.49392713  5.017116e-73
## transmission=Manual         0.4703116  1.4466546 34.43319838  3.712472e-94
##                                v.test
## auxMpg=[5,45]              23.389477
## auxPrice=(26,90]           22.670642
## model=VW- Touareg          11.952236
## transmission=SemiAuto       9.718864
## model=Mercedes- GLE Class   9.600445
## model=Audi- Q7              9.492279
## model=BMW- X5               8.447101
## manufacturer=BMW            8.195656
## transmission=Automatic      7.423433
## model=Audi- A8              6.698101
## model=Mercedes- GLS Class   6.305460
## model=Mercedes- CLS Class   5.966573
## model=BMW- M4               5.954759
## model=BMW- 7 Series         5.954759
## model=BMW- X6               5.355213
## model=Audi- A7              4.841852
## model=BMW- i3               4.761580
## auxTax=(145,570]            4.284302
## model=Mercedes- S Class     4.272379
## model=BMW- 6 Series         4.268296
## model=Mercedes- E Class     4.178032
## model=BMW- X4               3.795214
## model=BMW- M3               3.782078
## model=Audi- Q8              3.782078
## auxAge=(1,3]                3.713457
## model=BMW- 4 Series         3.605373
## model=VW- Amarok            3.363877
## model=BMW- M6               3.195468
## model=Audi- RS6             3.195468
## fuelType=Diesel             3.079418
## manufacturer=Mercedes       2.888927
## year=year_2017              2.842427
## year=year_2018              2.642238
## model=Mercedes- SL CLASS    2.510941
## year=year_2004              2.497389
## model=BMW- M5               2.497389
## model=BMW- 8 Series         2.497389
## model=Audi- SQ7             2.497389
## model=Audi- RS5             2.497389
## model=Audi- RS3             2.497389
## model=Audi- Q5              2.247209
## model=Audi- SQ5             2.095377
## model=VW- Golf SV          -2.002106
## model=VW- Sharan           -2.242696
## year=year_2013             -2.261454
## model=BMW- 2 Series        -2.303708
## model=VW- Touran           -2.421765
## model=Mercedes- C Class    -2.493411
## model=BMW- X2              -2.507506
## year=year_2016             -2.518383
## model=Mercedes- CL Class   -2.567265
## auxAge=(3,4]               -2.642707
## model=Mercedes- B Class    -2.712288
## fuelType=Petrol            -2.874735
## auxAge=(4,22]              -2.902937
## model=VW- Passat           -3.457304
## auxMileage=(34,153]        -3.593408
## model=VW- T-Roc            -3.651507
## model=Audi- Q2             -3.743330
```

```
## model=Mercedes- GLA Class  -3.921367
## model=BMW- X1              -4.120575
## model=VW- Up               -4.623084
## model=Audi- Q3             -4.763850
## model=Audi- A1             -5.127562
## model=VW- Tiguan           -5.590486
## model=Audi- A3             -6.140742
## model=Mercedes- A Class    -6.587974
## auxTax=[0,125]             -7.112032
## auxPrice=(15,20]           -8.489762
## model=VW- Polo             -8.583636
## model=VW- Golf            -10.339205
## auxMpg=(53,62]            -13.004620
## manufacturer=VW           -13.473727
## auxMpg=(62,470]           -17.578697
## auxPrice=[0,15]           -18.074983
## transmission=Manual       -20.585363
##
## $`3`
##                              Cla/Mod    Mod/Cla     Global       p.value
## auxMileage=(17,34]        66.6396761 53.1310523 25.0000000 7.930063e-199
## auxAge=(1,3]              61.3737075 53.6475145 27.4089069 2.421170e-164
## auxMpg=(62,470]           62.5108225 46.6107166 23.3805668 1.472795e-141
## year=year_2017            66.7053364 37.1207230 17.4493927 1.596990e-124
## auxMpg=(53,62]            50.6777108 43.4473854 26.8825911  1.438826e-67
## auxPrice=(15,20]          48.0172414 35.9586830 23.4817814  1.673811e-42
## auxAge=(3,4]              49.8868778 28.4699806 17.8947368  3.885319e-37
## year=year_2016            49.7737557 28.4054229 17.8947368  1.031005e-36
## model=VW- Polo            61.7554859 12.7178825  6.4574899  6.850685e-31
## year=year_2018            51.4056225 16.5267915 10.0809717  9.689007e-23
## transmission=Manual       40.2704292 44.2220788 34.4331984  3.129462e-22
## auxPrice=[0,15]           40.0823610 37.7017431 29.4939271  2.935855e-17
## auxMileage=(6,17]         38.6914378 30.9231762 25.0607287  2.172032e-10
## model=Mercedes- A Class   48.3870968  7.7469335  5.0202429  1.012115e-08
## model=Mercedes- E Class   48.5714286  6.5848935  4.2510121  1.137824e-07
## Audi=No                   33.0519314 83.4086507 79.1295547  3.881433e-07
## manufacturer=VW           36.2666667 35.1194319 30.3643725  1.077097e-06
## model=Audi- A1            52.0000000  4.1962556  2.5303644  1.341695e-06
## auxTax=[0,125]            44.0860215  7.9406068  5.6477733  4.458210e-06
## manufacturer=Mercedes     36.1132364 30.4712718 26.4574899  1.801640e-05
## model=VW- Up              50.9615385  3.4215623  2.1052632  2.904195e-05
## model=Mercedes- GLA Class 52.5641026  2.6468689  1.5789474  9.865097e-05
## fuelType=Diesel           33.5834227 60.6843125 56.6599190  1.112254e-04
## model=BMW- X1             44.7058824  2.4531956  1.7206478  9.499350e-03
## model=VW- Golf            35.9667360 11.1684958  9.7368421  2.313889e-02
## model=VW- Caravelle        0.0000000  0.0000000  0.1619433  4.916781e-02
## model=VW- Amarok           0.0000000  0.0000000  0.1619433  4.916781e-02
## model=Mercedes- X-CLASS    0.0000000  0.0000000  0.1619433  4.916781e-02
## model=BMW- M4              0.0000000  0.0000000  0.1821862  3.372561e-02
## model=BMW- 7 Series        0.0000000  0.0000000  0.1821862  3.372561e-02
## year=year_2009             0.0000000  0.0000000  0.2024291  2.313121e-02
## model=Mercedes- GLS Class  0.0000000  0.0000000  0.2024291  2.313121e-02
## model=BMW- 6 Series        0.0000000  0.0000000  0.2024291  2.313121e-02
## model=VW- Passat          19.0476190  1.0329245  1.7004049  1.151127e-02
## model=Mercedes- CLS Class  8.3333333  0.1291156  0.4858300  9.621174e-03
## year=year_2010             0.0000000  0.0000000  0.2631579  7.458853e-03
## model=Mercedes- S Class    0.0000000  0.0000000  0.2631579  7.458853e-03
## model=Audi- A7             0.0000000  0.0000000  0.2631579  7.458853e-03
## model=Audi- A6            17.5000000  0.9038089  1.6194332  5.193242e-03
## model=BMW- Z4              0.0000000  0.0000000  0.3036437  3.505789e-03
## model=Audi- A4            19.6850394  1.6139445  2.5708502  3.034399e-03
## model=BMW- 3 Series       23.0769231  3.8734668  5.2631579  2.530424e-03
## model=BMW- X6              0.0000000  0.0000000  0.3238866  2.403156e-03
## model=Audi- A5            16.2500000  0.8392511  1.6194332  2.159854e-03
```

