Business Analytics-Group Project Accuracy check

Khushboo Yadav

11/24/2020

Conclusion : As per the result decision tree seems to be more accurate .

```
library(plyr)
library(ggplot2)
library(caret)
```

1.Import Libraries

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

```
library(party)
```

```
## Loading required package: grid

## Loading required package: mvtnorm

## Loading required package: modeltools

## Loading required package: stats4

##
## Attaching package: 'modeltools'

## The following object is masked from 'package:plyr':
##
##     empty

## Loading required package: strucchange

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

## Loading required package: sandwich
```

```
library(rpart)
library(rpart.plot)
```

```
Churn_Train <- read.csv("Churn_Train(1).csv")
summary(Churn_Train)
```

2.Reading the dataset

```
##     state           account_length     area_code         international_plan
##  Length:3333        Min.   :-209.00   Length:3333        Length:3333
##  Class :character   1st Qu.:  72.00   Class :character   Class :character
##  Mode  :character   Median : 100.00   Mode  :character   Mode  :character
##                     Mean   :  97.32
##                     3rd Qu.: 127.00
##                     Max.   : 243.00
##                     NA's   :501
##  voice_mail_plan    number_vmail_messages total_day_minutes total_day_calls
##  Length:3333        Min.   :-10.000       Min.   :   0.0    Min.   :  0.0
##  Class :character   1st Qu.:  0.000       1st Qu.: 149.3    1st Qu.: 87.0
##  Mode  :character   Median :  0.000       Median : 190.5    Median :101.0
##                     Mean   :  7.333       Mean   : 418.9    Mean   :100.3
##                     3rd Qu.: 16.000       3rd Qu.: 237.8    3rd Qu.:114.0
##                     Max.   : 51.000       Max.   :2185.1    Max.   :165.0
##                     NA's   :200           NA's   :200       NA's   :200
##  total_day_charge total_eve_minutes total_eve_calls total_eve_charge
##  Min.   : 0.00    Min.   :   0.0    Min.   :  0.0   Min.   : 0.00
##  1st Qu.:24.45    1st Qu.: 170.5    1st Qu.: 87.0   1st Qu.:14.14
##  Median :30.65    Median : 209.9    Median :100.0   Median :17.09
##  Mean   :30.63    Mean   : 324.3    Mean   :100.1   Mean   :17.08
##  3rd Qu.:36.84    3rd Qu.: 257.6    3rd Qu.:114.0   3rd Qu.:20.00
##  Max.   :59.64    Max.   :1244.2    Max.   :170.0   Max.   :30.91
##  NA's   :200      NA's   :301       NA's   :200     NA's   :200
##  total_night_minutes total_night_calls total_night_charge total_intl_minutes
##  Min.   : 23.2       Min.   : 33.0     Min.   : 1.040     Min.   : 0.00
##  1st Qu.:167.3       1st Qu.: 87.0     1st Qu.: 7.530     1st Qu.: 8.50
##  Median :201.4       Median :100.0     Median : 9.060     Median :10.30
##  Mean   :201.2       Mean   :100.1     Mean   : 9.054     Mean   :10.23
##  3rd Qu.:235.3       3rd Qu.:113.0     3rd Qu.:10.590     3rd Qu.:12.10
##  Max.   :395.0       Max.   :175.0     Max.   :17.770     Max.   :20.00
##  NA's   :200                           NA's   :200        NA's   :200
##  total_intl_calls total_intl_charge number_customer_service_calls
##  Min.   : 0.00    Min.   :0.000     Min.   :0.000
##  1st Qu.: 3.00    1st Qu.:2.300     1st Qu.:1.000
##  Median : 4.00    Median :2.780     Median :1.000
##  Mean   : 4.47    Mean   :2.762     Mean   :1.561
##  3rd Qu.: 6.00    3rd Qu.:3.270     3rd Qu.:2.000
##  Max.   :20.00    Max.   :5.400     Max.   :9.000
##  NA's   :301      NA's   :200       NA's   :200
##     churn
##  Length:3333
##  Class :character
##  Mode  :character
##
##
##
##
```

