

MVA_Assignment_4

R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

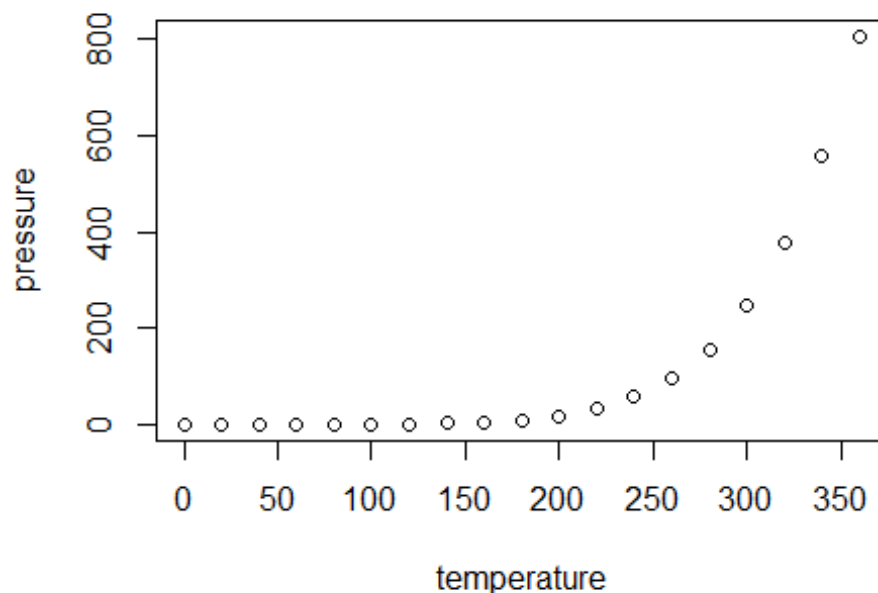
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed      dist
##  Min.   : 4.0    Min.   :  2.00
## 1st Qu.:12.0    1st Qu.: 26.00
## Median :15.0    Median : 36.00
## Mean   :15.4    Mean    : 42.98
## 3rd Qu.:19.0    3rd Qu.: 56.00
## Max.   :25.0    Max.    :120.00
```

Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

```
library(data.table)
library(tidyverse) # data manipulation

## -- Attaching packages -----
tidyverse 1.3.0 --

## v ggplot2 3.2.1      v purrr  0.3.3
## v tibble  2.1.3      v dplyr  0.8.4
## v tidyr   1.0.2      v stringr 1.4.0
## v readr   1.3.1      v forcats 0.4.0

## -- Conflicts -----
tidyverse_conflicts() --
## x dplyr::between()   masks data.table::between()
## x dplyr::filter()    masks stats::filter()
## x dplyr::first()     masks data.table::first()
## x dplyr::lag()       masks stats::lag()
## x dplyr::last()      masks data.table::last()
## x purrr::transpose() masks data.table::transpose()

library(data.table) # fast file reading
library(gridExtra)  # arranging ggplot in grid

##
## Attaching package: 'gridExtra'
```

```
## The following object is masked from 'package:dplyr':
##
##      combine

library(rmarkdown)
library(tinytex)
library(latexpdf)
library(latex2exp)

bank <- read.csv("C:/Users/Shamali/Desktop/Rutgers
Spring/multivariat/project/bank-marketing-dataset/bank.csv")

bank1<- bank[ ,c(1,5,6,10,12,13,14,15,17)]

bank1_pca <- prcomp(bank1[, -1], scale=FALSE)

bank1_pca

## Standard deviations (1, ..., p=8):
## [1] 3225.4233974  347.0547106  108.7037873    8.4012846    2.6798358
## [6]   1.9739796    0.4320433    0.1213404
##
## Rotation (n x k) = (8 x 8):
##
##          PC1          PC2          PC3          PC4
PC5
## default -2.301152e-06 -2.901819e-06  3.977508e-05  0.0002243681
1.103771e-03
## balance  9.999968e-01 -2.437063e-03  6.111252e-04 -0.0000315371
1.087512e-05
## day      2.731106e-05 -4.495770e-04  6.082131e-03  0.9988831188 -
4.640695e-02
## duration 2.442855e-03  9.999500e-01 -9.652725e-03  0.0005246749
3.339633e-04
## campaign -1.173648e-05 -3.211287e-04  2.602661e-03  0.0464153238
9.987384e-01
## pdays   5.875094e-04 -9.656965e-03 -9.998741e-01  0.0062555015
2.228881e-03
## previous 2.189243e-05 -1.912152e-04 -1.067605e-02 -0.0058038794
9.171479e-03
## deposit  1.257854e-05  6.470195e-04 -7.541632e-04 -0.0022337784 -
1.665930e-02
##
##          PC6          PC7          PC8
## default  1.127990e-03  7.758188e-03  9.999686e-01
## balance  1.633325e-05  1.011121e-05  2.168037e-06
## day      -6.317666e-03 -1.333395e-03 -1.556720e-04
## duration -7.468342e-05  6.493507e-04 -2.148716e-06
## campaign  8.514529e-03 -1.693552e-02 -9.911438e-04
## pdays    1.067406e-02  4.750723e-04  2.015439e-05
## previous -9.996699e-01  2.067405e-02  9.588572e-04
## deposit  -2.079730e-02 -9.996115e-01  7.797799e-03
```

