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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(readxl)  
library(ggplot2)  
library(DBI)  
library(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ forcats 1.0.0 ✔ stringr 1.5.1  
## ✔ lubridate 1.9.4 ✔ tibble 3.2.1  
## ✔ purrr 1.0.2 ✔ tidyr 1.3.1  
## ✔ readr 2.1.5

## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(data.table)

##   
## Attaching package: 'data.table'  
##   
## The following objects are masked from 'package:lubridate':  
##   
## hour, isoweek, mday, minute, month, quarter, second, wday, week,  
## yday, year  
##   
## The following object is masked from 'package:purrr':  
##   
## transpose  
##   
## The following objects are masked from 'package:dplyr':  
##   
## between, first, last

library(caret) # For machine learning

## Loading required package: lattice  
##   
## Attaching package: 'caret'  
##   
## The following object is masked from 'package:purrr':  
##   
## lift

library(tensorflow) # For TensorFlow backend

##   
## Attaching package: 'tensorflow'  
##   
## The following object is masked from 'package:caret':  
##   
## train

library(keras) # For neural networks  
library(doParallel)

## Loading required package: foreach  
##   
## Attaching package: 'foreach'  
##   
## The following objects are masked from 'package:purrr':  
##   
## accumulate, when  
##   
## Loading required package: iterators  
## Loading required package: parallel

########################################################## Policy Data Cleaning  
##read all policies excel files with .xlsx pattern.  
  
file.list = list.files( pattern='\*.xlsx' , recursive = TRUE )  
policies <- lapply(file.list[4:33], read\_excel)  
#  
# # bind each files with row  
all\_policies\_df = bind\_rows(policies)  
  
  
#remove some columns manualy  
  
df\_sodor = as.data.table(  
 all\_policies\_df[,-c(1,2,3,4,10,19,20,23,26,28,29,33,34,35,36,37)]  
 )  
  
df\_sodor =  
 df\_sodor %>%  
 separate(col = `سابقه مالی / جانی`, into = c("c1", "FinanceHistory","LifeHistory"), sep = ":", remove = T)  
df\_sodor = df\_sodor[,-c(which(names(df\_sodor) == "c1"))]  
df\_sodor$FinanceHistory = substr(df\_sodor$FinanceHistory ,  
 start = 1, stop = nchar(df\_sodor$FinanceHistory)-6)  
df\_sodor= as.data.table(df\_sodor)  
# save(df\_sodor , file = "policies\_list.RData")  
# load("policies\_list.RData")  
#find columns with low or very high variance to delete them  
  
  
  
# ایجاد یک داده‌فریم نمونه با 40 ستون categorical  
set.seed(123)  
coded\_dfs <- list()  
categorical\_columns <- names(which(  
 sapply(df\_sodor, is.factor) | sapply(df\_sodor, is.character) == T))  
# حلقه برای کددهی به هر ستون و ایجاد داده‌فریم جداگانه  
for (col in categorical\_columns) {  
 # ایجاد ستون کد  
 df\_sodor[, paste0(col, "\_Code") := as.numeric(factor(get(col)))]  
  
 # ایجاد داده‌فریم جداگانه برای این ستون  
 coded\_dfs[[col]] <- df\_sodor[, .(get(col), get(paste0(col, "\_Code")))]  
 coded\_dfs[[col]] <- unique(df\_sodor[, .(get(col), get(paste0(col, "\_Code")))])  
 names(coded\_dfs[[col]]) <- c(col, paste0(col, "\_Code"))  
}  
  
# save(coded\_dfs , file = "coded\_dfs.RData")  
# load("coded\_dfs.RData")  
df\_sodor = as.data.frame(df\_sodor)  
df\_with\_coding = df\_sodor[,which(names(df\_sodor) %notin% categorical\_columns)]  
  
# remove some linearity columns mannulay for example A+B-C = D  
df\_with\_coding = df\_with\_coding[,-c(21,22)]  
names(df\_with\_coding)

## [1] "کد یونیک بیمه گذار" "مدت (روز)"   
## [3] "سال ساخت خودرو (شمسی)" "پوشش جانی (میلیون ریال)"   
## [5] "پوشش مالی(میلیون ریال)" "پوشش حوادث راننده(میلیون ریال)"   
## [7] "حق بیمه ثالث اجباری" "حق بیمه تعدد دیات"   
## [9] "حق بیمه مازاد جانی" "حق بیمه مازاد مالی"   
## [11] "حق بیمه حوادث راننده" "حق بیمه صندوق"   
## [13] "حق بیمه پایه" "عوارض بهداشت"   
## [15] "عوارض رديف 160111 قانون بودجه" "حق بیمه صندوق (سهم بیمه مرکزی)"   
## [17] "مالیات ارزش افزوده" "عوارض ارزش افزوده"   
## [19] "حق بیمه صندوق (سهم بیمه گر)" "خالص حق بیمه"   
## [21] "واحد صدور بیمه نامه\_Code" "استان واحد صدور بیمه نامه\_Code"   
## [23] "تاریخ صدور\_Code" "نام بیمه گذار\_Code"   
## [25] "بازاریاب\_Code" "نوع خودرو\_Code"   
## [27] "گروه خودرو\_Code" "دسته بندی خودرو\_Code"   
## [29] "مورد استفاده خودرو\_Code" "تاریخ شروع\_Code"   
## [31] "تاریخ پایان\_Code" "نام کاربر ثبت کننده بیمه نامه\_Code"  
## [33] "شماره کامل\_Code" "نوع بیمه گذار\_Code"   
## [35] "شرکت بیمه سال قبل\_Code" "پلاک\_Code"   
## [37] "سیستم خودرو\_Code" "نوع پلاک\_Code"   
## [39] "سابقه سرنشین\_Code" "FinanceHistory\_Code"   
## [41] "LifeHistory\_Code"