analysing count of NA value in the dataset

```
sapply(Churn_Train, function(x) sum(is.na(x))) # NA data
```

```
##                         state                account_length
##                             0                           501
##                     area_code            international_plan
##                             0                             0
##               voice_mail_plan         number_vmail_messages
##                             0                           200
##             total_day_minutes               total_day_calls
##                           200                           200
##              total_day_charge             total_eve_minutes
##                           200                           301
##               total_eve_calls              total_eve_charge
##                           200                           200
##           total_night_minutes             total_night_calls
##                           200                             0
##            total_night_charge            total_intl_minutes
##                           200                           200
##              total_intl_calls             total_intl_charge
##                           301                           200
## number_customer_service_calls                         churn
##                           200                             0
```

NA values

```
## 'data.frame':    3333 obs. of  20 variables:
##  $ state                        : chr  "NV" "HI" "DC" "HI" ...
##  $ account_length               : int  125 108 82 NA 83 89 135 28 86 65 ...
##  $ area_code                    : chr  "area_code_510" "area_code_415" "area_code_415" "area_code_40
##  $ international_plan           : chr  "no" "no" "no" "no" ...
##  $ voice_mail_plan              : chr  "no" "no" "no" "yes" ...
##  $ number_vmail_messages        : int  0 0 0 30 0 0 0 0 0 0 ...
##  $ total_day_minutes            : num  2013 292 300 110 337 ...
##  $ total_day_calls              : int  99 99 109 71 120 81 81 87 115 137 ...
##  $ total_day_charge             : num  28.7 49.6 51 18.8 57.4 ...
##  $ total_eve_minutes            : num  1108 221 181 182 227 ...
##  $ total_eve_calls              : int  107 93 100 108 116 74 114 92 112 83 ...
##  $ total_eve_charge             : num  14.9 18.8 15.4 15.5 19.3 ...
##  $ total_night_minutes          : num  243 229 270 184 154 ...
##  $ total_night_calls            : int  92 110 73 88 114 120 82 112 95 111 ...
##  $ total_night_charge           : num  10.95 10.31 12.15 8.27 6.93 ...
##  $ total_intl_minutes           : num  10.9 14 11.7 11 15.8 9.1 10.3 10.1 9.8 12.7 ...
##  $ total_intl_calls             : int  7 9 4 8 7 4 6 3 7 6 ...
##  $ total_intl_charge            : num  2.94 3.78 3.16 2.97 4.27 2.46 2.78 2.73 2.65 3.43 ...
##  $ number_customer_service_calls: int  0 2 0 2 0 1 1 3 2 4 ...
##  $ churn                        : chr  "no" "yes" "yes" "no" ...
```

```
## 
## Attaching package: 'mice'
```

```
## The following objects are masked from 'package:base':
## 
##     cbind, rbind
```

```
## 
##  iter imp variable
##   1   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   1   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   1   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   1   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   1   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   2   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   2   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   2   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   2   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   2   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   3   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   3   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   3   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   3   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   3   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   4   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   4   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   4   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   4   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   4   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   5   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   5   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   5   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   5   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   5   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   6   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   6   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   6   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   6   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   6   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   7   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   7   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   7   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   7   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   7   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   8   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   8   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   8   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   8   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   8   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   9   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   9   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   9   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   9   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   9   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   10   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   10   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   10   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   10   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   10   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   11   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   11   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   11   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   11   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   11   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   12   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   12   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   12   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   12   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   12   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   13   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   13   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   13   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   13   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   13   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   14   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   14   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   14   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   14   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   14   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   15   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   15   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   15   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   15   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   15   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   16   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   16   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   16   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   16   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   16   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   17   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   17   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   17   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   17   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   17   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   18   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   18   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   18   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   18   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   18   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   19   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   19   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   19   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   19   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   19   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   20   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   20   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   20   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   20   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   20   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   21   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   21   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   21   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   21   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   21   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   22   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   22   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   22   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   22   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   22   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   23   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   23   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   23   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   23   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   23   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   24   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   24   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   24   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   24   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   24   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   25   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   25   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   25   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   25   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   25   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   26   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   26   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   26   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   26   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   26   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   27   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   27   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   27   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   27   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   27   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   28   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   28   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   28   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   28   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   28   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   29   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   29   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   29   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   29   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   29   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   30   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   30   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   30   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   30   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   30   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   31   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   31   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   31   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   31   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   31   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   32   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   32   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   32   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   32   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   32   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   33   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   33   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   33   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   33   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charg
##   33   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   34   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   34   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   34   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   34   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   34   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   35   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   35   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   35   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   35   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   35   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   36   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   36   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   36   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   36   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   36   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   37   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   37   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   37   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   37   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   37   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   38   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   38   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   38   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   38   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   38   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   39   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   39   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   39   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   39   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   39   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   40   1  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   40   2  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   40   3  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   40   4  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
##   40   5  account_length  number_vmail_messages  total_day_minutes  total_day_calls  total_day_charge
```

```
## Warning: Number of logged events: 7
```

```
##                     state          account_length
##                  0.000000                0.000000
##                 area_code      international_plan
##                  0.000000                0.000000
##           voice_mail_plan   number_vmail_messages
##                  0.000000                0.000000
##         total_day_minutes         total_day_calls
##                  0.000000                0.000000
##          total_day_charge       total_eve_minutes
##                  0.000000                0.000000
##           total_eve_calls        total_eve_charge
##                  0.000000                0.000000
##       total_night_minutes       total_night_calls
##                  0.000000                0.000000
##        total_night_charge      total_intl_minutes
##                  0.060006                0.000000
##               total_intl_calls             total_intl_charge
##                       0.000000                      0.060006
## number_customer_service_calls                          churn
##                       0.000000                      0.000000
```

