PCA analysis of NYCABS datase

Katerina Dimitrova, Jose Romero, Sergi Munoz

March 18, 2018

Previous work

Load requiered packages

PCA analysis

1. The Kaiser rule is to drop all components with eigenvalues under 1.0 According to the Elbow rule when the drop ceases and the curve makes an elbow toward less steep declinewe should drop all further components after the one starting the elbow.

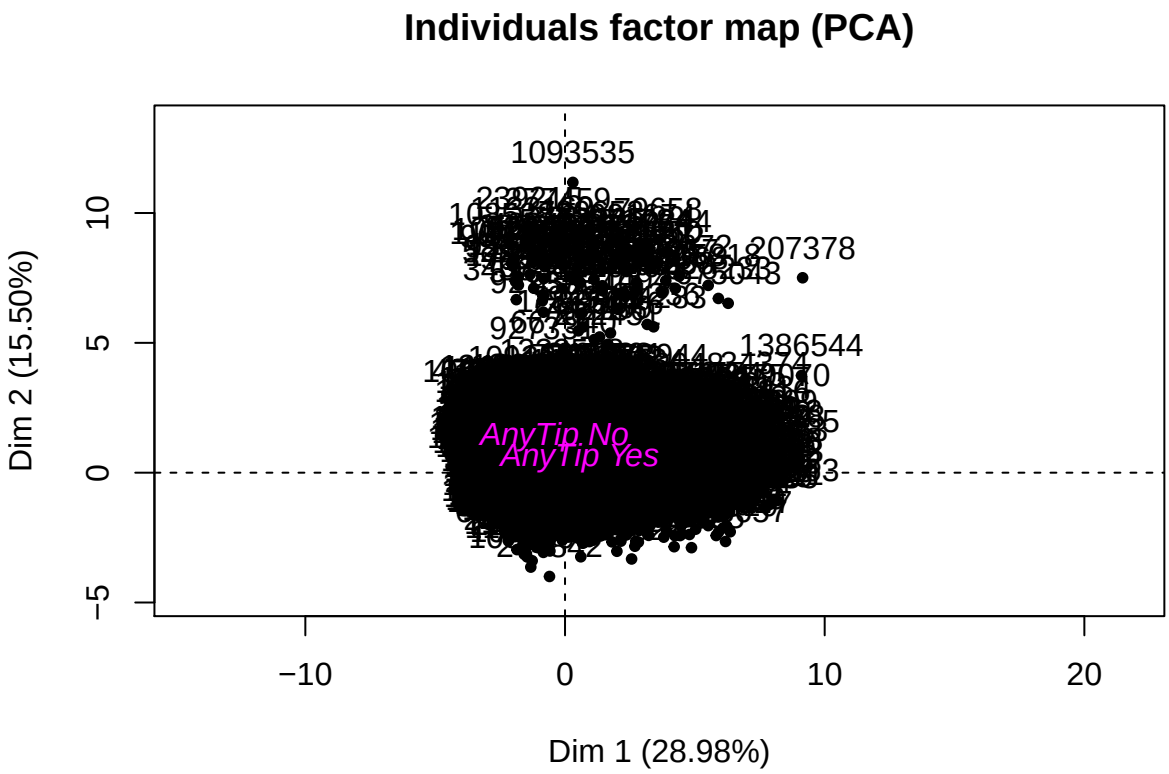
I. I. Eigenvalues and axes

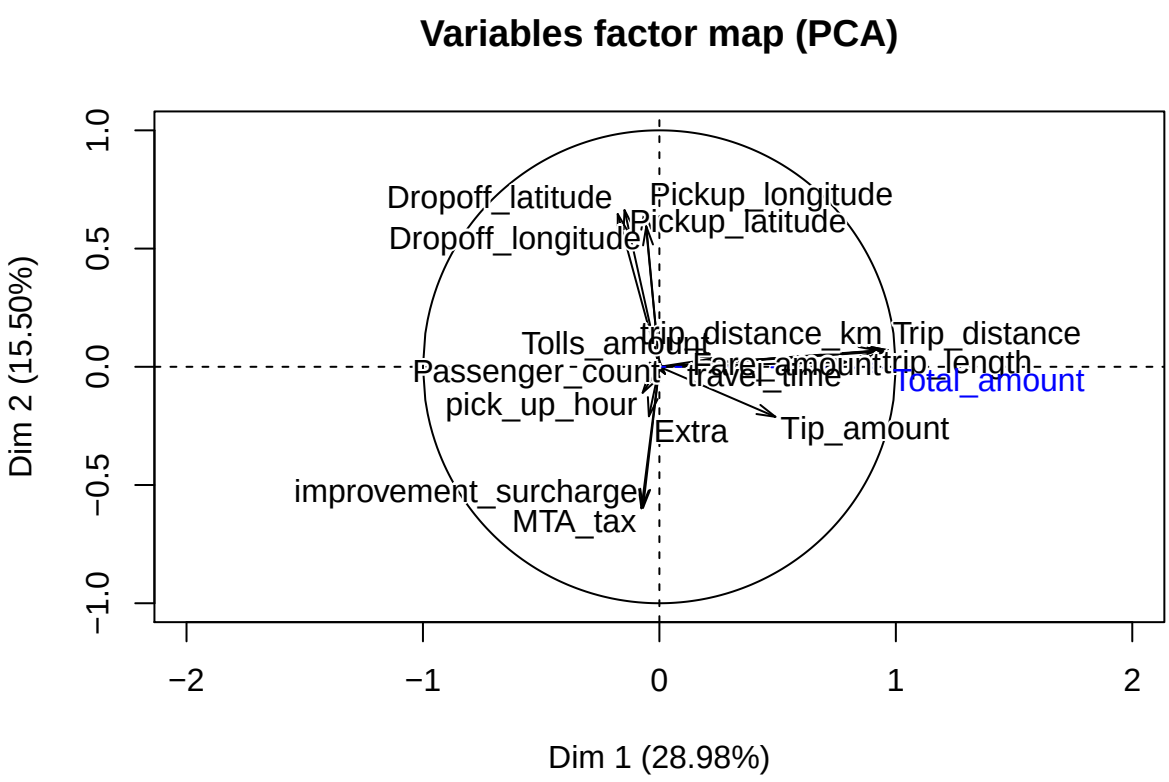
For the PCA analysis we take all numerical variables as activ, where TotalAmount nd Anytip are supementary.

```
load("Taxi5000_raw_DataClean.RData")
library(FactoMineR)
names (df)
```

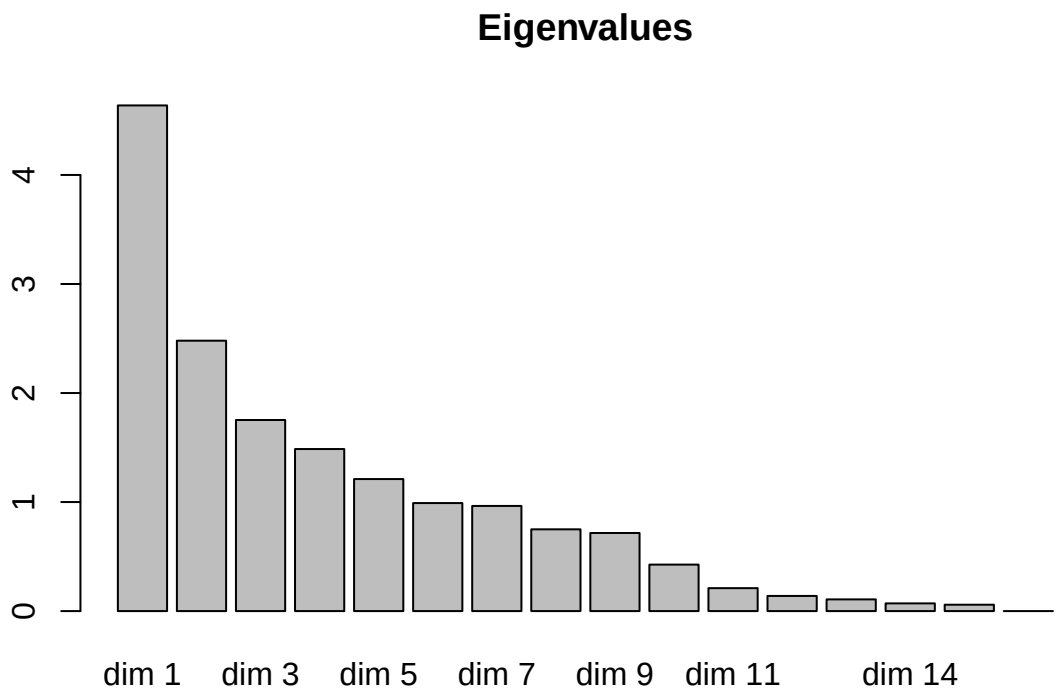
```
##  [1] "VendorID"                "lpep_pickup_datetime"
##  [3] "Lpep_dropoff_datetime"   "Store_and_fwd_flag"
##  [5] "RateCodeID"              "Pickup_longitude"
##  [7] "Pickup_latitude"         "Dropoff_longitude"
##  [9] "Dropoff_latitude"        "Passenger_count"
## [11] "Trip_distance"           "Fare_amount"
## [13] "Extra"                   "MTA_tax"
## [15] "Tip_amount"              "Tolls_amount"
## [17] "improvement_surcharge"   "Total_amount"
## [19] "Payment_type"            "Trip_type"
## [21] "mis_ind"                 "AnyTip"
## [23] "trip_length"             "trip_distance_km"
## [25] "travel_time"             "pick_up_hour"
## [27] "pick_up_period"          "espeed"
## [29] "f.passenger"             "f.distance"
## [31] "f.pickup_longitude"      "f.pickup_latitude"
## [33] "f.dropoff_longitude"     "f.dropoff_latitude"
## [35] "f.fare_amount"           "f.extra"
## [37] "f.MTA_tax"               "f.Improvement_surcharge"
## [39] "f.tip_amount"            "f.toll"
## [41] "f.total"
```

```
vars_con_pca<-c(6,7,8,9,10,11,12,13,14,15,16,17,18,22,23,24,25,26)

#From te plot we see that the variables "Trip_distance", "Trip_length", "Travel_time" and "Fare_amount"
res.pca<-PCA(df[,vars_con_pca], quanti.sup = 13, quali.sup = 14, ncp = 6 ) # TotalAmount and AnyTip
```

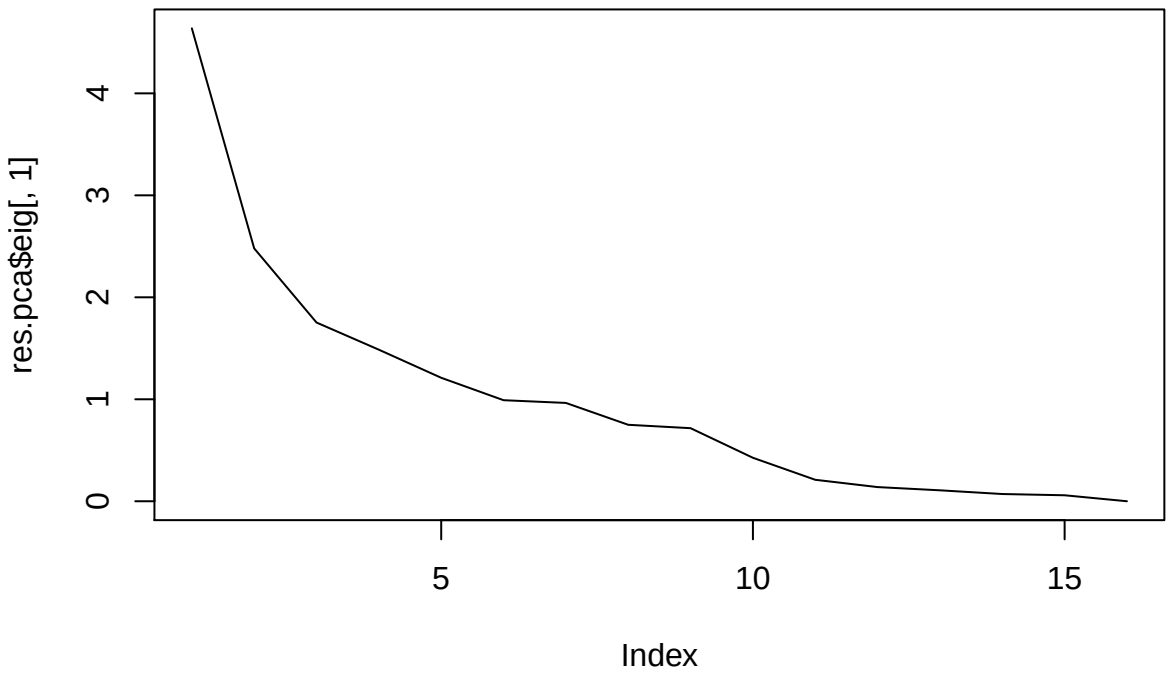

Individuals factor map (PCA)
1093535
207378
1386544
AnyTip No
AnyTip Yes
Dim 2 (15.50%)
Dim 1 (28.98%)
10
5
0
−5
−10
0
10
20




```
barplot(res.pca$eig[,1], main="Eigenvalues", names.arg = paste("dim", 1:nrow(res.pca$eig)))
```