```
## model=Audi- A8             0.0000000  0.0000000  0.3441296  1.647167e-03
## model=VW- T-Roc           14.4927536  0.6455778  1.3967611  1.370266e-03
## model=Mercedes- V Class    0.0000000  0.0000000  0.3643725  1.128893e-03
## year=year_2011             0.0000000  0.0000000  0.4251012  3.632081e-04
## model=BMW- X3             11.7647059  0.5164622  1.3765182  1.741309e-04
## model=VW- T-Cross          0.0000000  0.0000000  0.4655870  1.704595e-04
## model=BMW- X2              5.4054054  0.1291156  0.7489879  1.505716e-04
## model=VW- Arteon           0.0000000  0.0000000  0.5060729  7.996947e-05
## model=Mercedes- GLE Class  8.6206897  0.3227889  1.1740891  4.128055e-05
## fuelType=Petrol           28.1219748 37.5080697 41.8218623  3.117313e-05
## auxTax=(145,570]          27.5576582 30.0839251 34.2307692  3.008647e-05
## transmission=SemiAuto     27.7777778 33.8928341 38.2591093  1.836733e-05
## year=year_2012             0.0000000  0.0000000  0.6680162  3.859304e-06
## model=VW- Touareg          0.0000000  0.0000000  0.7287449  1.236461e-06
## model=BMW- X5              0.0000000  0.0000000  0.7489879  8.459065e-07
## model=Audi- Q7             0.0000000  0.0000000  0.7489879  8.459065e-07
## manufacturer=Audi         24.9272551 16.5913493 20.8704453  3.881433e-07
## Audi=Yes                  24.9272551 16.5913493 20.8704453  3.881433e-07
## manufacturer=BMW          25.0453721 17.8179471 22.3076923  2.058331e-07
## transmission=Automatic    25.1297257 21.8850872 27.3076923  4.849627e-09
## model=Audi- Q5             6.3157895  0.3873467  1.9230769  2.402201e-09
## year=year_2015            16.3434903  3.8089090  7.3076923  1.750432e-11
## year=year_2014             5.7142857  0.7746934  4.2510121  1.408892e-20
## year=year_2013             1.4084507  0.1291156  2.8744939  5.854541e-21
## year=year_2020             2.6143791  0.5164622  6.1943320  8.036266e-40
## auxAge=(4,22]              8.8484848  4.7127179 16.7004049  1.269499e-62
## auxMpg=(45,53]            12.3164763  9.7482247 24.8178138  2.798156e-69
## auxMileage=(34,153]       10.5000000  8.1342802 24.2914980  3.718582e-82
## year=year_2019            12.5399872 12.6533247 31.6396761  1.461136e-92
## auxMileage=[0,6]           9.5501184  7.8114913 25.6477733  5.669973e-97
## auxPrice=(26,90]           7.4074074  5.9393157 25.1417004 5.911246e-117
## auxAge=[0,1]              10.8684070 13.1697870 37.9959514 6.133010e-144
## auxMpg=[5,45]              0.2437043  0.1936733 24.9190283 2.392592e-232
##                               v.test
## auxMileage=(17,34]         30.083647
## auxAge=(1,3]               27.320503
## auxMpg=(62,470]            25.330534
## year=year_2017             23.734277
## auxMpg=(53,62]             17.368112
## auxPrice=(15,20]           13.663649
## auxAge=(3,4]               12.732823
## year=year_2016             12.656415
## model=VW- Polo             11.556419
## year=year_2018              9.815154
## transmission=Manual         9.696197
## auxPrice=[0,15]             8.449089
## auxMileage=(6,17]           6.348657
## model=Mercedes- A Class     5.728686
## model=Mercedes- E Class     5.303212
## Audi=No                     5.074683
## manufacturer=VW             4.877003
## model=Audi- A1              4.833476
## auxTax=[0,125]              4.588791
## manufacturer=Mercedes       4.288154
## model=VW- Up                4.180851
## model=Mercedes- GLA Class   3.893886
## fuelType=Diesel             3.864701
## model=BMW- X1               2.593540
## model=VW- Golf              2.271134
## model=VW- Caravelle        -1.967134
## model=VW- Amarok           -1.967134
## model=Mercedes- X-CLASS    -1.967134
## model=BMW- M4              -2.123337
## model=BMW- 7 Series        -2.123337
```

```
## year=year_2009             -2.271260
## model=Mercedes- GLS Class  -2.271260
## model=BMW- 6 Series        -2.271260
## model=VW- Passat           -2.526783
## model=Mercedes- CLS Class  -2.589155
## year=year_2010             -2.675632
## model=Mercedes- S Class    -2.675632
## model=Audi- A7             -2.675632
## model=Audi- A6             -2.794796
## model=BMW- Z4              -2.919513
## model=Audi- A4             -2.964232
## model=BMW- 3 Series        -3.019679
## model=BMW- X6              -3.035276
## model=Audi- A5             -3.067323
## model=Audi- A8             -3.147423
## model=VW- T-Roc            -3.200842
## model=Mercedes- V Class    -3.256262
## year=year_2011             -3.565468
## model=BMW- X3              -3.753862
## model=VW- T-Cross          -3.759197
## model=BMW- X2              -3.790125
## model=VW- Arteon           -3.944492
## model=Mercedes- GLE Class  -4.100193
## fuelType=Petrol            -4.164723
## auxTax=(145,570]           -4.172811
## transmission=SemiAuto      -4.283866
## year=year_2012             -4.618819
## model=VW- Touareg          -4.849704
## model=BMW- X5              -4.924467
## model=Audi- Q7             -4.924467
## manufacturer=Audi          -5.074683
## Audi=Yes                   -5.074683
## manufacturer=BMW           -5.193991
## transmission=Automatic     -5.852251
## model=Audi- Q5             -5.967972
## year=year_2015             -6.725456
## year=year_2014             -9.299665
## year=year_2013             -9.392585
## year=year_2020            -13.206610
## auxAge=(4,22]             -16.701903
## auxMpg=(45,53]            -17.592778
## auxMileage=(34,153]       -19.199753
## year=year_2019            -20.406596
## auxMileage=[0,6]          -20.897267
## auxPrice=(26,90]          -22.989688
## auxAge=[0,1]              -25.545676
## auxMpg=[5,45]             -32.545905
##
## $`4`
##                              Cla/Mod     Mod/Cla      Global      p.value
## auxTax=(145,570]           7.7468953 100.0000000 34.23076923 3.299393e-63
## auxAge=(4,22]              8.6060606  54.1984733 16.70040486 3.059475e-23
## auxMpg=(45,53]             6.4437194  60.3053435 24.81781377 2.990843e-18
## model=Audi- Q5            24.2105263  17.5572519  1.92307692 1.113425e-16
## auxMileage=(34,153]        6.0833333  55.7251908 24.29149798 6.868024e-15
## year=year_2015             9.1412742  25.1908397  7.30769231 1.318155e-10
## manufacturer=Audi          4.9466537  38.9312977 20.87044534 1.799524e-06
## Audi=Yes                   4.9466537  38.9312977 20.87044534 1.799524e-06
## auxAge=(3,4]               5.0904977  34.3511450 17.89473684 4.958682e-06
## year=year_2016             5.0904977  34.3511450 17.89473684 4.958682e-06
## year=year_2014             8.0952381  12.9770992  4.25101215 4.031549e-05
## model=BMW- X5             18.9189189   5.3435115  0.74898785 4.563462e-05
## model=Audi- Q7            18.9189189   5.3435115  0.74898785 4.563462e-05
## auxMpg=[5,45]              4.2242080  39.6946565 24.91902834 1.651819e-04
```

