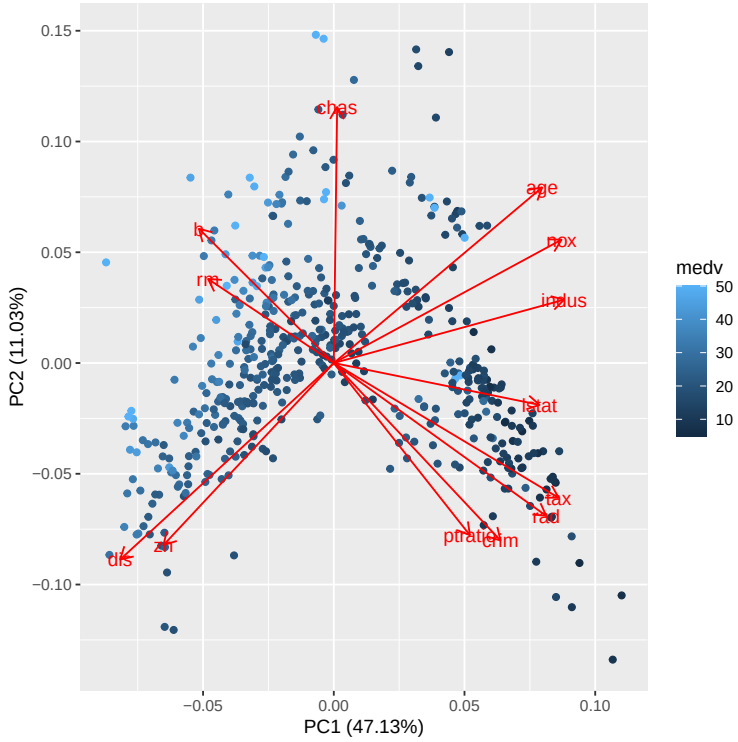
November 1, 2023

The results below are generated from an R script.

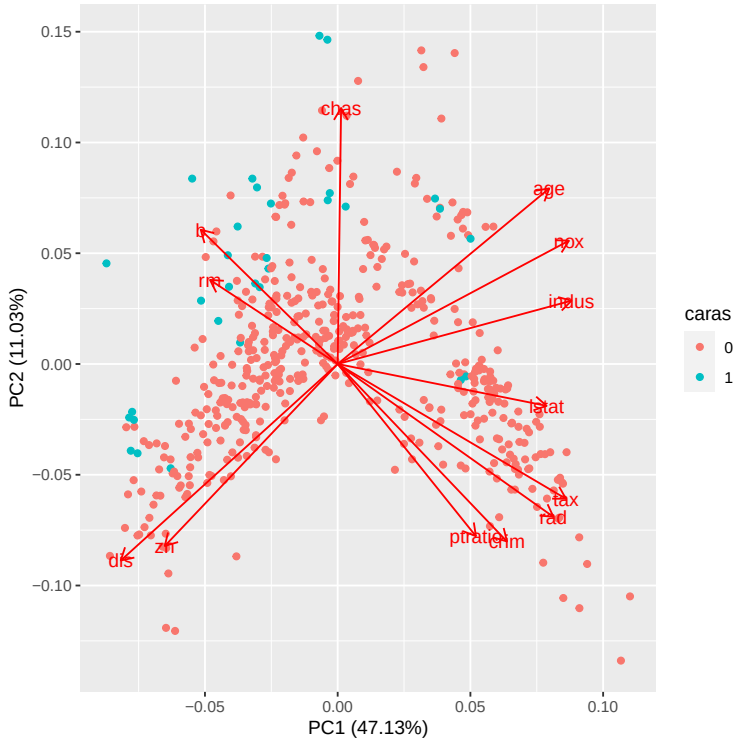
```
# Librerías necesarias
library(mlbench)
library(dplyr)
library(ggfortify)


## Cargamos los datos
df=BostonHousing

summary(df)

##       crim                zn             indus       chas         nox
##  Min.   : 0.00632   Min.   :  0.00   Min.   : 0.46   0:471   Min.   :0.3850
##  1st Qu.: 0.08205   1st Qu.:  0.00   1st Qu.: 5.19   1: 35   1st Qu.:0.4490
##  Median : 0.25651   Median :  0.00   Median : 9.69           Median :0.5380
##  Mean   : 3.61352   Mean   : 11.36   Mean   :11.14           Mean   :0.5547
##  3rd Qu.: 3.67708   3rd Qu.: 12.50   3rd Qu.:18.10           3rd Qu.:0.6240
##  Max.   :88.97620   Max.   :100.00   Max.   :27.74           Max.   :0.8710
##        rm             age              dis              rad              tax
##  Min.   :3.561   Min.   :  2.90   Min.   : 1.130   Min.   : 1.000   Min.   :187.0
##  1st Qu.:5.886   1st Qu.: 45.02   1st Qu.: 2.100   1st Qu.: 4.000   1st Qu.:279.0
##  Median :6.208   Median : 77.50   Median : 3.207   Median : 5.000   Median :330.0
##  Mean   :6.285   Mean   : 68.57   Mean   : 3.795   Mean   : 9.549   Mean   :408.2
##  3rd Qu.:6.623   3rd Qu.: 94.08   3rd Qu.: 5.188   3rd Qu.:24.000   3rd Qu.:666.0
##  Max.   :8.780   Max.   :100.00   Max.   :12.127   Max.   :24.000   Max.   :711.0
##     ptratio            b              lstat            medv
##  Min.   :12.60   Min.   :  0.32   Min.   : 1.73   Min.   : 5.00
##  1st Qu.:17.40   1st Qu.:375.38   1st Qu.: 6.95   1st Qu.:17.02
##  Median :19.05   Median :391.44   Median :11.36   Median :21.20
##  Mean   :18.46   Mean   :356.67   Mean   :12.65   Mean   :22.53
##  3rd Qu.:20.20   3rd Qu.:396.23   3rd Qu.:16.95   3rd Qu.:25.00
##  Max.   :22.00   Max.   :396.90   Max.   :37.97   Max.   :50.00

# Convertimos la variable CHAS a numérica
df =
