Untitled

ParkJiHeon

2021 3 22

library(tidyverse)

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

## √ ggplot2 3.3.3 √ purrr 0.3.4  
## √ tibble 3.1.0 √ dplyr 1.0.5  
## √ tidyr 1.1.3 √ stringr 1.4.0  
## √ readr 1.4.0 √ forcats 0.5.1

## -- Conflicts ------------------------------------------ tidyverse\_conflicts() --  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

library(VIM)

## Loading required package: colorspace

## Loading required package: grid

## VIM is ready to use.

## Suggestions and bug-reports can be submitted at: https://github.com/statistikat/VIM/issues

##   
## Attaching package: 'VIM'

## The following object is masked from 'package:datasets':  
##   
## sleep

library(cowplot)  
library(ggcorrplot)  
library(GGally)

## Registered S3 method overwritten by 'GGally':  
## method from   
## +.gg ggplot2

library(ggthemes)

##   
## Attaching package: 'ggthemes'

## The following object is masked from 'package:cowplot':  
##   
## theme\_map

library(MASS)

##   
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':  
##   
## select

library(car)

## Loading required package: carData

##   
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':  
##   
## recode

## The following object is masked from 'package:purrr':  
##   
## some

library(caret)

## Loading required package: lattice

##   
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':  
##   
## lift

library(ROCR)  
library(e1071)  
library(gmodels)  
library(splitstackshape)  
data <- read.csv("ChurnData.csv",stringsAsFactors = F)  
data <- data[1:1000,]  
load("telData20210317.Rda")  
### 로지스틱회귀분석  
str(finalData)

## 'data.frame': 1000 obs. of 24 variables:  
## $ 고객ID : int 1 2 3 4 5 6 7 8 9 10 ...  
## $ 성별 : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 1 1 2 ...  
## $ 통화품질불만 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ 이탈여부 : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 1 2 1 ...  
## $ d.dummy.고 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ d.dummy.중고 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ d.dummy.중 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 2 2 2 ...  
## $ d.dummy.중저 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ d.dummy.저 : Factor w/ 2 levels "0","1": 2 2 2 2 2 2 2 1 1 1 ...  
## $ 연령 : int 37 38 30 33 40 44 26 45 34 27 ...  
## $ 서비스기간 : num 20.3 35 17.5 26 51.5 ...  
## $ 단선횟수 : int 1 1 0 0 2 1 0 2 2 5 ...  
## $ 주간통화횟수 : int 29 25 2 10 7 4 7 234 337 345 ...  
## $ 주간통화시간\_분: num 46.8 33 67.8 52.2 25 ...  
## $ 야간통화횟수 : int 17 20 6 48 24 17 1 185 11 75 ...  
## $ 야간통화시간\_분: num 47.4 19.8 30.6 90.3 39.7 ...  
## $ 주말통화횟수 : int 3 2 8 12 2 24 27 46 29 6 ...  
## $ 주말통화시간\_분: num 30 37.22 75 19.5 2.95 ...  
## $ 국제통화시간\_분: num 14.56 12.09 42.72 19.3 1.41 ...  
## $ 국내통화횟수 : int 49 47 16 70 33 45 35 465 377 426 ...  
## $ 국내통화시간\_분: num 124.2 90.1 173.4 162 67.7 ...  
## $ 총통화시간\_분 : num 138.8 102.2 216.1 181.3 69.1 ...  
## $ 총통화요금 : num 5.822 4.837 17.086 7.72 0.565 ...  
## $ 부과요금 : num 65.8 64.8 77 67.7 60.5 ...

summary(finalData)

## 고객ID 성별 통화품질불만 이탈여부 d.dummy.고 d.dummy.중고  
## Min. : 1.0 0:476 0:976 0:700 0:910 0:706   
## 1st Qu.: 250.8 1:524 1: 24 1:300 1: 90 1:294   
## Median : 500.5   
## Mean : 500.5   
## 3rd Qu.: 750.2   
## Max. :1000.0   
## d.dummy.중 d.dummy.중저 d.dummy.저 연령 서비스기간   
## 0:425 0:966 0:993 Min. :13.00 Min. : 9.667   
## 1:575 1: 34 1: 7 1st Qu.:30.00 1st Qu.:22.867   
## Median :35.00 Median :34.633   
## Mean :37.54 Mean :34.304   
## 3rd Qu.:44.00 3rd Qu.:46.200   
## Max. :71.00 Max. :58.200   
## 단선횟수 주간통화횟수 주간통화시간\_분 야간통화횟수   
## Min. : 0.000 Min. : 0.0 Min. : 0.0 Min. : 0.0   
## 1st Qu.: 1.000 1st Qu.: 177.8 1st Qu.: 606.0 1st Qu.: 27.0   
## Median : 1.000 Median : 372.5 Median : 848.1 Median : 68.0   
## Mean : 2.588 Mean : 416.4 Mean : 924.0 Mean : 96.5   
## 3rd Qu.: 2.000 3rd Qu.: 581.0 3rd Qu.:1150.3 3rd Qu.:145.0   
## Max. :15.000 Max. :1581.0 Max. :2846.4 Max. :500.0   
## 야간통화시간\_분 주말통화횟수 주말통화시간\_분 국제통화시간\_분   
## Min. : 0.0 Min. : 0.00 Min. : 0.00 Min. : 0.1943   
## 1st Qu.:134.7 1st Qu.: 4.00 1st Qu.: 21.90 1st Qu.:212.3943   
## Median :255.9 Median :10.00 Median : 43.00 Median :262.4638   
## Mean :272.8 Mean :15.92 Mean : 49.73 Mean :290.5778   
## 3rd Qu.:383.2 3rd Qu.:23.00 3rd Qu.: 72.00 3rd Qu.:345.2667   
## Max. :883.8 Max. :92.00 Max. :195.50 Max. :892.5571   
## 국내통화횟수 국내통화시간\_분 총통화시간\_분 총통화요금   
## Min. : 16.0 Min. : 67.69 Min. : 69.1 Min. : 0.0907   
## 1st Qu.: 277.0 1st Qu.: 887.48 1st Qu.:1120.8 1st Qu.: 78.6070   
## Median : 487.0 Median :1159.40 Median :1442.9 Median :100.2785   
## Mean : 528.8 Mean :1246.57 Mean :1537.1 Mean :114.1718   
## 3rd Qu.: 732.2 3rd Qu.:1560.05 3rd Qu.:1892.3 3rd Qu.:129.6040   
## Max. :1802.0 Max. :3192.90 Max. :3899.8 Max. :410.3089   
## 부과요금   
## Min. : 60.03   
## 1st Qu.:206.91   
## Median :235.47   
## Mean :247.41   
## 3rd Qu.:278.29   
## Max. :560.31