```
## year=year_2006             60.0000000   2.2900763  0.10121457 1.776390e-04
## auxMileage=(17,34]          4.2105263  39.6946565 25.00000000 1.809802e-04
## model=Mercedes- GLE Class  12.0689655   5.3435115  1.17408907 8.894576e-04
## model=Mercedes- M Class    66.6666667   1.5267176  0.06072874 2.075733e-03
## transmission=Automatic      3.7805782  38.9312977 27.30769231 3.484580e-03
## year=year_2010             23.0769231   2.2900763  0.26315789 4.570197e-03
## model=Mercedes- S Class    23.0769231   2.2900763  0.26315789 4.570197e-03
## model=BMW- X6              18.7500000   2.2900763  0.32388664 8.596191e-03
## auxPrice=(20,26]            3.7002775  30.5343511 21.88259109 1.933303e-02
## model=VW- Caddy Maxi      100.0000000   0.7633588  0.02024291 2.651822e-02
## year=year_2013              5.6338028   6.1068702  2.87449393 4.657881e-02
## year=year_2008             15.3846154   1.5267176  0.26315789 4.925693e-02
## auxPrice=(26,90]            1.8518519  17.5572519 25.14170040 3.788859e-02
## model=BMW- 3 Series         0.7692308   1.5267176  5.26315789 3.400656e-02
## model=Audi- A1              0.0000000   0.0000000  2.53036437 3.327334e-02
## manufacturer=VW             1.8000000  20.6106870 30.36437247 1.164330e-02
## auxTax=[0,125]              0.0000000   0.0000000  5.64777328 4.434996e-04
## model=Mercedes- C Class     0.2659574   0.7633588  7.61133603 3.554525e-04
## transmission=Manual         1.5285126  19.8473282 34.43319838 2.218338e-04
## year=year_2020              0.0000000   0.0000000  6.19433198 2.049555e-04
## model=VW- Polo              0.0000000   0.0000000  6.45748988 1.411053e-04
## auxAge=(1,3]                1.1078287  11.4503817 27.40890688 8.042424e-06
## Audi=No                     2.0465592  61.0687023 79.12955466 1.799524e-06
## year=year_2018              0.0000000   0.0000000 10.08097166 7.396746e-07
## auxMileage=(6,17]           0.4038772   3.8167939 25.06072874 3.947239e-11
## auxMpg=(62,470]             0.0000000   0.0000000 23.38056680 4.123081e-16
## auxMileage=[0,6]            0.0789266   0.7633588 25.64777328 3.669946e-16
## auxMpg=(53,62]              0.0000000   0.0000000 26.88259109 8.046715e-19
## year=year_2019              0.0000000   0.0000000 31.63967611 1.011954e-22
## auxAge=[0,1]                0.0000000   0.0000000 37.99595142 2.174970e-28
## auxTax=(125,145]            0.0000000   0.0000000 60.12145749 3.404598e-54
##                               v.test
## auxTax=(145,570]           16.782103
## auxAge=(4,22]               9.930749
## auxMpg=(45,53]              8.711801
## model=Audi- Q5              8.292019
## auxMileage=(34,153]         7.786887
## year=year_2015              6.425062
## manufacturer=Audi           4.774726
## Audi=Yes                    4.774726
## auxAge=(3,4]                4.566528
## year=year_2016              4.566528
## year=year_2014              4.105664
## model=BMW- X5               4.076928
## model=Audi- Q7              4.076928
## auxMpg=[5,45]               3.767059
## year=year_2006              3.748862
## auxMileage=(17,34]          3.744185
## model=Mercedes- GLE Class   3.323342
## model=Mercedes- M Class     3.079177
## transmission=Automatic      2.921404
## year=year_2010              2.835864
## model=Mercedes- S Class     2.835864
## model=BMW- X6               2.627709
## auxPrice=(20,26]            2.339046
## model=VW- Caddy Maxi        2.218537
## year=year_2013              1.990110
## year=year_2008              1.966361
## auxPrice=(26,90]           -2.076058
## model=BMW- 3 Series        -2.119994
## model=Audi- A1             -2.128769
## manufacturer=VW            -2.522775
## auxTax=[0,125]             -3.512747
## model=Mercedes- C Class    -3.571124
```

```
## transmission=Manual        -3.692760
## year=year_2020             -3.712829
## model=VW- Polo             -3.806223
## auxAge=(1,3]               -4.464051
## Audi=No                    -4.774726
## year=year_2018             -4.950646
## auxMileage=(6,17]          -6.606045
## auxMpg=(62,470]            -8.134891
## auxMileage=[0,6]           -8.148984
## auxMpg=(53,62]             -8.859371
## year=year_2019             -9.810768
## auxAge=[0,1]              -11.050706
## auxTax=(125,145]          -15.501203
##
## $`5`
##                                Cla/Mod     Mod/Cla      Global       p.value
## auxMileage=(34,153]         75.0000000 89.19722498 24.29149798  0.000000e+00
## auxAge=(4,22]               74.0606061 60.55500496 16.70040486 4.804523e-315
## auxPrice=[0,15]             49.8284146 71.95242815 29.49392713 2.717816e-223
## year=year_2015              65.0969529 23.29038652  7.30769231  4.355741e-83
## auxTax=(145,570]            36.0733294 60.45589693 34.23076923  2.312972e-82
## year=year_2014              77.1428571 16.05550050  4.25101215  1.876510e-73
## year=year_2013              87.3239437 12.28939544  2.87449393  3.940189e-68
## auxMpg=(62,470]             36.4502165 41.72447968 23.38056680  4.433832e-49
## fuelType=Diesel             27.1882815 75.42120912 56.65991903  2.416556e-43
## auxTax=[0,125]              55.1971326 15.26263627  5.64777328  6.222943e-40
## transmission=Manual         29.8059965 50.24777007 34.43319838  2.893474e-31
## auxAge=(3,4]                35.4072398 31.02081269 17.89473684  5.988352e-31
## year=year_2016              35.4072398 31.02081269 17.89473684  5.988352e-31
## year=year_2012              87.8787879  2.87413280  0.66801619  1.281966e-16
## auxMpg=(53,62]              27.5602410 36.27353816 26.88259109  1.676859e-13
## year=year_2011              95.2380952  1.98216056  0.42510121  2.359059e-13
## model=Audi- A6              42.5000000  3.36967294  1.61943320  6.853525e-06
## model=BMW- 3 Series         31.9230769  8.22596630  5.26315789  7.453142e-06
## year=year_2010              76.9230769  0.99108028  0.26315789  2.023577e-05
## year=year_2009              80.0000000  0.79286422  0.20242915  9.452384e-05
## model=VW- CC                64.7058824  1.09018831  0.34412955  1.007211e-04
## year=year_2008              69.2307692  0.89197225  0.26315789  2.115139e-04
## model=Mercedes- SLK         69.2307692  0.89197225  0.26315789  2.115139e-04
## model=Audi- A3              31.0000000  6.14469772  4.04858300  3.149206e-04
## year=year_2007              85.7142857  0.59464817  0.14170040  4.293365e-04
## model=BMW- 1 Series         30.1020408  5.84737364  3.96761134  1.056383e-03
## model=VW- Passat            32.1428571  2.67591675  1.70040486  1.100611e-02
## manufacturer=Audi           23.1813773 23.68681863 20.87044534  1.460347e-02
## Audi=Yes                    23.1813773 23.68681863 20.87044534  1.460347e-02
## transmission=Automatic      22.6093403 30.22794846 27.30769231  2.047808e-02
## model=Audi- A1              28.8000000  3.56788900  2.53036437  2.371458e-02
## model=VW- Beetle            55.5555556  0.49554014  0.18218623  2.469080e-02
## model=BMW- 5 Series         29.0909091  3.17145689  2.22672065  2.857745e-02
## year=year_2005             100.0000000  0.19821606  0.04048583  4.168557e-02
## manufacturer=BMW            22.5952813 24.67789891 22.30769231  4.421201e-02
## model=Mercedes- CL Class    31.5789474  1.78394450  1.15384615  4.608814e-02
## model=Mercedes- SL CLASS     3.5714286  0.09910803  0.56680162  1.508971e-02
## Audi=No                     19.6981325 76.31318137 79.12955466  1.460347e-02
## model=BMW- 2 Series         11.7647059  1.38751239  2.40890688  1.311655e-02
## model=VW- Sharan             3.2258065  0.09910803  0.62753036  8.209311e-03
## model=VW- T-Cross            0.0000000  0.00000000  0.46558704  5.153728e-03
## manufacturer=Mercedes       17.7505738 22.99306244 26.45748988  4.773574e-03
## model=VW- Arteon             0.0000000  0.00000000  0.50607287  3.255422e-03
## model=VW- Touareg            2.7777778  0.09910803  0.72874494  2.935101e-03
## model=Audi- Q7               2.7027027  0.09910803  0.74898785  2.385027e-03
## model=Audi- Q5               8.4210526  0.79286422  1.92307692  1.569311e-03
## model=Mercedes- GLC Class    7.2164948  0.69375619  1.96356275  3.591618e-04
## model=BMW- X2                0.0000000  0.00000000  0.74898785  2.058746e-04
```