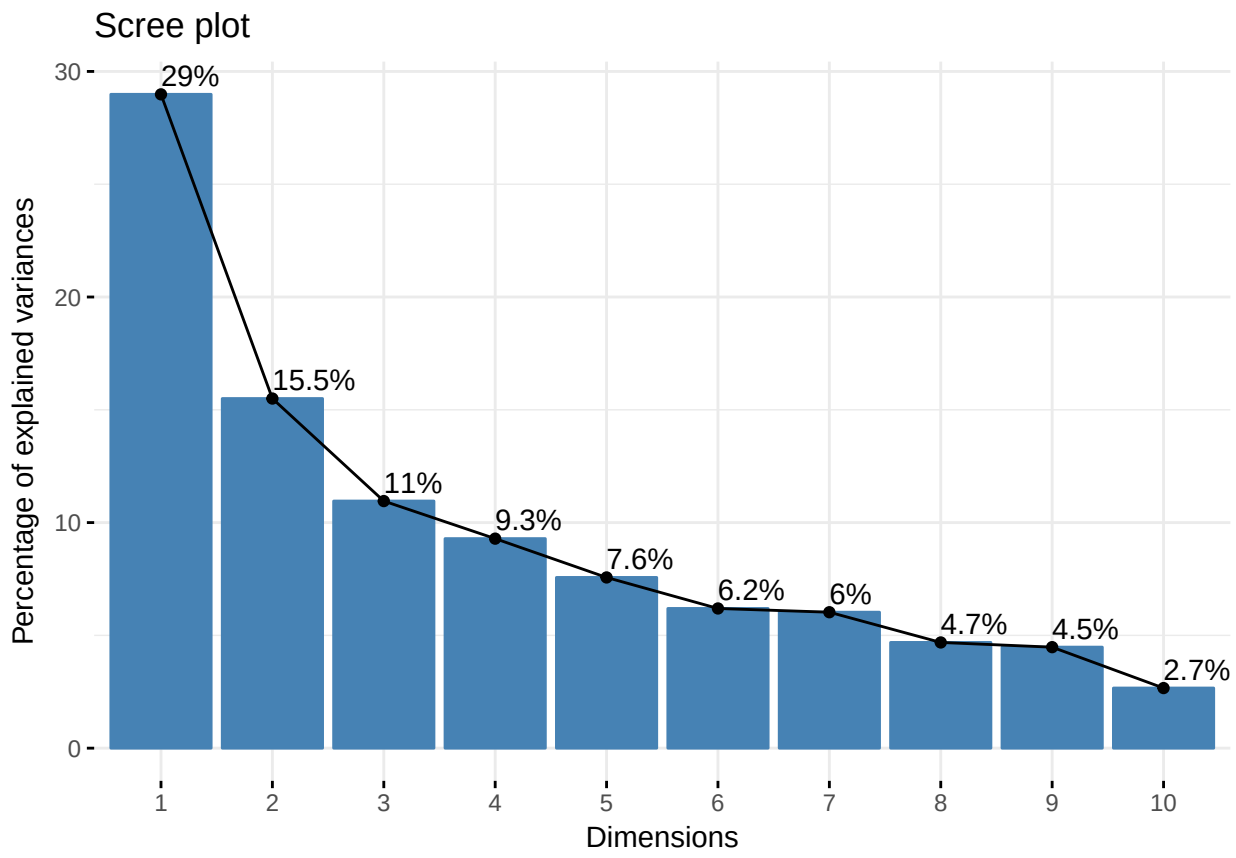

```
# With the PCA transformation the PC1 covers 29% of the variance, PC2 - 15,5%, PCA3 - 11%, PCA4 - 9,3% 
plot(res.pca$eig[,1], type = "l") # line chart
```



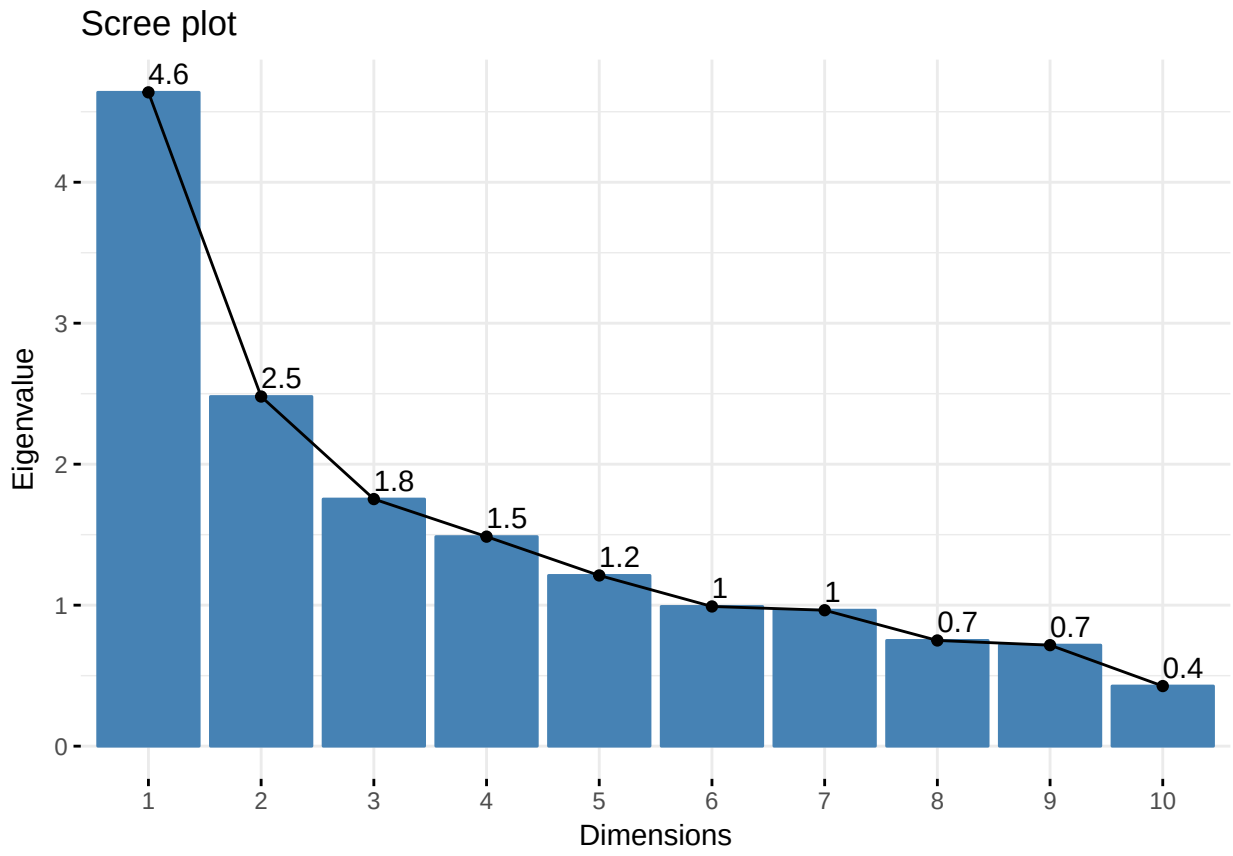

```
length <-length(which(res.pca$eig[,1]>=1));length
```

```
## [1] 5
```

```
kaiser <- res.pca$eig[1:length,1] #keep only EV >=1 ->first 7
#If we use the kaiser rule we have to keep all EV greater than 1, which results in saving the first 6 d
#facto extra
fviz_eig(res.pca, addlabels = TRUE)
```




```
fviz_eig(res.pca, choice = "eigenvalue",addlabels = TRUE)
```




```
#According to the elbow rule we have to take the first 6 dimentions as the slope of the graphic shows.
elbow <- kaiser
```

II. Individuals point of view

Look at variables that are too contributive

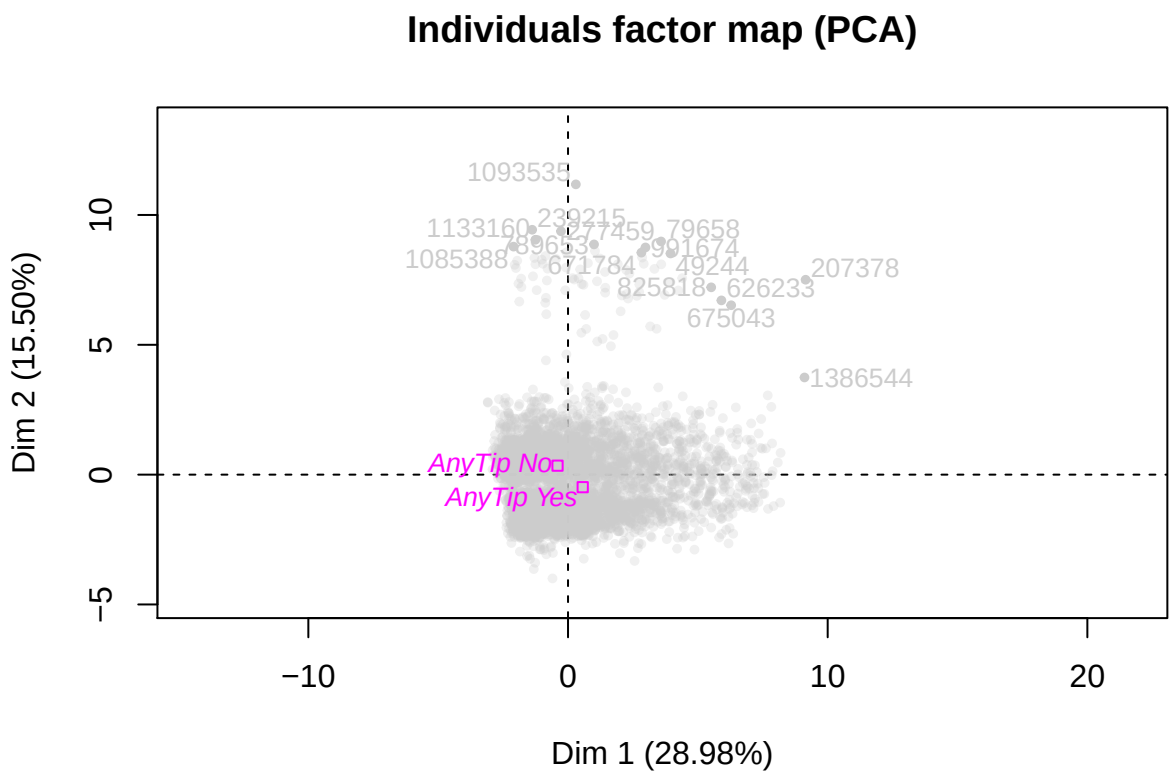
```
summary(res.pca, dig = 2, nbelements = 17, nbind=3, ncp=4)
```

```
##
## Call:
## PCA(X = df[, vars_con_pca], ncp = 6, quanti.sup = 13, quali.sup = 14)
##
##
## Eigenvalues
##                        Dim.1   Dim.2   Dim.3   Dim.4   Dim.5   Dim.6
## Variance               4.638   2.480   1.753   1.486   1.211   0.991
## % of var.             28.984  15.499  10.954   9.288   7.568   6.193
## Cumulative % of var.  28.984  44.483  55.437  64.725  72.293  78.485
##                        Dim.7   Dim.8   Dim.9  Dim.10  Dim.11  Dim.12
## Variance               0.964   0.750   0.716   0.426   0.210   0.139
## % of var.              6.026   4.686   4.478   2.664   1.315   0.868
## Cumulative % of var.  84.512  89.198  93.675  96.339  97.654  98.522
##                       Dim.13  Dim.14  Dim.15  Dim.16
## Variance               0.107   0.071   0.058   0.000
```

```
## % of var.              0.670   0.442   0.365   0.000
## Cumulative % of var.  99.192  99.635 100.000 100.000
##
## Individuals (the 3 first)
##                          Dist    Dim.1    ctr   cos2    Dim.2    ctr
## 285                   |  3.346 |  1.366  0.008  0.167 | -0.018  0.000
## 307                   |  3.299 |  1.648  0.012  0.249 |  0.833  0.006
## 401                   |  2.613 |  0.939  0.004  0.129 | -0.259  0.001
##                          cos2    Dim.3    ctr   cos2    Dim.4    ctr   cos2
## 285                   0.000 |  0.066  0.000  0.000 |  1.838  0.047  0.302
## 307                   0.064 |  0.839  0.008  0.065 | -0.398  0.002  0.015
## 401                   0.010 |  0.007  0.000  0.000 |  0.383  0.002  0.021
##
## 285                   |
## 307                   |
## 401                   |
##
## Variables
##                            Dim.1    ctr   cos2    Dim.2    ctr   cos2
## Pickup_longitude      | -0.063  0.086  0.004 |  0.660 17.558  0.435 |
## Pickup_latitude       | -0.148  0.469  0.022 |  0.663 17.705  0.439 |
## Dropoff_longitude     | -0.055  0.066  0.003 |  0.593 14.203  0.352 |
## Dropoff_latitude      | -0.176  0.670  0.031 |  0.646 16.838  0.418 |
## Passenger_count       |  0.024  0.013  0.001 | -0.030  0.037  0.001 |
## Trip_distance         |  0.965 20.099  0.932 |  0.070  0.199  0.005 |
## Fare_amount           |  0.960 19.853  0.921 |  0.066  0.176  0.004 |
## Extra                 | -0.044  0.043  0.002 | -0.209  1.765  0.044 |
## MTA_tax               | -0.076  0.124  0.006 | -0.599 14.447  0.358 |
## Tip_amount            |  0.491  5.193  0.241 | -0.212  1.805  0.045 |
## Tolls_amount          |  0.234  1.176  0.055 |  0.036  0.052  0.001 |
## improvement_surcharge | -0.069  0.103  0.005 | -0.596 14.321  0.355 |
## trip_length           |  0.922 18.340  0.851 |  0.069  0.191  0.005 |
## trip_distance_km      |  0.965 20.099  0.932 |  0.070  0.199  0.005 |
## travel_time           |  0.793 13.557  0.629 |  0.020  0.016  0.000 |
## pick_up_hour          | -0.071  0.108  0.005 | -0.110  0.488  0.012 |
##                           Dim.3    ctr   cos2    Dim.4    ctr   cos2
## Pickup_longitude       0.306  5.349  0.094 |  0.572 21.996  0.327 |
## Pickup_latitude        0.418  9.953  0.174 | -0.513 17.683  0.263 |
## Dropoff_longitude      0.287  4.688  0.082 |  0.663 29.570  0.439 |
## Dropoff_latitude       0.415  9.836  0.172 | -0.527 18.706  0.278 |
## Passenger_count        0.026  0.039  0.001 |  0.112  0.845  0.013 |
## Trip_distance          0.078  0.350  0.006 |  0.007  0.003  0.000 |
## Fare_amount            0.042  0.102  0.002 |  0.003  0.001  0.000 |
## Extra                  0.129  0.951  0.017 |  0.325  7.128  0.106 |
## MTA_tax                0.763 33.210  0.582 |  0.022  0.034  0.001 |
## Tip_amount             0.013  0.010  0.000 | -0.145  1.407  0.021 |
## Tolls_amount           0.138  1.090  0.019 | -0.161  1.739  0.026 |
## improvement_surcharge  0.767 33.530  0.588 |  0.037  0.091  0.001 |
## trip_length            0.088  0.439  0.008 |  0.032  0.068  0.001 |
## trip_distance_km       0.078  0.350  0.006 |  0.007  0.003  0.000 |
## travel_time           -0.034  0.067  0.001 | -0.011  0.008  0.000 |
## pick_up_hour          -0.025  0.036  0.001 |  0.103  0.717  0.011 |
##
## Supplementary continuous variable
```

```
##                          Dim.1   cos2    Dim.2   cos2    Dim.3   cos2
## Total_amount           |  0.966  0.933 | -0.004  0.000 |  0.068  0.005 |
##                         Dim.4   cos2
## Total_amount           -0.029  0.001 |
##
## Supplementary categories
##                             Dist     Dim.1    cos2  v.test     Dim.2
## AnyTip No               |   0.742 |  -0.404   0.296 -15.479 |   0.346
## AnyTip Yes              |   1.040 |   0.566   0.296  15.479 |  -0.484
##                            cos2  v.test     Dim.3    cos2  v.test     Dim.4
## AnyTip No                 0.217  18.114 |   0.031   0.002   1.951 |   0.168
## AnyTip Yes                0.217 -18.114 |  -0.044   0.002  -1.951 |  -0.235
##                            cos2  v.test
## AnyTip No                 0.051  11.350 |
## AnyTip Yes                0.051 -11.350 |
```

```
#The summary confirms the correlations between the variables that we already interpreted from the plots
#The plot show us that individuals that had to pay more tend to leave a tip.
plot.PCA(res.pca, choix=c("ind"),cex=0.8,col.ind="grey80",select="contrib15",axes=c(1,2))
```




```
#DIMENSION1
#Since the multivariant detection didnt manage to find outliers well enogh we are going to obtain them

#characteristic of extreme otliers in dim1
summary(res.pca$ind$coord[,1])
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
```

```
## -3.0923 -1.5874 -0.6932  0.0000  1.0294  9.1502
```

```
iqrvar<-IQR(res.pca$ind$coord[,1])
quantil3<-quantile(res.pca$ind$coord[,1], .75);quantil3 #get 3rd quartile
```

```
##      75%
## 1.029432
```

```
outliers<-which(res.pca$ind$coord[,1]>(iqrvar*3)+quantil3);length(outliers)
```