```
summary(bank1_pca)

## Importance of components:
##              PC1          PC2          PC3          PC4  PC5  PC6
PC7
## Standard deviation    3225.4234 347.05471 108.70379 8.40128 2.68 1.974
0.432
## Proportion of Variance    0.9874    0.01143    0.00112 0.00001 0.00 0.000
0.000
## Cumulative Proportion    0.9874    0.99887    0.99999 1.00000 1.00 1.000
1.000
##              PC8
## Standard deviation    0.1213
## Proportion of Variance 0.0000
## Cumulative Proportion 1.0000

(eigen_bank <- bank1_pca$sdev^2)

## [1] 1.040336e+07 1.204470e+05 1.181651e+04 7.058158e+01 7.181520e+00
## [6] 3.896595e+00 1.866614e-01 1.472349e-02

names(eigen_bank) <- paste("PC",1:8,sep="")
eigen_bank

##          PC1          PC2          PC3          PC4          PC5
PC6
## 1.040336e+07 1.204470e+05 1.181651e+04 7.058158e+01 7.181520e+00
3.896595e+00
##          PC7          PC8
## 1.866614e-01 1.472349e-02

sumlambdas <- sum(eigen_bank)
sumlambdas

## [1] 10535701

propvar <- eigen_bank/sumlambdas
propvar

##          PC1          PC2          PC3          PC4          PC5
PC6
## 9.874384e-01 1.143227e-02 1.121569e-03 6.699277e-06 6.816366e-07
3.698468e-07
##          PC7          PC8
## 1.771704e-08 1.397486e-09

cumvar_bank <- cumsum(propvar)
cumvar_bank

##          PC1          PC2          PC3          PC4          PC5          PC6          PC7
PC8
```

```
## 0.9874384 0.9988707 0.9999922 0.9999989 0.9999996 1.0000000 1.0000000
1.0000000
```

```
matlambdas <- rbind(eigen_bank,propvar,cumvar_bank)
```

```
rownames(matlambdas) <- c("Eigenvalues","Prop. variance","Cum. prop.
variance")
```

```
round(matlambdas,4)
```

```
##          PC1          PC2          PC3          PC4          PC5
PC6
## Eigenvalues      1.040336e+07 120446.9722 11816.5134 70.5816 7.1815
3.8966
## Prop. variance    9.874000e-01    0.0114    0.0011  0.0000 0.0000
0.0000
## Cum. prop. variance 9.874000e-01    0.9989    1.0000  1.0000 1.0000
1.0000
##          PC7          PC8
## Eigenvalues      0.1867 0.0147
## Prop. variance    0.0000 0.0000
## Cum. prop. variance 1.0000 1.0000
```

```
summary(bank1_pca)
```

```
## Importance of components:
##          PC1          PC2          PC3          PC4  PC5  PC6
PC7
## Standard deviation    3225.4234 347.05471 108.70379 8.40128 2.68 1.974
0.432
## Proportion of Variance    0.9874    0.01143    0.00112 0.00001 0.00 0.000
0.000
## Cumulative Proportion    0.9874    0.99887    0.99999 1.00000 1.00 1.000
1.000
##          PC8
## Standard deviation    0.1213
## Proportion of Variance 0.0000
## Cumulative Proportion 1.0000
```

```
bank1_pca$rotation
```

```
##          PC1          PC2          PC3          PC4
PC5
## default -2.301152e-06 -2.901819e-06 3.977508e-05 0.0002243681
1.103771e-03
## balance 9.999968e-01 -2.437063e-03 6.111252e-04 -0.0000315371
1.087512e-05
## day      2.731106e-05 -4.495770e-04 6.082131e-03 0.9988831188 -
4.640695e-02
## duration 2.442855e-03 9.999500e-01 -9.652725e-03 0.0005246749
3.339633e-04
```