```
## model=Mercedes- GLE Class   1.7241379  0.09910803  1.17408907  2.757657e-05
## model=Audi- Q2               2.7777778  0.19821606  1.45748988  1.343160e-05
## model=VW- T-Roc              0.0000000  0.00000000  1.39676113  1.259079e-07
## auxMpg=(45,53]              12.4796085 15.16352825 24.81781377  1.255407e-16
## year=year_2017               9.6287703  8.22596630 17.44939271  2.065431e-20
## year=year_2020               0.0000000  0.00000000  6.19433198  3.409968e-32
## auxMileage=(17,34]           8.5020243 10.40634291 25.00000000  7.439081e-38
## fuelType=Petrol             11.4230397 23.38949455 41.82186235  1.648529e-42
## transmission=SemiAuto       10.4232804 19.52428147 38.25910931  4.905662e-46
## year=year_2018               0.4016064  0.19821606 10.08097166  4.003672e-49
## auxMpg=[5,45]                5.6051990  6.83845391 24.91902834  1.203947e-60
## auxAge=(1,3]                 6.2776957  8.42418236 27.40890688  2.115561e-61
## auxPrice=(20,26]             2.3126735  2.47770069 21.88259109  1.083615e-84
## auxPrice=(26,90]             0.4830918  0.59464817 25.14170040 2.095270e-132
## auxMileage=(6,17]            0.3231018  0.39643211 25.06072874 1.026697e-135
## auxMileage=[0,6]             0.0000000  0.00000000 25.64777328 5.002344e-149
## auxTax=(125,145]             8.2491582 24.28146680 60.12145749 1.778307e-149
## year=year_2019               0.0000000  0.00000000 31.63967611 2.095697e-192
## auxAge=[0,1]                 0.0000000  0.00000000 37.99595142 1.010285e-243
##                                v.test
## auxMileage=(34,153]               Inf
## auxAge=(4,22]               37.944226
## auxPrice=[0,15]             31.899445
## year=year_2015              19.310823
## auxTax=(145,570]            19.224400
## year=year_2014              18.129146
## year=year_2013              17.442282
## auxMpg=(62,470]             14.725317
## fuelType=Diesel             13.803833
## auxTax=[0,125]              13.225850
## transmission=Manual         11.630221
## auxAge=(3,4]                11.567969
## year=year_2016              11.567969
## year=year_2012               8.275240
## auxMpg=(53,62]               7.372318
## year=year_2011               7.326690
## model=Audi- A6               4.498187
## model=BMW- 3 Series          4.480319
## year=year_2010               4.262273
## year=year_2009               3.904235
## model=VW- CC                 3.888848
## year=year_2008               3.704852
## model=Mercedes- SLK          3.704852
## model=Audi- A3               3.602707
## year=year_2007               3.521362
## model=BMW- 1 Series          3.275063
## model=VW- Passat             2.542505
## manufacturer=Audi            2.442066
## Audi=Yes                     2.442066
## transmission=Automatic       2.317471
## model=Audi- A1               2.261722
## model=VW- Beetle             2.246206
## model=BMW- 5 Series          2.189267
## year=year_2005               2.036646
## manufacturer=BMW             2.012075
## model=Mercedes- CL Class     1.994585
## model=Mercedes- SL CLASS    -2.430219
## Audi=No                     -2.442066
## model=BMW- 2 Series         -2.480589
## model=VW- Sharan            -2.643338
## model=VW- T-Cross           -2.797265
## manufacturer=Mercedes       -2.821929
## model=VW- Arteon            -2.942530
## model=VW- Touareg           -2.974454
```

```
## model=Audi- Q7              -3.037559
## model=Audi- Q5              -3.161551
## model=Mercedes- GLC Class   -3.568404
## model=BMW- X2               -3.711697
## model=Mercedes- GLE Class   -4.192608
## model=Audi- Q2              -4.352953
## model=VW- T-Roc             -5.284704
## auxMpg=(45,53]              -8.277735
## year=year_2017              -9.258903
## year=year_2020             -11.811361
## auxMileage=(17,34]         -12.861222
## fuelType=Petrol            -13.664757
## transmission=SemiAuto      -14.243704
## year=year_2018             -14.732215
## auxMpg=[5,45]              -16.428088
## auxAge=(1,3]               -16.533214
## auxPrice=(20,26]           -19.500666
## auxPrice=(26,90]           -24.485751
## auxMileage=(6,17]          -24.794540
## auxMileage=[0,6]           -25.999613
## auxTax=(125,145]           -26.039303
## year=year_2019             -29.588583
## auxAge=[0,1]               -33.340201
```

##res.hcpc*desc.var*quanti

```
res.hcpc$desc.var$quanti #description of each cluster by the quantitative variables
```

```
## $`1`
##                v.test Mean in category Overall mean sd in category   Overall sd
## price       22.782004     25561.614252 21176.744332   7031.7461283 9.789187e+03
## tax         -5.362993       145.700656   146.831552      2.4626849 1.072500e+01
## engineSize -15.190310         1.749191     1.908200      0.3423245 5.323977e-01
## mpg        -31.439424        45.900183    53.007951      7.0922350 1.149848e+01
## mileage    -41.232529      6537.523642 22024.672986   5778.2347577 1.910352e+04
## age        -44.924166         1.043034     2.754676      0.6744052 1.937826e+00
##                  p.value
## price      6.915425e-115
## tax         8.185405e-08
## engineSize  4.099732e-52
## mpg        5.855590e-217
## mileage     0.000000e+00
## age         0.000000e+00
##
## $`2`
##                v.test Mean in category Overall mean sd in category   Overall sd
## engineSize  50.439979         2.984449     1.908200   1.945038e-01 5.323977e-01
## price       34.413156     34677.960217 21176.744332   1.222022e+04 9.789187e+03
## tax          5.862149       149.351294   146.831552   6.113485e+00 1.072500e+01
## age         -3.488127         2.483776     2.754676   1.721320e+00 1.937826e+00
## mileage     -4.113124     18875.569933 22024.672986   1.608628e+04 1.910352e+04
## mpg        -27.676977        40.253526    53.007951   8.572807e+00 1.149848e+01
##                  p.value
## engineSize  0.000000e+00
## price      1.602909e-259
## tax         4.569137e-09
## age         4.864169e-04
## mileage     3.903411e-05
## mpg        1.321913e-168
##
## $`3`
##                v.test Mean in category Overall mean sd in category   Overall sd
## mpg         36.800066        61.916515    53.007951      7.5087463 1.149848e+01
```