pSeed<-12345  
set.seed(pSeed)  
training800 <-stratified(finalData,"이탈여부",0.8)  
testing200 <-finalData[!finalData$고객ID%in%training800$고객ID,]  
  
table(training800$이탈여부)

##   
## 0 1   
## 560 240

table(testing200$이탈여부)

##   
## 0 1   
## 140 60

training800<-training800[,-1]  
model1\_1 <- glm(이탈여부~.,data = training800,family = binomial(link = "logit"))

## Warning: glm.fit: algorithm did not converge

summary(model1\_1)

##   
## Call:  
## glm(formula = 이탈여부 ~ ., family = binomial(link = "logit"),   
## data = training800)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.1865 -0.7519 -0.6585 1.1403 2.0592   
##   
## Coefficients: (3 not defined because of singularities)  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.807e+14 1.291e+14 -2.174 0.02969 \*   
## 성별1 3.574e-01 1.676e-01 2.133 0.03294 \*   
## 통화품질불만1 3.413e+00 1.063e+00 3.212 0.00132 \*\*  
## d.dummy.고1 2.807e+14 1.291e+14 2.174 0.02969 \*   
## d.dummy.중고1 2.807e+14 1.291e+14 2.174 0.02969 \*   
## d.dummy.중1 2.807e+14 1.291e+14 2.174 0.02969 \*   
## d.dummy.중저1 2.807e+14 1.291e+14 2.174 0.02969 \*   
## d.dummy.저1 2.807e+14 1.291e+14 2.174 0.02969 \*   
## 연령 -6.902e-03 8.722e-03 -0.791 0.42879   
## 서비스기간 6.622e-04 6.031e-03 0.110 0.91257   
## 단선횟수 1.773e-02 2.767e-02 0.641 0.52160   
## 주간통화횟수 -1.069e-04 6.757e-04 -0.158 0.87434   
## 주간통화시간\_분 -3.131e-03 1.889e-03 -1.657 0.09751 .   
## 야간통화횟수 2.503e-05 1.322e-03 0.019 0.98490   
## 야간통화시간\_분 -2.637e-03 1.770e-03 -1.490 0.13628   
## 주말통화횟수 -2.466e-03 7.370e-03 -0.335 0.73794   
## 주말통화시간\_분 -3.294e-03 3.626e-03 -0.908 0.36363   
## 국제통화시간\_분 -7.528e-03 6.107e-03 -1.233 0.21773   
## 국내통화횟수 NA NA NA NA   
## 국내통화시간\_분 NA NA NA NA   
## 총통화시간\_분 NA NA NA NA   
## 총통화요금 -1.171e-02 6.984e-03 -1.677 0.09357 .   
## 부과요금 3.547e-02 2.427e-02 1.461 0.14398   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 977.38 on 799 degrees of freedom  
## Residual deviance: 903.07 on 780 degrees of freedom  
## AIC: 943.07  
##   
## Number of Fisher Scoring iterations: 25

model1\_2 <- stepAIC(model1\_1,direction = "both")

## Start: AIC=943.07  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 야간통화시간\_분 + 주말통화횟수 + 주말통화시간\_분 + 국제통화시간\_분 +   
## 국내통화횟수 + 국내통화시간\_분 + 총통화시간\_분 + 총통화요금 +   
## 부과요금

## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge

## Warning in stepAIC(model1\_1, direction = "both"): 0 df terms are changing AIC

## Warning: glm.fit: algorithm did not converge

##   
## Step: AIC=939.92  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 야간통화시간\_분 + 주말통화횟수 + 주말통화시간\_분 + 국제통화시간\_분 +   
## 국내통화횟수 + 국내통화시간\_분 + 총통화시간\_분 + 총통화요금

## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge

## Warning in stepAIC(model1\_1, direction = "both"): 0 df terms are changing AIC

##   
## Step: AIC=935.7  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국제통화시간\_분 + 국내통화횟수 +   
## 국내통화시간\_분 + 총통화시간\_분 + 총통화요금

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: algorithm did not converge

## Warning in stepAIC(model1\_1, direction = "both"): 0 df terms are changing AIC

##   
## Step: AIC=935.7  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국제통화시간\_분 + 국내통화시간\_분 +   
## 총통화시간\_분 + 총통화요금

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: algorithm did not converge  
  
## Warning: glm.fit: algorithm did not converge

## Warning in stepAIC(model1\_1, direction = "both"): 0 df terms are changing AIC

##   
## Step: AIC=934.33  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국제통화시간\_분 + 국내통화시간\_분 +   
## 총통화시간\_분

## Warning: glm.fit: algorithm did not converge  
  
## Warning: 0 df terms are changing AIC

##   
## Step: AIC=934.33  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국내통화시간\_분 + 총통화시간\_분

## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: algorithm did not converge

## Warning in stepAIC(model1\_1, direction = "both"): 0 df terms are changing AIC

## Warning: glm.fit: algorithm did not converge

##   
## Step: AIC=935.08  
## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국내통화시간\_분

summary(model1\_2)

##   
## Call:  
## glm(formula = 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국내통화시간\_분, family = binomial(link = "logit"),   
## data = training800)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -2.2668 -0.7953 -0.7083 1.1518 1.9294   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -5.602e+13 7.078e+13 -0.791 0.42870   
## 성별1 3.583e-01 1.667e-01 2.150 0.03156 \*   
## 통화품질불만1 3.369e+00 1.042e+00 3.233 0.00123 \*\*  
## d.dummy.고1 5.602e+13 7.078e+13 0.791 0.42870   
## d.dummy.중고1 5.602e+13 7.078e+13 0.791 0.42870   
## d.dummy.중1 5.602e+13 7.078e+13 0.791 0.42870   
## d.dummy.중저1 5.602e+13 7.078e+13 0.791 0.42870   
## d.dummy.저1 5.602e+13 7.078e+13 0.791 0.42870   
## 연령 -6.793e-03 8.676e-03 -0.783 0.43362   
## 서비스기간 9.164e-04 5.998e-03 0.153 0.87857   
## 단선횟수 1.813e-02 2.748e-02 0.660 0.50950   
## 주간통화횟수 4.585e-05 6.663e-04 0.069 0.94514   
## 주간통화시간\_분 -3.256e-04 7.873e-04 -0.414 0.67924   
## 야간통화횟수 3.482e-05 1.318e-03 0.026 0.97892   
## 주말통화횟수 -1.575e-03 7.337e-03 -0.215 0.83002   
## 주말통화시간\_분 -8.712e-04 3.288e-03 -0.265 0.79105   
## 국내통화시간\_분 -3.749e-04 7.922e-04 -0.473 0.63600   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 977.38 on 799 degrees of freedom  
## Residual deviance: 901.08 on 783 degrees of freedom  
## AIC: 935.08  
##   
## Number of Fisher Scoring iterations: 25

formula(model1\_2)

## 이탈여부 ~ 성별 + 통화품질불만 + d.dummy.고 + d.dummy.중고 +   
## d.dummy.중 + d.dummy.중저 + d.dummy.저 + 연령 + 서비스기간 +   
## 단선횟수 + 주간통화횟수 + 주간통화시간\_분 + 야간통화횟수 +   
## 주말통화횟수 + 주말통화시간\_분 + 국내통화시간\_분

(vif\_vars <- as.data.frame(vif(model1\_2)))

## vif(model1\_2)  
## 성별 1.112531e+00  
## 통화품질불만 5.834168e-01  
## d.dummy.고 1.422189e+15  
## d.dummy.중고 9.481262e+14  
## d.dummy.중 6.162821e+15  
## d.dummy.중저 4.740631e+14  
## d.dummy.저 9.481262e+14  
## 연령 1.009470e+00  
## 서비스기간 1.015450e+00  
## 단선횟수 1.093504e+00  
## 주간통화횟수 1.864372e+00  
## 주간통화시간\_분 4.729658e+00  
## 야간통화횟수 1.840731e+00  
## 주말통화횟수 2.051327e+00  
## 주말통화시간\_분 2.084938e+00  
## 국내통화시간\_분 3.795819e+00

model1\_3 <- glm(이탈여부~성별+d.dummy.고+d.dummy.중저+연령+서비스기간+단선횟수+주간통화횟수+주간통화시간\_분+야간통화횟수+주말통화횟수+주말통화시간\_분+국내통화시간\_분,data = training800,family = binomial)  
summary(model1\_3)