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

```
df$f.outlierPCAd1<-0
df[outliers,"f.outlierPCAd1"]<-1
df$f.outlierPCAd1<-factor(df$f.outlierPCAd1,labels=c("NoOutDim1", "YesOutDim1"))
summary(df$f.outlierPCAd1)
```

```
##  NoOutDim1 YesOutDim1
##       4864          2
```

```
names(df)
```

```
##  [1] "VendorID"                "lpep_pickup_datetime"
##  [3] "Lpep_dropoff_datetime"   "Store_and_fwd_flag"
##  [5] "RateCodeID"              "Pickup_longitude"
##  [7] "Pickup_latitude"         "Dropoff_longitude"
##  [9] "Dropoff_latitude"        "Passenger_count"
## [11] "Trip_distance"           "Fare_amount"
## [13] "Extra"                   "MTA_tax"
## [15] "Tip_amount"              "Tolls_amount"
## [17] "improvement_surcharge"   "Total_amount"
## [19] "Payment_type"            "Trip_type"
## [21] "mis_ind"                 "AnyTip"
## [23] "trip_length"             "trip_distance_km"
## [25] "travel_time"             "pick_up_hour"
## [27] "pick_up_period"          "espeed"
## [29] "f.passenger"             "f.distance"
## [31] "f.pickup_longitude"      "f.pickup_latitude"
## [33] "f.dropoff_longitude"     "f.dropoff_latitude"
## [35] "f.fare_amount"           "f.extra"
## [37] "f.MTA_tax"               "f.Improvement_surcharge"
## [39] "f.tip_amount"            "f.toll"
## [41] "f.total"                 "f.outlierPCAd1"
```

```
#catdes(,names(df)[c(22)])

#DIMENSION2
#characteristic of extreme otliers in dim1
summary(res.pca$ind$coord[,2])
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -3.9975 -1.1969  0.2116  0.0000  0.8072 11.1786
```

```
iqrvar<-IQR(res.pca$ind$coord[,2])
quantil3<-quantile(res.pca$ind$coord[,2], .75);quantil3 #get 3rd quartile
```

```
##       75%
## 0.8072157
```

```
outliers2<-which(res.pca$ind$coord[,2]>(iqrvar*3)+quantil3);length(outliers2)
```

```
## [1] 60
```

```
df$f.outlierPCAd2<-0
df[outliers2,"f.outlierPCAd2"]<-1
df$f.outlierPCAd2<-factor(df$f.outlierPCAd2,labels=c("NoOutDim2", "YesOutDim2"))
summary(df$f.outlierPCAd2)
```

```
##  NoOutDim2 YesOutDim2
##       4806         60
```

```
names(df)
```

```
##  [1] "VendorID"                "lpep_pickup_datetime"
##  [3] "Lpep_dropoff_datetime"   "Store_and_fwd_flag"
##  [5] "RateCodeID"              "Pickup_longitude"
##  [7] "Pickup_latitude"         "Dropoff_longitude"
##  [9] "Dropoff_latitude"        "Passenger_count"
## [11] "Trip_distance"           "Fare_amount"
## [13] "Extra"                   "MTA_tax"
## [15] "Tip_amount"              "Tolls_amount"
## [17] "improvement_surcharge"   "Total_amount"
## [19] "Payment_type"            "Trip_type"
## [21] "mis_ind"                 "AnyTip"
## [23] "trip_length"             "trip_distance_km"
## [25] "travel_time"             "pick_up_hour"
## [27] "pick_up_period"          "espeed"
## [29] "f.passenger"             "f.distance"
## [31] "f.pickup_longitude"      "f.pickup_latitude"
## [33] "f.dropoff_longitude"     "f.dropoff_latitude"
## [35] "f.fare_amount"           "f.extra"
## [37] "f.MTA_tax"               "f.Improvement_surcharge"
## [39] "f.tip_amount"            "f.toll"
## [41] "f.total"                 "f.outlierPCAd1"
## [43] "f.outlierPCAd2"
```

```
#DIMENSION3
#characteristic of extreme otliers in dim1
summary(res.pca$ind$coord[,3])
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -10.9758  -0.5999   0.3556   0.0000   0.6596   3.0814
```

```
iqrvar<-IQR(res.pca$ind$coord[,3])
quantil3<-quantile(res.pca$ind$coord[,3], .75);quantil3 #get 3rd quartile
```

```
##       75%
## 0.6595931
```

```
outliers3<-which(res.pca$ind$coord[,3]>(iqrvar*3)+quantil3);length(outliers3)
```

```
## [1] 0
```

```
df$f.outlierPCAd3<-0
df$f.outlierPCAd3<-factor(df$f.outlierPCAd3,labels=c("NoOutDim3"))
summary(df$f.outlierPCAd3)
```

```
## NoOutDim3
##      4866
```

```
names(df)
```

```
##  [1] "VendorID"                "lpep_pickup_datetime"
##  [3] "Lpep_dropoff_datetime"   "Store_and_fwd_flag"
##  [5] "RateCodeID"              "Pickup_longitude"
##  [7] "Pickup_latitude"         "Dropoff_longitude"
##  [9] "Dropoff_latitude"        "Passenger_count"
## [11] "Trip_distance"           "Fare_amount"
## [13] "Extra"                   "MTA_tax"
## [15] "Tip_amount"              "Tolls_amount"
## [17] "improvement_surcharge"   "Total_amount"
## [19] "Payment_type"            "Trip_type"
## [21] "mis_ind"                 "AnyTip"
## [23] "trip_length"             "trip_distance_km"
## [25] "travel_time"             "pick_up_hour"
## [27] "pick_up_period"          "espeed"
## [29] "f.passenger"             "f.distance"
## [31] "f.pickup_longitude"      "f.pickup_latitude"
## [33] "f.dropoff_longitude"     "f.dropoff_latitude"
## [35] "f.fare_amount"           "f.extra"
## [37] "f.MTA_tax"               "f.Improvement_surcharge"
## [39] "f.tip_amount"            "f.toll"
## [41] "f.total"                 "f.outlierPCAd1"
## [43] "f.outlierPCAd2"          "f.outlierPCAd3"
```

```
#DIMENSION4
#characteristic of extreme otliers in dim1
summary(res.pca$ind$coord[,4])
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -5.07857 -0.95074 -0.09769  0.00000  0.69112  4.57227
```

```
iqrvar<-IQR(res.pca$ind$coord[,4])
quantil3<-quantile(res.pca$ind$coord[,4], .75);quantil3 #get 3rd quartile
```

```
##       75%
## 0.6911202
```

```
outliers4<-which(res.pca$ind$coord[,4]>(iqrvar*3)+quantil3);length(outliers4)
```

```
## [1] 0
```

```
df$f.outlierPCAd4<-0
df$f.outlierPCAd4<-factor(df$f.outlierPCAd4,labels=c("NoOutDim4"))
summary(df$f.outlierPCAd4)
```

```
## NoOutDim4
##      4866
```

```
names(df)
```

```
##  [1] "VendorID"                "lpep_pickup_datetime"
##  [3] "Lpep_dropoff_datetime"   "Store_and_fwd_flag"
##  [5] "RateCodeID"              "Pickup_longitude"
##  [7] "Pickup_latitude"         "Dropoff_longitude"
##  [9] "Dropoff_latitude"        "Passenger_count"
```

```
## [11] "Trip_distance"           "Fare_amount"
## [13] "Extra"                   "MTA_tax"
## [15] "Tip_amount"              "Tolls_amount"
## [17] "improvement_surcharge"   "Total_amount"
## [19] "Payment_type"            "Trip_type"
## [21] "mis_ind"                 "AnyTip"
## [23] "trip_length"             "trip_distance_km"
## [25] "travel_time"             "pick_up_hour"
## [27] "pick_up_period"          "espeed"
## [29] "f.passenger"             "f.distance"
## [31] "f.pickup_longitude"      "f.pickup_latitude"
## [33] "f.dropoff_longitude"     "f.dropoff_latitude"
## [35] "f.fare_amount"           "f.extra"
## [37] "f.MTA_tax"               "f.Improvement_surcharge"
## [39] "f.tip_amount"            "f.toll"
## [41] "f.total"                 "f.outlierPCAd1"
## [43] "f.outlierPCAd2"          "f.outlierPCAd3"
## [45] "f.outlierPCAd4"
```

```
#Finally we obtained 62 extreme outliers.
llvout<- c(outliers, outliers2);length(llvout)
```

```
## [1] 62
```

```
catdes(df, 42)
```

```
## $test.chi2
##                               p.value df
## f.outlierPCAd3          0.000000e+00  1
## f.outlierPCAd4          0.000000e+00  1
## Trip_type               7.361875e-28  1
## f.Improvement_surcharge 3.287829e-27  1
## RateCodeID              6.763510e-27  1
## f.MTA_tax               6.763510e-27  1
## f.outlierPCAd2          4.083972e-10  1
##
## $category
## $category$NoOutDim1
##                                              Cla/Mod   Mod/Cla      Global
## Trip_type=Street-hail                      100.00000 98.396382 98.35593917
## f.Improvement_surcharge=(0.1,0.8]          100.00000 98.355263 98.31483765
## f.MTA_tax=(0.4,0.5]                        100.00000 98.334704 98.29428689
## RateCodeID=Standard rate                   100.00000 98.334704 98.29428689
## f.outlierPCAd2=NoOutDim2                    99.97919 98.787007 98.76695438
## f.outlierPCAd2=YesOutDim2                   98.33333  1.212993  1.23304562
## Lpep_dropoff_datetime=2016-01-31 02:00:28    0.00000  0.000000  0.02055076
## Lpep_dropoff_datetime=2016-01-05 09:29:16    0.00000  0.000000  0.02055076
## lpep_pickup_datetime=2016-01-30 22:25:55     0.00000  0.000000  0.02055076
## lpep_pickup_datetime=2016-01-05 08:34:06     0.00000  0.000000  0.02055076
## f.MTA_tax=(-0.1,0.4]                        97.59036  1.665296  1.70571311
## RateCodeID=Special rate                     97.59036  1.665296  1.70571311
## f.Improvement_surcharge=(-0.1,0.1]          97.56098  1.644737  1.68516235
## Trip_type=Dispatch                          97.50000  1.603618  1.64406083
##                                                 p.value    v.test
## Trip_type=Street-hail                     0.0002669698  3.645406
```

```
## f.Improvement_surcharge=(0.1,0.8]         0.0002805717  3.632607
## f.MTA_tax=(0.4,0.5]                       0.0002874994  3.626311
## RateCodeID=Standard rate                  0.0002874994  3.626311
## f.outlierPCAd2=NoOutDim2                  0.0246609125  2.246673
## f.outlierPCAd2=YesOutDim2                 0.0246609125 -2.246673
## Lpep_dropoff_datetime=2016-01-31 02:00:28 0.0004110152 -3.532908
## Lpep_dropoff_datetime=2016-01-05 09:29:16 0.0004110152 -3.532908
## lpep_pickup_datetime=2016-01-30 22:25:55  0.0004110152 -3.532908
## lpep_pickup_datetime=2016-01-05 08:34:06  0.0004110152 -3.532908
## f.MTA_tax=(-0.1,0.4]                      0.0002874994 -3.626311
## RateCodeID=Special rate                   0.0002874994 -3.626311
## f.Improvement_surcharge=(-0.1,0.1]        0.0002805717 -3.632607
## Trip_type=Dispatch                        0.0002669698 -3.645406
##
## $category$YesOutDim1
##                                             Cla/Mod Mod/Cla      Global
## Trip_type=Dispatch                        2.50000000     100  1.64406083
## f.Improvement_surcharge=(-0.1,0.1]        2.43902439     100  1.68516235
## f.MTA_tax=(-0.1,0.4]                      2.40963855     100  1.70571311
## RateCodeID=Special rate                   2.40963855     100  1.70571311
## Lpep_dropoff_datetime=2016-01-31 02:00:28 100.00000000    50  0.02055076
## Lpep_dropoff_datetime=2016-01-05 09:29:16 100.00000000    50  0.02055076
## lpep_pickup_datetime=2016-01-30 22:25:55  100.00000000    50  0.02055076
## lpep_pickup_datetime=2016-01-05 08:34:06  100.00000000    50  0.02055076
## f.outlierPCAd2=YesOutDim2                   1.66666667    50  1.23304562
## f.outlierPCAd2=NoOutDim2                    0.02080732    50 98.76695438
## f.MTA_tax=(0.4,0.5]                         0.00000000     0 98.29428689
## RateCodeID=Standard rate                    0.00000000     0 98.29428689
## f.Improvement_surcharge=(0.1,0.8]           0.00000000     0 98.31483765
## Trip_type=Street-hail                       0.00000000     0 98.35593917
##                                               p.value    v.test
## Trip_type=Dispatch                        0.0002669698  3.645406
## f.Improvement_surcharge=(-0.1,0.1]        0.0002805717  3.632607
## f.MTA_tax=(-0.1,0.4]                      0.0002874994  3.626311
## RateCodeID=Special rate                   0.0002874994  3.626311
## Lpep_dropoff_datetime=2016-01-31 02:00:28 0.0004110152  3.532908
## Lpep_dropoff_datetime=2016-01-05 09:29:16 0.0004110152  3.532908
## lpep_pickup_datetime=2016-01-30 22:25:55  0.0004110152  3.532908
## lpep_pickup_datetime=2016-01-05 08:34:06  0.0004110152  3.532908
## f.outlierPCAd2=YesOutDim2                 0.0246609125  2.246673
## f.outlierPCAd2=NoOutDim2                  0.0246609125 -2.246673
## f.MTA_tax=(0.4,0.5]                       0.0002874994 -3.626311
## RateCodeID=Standard rate                  0.0002874994 -3.626311
## f.Improvement_surcharge=(0.1,0.8]         0.0002805717 -3.632607
## Trip_type=Street-hail                     0.0002669698 -3.645406
##
##
## $quanti.var
##                                Eta2      P-value
## travel_time           0.0654142628 1.567072e-73
## MTA_tax               0.0236951094 3.462099e-27
## improvement_surcharge 0.0232809064 9.797386e-27
## mis_ind               0.0072774270 2.520328e-09
## trip_length           0.0022486676 9.366881e-04
```

```
## trip_distance_km      0.0015711379 5.685930e-03
## Trip_distance         0.0015711379 5.685930e-03
## Dropoff_latitude      0.0013653916 9.942778e-03
## Fare_amount           0.0011964249 1.582427e-02
## Total_amount          0.0010996816 2.070749e-02
## espeed                0.0007912635 4.975093e-02
##
## $quanti
## $quanti$NoOutDim1
##                           v.test Mean in category Overall mean
## MTA_tax                10.736699        0.4916735    0.4914714
## improvement_surcharge  10.642444        0.2951624    0.2950411
## Dropoff_latitude        2.577330       40.7447051   40.7446630
## espeed                  1.962013       21.3229435   21.3177354
## Total_amount           -2.312996       13.4884005   13.4937485
## Fare_amount            -2.412593       11.1498725   11.1547431
## trip_distance_km       -2.764704        4.0616233    4.0643323
## Trip_distance          -2.764704        2.5237757    2.5254590
## trip_length            -3.307532        4.0010371    4.0037179
## mis_ind                -5.950183        2.4917763    2.4928072
## travel_time           -17.839293       12.0918446   12.1423035
##                       sd in category Overall sd      p.value
## MTA_tax                  0.06398367 0.06474215 6.844810e-27
## improvement_surcharge    0.03875921 0.03921036 1.891034e-26
## Dropoff_latitude         0.05621814 0.05624604 9.956682e-03
## espeed                   9.12782900 9.13058219 4.976092e-02
## Total_amount             7.94415294 7.95310822 2.072286e-02
## Fare_amount              6.93716919 6.94416418 1.583948e-02
## trip_distance_km         3.36666751 3.37034414 5.697454e-03
## Trip_distance            2.09195021 2.09423476 5.697454e-03
## trip_length              2.78445515 2.78797993 9.412196e-04
## mis_ind                  0.59390944 0.59595986 2.678422e-09
## travel_time              9.26784462 9.72933787 3.500950e-71
##
## $quanti$YesOutDim1
##                           v.test Mean in category Overall mean
## travel_time            17.839293       134.858333   12.1423035
## mis_ind                 5.950183         5.000000    2.4928072
## trip_length             3.307532        10.523515    4.0037179
## trip_distance_km        2.764704        10.652478    4.0643323
## Trip_distance           2.764704         6.619143    2.5254590
## Fare_amount             2.412593        23.000000   11.1547431
## Total_amount            2.312996        26.500000   13.4937485
## espeed                 -1.962013         8.651697   21.3177354
## Dropoff_latitude       -2.577330        40.642168   40.7446630
## improvement_surcharge -10.642444         0.000000    0.2950411
## MTA_tax               -10.736699         0.000000    0.4914714
##                       sd in category Overall sd      p.value
## travel_time              79.69166667 9.72933787 3.500950e-71
## mis_ind                   0.00000000 0.59595986 2.678422e-09
## trip_length               3.60776586 2.78797993 9.412196e-04
## trip_distance_km          5.30821789 3.37034414 5.697454e-03
## Trip_distance             3.29837368 2.09423476 5.697454e-03
## Fare_amount              12.00000000 6.94416418 1.583948e-02
```

```
## Total_amount             15.50000000 7.95310822 2.072286e-02
## espeed                    6.71767213 9.13058219 4.976092e-02
## Dropoff_latitude          0.01688957 0.05624604 9.956682e-03
## improvement_surcharge     0.00000000 0.03921036 1.891034e-26
## MTA_tax                   0.00000000 0.06474215 6.844810e-27
##
##
## attr(,"class")
## [1] "catdes" "list "
```

