Tarea_8

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El presente código prepara los datos de la base "mt cars" para un análisis de k-medias. Defino inicialmente 5 clusters basándome en la estabilidad de la variabilidad intracluster del gráfico de codo y la facilidad de visualización de dichos clusteres.
La función kmeans() realizará las siguientes operaciones:
1. Toma los puntos más lejanos y, comparando las distancias de cada observación con su extremo, asigna a los clusters por cercanías.
2. Traza un centroide a partir de la suma vectorial de los ejemplares asignados a cada cluster
3. Como dichos centroides son los nuevos representantes de cada categoría, será necesario recalcular las distancias de cada ejemplar y reasignar si es necesario.

```
# http://www.sthda.com/english/wiki/factoextra-r-package-easy-multivariate-data-analyses-and-elegant-


library(factoextra)
```

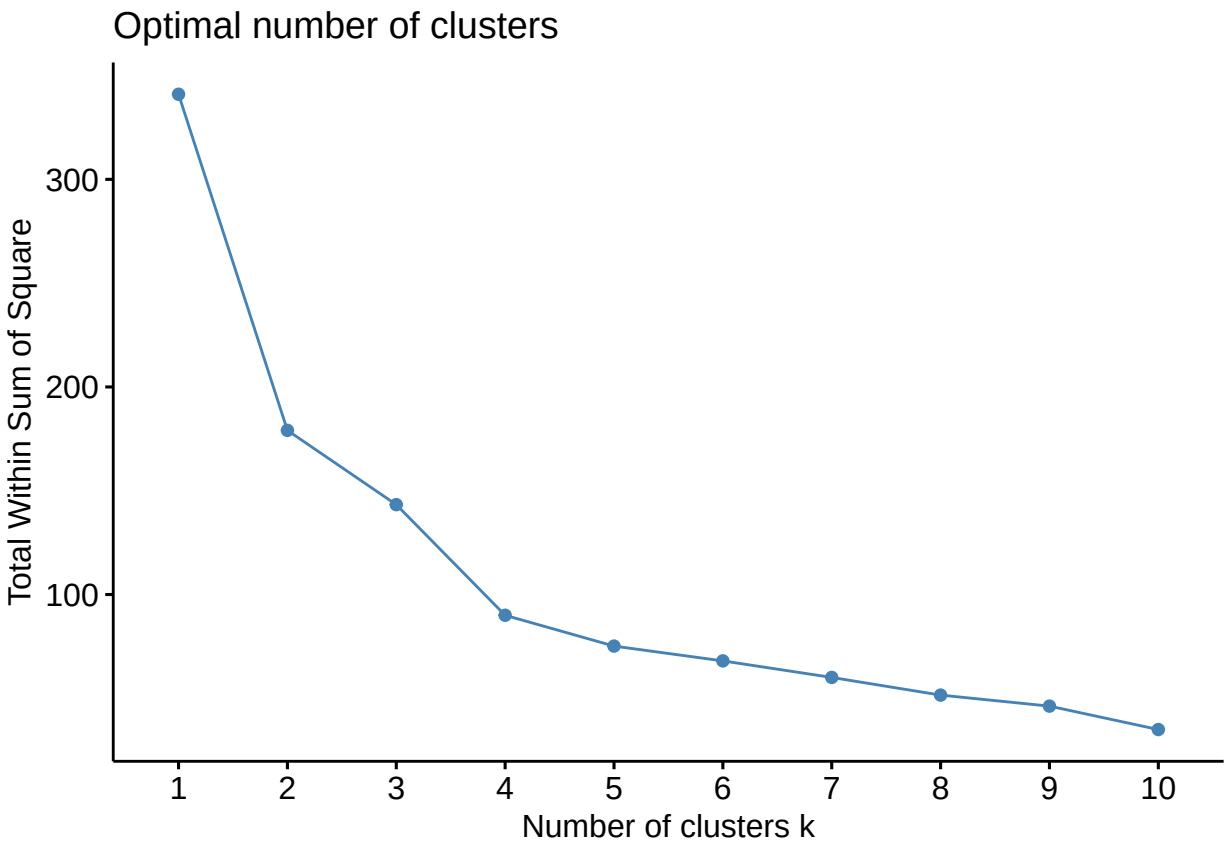
```
## Loading required package: ggplot2
```

```
## Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa
```

```
df <- scale(mtcars)  # Scaling the data
head(df, n = 3)
```

```
##                     mpg        cyl       disp         hp      drat         wt
## Mazda RX4     0.1508848 -0.1049878 -0.5706198 -0.5350928 0.5675137 -0.6103996
## Mazda RX4 Wag 0.1508848 -0.1049878 -0.5706198 -0.5350928 0.5675137 -0.3497853
## Datsun 710    0.4495434 -1.2248578 -0.9901821 -0.7830405 0.4739996 -0.9170046
##                     qsec         vs       am      gear       carb
## Mazda RX4     -0.7771651 -0.8680278 1.189901 0.4235542  0.7352031
## Mazda RX4 Wag -0.4637808 -0.8680278 1.189901 0.4235542  0.7352031
## Datsun 710     0.4260068  1.1160357 1.189901 0.4235542 -1.1221521
```

```
set.seed(123)
elbow <- fviz_nbclust(df,
    kmeans, method = "wss",
    k.max = 10)  ## elbow
elbow
```




```
km.res <- kmeans(df,
    4, nstart = 25)



print(km.res)
```

```
## K-means clustering with 4 clusters of sizes 8, 5, 12, 7
##
## Cluster means:
##          mpg        cyl        disp         hp        drat          wt
## 1  1.3247791 -1.2248578 -1.10626771 -0.9453003  1.09820619 -1.20086981
## 2 -0.2639188  0.3429602 -0.05907659  0.7600688  0.44781564 -0.22101115
## 3 -0.8363478  1.0148821  1.02385129  0.6924910 -0.88974768  0.90635862
## 4  