Untitled

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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[1:5000,])  
for(i in 42:44){  
 FinalDf[,i] = ifelse(is.na(FinalDf[,i]) , 0 , FinalDf[,i])  
}  
  
FinalDf$TotalLoss = FinalDf$LifeLoss\_Value +  
 FinalDf$PassengerLoss\_Value +  
 FinalDf$FinanceLoss\_Value  
  
#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] 4000 35

head(train\_set)

## PolicyHolderCode Duration CarProductYear SideCover\_MR FinanceCover\_MR  
## 2463 322850.7 365 1383 470 10  
## 2511 323170.7 365 1363 470 10  
## 2227 211925.2 235 1385 470 10  
## 526 221096.4 365 1364 400 20  
## 4291 232034.2 365 1379 400 20  
## 2986 339338.5 365 1385 470 10  
## ThirdParty\_Pr MultipleBloodMoney\_Pr ExcessLife\_Pr ExcessFinance\_Pr  
## 2463 1267775 0 34114 14620  
## 2511 4748600 0 109774 47046  
## 2227 1327521 0 35854 15366  
## 526 378250 0 2165756 721919  
## 4291 234000 0 1314197 438066  
## 2986 1573650 0 44538 19088  
## DriverAccident\_Pr Pension\_Pr Basis\_Pr Health\_Complications  
## 2463 136000 0 1743013 145252  
## 2511 100000 4748600 6006506 500543  
## 2227 176000 0 1865693 155476  
## 526 93500 0 4031311 335943  
## 4291 792000 0 3333917 277827  
## 2986 152000 0 2147132 178928  
## Goverment\_Complications CentralInsurance\_Pension\_Pr ValueAdded\_Tax  
## 2463 0 0 0  
## 2511 0 4748600 0  
## 2227 0 0 0  
## 526 0 0 0  
## 4291 0 0 0  
## 2986 0 0 0  
## ValueAdded\_Complications Insurer\_Pension\_Pr Net\_Pr  
## 2463 0 0 1597761  
## 2511 0 0 10254563  
## 2227 0 0 1710217  
## 526 0 0 3695368  
## 4291 0 0 3056090  
## 2986 0 0 1968204  
## ID\_PolicyLuncher\_Departmant ID\_PolicyLuncher\_Province ID\_LunchDate  
## 2463 195 27 684  
## 2511 246 7 686  
## 2227 1163 8 585  
## 526 1114 8 260  
## 4291 644 15 393  
## 2986 85 4 769  
## ID\_AutomobileType ID\_AutomobileGroup ID\_AutomobuileUssage ID\_StartDate  
## 2463 969 3 67 813  
## 2511 4717 1 6 815  
## 2227 3823 2 19 693  
## 526 2981 2 19 303  
## 4291 5301 2 19 460  
## 2986 2084 3 67 915  
## ID\_EndDate ID\_RegisterUser ID\_Policy ID\_PolicyHolderType  
## 2463 817 538 14728 2  
## 2511 819 459 18950 2  
## 2227 571 2262 9730 1  
## 526 307 250 5915 1  
## 4291 464 443 8263 1  
## 2986 919 112 12567 2  
## ID\_AutomobileZipCodeType ID\_Passengers\_Claim ID\_Finance\_Claim  
## 2463 10 13 13  
## 2511 12 11 11  
## 2227 11 17 17  
## 526 12 13 13  
## 4291 7 9 9  
## 2986 10 23 23  
## ID\_Life\_Claim TotalLoss  
## 2463 13 0  
## 2511 11 0  
## 2227 17 0  
## 526 13 0  
## 4291 9 0  
## 2986 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: lm"  
## [1] "Training model: glmnet"  
## [1] "Training model: rpart"  
## [1] "Training model: rf"  
## [1] "Training model: gbm"  
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 170326470995053.4062 nan 0.1000 -82585945171.3092  
## 2 170191475342734.9375 nan 0.1000 -17301746087.3311  
## 3 169764016735974.2500 nan 0.1000 -343572126993.7203  
## 4 169648776094616.0312 nan 0.1000 -31962080073.6191  
## 5 169601604257530.0312 nan 0.1000 -54199469590.1823  
## 6 169571925679956.8750 nan 0.1000 -82730062270.1878  
## 7 169545532492922.8438 nan 0.1000 -106509341505.5722  
## 8 169251764840797.8750 nan 0.1000 -167360068684.7641  
## 9 169051768517991.5938 nan 0.1000 -125963595279.3292  
## 10 168984417880593.1250 nan 0.1000 -7815683481.8292  
## 20 168365667508891.7500 nan 0.1000 -304660298614.6779  
## 40 