Assignment 3

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```
#Importing the dataset
Univ_Bank <- read.csv("C:/Users/RAJEEV VARMA/Downloads/UniversalBank.csv")
```

```
#Converting the predictor attributes to factors
Univ_Bank$Online <- as.factor(Univ_Bank$Online)
Univ_Bank$CreditCard <- as.factor(Univ_Bank$CreditCard)
Univ_Bank$Personal.Loan <- as.factor(Univ_Bank$Personal.Loan)
```

```
#Checking for NULL VALUES and loading packages
sum(is.na(Univ_Bank))
```

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

```
library(class)
library(caret)
```

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

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

```
library(e1071)
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(ggplot2)
library(reshape)
```

```
##
## Attaching package: 'reshape'
```

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

```
## The following object is masked from 'package:class':
##
##     condense
```

```r
library(melt)
library(ISLR)
library(reshape2)
```

```
##
## Attaching package: 'reshape2'

## The following objects are masked from 'package:reshape':
##
##     colsplit, melt, recast
```

```r
library(readr)
library(naivebayes)
```

```
## naivebayes 0.9.7 loaded
```

```r
library(pROC)
```

```
## Type 'citation("pROC")' for a citation.

##
## Attaching package: 'pROC'

## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```r
#Data Partition to 60:40
set.seed(123)
datapart <- createDataPartition(Univ_Bank$Personal.Loan,p=.6, list=F)
Train <- Univ_Bank[datapart,]
Validate <- Univ_Bank[-datapart,]
```

```r
#Data Normalization
ModelNorm <- preProcess(Train[,-c(10,13:14)],
                method=c("center","scale"))
Trainnorm <- predict(ModelNorm,Train)
Validatenorm <- predict(ModelNorm,Validate)
```

#A)

```r
tab1<- ftable(Trainnorm[,c(14,10,13)])
tab1
```

```
##                           Online    0    1
## CreditCard Personal.Loan
## 0          0                      791 1144
##            1                       79  125
## 1          0                      310  467
##            1                       33   51
```

#B) 51/(51+467) = 0.0984.

#C)

```r
melt = melt(Train, id=c("CreditCard","Personal.Loan"), variable = "Online")
```

```
## Warning: attributes are not identical across measure variables; they will be
## dropped
```

```r
castbank = dcast(melt, CreditCard+Personal.Loan~Online)
```

```
## Aggregation function missing: defaulting to length
```

```r
castbank[,c(1:2,14)]
```

```
##   CreditCard Personal.Loan Online
## 1          0             0   1935
## 2          0             1    204
## 3          1             0    777
## 4          1             1     84
```

#D)

```r
ftable(Trainnorm[,c(10,13)])
```

```
##               Online    0    1
## Personal.Loan
## 0                    1101 1611
## 1                     112  176
```

```r
ftable(Trainnorm[,c(10,14)])
```

```
##               CreditCard    0    1
## Personal.Loan
## 0                        1935  777
## 1                         204   84
```

```r
ftable(Trainnorm[,10])
```

```
##     0    1
##
##  2712  288
```

```r
#1. P(CC = 1 | Loan = 1) = (84/84+204) = 0.291
#2. P(Online = 1 | Loan = 1)  = (176/176+112) = 0.611
#3. P(Loan = 1) = (288/288+2712) = 0.096
#4. P(CC = 1 | Loan = 0) = (777/777+1935) = 0.286
#5. P(Online = 1 | Loan = 0) = (1611/ 1611+1101) = 0.595
#6. P(Loan = 0) = (2712/ 2712+288) = 0.904
```

#E)

```r
#Computing the naive bayes probability:
#(0.291 x 0.611 x 0.096) / (0.271 x 0.611 x 0.096) + (0.286 x 0.595 x 0.904) = 0.1000
```

#F) Although Naive Bayes has a higher probability than that with the direct calculation, the value obtained in step b, which is 0.0984, and the value obtained in step a, which is 0.1000, are almost similar.

#G)

```r
naive_bayes <- naive_bayes(Personal.Loan~Online+CreditCard,data=Trainnorm)
naive_bayes
```

```
##
## ================================== Naive Bayes ==================================
##
##  Call:
## naive_bayes.formula(formula = Personal.Loan ~ Online + CreditCard,
##     data = Trainnorm)
```

```
##
## -------------------------------------------------------------------------------
##
## Laplace smoothing: 0
##
## -------------------------------------------------------------------------------
##
##  A priori probabilities:
##
##     0     1
## 0.904 0.096
##
## -------------------------------------------------------------------------------
##
##  Tables:
##
## -------------------------------------------------------------------------------
##  ::: Online (Bernoulli)
## -------------------------------------------------------------------------------
##
## Online         0         1
##      0 0.4059735 0.3888889
##      1 0.5940265 0.6111111
##
## -------------------------------------------------------------------------------
##  ::: CreditCard (Bernoulli)
## -------------------------------------------------------------------------------
##
## CreditCard         0         1
##          0 0.7134956 0.7083333
##          1 0.2865044 0.2916667
##
## -------------------------------------------------------------------------------
```

