ML assignment 2

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Assignment Details:

#implementation of KNN in R #Liability customers - Majority - Depositors #Asset customers - Small - Borrowers #Campaign of last year - conversion rate of 9.6% [Among the 5000 customers, only 480 (= 9.6%) accepted the personal loan that was offered to them in the earlier campaign.] #Goal= use k-NN to predict whether a new customer will accept a loan offer. # Data (rows): 5000 customers #Success class as 1 (loan acceptance)

#packages used

```r
library(class)  # knn is present in class package
library(caret)  #for data partition, normalize data
```

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

```
## Loading required package: lattice
```

```r
library(FNN)    #for Perfoming knn classification
```

```
##
## Attaching package: 'FNN'
```

```
## The following objects are masked from 'package:class':
##
##     knn, knn.cv
```

```r
library(psych)  #for creating dummies
```

```
##
## Attaching package: 'psych'
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```r
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

library(readr)
```

import a universal bank dataset

```
input<-read.csv("UniversalBank.csv")
```

#Eliminating variables [id & zip code] from the data set

```
df=subset(input, select=-c(ID, ZIP.Code ))
```

#creating dummy variables for the categorical variables

```
dummy_Education_1 <- as.data.frame(dummy.code(df$Education))
names(dummy_Education_1) <- c("Education_1", "Education_2","Education_3") #renaming the dummy variable
df_without_education <- subset(df, select=-c(Education))                  #eliminating education variab

UBank_data <- cbind(df_without_education, dummy_Education_1)             #main dataset
```

###Data partition

Spliting the data into Two Groups Traning(60%) and Validation(40%)

```
set.seed(1234)
Train_Index     = createDataPartition(UBank_data$Age, p= 0.6 , list=FALSE) #Traning group data 60%
Train_Data      = UBank_data[Train_Index,]  #3001 observations
Validation_Data = UBank_data[-Train_Index,] #1999 observations
```

#Generating test data

```
Test_Data <- data.frame(Age=40 , Experience=10, Income = 84, Family = 2, CCAvg = 2, Education_1 = 0, Ed
```

#Data Normalization(data has to be normalized before the process)

```
train.norm.df     <- Train_Data
valid.norm.df     <- Validation_Data
test.norm.df      <- Test_Data
maindata.norm.df <- UBank_data

head(maindata.norm.df)
```

```
##   Age Experience Income Family CCAvg Mortgage Personal.Loan Securities.Account
## 1  25          1     49      4   1.6        0             0                   1
## 2  45         19     34      3   1.5        0             0                   1
## 3  39         15     11      1   1.0        0             0                   0
## 4  35          9    100      1   2.7        0             0                   0
## 5  35          8     45      4   1.0        0             0                   0
## 6  37         13     29      4   0.4      155             0                   0
##   CD.Account Online CreditCard Education_1 Education_2 Education_3
## 1          0      0          0           1           0           0
## 2          0      0          0           1           0           0
## 3          0      0          0           1           0           0
## 4          0      0          0           0           0           1
## 5          0      0          1           0           0           1
## 6          0      1          0           0           0           1
```

```r
# use preProcess() from the caret package to normalize .
norm.values <- preProcess(Train_Data[,-7], method=c("center", "scale"))

train.norm.df[,-7] <- predict(norm.values, Train_Data[,-7])   #Training Data
valid.norm.df [,-7]<- predict(norm.values, Validation_Data[,-7])#Validation Data
test.norm.df <- predict(norm.values, Test_Data)#Test Data
maindata.norm.df[,-7] <- predict(norm.values,UBank_data[,-7]) #Training + Validation data

head(maindata.norm.df)
```

```
##           Age  Experience     Income     Family      CCAvg   Mortgage
## 1 -1.77136698 -1.6613124 -0.5177762  1.3933091 -0.1845814 -0.5438042
## 2 -0.03145296 -0.0978843 -0.8425723  0.5187388 -0.2419870 -0.5438042
## 3 -0.55342717 -0.4453128 -1.3405930 -1.2304018 -0.5290146 -0.5438042
## 4 -0.90140997 -0.9664555  0.5865306 -1.2304018  0.4468794 -0.5438042
## 5 -0.90140997 -1.0533126 -0.6043885  1.3933091 -0.5290146 -0.5438042
## 6 -0.72741857 -0.6190270 -0.9508377  1.3933091 -0.8734478  1.0035659
##   Personal.Loan Securities.Account CD.Account     Online CreditCard Education_1
## 1             0          2.9564494 -0.2533042 -1.2038741 -0.6538696   1.1696714
## 2             0          2.9564494 -0.2533042 -1.2038741 -0.6538696   1.1696714
## 3             0         -0.3381309 -0.2533042 -1.2038741 -0.6538696   1.1696714
## 4             0         -0.3381309 -0.2533042 -1.2038741 -0.6538696  -0.8546561
## 5             0         -0.3381309 -0.2533042 -1.2038741  1.5288474  -0.8546561
## 6             0         -0.3381309 -0.2533042  0.8303749 -0.6538696  -0.8546561
##   Education_2 Education_3
## 1  -0.6414311  -0.6331615
## 2  -0.6414311  -0.6331615
## 3  -0.6414311  -0.6331615
## 4  -0.6414311   1.5788497
## 5  -0.6414311   1.5788497
## 6  -0.6414311   1.5788497
```