167724124291966.7500 nan 0.1000 25086051976.6345  
## 60 167496263025634.4688 nan 0.1000 -383312258141.3162  
## 80 167309292605046.8750 nan 0.1000 -222278764112.2214  
## 100 167266538646545.3750 nan 0.1000 -344570021317.4310  
## 120 167001329800498.6562 nan 0.1000 -220554098131.3493  
## 140 166743987629009.0625 nan 0.1000 -742129348502.9833  
## 150 166503134212531.0312 nan 0.1000 -32962744261.1600  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 170111815723181.4062 nan 0.1000 -97573987896.1299  
## 2 169597324728559.6250 nan 0.1000 -118853855704.3156  
## 3 169259419097211.9375 nan 0.1000 -73985256376.4626  
## 4 169028710024570.1875 nan 0.1000 -18187906306.9526  
## 5 168831051579692.6250 nan 0.1000 -19980641201.3174  
## 6 168509371206162.8125 nan 0.1000 -212646515003.6896  
## 7 167778723383735.7500 nan 0.1000 222372566448.6755  
## 8 167523370015830.2188 nan 0.1000 -93327760070.7114  
## 9 167395709905735.6250 nan 0.1000 -389697604944.8498  
## 10 167432452205164.5312 nan 0.1000 -256712621543.9903  
## 20 166501934525755.4688 nan 0.1000 -212005379496.1222  
## 40 165173723691277.3750 nan 0.1000 -150130443443.2675  
## 60 161788546776885.3125 nan 0.1000 -522954400940.3672  
## 80 161477344333054.5312 nan 0.1000 -464797394075.1166  
## 100 160367481523369.7500 nan 0.1000 -555069437779.7161  
## 120 159077580373845.1875 nan 0.1000 -463979684761.2294  
## 140 157502541885639.6562 nan 0.1000 -147520684452.0262  
## 150 157012364168591.8125 nan 0.1000 -306182126815.0229  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 169605954353447.6875 nan 0.1000 156026449498.1554  
## 2 169026227281356.5938 nan 0.1000 -203449221269.8962  
## 3 168473495579594.3125 nan 0.1000 -197410211597.3423  
## 4 167810044829927.5312 nan 0.1000 -138352296905.1042  
## 5 167410444389246.5000 nan 0.1000 -103759664522.6291  
## 6 167263198794615.9062 nan 0.1000 -408218067539.5877  
## 7 166571415711219.0938 nan 0.1000 -383589921189.9219  
## 8 165908160295654.8750 nan 0.1000 -83402729109.7409  
## 9 165662022477464.7500 nan 0.1000 -90441360308.5755  
## 10 165272622969942.8125 nan 0.1000 -397673029066.2810  
## 20 163003961492401.0625 nan 0.1000 -131104557758.7109  
## 40 160421448272168.9375 nan 0.1000 -252729921567.2248  
## 60 158616962557756.3438 nan 0.1000 -449988286231.2148  
## 80 156394804000626.9062 nan 0.1000 -431443022532.1169  
## 100 153080392954287.2188 nan 0.1000 -390996250757.0846  
## 120 150193560172152.1562 nan 0.1000 -1101538301851.2502  
## 140 148980529812422.0625 nan 0.1000 -434435296416.5415  
## 150 148721781316742.8125 nan 0.1000 -497974579514.3453  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 99681438819459.8594 nan 0.1000 -14260113743.6168  
## 2 99027872898560.6562 nan 0.1000 -90037563557.1528  
## 3 98995853343257.1250 nan 0.1000 24515241558.2338  
## 4 98590394894930.1250 nan 0.1000 -207890098798.4901  
## 5 98518442492234.4844 nan 0.1000 -24586748770.6921  
## 6 98214549200253.6250 nan 0.1000 -386126887107.7280  
## 7 98304335085754.5156 nan 0.1000 -329168965391.8069  
## 8 98129408727022.7188 nan 0.1000 -281257613469.4332  
## 9 98028723920431.6562 nan 0.1000 -274920681072.8276  
## 10 97978255606194.3125 nan 0.1000 -311671033246.5545  
## 20 97892974558316.2188 nan 0.1000 -559034669946.6735  
## 40 97194687515595.6250 nan 0.1000 -82461243581.8233  
## 60 97097367329135.3438 nan 0.1000 -381868620031.4281  
## 80 96936385156239.2031 nan 0.1000 -108183588244.1220  
