project

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```
library(rJava, warn.conflicts = FALSE, quietly=TRUE)
library(xlsx, warn.conflicts = FALSE, quietly=TRUE)
library(stringr, warn.conflicts = FALSE, quietly=TRUE)
library(dplyr, warn.conflicts = FALSE, quietly=TRUE)
library(readr, warn.conflicts = FALSE, quietly=TRUE)
library(randomForestSRC, warn.conflicts = FALSE, quietly=TRUE)
```

```
##
##  randomForestSRC 2.5.1
##
##  Type rfsrc.news() to see new features, changes, and bug fixes.
##
```

```
library(ggplot2, warn.conflicts = FALSE, quietly=TRUE)
library(caret, warn.conflicts = FALSE, quietly=TRUE)
library(tidyr, warn.conflicts = FALSE, quietly=TRUE)
library(scales, warn.conflicts = FALSE, quietly=TRUE)
library(data.table, warn.conflicts = FALSE, quietly=TRUE)
library(effects, warn.conflicts = FALSE, quietly=TRUE )
```

```
## Use the command
##     lattice::trellis.par.set(effectsTheme())
##   to customize lattice options for effects plots.
## See ?efffectTheme for details.
```

```
#Functions


#The AccuracyCutoffInfo function is a modified version of codes from the following github page
#https://github.com/ethen8181/machine-learning/blob/master/unbalanced/unbalanced_code/unbalanced_functi
#All Credit to user ethen8181


# ------------------------------------------------------------------------------------
# [AccuracyCutoffInfo] :
# Obtain the accuracy on the trainining and testing dataset.
# for cutoff value ranging from .4 to .8 ( with a .05 increase )
# @train   : your data.table or data.frame type training data ( assumes you have the predicted score in
# @test    : your data.table or data.frame type testing data
# @predict : prediction's column name (assumes the same for training and testing set)
# @actual  : actual results' column name
# returns  : 1. data : a data.table with three columns.
#                      each row indicates the cutoff value and the accuracy for the
#                      train and test set respectively.
#            2. plot : plot that visualizes the data.table

AccuracyCutoffInfo <- function( train, test, predict, actual )
{
```

```
  # change the cutoff value's range as you please
  cutoff <- seq( .05, 1, by = .025 )

  accuracy <- lapply( cutoff, function(c)
  {
    train_prediction <- as.factor(as.numeric( train[[predict]] > c ))
    test_prediction <- as.factor(as.numeric( test[[predict]] > c ))

    levels(train_prediction) <- c(levels(train[[actual]][1]),levels(train[[actual]])[2])
    levels(test_prediction) <- c(levels(test[[actual]][1]),levels(test[[actual]])[2])


    # use the confusionMatrix from the caret package
    cm_train <- confusionMatrix( train_prediction, train[[actual]] )
    cm_test  <- confusionMatrix( test_prediction, test[[actual]] )

    dt <- data.table( cutoff = c,
                      train  = cm_train$overall[["Accuracy"]],
                      test   = cm_test$overall[["Accuracy"]] )
    return(dt)
  }) %>% rbindlist()

  # visualize the accuracy of the train and test set for different cutoff value
  # accuracy in percentage.
  accuracy_long <- gather( accuracy, "data", "accuracy", -1 )

  plot <- ggplot( accuracy_long, aes( cutoff, accuracy, group = data, color = data ) ) +
    geom_line( size = 1 ) + geom_point( size = 3 ) +
    scale_y_continuous( label = percent ) +
    ggtitle( "Train/Test Accuracy for Different Cutoff" ) +
    scale_x_continuous(breaks=seq(0, 1, 0.1)) +
    theme_bw()

  return( list( data = accuracy, plot = plot ) )
}


#----------------------

#delete_dup

#Some varaibles are forced into the model regardless of variable section result
#If the forced variable ended up being selected, this model will removed the duplicated variable.

delete_dup <- function(subset, data){
  remove <- c()
  for(i in 1:length(subset)){
    result <- str_detect(subset[i],names(data))
    for(j in 1:length(result)){
      if(result[j]){
        remove <- c(remove,i)
      }
    }
```

```
  }
  if(is.null(remove))
    return(subset)
  subset <- subset[-c(remove)]
  return(subset)
}


#data = data file
#Predition: predicted result
#response: The name of response variable
#cut_off: probabilty cut off point

Classify <- function(data, prediction,response, cut_off ){
  for(i in 1:length(prediction)){
    if(prediction[i] < cut_off){
      prediction[i] <- levels(data[[response]])[1]
    } else{
      prediction[i] <- levels(data[[response]])[2]
    }
  }

  prediction <- as.factor(prediction)
  levels(prediction) <- c(levels(data[[response]])[1],levels(data[[response]])[2])
  confuseion_matrix <- table(data[[response]],prediction)
  print(confuseion_matrix)
  Accuracy <- (confuseion_matrix[1,1] + confuseion_matrix[2,2])/sum(confuseion_matrix)
  return(print(paste("The accuracy is", round(Accuracy*100,3),"%")))
}



#K fold K = 10

#data = data using for prediction
#response = name of the response variable
#cut off = probability cut off point
#interaction = you can type addition interaction term in text
#Example
#cv.error(CNP_logi_subset,"Subject_Type","+Age*Auditory.global_eff", 0.8)


cv.error <- function(data, response, interaction = "", cut_off = 0.5){

  #generate random seeds
  r <- runif(1,0,9999)
  set.seed(r)
  folds <- createFolds(data[[response]],k = 10)
  Accuracy <- rep(NA,10)

  for(i in 1:10){

    #training and testing
```

```
    train <- data[-folds[[i]],]
    test <- data[folds[[i]],]

    levels(test[[response]]) <- c(levels(data[[response]])[1],levels(data[[response]])[2])

    logi_cv <-glm(paste(response,"~.",interaction), data = train, family = "binomial")

    prediction <- predict(logi_cv, test, type = "response")
    for(j in 1:length(prediction)){
      if(prediction[j] < cut_off){
        prediction[j] <- levels(test[[response]])[1]
      } else{
        prediction[j] <- levels(test[[response]])[2]
      }
    }
    prediction <- as.factor(prediction)
    levels(prediction) <- c(levels(data[[response]])[1],levels(data[[response]])[2])

    confuseion_matrix <- table(test[[response]],prediction)
    Accuracy[i] <- (confuseion_matrix[1,1] + confuseion_matrix[2,2])/sum(confuseion_matrix)
  }
  return(Accuracy)
}
```

```
#Load data

setwd("A:/Winter 2018/Stats 141SL/project/")

#load CNP data

CNP_between <- read.table("CNP_between_nets.txt", header =  TRUE)
CNP_within <- read.table("CNP_within_nets.txt", header = TRUE)
CNPDemographic <- read.xlsx("CNPDemographicMeasures.xlsx", sheetName = "SNF")


#load COBRE data


COBRE_between <- read.table("COBRE_between_nets.txt", header = TRUE)

COBRE_within <- read.table("COBRE_within_nets.txt", header = TRUE)

COBREDemographic <- read.xlsx("COBRE INDI Additional data.xls", sheetName = "NP")

COBRE_phenotypic <- read_csv("COBRE_phenotypic_data.csv")
```

```
## Parsed with column specification:
## cols(
##   X1 = col_integer(),
##   `Current Age` = col_character(),
##   Gender = col_character(),
##   Handedness = col_character(),
##   `Subject Type` = col_character(),
##   Diagnosis = col_character()
```

```
## )
#Data cleaning process

#Removed character string

pattern <- "[a-z]*-"

CNP_within$Subject_ID <- as.numeric(str_replace_all(CNP_within$Subject_ID
, pattern,""))

CNP_between$Subject_ID <- as.numeric(str_replace_all(CNP_between$Subject_ID
, pattern,""))




#Merge data
CNP_within_merge <- left_join(CNP_within,CNPDemographic, by = c("Subject_ID" = "PTID"))

#summary(CNP_within_merge)

CNP_between_merge <- left_join(CNP_between,CNPDemographic, by = c("Subject_ID" = "PTID"))

#summary(CNP_between_merge)




#Revmove character string

COBRE_between$Subject_ID <- as.numeric(str_replace_all(COBRE_between$Subject_ID
, pattern,""))

COBRE_within$Subject_ID <- as.numeric(str_replace_all(COBRE_within$Subject_ID
, pattern,""))




#remove 00

pattern <- "^00"

COBREDemographic$ID <- as.numeric(str_replace_all(COBREDemographic$ID, pattern,""))


#Merge data

COBRE_within_merge <- left_join(COBRE_within,COBREDemographic, by = c("Subject_ID" = "ID"))