data manipulation ##updating the values of International plan , voice mail plan and churn to 1 or 0

```r
#for Churn_Train data
Churn_Train$international_plan<-ifelse(Churn_Train$international_plan=="yes",1,0)
Churn_Train$voice_mail_plan<- ifelse(Churn_Train$voice_mail_plan=="yes",1,0)
Churn_Train$churn<- ifelse(Churn_Train$churn=="yes",1,0)
##Factorization of above data
#for Churn_Train data
Churn_Train$international_plan<-as.factor(Churn_Train$international_plan)
Churn_Train$voice_mail_plan <-as.factor(Churn_Train$voice_mail_plan)
Churn_Train$churn<- as.factor(Churn_Train$churn)
Churn_Train$area_code<- as.factor(Churn_Train$area_code) # added because of decision trees
Churn_Train$state<- as.factor(Churn_Train$state)
summary(Churn_Train)
```

```
##      state      account_length           area_code    international_plan
##  WV     : 106   Min.   :-209.00   area_code_408: 838   0:3010
##  MN     :  84   1st Qu.:  71.00   area_code_415:1655   1: 323
##  NY     :  83   Median : 100.00   area_code_510: 840
##  AL     :  80   Mean   :  97.09
##  OH     :  78   3rd Qu.: 127.00
##  OR     :  78   Max.   : 243.00
##  (Other):2824
##  voice_mail_plan number_vmail_messages total_day_minutes total_day_calls
##  0:2411          Min.   :-10.000       Min.   :   0.0    Min.   :  0.0
##  1: 922          1st Qu.:  0.000       1st Qu.: 147.0    1st Qu.: 87.0
##                  Median :  0.000       Median : 191.0    Median :101.0
##                  Mean   :  7.331       Mean   : 418.0    Mean   :100.2
##                  3rd Qu.: 16.000       3rd Qu.: 242.6    3rd Qu.:114.0
##                  Max.   : 51.000       Max.   :2185.1    Max.   :165.0
##
##  total_day_charge total_eve_minutes total_eve_calls total_eve_charge
##  Min.   : 0.00    Min.   :   0.0    Min.   :  0.0   Min.   : 0.00
##  1st Qu.:24.51    1st Qu.: 168.7    1st Qu.: 87.0   1st Qu.:14.20
##  Median :30.60    Median : 209.9    Median :100.0   Median :17.09
##  Mean   :30.58    Mean   : 319.7    Mean   :100.1   Mean   :17.07
##  3rd Qu.:36.70    3rd Qu.: 258.4    3rd Qu.:114.0   3rd Qu.:19.92
##  Max.   :59.64    Max.   :1244.2    Max.   :170.0   Max.   :30.91
##
##  total_night_minutes total_night_calls total_night_charge total_intl_minutes
##  Min.   : 23.2       Min.   : 33.0     Min.   : 1.040     Min.   : 0.00
##  1st Qu.:167.8       1st Qu.: 87.0     1st Qu.: 7.530     1st Qu.: 8.50
##  Median :202.0       Median :100.0     Median : 9.060     Median :10.30
##  Mean   :201.5       Mean   :100.1     Mean   : 9.054     Mean   :10.22
##  3rd Qu.:235.8       3rd Qu.:113.0     3rd Qu.:10.590     3rd Qu.:12.10
##  Max.   :395.0       Max.   :175.0     Max.   :17.770     Max.   :20.00
##                                        NA's   :200
##  total_intl_calls total_intl_charge number_customer_service_calls churn
##  Min.   : 0.000   Min.   :0.000     Min.   :0.000                 0:2850
##  1st Qu.: 3.000   1st Qu.:2.300     1st Qu.:1.000                 1: 483
##  Median : 4.000   Median :2.780     Median :1.000
##  Mean   : 4.488   Mean   :2.762     Mean   :1.561
##  3rd Qu.: 6.000   3rd Qu.:3.270     3rd Qu.:2.000
##  Max.   :20.000   Max.   :5.400     Max.   :9.000
##                   NA's   :200
```

```
str(Churn_Train)
```

```
## 'data.frame':    3333 obs. of  20 variables:
##  $ state                        : Factor w/ 51 levels "AK","AL","AR",..: 34 12 8 12 36 25 28 39 13 1
##  $ account_length               : int  125 108 82 31 83 89 135 28 86 65 ...
##  $ area_code                    : Factor w/ 3 levels "area_code_408",..: 3 2 2 1 2 2 2 2 1 2 ...
##  $ international_plan           : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...
##  $ voice_mail_plan              : Factor w/ 2 levels "0","1": 1 1 1 2 1 1 1 1 1 1 ...
##  $ number_vmail_messages        : int  0 0 0 30 0 0 0 0 0 0 ...
##  $ total_day_minutes            : num  2013 292 300 110 337 ...
##  $ total_day_calls              : int  99 99 109 71 120 81 81 87 115 137 ...
##  $ total_day_charge             : num  28.7 49.6 51 18.8 57.4 ...
##  $ total_eve_minutes            : num  1108 221 181 182 227 ...
##  $ total_eve_calls              : int  107 93 100 108 116 74 114 92 112 83 ...
##  $ total_eve_charge             : num  14.9 18.8 15.4 15.5 19.3 ...
##  $ total_night_minutes          : num  243 229 270 184 154 ...
##  $ total_night_calls            : int  92 110 73 88 114 120 82 112 95 111 ...
##  $ total_night_charge           : num  10.95 10.31 12.15 8.27 6.93 ...
##  $ total_intl_minutes           : num  10.9 14 11.7 11 15.8 9.1 10.3 10.1 9.8 12.7 ...
##  $ total_intl_calls             : int  7 9 4 8 7 4 6 3 7 6 ...
##  $ total_intl_charge            : num  2.94 3.78 3.16 2.97 4.27 2.46 2.78 2.73 2.65 3.43 ...
##  $ number_customer_service_calls: int  0 2 0 2 0 1 1 3 2 4 ...
##  $ churn                        : Factor w/ 2 levels "0","1": 1 2 2 1 2 1 1 1 1 2 ...
```