names(df\_with\_coding) = c("PolicyHolderCode" ,  
 "Duration",  
 "CarProductYear",  
 "SideCover\_MR",  
 "FinanceCover\_MR",  
 "AccidentCover\_MR",  
 "ThirdParty\_Pr",  
 "MultipleBloodMoney\_Pr",  
 "ExcessLife\_Pr",  
 "ExcessFinance\_Pr",  
 "DriverAccident\_Pr",  
 "Pension\_Pr",  
 "Basis\_Pr",  
 "Health\_Complications",  
 "Goverment\_Complications",  
 "CentralInsurance\_Pension\_Pr",  
 "ValueAdded\_Tax",  
 "ValueAdded\_Complications",  
 "Insurer\_Pension\_Pr",  
 "Net\_Pr",  
 "ID\_PolicyLuncher\_Departmant",  
 "ID\_PolicyLuncher\_Province",  
 "ID\_LunchDate",  
 "ID\_PolicyHolderName",  
 "ID\_MarkettingBy",  
 "ID\_AutomobileType",  
 "ID\_AutomobileGroup",  
 "ID\_AutomobileClass",  
 "ID\_AutomobuileUssage",  
 "ID\_StartDate",  
 "ID\_EndDate",  
 "ID\_RegisterUser",  
 "ID\_Policy",  
 "ID\_PolicyHolderType",  
 "ID\_LastInsurer",  
 "ID\_AutomobileZipCode",  
 "ID\_AutomobileSystem",  
 "ID\_AutomobileZipCodeType",  
 "ID\_Passengers\_Claim",  
 "ID\_Finance\_Claim",  
 "ID\_Life\_Claim"  
 )  
# save(df\_with\_coding , file = "df\_with\_coding.RData")  
# load("df\_with\_coding.RData")  
  
###########################################################Claim Data Cleaning  
file.list = list.files( pattern='\*.xlsx' , recursive = TRUE )  
 Claims <- lapply(file.list[1:3], read\_excel)  
 names(Claims[[1]])[54] = "LifeLoss\_Value"  
 names(Claims[[2]])[54] = "PassengerLoss\_Value"  
 names(Claims[[3]])[54] = "FinanceLoss\_Value"  
   
# bind each files with row  
 all\_claims\_df = bind\_rows(Claims)  
  
#remove some columns manualy  
  
 df\_claims = as.data.table(  
 all\_claims\_df[,c(17,54,56,57)]  
 )  
 df\_claims = as.data.frame(df\_claims)  
names(df\_claims)[1] = c("ID\_Policy")  
for(i in 2:4){  
 df\_claims[,i] = ifelse(is.na(df\_claims[,i]) , 0 , df\_claims[,i])  
}  
  
######################################################## Merging Data  
library(dplyr)  
library(readxl)  
library(ggplot2)  
library(DBI)  
library(tidyverse)  
library(data.table)  
  
  
# load("df\_with\_coding.RData")  
# load("Claims\_list.RData")  
# load("coded\_dfs.RData")  
names(coded\_dfs[["شماره کامل"]])[1] = "ID\_Policy"  
# coded\_dfs[["شماره کامل"]]$ID\_Policy = as.character(coded\_dfs[["شماره کامل"]]$ID\_Policy)  
claims\_with\_code = left\_join(df\_claims , coded\_dfs[["شماره کامل"]] , by = "ID\_Policy",keep = F )  
claims\_with\_code = claims\_with\_code[,-c(1)] #remove ID\_Ploicy column  
names(claims\_with\_code)[4] = "ID\_Policy"  
FinalDf = left\_join(df\_with\_coding , claims\_with\_code , by = "ID\_Policy")  
# save(FinalDf , file = "FinalDf.RData")  
  
  
########################################################### CV Modeling  
# cl <- makePSOCKcluster(4) # تعداد هسته‌های پردازنده (مثلاً 4)  
# registerDoParallel(cl)  
#load("FinalDf.RData")  
FinalDf = as.data.frame(FinalDf[1:1000,])  
for(i in 42:44){  
 FinalDf[,i] = ifelse(is.na(FinalDf[,i]) , 0 , FinalDf[,i])  
}  
  
FinalDf$HaveLoss =   
 ifelse(FinalDf$LifeLoss\_Value +  
 FinalDf$PassengerLoss\_Value +  
 FinalDf$FinanceLoss\_Value > 0 ,1,0)  
FinalDf$HaveLoss = as.factor(FinalDf$HaveLoss)  
#remove some columns for na values and other loss types.  
  