#summary(COBRE_within_merge)
```

```
COBRE_between_merge <- left_join(COBRE_between,COBREDemographic, by = c("Subject_ID" = "ID"))

#summary(COBRE_between_merge)

COBRE_phenotypic$Gender <- as.factor(COBRE_phenotypic$Gender)

COBRE_phenotypic <- COBRE_phenotypic %>%
  filter(!(COBRE_phenotypic$Gender == "Disenrolled"))
```

```
## Warning: package 'bindrcpp' was built under R version 3.4.2
```

```
COBRE_phenotypic$Gender <- droplevels(COBRE_phenotypic$Gender)

colnames(COBRE_phenotypic)[1:2] <- c("Subject_ID", "Age")

COBRE_between_merge <- merge(COBRE_between_merge,COBRE_phenotypic, all = TRUE)
COBRE_within_merge <- merge(COBRE_within_merge,COBRE_phenotypic, all = TRUE)


table(COBRE_between_merge$Diagnosis)
```

```
##
##                 290.3                 295.1                 295.2
##                     1                     3                     1
##                 295.3                 295.6                 295.7
##                    41                    12                     5
##   295.70 bipolar type 295.70 depressed type                 295.9
##                     1                     1                     5
##                295.92                296.26                 296.4
##                     1                     1                     1
##                   311                  None
##                     1                    72
```

```
table(COBRE_within_merge$Diagnosis)
```

```
##
##                 290.3                 295.1                 295.2
##                     1                     3                     1
##                 295.3                 295.6                 295.7
##                    41                    12                     5
##   295.70 bipolar type 295.70 depressed type                 295.9
##                     1                     1                     5
##                295.92                296.26                 296.4
##                     1                     1                     1
##                   311                  None
##                     1                    72
```

```
#CNP filter


CNP_within_merge <- CNP_within_merge %>%
  filter(Subject_Type == "Control" | Subject_Type == "Schizophrenia")

table(CNP_within_merge$Subject_Type)
```

```
##
```

```
##          ADHD       Bipolar       Control Schizophrenia
##             0             0           115            42
```

```
CNP_between_merge <- CNP_between_merge %>%
  filter(Subject_Type == "Control" | Subject_Type == "Schizophrenia")

table(CNP_between_merge$Subject_Type)
```

```
##
##          ADHD       Bipolar       Control Schizophrenia
##             0             0           115            42
```

```
#COBRE filter

COBRE_between_merge <- COBRE_between_merge %>%
  filter(!(Diagnosis == 290.3 | Diagnosis == 296.26 | Diagnosis == 296.4 | Diagnosis == 311))

COBRE_within_merge <- COBRE_within_merge %>%
  filter(!(Diagnosis == 290.3 | Diagnosis == 296.26 | Diagnosis == 296.4 | Diagnosis == 311))

table(COBRE_between_merge$Diagnosis)
```

```
##
##                 295.1                 295.2                 295.3
##                     3                     1                    41
##                 295.6                 295.7   295.70 bipolar type
##                    12                     5                     1
## 295.70 depressed type                 295.9                295.92
##                     1                     5                     1
##                  None
##                    72
```

```
table(COBRE_within_merge$Diagnosis)
```

```
##
##                 295.1                 295.2                 295.3
##                     3                     1                    41
##                 295.6                 295.7   295.70 bipolar type
##                    12                     5                     1
## 295.70 depressed type                 295.9                295.92
##                     1                     5                     1
##                  None
##                    72
```

```
#Recoding Patients to Schizophrenia in COBRE

pattern <- "Patient"

COBRE_between_merge$Subject_Type <- str_replace_all(COBRE_between_merge$Subject_Type,  pattern,"Schizopl
COBRE_within_merge$Subject_Type <- str_replace_all(COBRE_within_merge$Subject_Type,  pattern,"Schizophr

table(COBRE_between_merge$Subject_Type)
```

```
##
##       Control Schizophrenia
##            72            70
```

```r
table(COBRE_within_merge$Subject_Type)
```

```
##
##       Control Schizophrenia
##            72            70
```

```r
CNP_between_merge$Subject_Type <- droplevels(CNP_between_merge$Subject_Type)
levels(CNP_between_merge$Subject_Type)
```

```
## [1] "Control"       "Schizophrenia"
```

```r
CNP_within_merge$Subject_Type <- droplevels(CNP_within_merge$Subject_Type)
levels(CNP_within_merge$Subject_Type)
```

```
## [1] "Control"       "Schizophrenia"
```

```r
#CNP between
#remove 96:98, 112
CNP_between_merge <- CNP_between_merge %>%
  select(-c(96:98,112))



#CNP within get rid of
#75 #76 #91
CNP_within_merge <- CNP_within_merge %>%
  select(-c(75:77,91))


#Merge both data into CNP

CNP <- merge(CNP_between_merge,CNP_within_merge, all = TRUE)



#Use only the fMRI, MRI, and Age, keep global EFF

CNP_between_RF_subset <- CNP_between_merge %>%
  select(c(1:94))

CNP_within_RF_subset <- CNP_within_merge %>%
  select(c(1:72))

CNP_RF_subset <- CNP %>%
  select(-c(1,5:41))
```

```r
#CNP data modeling

set.seed(4321)


rfsrc_m3 <- rfsrc(as.factor(Subject_Type)~.,data = CNP_RF_subset, na.action = c("na.omit"), ntree= 1000)

max_var <- max.subtree(rfsrc_m3, conservative = TRUE)
max_var$topvars
```

```
## [1] "Ventral_Attention.Uncertain"
## [2] "Cingulo.opercular_Task_Control.mod"
```

```
#delete duplicate entity


#Logistic Regression Model

subset <- as.vector(max_var$topvars)

subset <- delete_dup(subset,CNP_RF_subset[,c(1,137:150)])

CNP_logi_subset <- CNP_RF_subset[,c("Subject_Type",names(CNP_RF_subset[,c(1,137:150)]), subset)]



#Using a previously grown forest, identify pairwise interactions for all pairs of variables from a spec

#method="maxsubtree"

#This invokes a maximal subtree analysis. In this case, a matrix is returned where entries [i][i] are t

#method="vimp"

#This invokes a joint-VIMP approach. Two variables are paired and their paired VIMP calculated (refered



#Find interaction
find.interaction(rfsrc_m3, xvar.names = names(CNP_logi_subset[,-c(1)]), sorted = FALSE)
```

```
##
##                                Method: maxsubtree
##                     No. of variables: 17
##   Variables sorted by minimal depth?: FALSE
##
##                                          Age Ventral_Attention.Uncertain
## Age                                     0.92                         1.00
## Ventral_Attention.Uncertain             0.99                         0.86
## Cingulo.opercular_Task_Control.mod      0.99                         0.99
## Auditory.global_eff                     1.00                         1.00
## Cerebellar.global_eff                   1.00                         1.00
## Cingulo.opercular_Task_Control.global_eff 1.00                       0.99
## Default_mode.global_eff                 1.00                         1.00
## Dorsal_attention.global_eff             1.00                         1.00
## Fronto.parietal_Task_Control.global_eff 0.99                         1.00
## Memory_retrieval.global_eff             1.00                         1.00
## Salience.global_eff                     1.00                         1.00
## Sensory.somatomotor_Hand.global_eff     1.00                         0.99
## Sensory.somatomotor_Mouth.global_eff    1.00                         1.00
## Subcortical.global_eff                  0.99                         0.99
## Uncertain.global_eff                    1.00                         1.00
## Ventral_attention.global_eff            1.00                         1.00
## Visual.global_eff                       1.00                         1.00
##                                         Cingulo.opercular_Task_Control.mod
```