III Interpret axis

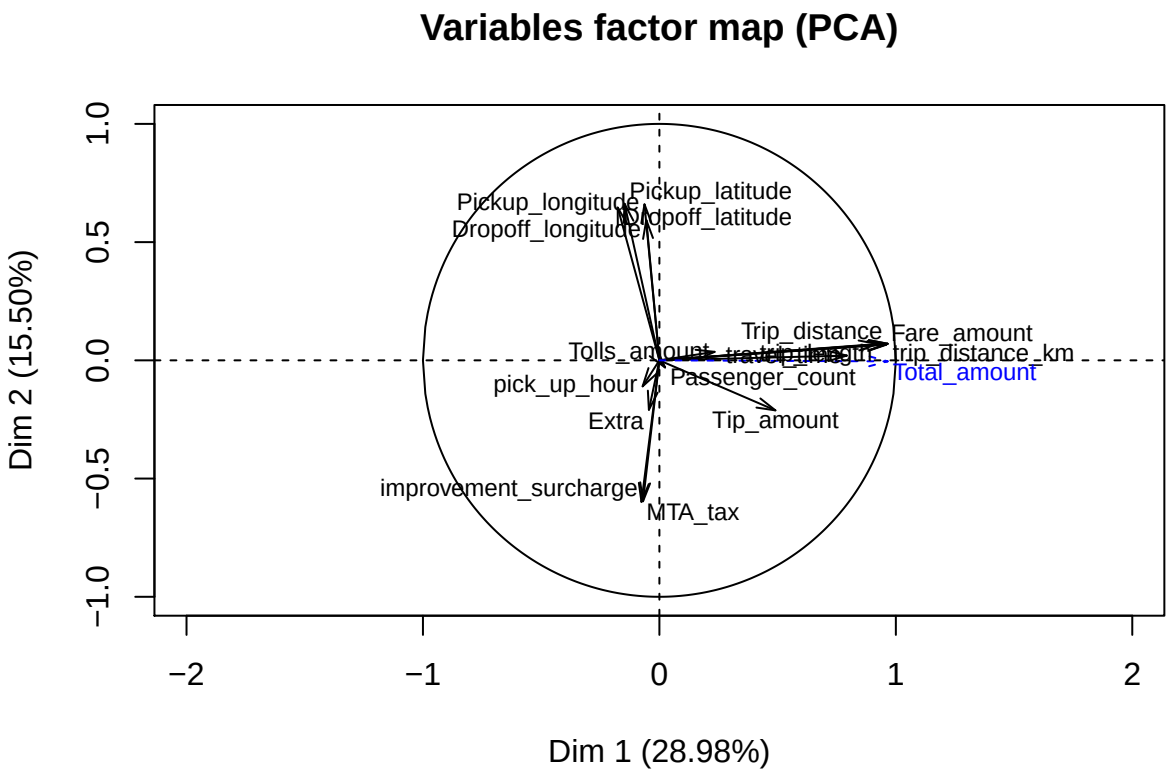
```
# Interential criteria

dimdesc (res.pca, axes=1:4)
```

```
## $Dim.1
## $Dim.1$quanti
##                       correlation       p.value
## Total_amount           0.96578021  0.000000e+00
## trip_distance_km       0.96545892  0.000000e+00
## Trip_distance          0.96545892  0.000000e+00
## Fare_amount            0.95952463  0.000000e+00
## trip_length            0.92223605  0.000000e+00
## travel_time            0.79291771  0.000000e+00
## Tip_amount             0.49073894 2.286608e-293
## Tolls_amount           0.23354094  2.825897e-61
## Extra                 -0.04441593  1.941467e-03
## Dropoff_longitude     -0.05536809  1.114226e-04
## Pickup_longitude      -0.06305806  1.072702e-05
## improvement_surcharge -0.06923616  1.336498e-06
## pick_up_hour          -0.07089733  7.401367e-07
## MTA_tax               -0.07585972  1.170775e-07
## Pickup_latitude       -0.14751746  4.440143e-25
## Dropoff_latitude      -0.17625772  2.993390e-35
##
## $Dim.1$quali
##                 R2      p.value
## AnyTip 0.04924904 2.338313e-55
##
## $Dim.1$category
##              Estimate      p.value
## AnyTip Yes  0.4847013 2.338313e-55
## AnyTip No  -0.4847013 2.338313e-55
##
##
## $Dim.2
## $Dim.2$quanti
##                       correlation      p.value
## Pickup_latitude        0.66260373 0.000000e+00
## Pickup_longitude       0.65985850 0.000000e+00
## Dropoff_latitude       0.64617666 0.000000e+00
## Dropoff_longitude      0.59347965 0.000000e+00
```