# Check for missing values in each column  
missing\_values <- colSums(is.na(FinalDf))  
  
FinalDf = FinalDf[,-c(42:44)]  
FinalDf = FinalDf[,-c(which(colnames(FinalDf) %in% names(which(missing\_values>0 ))))]  
  
  
split\_data <- function(data, train\_percentage) {  
 # Ensure the train\_percentage is between 0 and 1  
 if (train\_percentage < 0 || train\_percentage > 1) {  
 stop("train\_percentage must be between 0 and 1")  
 }  
   
 # Calculate the number of rows for the training set  
 n <- nrow(data)  
 n\_train <- floor(train\_percentage \* n)  
   
 # Randomly sample the indices for the training set  
 train\_indices <- sample(1:n, n\_train)  
   
 # Create the training and test sets  
 train\_set <- data[train\_indices, ]  
 test\_set <- data[-train\_indices, ]  
   
 # Return the training and test sets as a list  
 return(list(train = train\_set, test = test\_set))  
}  
set.seed(123)  
# Assuming finalDf is your dataset and you want 80% for training  
result <- split\_data(FinalDf, train\_percentage = 0.8)  
train\_set <- result$train  
test\_set <- result$test  
  
######  
dim(train\_set)

## [1] 800 36

head(train\_set)

## PolicyHolderCode Duration CarProductYear SideCover\_MR FinanceCover\_MR  
## 415 210800.4 365 1377 350 20  
## 463 214757.9 365 1382 350 10  
## 179 219846.8 365 1383 400 20  
## 526 221096.4 365 1364 400 20  
## 195 211513.5 4 1380 350 10  
## 938 267169.1 365 1384 350 10  
## ThirdParty\_Pr MultipleBloodMoney\_Pr ExcessLife\_Pr ExcessFinance\_Pr  
## 415 208250 0 818332 272777  
## 463 189000 0 896898 298966  
## 179 169575 0 981349 327116  
## 526 378250 0 2165756 721919  
## 195 12250 0 58454 19485  
## 938 232750 0 1110609 370203  
## DriverAccident\_Pr Pension\_Pr Basis\_Pr Health\_Complications  
## 415 119000 0 1702033 141837  
## 463 72000 0 1748238 145687  
## 179 104500 0 1899050 158255  
## 526 93500 0 4031311 335943  
## 195 4000 0 113029 9420  
## 938 76000 0 2147476 178957  
## Goverment\_Complications CentralInsurance\_Pension\_Pr ValueAdded\_Tax  
## 415 0 0 0  
## 463 0 0 0  
## 179 0 0 0  
## 526 0 0 0  
## 195 0 0 0  
## 938 0 0 0  
## ValueAdded\_Complications Insurer\_Pension\_Pr Net\_Pr  
## 415 0 0 1560196  
## 463 0 0 1602551  
## 179 0 0 1740795  
## 526 0 0 3695368  
## 195 0 0 103609  
## 938 0 0 1968519  
## ID\_PolicyLuncher\_Departmant ID\_PolicyLuncher\_Province ID\_LunchDate  
## 415 1114 8 167  
## 463 1114 8 167  
## 179 776 17 149  
## 526 1114 8 260  
## 195 1163 8 153  
## 938 1163 8 403  
## ID\_AutomobileType ID\_AutomobileGroup ID\_AutomobuileUssage ID\_StartDate  
## 415 4078 3 67 189  
## 463 969 3 67 189  
## 179 5088 2 47 168  
## 526 2981 2 19 303  
## 195 1038 3 57 172  
## 938 1069 3 67 472  
## ID\_EndDate ID\_RegisterUser ID\_Policy ID\_PolicyHolderType  
## 415 194 444 1514 1  
## 463 194 444 1557 1  
## 179 173 680 1977 2  
## 526 307 250 5915 1  
## 195 1 2173 787 1  
## 938 476 2262 3582 2  
## ID\_AutomobileZipCode ID\_AutomobileZipCodeType ID\_Passengers\_Claim  
## 415 3539 10 2  
## 463 3539 10 9  
## 179 2364 11 23  
## 526 537 12 13  
## 195 660 10 4  
## 938 657 10 23  
## ID\_Finance\_Claim ID\_Life\_Claim HaveLoss  
## 415 2 2 0  
## 463 9 9 0  
## 179 23 23 0  
## 526 13 13 0  
## 195 4 4 0  
## 938 23 23 0

# Separate features (X) and target (y) for training and testing sets  
X\_train <- train\_set[, -c(18:dim(train\_set)[2])] # All columns except the last one  
y\_train <- train\_set[, c(dim(train\_set)[2])] # Last column (TotalLoss)  
  
X\_test <- test\_set[, -c(18:dim(test\_set)[2])] # All columns except the last one  
y\_test <- test\_set[, c(dim(test\_set)[2])] # Last column (TotalLoss)  
# Scale/normalize the features  
preprocess\_params <- preProcess(X\_train, method = c("center", "scale"))  
X\_train\_scaled <- predict(preprocess\_params, X\_train)  
X\_test\_scaled <- predict(preprocess\_params, X\_test)  
  
  
X\_train\_scaled = cbind(X\_train\_scaled, train\_set[,18:32])  
X\_test\_scaled = cbind(X\_test\_scaled, test\_set[,18:32])  
  
train\_control <- trainControl(  
 method = "cv", # Cross-validation  
 number = 5, # 5-fold CV  
 savePredictions = "final",  
 allowParallel = TRUE,  
 #verboseIter = TRUE # Show progress updates  
   
)  
  
# Define a list of models to train  
models <- c(  
 #"lm", # Linear Regression  
 "glm", # Logistic Regression  
 "glmnet", # Ridge/Lasso Regression  
 "rpart", # Decision Trees  
 "rf", # Random Forests  
 "gbm", # Gradient Boosting Machines  
 "xgbTree", # XGBoost (Gradient Boosting)  
 "svmRadial", # Support Vector Machines (Radial Kernel)  
 "knn", # k-Nearest Neighbors  
 "pls", # Principal Component Regression  
 #"lda", # Linear Discriminant Analysis  
 #"qda", # Quadratic Discriminant Analysis  
 #"naive\_bayes", # Naive Bayes  
 "nnet" # Neural Networks  
)  
  