```
## age          4.911685         2.955060     2.754676      1.1147877 1.937826e+00
## mileage     -3.775144     20506.345253 22024.672986   9807.4219799 1.910352e+04
## tax        -12.276161       144.059645   146.831552      6.3212144 1.072500e+01
## price      -19.030215     17254.731440 21176.744332   5717.4272447 9.789187e+03
## engineSize -20.187565         1.681924     1.908200      0.3844407 5.323977e-01
##                  p.value
## mpg        1.841808e-296
## age         9.029721e-07
## mileage     1.599155e-04
## tax         1.216349e-34
## price       9.585810e-81
## engineSize  1.259199e-90
##
## $`4`
##                v.test Mean in category Overall mean sd in category   Overall sd
## tax         56.408888       198.989111   146.831552   5.024119e+00 1.072500e+01
## age         13.414152         4.995719     2.754676   1.536785e+00 1.937826e+00
## mileage     11.193291     40459.683532 22024.672986   1.735587e+04 1.910352e+04
## engineSize   8.968441         2.319847     1.908200   4.877773e-01 5.323977e-01
## price       -2.009004     19481.236641 21176.744332   7.213210e+03 9.789187e+03
## mpg         -8.537807        44.544275    53.007951   4.266739e+00 1.149848e+01
##                 p.value
## tax         0.000000e+00
## age         4.996144e-41
## mileage     4.398008e-29
## engineSize 3.007421e-19
## price       4.453666e-02
## mpg         1.367936e-17
##
## $`5`
##              v.test Mean in category Overall mean sd in category   Overall sd
## mileage   51.675831     49750.675812 22024.672986   13285.319243 19103.518682
## age       44.654392         5.185006     2.754676       1.480065     1.937826
## mpg       19.737780        59.382143    53.007951       9.355689    11.498481
## tax       -6.620286       144.837389   146.831552       9.656587    10.725005
## price    -31.052702     12639.210109 21176.744332    4247.199289  9789.187403
##                p.value
## mileage   0.000000e+00
## age       0.000000e+00
## mpg       1.021698e-86
## tax       3.585043e-11
## price   1.048968e-211
```

6.4 res.desc[[1]]mca1

```
res.mca<-MCA(df[,c("auxPrice","Audi",vars_dis[c(3:5,7:10)],"price")],quali.sup=c(1,2),quanti.sup=10,grap
res.desc <- dimdesc(res.mca, axes = c(1,2))
res.desc[[1]]
```

```
##
## Link between the variable and the continuous variables (R-square)
## ================================================================================
##       correlation p.value
## price   -0.671904       0
##
## Link between the variable and the categorical variable (1-way anova)
## ============================================
##                        R2       p.value
## auxPrice     0.519599867  0.000000e+00
## auxTax       0.431046264  0.000000e+00
## auxMileage   0.783449411  0.000000e+00
```

```
## auxMpg       0.357500735  0.000000e+00
## auxAge       0.814150399  0.000000e+00
## transmission 0.139431521 1.041948e-161
## fuelType     0.092828236 3.602387e-105
## manufacturer 0.005456659  5.857431e-06
##
## Link between variable and the categories of the categorical variables
## ============================================================
##                            Estimate       p.value
## auxAge=(4,22]           0.53191740  0.000000e+00
## auxMileage=(34,153]     0.68665481  0.000000e+00
## auxTax=(145,570]        0.15060368  0.000000e+00
## auxPrice=[0,15]         0.55582748  0.000000e+00
## auxAge=(3,4]            0.40565981 1.834479e-243
## auxMpg=(62,470]         0.42156224 1.228206e-170
## transmission=Manual     0.26644964 3.481922e-124
## auxMileage=(17,34]      0.33240342 5.919831e-120
## fuelType=Diesel         0.24918590 1.280499e-106
## auxTax=[0,125]          0.46329365 2.151844e-104
## auxMpg=(53,62]          0.27242932  9.779125e-84
## auxPrice=(15,20]        0.25248435  6.888021e-47
## manufacturer=VW         0.04081882  1.914167e-03
## fuelType=Hybrid        -0.12174989  3.052295e-03
## manufacturer=Mercedes -0.07074905  1.123084e-06
## auxAge=(1,3]           -0.11287471  7.722773e-07
## auxMpg=(45,53]         -0.18842805  1.231893e-35
## auxPrice=(20,26]       -0.26553938  8.884792e-74
## auxMileage=(6,17]      -0.31697564  1.493688e-96
## fuelType=Petrol        -0.12743601 3.274508e-100
## transmission=SemiAuto -0.27017376 7.994904e-129
## auxMpg=[5,45]          -0.50556351 2.615236e-276
## auxAge=[0,1]           -0.82470250  0.000000e+00
## auxMileage=[0,6]       -0.70208259  0.000000e+00
## auxTax=(125,145]       -0.61389733  0.000000e+00
## auxPrice=(26,90]       -0.54277245  0.000000e+00
```

6.5 res.desc[[2]]mca1

```
res.desc[[2]]
```

```
##
## Link between the variable and the continuous variables (R-square)
## ================================================================================
##       correlation       p.value
## price   0.3407212 1.593743e-134
##
## Link between the variable and the categorical variable (1-way anova)
## ============================================
##                         R2       p.value
## transmission 0.417591362  0.000000e+00
## fuelType     0.377751275  0.000000e+00
## manufacturer 0.516067526  0.000000e+00
## auxMpg       0.155431042 1.907230e-180
## auxPrice     0.116120550 9.546210e-132
## auxMileage   0.114776474 4.036183e-130
## auxAge       0.110967600 1.587096e-125
## auxTax       0.001961222  7.859524e-03
##
## Link between variable and the categories of the categorical variables
## ============================================================
##                            Estimate       p.value
```

```
## fuelType=Diesel          0.14250323  0.000000e+00
## transmission=Automatic   0.33371499 2.387772e-233
## manufacturer=Mercedes    0.32198469 4.715422e-218
## auxMpg=(62,470]          0.27573292 8.616064e-118
## manufacturer=BMW         0.25192982 6.304327e-107
## auxPrice=(26,90]         0.23593144  1.295867e-95
## auxMileage=(34,153]      0.21527983  1.158690e-70
## transmission=SemiAuto    0.10649818  1.303169e-46
## auxAge=(4,22]            0.20348287  9.420203e-43
## auxAge=[0,1]             0.08583639  1.874772e-26
## auxMileage=[0,6]         0.09902665  3.910349e-17
## fuelType=Hybrid          0.32177484  1.961116e-14
## auxMpg=[5,45]            0.06730561  3.122335e-10
## auxTax=(145,570]         0.03981429  7.306308e-03
## auxPrice=(20,26]         0.02377785  1.218002e-02
## auxTax=[0,125]          -0.04423404  4.258324e-02
## auxAge=(3,4]            -0.04079871  3.295998e-02
## auxPrice=(15,20]        -0.04492965  4.894627e-03
## auxMpg=(45,53]          -0.09471903  1.795819e-12
## auxMileage=(6,17]       -0.09956707  3.017110e-16
## auxMileage=(17,34]      -0.21473941  8.899756e-72
## auxPrice=[0,15]         -0.21477964  2.826369e-83
## auxMpg=(53,62]          -0.24831949  1.051467e-99
## auxAge=(1,3]            -0.24852056 7.998174e-103
## manufacturer=VW         -0.52481774  0.000000e+00
## fuelType=Petrol         -0.46427807  0.000000e+00
## transmission=Manual     -0.44021316  0.000000e+00
```

6.6 res.desc[[1]]mca2

```
res.mca <- MCA(df[,c(3:17)],quanti.sup=c("price",vars_con),quali.sup=c(10,15),graph=FALSE)
res.desc <- dimdesc(res.mca, axes = c(1,2))
res.desc[[1]]
```

```
##
## Link between the variable and the continuous variables (R-square)
## ================================================================================
##             correlation      p.value
## age          0.84560090 0.000000e+00
## mileage      0.82373188 0.000000e+00
## mpg          0.55921170 0.000000e+00
## tax          0.06410129 6.517534e-06
## engineSize -0.04154679 3.493091e-03
## price      -0.67190398 0.000000e+00
##
## Link between the variable and the categorical variable (1-way anova)
## ============================================
##                         R2       p.value
## auxPrice     0.519599867  0.000000e+00
## auxTax       0.431046264  0.000000e+00
## auxMileage   0.783449411  0.000000e+00
## auxMpg       0.357500735  0.000000e+00
## auxAge       0.814150399  0.000000e+00
## transmission 0.139431521 1.041948e-161
## fuelType     0.092828236 3.602387e-105
## manufacturer 0.005456659  5.857431e-06
##
## Link between variable and the categories of the categorical variables
## ================================================================
##                           Estimate       p.value
## auxAge=(4,22]           0.53191740  0.000000e+00
```