## 100 96667582996252.5625 nan 0.1000 -207896404178.2507  
## 120 96723782414222.5000 nan 0.1000 -195442707727.9055  
## 140 96624543729290.0625 nan 0.1000 -234343291472.6087  
## 150 96603544899888.7812 nan 0.1000 -176311571666.1066  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 99121444175622.1562 nan 0.1000 -110223663664.0997  
## 2 98877575408093.7031 nan 0.1000 347731464.8492  
## 3 98654933758726.8750 nan 0.1000 -29201606949.7019  
## 4 98325512403967.4375 nan 0.1000 -90310516034.0029  
## 5 97958025878074.8750 nan 0.1000 -204273783851.2888  
## 6 97729841592868.5156 nan 0.1000 -158126212009.3655  
## 7 97611005306974.5000 nan 0.1000 -32129952745.5899  
## 8 97457241543026.3594 nan 0.1000 -317008811959.4335  
## 9 97467341432022.4844 nan 0.1000 -212495378904.5223  
## 10 97032284275940.6250 nan 0.1000 -72782427598.2457  
## 20 96495143637420.6562 nan 0.1000 -329558349664.0479  
## 40 94951877167091.9844 nan 0.1000 -446046578579.1956  
## 60 93626852590996.9375 nan 0.1000 -432327384914.8383  
## 80 91939948271485.0469 nan 0.1000 -114503403067.4225  
## 100 89836187023084.1875 nan 0.1000 -289197139382.9894  
## 120 88652292687312.2656 nan 0.1000 -164287263785.2893  
## 140 87840351789896.9062 nan 0.1000 -101728448473.0422  
## 150 87370396575528.5625 nan 0.1000 -285890620213.2029  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 98964208017698.9219 nan 0.1000 -121987170643.8073  
## 2 98685552332626.4062 nan 0.1000 -19360229037.0683  
## 3 98511032375377.9844 nan 0.1000 -53399646845.3067  
## 4 97984133297359.1875 nan 0.1000 -27963453393.5783  
## 5 97583774525222.4219 nan 0.1000 -69408360101.4914  
## 6 97212545962308.8125 nan 0.1000 -109908047073.9394  
## 7 96667950813517.9531 nan 0.1000 -322527312141.3248  
## 8 96634411481438.5000 nan 0.1000 -461505320831.6997  
## 9 96249385443559.7031 nan 0.1000 -381548859871.5574  
## 10 95959886262910.9375 nan 0.1000 -570769263972.3308  
## 20 94702237410663.1250 nan 0.1000 -565135322805.9954  
## 40 92308849027251.6875 nan 0.1000 -185636464928.0694  
## 60 88841247219861.0625 nan 0.1000 -309563368380.2038  
## 80 88364758726338.0156 nan 0.1000 -401886153167.3055  
## 100 87772672573225.0938 nan 0.1000 -392491660601.1493  
## 120 85036615392082.0312 nan 0.1000 -290205628213.4143  
## 140 84066241559849.9688 nan 0.1000 -362311608994.5007  
## 150 83795369809467.4688 nan 0.1000 -333519107052.9135  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 140894502368780.6875 nan 0.1000 -151199702194.8635  
## 2 140457916344570.1250 nan 0.1000 -179573653716.3905  
## 3 140127132991839.5156 nan 0.1000 -269639987662.0779  
## 4 139909450188362.2656 nan 0.1000 -63680514240.5581  
## 5 139703483228100.2344 nan 0.1000 -273269091189.3069  
## 6 139522756486020.3750 nan 0.1000 -81140614349.2958  
## 7 139401692207299.9531 nan 0.1000 -205866768656.5450  
## 8 139266439362434.6875 nan 0.1000 -374232562894.7444  
## 9 139340210992116.7188 nan 0.1000 -392118594929.1943  
## 10 139224076636716.2656 nan 0.1000 -405614047292.8019  
## 20 138578303496061.9219 nan 0.1000 -94908113221.3799  
## 40 138221666545081.3750 nan 0.1000 -271610445767.0448  
## 60 138239769942759.4531 nan 0.1000 -192070874551.2754  
## 80 137865724845288.5469 nan 0.1000 -332950940712.7749  
## 100 137840229017239.8438 nan 0.1000 -466495185858.5737  
## 120 137908951658162.4219 nan 0.1000 -171796525071.0403  
## 140 137634442892392.7344 nan 0.1000 -162213767082.5942  
## 150 137830488246266.5781 nan 0.1000 -268098735782.2635  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 140842274764642.2500 nan 0.1000 31949156123.9001  
## 2 140228809337803.2812 nan 0.1000 -97437584138.9961  
## 3 139673743310327.7969 nan 0.1000 -321550159961.1819  
## 4 139551136601241.4844 nan 0.1000 -80702278390.9395  
## 5 139361553224290.1562 nan 0.1000 -64782877091.8372  
## 6 139044331177283.6875 nan 0.1000 -371255045743.0924  
## 7 138854906493608.8750 nan 0.1000 -321391058066.9966  
## 8 138689609556196.7344 nan 0.1000 -243108415766.6234  
## 9 138695630612251.1875 nan 0.1000 -235863159874.9819  
## 10 138727055064262.4844 nan 0.1000 -306768717468.8057  
## 20 137985198779799.4531 nan 0.1000 -561740169028.6720  
## 40 135428397616674.3438 nan 0.1000 -264773426182.4498  
## 60 134957194417490.5469 nan 0.1000 -494696857546.2919  
## 80 134048372865277.5781 nan 0.1000 -273994608304.3657  
## 100 131130516755818.0938 nan 0.1000 -274190386045.7821  
## 120 129725491723608.3125 nan 0.1000 -281644448130.2366  
## 140 129096804662247.1562 nan 0.1000 -421075915670.0566  
## 150 128456037363090.0469 nan 0.1000 -297731773102.7714  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 140840431923385.1250 nan 0.1000 -172252712742.8741  
## 2 140059292301272.5469 nan 0.1000 -93833939436.2039  
## 3 139056814443040.2344 nan 0.1000 333197958473.6539  
## 4 138433159169658.7656 nan 0.1000 194187509767.9965  
## 5 137406872560960.0625 nan 0.1000 -384335470561.0346  
## 6 136550820310516.2031 nan 0.1000 -379926978154.4330  
## 7 136166097405671.9531 nan 0.1000 -297024372048.7150  
## 8 136355065968343.1875 nan 0.1000 -635341324767.8794  
## 9 136033949559456.3438 nan 0.1000 -390702289926.1116  
## 10 135321503964532.4531 nan 0.1000 -107016813481.2596  
## 20 133252456914024.5938 nan 0.1000 -523863091099.9670  
## 40 129960781797255.4375 nan 0.1000 -498016219018.7187  
## 60 126911154576523.1406 nan 0.1000 -775731529952.6542  
## 80 126152013383480.1875 nan 0.1000 -387897188337.3649  
## 100 124908340737070.7188 nan 0.1000 -610704709485.8910  
## 120 121912710622787.9062 nan 0.1000 -261922794644.0215  
## 140 120210818894967.3750 nan 0.1000 -487164720307.6934  
## 150 119608953749954.3750 nan 0.1000 -358337313440.8256  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 126505614390500.2969 nan 0.1000 27438077774.7866  
## 2 126395931309105.7656 nan 0.1000 36498507775.0346  
## 3 126213340280846.7188 nan 0.1000 -63237619274.0157  
## 4 126155270792078.5938 nan 0.1000 -10363739893.0942  
## 5 125990458156367.1250 nan 0.1000 -105502207758.5423  
## 6 125887704109948.7344 nan 0.1000 -8828044987.6146  
## 7 125790194324268.9062 nan 0.1000 -202099631954.9261  
## 8 125718107649383.4531 nan 0.1000 -102760445465.8417  
## 9 125690452465078.8594 nan 0.1000 -141855797039.4459  
## 10 125672184378406.3125 nan 0.1000 -63990257655.4599  
## 20 125280937947437.4844 nan 0.1000 -9541266304.8500  
## 40 124767796629679.7188 nan 0.1000 -65611039937.2159  
## 60 124276547830282.3438 nan 0.1000 -44802363618.8848  
## 80 123798099886369.7344 nan 0.1000 -97539851175.7876  
## 100 123449507320324.9531 nan 0.1000 -34521909197.3016  
## 120 123231545273969.0625 nan 0.1000 -76995143249.5338  
## 140 122930600712824.7812 nan 0.1000 -76215248190.4778  
## 150 122737800201161.7188 nan 0.1000 -34563935053.2645  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 126585436581247.6406 