# Train and evaluate all models  
results <- list()  
test\_errors <- data.frame(Model = character(), RMSE = numeric(), R2 = numeric(), MAE = numeric(), stringsAsFactors = FALSE)  
  
for (model in models) {  
 set.seed(123) # For reproducibility  
 print(paste("Training model:", model))  
   
 # Train the model  
 fit <- caret::train(  
 x = X\_train\_scaled, # Features  
 y = y\_train, # Target variable  
 method = model, # Model type  
 trControl = train\_control  
 )  
   
 # Store the results  
 results[[model]] <- fit  
   
 # Predict on the test set  
 predictions <- predict(fit, newdata = X\_test\_scaled)  
   
 # Calculate test error metrics  
 if (is.factor(y\_test)) { # Classification  
 cm <- confusionMatrix(predictions, y\_test)  
 accuracy <- cm$overall["Accuracy"]  
 kappa <- cm$overall["Kappa"]  
 test\_errors <- rbind(test\_errors, data.frame(Model = model, Accuracy = accuracy, Kappa = kappa))  
 } else { # Regression  
 rmse <- sqrt(mean((as.numeric(predictions) - as.numeric(y\_test))^2))  
 r2 <- cor(as.numeric(predictions), as.numeric(y\_test))^2  
 mae <- mean(abs(as.numeric(predictions) - as.numeric(y\_test)))  
 test\_errors <- rbind(test\_errors, data.frame(Model = model, RMSE = rmse, R2 = r2, MAE = mae))  
 }  
}