```
## auxMileage=(34,153]    0.68665481  0.000000e+00
## auxTax=(145,570]       0.15060368  0.000000e+00
## auxPrice=[0,15]        0.55582748  0.000000e+00
## auxAge=(3,4]           0.40565981 1.834479e-243
## auxMpg=(62,470]        0.42156224 1.228206e-170
## transmission=Manual    0.26644964 3.481922e-124
## auxMileage=(17,34]     0.33240342 5.919831e-120
## fuelType=Diesel        0.24918590 1.280499e-106
## auxTax=[0,125]         0.46329365 2.151844e-104
## auxMpg=(53,62]         0.27242932  9.779125e-84
## auxPrice=(15,20]       0.25248435  6.888021e-47
## manufacturer=VW        0.04081882  1.914167e-03
## fuelType=Hybrid       -0.12174989  3.052295e-03
## manufacturer=Mercedes -0.07074905  1.123084e-06
## auxAge=(1,3]          -0.11287471  7.722773e-07
## auxMpg=(45,53]        -0.18842805  1.231893e-35
## auxPrice=(20,26]      -0.26553938  8.884792e-74
## auxMileage=(6,17]     -0.31697564  1.493688e-96
## fuelType=Petrol       -0.12743601 3.274508e-100
## transmission=SemiAuto -0.27017376 7.994904e-129
## auxMpg=[5,45]         -0.50556351 2.615236e-276
## auxAge=[0,1]          -0.82470250  0.000000e+00
## auxMileage=[0,6]      -0.70208259  0.000000e+00
## auxTax=(125,145]      -0.61389733  0.000000e+00
## auxPrice=(26,90]      -0.54277245  0.000000e+00
```

6.7 res.desc[[2]]mca2

```
res.desc[[2]]
```

```
##
## Link between the variable and the continuous variables (R-square)
## ================================================================================
##             correlation       p.value
## engineSize  0.54602312  0.000000e+00
## price       0.34072119 1.593743e-134
## mileage     0.14036536  3.684061e-23
## tax         0.08329701  4.538907e-09
## mpg         0.07586260  9.379257e-08
## age         0.05645322  7.187744e-05
##
## Link between the variable and the categorical variable (1-way anova)
## ============================================
##                        R2       p.value
## transmission 0.417591362  0.000000e+00
## fuelType     0.377751275  0.000000e+00
## manufacturer 0.516067526  0.000000e+00
## auxMpg       0.155431042 1.907230e-180
## auxPrice     0.116120550 9.546210e-132
## auxMileage   0.114776474 4.036183e-130
## auxAge       0.110967600 1.587096e-125
## auxTax       0.001961222  7.859524e-03
##
## Link between variable and the categories of the categorical variables
## ================================================================
##                           Estimate       p.value
## fuelType=Diesel         0.14250323  0.000000e+00
## transmission=Automatic  0.33371499 2.387772e-233
## manufacturer=Mercedes   0.32198469 4.715422e-218
## auxMpg=(62,470]         0.27573292 8.616064e-118
## manufacturer=BMW        0.25192982 6.304327e-107
```

```
## auxPrice=(26,90]         0.23593144  1.295867e-95
## auxMileage=(34,153]      0.21527983  1.158690e-70
## transmission=SemiAuto    0.10649818  1.303169e-46
## auxAge=(4,22]            0.20348287  9.420203e-43
## auxAge=[0,1]             0.08583639  1.874772e-26
## auxMileage=[0,6]         0.09902665  3.910349e-17
## fuelType=Hybrid          0.32177484  1.961116e-14
## auxMpg=[5,45]            0.06730561  3.122335e-10
## auxTax=(145,570]         0.03981429  7.306308e-03
## auxPrice=(20,26]         0.02377785  1.218002e-02
## auxTax=[0,125]          -0.04423404  4.258324e-02
## auxAge=(3,4]            -0.04079871  3.295998e-02
## auxPrice=(15,20]        -0.04492965  4.894627e-03
## auxMpg=(45,53]          -0.09471903  1.795819e-12
## auxMileage=(6,17]       -0.09956707  3.017110e-16
## auxMileage=(17,34]      -0.21473941  8.899756e-72
## auxPrice=[0,15]         -0.21477964  2.826369e-83
## auxMpg=(53,62]          -0.24831949  1.051467e-99
## auxAge=(1,3]            -0.24852056 7.998174e-103
## manufacturer=VW         -0.52481774  0.000000e+00
## fuelType=Petrol         -0.46427807  0.000000e+00
## transmission=Manual     -0.44021316  0.000000e+00
```

6.8 res.hcpcMCA*desc.var*category

```
res.hcpcMCA$desc.var$category #description of each cluster by the categories
```

```
## $`1`
##                            Cla/Mod    Mod/Cla    Global       p.value     v.test
## auxAge=[0,1]            85.6153436 96.3429257 37.995951  0.000000e+00        Inf
## auxMileage=[0,6]        93.9226519 71.3429257 25.647773  0.000000e+00        Inf
## auxPrice=(26,90]        76.7310789 57.1342926 25.141700 9.103823e-293  36.568375
## auxTax=(125,145]        49.8989899 88.8489209 60.121457 1.918332e-212  31.107308
## auxMpg=[5,45]           67.9122665 50.1199041 24.919028 4.484751e-181  28.694373
## transmission=SemiAuto   46.2962963 52.4580336 38.259109  4.169876e-48  14.573029
## auxPrice=(20,26]        48.1036078 31.1750600 21.882591  1.637973e-28  11.076132
## auxMpg=(45,53]          45.8401305 33.6930456 24.817814  3.009369e-24  10.159395
## fuelType=Petrol         40.4162633 50.0599520 41.821862  6.532956e-17   8.355186
## manufacturer=BMW        40.6533575 26.8585132 22.307692  5.665611e-08   5.429046
## auxMileage=(6,17]       36.5105008 27.0983213 25.060729  1.876608e-02   2.350145
## fuelType=Hybrid         46.6666667  2.0983213  1.518219  2.037753e-02   2.319323
## Audi=Yes                36.5664403 22.6019185 20.870445  3.326075e-02   2.128922
## manufacturer=Audi       36.5664403 22.6019185 20.870445  3.326075e-02   2.128922
## transmission=Automatic  35.9525574 29.0767386 27.307692  4.694600e-02   1.986787
## Audi=No                 33.0263494 77.3980815 79.129555  3.326075e-02  -2.128922
## manufacturer=VW         28.4666667 25.5995204 30.364372  1.610440e-07  -5.239464
## fuelType=Diesel         28.5101822 47.8417266 56.659919  5.122878e-19  -8.909575
## auxTax=[0,125]           0.0000000  0.0000000  5.647773  1.812999e-52 -15.243702
## auxPrice=(15,20]        14.3965517 10.0119904 23.481781  2.251268e-63 -16.804785
## transmission=Manual     18.1069959 18.4652278 34.433198  1.436181e-67 -17.368218
## auxMpg=(53,62]          13.3283133 10.6115108 26.882591  3.860577e-84 -19.435576
## auxMpg=(62,470]          8.0519481  5.5755396 23.380567 3.067846e-117 -23.018146
## auxTax=(145,570]        10.9994086 11.1510791 34.230769 7.064592e-147 -25.808794
## auxAge=(4,22]            0.4848485  0.2398082 16.700405 1.760001e-156 -26.650627
## auxAge=(3,4]             0.2262443  0.1199041 17.894737 2.914546e-174 -28.143054
## auxAge=(1,3]             4.0620384  3.2973621 27.408907 2.873900e-202 -30.345576
## auxMileage=(17,34]       1.8623482  1.3788969 25.000000 8.909662e-219 -31.572137
## auxMileage=(34,153]      0.2500000  0.1798561 24.291498 4.501677e-248 -33.639093
## auxPrice=[0,15]          1.9217570  1.6786571 29.493927 1.118616e-267 -34.954184
##
## $`2`
```