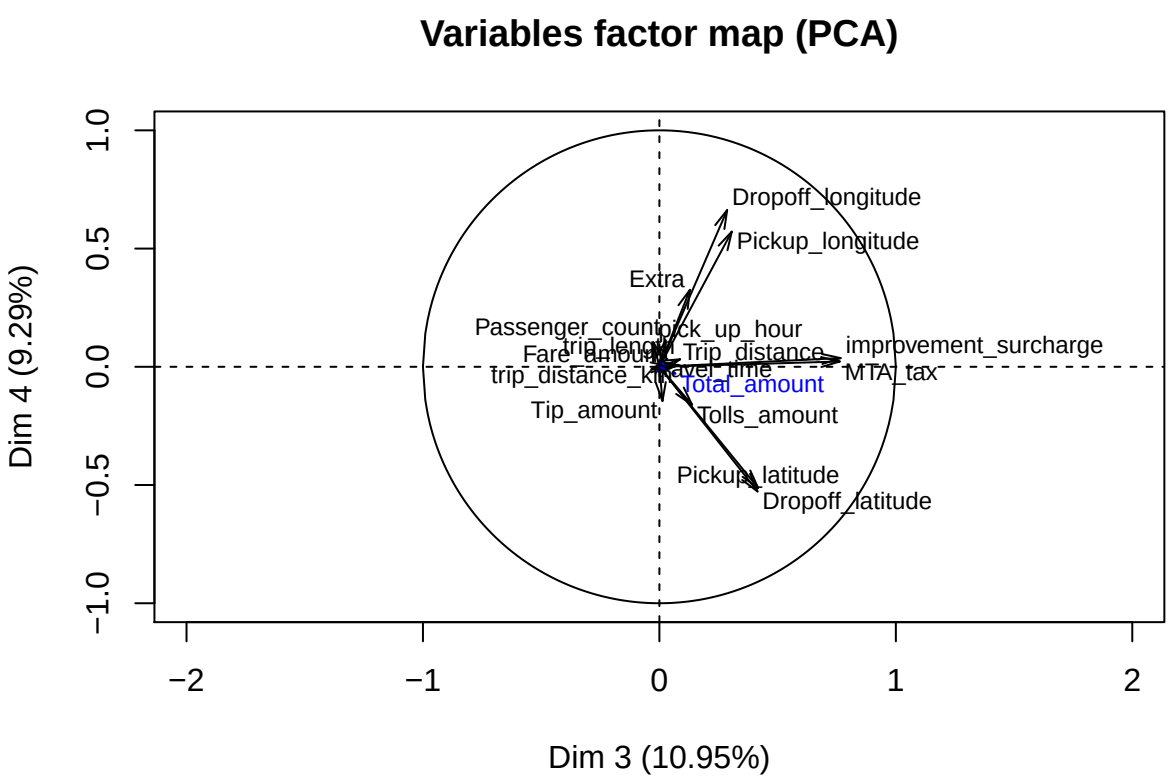
```
## trip_distance_km       0.07016348 9.624966e-07
## Trip_distance          0.07016348 9.624966e-07
## trip_length            0.06889982 1.503966e-06
## Fare_amount            0.06612191 3.906140e-06
## Tolls_amount           0.03596743 1.210264e-02
## Passenger_count       -0.03024353 3.489026e-02
## pick_up_hour          -0.11001618 1.406494e-14
## Extra                 -0.20918526 2.994770e-49
## Tip_amount            -0.21154095 2.378320e-50
## improvement_surcharge -0.59592529 0.000000e+00
## MTA_tax               -0.59855164 0.000000e+00
##
## $Dim.2$quali
##                R2      p.value
## AnyTip 0.06744473 7.785848e-76
##
## $Dim.2$category
##              Estimate      p.value
## AnyTip No   0.4147775 7.785848e-76
## AnyTip Yes -0.4147775 7.785848e-76
##
##
## $Dim.3
## $Dim.3$quanti
##                        correlation       p.value
## improvement_surcharge  0.76657280  0.000000e+00
## MTA_tax                0.76291440  0.000000e+00
## Pickup_latitude        0.41765439 9.463043e-205
## Dropoff_latitude       0.41519442 3.949101e-202
## Pickup_longitude       0.30618865 3.953837e-106
## Dropoff_longitude      0.28663331  1.124479e-92
## Tolls_amount           0.13824187  3.412117e-22
## Extra                  0.12912389  1.526769e-19
## trip_length            0.08771141  8.859842e-10
## trip_distance_km       0.07829221  4.541174e-08
## Trip_distance          0.07829221  4.541174e-08
## Total_amount           0.06766432  2.309738e-06
## Fare_amount            0.04231563  3.153515e-03
## travel_time           -0.03421414  1.699796e-02
##
##
## $Dim.4
## $Dim.4$quanti
##                        correlation       p.value
## Dropoff_longitude      0.66291516  0.000000e+00
## Pickup_longitude       0.57174226  0.000000e+00
## Extra                  0.32547576 1.885454e-120
## Passenger_count        0.11204182  4.564971e-15
## pick_up_hour           0.10324266  5.224927e-13
## improvement_surcharge  0.03681150  1.022695e-02
## trip_length            0.03176618  2.669876e-02
## Total_amount          -0.02884409  4.422305e-02
## Tip_amount            -0.14460125  3.760819e-24
## Tolls_amount          -0.16075354  1.570319e-29
```

```
## Pickup_latitude       -0.51263879  0.000000e+00
## Dropoff_latitude      -0.52725817  0.000000e+00
##
## $Dim.4$quali
##                 R2      p.value
## AnyTip 0.02647713 3.174086e-30
##
## $Dim.4$category
##              Estimate      p.value
## AnyTip No   0.2011856 3.174086e-30
## AnyTip Yes -0.2011856 3.174086e-30
```

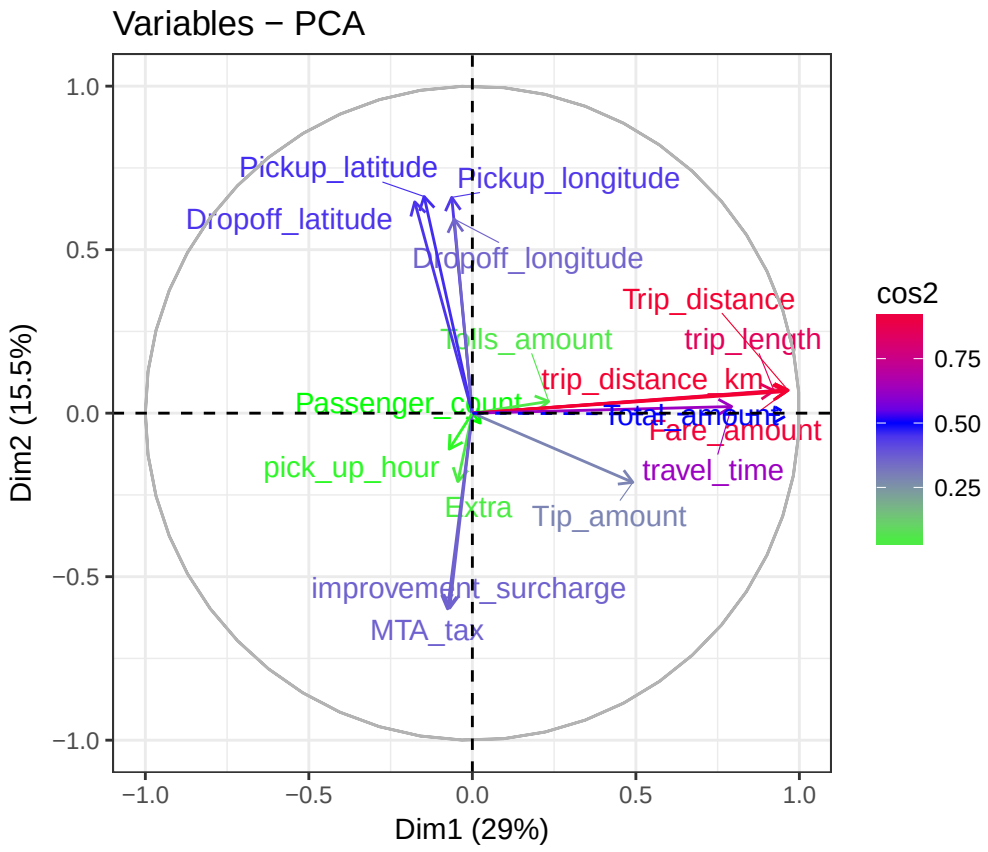
```
#The first Dimention is best described by the quantative variables Total_amount, trip_distance and Fare
plot(res.pca,choix="var", cex = 0.75)
```




```
plot(res.pca,choix="var", cex = 0.75, axes = (3:4))# 3rd and 4th PCA
```

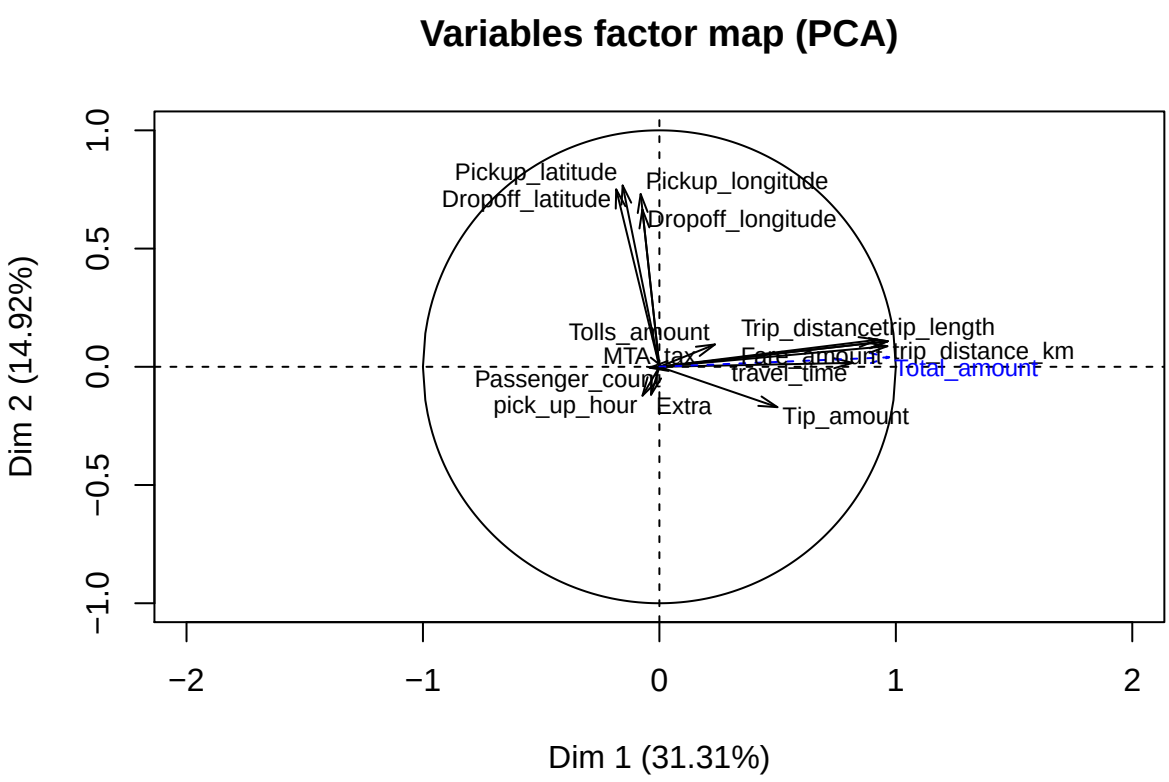



```
#modern factoextra

fviz_pca_var(res.pca,col.var="cos2", repel=TRUE)+scale_color_gradient2(low="green", mid="blue", high="r
```