##Churn Train data partitioning (60%,40%)

```
set.seed(2020)
partition<- createDataPartition(Churn_Train$churn,p=0.6,list=FALSE)
train_data<- Churn_Train[partition,]
validation_data<- Churn_Train[-partition,]
```

Accuracy for logistic regression

```
Model_Train <- glm(churn ~ .,family=binomial(link="logit"),data=train_data)
summary(Model_Train)
```

```
##
## Call:
## glm(formula = churn ~ ., family = binomial(link = "logit"), data = train_data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.0603  -0.4905  -0.2921  -0.1549   3.0545
##
## Coefficients:
##                                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -9.794e+00  1.318e+00  -7.428 1.10e-13 ***
## stateAL                         6.401e-01  9.668e-01   0.662  0.50796
## stateAR                         9.920e-01  9.574e-01   1.036  0.30015
## stateAZ                        6.517e-01  1.034e+00   0.630  0.52853    
## stateCA                        2.026e+00  9.937e-01   2.039  0.04148 *  
## stateCO                        3.609e-01  9.946e-01   0.363  0.71670    
## stateCT                        8.115e-01  9.458e-01   0.858  0.39087    
## stateDC                        8.501e-01  1.034e+00   0.822  0.41082    
## stateDE                        1.324e+00  9.319e-01   1.421  0.15541    
## stateFL                       -2.484e-01  1.161e+00  -0.214  0.83058    
## stateGA                        8.249e-01  1.028e+00   0.802  0.42246    
## stateHI                       -2.519e-02  1.141e+00  -0.022  0.98239    
## stateIA                        2.923e-01  1.131e+00   0.258  0.79613    
## stateID                        9.516e-01  9.473e-01   1.004  0.31514    
## stateIL                        5.253e-01  1.069e+00   0.492  0.62303    
## stateIN                        1.048e-01  9.801e-01   0.107  0.91488    
## stateKS                        9.906e-01  9.962e-01   0.994  0.32005    
## stateKY                        7.978e-01  9.625e-01   0.829  0.40720    
## stateLA                        7.566e-01  1.032e+00   0.733  0.46351    
## stateMA                        9.812e-01  9.943e-01   0.987  0.32375    
## stateMD                        1.299e+00  9.276e-01   1.400  0.16138    
## stateME                        1.252e+00  9.704e-01   1.290  0.19697    
## stateMI                        1.090e+00  9.614e-01   1.134  0.25672    
## stateMN                        1.410e+00  9.090e-01   1.552  0.12072    
## stateMO                        3.471e-01  1.061e+00   0.327  0.74366    
## stateMS                        1.534e+00  9.544e-01   1.607  0.10795    
## stateMT                        1.990e+00  9.182e-01   2.168  0.03018 *  
## stateNC                        3.070e-01  1.023e+00   0.300  0.76397    
## stateND                        8.085e-01  9.797e-01   0.825  0.40923    
## stateNE                        7.837e-01  9.927e-01   0.789  0.42986    
## stateNH                        1.315e+00  9.612e-01   1.368  0.17120    
## stateNJ                        1.788e+00  9.228e-01   1.938  0.05262 .  
## stateNM                        3.859e-01  1.004e+00   0.385  0.70061    
## stateNV                        1.554e+00  9.196e-01   1.690  0.09107 .  
## stateNY                        9.468e-01  9.488e-01   0.998  0.31836    
## stateOH                       -3.616e-01  1.138e+00  -0.318  0.75057    
## stateOK                        2.362e-01  1.044e+00   0.226  0.82101    
## stateOR                       -1.898e-01  1.088e+00  -0.174  0.86154    
## statePA                        1.494e+00  9.669e-01   1.546  0.12222    
## stateRI                       -3.172e-02  1.040e+00  -0.030  0.97567    
## stateSC                        1.993e+00  9.617e-01   2.072  0.03823 *  
## stateSD                        8.213e-01  1.003e+00   0.819  0.41298    
## stateTN                        1.051e+00  9.935e-01   1.058  0.29026    
## stateTX                        1.370e+00  9.184e-01   1.492  0.13574    
## stateUT                        1.684e+00  9.087e-01   1.854  0.06381 .  