0.1082193 -0.5849321 -0.44867013 -0.6496905 -0.04967936 -0.02346989
##         qsec         vs         am       gear       carb
## 1  0.3364684  0.8680278  1.1899014  0.7623975 -0.8125929
## 2 -1.2494801 -0.8680278  1.1899014  1.2367782  1.4781451
## 3 -0.3952280 -0.8680278 -0.8141431 -0.9318192  0.1676779
## 4  1.1854841  1.1160357 -0.8141431 -0.1573201 -0.4145882
##
## Clustering vector:
##           Mazda RX4       Mazda RX4 Wag          Datsun 710      Hornet 4 Drive
##                   2                   2                   1                   4
##   Hornet Sportabout             Valiant          Duster 360           Merc 240D
##                   3                   4                   3                   4
##            Merc 230            Merc 280           Merc 280C          Merc 450SE
##                   4                   4                   4                   3
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood Lincoln Continental
##                   3                   3                   3                   3
##   Chrysler Imperial            Fiat 128         Honda Civic      Toyota Corolla
##                   3                   1                   1                   1
##       Toyota Corona    Dodge Challenger         AMC Javelin          Camaro Z28
```

```
##                   4                   3                   3                   3
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2        Lotus Europa
##                   3                   1                   1                   1
##      Ford Pantera L        Ferrari Dino       Maserati Bora          Volvo 142E
##                   2                   2                   2                   1
##
## Within cluster sum of squares by cluster:
## [1] 19.04480 23.40276 23.08349 21.28798
##  (between_SS / total_SS =  74.5 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
## [6] "betweenss"    "size"         "iter"         "ifault"
```

```
km.res$cluster
```

```
##           Mazda RX4       Mazda RX4 Wag          Datsun 710      Hornet 4 Drive
##                   2                   2                   1                   4
##   Hornet Sportabout             Valiant          Duster 360           Merc 240D
##                   3                   4                   3                   4
##            Merc 230            Merc 280           Merc 280C          Merc 450SE
##                   4                   4                   4                   3
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood Lincoln Continental