```
#The Naive Bayes Model produces a result of 0.1000, which is equivalent to the result in E, when it is
```

```
#Examining the AUC value and ROC curve
Naive <- naiveBayes(Personal.Loan~Online+CreditCard,data=Trainnorm)
Naive
```

```
##
## Naive Bayes Classifier for Discrete Predictors
##
## Call:
## naiveBayes.default(x = X, y = Y, laplace = laplace)
##
## A-priori probabilities:
## Y
##     0     1
## 0.904 0.096
##
## Conditional probabilities:
##    Online
## Y           0         1
##   0 0.4059735 0.5940265
```

```
##   1 0.3888889 0.6111111
##
##    CreditCard
## Y           0         1
##   0 0.7134956 0.2865044
##   1 0.7083333 0.2916667
```

```r
predlab <- predict(Naive,Validatenorm,type = "raw")
head(predlab)
```

```
##              0          1
## [1,] 0.9082737 0.09172629
## [2,] 0.9021538 0.09784623
## [3,] 0.9061594 0.09384060
## [4,] 0.9082737 0.09172629
## [5,] 0.9082737 0.09172629
## [6,] 0.8999139 0.10008606
```

```r
roc(Validatenorm$Online,predlab[,2])
```

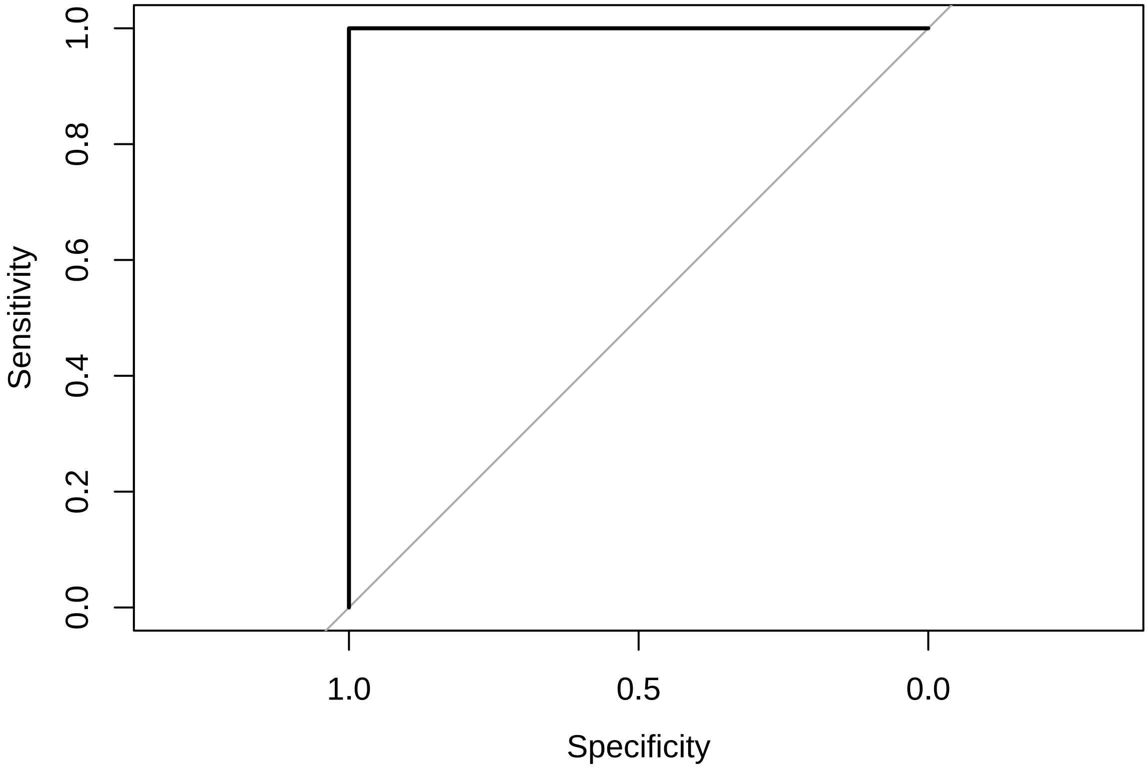
```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```
##
## Call:
## roc.default(response = Validatenorm$Online, predictor = predlab[,     2])
##
## Data: predlab[, 2] in 803 controls (Validatenorm$Online 0) < 1197 cases (Validatenorm$Online 1).
## Area under the curve: 1
```

```r
plot.roc(Validatenorm$Online,predlab[,2])
```

```
## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
```


1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
1.0
0.5
0.0
Specificity