```
## Age                                                                    1.00
## Ventral_Attention.Uncertain                                            0.99
## Cingulo.opercular_Task_Control.mod                                     0.85
## Auditory.global_eff                                                    1.00
## Cerebellar.global_eff                                                  1.00
## Cingulo.opercular_Task_Control.global_eff                              1.00
## Default_mode.global_eff                                                1.00
## Dorsal_attention.global_eff                                            1.00
## Fronto.parietal_Task_Control.global_eff                                1.00
## Memory_retrieval.global_eff                                            1.00
## Salience.global_eff                                                    1.00
## Sensory.somatomotor_Hand.global_eff                                    0.99
## Sensory.somatomotor_Mouth.global_eff                                   1.00
## Subcortical.global_eff                                                 0.99
## Uncertain.global_eff                                                   1.00
## Ventral_attention.global_eff                                           1.00
## Visual.global_eff                                                      1.00
##                                          Auditory.global_eff
## Age                                                     1.00
## Ventral_Attention.Uncertain                             1.00
## Cingulo.opercular_Task_Control.mod                      0.99
## Auditory.global_eff                                     0.96
## Cerebellar.global_eff                                   1.00
## Cingulo.opercular_Task_Control.global_eff               1.00
## Default_mode.global_eff                                 1.00
## Dorsal_attention.global_eff                             1.00
## Fronto.parietal_Task_Control.global_eff                 1.00
## Memory_retrieval.global_eff                             1.00
## Salience.global_eff                                     1.00
## Sensory.somatomotor_Hand.global_eff                     1.00
## Sensory.somatomotor_Mouth.global_eff                    1.00
## Subcortical.global_eff                                  1.00
## Uncertain.global_eff                                    1.00
## Ventral_attention.global_eff                            1.00
## Visual.global_eff                                       1.00
##                                          Cerebellar.global_eff
## Age                                                       1.00
## Ventral_Attention.Uncertain                               1.00
## Cingulo.opercular_Task_Control.mod                        1.00
## Auditory.global_eff                                       1.00
## Cerebellar.global_eff                                     0.94
## Cingulo.opercular_Task_Control.global_eff                 1.00
## Default_mode.global_eff                                   1.00
## Dorsal_attention.global_eff                               1.00
## Fronto.parietal_Task_Control.global_eff                   1.00
## Memory_retrieval.global_eff                               1.00
## Salience.global_eff                                       1.00
## Sensory.somatomotor_Hand.global_eff                       1.00
## Sensory.somatomotor_Mouth.global_eff                      1.00
## Subcortical.global_eff                                    1.00
## Uncertain.global_eff                                      1.00
## Ventral_attention.global_eff                              1.00
## Visual.global_eff                                         1.00
##                                          Cingulo.opercular_Task_Control.global_eff
```

```
## Age                                                                    1.00
## Ventral_Attention.Uncertain                                            1.00
## Cingulo.opercular_Task_Control.mod                                     0.99
## Auditory.global_eff                                                    1.00
## Cerebellar.global_eff                                                  1.00
## Cingulo.opercular_Task_Control.global_eff                              0.92
## Default_mode.global_eff                                                1.00
## Dorsal_attention.global_eff                                            1.00
## Fronto.parietal_Task_Control.global_eff                                1.00
## Memory_retrieval.global_eff                                            1.00
## Salience.global_eff                                                    1.00
## Sensory.somatomotor_Hand.global_eff                                    1.00
## Sensory.somatomotor_Mouth.global_eff                                   1.00
## Subcortical.global_eff                                                 1.00
## Uncertain.global_eff                                                   1.00
## Ventral_attention.global_eff                                           1.00
## Visual.global_eff                                                      1.00
##                                        Default_mode.global_eff
## Age                                                       1.00
## Ventral_Attention.Uncertain                               0.99
## Cingulo.opercular_Task_Control.mod                        1.00
## Auditory.global_eff                                       1.00
## Cerebellar.global_eff                                     1.00
## Cingulo.opercular_Task_Control.global_eff                 1.00
## Default_mode.global_eff                                   0.93
## Dorsal_attention.global_eff                               1.00
## Fronto.parietal_Task_Control.global_eff                   1.00
## Memory_retrieval.global_eff                               1.00
## Salience.global_eff                                       1.00
## Sensory.somatomotor_Hand.global_eff                       1.00
## Sensory.somatomotor_Mouth.global_eff                      1.00
## Subcortical.global_eff                                    0.99
## Uncertain.global_eff                                      1.00
## Ventral_attention.global_eff                              1.00
## Visual.global_eff                                         1.00
##                                        Dorsal_attention.global_eff
## Age                                                           1.00
## Ventral_Attention.Uncertain                                   1.00
## Cingulo.opercular_Task_Control.mod                            1.00
## Auditory.global_eff                                           1.00
## Cerebellar.global_eff                                         1.00
## Cingulo.opercular_Task_Control.global_eff                     1.00
## Default_mode.global_eff                                       1.00
## Dorsal_attention.global_eff                                   0.96
## Fronto.parietal_Task_Control.global_eff                       1.00
## Memory_retrieval.global_eff                                   1.00
## Salience.global_eff                                           1.00
## Sensory.somatomotor_Hand.global_eff                           1.00
## Sensory.somatomotor_Mouth.global_eff                          1.00
## Subcortical.global_eff                                        1.00
## Uncertain.global_eff                                          1.00
## Ventral_attention.global_eff                                  1.00
## Visual.global_eff                                             1.00
##                                        Fronto.parietal_Task_Control.global_eff
```

```
## Age                                                                  1.00
## Ventral_Attention.Uncertain                                          0.99
## Cingulo.opercular_Task_Control.mod                                   0.99
## Auditory.global_eff                                                  1.00
## Cerebellar.global_eff                                                1.00
## Cingulo.opercular_Task_Control.global_eff                            1.00
## Default_mode.global_eff                                              1.00
## Dorsal_attention.global_eff                                          1.00
## Fronto.parietal_Task_Control.global_eff                              0.92
## Memory_retrieval.global_eff                                          1.00
## Salience.global_eff                                                  1.00
## Sensory.somatomotor_Hand.global_eff                                  1.00
## Sensory.somatomotor_Mouth.global_eff                                 1.00
## Subcortical.global_eff                                               1.00
## Uncertain.global_eff                                                 1.00
## Ventral_attention.global_eff                                         1.00
## Visual.global_eff                                                    1.00
##                                          Memory_retrieval.global_eff
## Age                                                             1.00
## Ventral_Attention.Uncertain                                     1.00
## Cingulo.opercular_Task_Control.mod                              0.99
## Auditory.global_eff                                             1.00
## Cerebellar.global_eff                                           1.00
## Cingulo.opercular_Task_Control.global_eff                       1.00
## Default_mode.global_eff                                         1.00
## Dorsal_attention.global_eff                                     1.00
## Fronto.parietal_Task_Control.global_eff                         1.00
## Memory_retrieval.global_eff                                     0.96
## Salience.global_eff                                             1.00
## Sensory.somatomotor_Hand.global_eff                             1.00
## Sensory.somatomotor_Mouth.global_eff                            1.00
## Subcortical.global_eff                                          1.00
## Uncertain.global_eff                                            1.00
## Ventral_attention.global_eff                                    1.00
## Visual.global_eff                                               1.00
##                                          Salience.global_eff
## Age                                                     1.00
## Ventral_Attention.Uncertain                             1.00
## Cingulo.opercular_Task_Control.mod                      1.00
## Auditory.global_eff                                     1.00
## Cerebellar.global_eff                                   1.00
## Cingulo.opercular_Task_Control.global_eff               1.00
## Default_mode.global_eff                                 1.00
## Dorsal_attention.global_eff                             1.00
## Fronto.parietal_Task_Control.global_eff                 1.00
## Memory_retrieval.global_eff                             1.00
## Salience.global_eff                                     0.95
## Sensory.somatomotor_Hand.global_eff                     1.00
## Sensory.somatomotor_Mouth.global_eff                    1.00
## Subcortical.global_eff                                  1.00
## Uncertain.global_eff                                    1.00
## Ventral_attention.global_eff                            1.00
## Visual.global_eff                                       1.00
##                                          Sensory.somatomotor_Hand.global_eff
```