## stateVA                       -3.109e-01  1.121e+00  -0.277  0.78149    
## stateVT                       -5.575e-01  1.238e+00  -0.451  0.65233    
## stateWA                        1.515e+00  9.195e-01   1.648  0.09936 .  
## stateWI                       -4.747e-01  1.061e+00  -0.448  0.65449    
## stateWV                        1.092e+00  9.165e-01   1.191  0.23358    
## stateWY                        3.740e-01  9.769e-01   0.383  0.70182    
## account_length                 9.425e-04  1.650e-03   0.571  0.56792    
## area_codearea_code_415         1.694e-01  1.977e-01   0.857  0.39150    
## area_codearea_code_510        -1.086e-01  2.319e-01  -0.468  0.63954    
## international_plan1            2.330e+00  2.123e-01  10.975  < 2e-16 ***
## voice_mail_plan1              -1.339e+00  4.956e-01  -2.702  0.00688 ** 
## number_vmail_messages          1.156e-02  1.596e-02   0.724  0.46897    
## total_day_minutes             -2.200e-03  2.784e-03  -0.790  0.42941    
## total_day_calls                3.450e-03  3.998e-03   0.863  0.38811    
## total_day_charge               9.478e-02  1.637e-02   5.790 7.05e-09 ***
## total_eve_minutes              4.326e-03  5.500e-03   0.787  0.43149    
## total_eve_calls               -3.289e-03  3.942e-03  -0.834  0.40408    
## total_eve_charge               5.084e-02  6.672e-02   0.762  0.44607    
## total_night_minutes            6.066e-01  1.211e+00   0.501  0.61643    
## total_night_calls              5.963e-04  4.102e-03   0.145  0.88442    
## total_night_charge            -1.341e+01  2.691e+01  -0.498  0.61831    
## total_intl_minutes             3.009e-01  7.519e+00   0.040  0.96808    
## total_intl_calls              -7.914e-02  3.581e-02  -2.210  0.02709 *  
## total_intl_charge             -7.529e-01  2.785e+01  -0.027  0.97843    
## number_customer_service_calls  5.296e-01  5.757e-02   9.200  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## (Dispersion parameter for binomial family taken to be 1)
## 
##     Null deviance: 1561.4  on 1879  degrees of freedom
## Residual deviance: 1142.1  on 1810  degrees of freedom
##   (120 observations deleted due to missingness)
## AIC: 1282.1
## 
## Number of Fisher Scoring iterations: 6
```

```
predict_validation<-predict(Model_Train,newdata = validation_data,type='response')
resultcheck<-ifelse(predict_validation>0.5,1,0)
## Accuracy check
error<-mean(resultcheck!=validation_data$churn)
accuracy<-1-error
print(accuracy)
```

```
## [1] NA
```

```
#
table(validation_data$churn, resultcheck > 0.5)
```

```
## 
##     FALSE TRUE
##   0  1032   38
##   1   136   47
```

```
#confusion matrix
resultcheck<- as.factor(resultcheck)
confusionMatrix(resultcheck,validation_data$churn)
```

```
## Confusion Matrix and Statistics
## 
##           Reference
## Prediction    0    1
##          0 1032  136
##          1   38   47
## 
##                Accuracy : 0.8611          
##                  95% CI : (0.8407, 0.8798)
##     No Information Rate : 0.854           
##     P-Value [Acc > NIR] : 0.2499
##
##                   Kappa : 0.2845
##
##  Mcnemar's Test P-Value : 1.93e-13
##
##             Sensitivity : 0.9645
##             Specificity : 0.2568
##          Pos Pred Value : 0.8836
##          Neg Pred Value : 0.5529
##              Prevalence : 0.8540
##          Detection Rate : 0.8236
##    Detection Prevalence : 0.9322
##       Balanced Accuracy : 0.6107
##
##        'Positive' Class : 0
##
```