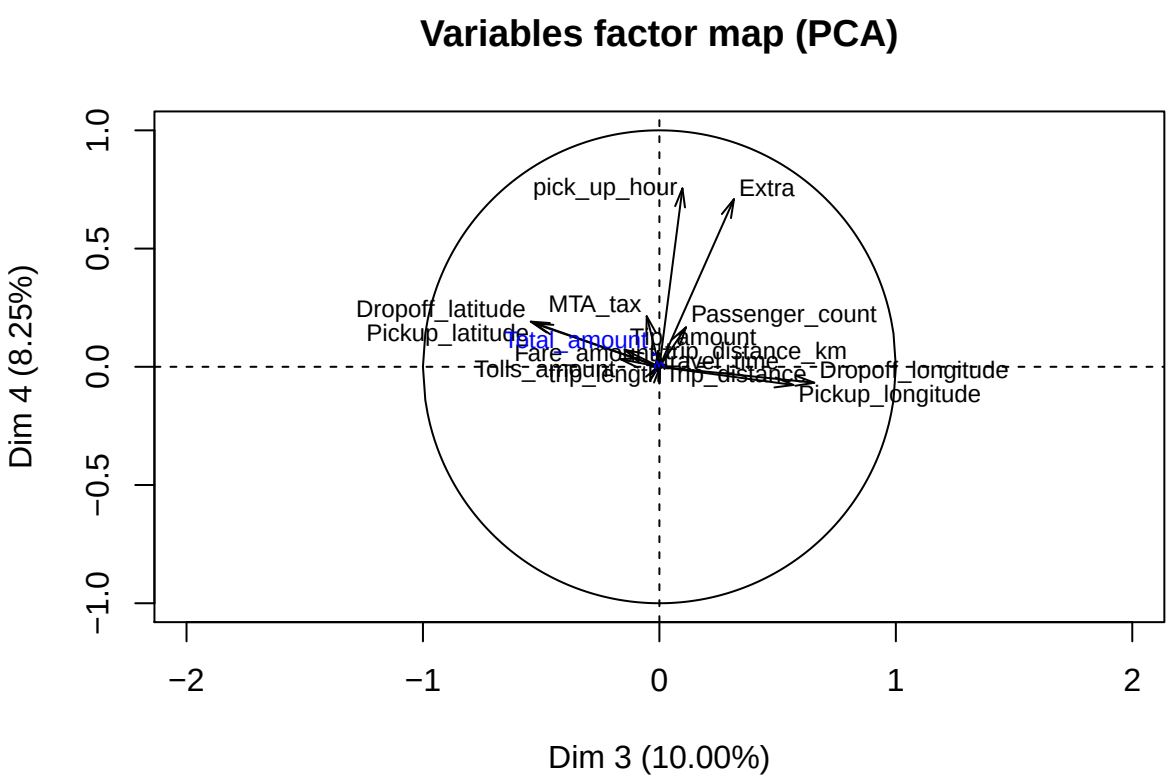


IV PCA execution with supplementary individuals

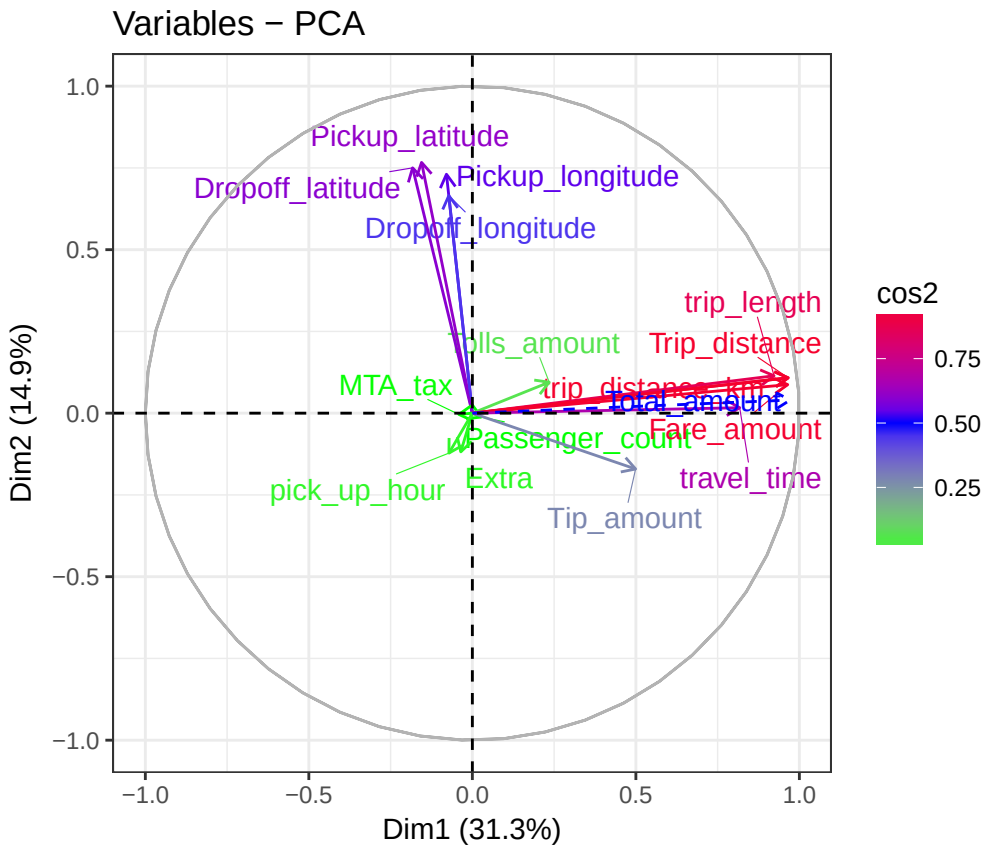
```
vec_out <- llvout
vars_con_pca <- names(df)[c(6:16,18,23:26)]
# We do a PCA analysis using the factorial variables Fare amount, total and the pickup perio in order t

res.pca<-PCA(df[,c(vars_con_pca, "f.fare_amount", "f.total", "pick_up_period")], ncp=6, quanti.sup=whic

plot(res.pca,choix="var", cex = 0.75)
```



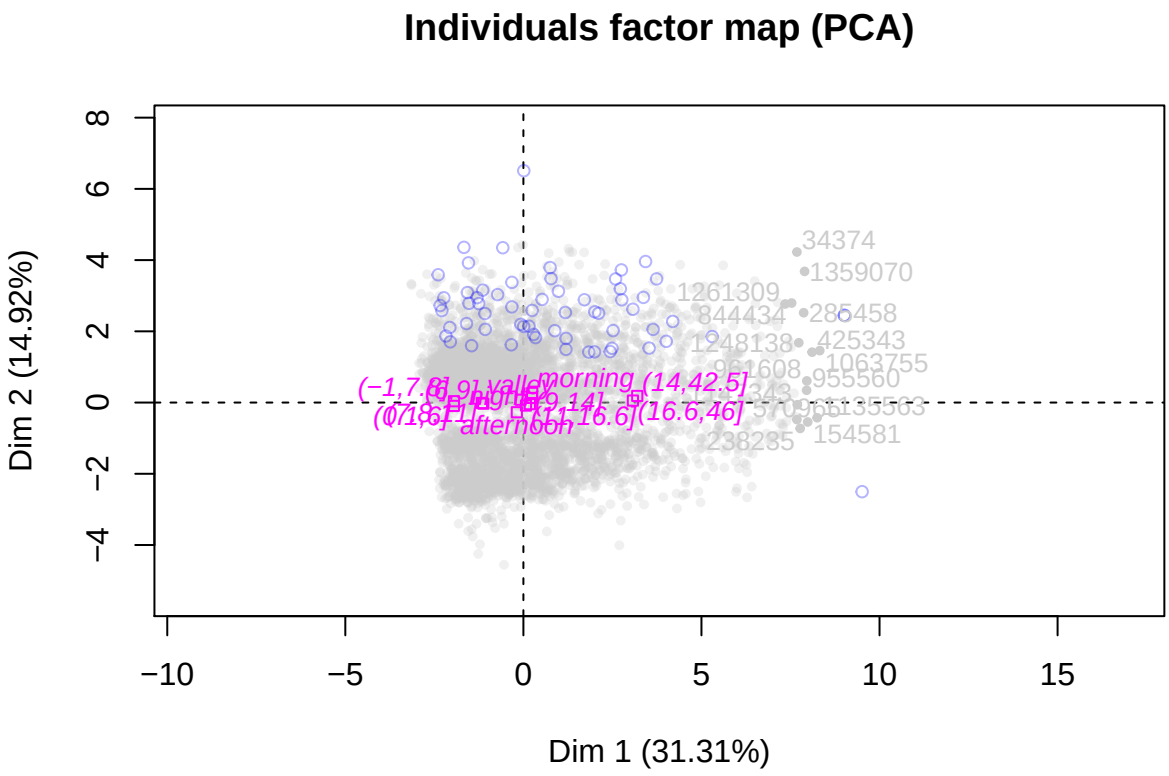

```
plot(res.pca,choix="var", cex = 0.75, axes = (3:4))# 3rd and 4th PCA
```




```
fviz_pca_var(res.pca,col.var="cos2", repel=TRUE)+scale_color_gradient2(low="green", mid="blue", high="r
```



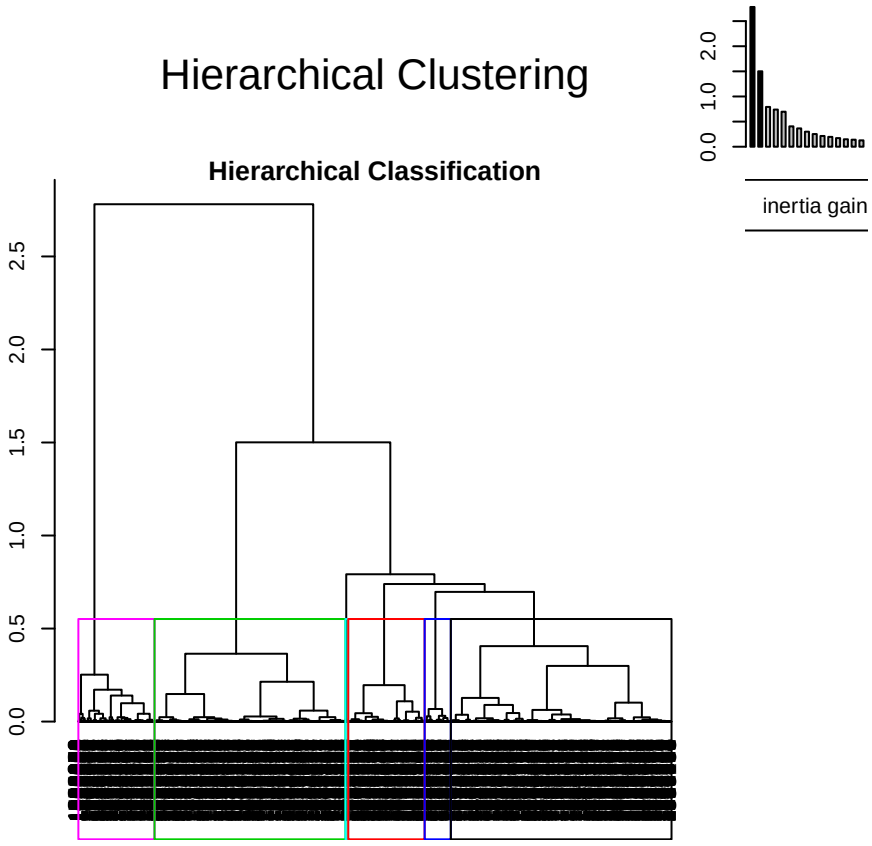

```
#We can see that trips in the afternoon tend to be longer and thus also more expensive than the ones du
plot.PCA(res.pca, choix=c("ind"),cex=0.8,col.ind="grey80",select="contrib15",axes=c(1,2))
```

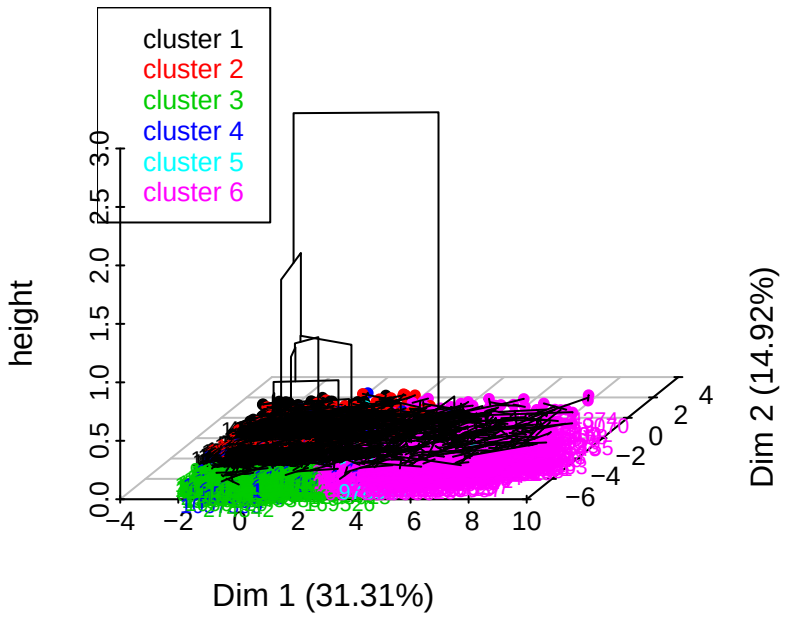


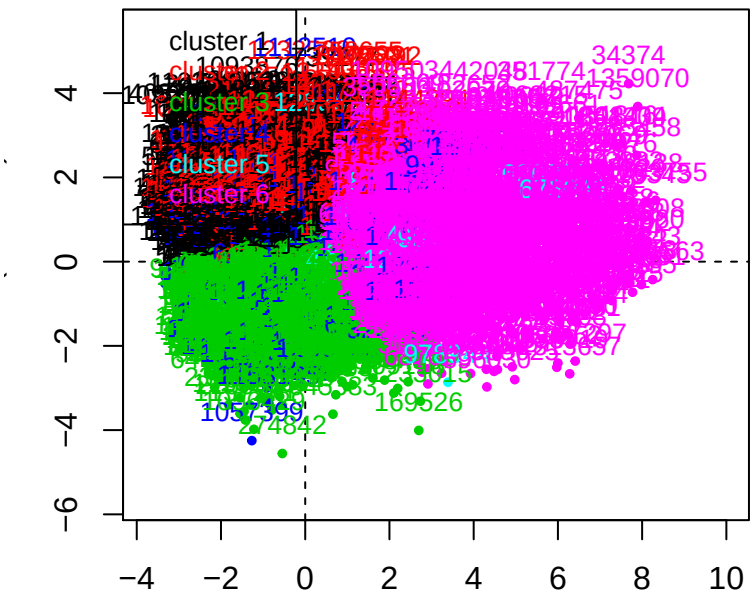
Hierarchical clustering

Generem 8 clusters amb el metode Hierarchichal a partir de les projeccions obtingudes amb el PCA.

```
library(FactoMineR)
library (ggplot2)
library(ggdendro)

res.hcpc <-HCPC(res.pca, nb.clust = 6, order=TRUE)
```


Hierarchical Clustering
Hierarchical Classification
0.0
0.5
1.0
1.5
2.0
2.5
0.0
1.0
2.0
inertia gain


Hierarchical clustering on the factor map
cluster 1
cluster 2
cluster 3
cluster 4
cluster 5
cluster 6
height
0.0
0.5
1.0
1.5
2.0
2.5
3.0
−4
−2
0
2
4
6
8
10
Dim 1 (31.31%)
Dim 2 (14.92%)
4
2
0
−2
−4
−6