##                   3                   3                   3                   3
##   Chrysler Imperial            Fiat 128         Honda Civic      Toyota Corolla
##                   3                   1                   1                   1
##       Toyota Corona    Dodge Challenger         AMC Javelin          Camaro Z28
##                   4                   3                   3                   3
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2        Lotus Europa
##                   3                   1                   1                   1
##      Ford Pantera L        Ferrari Dino       Maserati Bora          Volvo 142E
##                   2                   2                   2                   1
```

```
head(km.res$cluster,
    4)
```

```
##      Mazda RX4  Mazda RX4 Wag     Datsun 710 Hornet 4 Drive
##              2              2              1              4
```

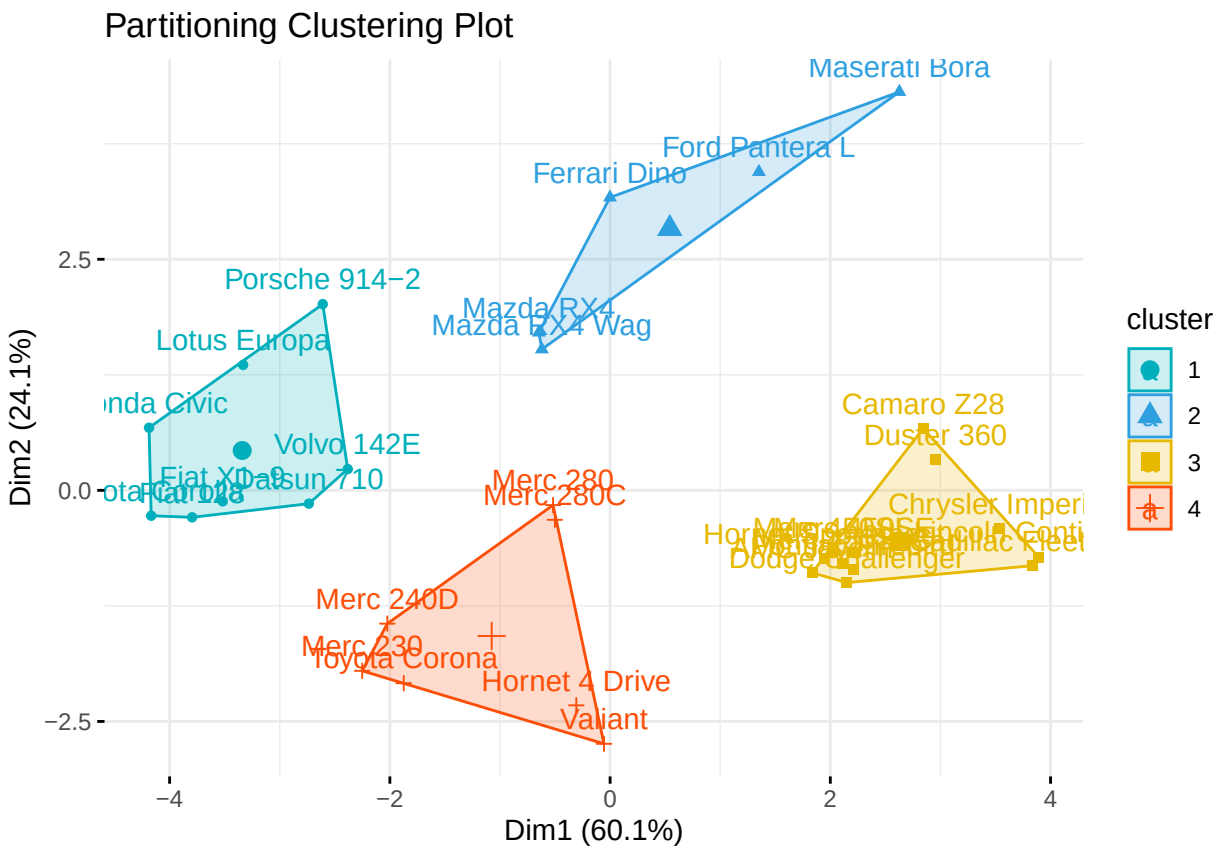
```
# Cluster size
km.res$size
```

```
## [1]  8  5 12  7
```

```
# Cluster means
km.res$centers
```

```
##          mpg        cyl        disp         hp        drat          wt
## 1  1.3247791 -1.2248578 -1.10626771 -0.9453003  1.09820619 -1.20086981
## 2 -0.2639188  0.3429602 -0.05907659  0.7600688  0.44781564 -0.22101115
## 3 -0.8363478  1.0148821  1.02385129  0.6924910 -0.88974768  0.90635862
## 4  0.1082193 -0.5849321 -0.44867013 -0.6496905 -0.04967936 -0.02346989
##         qsec         vs         am       gear       carb
## 1  0.3364684  0.8680278  1.1899014  0.7623975 -0.8125929
## 2 -1.2494801 -0.8680278  1.1899014  1.2367782  1.4781451
## 3 -0.3952280 -0.8680278 -0.8141431 -0.9318192  0.1676779
## 4  1.1854841  1.1160357 -0.8141431 -0.1573201 -0.4145882
```

```
fviz_cluster(km.res,
    data = df, palette = c("#00AFBB",
        "#2E9FDF", "#E7B800",
        "#FC4E07", "#00AFBB",
        "#2E9FDF", "#2E9FDF",
        "#2E9FDF", "#2E9FDF"),
    ggtheme = theme_minimal(),
    main = "Partitioning Clustering Plot")
```