nan 0.1000 -9635878146.5685  
## 2 126213047901614.4531 nan 0.1000 192335280796.8502  
## 3 125581695600699.2031 nan 0.1000 -205257850904.1834  
## 4 125360690509212.9062 nan 0.1000 -74055416421.0702  
## 5 125204215460664.8594 nan 0.1000 16792212954.8863  
## 6 124945737925821.9062 nan 0.1000 -54515993700.0343  
## 7 124642335436321.0781 nan 0.1000 -36180502518.8348  
## 8 124328330095160.0156 nan 0.1000 -160250480100.4744  
## 9 124159952941247.0156 nan 0.1000 -4730293903.0739  
## 10 124017264705275.2969 nan 0.1000 23059141741.2912  
## 20 121354118053155.2344 nan 0.1000 -90483103363.6568  
## 40 118478909360423.2344 nan 0.1000 -146112867180.6078  
## 60 117045779381157.7344 nan 0.1000 -24507092666.3280  
## 80 114759769921249.3438 nan 0.1000 -155019037592.3049  
## 100 113939350255035.5625 nan 0.1000 -111791142170.4923  
## 120 112531077997868.0781 nan 0.1000 -159509830603.8029  
## 140 111047345196981.1875 nan 0.1000 -162942520530.9294  
## 150 109822823128806.7812 nan 0.1000 -315041299318.6161  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 126075346170179.8750 nan 0.1000 -148063842377.7157  
## 2 125589068217026.9062 nan 0.1000 116525887074.6167  
## 3 124734001305682.3125 nan 0.1000 288787951213.3113  
## 4 124153870571372.1562 nan 0.1000 -23321547122.1856  
## 5 123607154060663.6562 nan 0.1000 -338423377904.3828  
## 6 122930501338129.3750 nan 0.1000 -188278217920.7215  
## 7 122592140844276.0781 nan 0.1000 -212892347864.5114  
## 8 122536042718982.7812 nan 0.1000 -118322049472.7450  
## 9 122334203127789.0938 nan 0.1000 -198845911527.4352  
## 10 121764967614189.9844 nan 0.1000 -240725572799.9983  
## 20 117636819505474.0625 nan 0.1000 -249955903905.8693  
## 40 113567210028485.4844 nan 0.1000 -181337155354.8789  
## 60 110130882900492.7656 nan 0.1000 -70758803120.5681  
## 80 107077642184225.5781 nan 0.1000 -189580104326.8963  
## 100 104204893077626.4531 nan 0.1000 -217017821571.6082  
## 120 100882632222224.5156 nan 0.1000 -79178631399.2961  
## 140 98319153371328.8125 nan 0.1000 -97628667100.3237  
## 150 97009215253351.0625 nan 0.1000 -381562607005.9953  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 158693334754909.4375 nan 0.1000 -77977347678.5944  
## 2 158299266807705.7188 nan 0.1000 -181357119640.3267  
## 3 158016800789687.9688 nan 0.1000 -365875065698.7273  
## 4 157863656060139.9688 nan 0.1000 -164113443537.0878  
## 5 157728743033346.4062 nan 0.1000 31017331740.7048  
## 6 157582304894495.9688 nan 0.1000 -423182693598.6577  
## 7 157559577300525.7500 nan 0.1000 -423897730455.0946  
## 8 157398697847978.7500 nan 0.1000 78704577363.8242  
## 9 157209538483339.7812 nan 0.1000 109603332851.5896  
## 10 157168557349198.8438 nan 0.1000 -339641556124.2332  
## 20 156852545807571.8750 nan 0.1000 -589439480594.4248  
## 40 155912583608979.4062 nan 0.1000 -286459603380.9980  
## 60 155621723872143.9062 nan 0.1000 -362582604240.2615  
## 80 155140425899672.1875 nan 0.1000 -225781399964.1226  
## 100 155237203450287.7188 nan 0.1000 -393350177269.4453  
## 120 155052221986705.2500 nan 0.1000 -335434846149.9984  
## 140 155005195832157.0938 nan 0.1000 -93935535275.6979  
## 150 155014658021735.7812 nan 0.1000 -320747452232.2794  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 158618180414856.3750 nan 0.1000 -42295037618.9450  
## 2 158376625873029.5000 nan 0.1000 -78477479891.6236  
## 3 158074156849693.2500 nan 0.1000 -62716182996.3501  
## 4 