##   
## Call:  
## glm(formula = 이탈여부 ~ 성별 + d.dummy.고 + d.dummy.중저 + 연령 +   
## 서비스기간 + 단선횟수 + 주간통화횟수 + 주간통화시간\_분 +   
## 야간통화횟수 + 주말통화횟수 + 주말통화시간\_분 + 국내통화시간\_분,   
## family = binomial, data = training800)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.6108 -0.8420 -0.7247 1.2528 2.0014   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.1453107 0.4831869 -0.301 0.7636   
## 성별1 0.3860431 0.1606879 2.402 0.0163 \*   
## d.dummy.고1 0.9550334 0.3823342 2.498 0.0125 \*   
## d.dummy.중저1 1.0106174 0.4581849 2.206 0.0274 \*   
## 연령 -0.0112470 0.0083263 -1.351 0.1768   
## 서비스기간 -0.0004309 0.0057466 -0.075 0.9402   
## 단선횟수 0.0648136 0.0228142 2.841 0.0045 \*\*  
## 주간통화횟수 0.0008591 0.0006280 1.368 0.1713   
## 주간통화시간\_분 -0.0007172 0.0007712 -0.930 0.3524   
## 야간통화횟수 0.0002044 0.0013006 0.157 0.8751   
## 주말통화횟수 -0.0008491 0.0071070 -0.119 0.9049   
## 주말통화시간\_분 -0.0010397 0.0031846 -0.326 0.7441   
## 국내통화시간\_분 -0.0003652 0.0006951 -0.525 0.5993   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 977.38 on 799 degrees of freedom  
## Residual deviance: 933.54 on 787 degrees of freedom  
## AIC: 959.54  
##   
## Number of Fisher Scoring iterations: 4

#model1\_1 AIC 936.85  
#model1\_2 AIC 923.18 lowest 채택  
#model1\_3 AIC 933.06  
  
  
pred <- predict(model1\_2,newdata = testing200[,which(colnames(testing200)!= "이탈여부")],type = "response")  
pred

## 2 11 35 36 37 47 56 57   
## 1.0000000 0.3443393 0.2151747 0.2290902 0.2161243 0.2427841 0.2169052 0.3103905   
## 59 75 83 95 105 119 122 133   
## 0.1982491 0.2101780 0.3154100 0.2597690 0.2193870 0.2637716 0.2701142 0.2735292   
## 136 137 140 141 142 146 148 151   
## 0.2925393 0.2212410 0.2721762 0.2534923 0.2406032 0.2595409 0.2790059 0.2379014   
## 160 166 175 177 182 183 187 191   
## 0.2757462 0.3241738 0.2196149 0.2839871 0.2188791 0.2822584 0.2773229 0.2136556   
## 195 199 200 205 210 215 217 221   
## 0.2975555 0.3119272 0.3329426 0.2713892 0.2696465 0.2797452 0.2171362 0.2409358   
## 224 234 247 249 250 254 257 263   
## 0.1894704 0.2338071 0.2918038 0.2963729 0.1955830 0.2246624 0.2929136 0.2619469   
## 266 286 291 298 302 305 309 311   
## 0.2565378 0.3170087 0.3970932 0.2604326 0.2694929 0.2488741 0.2184067 0.2262109   
## 313 317 326 327 329 330 333 338   
## 0.3015496 0.2230211 0.4024670 0.2283291 0.1883645 0.1856746 0.4523195 0.2319617   
## 348 360 363 370 378 387 388 390   
## 0.2045058 0.2428121 0.2552512 0.2397655 0.3720691 0.2851896 0.2378800 0.2606646   
## 394 398 403 415 418 421 422 428   
## 0.3310678 0.2430762 0.3080738 0.2658250 0.2582119 0.1935970 0.2496778 0.2047884   
## 431 434 436 437 442 448 449 454   
## 0.2918169 0.3145894 0.3095305 0.2991642 0.2295065 0.2347197 0.4515701 0.2463538   
## 455 460 461 462 463 466 487 488   
## 0.2566090 0.2881909 0.2164925 0.2905032 0.2318734 0.2773211 0.2227622 0.2211584   
## 491 492 493 500 504 514 515 520   
## 0.2548352 0.2064111 0.3737310 0.2153343 0.2234739 0.3062947 0.4402306 0.3312028   
## 524 528 533 534 536 540 547 550   
## 0.2473576 0.2495907 0.2003692 0.3268521 0.3069773 0.2860441 0.2884109 0.1925836   
## 555 557 564 596 598 605 606 608   
## 0.3030448 0.2271560 0.1858934 0.2493943 0.3024440 0.2540880 0.3168467 0.2369925   
## 610 611 625 627 630 632 639 643   
## 0.2870896 0.2283922 0.2803028 0.3000195 0.1867506 0.1689534 0.2440003 0.1837311   
## 644 646 651 657 658 660 663 665   
## 0.1980372 0.4304186 0.1976992 0.2480633 0.1925333 0.2357945 0.4658907 0.2633666   
## 671 675 677 679 680 683 685 693   
## 0.2299692 0.3079768 0.2013618 0.2313485 0.2768374 0.2742676 0.2948758 0.2219381   
## 696 697 702 710 714 717 718 719   
## 0.2544833 0.2653346 0.2365539 0.2688990 0.2820346 0.3071793 0.2046290 0.2704777   
## 722 730 738 742 746 748 753 755   
## 0.4515669 0.2621822 0.2720141 0.2519910 0.2050055 0.3128859 0.2063233 0.2464564   
## 763 772 795 796 803 805 812 818   
## 0.3242986 0.1877584 0.3111681 0.2116081 0.2293506 0.2349478 0.1947681 0.1827454   
## 821 827 837 862 863 869 872 879   
## 0.1983089 0.2706561 0.2401131 0.2738439 0.2781530 0.1838791 0.1721913 0.2642789   
## 880 882 884 885 888 895 911 913   
## 0.1829639 0.1737778 0.2674742 0.2665937 0.2485623 0.2719467 0.1963972 0.9813319   
## 928 929 931 934 938 946 949 953   
## 0.2696740 0.1726724 0.1808128 0.2771819 0.1853585 0.1782897 0.1660459 0.2594173   
## 954 960 977 980 982 984 989 997   
## 0.9460790 0.5445031 0.5213212 0.5344488 0.9181357 0.6086160 0.9201546 0.9233628

summary(pred)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 0.1660 0.2212 0.2574 0.2851 0.2926 1.0000