## [1] "Training model: glm"  
## [1] "Training model: glmnet"  
## [1] "Training model: rpart"  
## [1] "Training model: rf"  
## [1] "Training model: gbm"  
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8370 nan 0.1000 0.0010  
## 2 0.8350 nan 0.1000 -0.0016  
## 3 0.8306 nan 0.1000 0.0003  
## 4 0.8279 nan 0.1000 -0.0004  
## 5 0.8257 nan 0.1000 0.0005  
## 6 0.8236 nan 0.1000 -0.0002  
## 7 0.8203 nan 0.1000 -0.0002  
## 8 0.8181 nan 0.1000 -0.0000  
## 9 0.8159 nan 0.1000 0.0004  
## 10 0.8139 nan 0.1000 -0.0001  
## 20 0.7976 nan 0.1000 -0.0016  
## 40 0.7647 nan 0.1000 -0.0002  
## 60 0.7489 nan 0.1000 -0.0002  
## 80 0.7360 nan 0.1000 -0.0011  
## 100 0.7212 nan 0.1000 -0.0006  
## 120 0.7070 nan 0.1000 -0.0006  
## 140 0.6946 nan 0.1000 -0.0005  
## 150 0.6929 nan 0.1000 -0.0009  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8350 nan 0.1000 0.0003  
## 2 0.8288 nan 0.1000 0.0016  
## 3 0.8221 nan 0.1000 -0.0012  
## 4 0.8180 nan 0.1000 -0.0001  
## 5 0.8136 nan 0.1000 -0.0005  
## 6 0.8092 nan 0.1000 -0.0007  
## 7 0.8017 nan 0.1000 -0.0009  
## 8 0.7974 nan 0.1000 0.0004  
## 9 0.7950 nan 0.1000 -0.0024  
## 10 0.7914 nan 0.1000 -0.0006  
## 20 0.7522 nan 0.1000 -0.0004  
## 40 0.6971 nan 0.1000 -0.0017  
## 60 0.6627 nan 0.1000 -0.0019  
## 80 0.6319 nan 0.1000 -0.0019  
## 100 0.6075 nan 0.1000 -0.0022  
## 120 0.5869 nan 0.1000 -0.0008  
## 140 0.5712 nan 0.1000 -0.0010  
## 150 0.5590 nan 0.1000 -0.0007  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8287 nan 0.1000 0.0016  
## 2 0.8200 nan 0.1000 0.0005  
## 3 0.8114 nan 0.1000 0.0013  
## 4 0.8043 nan 0.1000 0.0005  
## 5 0.7979 nan 0.1000 -0.0006  
## 6 0.7931 nan 0.1000 -0.0004  
## 7 0.7910 nan 0.1000 -0.0013  
## 8 0.7862 nan 0.1000 -0.0007  
## 9 0.7812 nan 0.1000 -0.0003  
## 10 0.7762 nan 0.1000 -0.0007  
## 20 0.7297 nan 0.1000 -0.0007  
## 40 0.6608 nan 0.1000 -0.0015  
## 60 0.6199 nan 0.1000 -0.0020  
## 80 0.5740 nan 0.1000 -0.0016  
## 100 0.5456 nan 0.1000 -0.0032  
## 120 0.5181 nan 0.1000 -0.0016  
## 140 0.4945 nan 0.1000 -0.0024  
## 150 0.4834 nan 0.1000 -0.0025  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8328 nan 0.1000 0.0024  
## 2 0.8300 nan 0.1000 -0.0001  
## 3 0.8263 nan 0.1000 0.0016  
## 4 0.8223 nan 0.1000 -0.0003  
## 5 0.8190 nan 0.1000 0.0012  
## 6 0.8173 nan 0.1000 -0.0014  
## 7 0.8145 nan 0.1000 0.0000  
## 8 0.8119 nan 0.1000 -0.0012  
## 9 0.8089 nan 0.1000 -0.0007  
## 10 0.8069 nan 0.1000 0.0001  
## 20 0.7901 nan 0.1000 -0.0011  
## 40 0.7644 nan 0.1000 -0.0010  
## 60 0.7421 nan 0.1000 -0.0008  
## 80 0.7286 nan 0.1000 -0.0017  
## 100 0.7136 nan 0.1000 -0.0002  
## 120 0.7001 nan 0.1000 -0.0010  
## 140 0.6858 nan 0.1000 0.0004  
## 150 0.6805 nan 0.1000 -0.0008  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8345 nan 0.1000 0.0010  
## 2 0.8244 nan 0.1000 0.0015  
## 3 0.8193 nan 0.1000 -0.0004  
## 4 0.8126 nan 0.1000 0.0006  
## 5 0.8085 nan 0.1000 0.0007  
## 6 0.8024 nan 0.1000 0.0005  
## 7 0.7964 nan 0.1000 -0.0002  
## 8 0.7927 nan 0.1000 -0.0014  
## 9 0.7871 nan 0.1000 0.0010  
## 10 0.7821 nan 0.1000 0.0004  
## 20 0.7474 nan 0.1000 -0.0031  
## 40 0.6970 nan 0.1000 -0.0008  
## 60 0.6520 nan 0.1000 -0.0006  
## 80 0.6222 nan 0.1000 -0.0009  
## 100 0.5936 nan 0.1000 -0.0021  
## 120 0.5733 nan 0.1000 -0.0009  
## 140 0.5545 nan 0.1000 -0.0014  
## 150 0.5433 nan 0.1000 -0.0018  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8319 nan 0.1000 0.0001  
## 2 0.8224 nan 0.1000 0.0016  
## 3 0.8153 nan 0.1000 -0.0005  
## 4 0.8088 nan 0.1000 0.0008  
## 5 0.8020 nan 0.1000 -0.0011  
## 6 0.7925 nan 0.1000 0.0018  
## 7 0.7841 nan 0.1000 -0.0012  
## 8 0.7758 nan 0.1000 0.0006  
## 9 0.7664 nan 0.1000 -0.0014  
## 10 0.7637 nan 0.1000 -0.0017  
## 20 0.7114 nan 0.1000 -0.0026  
## 40 0.6382 nan 0.1000 -0.0017  
## 60 0.5843 nan 0.1000 -0.0016  
## 80 0.5433 nan 0.1000 -0.0020  
## 100 0.5080 nan 0.1000 -0.0009  
## 120 0.4798 nan 0.1000 -0.0009  
## 140 0.4602 nan 0.1000 -0.0009  
## 150 0.4475 nan 0.1000 -0.0017  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8395 nan 0.1000 0.0012  
## 2 0.8337 nan 0.1000 0.0026  
## 3 0.8295 nan 0.1000 0.0001  
## 4 0.8235 nan 0.1000 0.0012  
## 5 0.8205 nan 0.1000 -0.0004  
## 6 0.8167 nan 0.1000 0.0000  
## 7 0.8130 nan 0.1000 0.0001  
## 8 0.8105 nan 0.1000 0.0002  
## 9 0.8074 nan 0.1000 0.0008  
## 10 0.8040 nan 0.1000 0.0003  
## 20 0.7825 nan 0.1000 -0.0009  
## 40 0.7555 nan 0.1000 -0.0013  
## 60 0.7358 nan 0.1000 -0.0010  
## 80 0.7219 nan 0.1000 -0.0004  
## 100 0.7090 nan 0.1000 -0.0008  
## 120 0.6993 nan 0.1000 -0.0001  
## 140 0.6887 nan 0.1000 -0.0005  
## 150 0.6830 nan 0.1000 -0.0019  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8413 nan 0.1000 0.0002  
## 2 0.8337 nan 0.1000 -0.0015  
## 3 0.8229 nan 0.1000 0.0024  
## 4 0.8120 nan 0.1000 0.0006  
## 5 0.8041 nan 0.1000 0.0017  
## 6 0.7968 nan 0.1000 0.0007  
## 7 0.7914 nan 0.1000 0.0013  
## 8 0.7891 nan 0.1000 -0.0024  
## 9 0.7870 nan 0.1000 -0.0013  
## 10 0.7827 nan 0.1000 0.0010  
## 20 0.7503 nan 0.1000 -0.0007  
## 40 0.7008 nan 0.1000 -0.0013  
## 60 0.6664 nan 0.1000 -0.0014  
## 80 0.6372 nan 0.1000 -0.0025  
## 100 0.6158 nan 0.1000 -0.0010  
## 120 0.5946 nan 0.1000 -0.0011  
## 140 0.5764 nan 0.1000 -0.0013  
## 150 0.5700 nan 0.1000 -0.0017  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8370 nan 0.1000 0.0006  
## 2 0.8217 nan 0.1000 0.0010  
## 3 0.8114 nan 0.1000 0.0011  
## 4 0.8022 nan 0.1000 0.0004  
## 5 