```
## campaign -1.173648e-05 -3.211287e-04 2.602661e-03 0.0464153238
9.987384e-01
## pdays 5.875094e-04 -9.656965e-03 -9.998741e-01 0.0062555015
2.228881e-03
## previous 2.189243e-05 -1.912152e-04 -1.067605e-02 -0.0058038794
9.171479e-03
## deposit 1.257854e-05 6.470195e-04 -7.541632e-04 -0.0022337784 -
1.665930e-02
## PC6 PC7 PC8
## default 1.127990e-03 7.758188e-03 9.999686e-01
## balance 1.633325e-05 1.011121e-05 2.168037e-06
## day -6.317666e-03 -1.333395e-03 -1.556720e-04
## duration -7.468342e-05 6.493507e-04 -2.148716e-06
## campaign 8.514529e-03 -1.693552e-02 -9.911438e-04
## pdays 1.067406e-02 4.750723e-04 2.015439e-05
## previous -9.996699e-01 2.067405e-02 9.588572e-04
## deposit -2.079730e-02 -9.996115e-01 7.797799e-03

# Sample scores stored in bank_pca$x
head(bank1_pca$x)

## PC1 PC2 PC3 PC4 PC5 PC6
PC7
## [1,] 816.0646 668.4989 46.29391 -10.71400 -0.91235277 0.2804991 -
0.08508411
## [2,] -1480.8899 1099.0781 40.78714 -10.41854 -0.79540938 0.2112248
0.16765440
## [3,] -256.0843 1018.0966 42.28868 -10.49809 -0.80813650 0.2370584
0.12939127
## [4,] 947.9331 205.1979 50.84440 -10.96112 -1.06553139 0.3172499 -
0.38438871
## [5,] -1343.8300 304.7787 48.53895 -10.79310 -0.06032618 0.2813083 -
0.36346016
## [6,] -1528.1006 194.2326 49.49795 -10.84553 -0.09939713 0.2865929 -
0.43739855
## PC8
## [1,] -0.009320344
## [2,] -0.015215698
## [3,] -0.012392252
## [4,] -0.008037139
## [5,] -0.014199403
## [6,] -0.014359815

# Identifying the scores by their deposit status
deposit_pca <- cbind(data.frame(bank1), bank1_pca$x)
head(deposit_pca)

## age default balance day duration campaign pdays previous deposit
PC1
## 1 59 0 2343 5 1042 1 -1 0 1
816.0646
```

```

## 2 56      0      45  5      1467      1  -1      0      1 -
1480.8899
## 3 41      0     1270  5      1389      1  -1      0      1 -
256.0843
## 4 55      0     2476  5      579      1  -1      0      1
947.9331
## 5 54      0      184  5      673      2  -1      0      1 -
1343.8300
## 6 42      0       0  5      562      2  -1      0      1 -
1528.1006
##          PC2          PC3          PC4          PC5          PC6          PC7
PC8
## 1 668.4989 46.29391 -10.71400 -0.91235277 0.2804991 -0.08508411 -
0.009320344
## 2 1099.0781 40.78714 -10.41854 -0.79540938 0.2112248 0.16765440 -
0.015215698
## 3 1018.0966 42.28868 -10.49809 -0.80813650 0.2370584 0.12939127 -
0.012392252
## 4 205.1979 50.84440 -10.96112 -1.06553139 0.3172499 -0.38438871 -
0.008037139
## 5 304.7787 48.53895 -10.79310 -0.06032618 0.2813083 -0.36346016 -
0.014199403
## 6 194.2326 49.49795 -10.84553 -0.09939713 0.2865929 -0.43739855 -
0.014359815

# Means of scores for all the PC's classified by Deposit status
tabmeansPC <- aggregate(deposit_pca[,2:6],by=list(Deposit=bank$deposit),mean)
tabmeansPC