ROC for logistic regression

```
library(pROC)
```

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

```
##
## Attaching package: 'pROC'
```

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

```
#ROC Curve for validation Data set
roc(validation_data$churn, predict_validation)
```

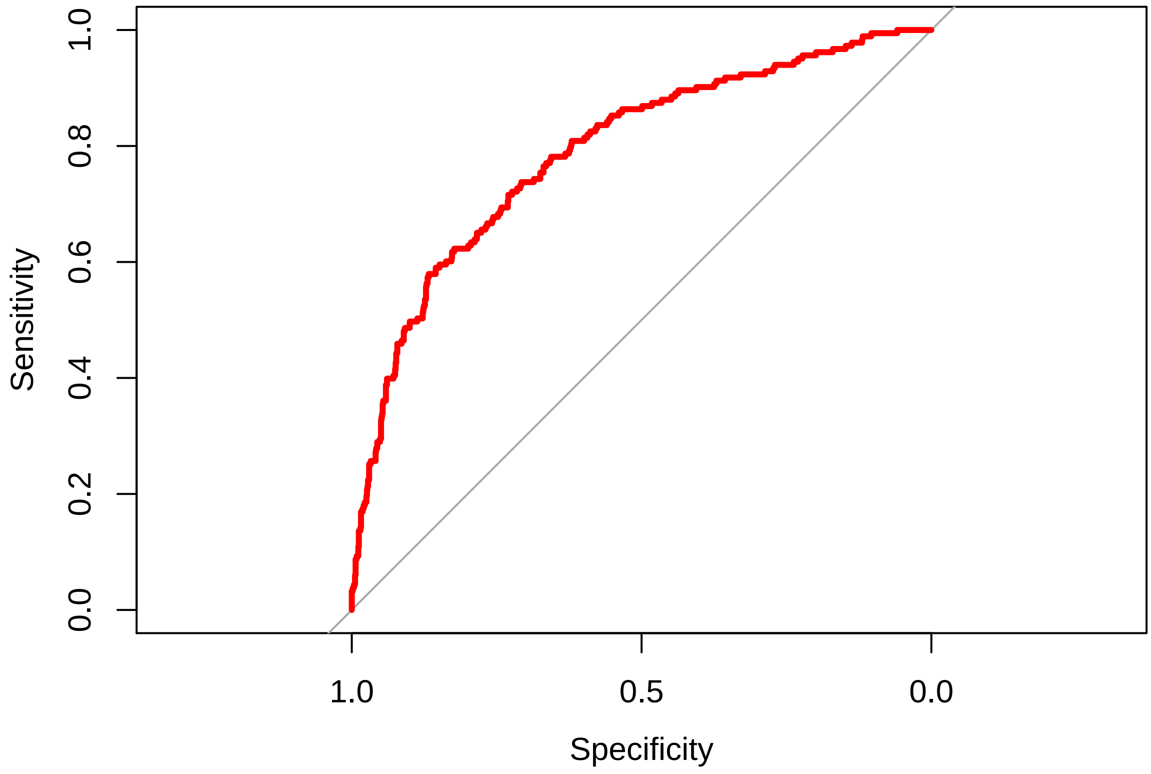
```
## Setting levels: control = 0, case = 1
```

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

```
##
## Call:
## roc.default(response = validation_data$churn, predictor = predict_validation)
##
## Data: predict_validation in 1070 controls (validation_data$churn 0) < 183 cases (validation_data$chu
## Area under the curve: 0.7892
```

```
plot.roc(validation_data$churn,predict_validation,col = "red", lwd = 3)
```

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



Accuracy for decision tree

```
D_model <- ctree(churn~ ., train_data)
pred_tree <- predict(D_model, validation_data)
#table
table(pred_tree)
```

```
## pred_tree
##    0    1
## 1190  143
```

```
#confusion matrix
confusionMatrix(pred_tree,validation_data$churn)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction    0    1
##          0 1124   66
##          1   16  127
##
##                Accuracy : 0.9385
##                  95% CI : (0.9242, 0.9508)
##     No Information Rate : 0.8552
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7216
##
##  Mcnemar's Test P-Value : 6.262e-08
```

```
##
##             Sensitivity : 0.9860
##             Specificity : 0.6580
##          Pos Pred Value : 0.9445
##          Neg Pred Value : 0.8881
##              Prevalence : 0.8552
##          Detection Rate : 0.8432
##    Detection Prevalence : 0.8927
##       Balanced Accuracy : 0.8220
##
##        'Positive' Class : 0
##
```