Using KNN CLASSIFICATION METHOD, using k = 1

```r
set.seed(1234)
prediction <- knn(train = train.norm.df[,-7], test = valid.norm.df[,-7],
```

```
          cl = train.norm.df[,7], k = 1, prob=TRUE)
actual= valid.norm.df$Personal.Loan
prediction_prob = attr(prediction,"prob")
table(prediction,actual)
```

```
##           actual
## prediction    0    1
##          0 1770   68
##          1   25  136
```

```
mean(prediction==actual)
```

```
## [1] 0.9534767
```

```
NROW(train.norm.df)
```

```
## [1] 3001
```

```
sqrt(3001)
```

```
## [1] 54.78138
```

```
accuracy.df <- data.frame(k = seq(1, 60, 1), accuracy = rep(0, 60))

# compute knn for different k on validation.
for(i in 1:60) {
prediction <- knn(train = train.norm.df[,-7], test = valid.norm.df[-7],
        cl = train.norm.df[,7], k = i, prob=TRUE)

accuracy.df[i,2] <- mean(prediction==actual)
}
accuracy.df
```

```
##     k  accuracy
## 1   1 0.9534767
## 2   2 0.9464732
## 3   3 0.9544772
## 4   4 0.9474737
## 5   5 0.9524762
## 6   6 0.9439720
## 7   7 0.9489745
## 8   8 0.9409705
## 9   9 0.9454727
## 10 10 0.9419710
## 11 11 0.9439720
## 12 12 0.9404702
## 13 13 0.9424712
## 14 14 0.9379690
## 15 15 0.9409705
## 16 16 0.9374687
```

```
## 17 17 0.9399700
## 18 18 0.9359680
## 19 19 0.9404702
## 20 20 0.9354677
## 21 21 0.9384692
## 22 22 0.9344672
## 23 23 0.9364682
## 24 24 0.9319660
## 25 25 0.9354677
## 26 26 0.9324662
## 27 27 0.9354677
## 28 28 0.9319660
## 29 29 0.9339670
## 30 30 0.9289645
## 31 31 0.9314657
## 32 32 0.9299650
## 33 33 0.9319660
## 34 34 0.9284642
## 35 35 0.9304652
## 36 36 0.9274637
## 37 37 0.9284642
## 38 38 0.9269635
## 39 39 0.9284642
## 40 40 0.9249625
## 41 41 0.9269635
## 42 42 0.9239620
## 43 43 0.9254627
## 44 44 0.9234617
## 45 45 0.9249625
## 46 46 0.9219610
## 47 47 0.9244622
## 48 48 0.9229615
## 49 49 0.9244622
## 50 50 0.9219610
## 51 51 0.9244622
## 52 52 0.9224612
## 53 53 0.9234617
## 54 54 0.9224612
## 55 55 0.9224612
## 56 56 0.9234617
## 57 57 0.9229615
## 58 58 0.9209605
## 59 59 0.9214607
## 60 60 0.9209605
```

The value of k we choose is 1 as it is given in the question [i.e the choice of k that balances between overfitting and ignoring the predictor information]

##Validation data results using best k value [i.e: k = 1]

```
set.seed(1234)
prediction <- knn(train = train.norm.df[,-7], test = valid.norm.df[,-7],
          cl = train.norm.df[,7], k = 1, prob=TRUE)
actual= valid.norm.df$Personal.Loan
```

```
prediction_prob = attr(prediction,"prob")
```

```
#3: confusion matrix for the best k value =1
table(prediction,actual)
```

```
##          actual
## prediction   0    1
##        0 1770   68
##        1   25  136
```

```
#accuracy of the best k=1
mean(prediction==actual)
```

```
## [1] 0.9534767
```

Classifying the customer using the best k [perfominng k-NN classification on test data]

```
prediction_test <- knn(train = maindata.norm.df[,-7], test = Test_Data,
          cl = maindata.norm.df[,7], k = 1, prob=TRUE)
head(prediction_test)
```

```
## [1] 1
## Levels: 1
```

k-NN model predicted that the new customer will accept a loan offer [loan accepted]