Dado que contamos con 11 variables y el procedimiento utiliza reducción de dimensiones por ACP, podemos profundizar en la estructura de dichos factores resultantes:

```
library(hornpa)
pca.res <- prcomp(df,
    rank = 2)
pca.res$rotation
```

```
##              PC1         PC2
## mpg  -0.3625305  0.01612440
## cyl   0.3739160  0.04374371
## disp  0.3681852 -0.04932413
## hp    0.3300569  0.24878402
## drat -0.2941514  0.27469408
## wt    0.3461033 -0.14303825
## qsec -0.2004563 -0.46337482
## vs   -0.3065113 -0.23164699
## am   -0.2349429  0.42941765
## gear -0.2069162  0.46234863
## carb  0.2140177  0.41357106
```

```r
pca.var = pca.res$sdev^2
## Comparo datos
## simulados con
## los autovalores
## del dataset
simulacion <- hornpa(k = 11,
    size = 50, reps = 500,
    seed = 123)
```

```
##
##  Parallel Analysis Results
##
## Method: pca
## Number of variables: 11
## Sample size: 50
## Number of correlation matrices: 500
## Seed: 123
## Percentile: 0.95
##
## Compare your observed eigenvalues from your original dataset to the 95 percentile in the table below generate
##
##  Component  Mean  0.95
##          1 1.838 2.076
##          2 1.570 1.742
##          3 1.370 1.496
##          4 1.212 1.323
##          5 1.075 1.183
##          6 0.945 1.037
##          7 0.824 0.919
##          8 0.711 0.802
##          9 0.599 0.693
##         10 0.487 0.577
##         11 0.366 0.463
```

```r
pca.var
```

```
##  [1] 6.60840025 2.65046789 0.62719727 0.26959744 0.22345110 0.21159612
##  [7] 0.13526199 0.12290143 0.07704665 0.05203544 0.02204441
```

Probamos un número superior de iteraciones

```r
set.seed(123)
km.res <- kmeans(df,
    4, nstart = 250)  ## Aumento número de iteraciones



print(km.res)
```

```
## K-means clustering with 4 clusters of sizes 7, 5, 8, 12
##
## Cluster means:
##          mpg        cyl        disp         hp        drat          wt
## 1  0.1082193 -0.5849321 -0.44867013 -0.6496905 -0.04967936 -0.02346989
## 2 -0.2639188  0.3429602 -0.05907659  0.7600688  0.44781564 -0.22101115
## 3  1.3247791 -1.2248578 -1.10626771 -0.9453003  1.09820619 -1.20086981
## 4 -0.8363478  1.0148821  1.02385129  0.6924910 -0.88974768  0.90635862
##         qsec         vs         am       gear       carb
## 1  1.1854841  1.1160357 -0.8141431 -0.1573201 -0.4145882
```