```
##                           Cla/Mod   Mod/Cla    Global       p.value     v.test
## auxAge=(1,3]            48.966027 63.811357 27.408907 1.641492e-175  28.244958
## manufacturer=Mercedes   44.912012 56.496631 26.457490 1.800203e-122  23.534715
## fuelType=Diesel         30.332262 81.713186 56.659919  5.313560e-81  19.061110
## auxMileage=(17,34]      40.485830 48.123195 25.000000  3.624478e-76  18.469647
## auxMpg=(62,470]         41.125541 45.717036 23.380567  8.159934e-74  18.174885
## auxMileage=(6,17]       32.552504 38.787295 25.060729  1.176198e-28  11.105754
## auxPrice=(15,20]        32.241379 35.996150 23.481781  4.657296e-25  10.339754
## transmission=SemiAuto   28.306878 51.491819 38.259109  1.578123e-22   9.765831
## Audi=No                 23.663341 89.027911 79.129555  1.044467e-20   9.331435
## auxPrice=(20,26]        31.359852 32.627526 21.882591  8.486617e-20   9.106776
## transmission=Automatic  29.725723 38.594803 27.307692  3.260838e-19   8.959524
## auxTax=(125,145]        24.141414 69.008662 60.121457  2.811950e-11   6.656097
## manufacturer=BMW        26.134301 27.718961 22.307692  3.698556e-06   4.627640
## auxAge=(3,4]            24.208145 20.596728 17.894737  1.154965e-02   2.525613
## auxTax=(145,570]        19.041987 30.991338 34.230769  1.287496e-02  -2.487209
## auxPrice=(26,90]        18.518519 22.136670 25.141700  1.132266e-02  -2.532580
## auxMpg=(53,62]          17.921687 22.906641 26.882591  1.011095e-03  -3.287421
## auxMpg=(45,53]          14.437194 17.035611 24.817814  1.697811e-11  -6.729899
## auxMpg=[5,45]           12.103981 14.340712 24.919028  1.919649e-20  -9.266716
## Audi=Yes                11.057226 10.972089 20.870445  1.044467e-20  -9.331435
## manufacturer=Audi       11.057226 10.972089 20.870445  1.044467e-20  -9.331435
## auxTax=[0,125]           0.000000  0.000000  5.647773  2.751512e-30 -11.436372
## auxMileage=(34,153]      9.416667 10.875842 24.291498  1.098826e-33 -12.096745
## auxPrice=[0,15]          6.588881  9.239654 29.493927  2.098890e-68 -17.478237
## auxAge=(4,22]            1.939394  1.539942 16.700405  9.623328e-69 -17.522652
## auxAge=[0,1]             7.778370 14.051973 37.995951  7.032868e-80 -18.925493
## fuelType=Petrol          8.470474 16.843118 41.821862  4.043430e-82 -19.195402
## transmission=Manual      6.055262  9.913378 34.433198  5.693426e-91 -20.226750
## manufacturer=VW          3.333333  4.812320 30.364372 5.386123e-114 -22.691899
## auxMileage=[0,6]         1.815312  2.213667 25.647773 1.172720e-114 -22.758854
##
## $`3`
##                             Cla/Mod   Mod/Cla    Global       p.value     v.test
## manufacturer=VW          48.4666667 76.849894 30.364372 1.181596e-244  33.404446
## transmission=Manual      42.9747208 77.272727 34.433198 1.180846e-201  30.299022
## fuelType=Petrol          36.3504356 79.386892 41.821862 3.558576e-152  26.276517
## auxAge=(1,3]             40.1033973 57.399577 27.408907 1.762010e-106  21.917683
## auxPrice=[0,15]          38.5037749 59.302326 29.493927 2.896717e-102  21.471164
## auxMpg=(53,62]           38.0271084 53.382664 26.882591  1.177743e-84  19.496405
## auxMileage=(17,34]       36.8421053 48.097252 25.000000  2.040546e-67  17.348050
## auxMileage=(6,17]        28.4329564 37.209302 25.060729  1.659183e-20   9.282262
## auxAge=(3,4]             25.9049774 24.207188 17.894737  4.596212e-08   5.466263
## auxTax=(145,570]         21.7622708 38.900634 34.230769  8.336188e-04   3.341384
## fuelType=Hybrid           0.0000000  0.000000  1.518219  1.041458e-07  -5.319337
## auxPrice=(20,26]         12.1184089 13.847780 21.882591  4.713648e-12  -6.913943
## auxMpg=(62,470]          12.2077922 14.904863 23.380567  1.140198e-12  -7.112427
## auxTax=[0,125]            1.4336918  0.422833  5.647773  2.893632e-21  -9.466505
## auxAge=(4,22]             6.3030303  5.496829 16.700405  7.441628e-30 -11.349702
## auxMileage=(34,153]       7.2500000  9.196617 24.291498  8.738095e-39 -13.025713
## transmission=SemiAuto     9.3650794 18.710359 38.259109  1.540607e-46 -14.324396
## auxMpg=[5,45]             6.2550772  8.139535 24.919028  1.265030e-47 -14.497032
## auxMileage=[0,6]          4.1041831  5.496829 25.647773  3.843991e-70 -17.704895
## auxAge=[0,1]              6.4997336 12.896406 37.995951  4.151697e-79 -18.831706
## manufacturer=BMW          1.7241379  2.008457 22.307692  2.542713e-86 -19.691650
## transmission=Automatic    2.8169014  4.016913 27.307692  1.401991e-92 -20.408616
## auxPrice=(26,90]          0.9661836  1.268499 25.141700 2.008873e-112 -22.532166
## manufacturer=Mercedes     1.0711553  1.479915 26.457490 2.051364e-117 -23.035592
## fuelType=Diesel           6.9667738 20.613108 56.659919 4.216957e-140 -25.197963
##
## $`4`
##                             Cla/Mod    Mod/Cla    Global       p.value     v.test
## auxAge=(4,22]            78.5454545 66.1224490 16.700405  0.000000e+00        Inf
## auxMileage=(34,153]      69.6666667 85.3061224 24.291498  0.000000e+00        Inf
```