```
## Age                                                                  1.00
## Ventral_Attention.Uncertain                                          1.00
## Cingulo.opercular_Task_Control.mod                                   0.99
## Auditory.global_eff                                                  1.00
## Cerebellar.global_eff                                                1.00
## Cingulo.opercular_Task_Control.global_eff                            1.00
## Default_mode.global_eff                                              1.00
## Dorsal_attention.global_eff                                          1.00
## Fronto.parietal_Task_Control.global_eff                              1.00
## Memory_retrieval.global_eff                                          1.00
## Salience.global_eff                                                  1.00
## Sensory.somatomotor_Hand.global_eff                                  0.93
## Sensory.somatomotor_Mouth.global_eff                                 1.00
## Subcortical.global_eff                                               1.00
## Uncertain.global_eff                                                 1.00
## Ventral_attention.global_eff                                         1.00
## Visual.global_eff                                                    1.00
##                                        Sensory.somatomotor_Mouth.global_eff
## Age                                                                   1.00
## Ventral_Attention.Uncertain                                           1.00
## Cingulo.opercular_Task_Control.mod                                    0.99
## Auditory.global_eff                                                   1.00
## Cerebellar.global_eff                                                 1.00
## Cingulo.opercular_Task_Control.global_eff                             1.00
## Default_mode.global_eff                                               1.00
## Dorsal_attention.global_eff                                           1.00
## Fronto.parietal_Task_Control.global_eff                               1.00
## Memory_retrieval.global_eff                                           1.00
## Salience.global_eff                                                   1.00
## Sensory.somatomotor_Hand.global_eff                                   1.00
## Sensory.somatomotor_Mouth.global_eff                                  0.95
## Subcortical.global_eff                                                1.00
## Uncertain.global_eff                                                  1.00
## Ventral_attention.global_eff                                          1.00
## Visual.global_eff                                                     1.00
##                                        Subcortical.global_eff
## Age                                                      1.00
## Ventral_Attention.Uncertain                              0.99
## Cingulo.opercular_Task_Control.mod                       0.99
## Auditory.global_eff                                      1.00
## Cerebellar.global_eff                                    1.00
## Cingulo.opercular_Task_Control.global_eff                1.00
## Default_mode.global_eff                                  1.00
## Dorsal_attention.global_eff                              1.00
## Fronto.parietal_Task_Control.global_eff                  1.00
## Memory_retrieval.global_eff                              1.00
## Salience.global_eff                                      1.00
## Sensory.somatomotor_Hand.global_eff                      1.00
## Sensory.somatomotor_Mouth.global_eff                     1.00
## Subcortical.global_eff                                   0.88
## Uncertain.global_eff                                     1.00
## Ventral_attention.global_eff                             1.00
## Visual.global_eff                                        1.00
##                                        Uncertain.global_eff
```

```
## Age                                                    1.00
## Ventral_Attention.Uncertain                            1.00
## Cingulo.opercular_Task_Control.mod                     1.00
## Auditory.global_eff                                    1.00
## Cerebellar.global_eff                                  1.00
## Cingulo.opercular_Task_Control.global_eff              1.00
## Default_mode.global_eff                                1.00
## Dorsal_attention.global_eff                            1.00
## Fronto.parietal_Task_Control.global_eff                1.00
## Memory_retrieval.global_eff                            1.00
## Salience.global_eff                                    1.00
## Sensory.somatomotor_Hand.global_eff                    1.00
## Sensory.somatomotor_Mouth.global_eff                   1.00
## Subcortical.global_eff                                 1.00
## Uncertain.global_eff                                   0.96
## Ventral_attention.global_eff                           1.00
## Visual.global_eff                                      1.00
##                                          Ventral_attention.global_eff
## Age                                                              1.00
## Ventral_Attention.Uncertain                                      0.99
## Cingulo.opercular_Task_Control.mod                               0.99
## Auditory.global_eff                                              1.00
## Cerebellar.global_eff                                            1.00
## Cingulo.opercular_Task_Control.global_eff                        0.99
## Default_mode.global_eff                                          1.00
## Dorsal_attention.global_eff                                      1.00
## Fronto.parietal_Task_Control.global_eff                          1.00
## Memory_retrieval.global_eff                                      1.00
## Salience.global_eff                                              1.00
## Sensory.somatomotor_Hand.global_eff                              1.00
## Sensory.somatomotor_Mouth.global_eff                             1.00
## Subcortical.global_eff                                           0.99
## Uncertain.global_eff                                             1.00
## Ventral_attention.global_eff                                     0.92
## Visual.global_eff                                                1.00
##                                          Visual.global_eff
## Age                                                   1.00
## Ventral_Attention.Uncertain                           1.00
## Cingulo.opercular_Task_Control.mod                    0.99
## Auditory.global_eff                                   1.00
## Cerebellar.global_eff                                 1.00
## Cingulo.opercular_Task_Control.global_eff             1.00
## Default_mode.global_eff                               1.00
## Dorsal_attention.global_eff                           1.00
## Fronto.parietal_Task_Control.global_eff               1.00
## Memory_retrieval.global_eff                           1.00
## Salience.global_eff                                   1.00
## Sensory.somatomotor_Hand.global_eff                   1.00
## Sensory.somatomotor_Mouth.global_eff                  1.00
## Subcortical.global_eff                                1.00
## Uncertain.global_eff                                  1.00
## Ventral_attention.global_eff                          1.00
## Visual.global_eff                                     0.94
```

```r
#No interactioin fund base on the result, we don't have to add interaction term

CNP_logi_subset <- na.omit(CNP_logi_subset)



#Correlation check
high_cor <- findCorrelation(cor(CNP_logi_subset[,-c(1:2)]),cutoff = 0.75) + 2

#No potential multicollinearity problem

index <- sample(1:nrow(CNP_logi_subset), size = round(nrow(CNP_logi_subset)*0.7,0),replace = FALSE)

CNP_train <- CNP_logi_subset[index,]
CNP_test <- CNP_logi_subset[-index,]
logi_m3 <-glm(Subject_Type~. , data = CNP_train, family = "binomial")
summary(logi_m3)
```

```
##
## Call:
## glm(formula = Subject_Type ~ ., family = "binomial", data = CNP_train)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.6210  -0.6679  -0.3474   0.5809   3.0634
##
## Coefficients:
##                                          Estimate Std. Error z value
## (Intercept)                             -36.66274   10.60635  -3.457
## Age                                       0.09210    0.03765   2.446
## Auditory.global_eff                      -1.45152    5.54563  -0.262
## Cerebellar.global_eff                     1.39886    2.49731   0.560
## Cingulo.opercular_Task_Control.global_eff  0.53428    5.27827   0.101
## Default_mode.global_eff                  22.41674   10.99170   2.039
## Dorsal_attention.global_eff               7.27495    5.27996   1.378
## Fronto.parietal_Task_Control.global_eff   9.23053   10.06470   0.917
## Memory_retrieval.global_eff              -0.22921    2.60121  -0.088
## Salience.global_eff                       6.63720    6.23598   1.064
## Sensory.somatomotor_Hand.global_eff       5.92777    9.74529   0.608
## Sensory.somatomotor_Mouth.global_eff     -3.71479    3.49948  -1.062
## Subcortical.global_eff                   11.50150    7.35348   1.564
## Uncertain.global_eff                     17.73280    7.80626   2.272
## Ventral_attention.global_eff             -3.26263    5.04575  -0.647
## Visual.global_eff                        10.05025    7.72529   1.301
## Ventral_Attention.Uncertain             -23.06196    6.85356  -3.365
## Cingulo.opercular_Task_Control.mod       12.30151    4.55364   2.701
##                                          Pr(>|z|)
## (Intercept)                              0.000547 ***
## Age                                      0.014436 *
## Auditory.global_eff                      0.793522
## Cerebellar.global_eff                    0.575381
## Cingulo.opercular_Task_Control.global_eff 0.919375
## Default_mode.global_eff                  0.041408 *
## Dorsal_attention.global_eff              0.168252
```

```
## Fronto.parietal_Task_Control.global_eff   0.359080
## Memory_retrieval.global_eff               0.929783
## Salience.global_eff                       0.287175
## Sensory.somatomotor_Hand.global_eff       0.543008
## Sensory.somatomotor_Mouth.global_eff      0.288451
## Subcortical.global_eff                    0.117797
## Uncertain.global_eff                      0.023110 *
## Ventral_attention.global_eff              0.517884
## Visual.global_eff                         0.193274
## Ventral_Attention.Uncertain               0.000766 ***
## Cingulo.opercular_Task_Control.mod        0.006903 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 130.826  on 109  degrees of freedom
## Residual deviance:  91.494  on  92  degrees of freedom
## AIC: 127.49
##
## Number of Fisher Scoring iterations: 6
```

```
round(exp(coef(logi_m3)),3)
```

```
##                                (Intercept)
##                                  0.000000e+00
##                                           Age
##                                  1.096000e+00
##                          Auditory.global_eff
##                                  2.340000e-01
##                        Cerebellar.global_eff
##                                  4.051000e+00
## Cingulo.opercular_Task_Control.global_eff
##                                  1.706000e+00
##                      Default_mode.global_eff
##                                  5.438364e+09
##                 Dorsal_attention.global_eff
##                                  1.443676e+03
##   Fronto.parietal_Task_Control.global_eff
##                                  1.020399e+04
##                 Memory_retrieval.global_eff
##                                  7.950000e-01
##                           Salience.global_eff
##                                  7.629580e+02
##       Sensory.somatomotor_Hand.global_eff
##                                  3.753160e+02
##      Sensory.somatomotor_Mouth.global_eff
##                                  2.400000e-02
##                       Subcortical.global_eff
##                                  9.886398e+04
##                         Uncertain.global_eff
##                                  5.026382e+07
##                Ventral_attention.global_eff
##                                  3.800000e-02
##                            Visual.global_eff
```