5)Repartition the data, this time into training, validation, and test sets (50% : 30% : 20%). Apply the k-NN method with the k chosen above. Compare the confusion matrix of the test set with that of the training and validation sets.

```
#Partitioning the data into Traning(50%) ,Validation(30%), Test(20%)
set.seed(1234)

Test_Index_1 = createDataPartition(UBank_data$Age, p= 0.2 , list=FALSE) #20% test data
Test_Data_1  = UBank_data [Test_Index_1,]

Rem_DATA = UBank_data[-Test_Index_1,] #80% remaining data [training + validation]

Train_Index_1 = createDataPartition(Rem_DATA$Age, p= 0.5 , list=FALSE)
Train_Data_1 = Rem_DATA[Train_Index_1,] #Training data

Validation_Data_1 = Rem_DATA[-Train_Index_1,] #Validation data
```

```r
#Data Normalization


# Copy the original data
train.norm.df_1 <- Train_Data_1
valid.norm.df_1 <- Validation_Data_1
test.norm.df_1 <- Test_Data_1
rem_data.norm.df_1 <- Rem_DATA

# use preProcess() from the caret package to normalize Sales and Age.
norm.values_1 <- preProcess(Train_Data_1[-7], method=c("center", "scale"))

train.norm.df_1[-7] <- predict(norm.values_1, Train_Data_1[-7])  #Training Data
valid.norm.df_1[-7] <- predict(norm.values_1, Validation_Data_1[-7])#Validation Data
test.norm.df_1[-7] <- predict(norm.values_1, test.norm.df_1[-7]) #Test Data
test.norm.df_1[-7] <- predict(norm.values_1, Test_Data_1[-7])
rem_data.norm.df_1[-7] <- predict(norm.values_1,Rem_DATA[-7]) #Training + Validation data

head(test.norm.df_1)
```

```
##             Age   Experience      Income     Family        CCAvg   Mortgage
## 9   -0.90840439 -0.883582836   0.1435652  0.5333142 -0.780693325  0.4495336
## 28   0.05751618 -0.008054857   1.8189997 -1.2081200  0.234699617 -0.5532869
## 32  -0.46934959 -0.358266049  -0.9878972 -1.2081200  0.009056741 -0.5532869
## 40  -0.64497151 -0.620924443   0.1218063  1.4040313 -0.724282606  2.1948269
## 42  -0.99621536 -0.971135634  -0.3133715  0.5333142  0.178288898 -0.5532869
## 63  -0.29372767 -0.183160453  -1.1402094 -1.2081200 -0.555050449 -0.5532869
##     Personal.Loan Securities.Account CD.Account      Online CreditCard
## 9               0         -0.3360202 -0.2646808   0.8429167 -0.6350646
## 28              0         -0.3360202 -0.2646808   0.8429167  1.5738557
## 32              0         -0.3360202 -0.2646808   0.8429167 -0.6350646
## 40              0         -0.3360202 -0.2646808   0.8429167 -0.6350646
## 42              0         -0.3360202 -0.2646808  -1.1857637 -0.6350646
## 63              0         -0.3360202 -0.2646808  -1.1857637 -0.6350646
##     Education_1 Education_2 Education_3
## 9     -0.827392  -0.6607293    1.566207
## 28     1.208013  -0.6607293   -0.638166
## 32    -0.827392  -0.6607293    1.566207
## 40    -0.827392   1.5127224   -0.638166
## 42     1.208013  -0.6607293   -0.638166
## 63     1.208013  -0.6607293   -0.638166
```

##Perfoming k-NN classification on Training Data, k = 1

```r
set.seed(1234)
prediction_Q5 <- knn(train = train.norm.df_1[,-7], test = valid.norm.df_1[,-7],
        cl = train.norm.df_1[,7], k = 1, prob=TRUE)
actual= valid.norm.df_1$Personal.Loan
prediction_prob = attr(prediction_Q5,"prob")

table(prediction_Q5,actual)  #confusion matrix for the best k value =1
```

```
##              actual
```

```
## prediction_Q5    0    1
##              0 1795   69
##              1   16  119
```

```
mean(prediction_Q5==actual)  #accuracy of the best k=1
```

```
## [1] 0.9574787
```

```
set.seed(1234)
prediction_Q5 <- knn(train = rem_data.norm.df_1[,-7], test = test.norm.df_1[,-7],
         cl = rem_data.norm.df_1[,7], k = 1, prob=TRUE)
actual= test.norm.df_1$Personal.Loan
prediction_prob = attr(prediction_Q5,"prob")

table(prediction_Q5,actual)  #confusion matrix for the best k value =1
```

```
##              actual
## prediction_Q5   0    1
##              0 907   25
##              1  12   57
```

```
mean(prediction_Q5==actual)  #accuracy of the best k=1
```

```
## [1] 0.963037
```

THE K VALUE WHICH WE GIVE IN TEST TRAIN VALID WILL BE DIFFERENT,AND ACCURACY WILL ALSO BE DIFFERENT,SO DOES CLASSIFICATION