```
## auxTax=(145,570]       47.1318746 81.3265306 34.230769 3.869569e-257  34.253490
## auxPrice=[0,15]        43.5827042 64.7959184 29.493927 7.354123e-149  25.984809
## auxMpg=(62,470]        38.6147186 45.5102041 23.380567  2.945751e-67  17.326943
## fuelType=Diesel        27.3669168 78.1632653 56.659919  4.289837e-55  15.633724
## auxAge=(3,4]           33.2579186 30.0000000 17.894737  8.747247e-26  10.498814
## Audi=Yes               30.0678952 31.6326531 20.870445  4.917659e-19   8.914106
## manufacturer=Audi      30.0678952 31.6326531 20.870445  4.917659e-19   8.914106
## transmission=Manual    26.3962375 45.8163265 34.433198  1.613863e-16   8.247764
## transmission=Automatic 23.5730170 32.4489796 27.307692  6.835500e-05   3.981940
## auxMpg=(45,53]         15.9869494 20.0000000 24.817814  7.393648e-05  -3.963249
## manufacturer=VW        15.9333333 24.3877551 30.364372  4.023900e-06  -4.610144
## fuelType=Hybrid         1.3333333  0.1020408  1.518219  1.140226e-06  -4.865752
## manufacturer=Mercedes  15.0726855 20.1020408 26.457490  2.714442e-07  -5.142266
## auxMpg=[5,45]          13.7286759 17.2448980 24.919028  1.688538e-10  -6.387288
## auxMpg=(53,62]         12.7259036 17.2448980 26.882591  3.712917e-15  -7.864258
## Audi=No                17.1399335 68.3673469 79.129555  4.917659e-19  -8.914106
## auxMileage=(17,34]     11.1740891 14.0816327 25.000000  2.632584e-20  -9.232958
## auxTax=[0,125]          0.3584229  0.1020408  5.647773  1.615334e-26 -10.657113
## transmission=SemiAuto  11.2698413 21.7346939 38.259109  1.481251e-34 -12.260205
## auxPrice=(20,26]        6.2904718  6.9387755 21.882591  7.552188e-44 -13.887405
## fuelType=Petrol        10.3097773 21.7346939 41.821862  8.157435e-49 -14.684046
## auxPrice=(26,90]        3.3011272  4.1836735 25.141700  2.480675e-82 -19.220769
## auxAge=(1,3]            2.8064993  3.8775510 27.408907  1.710014e-98 -21.063772
## auxMileage=(6,17]       0.4038772  0.5102041 25.060729 4.288318e-129 -24.172913
## auxMileage=[0,6]        0.0789266  0.1020408 25.647773 1.745978e-141 -25.323826
## auxTax=(125,145]        6.1279461 18.5714286 60.121457 5.430749e-196 -29.866067
## auxAge=[0,1]            0.0000000  0.0000000 37.995951 1.367791e-235 -32.774317
##
## $`5`
##                          Cla/Mod    Mod/Cla    Global       p.value     v.test
## auxTax=[0,125]         98.2078853 89.2508143  5.647773  0.000000e+00        Inf
## auxMpg=(53,62]         17.9969880 77.8501629 26.882591  5.531893e-83  19.298474
## auxAge=(3,4]           16.4027149 47.2312704 17.894737  1.574026e-34  12.255281
## auxMileage=(34,153]    13.4166667 52.4429967 24.291498  4.435687e-28  10.986548
## auxPrice=(15,20]       12.1551724 45.9283388 23.481781  4.706616e-19   8.918966
## auxAge=(4,22]          12.7272727 34.2019544 16.700405  1.078847e-14   7.729600
## fuelType=Hybrid        32.0000000  7.8175896  1.518219  7.337219e-12   6.850928
## manufacturer=BMW       10.2540835 36.8078176 22.307692  2.567002e-09   5.957134
## auxPrice=[0,15]         9.4028826 44.6254072 29.493927  6.995736e-09   5.791027
## auxMileage=(17,34]      9.6356275 38.7622150 25.000000  3.896691e-08   5.495471
## Audi=No                 6.7280634 85.6677524 79.129555  2.596629e-03   3.011848
## transmission=Automatic  7.9318013 34.8534202 27.307692  2.743285e-03   2.995129
## fuelType=Diesel         6.8238657 62.2149837 56.659919  4.201256e-02   2.033396
## Audi=Yes                4.2677013 14.3322476 20.870445  2.596629e-03  -3.011848
## manufacturer=Audi       4.2677013 14.3322476 20.870445  2.596629e-03  -3.011848
## transmission=SemiAuto   4.7619048 29.3159609 38.259109  7.376025e-04  -3.375207
## auxAge=(1,3]            4.0620384 17.9153094 27.408907  6.584222e-05  -3.990831
## fuelType=Petrol         4.4530494 29.9674267 41.821862  1.017581e-05  -4.413404
## manufacturer=VW         3.8000000 18.5667752 30.364372  1.379556e-06  -4.827936
## auxPrice=(20,26]        2.1276596  7.4918567 21.882591  3.187084e-12  -6.969218
## auxMileage=(6,17]       2.1001616  8.4690554 25.060729  2.229692e-14  -7.636637
## auxPrice=(26,90]        0.4830918  1.9543974 25.141700  2.510927e-31 -11.642320
## auxTax=(145,570]        1.0644589  5.8631922 34.230769  2.030019e-34 -12.234640
## auxMpg=(62,470]         0.0000000  0.0000000 23.380567  1.473818e-37 -12.808271
## auxMileage=[0,6]        0.0789266  0.3257329 25.647773  1.147694e-39 -13.179751
## auxMpg=[5,45]           0.0000000  0.0000000 24.919028  2.224397e-40 -13.302975
## auxAge=[0,1]            0.1065530  0.6514658 37.995951  8.758938e-63 -16.724031
## auxTax=(125,145]        0.5050505  4.8859935 60.121457 3.181254e-101 -21.359511
```

6.9 res.hcpcMCA*desc.var*quanti

```
res.hcpcMCA$desc.var$quanti #description of each cluster by the quantitative variables
```

```
## $`1`
##                v.test Mean in category Overall mean sd in category   Overall sd
## price       41.915003     2.935396e+04 21176.744332   9111.8657138 9.789187e+03
## engineSize   5.455484     1.966084e+00     1.908200      0.5175281 5.323977e-01
## tax         -6.403038     1.454630e+02   146.831552      2.0787671 1.072500e+01
## mpg        -33.837108     4.525400e+01    53.007951      9.6105623 1.149848e+01
## mileage    -44.804378     4.966876e+03 22024.672986   4499.1343456 1.910352e+04
## age        -48.571081     8.788969e-01     2.754676      0.5191403 1.937826e+00
##                  p.value
## price       0.000000e+00
## engineSize  4.883949e-08
## tax         1.523156e-10
## mpg        5.616525e-251
## mileage     0.000000e+00
## age         0.000000e+00
##
## $`2`
##                v.test Mean in category Overall mean sd in category   Overall sd
## mpg         16.745920        58.316919     53.00795     11.4303402   11.4984811
## engineSize 14.349369         2.118835      1.90820      0.4734369    0.5323977
## price       4.508438     22393.584216  21176.74433   6941.0456466 9789.1874029
## tax         3.645093       147.909423    146.83155      9.6931442   10.7250047
##                  p.value
## mpg        6.064583e-63
## engineSize 1.075108e-46
## price      6.530664e-06
## tax        2.672956e-04
##
## $`3`
##                v.test Mean in category Overall mean sd in category   Overall sd
## mpg          7.837828        55.642918    53.007951       7.663939 1.149848e+01
## age          2.527445         2.897873     2.754676       1.182717 1.937826e+00
## mileage     -2.462882     20649.061311 22024.672986   11295.633669 1.910352e+04
## price      -22.625310     14701.142706 21176.744332    5085.794087 9.789187e+03
## engineSize -30.169767         1.438579     1.908200       0.398470 5.323977e-01
##                  p.value
## mpg         4.584049e-15
## age         1.148957e-02
## mileage     1.378254e-02
## price      2.442428e-113
## engineSize 5.905482e-200
##
## $`4`
##                v.test Mean in category Overall mean sd in category   Overall sd
## mileage     46.846036     47622.391419 22024.672986   1.433247e+04 1.910352e+04
## age         45.997638         5.304236     2.754676   1.404407e+00 1.937826e+00
## tax         23.652834       154.087526   146.831552   1.524896e+01 1.072500e+01
## mpg         12.228716        57.029898    53.007951   1.233985e+01 1.149848e+01
## engineSize   9.232182         2.048790     1.908200   5.164597e-01 5.323977e-01
## price      -25.461125     14047.569388 21176.744332   6.471259e+03 9.789187e+03
##                  p.value
## mileage     0.000000e+00
## age         0.000000e+00
## tax        1.103651e-123
## mpg         2.183624e-34
## engineSize  2.651751e-20
## price      5.316137e-143
##
```

```
## $`5`
##             v.test Mean in category Overall mean sd in category   Overall sd
## age      16.234627         4.493675     2.754676       1.409056     1.937826
## mileage  15.603396     38501.552214 22024.672986   16962.806920 19103.518682
## mpg       5.039634        56.211135    53.007951       3.328431    11.498481
## price   -10.783486     15341.644951 21176.744332    4542.840248  9789.187403
## tax     -33.260191       127.113470   146.831552       6.327003    10.725005
##               p.value
## age      2.869855e-59
## mileage  6.902230e-55
## mpg      4.664226e-07
## price    4.119726e-27
## tax     1.454090e-242
```