```
## 2 -1.2494801 -0.8680278  1.1899014  1.2367782  1.4781451
## 3  0.3364684  0.8680278  1.1899014  0.7623975 -0.8125929
## 4 -0.3952280 -0.8680278 -0.8141431 -0.9318192  0.1676779
##
## Clustering vector:
##           Mazda RX4       Mazda RX4 Wag          Datsun 710      Hornet 4 Drive
##                   2                   2                   3                   1
##   Hornet Sportabout             Valiant          Duster 360           Merc 240D
##                   4                   1                   4                   1
##            Merc 230            Merc 280           Merc 280C          Merc 450SE
##                   1                   1                   1                   4
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood Lincoln Continental
##                   4                   4                   4                   4
##   Chrysler Imperial            Fiat 128        Honda Civic      Toyota Corolla
##                   4                   3                   3                   3
##       Toyota Corona    Dodge Challenger         AMC Javelin          Camaro Z28
##                   1                   4                   4                   4
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2        Lotus Europa
##                   4                   3                   3                   3
##      Ford Pantera L        Ferrari Dino       Maserati Bora          Volvo 142E
##                   2                   2                   2                   3
##
## Within cluster sum of squares by cluster:
## [1] 21.28798 23.40276 19.04480 23.08349
##  (between_SS / total_SS =  74.5 %)
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## Available components:
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## [1] "cluster"      "centers"      "totss"        "withinss"     "tot.withinss"
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```
km.res$cluster
```

```
##           Mazda RX4       Mazda RX4 Wag          Datsun 710      Hornet 4 Drive
##                   2                   2                   3                   1
##   Hornet Sportabout             Valiant          Duster 360           Merc 240D
##                   4                   1                   4                   1
##            