# check model test  
pred\_churn <- factor(ifelse(pred >= 0.50, "Yes", "No"))  
actual\_churn <- factor(ifelse(testing200$이탈여부==1,"Yes","No"))  
pred\_churn

## 2 11 35 36 37 47 56 57 59 75 83 95 105 119 122 133 136 137 140 141   
## Yes No No No No No No No No No No No No No No No No No No No   
## 142 146 148 151 160 166 175 177 182 183 187 191 195 199 200 205 210 215 217 221   
## No No No No No No No No No No No No No No No No No No No No   
## 224 234 247 249 250 254 257 263 266 286 291 298 302 305 309 311 313 317 326 327   
## No No No No No No No No No No No No No No No No No No No No   
## 329 330 333 338 348 360 363 370 378 387 388 390 394 398 403 415 418 421 422 428   
## No No No No No No No No No No No No No No No No No No No No   
## 431 434 436 437 442 448 449 454 455 460 461 462 463 466 487 488 491 492 493 500   
## No No No No No No No No No No No No No No No No No No No No   
## 504 514 515 520 524 528 533 534 536 540 547 550 555 557 564 596 598 605 606 608   
## No No No No No No No No No No No No No No No No No No No No   
## 610 611 625 627 630 632 639 643 644 646 651 657 658 660 663 665 671 675 677 679   
## No No No No No No No No No No No No No No No No No No No No   
## 680 683 685 693 696 697 702 710 714 717 718 719 722 730 738 742 746 748 753 755   
## No No No No No No No No No No No No No No No No No No No No   
## 763 772 795 796 803 805 812 818 821 827 837 862 863 869 872 879 880 882 884 885   
## No No No No No No No No No No No No No No No No No No No No   
## 888 895 911 913 928 929 931 934 938 946 949 953 954 960 977 980 982 984 989 997   
## No No No Yes No No No No No No No No Yes Yes Yes Yes Yes Yes Yes Yes   
## Levels: No Yes

actual\_churn

## [1] Yes No No No No No No No Yes Yes No Yes No Yes No No Yes No   
## [19] No No No Yes No Yes Yes Yes No No Yes Yes No No No No No No   
## [37] No No Yes Yes No No Yes No No No No No No No No No No No   
## [55] Yes No Yes No No No No No No No No Yes Yes No Yes No Yes No   
## [73] No No No Yes No No No No No No No Yes No No No Yes Yes No   
## [91] No No No No No No No No No No Yes Yes No No Yes No No Yes  
## [109] Yes No No No Yes Yes Yes No No No Yes No Yes No No No Yes No   
## [127] No No No No No No Yes No No No Yes No Yes No Yes No Yes No   
## [145] No Yes No No Yes No No No No No Yes No Yes No Yes No No No   
## [163] Yes Yes No No Yes No No No Yes No Yes No No No No No No Yes  
## [181] No Yes No Yes No No No No No No No Yes Yes Yes No No Yes No   
## [199] Yes Yes  
## Levels: No Yes

table(actual\_churn,pred\_churn)

## pred\_churn  
## actual\_churn No Yes  
## No 137 3  
## Yes 53 7

caret::confusionMatrix(pred\_churn,actual\_churn,positive = "Yes")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction No Yes  
## No 137 53  
## Yes 3 7  
##   
## Accuracy : 0.72   
## 95% CI : (0.6523, 0.781)  
## No Information Rate : 0.7   
## P-Value [Acc > NIR] : 0.2972   
##   
## Kappa : 0.125   
##   
## Mcnemar's Test P-Value : 5.835e-11   
##   
## Sensitivity : 0.1167   
## Specificity : 0.9786   
## Pos Pred Value : 0.7000   
## Neg Pred Value : 0.7211   
## Prevalence : 0.3000   
## Detection Rate : 0.0350   
## Detection Prevalence : 0.0500   
## Balanced Accuracy : 0.5476   
##   
## 'Positive' Class : Yes   
##

###로지스틱회귀분석 적중률 72  
  
  
############ Bayes  
bayDf <- finalData[,c(1,4,10:20)]  
bay.train <- stratified(bayDf,"이탈여부",0.8)  
bay.test <- bayDf[!bayDf$고객ID%in%bay.train$고객ID,]  
  
trainingLabels <- bay.train$이탈여부  
testingLabels <- bay.test$이탈여부  
model2 <- naiveBayes(bay.train,trainingLabels)  
pred2<-predict(model2,bay.test[,which(colnames(bay.test)!= "이탈여부")])  
pred2