157808356710147.5312 nan 0.1000 -75862564026.9738  
## 5 157392559084146.4375 nan 0.1000 -120029612865.0967  
## 6 157238431687442.5000 nan 0.1000 -16349346070.1659  
## 7 157124121962559.2812 nan 0.1000 -81253268965.8638  
## 8 157013219244833.0312 nan 0.1000 -10204014710.5507  
## 9 157083316635976.0938 nan 0.1000 -233909329515.2045  
## 10 156528389186118.3125 nan 0.1000 -70017988391.6331  
## 20 154520432847095.2812 nan 0.1000 -444031708679.6442  
## 40 151975609941375.8125 nan 0.1000 -371902303370.9175  
## 60 150925025145795.4062 nan 0.1000 -531728060096.0407  
## 80 150218070612417.3125 nan 0.1000 -480487041424.6510  
## 100 147999372108883.3750 nan 0.1000 -306990528302.4765  
## 120 147559522850194.1875 nan 0.1000 -467446202414.5502  
## 140 146915624030025.8750 nan 0.1000 -328726812333.0231  
## 150 146443649121468.9688 nan 0.1000 -400387613397.4006  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 158475151871804.2500 nan 0.1000 117648171812.1558  
## 2 157371408049542.4062 nan 0.1000 211425797851.0312  
## 3 156588983467857.4062 nan 0.1000 -436191038631.6754  
## 4 156014238570156.1562 nan 0.1000 -187558304589.4968  
## 5 155395702041002.3438 nan 0.1000 -151794533272.8021  
## 6 154922026909732.7500 nan 0.1000 -97573180803.7634  
## 7 154202236402956.6875 nan 0.1000 -176515633686.0695  
## 8 153633600390116.1875 nan 0.1000 -390181927868.5126  
## 9 153244310340649.9688 nan 0.1000 -636085930551.4875  
## 10 152881866806479.5000 nan 0.1000 -271194939993.2987  
## 20 151117990568590.6250 nan 0.1000 -447408721044.8655  
## 40 146566095376212.4062 nan 0.1000 -753716976694.5103  
## 60 144663084203331.4688 nan 0.1000 -250669110793.6440  
## 80 142700303564142.8125 nan 0.1000 -478340934191.0111  
## 100 141102130622212.1250 nan 0.1000 -291732078365.4090  
## 120 140141968869543.5938 nan 0.1000 -525373295668.7690  
## 140 137609663307535.3750 nan 0.1000 -309506879200.4733  
## 150 135737648355380.3125 nan 0.1000 -246549844116.9721  
##   
## Iter TrainDeviance ValidDeviance StepSize Improve  
## 1 139350819069016.4375 nan 0.1000 -27033309312.5137  
## 2 139182090862242.9531 nan 0.1000 70933570360.1904  
## 3 138959636120711.7188 nan 0.1000 -40122666120.0705  
## 4 138888784074766.7656 nan 0.1000 -42207344809.1933  
## 5 138786014075444.5312 nan 0.1000 -44442836175.4821  
## 6 138507472938871.8594 nan 0.1000 -196709721361.8694  
## 7 138407459526768.8125 nan 0.1000 -70908685492.0237  
## 8 138314634332625.1562 nan 0.1000 -92971029595.9464  
## 9 138252247971710.0312 nan 0.1000 -49349970220.6889  
## 10 138103371974334.7812 nan 0.1000 -170129658732.9766  
## 20 137861996549516.3750 nan 0.1000 -230126484559.9568  
## 40 137086044575843.8125 nan 0.1000 -278365192269.7064  
## 50 137098042174348.0469 nan 0.1000 -177273077198.4895  
##   
## [1] "Training model: xgbTree"  
## [12:42:14] WARNING: src/c\_api/c\_api.cc:935: `ntree\_limit` is deprecated, use `iteration\_range` instead.  
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## [12:42:15] WARNING: src/c\_api/c\_api.cc:935: `ntree\_limit` is deprecated, use `iteration\_range` instead.  
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## [12:42:16] WARNING: src/c\_api/c\_api.cc:935: `ntree\_limit` is deprecated, use `iteration\_range` instead.  
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## [12:42:17] WARNING: src/c\_api/c\_api.cc:935: `ntree\_limit` is deprecated, use `iteration\_range` instead.  