Merc 230            Merc 280           Merc 280C          Merc 450SE
##                   1                   1                   1                   4
##          Merc 450SL         Merc 450SLC  Cadillac Fleetwood Lincoln Continental
##                   4                   4                   4                   4
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##                   4                   3                   3                   3
##       Toyota Corona    Dodge Challenger         AMC Javelin          Camaro Z28
##                   1                   4                   4                   4
##    Pontiac Firebird           Fiat X1-9       Porsche 914-2        Lotus Europa
##                   4                   3                   3                   3
##      Ford Pantera L        Ferrari Dino       Maserati Bora          Volvo 142E
##                   2                   2                   2                   3
```

```
head(km.res$cluster,
    4)
```

```
##      Mazda RX4  Mazda RX4 Wag     Datsun 710 Hornet 4 Drive
##              2              2              3              1
```

```
# Cluster size
km.res$size
```

```
## [1]  7  5  8 12
```

```
# Cluster means
km.res$centers
```

```
##          mpg        cyl        disp         hp        drat          wt
## 1  0.1082193 -0.5849321 -0.44867013 -0.6496905 -0.04967936 -0.02346989
## 2 -0.2639188  0.3429602 -0.05907659  0.7600688  0.44781564 -0.22101115
## 3  1.3247791 -1.2248578 -1.10626771 -0.9453003  1.09820619 -1.20086981
## 4 -0.8363478  1.0148821  1.02385129  0.6924910 -0.88974768  0.90635862
##         qsec         vs         am       gear       carb
## 1  1.1854841  1.1160357 -0.8141431 -0.1573201 -0.4145882
## 2 -1.2494801 -0.8680278  1.1899014  1.2367782  1.4781451
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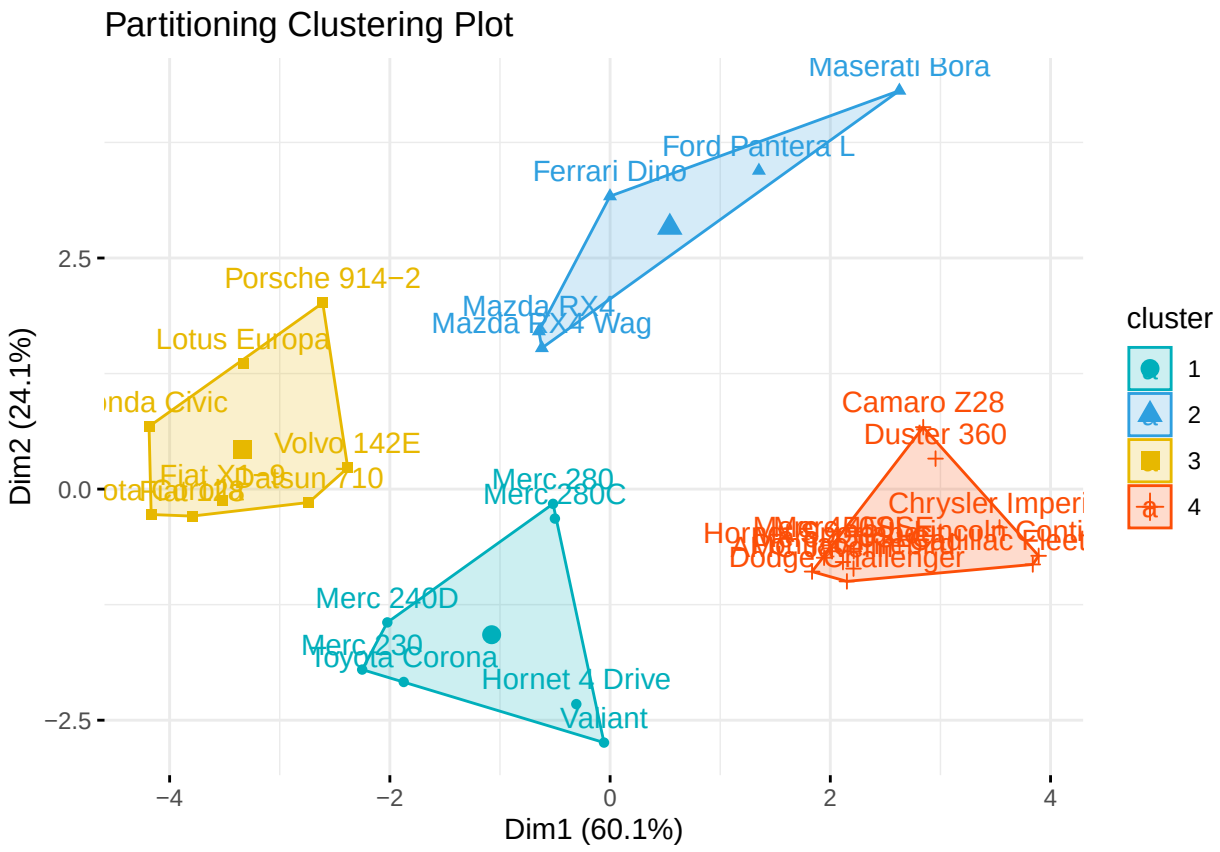
```

```
fviz_cluster(km.res,
    data = df, palette = c("#00AFBB",
        "#2E9FDF", "#E7B800",
        "#FC4E07", "#00AFBB",
        "#2E9FDF", "#2E9FDF",
        "#2E9FDF", "#2E9FDF"),
    ggtheme = theme_minimal(),
    main = "Partitioning Clustering Plot")
```



Comprobamos que en 25 iteraciones ya se llegó a la solución óptima, dado que los ejemplares ya se encontraban lo suficientemente diferenciados.