```
##                              2.316169e+04
##               Ventral_Attention.Uncertain
##                              0.000000e+00
##        Cingulo.opercular_Task_Control.mod
##                              2.200287e+05
```

```
anova(logi_m3, test = "Chisq")
```

```
## Analysis of Deviance Table
##
## Model: binomial, link: logit
##
## Response: Subject_Type
##
## Terms added sequentially (first to last)
##
##
##                                          Df Deviance Resid. Df Resid. Dev
## NULL                                                        109    130.826
## Age                                       1   3.5821       108    127.244
## Auditory.global_eff                       1   0.3403       107    126.903
## Cerebellar.global_eff                     1   0.2195       106    126.684
## Cingulo.opercular_Task_Control.global_eff 1   0.0091       105    126.675
## Default_mode.global_eff                   1   0.0117       104    126.663
## Dorsal_attention.global_eff               1   0.2303       103    126.433
## Fronto.parietal_Task_Control.global_eff   1   0.6998       102    125.733
## Memory_retrieval.global_eff               1   0.0689       101    125.664
## Salience.global_eff                       1   0.0166       100    125.647
## Sensory.somatomotor_Hand.global_eff       1   1.5916        99    124.056
## Sensory.somatomotor_Mouth.global_eff      1   6.0241        98    118.032
## Subcortical.global_eff                    1   0.0072        97    118.025
## Uncertain.global_eff                      1   1.8716        96    116.153
## Ventral_attention.global_eff              1   1.1439        95    115.009
## Visual.global_eff                         1   0.1207        94    114.888
## Ventral_Attention.Uncertain               1  13.8856        93    101.003
## Cingulo.opercular_Task_Control.mod        1   9.5089        92     91.494
##                                           Pr(>Chi)
## NULL
## Age                                       0.0584057 .
## Auditory.global_eff                       0.5596684
## Cerebellar.global_eff                     0.6394285
## Cingulo.opercular_Task_Control.global_eff 0.9240192
## Default_mode.global_eff                   0.9137170
## Dorsal_attention.global_eff               0.6313287
## Fronto.parietal_Task_Control.global_eff   0.4028610
## Memory_retrieval.global_eff               0.7929193
## Salience.global_eff                       0.8975062
## Sensory.somatomotor_Hand.global_eff       0.2071033
## Sensory.somatomotor_Mouth.global_eff      0.0141116 *
## Subcortical.global_eff                    0.9321680
## Uncertain.global_eff                      0.1712969
## Ventral_attention.global_eff              0.2848198
## Visual.global_eff                         0.7282840
## Ventral_Attention.Uncertain               0.0001943 ***
## Cingulo.opercular_Task_Control.mod        0.0020447 **
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