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## [1] "Training model: svmRadial"  
## [1] "Training model: knn"  
## [1] "Training model: pls"  
## [1] "Training model: nnet"  
## # weights: 35  
## initial value 550750638947547520.000000   
## final value 550750635059418688.000000   
## converged  
## # weights: 103  
## initial value 550750639262402496.000000   
## final value 550750635059418688.000000   
## converged  
## # weights: 171  
## initial value 550750640412326592.000000   
## final value 550750635059418688.000000   
## converged  
## # weights: 35  
## initial value 550750638405175808.000000   
## final value 550750635061647040.000000   
## converged  
## # weights: 103  
## initial value 550750637470827520.000000   
## final value 550750635062907072.000000   
## converged  
## # weights: 171  
## initial value 550750637796382528.000000   
## final value 550750635063350784.000000   
## converged  
## # weights: 35  
## initial value 550750638361639808.000000   
## final value 550750635059420928.000000   
## converged  
## # weights: 103  
## initial value 550750639021360576.000000   
## final value 550750635059427712.000000   
## converged  
## # weights: 171  
## initial value 550750639301170624.000000   
## final value 550750635059425280.000000   
## converged  
## # weights: 35  
## initial value 321626777411726080.000000   
## final value 321626774458541952.000000   
## converged  
## # weights: 103  
## initial value 321626777771287040.000000   
## final value 321626774458541952.000000   
## converged  
## # weights: 171  
## initial value 321626777142754112.000000   
## final value 321626774458541952.000000   
## converged  
## # weights: 35  
## initial value 321626777055122240.000000   
## final value 321626774490233664.000000   
## converged  
## # weights: 103  
## initial value 321626777197753088.000000   
## final value 321626774461101120.000000   
## converged  
## # weights: 171  
## initial value 321626775940420992.000000   
## final value 321626774461652160.000000   
## converged  
## # weights: 35  
## initial value 321626778094074624.000000   
## final value 321626774458544064.000000   
## converged  
## # weights: 103  
## initial value 321626775942636736.000000   
## final value 321626774458545088.000000   
## converged  
## # weights: 171  
## initial value 321626777594675392.000000   
## final value 321626774458546944.000000   
## converged  
## # weights: 35  
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## final value 456110189595167104.000000   
## converged  
## # weights: 103  
## initial value 456110192606240320.000000   
## final value 456110189595167104.000000   
## converged  
## # weights: 171  
## initial value 456110190621267520.000000   
## final value 456110189595167104.000000   
## converged  
## # weights: 35  
## initial value 456110191816892992.000000   
## final value 456110189597957632.000000   
## converged  
## # weights: 103  
## initial value 456110191721852864.000000   
## final value 456110189599175744.000000   
## converged  
## # weights: 171  
## initial value 456110193852414144.000000   
## final value 456110189599338304.000000   
## converged  
## # weights: 35  
## initial value 456110193250749760.000000   
## final value 456110189595170432.000000   
## converged  
## # weights: 103  
## initial value 456110193678617472.000000   
## final value 456110189595170048.000000   
## converged  
## # weights: 171  
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## converged  
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## converged  
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## initial value 408657489935520704.000000   
## final value 408657487915400448.000000   
## converged  
## # weights: 171  
## initial value 408657491765713728.000000   
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## converged  
## # weights: 35  
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## converged  