ROC for decision tree

```
pred_tree1 <- predict(D_model, validation_data, type='node')
#ROC Curve for validation Data set
roc(validation_data$churn, pred_tree1)
```

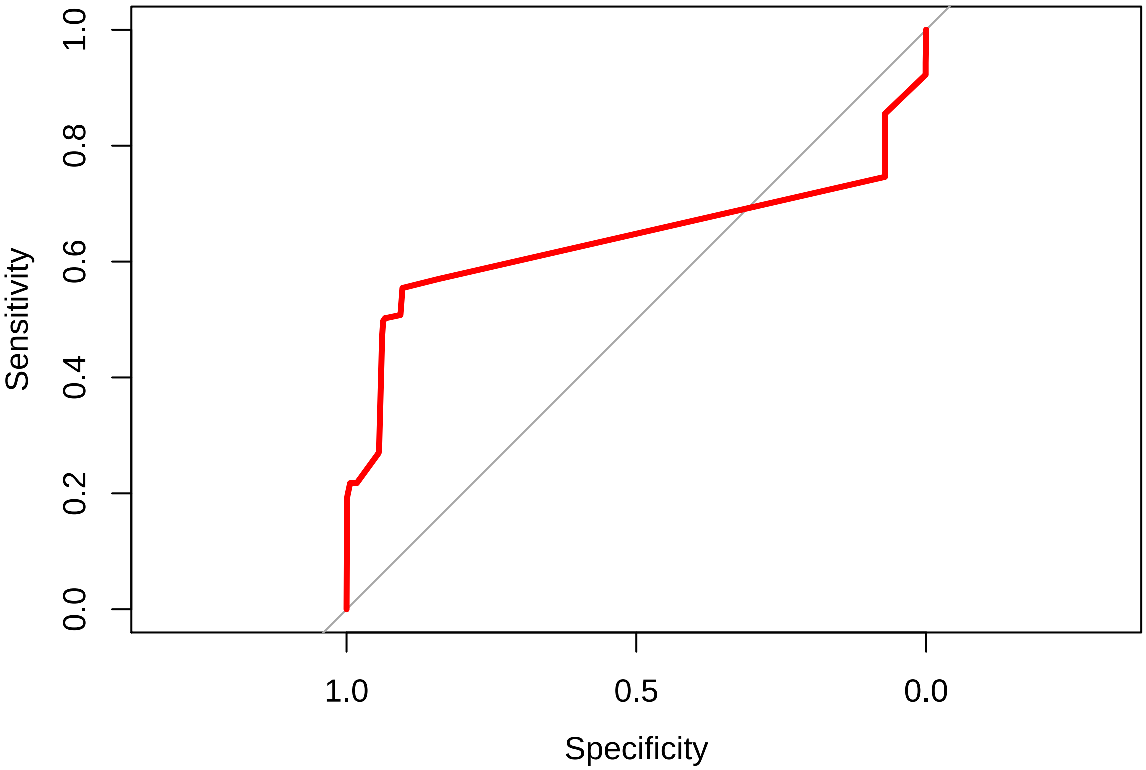
```
## Setting levels: control = 0, case = 1
```

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

```
##
## Call:
## roc.default(response = validation_data$churn, predictor = pred_tree1)
##
## Data: pred_tree1 in 1140 controls (validation_data$churn 0) < 193 cases (validation_data$churn 1).
## Area under the curve: 0.6378
```

```
plot.roc(validation_data$churn,pred_tree1,col = "red", lwd = 3)
```

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


Sensitivity
0.0
0.2
0.4
0.6
0.8
1.0
1.0
0.5
0.0
Specificity