  df %>%
  mutate(chas=as.numeric(chas))

# PCA
df_pca <- prcomp(df[, -14], scale= TRUE)
summary(df_pca)

## Importance of components:
##                           PC1    PC2     PC3     PC4     PC5     PC6     PC7     PC8
```

```
## Standard deviation     2.4752 1.1972 1.11473 0.92605 0.91368 0.81081 0.73168 0.62936
## Proportion of Variance 0.4713 0.1103 0.09559 0.06597 0.06422 0.05057 0.04118 0.03047
## Cumulative Proportion  0.4713 0.5816 0.67713 0.74310 0.80732 0.85789 0.89907 0.92954
##                            PC9    PC10    PC11    PC12    PC13
## Standard deviation     0.5263 0.46930 0.43129 0.41146 0.25201
## Proportion of Variance 0.0213 0.01694 0.01431 0.01302 0.00489
## Cumulative Proportion  0.9508 0.96778 0.98209 0.99511 1.00000
```

```
autoplot(df_pca,data=df,colour='medv',loadings=TRUE,loadings.label=TRUE)
```




```
# Las casas más caras parecen situarse, especialmente, en la esquina superior izquierda.
df =
  df %>%
  mutate(caras=as.factor(ifelse(medv>40,1,0)))

autoplot(df_pca,data=df,colour='caras',loadings=TRUE,loadings.label=TRUE)
```




```
# Las casas caras parecen estar asociadas a `chas`=1 y valores altos de "b"
# y "rm"

# Interpretación de las dos primeras componentes
df_pca$rotation[, 1:2]

##                 PC1         PC2
## crim     0.250951397 -0.31525237
## zn      -0.256314541 -0.32331290
## indus    0.346672065  0.11249291
## chas     0.005042434  0.45482914
## nox      0.342852313  0.21911553
## rm      -0.189242570  0.14933154
## age      0.313670596  0.31197778
## dis     -0.321543866 -0.34907000
## rad      0.319792768 -0.27152094
## tax      0.338469147 -0.23945365
## ptratio  0.204942258 -0.30589695
## b       -0.202972612  0.23855944
## lstat    0.309759840 -0.07432203