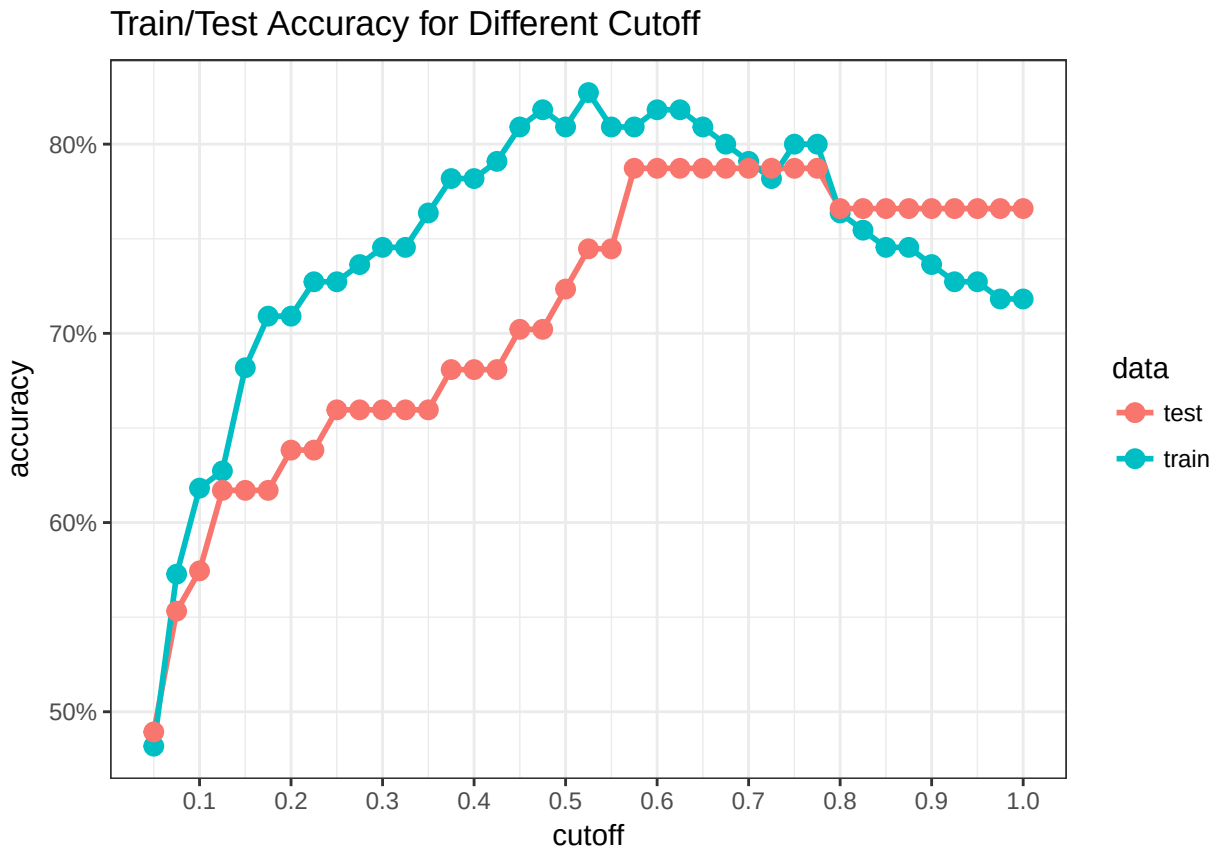
```
#R-squared

R_squared <- 1 - (summary(logi_m3)[[4]]/summary(logi_m3)[[8]])
R_squared
```

```
## [1] 0.3006434
```

```
#70/30 CV check

#Train
CNP_train$prediction <- predict(logi_m3, CNP_train, type = "response")


#Test
CNP_test$prediction <- predict(logi_m3, CNP_test, type = "response")

prop.table(table(CNP$Subject_Type))
```

```
##
##       Control Schizophrenia
##     0.7324841     0.2675159
```

```
accuracy_info <- AccuracyCutoffInfo( train = CNP_train, test = CNP_test,
                                     predict = "prediction", actual = "Subject_Type" )

accuracy_info$plot
```




```
Classify(CNP_train, CNP_train$prediction,"Subject_Type", 0.75 )
```

```
##                prediction
##                 Control Schizophrenia
##   Control            79             0
##   Schizophrenia      22             9
## [1] "The accuracy is 80 %"
```

```
Classify(CNP_test, CNP_test$prediction,"Subject_Type", 0.75 )
```

```
##                prediction
##                 Control Schizophrenia
##   Control            36             0
##   Schizophrenia      10             1
## [1] "The accuracy is 78.723 %"
```

```
#CNP model k fold CV check
set.seed(4321)

Accuracy.k <- cv.error(CNP_logi_subset, "Subject_Type",cut_off = 0.75)
Accuracy.k
```

```
##  [1] 0.6470588 0.6875000 0.7333333 0.8125000 0.7500000 0.8125000 0.7333333
##  [8] 0.6666667 0.8000000 0.6875000
```

```
mean(Accuracy.k)
```

```
## [1] 0.7330392
```

```r
#COBRE data modeling

set.seed(4321)

COBRE <- merge(COBRE_between_merge, COBRE_within_merge, all = TRUE)


COBRE_RF_subset<- COBRE %>%
  select(-c(1,5:111))

COBRE_RF_subset$Subject_Type <- as.factor(COBRE_RF_subset$Subject_Type)

#Random Forest variable section
rfsrc_m4 <- rfsrc(Subject_Type~.,data = COBRE_RF_subset, na.action = c("na.omit"), ntree= 1000)


max_var <- max.subtree(rfsrc_m4, conservative = TRUE)
max_var$topvars
```

```
## [1] "Visual.Subcortical"
```

```r
#delete duplicate entity


subset <- as.vector(max_var$topvars)

subset <- delete_dup(subset,COBRE_RF_subset[,c(1,137:150)])


#Logistic Regression model


COBRE_logi_subset <- COBRE_RF_subset[,c("Subject_Type",names(COBRE_RF_subset[,c(1,137:150)]), subset)]


#Find interaction
find.interaction(rfsrc_m4, xvar.names = names(COBRE_logi_subset[,-c(1)]), sorted = FALSE)
```

```
##
##                              Method: maxsubtree
##                      No. of variables: 16
##    Variables sorted by minimal depth?: FALSE
##
##                                             Age Visual.Subcortical
## Age                                        0.95               1.00
## Visual.Subcortical                         1.00               0.83
## Auditory.global_eff                        1.00               1.00
## Cerebellar.global_eff                      1.00               1.00
## Cingulo.opercular_Task_Control.global_eff  1.00               0.99
## Default_mode.global_eff                    1.00               0.99
## Dorsal_attention.global_eff                1.00               1.00
## Fronto.parietal_Task_Control.global_eff    1.00               1.00
## Memory_retrieval.global_eff                1.00               1.00
## Salience.global_eff                        1.00               1.00
## Sensory.somatomotor_Hand.global_eff        1.00               1.00
```

```
## Sensory.somatomotor_Mouth.global_eff      1.00                0.99
## Subcortical.global_eff                    1.00                1.00
## Uncertain.global_eff                      1.00                1.00
## Ventral_attention.global_eff              1.00                1.00
## Visual.global_eff                         0.99                1.00
##                                          Auditory.global_eff
## Age                                                     1.00
## Visual.Subcortical                                      1.00
## Auditory.global_eff                                     0.95
## Cerebellar.global_eff                                   1.00
## Cingulo.opercular_Task_Control.global_eff               0.99
## Default_mode.global_eff                                 1.00
## Dorsal_attention.global_eff                             1.00
## Fronto.parietal_Task_Control.global_eff                 1.00
## Memory_retrieval.global_eff                             1.00
## Salience.global_eff                                     1.00
## Sensory.somatomotor_Hand.global_eff                     1.00
## Sensory.somatomotor_Mouth.global_eff                    1.00
## Subcortical.global_eff                                  1.00
## Uncertain.global_eff                                    1.00
## Ventral_attention.global_eff                            1.00
## Visual.global_eff                                       1.00
##                                          Cerebellar.global_eff
## Age                                                       1.00
## Visual.Subcortical                                        1.00
## Auditory.global_eff                                       1.00
## Cerebellar.global_eff                                     0.93
## Cingulo.opercular_Task_Control.global_eff                 1.00
## Default_mode.global_eff                                   1.00
## Dorsal_attention.global_eff                               1.00
## Fronto.parietal_Task_Control.global_eff                   1.00
## Memory_retrieval.global_eff                               1.00
## Salience.global_eff                                       1.00
## Sensory.somatomotor_Hand.global_eff                       1.00
## Sensory.somatomotor_Mouth.global_eff                      1.00
## Subcortical.global_eff                                    1.00
## Uncertain.global_eff                                      1.00
## Ventral_attention.global_eff                              1.00
## Visual.global_eff                                         1.00
##                                          Cingulo.opercular_Task_Control.global_eff
## Age                                                                           1.00
## Visual.Subcortical                                                            0.99
## Auditory.global_eff                                                           1.00
## Cerebellar.global_eff                                                         1.00
## Cingulo.opercular_Task_Control.global_eff                                     0.88
## Default_mode.global_eff                                                       1.00
## Dorsal_attention.global_eff                                                   1.00
## Fronto.parietal_Task_Control.global_eff                                       1.00
## Memory_retrieval.global_eff                                                   1.00
## Salience.global_eff                                                           1.00
## Sensory.somatomotor_Hand.global_eff                                           1.00
## Sensory.somatomotor_Mouth.global_eff                                          1.00
## Subcortical.global_eff                                                        1.00
## Uncertain.global_eff                                                          1.00
```

```
## Ventral_attention.global_eff                                                  1.00
## Visual.global_eff                                                             1.00
##                                          Default_mode.global_eff
## Age                                                         1.00
## Visual.Subcortical                                          0.99
## Auditory.global_eff                                         1.00
## Cerebellar.global_eff                                       1.00
## Cingulo.opercular_Task_Control.global_eff                   1.00
## Default_mode.global_eff                                     0.93
## Dorsal_attention.global_eff                                 1.00
## Fronto.parietal_Task_Control.global_eff                     1.00
## Memory_retrieval.global_eff                                 1.00
## Salience.global_eff                                         1.00
## Sensory.somatomotor_Hand.global_eff                         1.00
## Sensory.somatomotor_Mouth.global_eff                        1.00
## Subcortical.global_eff                                      1.00
## Uncertain.global_eff                                        1.00
## Ventral_attention.global_eff                                1.00
## Visual.global_eff                                           1.00
##                                          Dorsal_attention.global_eff
## Age                                                             1.00
## Visual.Subcortical                                              0.99
## Auditory.global_eff                                             1.00
## Cerebellar.global_eff                                           1.00
## Cingulo.opercular_Task_Control.global_eff                       1.00
## Default_mode.global_eff                                         1.00
## Dorsal_attention.global_eff                                     0.93
## Fronto.parietal_Task_Control.global_eff                         1.00
## Memory_retrieval.global_eff                                     1.00
## Salience.global_eff                                             1.00
## Sensory.somatomotor_Hand.global_eff                             1.00
## Sensory.somatomotor_Mouth.global_eff                            1.00
## Subcortical.global_eff                                          1.00
## Uncertain.global_eff                                            1.00
## Ventral_attention.global_eff                                    1.00
## Visual.global_eff                                               1.00
##                                          Fronto.parietal_Task_Control.global_eff
## Age                                                                        1.00
## Visual.Subcortical                                                         0.99
## Auditory.global_eff                                                        1.00
## Cerebellar.global_eff                                                      1.00
## Cingulo.opercular_Task_Control.global_eff                                  0.99
## Default_mode.global_eff                                                    1.00
## Dorsal_attention.global_eff                                                1.00
## Fronto.parietal_Task_Control.global_eff                                    0.94
## Memory_retrieval.global_eff                                                1.00
## Salience.global_eff                                                        1.00
## Sensory.somatomotor_Hand.global_eff                                        1.00
## Sensory.somatomotor_Mouth.global_eff                                       1.00
## Subcortical.global_eff                                                     1.00
## Uncertain.global_eff                                                       1.00
## Ventral_attention.global_eff                                               1.00
## Visual.global_eff                                                          1.00
##                                          Memory_retrieval.global_eff
```

```
## Age                                                    1.00
## Visual.Subcortical                                     1.00
## Auditory.global_eff                                    1.00
## Cerebellar.global_eff                                  1.00
## Cingulo.opercular_Task_Control.global_eff              1.00
## Default_mode.global_eff                                1.00
## Dorsal_attention.global_eff                            1.00
## Fronto.parietal_Task_Control.global_eff                1.00
## Memory_retrieval.global_eff                            0.93
## Salience.global_eff                                    1.00
## Sensory.somatomotor_Hand.global_eff                    1.00
## Sensory.somatomotor_Mouth.global_eff                   1.00
## Subcortical.global_eff                                 1.00
## Uncertain.global_eff                                   1.00
## Ventral_attention.global_eff                           1.00
## Visual.global_eff                                      1.00
##                                          Salience.global_eff
## Age                                                     1.00
## Visual.Subcortical                                      1.00
## Auditory.global_eff                                     1.00
## Cerebellar.global_eff                                   1.00
## Cingulo.opercular_Task_Control.global_eff               0.99
## Default_mode.global_eff                                 1.00
## Dorsal_attention.global_eff                             1.00
## Fronto.parietal_Task_Control.global_eff                 1.00
## Memory_retrieval.global_eff                             1.00
## Salience.global_eff                                     0.95
## Sensory.somatomotor_Hand.global_eff                     1.00
## Sensory.somatomotor_Mouth.global_eff                    1.00
## Subcortical.global_eff                                  1.00
## Uncertain.global_eff                                    1.00
## Ventral_attention.global_eff                            1.00
## Visual.global_eff                                       1.00
##                                          Sensory.somatomotor_Hand.global_eff
## Age                                                                     1.00
## Visual.Subcortical                                                      1.00
## Auditory.global_eff                                                     1.00
## Cerebellar.global_eff                                                   1.00
## Cingulo.opercular_Task_Control.global_eff                               1.00
## Default_mode.global_eff                                                 1.00
## Dorsal_attention.global_eff                                             1.00
## Fronto.parietal_Task_Control.global_eff                                 1.00
## Memory_retrieval.global_eff                                             1.00
## Salience.global_eff                                                     1.00
## Sensory.somatomotor_Hand.global_eff                                     0.95
## Sensory.somatomotor_Mouth.global_eff                                    1.00
## Subcortical.global_eff                                                  1.00
## Uncertain.global_eff                                                    1.00
## Ventral_attention.global_eff                                            1.00
## Visual.global_eff                                                       1.00
##                                          Sensory.somatomotor_Mouth.global_eff
## Age                                                                      1.00
## Visual.Subcortical                                                       1.00
## Auditory.global_eff                                                      1.00
```

