Assignmnet_3

```
library(readr)

universalbank <- read_csv("C:/Users/Dell/Desktop/universalbank.csv")
```

```
## Rows: 5000 Columns: 14

## -- Column specification --------------------------------------------------------
## Delimiter: ","
## dbl (14): ID, Age, Experience, Income, ZIP Code, Family, CCAvg, Education, M...

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
View(universalbank)
summary(universalbank)
```

```
##        ID            Age          Experience       Income          ZIP Code
##  Min.   :   1   Min.   :23.00   Min.   :-3.0   Min.   :  8.00   Min.   : 9307
##  1st Qu.:1251   1st Qu.:35.00   1st Qu.:10.0   1st Qu.: 39.00   1st Qu.:91911
##  Median :2500   Median :45.00   Median :20.0   Median : 64.00   Median :93437
##  Mean   :2500   Mean   :45.34   Mean   :20.1   Mean   : 73.77   Mean   :93153
##  3rd Qu.:3750   3rd Qu.:55.00   3rd Qu.:30.0   3rd Qu.: 98.00   3rd Qu.:94608
##  Max.   :5000   Max.   :67.00   Max.   :43.0   Max.   :224.00   Max.   :96651
##      Family          CCAvg          Education        Mortgage
##  Min.   :1.000   Min.   : 0.000   Min.   :1.000   Min.   :  0.0
##  1st Qu.:1.000   1st Qu.: 0.700   1st Qu.:1.000   1st Qu.:  0.0
##  Median :2.000   Median : 1.500   Median :2.000   Median :  0.0
##  Mean   :2.396   Mean   : 1.938   Mean   :1.881   Mean   : 56.5
##  3rd Qu.:3.000   3rd Qu.: 2.500   3rd Qu.:3.000   3rd Qu.:101.0
##  Max.   :4.000   Max.   :10.000   Max.   :3.000   Max.   :635.0
##  personal.loan   Securities Account   CD Account         Online
##  Min.   :0.000   Min.   :0.0000     Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.000   1st Qu.:0.0000     1st Qu.:0.0000   1st Qu.:0.0000
##  Median :0.000   Median :0.0000     Median :0.0000   Median :1.0000
##  Mean   :0.096   Mean   :0.1044     Mean   :0.0604   Mean   :0.5968
##  3rd Qu.:0.000   3rd Qu.:0.0000     3rd Qu.:0.0000   3rd Qu.:1.0000
##  Max.   :1.000   Max.   :1.0000     Max.   :1.0000   Max.   :1.0000
##    CreditCard
##  Min.   :0.000
##  1st Qu.:0.000
##  Median :0.000
##  Mean   :0.294
##  3rd Qu.:1.000
##  Max.   :1.000
```

```
universalbank$personal.loan<- as.factor(universalbank$personal.loan)
universalbank$Online <-as.factor(universalbank$Online)
universalbank$CreditCard <- as.factor(universalbank$CreditCard)
summary(universalbank)
```

```
##        ID            Age          Experience       Income          ZIP Code
##  Min.   :   1   Min.   :23.00   Min.   :-3.0   Min.   :  8.00   Min.   : 9307
##  1st Qu.:1251   1st Qu.:35.00   1st Qu.:10.0   1st Qu.: 39.00   1st Qu.:91911
##  Median :2500   Median :45.00   Median :20.0   Median : 64.00   Median :93437
##  Mean   :2500   Mean   :45.34   Mean   :20.1   Mean   : 73.77   Mean   :93153
##  3rd Qu.:3750   3rd Qu.:55.00   3rd Qu.:30.0   3rd Qu.: 98.00   3rd Qu.:94608
##  Max.   :5000   Max.   :67.00   Max.   :43.0   Max.   :224.00   Max.   :96651
##      Family          CCAvg          Education        Mortgage     personal.loan
##  Min.   :1.000   Min.   : 0.000   Min.   :1.000   Min.   :  0.0   0:4520
##  1st Qu.:1.000   1st Qu.: 0.700   1st Qu.:1.000   1st Qu.:  0.0   1: 480
##  Median :2.000   Median : 1.500   Median :2.000   Median :  0.0
##  Mean   :2.396   Mean   : 1.938   Mean   :1.881   Mean   : 56.5
##  3rd Qu.:3.000   3rd Qu.: 2.500   3rd Qu.:3.000   3rd Qu.:101.0
##  Max.   :4.000   Max.   :10.000   Max.   :3.000   Max.   :635.0
##  Securities Account   CD Account     Online   CreditCard
##  Min.   :0.0000     Min.   :0.0000   0:2016   0:3530
##  1st Qu.:0.0000     1st Qu.:0.0000   1:2984   1:1470
##  Median :0.0000     Median :0.0000
##  Mean   :0.1044     Mean   :0.0604
##  3rd Qu.:0.0000     3rd Qu.:0.0000
##  Max.   :1.0000     Max.   :1.0000
```

```
library("caret")
```