## [1] 1 1 0 1 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## [38] 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0  
## [75] 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0  
## [112] 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 1 0 0 0 0 1  
## [149] 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 1  
## [186] 0 0 1 0 0 0 1 1 1 1 1 1 1 1 1  
## Levels: 0 1

table(pred2)

## pred2  
## 0 1   
## 165 35

CrossTable(pred2,testingLabels,prop.chisq = FALSE, prop.t = FALSE,   
 prop.r = FALSE, dnn = c('predicted', 'actual'))

##   
##   
## Cell Contents  
## |-------------------------|  
## | N |  
## | N / Col Total |  
## |-------------------------|  
##   
##   
## Total Observations in Table: 200   
##   
##   
## | actual   
## predicted | 0 | 1 | Row Total |   
## -------------|-----------|-----------|-----------|  
## 0 | 120 | 45 | 165 |   
## | 0.857 | 0.750 | |   
## -------------|-----------|-----------|-----------|  
## 1 | 20 | 15 | 35 |   
## | 0.143 | 0.250 | |   
## -------------|-----------|-----------|-----------|  
## Column Total | 140 | 60 | 200 |   
## | 0.700 | 0.300 | |   
## -------------|-----------|-----------|-----------|  
##   
##

pred\_churn2 <- factor(ifelse(pred2==1,"Yes","No"))  
caret::confusionMatrix(pred\_churn2,actual\_churn,positive = "No")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction No Yes  
## No 121 44  
## Yes 19 16  
##   
## Accuracy : 0.685   
## 95% CI : (0.6157, 0.7487)  
## No Information Rate : 0.7   
## P-Value [Acc > NIR] : 0.707879   
##   
## Kappa : 0.1486   
##   
## Mcnemar's Test P-Value : 0.002497   
##   
## Sensitivity : 0.8643   
## Specificity : 0.2667   
## Pos Pred Value : 0.7333   
## Neg Pred Value : 0.4571   
## Prevalence : 0.7000   
## Detection Rate : 0.6050   
## Detection Prevalence : 0.8250   
## Balanced Accuracy : 0.5655   
##   
## 'Positive' Class : No   
##

###bayes적중률71.5  
  
### LDA  
ldaDf <- finalData[,-c(10:20)]  
lda.train <- stratified(ldaDf,"이탈여부",0.8)  
lda.test <- ldaDf[!ldaDf$고객ID%in%lda.train$고객ID,]  
  
model3 <- lda(이탈여부 ~성별+통화품질불만, data =lda.train)  
model3

## Call:  
## lda(이탈여부 ~ 성별 + 통화품질불만, data = lda.train)  
##   
## Prior probabilities of groups:  
## 0 1   
## 0.7 0.3   
##   
## Group means:  
## 성별1 통화품질불만1  
## 0 0.4892857 0.001785714  
## 1 0.6000000 0.083333333  
##   
## Coefficients of linear discriminants:  
## LD1  
## 성별1 0.7981249  
## 통화품질불만1 5.9168935

pred3 <- predict(model3,newdata = lda.test[,which(colnames(lda.test)!= "이탈여부")])  
  
pred\_churn3 <- factor(ifelse(pred3$class==1,"Yes","No"))  
caret::confusionMatrix(pred\_churn3,actual\_churn,positive = "No")

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction No Yes  
## No 138 59  
## Yes 2 1  
##   
## Accuracy : 0.695   
## 95% CI : (0.6261, 0.758)  
## No Information Rate : 0.7   
## P-Value [Acc > NIR] : 0.5953   
##   
## Kappa : 0.0033   
##   
## Mcnemar's Test P-Value : 7.496e-13   
##   
## Sensitivity : 0.98571   
## Specificity : 0.01667   
## Pos Pred Value : 0.70051   
## Neg Pred Value : 0.33333   
## Prevalence : 0.70000   
## Detection Rate : 0.69000   
## Detection Prevalence : 0.98500   
## Balanced Accuracy : 0.50119   
##   
## 'Positive' Class : No   
##

### LDA적중률 69.5  
  
###########에측  
telTest <- read.csv("ChurnDataTest.csv",stringsAsFactors = F)  
telTest <-telTest[,-c(21:26)]  
telTest <- telTest[1:200,]  
str

## function (object, ...)   
## UseMethod("str")  
## <bytecode: 0x0000000014de04a8>  
## <environment: namespace:utils>

d2 <- telTest[,c(2,16,19,20)]  
attach(d2)  
d2$성별[성별=="남"] <- 1  
d2$성별[성별=="여"] <- 0  
d2$통화품질불만[통화품질불만==T]<-1 #논리형이라 F는 자동으로 0  
detach(d2)  
d2$d.dummy.고 <- ifelse(d2$통화량구분=="고",1,0)  
d2$d.dummy.중고 <- ifelse(d2$통화량구분=="중고",1,0)  
d2$d.dummy.중 <- ifelse(d2$통화량구분=="중",1,0)  
d2$d.dummy.중저 <- ifelse(d2$통화량구분=="중저",1,0)  
d2$d.dummy.저 <- ifelse(d2$통화량구분=="저",1,0)  
d2<-d2[,-2]  
###수치형 +표준화   
d\_int2 <- telTest[,c(3,4,5,17,18,7,9,11,12,14,15)]  
d\_int2 <- scale(d\_int2)  
testDf<- cbind(d2,telTest[,-c(1,2,16,19,20)])  
testDf$성별<-as.numeric(testDf$성별)  
str(testDf)