0.7966 nan 0.1000 0.0014  
## 6 0.7861 nan 0.1000 0.0016  
## 7 0.7797 nan 0.1000 -0.0018  
## 8 0.7731 nan 0.1000 0.0002  
## 9 0.7689 nan 0.1000 -0.0010  
## 10 0.7641 nan 0.1000 -0.0027  
## 20 0.7280 nan 0.1000 -0.0032  
## 40 0.6556 nan 0.1000 -0.0023  
## 60 0.6092 nan 0.1000 -0.0012  
## 80 0.5706 nan 0.1000 -0.0019  
## 100 0.5453 nan 0.1000 -0.0011  
## 120 0.5198 nan 0.1000 -0.0014  
## 140 0.4932 nan 0.1000 -0.0013  
## 150 0.4842 nan 0.1000 -0.0011  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8308 nan 0.1000 0.0033  
## 2 0.8260 nan 0.1000 0.0012  
## 3 0.8236 nan 0.1000 -0.0007  
## 4 0.8190 nan 0.1000 0.0006  
## 5 0.8133 nan 0.1000 0.0018  
## 6 0.8101 nan 0.1000 0.0008  
## 7 0.8075 nan 0.1000 0.0005  
## 8 0.8053 nan 0.1000 0.0008  
## 9 0.8026 nan 0.1000 0.0005  
## 10 0.8002 nan 0.1000 0.0001  
## 20 0.7782 nan 0.1000 -0.0001  
## 40 0.7536 nan 0.1000 -0.0022  
## 60 0.7331 nan 0.1000 -0.0002  
## 80 0.7144 nan 0.1000 -0.0006  
## 100 0.6986 nan 0.1000 -0.0006  
## 120 0.6850 nan 0.1000 -0.0008  
## 140 0.6768 nan 0.1000 -0.0012  
## 150 0.6718 nan 0.1000 -0.0007  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8302 nan 0.1000 -0.0001  
## 2 0.8174 nan 0.1000 0.0033  
## 3 0.8097 nan 0.1000 0.0021  
## 4 0.8063 nan 0.1000 -0.0011  
## 5 0.8002 nan 0.1000 0.0019  
## 6 0.7944 nan 0.1000 -0.0007  
## 7 0.7901 nan 0.1000 0.0005  
## 8 0.7843 nan 0.1000 0.0022  
## 9 0.7796 nan 0.1000 0.0001  
## 10 0.7774 nan 0.1000 -0.0014  
## 20 0.7392 nan 0.1000 -0.0013  
## 40 0.7016 nan 0.1000 -0.0020  
## 60 0.6642 nan 0.1000 -0.0018  
## 80 0.6366 nan 0.1000 -0.0022  
## 100 0.6105 nan 0.1000 -0.0006  
## 120 0.5902 nan 0.1000 -0.0023  
## 140 0.5755 nan 0.1000 -0.0012  
## 150 0.5654 nan 0.1000 -0.0020  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8268 nan 0.1000 -0.0009  
## 2 0.8132 nan 0.1000 0.0037  
## 3 0.8014 nan 0.1000 0.0021  
## 4 0.7939 nan 0.1000 0.0026  
## 5 0.7867 nan 0.1000 0.0002  
## 6 0.7811 nan 0.1000 -0.0003  
## 7 0.7736 nan 0.1000 0.0015  
## 8 0.7690 nan 0.1000 0.0001  
## 9 0.7591 nan 0.1000 0.0018  
## 10 0.7542 nan 0.1000 0.0003  
## 20 0.7089 nan 0.1000 -0.0038  
## 40 0.6407 nan 0.1000 -0.0001  
## 60 0.5971 nan 0.1000 -0.0036  
## 80 0.5596 nan 0.1000 -0.0028  
## 100 0.5311 nan 0.1000 -0.0014  
## 120 0.5007 nan 0.1000 -0.0017  
## 140 0.4782 nan 0.1000 -0.0016  
## 150 0.4668 nan 0.1000 -0.0008  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8329 nan 0.1000 0.0001  
## 2 0.8254 nan 0.1000 0.0035  
## 3 0.8223 nan 0.1000 0.0008  
## 4 0.8160 nan 0.1000 -0.0010  
## 5 0.8125 nan 0.1000 0.0012  
## 6 0.8111 nan 0.1000 -0.0008  
## 7 0.8070 nan 0.1000 0.0001  
## 8 0.8050 nan 0.1000 0.0003  
## 9 0.8045 nan 0.1000 -0.0015  
## 10 0.8012 nan 0.1000 -0.0023  
## 20 0.7765 nan 0.1000 -0.0006  
## 40 0.7462 nan 0.1000 -0.0004  
## 60 0.7277 nan 0.1000 -0.0011  
## 80 0.7141 nan 0.1000 -0.0015  
## 100 0.6994 nan 0.1000 -0.0010  
## 120 0.6845 nan 0.1000 0.0000  
## 140 0.6731 nan 0.1000 -0.0001  
## 150 0.6696 nan 0.1000 -0.0003  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8322 nan 0.1000 -0.0006  
## 2 0.8244 nan 0.1000 0.0007  
## 3 0.8136 nan 0.1000 0.0031  
## 4 0.8035 nan 0.1000 0.0031  
## 5 0.7991 nan 0.1000 -0.0006  
## 6 0.7919 nan 0.1000 -0.0013  
## 7 0.7854 nan 0.1000 0.0001  
## 8 0.7815 nan 0.1000 0.0004  
## 9 0.7769 nan 0.1000 0.0000  
## 10 0.7721 nan 0.1000 0.0004  
## 20 0.7393 nan 0.1000 -0.0002  
## 40 0.6856 nan 0.1000 -0.0019  
## 60 0.6523 nan 0.1000 -0.0014  
## 80 0.6257 nan 0.1000 -0.0016  
## 100 0.6002 nan 0.1000 -0.0009  
## 120 0.5796 nan 0.1000 -0.0020  
## 140 0.5520 nan 0.1000 -0.0008  
## 150 0.5459 nan 0.1000 -0.0019  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8248 nan 0.1000 0.0033  
## 2 0.8132 nan 0.1000 0.0038  
## 3 0.8018 nan 0.1000 0.0007  
## 4 0.7937 nan 0.1000 0.0012  
## 5 0.7853 nan 0.1000 0.0019  
## 6 0.7792 nan 0.1000 0.0003  
## 7 0.7679 nan 0.1000 0.0022  
## 8 0.7625 nan 0.1000 -0.0009  
## 9 0.7559 nan 0.1000 -0.0002  
## 10 0.7505 nan 0.1000 0.0000  
## 20 0.6977 nan 0.1000 -0.0009  
## 40 0.6376 nan 0.1000 0.0000  
## 60 0.5929 nan 0.1000 -0.0016  
## 80 0.5536 nan 0.1000 -0.0017  
## 100 0.5218 nan 0.1000 -0.0019  
## 120 0.4900 nan 0.1000 -0.0011  
## 140 0.4686 nan 0.1000 -0.0016  
## 150 0.4540 nan 0.1000 -0.0022  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 0.8344 nan 0.1000 0.0017  
## 2 0.8275 nan 0.1000 0.0002  
## 3 0.8189 nan 0.1000 0.0020  
## 4 0.8121 nan 0.1000 0.0015  
## 5 0.8066 nan 0.1000 0.0006  
## 6 0.8014 nan 0.1000 0.0013  
## 7 0.7977 nan 0.1000 -0.0005  
## 8 0.7929 nan 0.1000 -0.0015  
## 9 0.7905 nan 0.1000 -0.0012  
## 10 0.7865 nan 0.1000 -0.0005  
## 20 0.7511 nan 0.1000 -0.0001  
## 40 0.7054 nan 0.1000 0.0000  
## 50 0.6919 nan 0.1000 -0.0006  
##   
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## [1] "Training model: svmRadial"  