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

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

```
library('class')
library('ISLR')
```

Question A

##partitioning the data into training (60%) and validation set(40%)

```
set.seed(64060)
Train_Index = createDataPartition(universalbank$personal.loan,p=0.6, list=FALSE)

Train.df=universalbank[Train_Index,]
Validation.df=universalbank[-Train_Index,]
```

a pivot table for the training data with Online as a column variable, CC as a rowvariable, and Loan as a secondary row variable.

```
mytable <- xtabs(~ Online+CreditCard+personal.loan, data =Train.df)

ftable(mytable)
```

```
##                   personal.loan    0    1
## Online CreditCard
## 0      0                         772   75
##        1                         309   34
## 1      0                        1152  120
##        1                         479   59
```

Question B

probability of customer accepting loan with the condition on having credit card and using online services = 59/59+479= 0.1096

Question C

pivot tables for the loan and online ,loan and creditcard

```
table(Online=Train.df$Online, personal.loan=Train.df$personal.loan)
```

```
##       personal.loan
## Online    0    1
##      0 1081  109
##      1 1631  179
```

```
table(CreditCard=Train.df$CreditCard, personal.loan=Train.df$personal.loan)
```

```
##           personal.loan
## CreditCard    0    1
##          0 1924  195
##          1  788   93
```

question D

P(CC = 1 | Loan = 1) = 93/93+195 = 0.3229166

P(Online = 1 | Loan = 1) = 179/179+109 =0.6215277

P(Loan = 1) = 109+179/179+109+1631+1081=0.096

P(CC = 1 | Loan = 0) =788/788+1924=0.2905604

P(Online = 1 | Loan = 0)=1631/1631+1081=0.6014011

P(Loan = 0)=1924+788/1924+788+195+93=0.904

Question E

naive Bayes probability P(Loan = 1 | CC = 1, Online = 1).

naive bayes formula p(Y/x1,. . . .xn) = p(x1,x2,. . . xn)/y*p(y)/p(x1,x2,. . . xn)

y=loan1

x1= creditcard1

x2= online1

p(creditcard1(x1))=788+93/788+93+1924+195=0.29366

p(online1(x2)) = 1631+179/1631+179+1081+109 = 0.6033

p(loan1/creditcard1,online1)= p(creditcard1/loan1)*p(online1/loan1)*p(loan)

/p(creditcard1)*p(online1)

```
= 0.3229166*0.6215277*0.096/0.29366*0.6033

= 0.1087
```

Question F

value obtained in pivot table is 0.1096 and naive bayes probabilty is 0.1087. both values are merely same but the most accurate estimate is table value because of the assumption that we made in naive bayes as variables are independent.

Question G

entries for computing g P(Loan = 1 | CC = 1, Online = 1)

```
library(e1071)

nb.model<-naiveBayes (personal.loan~Online+CreditCard, data=Train.df)
To_Predict=data.frame(Online='1', CreditCard='1')
predict(nb.model,To_Predict,type='raw')
```

```
##              0         1
## [1,] 0.8912894 0.1087106
```

Value obtained from naive bias formula (from question E) and the value obtained from computing naive bias by entry are same.