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

```
##
##    1    2    3    4    5    6
## 1522  756 1455  241   22  809
```

```
#Block A descripcion per variables
res.hcpc$desc.var
```

```
## $test.chi2
##                      p.value df
## f.fare_amount  0.000000e+00 15
## f.total        0.000000e+00 15
## pick_up_period 1.388397e-34 15
##
## $category
## $category$`1`
##                                Cla/Mod   Mod/Cla   Global       p.value
## f.total=(-1,7.8]             47.996795 39.356110 25.97294  3.010774e-45
## f.fare_amount=(0.1,6]        45.600000 37.450723 26.01457  1.371224e-33
## f.fare_amount=(6,9]          42.028986 34.296978 25.84807  2.926343e-19
## f.total=(7.8,11]             39.536878 30.289093 24.26639  5.908761e-11
## pick_up_period=morning       40.540541 25.624179 20.02081  7.753913e-11
## pick_up_period=valley        36.740741 32.588699 28.09573  2.854485e-06
## pick_up_period=afternoon     28.904429 32.588699 35.71280  2.027034e-03
## pick_up_period=night         18.018018  9.198423 16.17066  1.286503e-20
## f.fare_amount=(14,42.5]       5.643739  4.204993 23.60042 7.194958e-127
```

```
## f.total=(16.6,46]         5.643154  4.467806 25.07804 1.123791e-136
##                              v.test
## f.total=(-1,7.8]          14.116377
## f.fare_amount=(0.1,6]     12.078546
## f.fare_amount=(6,9]        8.971451
## f.total=(7.8,11]           6.546028
## pick_up_period=morning     6.505299
## pick_up_period=valley      4.681022
## pick_up_period=afternoon  -3.086243
## pick_up_period=night      -9.309323
## f.fare_amount=(14,42.5]  -23.960426
## f.total=(16.6,46]        -24.883459
##
## $category$`2`
##                            Cla/Mod  Mod/Cla   Global      p.value    v.test
## f.fare_amount=(9,14]    21.204411 33.06878 24.53694 7.459414e-09  5.780240
## pick_up_period=night    21.492921 22.08995 16.17066 3.267506e-06  4.653246
## f.total=(11,16.6]       19.814503 31.08466 24.68262 1.322624e-05  4.356328
## f.total=(7.8,11]        19.296741 29.76190 24.26639 1.633699e-04  3.769813
## f.fare_amount=(6,9]     18.035427 29.62963 25.84807 1.051032e-02  2.558572
## pick_up_period=morning  11.850312 15.07937 20.02081 1.491105e-04 -3.792546
## f.fare_amount=(14,42.5]  8.553792 12.83069 23.60042 1.119713e-15 -8.012970
## f.total=(16.6,46]        7.717842 12.30159 25.07804 6.665484e-21 -9.378915
##
## $category$`3`
##                            Cla/Mod   Mod/Cla   Global      p.value
## f.total=(11,16.6]        40.55649 33.058419 24.68262 2.734320e-18
## f.fare_amount=(9,14]     40.20356 32.577320 24.53694 4.757062e-17
## pick_up_period=afternoon 35.31469 41.649485 35.71280 1.848224e-08
## f.total=(7.8,11]         35.16295 28.178694 24.26639 3.622051e-05
## f.fare_amount=(6,9]      34.29952 29.278351 25.84807 3.810595e-04
## f.fare_amount=(0.1,6]    33.84000 29.072165 26.01457 1.561249e-03
## pick_up_period=night     33.84813 18.075601 16.17066 1.900267e-02
## pick_up_period=valley    27.25926 25.292096 28.09573 4.192053e-03
## pick_up_period=morning   22.66112 14.982818 20.02081 4.474485e-09
## f.total=(16.6,46]        15.76763 13.058419 25.07804 6.958904e-40
## f.fare_amount=(14,42.5]  11.64021  9.072165 23.60042 2.444321e-62
##                             v.test
## f.total=(11,16.6]         8.721958
## f.fare_amount=(9,14]      8.392551
## pick_up_period=afternoon  5.625639
## f.total=(7.8,11]          4.130354
## f.fare_amount=(6,9]       3.552865
## f.fare_amount=(0.1,6]     3.163051
## pick_up_period=night      2.345479
## pick_up_period=valley    -2.863336
## pick_up_period=morning   -5.865623
## f.total=(16.6,46]       -13.217444
## f.fare_amount=(14,42.5] -16.662771
##
## $category$`4`
##                            Cla/Mod  Mod/Cla   Global      p.value    v.test
## pick_up_period=afternoon 6.118881 43.56846 35.71280 0.0099643414  2.577064
## pick_up_period=night     6.821107 21.99170 16.17066 0.0152154712  2.427209
```

```
## f.fare_amount=(14,42.5]  3.262787 15.35270 23.60042 0.0013155002 -3.212577
## f.total=(16.6,46]        3.236515 16.18257 25.07804 0.0006878920 -3.394360
## pick_up_period=morning   2.806653 11.20332 20.02081 0.0002061717 -3.711332
##
## $category$`5`
##                          Cla/Mod  Mod/Cla   Global      p.value    v.test
## f.fare_amount=(14,42.5] 1.234568 63.63636 23.60042 0.0000815193  3.939889
## f.total=(16.6,46]       1.161826 63.63636 25.07804 0.0001682944  3.762394
## f.fare_amount=(0.1,6]   0.000000  0.00000 26.01457 0.0012997192 -3.216042
##
## $category$`6`
##                              Cla/Mod    Mod/Cla   Global       p.value
## f.total=(16.6,46]        66.47302905 99.0111248 25.07804  0.000000e+00
## f.fare_amount=(14,42.5]  69.66490300 97.6514215 23.60042  0.000000e+00
## pick_up_period=morning   21.72557173 25.8343634 20.02081  9.940138e-06
## pick_up_period=afternoon 13.63636364 28.9245983 35.71280  7.807610e-06
## f.fare_amount=(9,14]      1.35708227  1.9777503 24.53694  1.190223e-83
## f.total=(11,16.6]         0.50590219  0.7416564 24.68262  3.820508e-99
## f.total=(7.8,11]          0.08576329  0.1236094 24.26639 9.049492e-107
## f.fare_amount=(0.1,6]     0.16000000  0.2472188 26.01457 9.385963e-114
## f.fare_amount=(6,9]       0.08051530  0.1236094 25.84807 3.962574e-115
## f.total=(-1,7.8]          0.08012821  0.1236094 25.97294 8.498683e-116
##                             v.test
## f.total=(16.6,46]              Inf
## f.fare_amount=(14,42.5]        Inf
## pick_up_period=morning     4.418472
## pick_up_period=afternoon  -4.470393
## f.fare_amount=(9,14]     -19.377712
## f.total=(11,16.6]        -21.134645
## f.total=(7.8,11]         -21.948001
## f.fare_amount=(0.1,6]    -22.667458
## f.fare_amount=(6,9]      -22.806387
## f.total=(-1,7.8]         -22.873665
##
##
## $quanti.var
##                           Eta2       P-value
## Pickup_longitude  0.595855793  0.000000e+00
## Pickup_latitude   0.611624674  0.000000e+00
## Dropoff_longitude 0.488354469  0.000000e+00
## Dropoff_latitude  0.590348251  0.000000e+00
## Passenger_count   0.763317675  0.000000e+00
## Trip_distance     0.636966471  0.000000e+00
## Fare_amount       0.631803706  0.000000e+00
## MTA_tax           1.000000000  0.000000e+00
## Total_amount      0.645064694  0.000000e+00
## trip_length       0.541374081  0.000000e+00
## trip_distance_km  0.636966471  0.000000e+00
## travel_time       0.432624782  0.000000e+00
## Tip_amount        0.186933260 1.597351e-212
## Tolls_amount      0.047464928  1.957846e-48
## Extra             0.015686740  6.033039e-15
## pick_up_hour      0.006025938  2.303082e-05
##
```

```
## $quanti
## $quanti$`1`
##                       v.test Mean in category Overall mean sd in category
## Pickup_latitude    47.598688      40.80159258  40.74593355     0.02844638
## Dropoff_latitude   47.278397      40.79971455  40.74390608     0.02975843
## MTA_tax             3.200623       0.50000000   0.49771072     0.00000000
## pick_up_hour        2.017448      13.77660972  13.48553590     5.95394321
## Dropoff_longitude  -3.712485     -73.94024312 -73.93655617     0.02167351
## Tolls_amount       -4.463365       0.01455979   0.07963788     0.28363577
## Extra              -6.412345       0.30486202   0.35411030     0.37369486
## Passenger_count   -12.108148       1.09001314   1.35150884     0.32490593
## Tip_amount        -12.837756       0.64638633   1.13662227     1.11570091
## travel_time       -19.134311       8.30912816  12.05645354     4.72184646
## trip_length       -21.503319       2.72623912   3.99248724     1.62720935
## Fare_amount       -22.444090       7.81865966  11.11978772     3.16906969
## Trip_distance     -22.823553       1.50456882   2.51292892     0.88814687
## trip_distance_km  -22.823553       2.42136881   4.04416709     1.42933384
## Total_amount      -23.124081       9.58427070  13.48665557     3.57102687
##                   Overall sd       p.value
## Pickup_latitude   0.05518411  0.000000e+00
## Dropoff_latitude  0.05570713  0.000000e+00
## MTA_tax           0.03375500  1.371308e-03
## pick_up_hour      6.80885517  4.364874e-02
## Dropoff_longitude 0.04686801  2.052341e-04
## Tolls_amount      0.68809078  8.068235e-06
## Extra             0.36244956  1.432984e-10
## Passenger_count   1.01920186  9.562854e-34
## Tip_amount        1.80214366  1.007526e-37
## travel_time       9.24234052  1.307976e-81
## trip_length       2.77898821 1.449431e-102
## Fare_amount       6.94118718 1.461647e-111
## Trip_distance     2.08499866 2.676475e-115
## trip_distance_km  3.35548009 2.676475e-115
## Total_amount      7.96414229 2.651072e-118
##
## $quanti$`2`
##                       v.test Mean in category Overall mean sd in category
## Pickup_longitude   49.023893      -73.8702054 -73.93692250     0.03053626
## Dropoff_longitude  45.779901      -73.8649150 -73.93655617     0.03464036
## Extra               3.147025        0.3921958   0.35411030     0.35160997
## MTA_tax             2.031186        0.5000000   0.49771072     0.00000000
## Dropoff_latitude   -2.079665       40.7400378  40.74390608     0.03123097
## Pickup_latitude    -2.539641       40.7412541  40.74593355     0.02618321
## Tolls_amount       -3.466270        0.0000000   0.07963788     0.00000000
## trip_length        -4.378894        3.5861724   3.99248724     2.14405977
## Passenger_count    -6.442221        1.1322751   1.35150884     0.42222090
## Trip_distance      -6.747609        2.0431785   2.51292892     1.27163247
## trip_distance_km   -6.747609        3.2881770   4.04416709     2.04649408
## travel_time        -7.055161        9.8792431  12.05645354     5.09360578
## Fare_amount        -7.599649        9.3584656  11.11978772     3.87603132
## Total_amount       -9.228985       11.0324868  13.48665557     4.13939940
## Tip_amount        -10.881924        0.4818254   1.13662227     1.03184768
##                   Overall sd      p.value
## Pickup_longitude  0.04075847 0.000000e+00
```

```
## Dropoff_longitude 0.04686801 0.000000e+00
## Extra             0.36244956 1.649408e-03
## MTA_tax           0.03375500 4.223615e-02
## Dropoff_latitude  0.05570713 3.755625e-02
## Pickup_latitude   0.05518411 1.109665e-02
## Tolls_amount      0.68809078 5.277321e-04
## trip_length       2.77898821 1.192830e-05
## Passenger_count   1.01920186 1.177374e-10
## Trip_distance     2.08499866 1.503008e-11
## trip_distance_km  3.35548009 1.503008e-11
## travel_time       9.24234052 1.724006e-12
## Fare_amount       6.94118718 2.969348e-14
## Total_amount      7.96414229 2.732091e-20
## Tip_amount        1.80214366 1.405639e-27
##
## $quanti$`3`
##                      v.test Mean in category Overall mean sd in category
## Extra              4.960478       0.39347079   0.35411030     0.35024584
## MTA_tax            3.097931       0.50000000   0.49771072     0.00000000
## pick_up_hour       2.838138      13.90859107  13.48553590     7.20799683
## Tolls_amount      -4.781175       0.00761512   0.07963788     0.20525539
## Passenger_count   -9.593327       1.13745704   1.35150884     0.41658783
## travel_time      -10.448783       9.94229731  12.05645354     5.37245981
## Total_amount     -12.953976      11.22809622  13.48665557     4.19896081
## Fare_amount      -14.496925       8.91686598  11.11978772     3.66431531
## trip_length      -14.646511       3.10142039   3.99248724     1.75093055
## Trip_distance    -14.854197       1.83490603   2.51292892     1.05465751
## trip_distance_km -14.854197       2.95299500   4.04416709     1.69730673
## Dropoff_longitude -27.476019     -73.96474777 -73.93655617     0.02390941
## Pickup_longitude  -33.990571     -73.96725204 -73.93692250     0.01966000
## Dropoff_latitude  -42.986658      40.69148163  40.74390608     0.02523324
## Pickup_latitude   -44.479810      40.69219742  40.74593355     0.02195261
##                   Overall sd       p.value
## Extra             0.36244956  7.032004e-07
## MTA_tax           0.03375500  1.948768e-03
## pick_up_hour      6.80885517  4.537757e-03
## Tolls_amount      0.68809078  1.742740e-06
## Passenger_count   1.01920186  8.528912e-22
## travel_time       9.24234052  1.484176e-25
## Total_amount      7.96414229  2.230931e-38
## Fare_amount       6.94118718  1.266991e-47
## trip_length       2.77898821  1.418135e-48
## Trip_distance     2.08499866  6.534644e-50
## trip_distance_km  3.35548009  6.534644e-50
## Dropoff_longitude 0.04686801 3.396996e-166
## Pickup_longitude  0.04075847 3.070519e-253
## Dropoff_latitude  0.05570713  0.000000e+00
## Pickup_latitude   0.05518411  0.000000e+00
##
## $quanti$`4`
##                     v.test Mean in category Overall mean sd in category
## Passenger_count  60.386964        5.2157676    1.3515088      0.6271191
## Extra             2.855277        0.4190871    0.3541103      0.3449229
## trip_length      -2.724836        3.5170536    3.9924872      2.2793668
```

```
## Trip_distance    -3.209743        2.0927456    2.5129289      1.4345710
## trip_distance_km -3.209743        3.3679476    4.0441671      2.3087183
## travel_time      -3.502259       10.0241293   12.0564535      5.8153887
## Total_amount     -3.600101       11.6864730   13.4866556      5.3797204
## Fare_amount      -3.769101        9.4771784   11.1197877      4.4696415
##                  Overall sd      p.value
## Passenger_count   1.0192019 0.0000000000
## Extra             0.3624496 0.0042999365
## trip_length       2.7789882 0.0064333407
## Trip_distance     2.0849987 0.0013285377
## trip_distance_km  3.3554801 0.0013285377
## travel_time       9.2423405 0.0004613314
## Total_amount      7.9641423 0.0003180931
## Fare_amount       6.9411872 0.0001638369
##
## $quanti$`5`
##                  v.test Mean in category Overall mean sd in category
## Fare_amount    5.568728       19.3427273   11.1197877      9.6130201
## Total_amount   4.050705       20.3495455   13.4866556      9.9789244
## travel_time    2.216411       16.4142775   12.0564535     10.9292303
## Extra         -3.118768        0.1136364    0.3541103      0.4245805
## MTA_tax      -69.310894        0.0000000    0.4977107      0.0000000
##              Overall sd      p.value
## Fare_amount   6.9411872 2.566060e-08
## Total_amount  7.9641423 5.106344e-05
## travel_time   9.2423405 2.666334e-02
## Extra         0.3624496 1.816088e-03
## MTA_tax       0.0337550 0.000000e+00
##
## $quanti$`6`
##                     v.test Mean in category Overall mean sd in category
## Total_amount      55.004828       27.5334363  13.48665557     7.11825283
## trip_distance_km  54.835178        9.9441521   4.04416709     3.05279683
## Trip_distance     54.835178        6.1790096   2.51292892     1.89692001
## Fare_amount       54.293271       23.2039555  11.11978772     6.31006097
## trip_length       50.382267        8.4820225   3.99248724     2.11630881
## travel_time       45.126987       25.4302677  12.05645354    12.50733914
## Tip_amount        28.621246        2.7905439   1.13662227     2.86474236
## Tolls_amount      15.035141        0.4113721   0.07963788     1.52942437
## MTA_tax            2.115067        0.5000000   0.49771072     0.00000000
## Pickup_latitude   -2.075765       40.7422605  40.74593355     0.05650315
## Passenger_count   -2.169922        1.2805933   1.35150884     0.79810136
## Extra             -2.284046        0.3275649   0.35411030     0.35888046
## Dropoff_latitude  -3.986456       40.7367852  40.74390608     0.05490046
## pick_up_hour      -4.341319       12.5377009  13.48553590     6.76765193
## Pickup_longitude  -5.657573      -73.9443166 -73.93692250     0.03693034
## Dropoff_longitude -7.103771      -73.9472320 -73.93655617     0.05503831
##                   Overall sd       p.value
## Total_amount      7.96414229  0.000000e+00
## trip_distance_km  3.35548009  0.000000e+00
## Trip_distance     2.08499866  0.000000e+00
## Fare_amount       6.94118718  0.000000e+00
## trip_length       2.77898821  0.000000e+00
## travel_time       9.24234052  0.000000e+00
```

```
## Tip_amount        1.80214366 3.655747e-180
## Tolls_amount      0.68809078  4.321258e-51
## MTA_tax           0.03375500  3.442422e-02
## Pickup_latitude   0.05518411  3.791566e-02
## Passenger_count   1.01920186  3.001276e-02
## Extra             0.36244956  2.236883e-02
## Dropoff_latitude  0.05570713  6.706750e-05
## pick_up_hour      6.80885517  1.416300e-05
## Pickup_longitude  0.04075847  1.535284e-08
## Dropoff_longitude 0.04686801  1.213984e-12
##
##
## attr(,"class")
## [1] "catdes" "list "
```

```
#Block B descripcion per eixos
#She doesn't recommend that (not very usefull by her opinion)
res.hcpc$desc.axes
```

```
## $quanti.var
##             Eta2     P-value
## Dim.1 0.67109834 0.00000e+00
## Dim.2 0.63739845 0.00000e+00
## Dim.3 0.52264765 0.00000e+00
## Dim.5 0.74730335 0.00000e+00
## Dim.6 0.68776489 0.00000e+00
## Dim.4 0.09331422 2.09914e-99
##
## $quanti
## $quanti$`1`
##           v.test Mean in category  Overall mean sd in category Overall sd
## Dim.2  27.443757       0.87005073 -5.062992e-13      0.7201106   1.496147
## Dim.4   8.479036       0.19987477  6.084197e-13      1.0456575   1.112461
## Dim.5  -3.241831      -0.06905784  4.682821e-13      0.2931861   1.005301
## Dim.6 -10.112275      -0.21334016  5.340819e-14      0.3734743   0.995628
## Dim.1 -26.553752      -1.21944878 -5.185978e-14      0.9965003   2.167260
## Dim.3 -37.000861      -0.96043352 -2.104400e-12      0.6572895   1.224980
##             p.value
## Dim.2 8.247983e-166
## Dim.4  2.270676e-17
## Dim.5  1.187646e-03
## Dim.6  4.873905e-24
## Dim.1 2.324363e-155
## Dim.3 1.109185e-299
##
## $quanti$`2`
##          v.test Mean in category  Overall mean sd in category Overall sd
## Dim.3 41.460145        1.6957865 -2.104400e-12      0.9695120   1.224980
## Dim.2 27.468540        1.3722128 -5.062992e-13      0.7081247   1.496147
## Dim.5  8.505206        0.2854910  4.682821e-13      0.2870454   1.005301
## Dim.4 -7.452525       -0.2768215  6.084197e-13      1.0713248   1.112461
## Dim.6 -7.870793       -0.2616538  5.340819e-14      0.4483228   0.995628
## Dim.1 -9.164301       -0.6631655 -5.185978e-14      1.2653732   2.167260
##             p.value
## Dim.3  0.000000e+00
```

```
## Dim.2 4.172984e-166
## Dim.5  1.812738e-17
## Dim.4  9.157017e-14
## Dim.6  3.523995e-15
## Dim.1  4.986901e-20
##
## $quanti$`3`
##           v.test Mean in category  Overall mean sd in category Overall sd
## Dim.3   7.038462        0.1887540 -2.104400e-12      0.6177491   1.224980
## Dim.5   6.740043        0.1483365  4.682821e-13      0.2850575   1.005301
## Dim.4  -6.995461       -0.1703690  6.084197e-13      1.0578699   1.112461
## Dim.6  -8.181636       -0.1783309  5.340819e-14      0.4418606   0.995628
## Dim.1 -10.116389       -0.4799831 -5.185978e-14      1.1555060   2.167260
## Dim.2 -52.249889       -1.7113907 -5.062992e-13      0.6579794   1.496147
##            p.value
## Dim.3 1.943727e-12
## Dim.5 1.583393e-11
## Dim.4 2.643875e-12
## Dim.6 2.800150e-16
## Dim.1 4.673400e-24
## Dim.2 0.000000e+00
##
## $quanti$`4`
##           v.test Mean in category  Overall mean sd in category Overall sd
## Dim.6  57.325846        3.5835246  5.340819e-14      0.6592727   0.995628
## Dim.4  10.014128        0.6994567  6.084197e-13      1.0751834   1.112461
## Dim.3   6.097473        0.4689662 -2.104400e-12      1.0864753   1.224980
## Dim.1  -3.228332       -0.4392907 -5.185978e-14      1.5069990   2.167260
## Dim.5 -10.334111       -0.6522768  4.682821e-13      0.4893148   1.005301
##            p.value
## Dim.6 0.000000e+00
## Dim.4 1.321221e-23
## Dim.3 1.077584e-09
## Dim.1 1.245146e-03
## Dim.5 4.939735e-25
##
## $quanti$`5`
##           v.test Mean in category  Overall mean sd in category Overall sd
## Dim.3   3.719915        0.9693915 -2.104400e-12      1.4406635   1.224980
## Dim.1   2.851316        1.3146003 -5.185978e-14      2.0845845   2.167260
## Dim.6  -2.838523       -0.6012109  5.340819e-14      1.0513642   0.995628
## Dim.4 -14.839165       -3.5118156  6.084197e-13      0.9565864   1.112461
## Dim.5 -58.231768      -12.4535564  4.682821e-13      0.3938538   1.005301
##            p.value
## Dim.3 1.992900e-04
## Dim.1 4.353871e-03
## Dim.6 4.532286e-03
## Dim.4 8.176680e-50
## Dim.5 0.000000e+00
##
## $quanti$`6`
##          v.test Mean in category  Overall mean sd in category Overall sd
## Dim.1 55.721029       3.87228363 -5.185978e-14      1.6171043   2.167260
## Dim.5  4.011825       0.12932279  4.682821e-13      1.0278268   1.005301
```

```
## Dim.2  3.136536       0.15047408 -5.062992e-13      1.4093541   1.496147
## Dim.4  2.136146       0.07619963  6.084197e-13      1.0737796   1.112461
## Dim.6 -2.649006      -0.08457014  5.340819e-14      0.9366946   0.995628
## Dim.3 -7.213345      -0.28333651 -2.104400e-12      1.2119561   1.224980
##           p.value
## Dim.1 0.000000e+00
## Dim.5 6.025103e-05
## Dim.2 1.709563e-03
## Dim.4 3.266749e-02
## Dim.6 8.072889e-03
## Dim.3 5.459386e-13
##
##
## attr(,"class")
## [1] "catdes" "list "
```

```
#Block C individus
#parangons. per cadascun dels clusters tenim els seus parangons i els seus mis espeicifis (dist) -> que
res.hcpc$desc.ind
```

```
## $para
## Cluster: 1
##    419422    253799   1435375     87900     92598
## 0.3344669 0.3389733 0.4344772 0.4478629 0.4596034
## ------------------------------------------------------------
## Cluster: 2
##    746656     90225   1362378   1372589   1363325
## 0.5465155 0.5990569 0.6160073 0.6186373 0.6641605
## ------------------------------------------------------------
## Cluster: 3
##    473230   1369263   1076497    474605    748186
## 0.5275761 0.5798164 0.6081080 0.6235652 0.6706031
## ------------------------------------------------------------
## Cluster: 4
##    473235    745377   1361206   1370940    415886
## 0.6884401 0.7522253 1.0351214 1.0543070 1.1090335
## ------------------------------------------------------------
## Cluster: 5
##   272451   725855   782156   829507   885046
## 1.361694 1.376902 1.737938 1.804818 1.842608
## ------------------------------------------------------------
## Cluster: 6
##    678042     53452     50328   1406084     11713
## 0.9302321 1.0911229 1.1229448 1.1666184 1.1683024
##
## $dist
## Cluster: 1
##   572868   915921  1178619   955214   529632
## 5.229943 5.148077 5.109972 5.064625 4.344363
## ------------------------------------------------------------
## Cluster: 2
##   532659  1404537   657301     9207   576477
## 6.142807 5.957720 5.839240 5.818861 5.809140
## ------------------------------------------------------------
## Cluster: 3
```

```
##   274842   645383  1157271   229968   573367
## 5.790128 5.294909 5.290883 5.217173 5.210914
## ------------------------------------------------------------
## Cluster: 4
##  1137082   329313  1112510   749823  1123289
## 7.439163 7.017419 6.044010 5.771125 5.661158
## ------------------------------------------------------------
## Cluster: 5
##   675043   978944   984283  1283504   424236
## 13.83254 13.78378 13.61879 13.53750 13.51863
## ------------------------------------------------------------
## Cluster: 6
##    285458    868718   1135563    425343    154581
## 12.172935 10.987981  9.975215  9.874141  9.794942
```

```
#Donar-li una classe (the last one) a tots els outliers multidimensionals (sup.)
df$claHP<-7
df[row.names(res.hcpc$data.clust),"claHP"]<-res.hcpc$data.clust$clust
table(df$claHP)
```

```
##
##    1    2    3    4    5    6    7
## 1522  756 1455  241   22  809   61
```

```
#No ens hem de preocupar de la clase outliers, nomis caracteritzar els clusters del metode per defecte
```