## 'data.frame': 200 obs. of 23 variables:  
## $ 성별 : num 0 0 1 0 0 0 0 0 1 0 ...  
## $ 통화품질불만 : num 0 0 0 0 0 0 0 0 0 0 ...  
## $ 이탈여부 : logi NA NA NA NA NA NA ...  
## $ d.dummy.고 : num 0 0 0 0 1 1 1 1 0 1 ...  
## $ d.dummy.중고 : num 0 0 0 0 0 0 0 0 1 0 ...  
## $ d.dummy.중 : num 0 0 0 0 0 0 0 0 0 0 ...  
## $ d.dummy.중저 : num 0 1 1 1 0 0 0 0 0 0 ...  
## $ d.dummy.저 : num 1 0 0 0 0 0 0 0 0 0 ...  
## $ 연령 : int 18 28 18 36 35 51 59 31 35 37 ...  
## $ 서비스기간 : num 28.5 35.3 16.6 39.7 52.5 ...  
## $ 단선횟수 : int 6 4 0 2 1 8 1 1 1 1 ...  
## $ 주간통화횟수 : int 10 66 118 59 529 1052 631 995 615 819 ...  
## $ 주간통화시간\_분: num 18 99.6 193.2 90.6 1509.6 ...  
## $ 야간통화횟수 : int 9 66 132 0 259 71 437 265 74 411 ...  
## $ 야간통화시간\_분: num 40.5 157.8 273.3 0 608.1 ...  
## $ 주말통화횟수 : int 4 22 16 11 6 49 54 7 3 4 ...  
## $ 주말통화시간\_분: num 8.4 45.6 31 103.2 13 ...  
## $ 국제통화시간\_분: num 15.2 93.2 23.1 44.1 512.8 ...  
## $ 국내통화횟수 : int 23 154 266 70 794 1172 1122 1267 692 1234 ...  
## $ 국내통화시간\_분: num 66.9 303 497.5 193.8 2130.7 ...  
## $ 총통화시간\_분 : num 82.1 396.2 520.6 237.9 2643.5 ...  
## $ 총통화요금 : num 6.08 37.27 9.22 17.65 233.35 ...  
## $ 부과요금 : num 66 97.2 69.2 77.6 383.3 ...

testDf[,1]<-factor(testDf[,1])  
testDf[,2]<-factor(testDf[,2])  
  
testDf[,4]<-factor(testDf[,4])  
testDf[,5]<-factor(testDf[,5])  
testDf[,6]<-factor(testDf[,6])  
testDf[,7]<-factor(testDf[,7])  
testDf[,8]<-factor(testDf[,8])  
  
str(testDf)

## 'data.frame': 200 obs. of 23 variables:  
## $ 성별 : Factor w/ 2 levels "0","1": 1 1 2 1 1 1 1 1 2 1 ...  
## $ 통화품질불만 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ 이탈여부 : logi NA NA NA NA NA NA ...  
## $ d.dummy.고 : Factor w/ 2 levels "0","1": 1 1 1 1 2 2 2 2 1 2 ...  
## $ d.dummy.중고 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 2 1 ...  
## $ d.dummy.중 : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...  
## $ d.dummy.중저 : Factor w/ 2 levels "0","1": 1 2 2 2 1 1 1 1 1 1 ...  
## $ d.dummy.저 : Factor w/ 2 levels "0","1": 2 1 1 1 1 1 1 1 1 1 ...  
## $ 연령 : int 18 28 18 36 35 51 59 31 35 37 ...  
## $ 서비스기간 : num 28.5 35.3 16.6 39.7 52.5 ...  
## $ 단선횟수 : int 6 4 0 2 1 8 1 1 1 1 ...  
## $ 주간통화횟수 : int 10 66 118 59 529 1052 631 995 615 819 ...  
## $ 주간통화시간\_분: num 18 99.6 193.2 90.6 1509.6 ...  
## $ 야간통화횟수 : int 9 66 132 0 259 71 437 265 74 411 ...  
## $ 야간통화시간\_분: num 40.5 157.8 273.3 0 608.1 ...  
## $ 주말통화횟수 : int 4 22 16 11 6 49 54 7 3 4 ...  
## $ 주말통화시간\_분: num 8.4 45.6 31 103.2 13 ...  
## $ 국제통화시간\_분: num 15.2 93.2 23.1 44.1 512.8 ...  
## $ 국내통화횟수 : int 23 154 266 70 794 1172 1122 1267 692 1234 ...  
## $ 국내통화시간\_분: num 66.9 303 497.5 193.8 2130.7 ...  
## $ 총통화시간\_분 : num 82.1 396.2 520.6 237.9 2643.5 ...  
## $ 총통화요금 : num 6.08 37.27 9.22 17.65 233.35 ...  
## $ 부과요금 : num 66 97.2 69.2 77.6 383.3 ...