## # weights: 35  
## initial value 408657490633964480.000000   
## final value 408657487915403520.000000   
## converged  
## # weights: 103  
## initial value 408657490657418816.000000   
## final value 408657487915403520.000000   
## converged  
## # weights: 171  
## initial value 408657489989804352.000000   
## final value 408657487915400704.000000   
## converged  
## # weights: 35  
## initial value 513900018145592768.000000   
## final value 513900013765821696.000000   
## converged  
## # weights: 103  
## initial value 513900017103022400.000000   
## final value 513900013765821696.000000   
## converged  
## # weights: 171  
## initial value 513900020215728960.000000   
## final value 513900013765821696.000000   
## converged  
## # weights: 35  
## initial value 513900017877991680.000000   
## final value 513900013815956800.000000   
## converged  
## # weights: 103  
## initial value 513900018932509312.000000   
## final value 513900013767552448.000000   
## converged  
## # weights: 171  
## initial value 513900017943414144.000000   
## final value 513900013773748480.000000   
## converged  
## # weights: 35  
## initial value 513900018126699712.000000   
## final value 513900013765869248.000000   
## converged  
## # weights: 103  
## initial value 513900017786541568.000000   
## final value 513900013765872576.000000   
## converged  
## # weights: 171  
## initial value 513900016825923840.000000   
## final value 513900016556406528.000000   
## converged  
## # weights: 35  
## initial value 562761279489655680.000000   
## final value 562761275201346560.000000   
## converged

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

## Model RMSE R2 MAE  
## 1 lm 12111655 7.577542e-03 2023279.5  
## 2 glmnet 12137877 2.521926e-03 1785569.7  
## 3 rpart 12152021 NA 1757009.3  
## 4 rf 12061654 5.830457e-02 1879754.0  
## 5 gbm 12249276 2.604434e-07 1765579.4  
## 6 xgbTree 12218576 1.285422e-04 1746859.3  
## 7 svmRadial 12187839 4.333891e-05 938013.9  
## 8 knn 12408737 8.810738e-03 1769944.2  
## 9 pls 12150476 7.807852e-04 1715390.1  
## 10 nnet 12187839 NA 938014.6

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

##   
## Call:  
## summary.resamples(object = comparison)  
##   
## Models: lm, glmnet, rpart, rf, gbm, xgbTree, svmRadial, knn, pls, nnet   
## Number of resamples: 5   
##   
## MAE   
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's  
## lm 1568375.7 2162837.1 2169739 4715544 2590211 15086557 0  
## glmnet 1365110.1 1644394.8 1935678 1854065 1975912 2349233 0  
## rpart 1518990.7 1625912.6 1921791 1882401 1997360 2347953 0  
## rf 1303205.5 1462854.2 2016174 1809407 2043095 2221705 0  
## gbm 1352627.0 1579794.0 1899099 1818482 1944172 2316716 0  
## xgbTree 1364307.3 1596558.2 1921744 1825358 1943095 2301088 0  
## svmRadial 480723.0 666285.5 1094425 1027827 1253263 1644439 0  
## knn 1508202.9 1535514.5 1942630 1843154 1957312 2272113 0  
## pls 1369933.6 1612923.4 1861716 1815418 1955502 2277015 0  
## nnet 480723.7 666286.2 1094426 1027828 1253264 1644440 0  
##   
## RMSE   
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's  
## lm 4148072 11507756 13752363 83882967 17271966 372734680 0  
## glmnet 3952250 7781068 11479904 10856375 13789536 17279119 0  
## rpart 4986841 8199590 11780494 11256746 13825284 17491521 0  
## rf 4157920 7908697 11802249 10983874 13835221 17215283 0  
## gbm 4052263 7934943 11627370 10959468 13822758 17360004 0  
## xgbTree 4126292 7954852 11590768 10961085 13804232 17329281 0  
## svmRadial 3874700 7815151 11546162 10895304 13879112 17361398 0  
## knn 5795935 8614432 12168781 11606145 14067034 17384545 0  
## pls 3862945 7788283 11491276 10846212 13809346 17279208 0  
## nnet 3874700 7815150 11546162 10895304 13879111 17361398 0  
##   
## Rsquared   
## Min. 1st Qu. Median Mean 3rd Qu.  
## lm 6.607616e-06 5.057336e-04 2.918003e-03 3.605835e-03 3.594963e-03  
## glmnet 2.508781e-03 2.694687e-03 2.727698e-03 4.000223e-03 5.929349e-03  
## rpart 9.450530e-07 3.397528e-06 7.521711e-06 9.426751e-06 1.355093e-05  
## rf 1.840883e-03 3.161563e-03 7.357405e-03 6.327388e-03 9.107633e-03  
## gbm 3.094441e-06 7.134114e-06 1.201415e-05 9.692009e-04 1.834171e-03  
## xgbTree 1.187228e-06 6.853130e-06 7.523724e-06 6.751554e-04 1.291078e-04  
## svmRadial 3.860368e-05 1.701439e-04 3.302606e-04 7.991708e-04 4.603660e-04  
## knn 4.841008e-05 6.057363e-04 1.850352e-03 2.845919e-03 3.360440e-03  
## pls 1.109931e-03 2.378800e-03 3.429091e-03 6.329786e-03 4.122843e-03  
## nnet NA NA NA NaN NA  
## Max. NA's  
## lm 1.100387e-02 0  
## glmnet 6.140599e-03 0  
## rpart 2.171853e-05 1  
## rf 1.016946e-02 0  
## gbm 2.989591e-03 0  
## xgbTree 3.231105e-03 0  
## svmRadial 2.996480e-03 0  
## knn 8.364655e-03 0  
## pls 2.060826e-02 0  
## nnet NA 5

# Visualize model performance  
dotplot(comparison)