## [1] "Training model: knn"  
## [1] "Training model: pls"  
## [1] "Training model: nnet"  
## # weights: 35  
## initial value 424.713924   
## final value 268.793070   
## converged  
## # weights: 103  
## initial value 391.059829   
## final value 268.793070   
## converged  
## # weights: 171  
## initial value 300.731313   
## final value 268.793070   
## converged  
## # weights: 35  
## initial value 493.883158   
## iter 10 value 269.090027  
## iter 20 value 268.945541  
## final value 268.945470   
## converged  
## # weights: 103  
## initial value 653.766235   
## iter 10 value 268.947930  
## iter 20 value 268.945413  
## iter 30 value 268.900437  
## iter 40 value 268.894601  
## iter 50 value 268.893319  
## final value 268.869324   
## converged  
## # weights: 171  
## initial value 592.115806   
## iter 10 value 268.946997  
## final value 268.945471   
## converged  
## # weights: 35  
## initial value 499.276680   
## final value 268.794049   
## converged  
## # weights: 103  
## initial value 416.453357   
## final value 268.794662   
## converged  
## # weights: 171  
## initial value 387.198401   
## final value 268.796021   
## converged  
## # weights: 35  
## initial value 419.264316   
## final value 268.793070   
## converged  
## # weights: 103  
## initial value 370.566069   
## final value 268.793070   
## converged  
## # weights: 171  
## initial value 462.087403   
## final value 268.793070   
## converged  
## # weights: 35  
## initial value 477.966355   
## iter 10 value 269.094211  
## iter 20 value 268.945529  
## final value 268.945471   
## converged  
## # weights: 103  
## initial value 454.565097   
## iter 10 value 268.953112  
## iter 20 value 268.945555  
## final value 268.945466   
## converged  
## # weights: 171  
## initial value 755.878113   
## iter 10 value 268.884274  
## iter 20 value 268.869486  
## final value 268.869316   
## converged  
## # weights: 35  
## initial value 334.403988   
## final value 268.793726   
## converged  
## # weights: 103  
## initial value 752.217208   
## final value 268.794776   
## converged  
## # weights: 171  
## initial value 393.336317   
## final value 268.796168   
## converged  
## # weights: 35  
## initial value 574.273168   
## final value 270.533816   
## converged  
## # weights: 103  
## initial value 476.320556   
## final value 270.533816   
## converged  
## # weights: 171  
## initial value 1018.428737   
## final value 270.533816   
## converged  
## # weights: 35  
## initial value 622.529078   
## iter 10 value 270.696930  
## iter 20 value 270.684222  
## final value 270.684078   
## converged  
## # weights: 103  
## initial value 645.246514   
## iter 10 value 270.639999  
## iter 20 value 270.633603  
## iter 30 value 270.630027  
## iter 40 value 270.619690  
## iter 50 value 270.609790  
## iter 60 value 270.609042  
## iter 60 value 270.609040  
## iter 60 value 270.609039  
## final value 270.609039   
## converged  
## # weights: 171  
## initial value 333.404046   
## iter 10 value 270.639123  
## iter 20 value 269.974875  
## iter 30 value 264.967234  
## iter 40 value 264.147516  
## iter 50 value 263.520376  
## iter 60 value 262.199072  
## iter 70 value 262.187265  
## iter 80 value 262.175855  
## iter 90 value 262.173073  
## iter 100 value 262.171636  
## final value 262.171636   
## stopped after 100 iterations  
## # weights: 35  
## initial value 390.593232   
## final value 270.534549   
## converged  
## # weights: 103  
## initial value 346.202316   
## final value 270.535588   
## converged  
## # weights: 171  
## initial value 593.326359   
## final value 270.536494   
## converged  
## # weights: 35  
## initial value 471.877960   
## final value 268.793070   
## converged  
## # weights: 103  
## initial value 650.012650   
## final value 268.793070   
## converged  
## # weights: 171  
## initial value 352.902968   
## final value 268.793070   
## converged  
## # weights: 35  
## initial value 327.261899   
## iter 10 value 269.026143  
## final value 268.945474   
## converged  
## # weights: 103  
## initial value 406.831987   
## iter 10 value 268.945645  
## iter 20 value 268.944838  
## iter 30 value 268.894811  
## iter 30 value 268.894809  
## iter 30 value 268.894809  
## final value 268.894809   
## converged  
## # weights: 171  
## initial value 457.638600   
## iter 10 value 268.952344  
## iter 20 value 268.945546  
## final value 268.945468   
## converged  
## # weights: 35  
## initial value 505.467742   
## final value 268.793729   
## converged  
## # weights: 103  
## initial value 501.426070   
## final value 268.794910   
## converged  
## # weights: 171  
## initial value 636.800001   
## final value 268.795522   
## converged  
## # weights: 35  
## initial value 357.552626   
## final value 268.793070   
## converged  
## # weights: 103  
## initial value 475.433705   
## final value 268.793070   
## converged  
## # weights: 171  
## initial value 276.608589   
## final value 268.793070   
## converged  
## # weights: 35  
## initial value 383.809521   
## iter 10 value 269.004298  
## final value 268.945466   
## converged  
## # weights: 103  
## initial value 300.789813   
## iter 10 value 268.945472  
## iter 10 value 268.945470  
## iter 10 value 268.945468  
## final value 268.945468   
## converged  
## # weights: 171  
## initial value 379.094085   
## iter 10 value 268.880311  
## iter 20 value 268.869441  
## final value 268.869316   
## converged  
## # weights: 35  
## initial value 359.265071   
## final value 268.793998   
## converged  
## # weights: 103  
## initial value 392.618796   
## final value 268.794915   
## converged  
## # weights: 171  
## initial value 523.827504   
## iter 10 value 267.049755  
## final value 267.018147   
## converged  
## # weights: 35  
## initial value 531.310358   
## iter 10 value 336.731307  
## iter 20 value 336.589691  
## iter 30 value 336.580283  
## iter 40 value 336.579765  
## iter 40 value 336.579763  
## iter 40 value 336.579763  
## final value 336.579763   
## converged