K-Means Classification

```
ppcc<-res.pca$ind$coord[,1:6]
dim(ppcc)
```

```
## [1] 4805    6
```

```
kc<-kmeans(ppcc,6,iter.max = 30, trace=T)
```

```
## KMNS(*, k=6): iter=  1, indx=11
##  QTRAN(): istep=4805, icoun=39
##  QTRAN(): istep=9610, icoun=59
##  QTRAN(): istep=14415, icoun=84
##  QTRAN(): istep=19220, icoun=178
##  QTRAN(): istep=24025, icoun=270
##  QTRAN(): istep=28830, icoun=354
##  QTRAN(): istep=33635, icoun=1705
## KMNS(*, k=6): iter=  2, indx=11
##  QTRAN(): istep=4805, icoun=8
##  QTRAN(): istep=9610, icoun=13
##  QTRAN(): istep=14415, icoun=54
##  QTRAN(): istep=19220, icoun=669
##  QTRAN(): istep=24025, icoun=2506
## KMNS(*, k=6): iter=  3, indx=552
##  QTRAN(): istep=4805, icoun=36
##  QTRAN(): istep=9610, icoun=315
##  QTRAN(): istep=14415, icoun=2217
##  QTRAN(): istep=19220, icoun=4800
```

```
## KMNS(*, k=6): iter=  4, indx=4805
```

```
table(kc$cluster)
```

```
##
##    1    2    3    4    5    6
##  781  745  388  632 1478  781
```

```
df$claKM<-7
df[names(kc$cluster),"claKM"]<-kc$cluster
kc$betweenss/kc$totss
```

```
## [1] 0.5464429
```

```
table(df$claKM)
```

```
##
##    1    2    3    4    5    6    7
##  781  745  388  632 1478  781   61
```

```
#caracteristaci claKM
#catdes(df, 44)
#veure si s'han posat d'acord o no
#table(df$claHP,df$claKM)
```

```
df$claHP<-factor(df$claHP,labels=paste("kHP-",1:7))
df$claKM<-factor(df$claKM,levels=c(2,3,1,5,4,6,7),labels=c("kKM-2","kKM-3","kKM-1","kKM-5","kKM-4","kKM
tt<-table(df$claHP,df$claKM)
tt
```

```
##
##          kKM-2 kKM-3 kKM-1 kKM-5 kKM-4 kKM-6 kKM-7
##   kHP- 1    16     0    88  1401    12     5     0
##   kHP- 2     4     0    30     3     3   716     0
##   kHP- 3   687     0   189     0   579     0     0
##   kHP- 4    36     7    31    69    38    60     0
##   kHP- 5     2     2    13     5     0     0     0
##   kHP- 6     0   379   430     0     0     0     0
##   kHP- 7     0     0     0     0     0     0    61
```

```
sum(diag(tt)/sum(tt))
```

```
## [1] 0.06884505
```