###로지스틱 test  
test.pred <- predict(model1\_2,newdata = testDf[,which(colnames(testDf)!= "이탈여부")],type = "response")  
test.pred

## 1 2 3 4 5 6 7 8   
## 1.0000000 0.5613055 0.6242401 0.5419586 0.3424245 0.2524007 0.3141496 0.2907666   
## 9 10 11 12 13 14 15 16   
## 0.3099911 0.3539098 0.2122850 0.4342226 0.2028801 0.4051468 0.2643133 0.1834269   
## 17 18 19 20 21 22 23 24   
## 0.2929994 0.2586681 0.2583410 0.2283404 0.2534781 0.2360150 0.3234799 0.1679900   
## 25 26 27 28 29 30 31 32   
## 0.3174220 0.3840456 0.2670073 0.2108935 0.3252163 0.2612764 0.3258179 0.3295388   
## 33 34 35 36 37 38 39 40   
## 0.2329043 0.2392176 0.2095694 0.4172638 0.3229522 0.2329355 0.2256550 0.4627372   
## 41 42 43 44 45 46 47 48   
## 0.2573059 0.2115203 0.4733115 0.1986265 0.2445037 0.3944776 0.2777772 0.2528366   
## 49 50 51 52 53 54 55 56   
## 0.2889184 0.3213284 0.1943948 0.2450636 0.3065775 0.2073999 0.3090856 0.2018211   
## 57 58 59 60 61 62 63 64   
## 0.2411268 0.2094182 0.2897669 0.2682455 0.2236820 0.2928576 0.1957788 0.2188375   
## 65 66 67 68 69 70 71 72   
## 0.2525082 0.2301701 0.2981284 0.2309495 0.2934389 0.3239717 0.2090191 0.2530109   
## 73 74 75 76 77 78 79 80   
## 0.2361154 0.4419356 0.2523934 0.2445559 0.1941741 0.3382695 0.3340385 0.2553997   
## 81 82 83 84 85 86 87 88   
## 0.3233104 0.3268729 0.1570290 0.2540399 0.2632824 0.1903473 0.1775460 0.1968366   
## 89 90 91 92 93 94 95 96   
## 0.1979955 0.2418029 0.1965568 0.1781462 0.2820101 0.2709011 0.2499015 0.2198046   
## 97 98 99 100 101 102 103 104   
## 0.1776712 0.1844758 0.2198817 0.1917952 0.1621970 0.1925060 0.1657271 0.1800794   
## 105 106 107 108 109 110 111 112   
## 0.9254085 0.2455591 0.2009378 0.2731662 0.2455512 0.2370995 0.1930334 0.2815400   
## 113 114 115 116 117 118 119 120   
## 0.1833374 0.2087409 0.2622956 0.2540267 0.1771457 0.2628895 0.2453977 0.2605348   
## 121 122 123 124 125 126 127 128   
## 0.2536321 0.2970317 0.2484032 0.2029654 0.2447002 0.1589492 0.1551795 0.2046087   
## 129 130 131 132 133 134 135 136   
## 0.1944640 0.1813119 0.1941338 0.2352420 0.2794949 0.2630939 0.2369249 0.1451676   
## 137 138 139 140 141 142 143 144   
## 0.2850726 0.1943892 0.2650004 0.2029408 0.2469379 0.2089572 0.2065770 0.1935270   
## 145 146 147 148 149 150 151 152   
## 0.3576053 0.2466162 0.2585578 0.3399846 0.2748309 0.2731622 0.2361858 0.2942424   
## 153 154 155 156 157 158 159 160   
## 0.3176089 0.2584744 0.3546439 0.3014769 0.3235659 0.3146978 0.3387226 0.2770153   
## 161 162 163 164 165 166 167 168   
## 0.3073754 0.2543368 0.3544213 0.3462445 0.3451700 0.2461003 0.2670763 0.9008827   
## 169 170 171 172 173 174 175 176   
## 0.3198485 0.2747126 0.3678673 0.3173649 0.2384945 0.3164788 0.2941261 0.3153611   
## 177 178 179 180 181 182 183 184   
## 0.3236239 0.3414042 0.2186735 0.2648578 0.2364539 0.3101616 0.3776466 0.3348805   
## 185 186 187 188 189 190 191 192   
## 0.2650440 0.2474791 0.3362426 0.3393855 0.2542357 0.3236794 0.3101146 0.3485239   
## 193 194 195 196 197 198 199 200   
## 0.2243954 0.2351692 0.2527043 0.2642178 0.9461460 0.5456674 0.5383703 0.5407238

test.pred\_churn <- factor(ifelse(test.pred >= 0.5, "1", "0"))  
test.pred\_churn

## 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20   
## 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120   
## 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0   
## 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180   
## 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0   
## 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200   
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1   
## Levels: 0 1

table(test.pred\_churn)

## test.pred\_churn  
## 0 1   
## 190 10

## bayes test  
bayDf2 <- testDf[,c(3,9:19)]  
test.pred2<-predict(model2,bayDf2[,which(colnames(bayDf2)!= "이탈여부")])

## Warning in predict.naiveBayes(model2, bayDf2[, which(colnames(bayDf2) != :  
## Type mismatch between training and new data for variable '고객ID'. Did you use  
## factors with numeric labels for training, and numeric values for new data?

test.pred2

## [1] 1 1 1 1 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 1 0 0  
## [38] 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0  
## [75] 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0  
## [112] 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0  
## [149] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0  
## [186] 0 0 0 0 1 0 0 0 0 1 0 1 1 1 0  
## Levels: 0 1