#La primera componente principal parece tener valores elevados en las variables
# `dis`, `zn`, 'b' y 'rm', frente a valores altos en todas las demas, a
# excepción de la variable chas. La segunda componente principal enfrenta
# observaciones con valores altos en `chas`, `age`, `nox`y `b`, frente a
# observaciones con valores altos en `crim`, `zn`, `dis` y `ptratio`.
```

The R session information (including the OS info, R version and all packages used):

```
sessionInfo()
```

```
## R version 4.3.1 (2023-06-16)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.6 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/atlas/libblas.so.3.10.3
## LAPACK: /usr/lib/x86_64-linux-gnu/atlas/liblapack.so.3.10.3;  LAPACK version 3.9.0
##
## locale:
##  [1] LC_CTYPE=es_ES.UTF-8       LC_NUMERIC=C               LC_TIME=es_ES.UTF-8
##  [4] LC_COLLATE=es_ES.UTF-8     LC_MONETARY=es_ES.UTF-8    LC_MESSAGES=es_ES.UTF-8
##  [7] LC_PAPER=es_ES.UTF-8       LC_NAME=C                  LC_ADDRESS=C
## [10] LC_TELEPHONE=C             LC_MEASUREMENT=es_ES.UTF-8 LC_IDENTIFICATION=C
##
## time zone: Europe/Madrid
## tzcode source: system (glibc)
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] ggfortify_0.4.16 factoextra_1.0.7 mlbench_2.1-3.1  readxl_1.4.3     caret_6.0-94
##  [6] lattice_0.21-9   ggplot2_3.4.3    rpart.plot_3.1.1 rpart_4.1.19     caTools_1.18.2
## [11] dplyr_1.1.3      ISLR2_1.3-2
##
## loaded via a namespace (and not attached):
##  [1] tidyselect_1.2.0     timeDate_4022.108    farver_2.1.1         bitops_1.0-7
##  [5] fastmap_1.1.1        pROC_1.18.4          digest_0.6.33        timechange_0.2.0
##  [9] lifecycle_1.0.3      survival_3.5-7       magrittr_2.0.3       compiler_4.3.1
## [13] rlang_1.1.1          tools_4.3.1          utf8_1.2.3           yaml_2.3.7
## [17] data.table_1.14.8    knitr_1.44           labeling_0.4.3       plyr_1.8.9
## [21] withr_2.5.1          purrr_1.0.2          nnet_7.3-19          grid_4.3.1
## [25] stats4_4.3.1         fansi_1.0.5          e1071_1.7-13         colorspace_2.1-0
## [29] future_1.33.0        globals_0.16.2       scales_1.2.1         iterators_1.0.14
## [33] MASS_7.3-60          tinytex_0.47         cli_3.6.1            rmarkdown_2.25
## [37] generics_0.1.3       rstudioapi_0.15.0    future.apply_1.11.0  reshape2_1.4.4
## [41] tzdb_0.4.0           proxy_0.4-27         stringr_1.5.0        splines_4.3.1
## [45] parallel_4.3.1       cellranger_1.1.0     vctrs_0.6.3          hardhat_1.3.0
## [49] Matrix_1.6-1.1       hms_1.1.3            ggrepel_0.9.3        listenv_0.9.0
## [53] foreach_1.5.2        tidyr_1.3.0          gower_1.0.1          recipes_1.0.8
## [57] glue_1.6.2           parallelly_1.36.0    codetools_0.2-19     lubridate_1.9.3
## [61] stringi_1.7.12       gtable_0.3.4         munsell_0.5.0        tibble_3.2.1
## [65] pillar_1.9.0         htmltools_0.5.6.1    ipred_0.9-14         lava_1.7.2.1
## [69] R6_2.5.1             evaluate_0.22        readr_2.1.4          highr_0.10
## [73] class_7.3-22         Rcpp_1.0.11          gridExtra_2.3        nlme_3.1-163
## [77] prodlim_2023.08.28   xfun_0.40            pkgconfig_2.0.3      ModelMetrics_1.2.2.2
```

```
Sys.time()
```

```
## [1] "2023-11-01 22:05:09 CET"
```