```
## Cerebellar.global_eff                                                1.00
## Cingulo.opercular_Task_Control.global_eff                            1.00
## Default_mode.global_eff                                              1.00
## Dorsal_attention.global_eff                                          1.00
## Fronto.parietal_Task_Control.global_eff                              1.00
## Memory_retrieval.global_eff                                          1.00
## Salience.global_eff                                                  1.00
## Sensory.somatomotor_Hand.global_eff                                  1.00
## Sensory.somatomotor_Mouth.global_eff                                 0.94
## Subcortical.global_eff                                               1.00
## Uncertain.global_eff                                                 1.00
## Ventral_attention.global_eff                                         1.00
## Visual.global_eff                                                    1.00
##                                          Subcortical.global_eff
## Age                                                        1.00
## Visual.Subcortical                                         1.00
## Auditory.global_eff                                        1.00
## Cerebellar.global_eff                                      1.00
## Cingulo.opercular_Task_Control.global_eff                  1.00
## Default_mode.global_eff                                    1.00
## Dorsal_attention.global_eff                                1.00
## Fronto.parietal_Task_Control.global_eff                    1.00
## Memory_retrieval.global_eff                                1.00
## Salience.global_eff                                        1.00
## Sensory.somatomotor_Hand.global_eff                        1.00
## Sensory.somatomotor_Mouth.global_eff                       1.00
## Subcortical.global_eff                                     0.95
## Uncertain.global_eff                                       1.00
## Ventral_attention.global_eff                               1.00
## Visual.global_eff                                          1.00
##                                          Uncertain.global_eff
## Age                                                      1.00
## Visual.Subcortical                                       0.99
## Auditory.global_eff                                      1.00
## Cerebellar.global_eff                                    1.00
## Cingulo.opercular_Task_Control.global_eff                1.00
## Default_mode.global_eff                                  1.00
## Dorsal_attention.global_eff                              1.00
## Fronto.parietal_Task_Control.global_eff                  1.00
## Memory_retrieval.global_eff                              1.00
## Salience.global_eff                                      1.00
## Sensory.somatomotor_Hand.global_eff                      1.00
## Sensory.somatomotor_Mouth.global_eff                     1.00
## Subcortical.global_eff                                   1.00
## Uncertain.global_eff                                     0.94
## Ventral_attention.global_eff                             1.00
## Visual.global_eff                                        1.00
##                                          Ventral_attention.global_eff
## Age                                                              1.00
## Visual.Subcortical                                               0.99
## Auditory.global_eff                                              1.00
## Cerebellar.global_eff                                            1.00
## Cingulo.opercular_Task_Control.global_eff                        1.00
## Default_mode.global_eff                                          1.00
```

```
## Dorsal_attention.global_eff                                    1.00
## Fronto.parietal_Task_Control.global_eff                        1.00
## Memory_retrieval.global_eff                                    1.00
## Salience.global_eff                                            1.00
## Sensory.somatomotor_Hand.global_eff                            1.00
## Sensory.somatomotor_Mouth.global_eff                           1.00
## Subcortical.global_eff                                         1.00
## Uncertain.global_eff                                           1.00
## Ventral_attention.global_eff                                   0.95
## Visual.global_eff                                              1.00
##                                              Visual.global_eff
## Age                                                       1.00
## Visual.Subcortical                                        0.99
## Auditory.global_eff                                       1.00
## Cerebellar.global_eff                                     1.00
## Cingulo.opercular_Task_Control.global_eff                 1.00
## Default_mode.global_eff                                   1.00
## Dorsal_attention.global_eff                               1.00
## Fronto.parietal_Task_Control.global_eff                   1.00
## Memory_retrieval.global_eff                               1.00
## Salience.global_eff                                       1.00
## Sensory.somatomotor_Hand.global_eff                       1.00
## Sensory.somatomotor_Mouth.global_eff                      1.00
## Subcortical.global_eff                                    1.00
## Uncertain.global_eff                                      1.00
## Ventral_attention.global_eff                              1.00
## Visual.global_eff                                         0.92
```

```r
#No interactioin fund base on the result, we don't have to add interaction term


COBRE_logi_subset <- na.omit(COBRE_logi_subset)

#Correlation check
high_cor <- findCorrelation(cor(COBRE_logi_subset[,-c(1:2)]),cutoff = 0.75) + 2

#No potential multicollinearity problem


index <- sample(1:nrow(COBRE_logi_subset), size = round(nrow(COBRE_logi_subset)*0.7,0),replace = FALSE)

COBRE_train <- COBRE_logi_subset[index,]
COBRE_test <- COBRE_logi_subset[-index,]
logi_m4 <-glm(Subject_Type~. , data = COBRE_train, family = "binomial")
summary(logi_m4)
```

```
##
## Call:
## glm(formula = Subject_Type ~ ., family = "binomial", data = COBRE_train)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.7740  -0.8927  -0.3029   0.8723   2.7946
##
## Coefficients:
```

```
##                                          Estimate Std. Error z value
## (Intercept)                              22.00979    6.63389   3.318
## Age                                      -0.03721    0.02465  -1.510
## Auditory.global_eff                       4.62094    4.73165   0.977
## Cerebellar.global_eff                    -0.25428    2.32363  -0.109
## Cingulo.opercular_Task_Control.global_eff -11.01674    5.74838  -1.916
## Default_mode.global_eff                  -10.74635    9.40644  -1.142
## Dorsal_attention.global_eff               -2.41883    4.12905  -0.586
## Fronto.parietal_Task_Control.global_eff   -15.44024    7.44928  -2.073
## Memory_retrieval.global_eff               -1.19137    2.45656  -0.485
## Salience.global_eff                       -3.92087    6.01820  -0.652
## Sensory.somatomotor_Hand.global_eff        2.16895    7.32905   0.296
## Sensory.somatomotor_Mouth.global_eff      -2.74723    2.87929  -0.954
## Subcortical.global_eff                    -4.86988    5.14154  -0.947
## Uncertain.global_eff                       8.19151    6.57237   1.246
## Ventral_attention.global_eff               6.36820    4.54279   1.402
## Visual.global_eff                        -15.41617    8.05331  -1.914
## Visual.Subcortical                         8.69811    2.75434   3.158
##                                          Pr(>|z|)
## (Intercept)                              0.000907 ***
## Age                                      0.131141
## Auditory.global_eff                      0.328766
## Cerebellar.global_eff                    0.912860
## Cingulo.opercular_Task_Control.global_eff 0.055302 .
## Default_mode.global_eff                  0.253269
## Dorsal_attention.global_eff              0.558005
## Fronto.parietal_Task_Control.global_eff  0.038199 *
## Memory_retrieval.global_eff              0.627693
## Salience.global_eff                      0.514722
## Sensory.somatomotor_Hand.global_eff      0.767277
## Sensory.somatomotor_Mouth.global_eff     0.340015
## Subcortical.global_eff                   0.343556
## Uncertain.global_eff                     0.212634
## Ventral_attention.global_eff             0.160967
## Visual.global_eff                        0.055586 .
## Visual.Subcortical                       0.001589 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 136.42  on 98  degrees of freedom
## Residual deviance: 105.62  on 82  degrees of freedom
## AIC: 139.62
##
## Number of Fisher Scoring iterations: 5
```

```
round(exp(coef(logi_m4)),3)
```

```
##                              (Intercept)
##                             3.620181e+09
##                                      Age
##                             9.630000e-01
##                       Auditory.global_eff
##                             1.015900e+02
```

```
##                     Cerebellar.global_eff
##                                7.750000e-01
## Cingulo.opercular_Task_Control.global_eff
##                                0.000000e+00
##                   Default_mode.global_eff
##                                0.000000e+00
##               Dorsal_attention.global_eff
##                                8.900000e-02
##   Fronto.parietal_Task_Control.global_eff
##                                0.000000e+00
##               Memory_retrieval.global_eff
##                                3.040000e-01
##                       Salience.global_eff
##                                2.000000e-02
##       Sensory.somatomotor_Hand.global_eff
##                                8.749000e+00
##      Sensory.somatomotor_Mouth.global_eff
##                                6.400000e-02
##                     Subcortical.global_eff
##                                8.000000e-03
##                       Uncertain.global_eff
##                                3.610165e+03
##              Ventral_attention.global_eff
##                                5.830070e+02
##                          Visual.global_eff
##                                0.000000e+00
##                         Visual.Subcortical
##                                5.991594e+03
```

```
anova(logi_m4, test = "Chisq")
```

```
## Analysis of Deviance Table
##
## Model: binomial, link: logit
##
## Response: Subject_Type
##
## Terms added sequentially (first to last)
##
##
##                                          Df Deviance Resid. Df Resid. Dev
## NULL                                                        98     136.42
## Age                                       1   0.0417        97     136.38
## Auditory.global_eff                       1   0.3108        96     136.07
## Cerebellar.global_eff                     1   1.8761        95     134.19
## Cingulo.opercular_Task_Control.global_eff 1   3.9597        94     130.24
## Default_mode.global_eff                   1   1.2625        93     128.97
## Dorsal_attention.global_eff               1   0.4660        92     128.51
## Fronto.parietal_Task_Control.global_eff   1   1.0467        91     127.46
## Memory_retrieval.global_eff               1   0.4759        90     126.98
## Salience.global_eff                       1   0.0280        89     126.96
## Sensory.somatomotor_Hand.global_eff       1   0.0038        88     126.95
## Sensory.somatomotor_Mouth.global_eff      1   1.9567        87     125.00
## Subcortical.global_eff                    1   0.0634        86     124.93
## Uncertain.global_eff                      1   1.4932        85     123.44
```

```
## Ventral_attention.global_eff                1   2.6970        84     120.74
## Visual.global_eff                           1   2.0923        83     118.65
## Visual.Subcortical                          1  13.0328        82     105.62
##                                            Pr(>Chi)
## NULL
## Age                                       0.8382831
## Auditory.global_eff                       0.5771834
## Cerebellar.global_eff                     0.1707794
## Cingulo.opercular_Task_Control.global_eff 0.0466033 *
## Default_mode.global_eff                   0.2611782
## Dorsal_attention.global_eff               0.4948425
## Fronto.parietal_Task_Control.global_eff   0.3062618
## Memory_retrieval.global_eff               0.4902644
## Salience.global_eff                       0.8671524
## Sensory.somatomotor_Hand.global_eff       0.9505287
## Sensory.somatomotor_Mouth.global_eff      0.1618715
## Subcortical.global_eff                    0.8011719
## Uncertain.global_eff                      0.2217196
## Ventral_attention.global_eff              0.1005368
## Visual.global_eff                         0.1480421
## Visual.Subcortical                        0.0003061 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

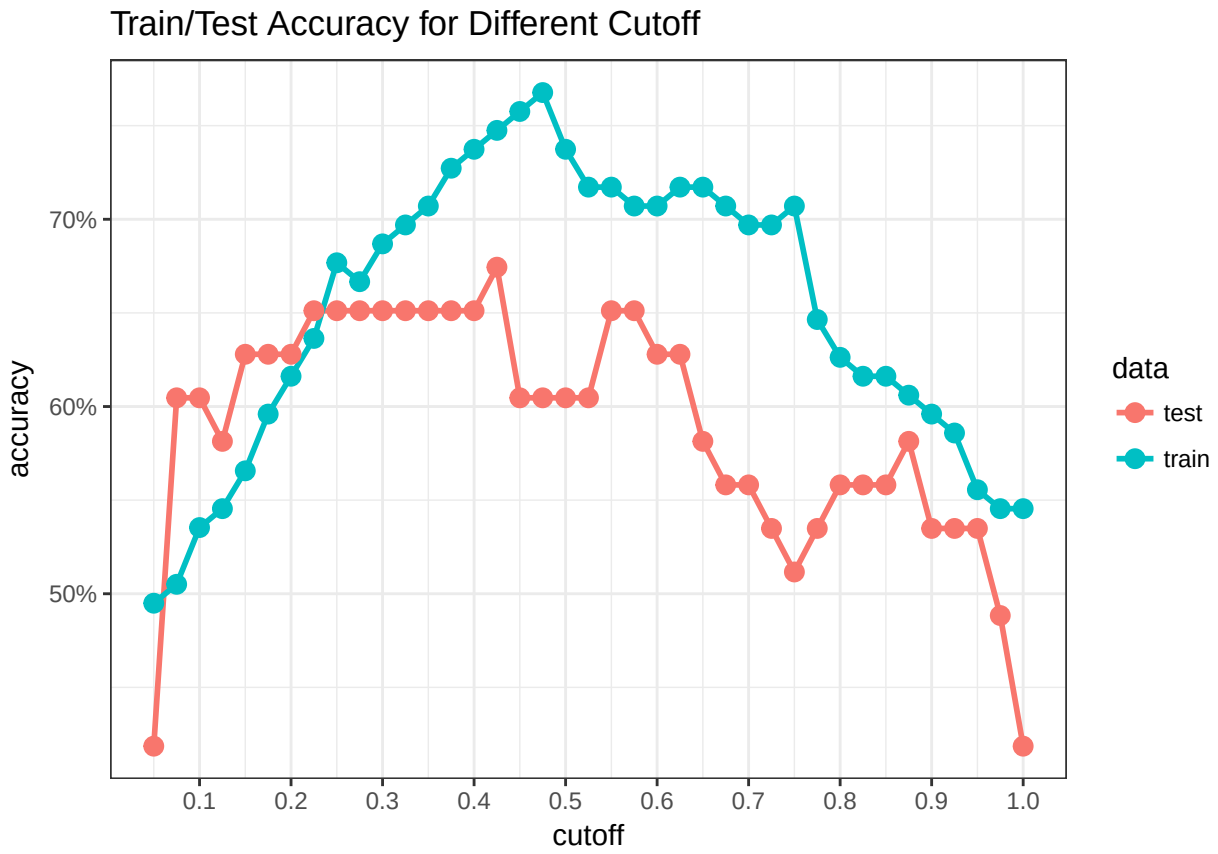
```
#R-squared
R_squared <- 1 - (summary(logi_m4)[[4]]/summary(logi_m4)[[8]])
R_squared
```