# Stop parallel processing  
# stopCluster(cl)  
  
# Print test errors  
print(test\_errors)

## Model Accuracy Kappa  
## Accuracy glm 0.840 -0.019108280  
## Accuracy1 glmnet 0.845 -0.009771987  
## Accuracy2 rpart 0.850 0.000000000  
## Accuracy3 rf 0.865 0.158878505  
## Accuracy4 gbm 0.835 0.014925373  
## Accuracy5 xgbTree 0.850 0.122807018  
## Accuracy6 svmRadial 0.850 0.000000000  
## Accuracy7 knn 0.845 -0.009771987  
## Accuracy8 pls 0.850 0.000000000  
## Accuracy9 nnet 0.850 0.000000000

# Compare model performance (cross-validation results)  
comparison <- resamples(results)  
summary(comparison)

##   
## Call:  
## summary.resamples(object = comparison)  
##   
## Models: glm, glmnet, rpart, rf, gbm, xgbTree, svmRadial, knn, pls, nnet   
## Number of resamples: 5   
##   
## Accuracy   
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's  
## glm 0.84375 0.85000 0.8500 0.85000 0.85000 0.85625 0  
## glmnet 0.85000 0.85000 0.8500 0.85125 0.85000 0.85625 0  
## rpart 0.82500 0.84375 0.8500 0.84375 0.85000 0.85000 0  
## rf 0.84375 0.85625 0.8625 0.85875 0.86250 0.86875 0  
## gbm 0.83125 0.85000 0.8625 0.85625 0.86875 0.86875 0  
## xgbTree 0.83125 0.85625 0.8625 0.85625 0.86250 0.86875 0  
## svmRadial 0.85000 0.85000 0.8500 0.85125 0.85000 0.85625 0  
## knn 0.82500 0.83750 0.8375 0.84000 0.85000 0.85000 0  
## pls 0.85000 0.85000 0.8500 0.85125 0.85000 0.85625 0  
## nnet 0.85000 0.85000 0.8500 0.85125 0.85000 0.85625 0  
##   
## Kappa   
## Min. 1st Qu. Median Mean 3rd Qu.  
## glm -0.01214575 0.00000000 0.00000000 -0.002429150 0.00000000  
## glmnet 0.00000000 0.00000000 0.00000000 0.000000000 0.00000000  
## rpart -0.04477612 0.00000000 0.00000000 0.008524119 0.04214559  
## rf 0.09090909 0.14022518 0.17910448 0.180942715 0.20415225  
## gbm -0.03448276 0.05511811 0.14022518 0.107073461 0.17910448  
## xgbTree -0.03448276 0.07221929 0.11877395 0.114395719 0.17910448  
## svmRadial 0.00000000 0.00000000 0.00000000 0.000000000 0.00000000  
## knn -0.04477612 -0.03431129 -0.02362205 -0.020541891 0.00000000  
## pls 0.00000000 0.00000000 0.00000000 0.000000000 0.00000000  
## nnet 0.00000000 0.00000000 0.00000000 0.000000000 0.00000000  
## Max. NA's  
## glm 0.00000000 0  
## glmnet 0.00000000 0  
## rpart 0.04525112 0  
## rf 0.29032258 0  
## gbm 0.19540230 0  
## xgbTree 0.23636364 0  
## svmRadial 0.00000000 0  
## knn 0.00000000 0  
## pls 0.00000000 0  
## nnet 0.00000000 0

# Visualize model performance  
dotplot(comparison)