## Deposit      default balance      day duration campaign
## 1      0 0.019751405 1280.227 16.10812 223.1303 2.839264
## 2      1 0.009831726 1804.268 15.15825 537.2946 2.141047

tabmeansPC <- tabmeansPC[rev(order(tabmeansPC$Deposit)),]
tabmeansPC

## Deposit      default balance      day duration campaign
## 2      1 0.009831726 1804.268 15.15825 537.2946 2.141047
## 1      0 0.019751405 1280.227 16.10812 223.1303 2.839264

tabfmeans <- t(tabmeansPC[, -1])
tabfmeans

##          2          1
## default 9.831726e-03 0.0197514
## balance 1.804268e+03 1280.2271412
## day      1.515825e+01 16.1081219
## duration 5.372946e+02 223.1302571
## campaign 2.141047e+00 2.8392644

```

```

colnames(tabfmeans) <- t(as.vector(tabmeansPC[1]))
tabfmeans

##              1              0
## default  9.831726e-03  0.0197514
## balance  1.804268e+03 1280.2271412
## day      1.515825e+01  16.1081219
## duration 5.372946e+02 223.1302571
## campaign 2.141047e+00  2.8392644

# Standard deviations of scores for all the PC's classified by Deposit status
tabstdsPC <- aggregate(deposit_pca[,2:6],by=list(Deposit=bank$deposit),sd)
tabstds <- t(tabstdsPC[, -1])
colnames(tabstds) <- t(as.vector(tabstdsPC[1]))
tabstds

##              0              1
## default    0.1391567 9.867575e-02
## balance  2933.4119343 3.501105e+03
## day       8.3220713 8.501875e+00
## duration  208.5775301 3.925253e+02
## campaign   3.2444741 1.921826e+00

t.test(PC1~bank$deposit,data=deposit_pca)

##
## Welch Two Sample t-test
##
## data: PC1 by bank$deposit
## t = -8.5333, df = 10359, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -645.385 -404.267
## sample estimates:
## mean in group 0 mean in group 1
##    -248.6834      276.1425

t.test(PC2~bank$deposit,data=deposit_pca)

##
## Welch Two Sample t-test
##
## data: PC2 by bank$deposit
## t = -51.649, df = 7853.3, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -324.4163 -300.6914
## sample estimates:
## mean in group 0 mean in group 1
##    -148.1004      164.4534

t.test(PC3~bank$deposit,data=deposit_pca)

```



```

##
## Welch Two Sample t-test
##
## data: PC3 by bank$deposit
## t = 17.396, df = 10206, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 31.71374 39.76818
## sample estimates:
## mean in group 0 mean in group 1
## 16.93549 -18.80547

t.test(PC4~bank$deposit,data=deposit_pca)

##
## Welch Two Sample t-test
##
## data: PC4 by bank$deposit
## t = 3.9672, df = 10966, p-value = 7.317e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.3199010 0.9447568
## sample estimates:
## mean in group 0 mean in group 1
## 0.2996226 -0.3327063

t.test(PC5~bank$deposit,data=deposit_pca)

##
## Welch Two Sample t-test
##
## data: PC5 by bank$deposit
## t = 9.7124, df = 9863.6, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.3829862 0.5766678
## sample estimates:
## mean in group 0 mean in group 1
## 0.2273611 -0.2524659

#F-test
var.test(PC1~bank$deposit,data=deposit_pca)

##
## F test to compare two variances
##
## data: PC1 by bank$deposit
## F = 0.70202, num df = 5872, denom df = 5288, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
## 0.6660526 0.7398708

```

```

## sample estimates:
## ratio of variances
##          0.7020178

var.test(PC2~bank$deposit,data=deposit_pca)

##
## F test to compare two variances
##
## data:  PC2 by bank$deposit
## F = 0.28137, num df = 5872, denom df = 5288, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2669565 0.2965431
## sample estimates:
## ratio of variances
##          0.2813715

var.test(PC3~bank$deposit,data=deposit_pca)

##
## F test to compare two variances
##
## data:  PC3 by bank$deposit
## F = 0.66204, num df = 5872, denom df = 5288, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6281230 0.6977374
## sample estimates:
## ratio of variances
##          0.66204

var.test(PC4~bank$deposit,data=deposit_pca)

##
## F test to compare two variances
##
## data:  PC4 by bank$deposit
## F = 0.9451, num df = 5872, denom df = 5288, p-value = 0.03509
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.8966825 0.9960612
## sample estimates:
## ratio of variances
##          0.9451011

var.test(PC5~bank$deposit,data=deposit_pca)

##
## F test to compare two variances
##
## data:  PC5 by bank$deposit

```

```
## F = 2.6818, num df = 5872, denom df = 5288, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  2.544403 2.826397
## sample estimates:
## ratio of variances
##           2.681794
```