```
## [1] 0.2258151
```

```
#70/30 CV check

#Train
COBRE_train$prediction <- predict(logi_m4, COBRE_train, type = "response")


#Test
COBRE_test$prediction <- predict(logi_m4, COBRE_test, type = "response")

prop.table(table(COBRE$Subject_Type))
```

```
##
##       Control Schizophrenia
##     0.5070423     0.4929577
```

```
accuracy_info <- AccuracyCutoffInfo( train = COBRE_train, test = COBRE_test,
                                     predict = "prediction", actual = "Subject_Type" )

accuracy_info$plot
```




```
Classify(COBRE_train, COBRE_train$prediction,"Subject_Type", 0.425)
```

```
##                prediction
##                 Control Schizophrenia
##   Control            37            17
##   Schizophrenia       8            37
## [1] "The accuracy is 74.747 %"
```

```
Classify(COBRE_test, COBRE_test$prediction,"Subject_Type", 0.425)
```

```
##                prediction
##                 Control Schizophrenia
##   Control             9             9
##   Schizophrenia       5            20
## [1] "The accuracy is 67.442 %"
```

```
#COBRE model k fold CV check

set.seed(4321)

Accuracy.k <- cv.error(COBRE_logi_subset, "Subject_Type", cut_off = 0.425)
Accuracy.k
```

```
##  [1] 0.7142857 0.3571429 0.5714286 0.7333333 0.7142857 0.4285714 0.6428571
##  [8] 0.5714286 0.7857143 0.6666667
```

```
mean(Accuracy.k)
```

```
## [1] 0.6185714
```

```r
#Combine data

#Further data cleaning to merge CNP and COBRE data
Study <- rep("CNP",nrow(CNP))

CNP <- data.frame(CNP,Study)

CNP <- CNP %>%
  select(-c(7:41))

colnames(CNP)[5:6] <- c("Ethnicity","Education")

levels(CNP$Gender) <- c("Female","Male")

Study <- rep("COBRE",nrow(COBRE))
COBRE <- data.frame(COBRE,Study)

COBRE <- COBRE %>%
  select(-c(5,8:111))

# CNP Ethinicty
#1=Hispanic origin
#2=Not of Hispanic origin

#COBRE Ethinicty
#Caucasian = 1
#African-American   = 2
#Hispanic   = 3

#Recoding required

table(COBRE$Ethnicity)
```

```
##
##  1  2  3
## 69  9 53
```

```r
for(i in 1:length(COBRE$Ethnicity)){
  if(!is.na(COBRE$Ethnicity[i])){
    if(COBRE$Ethnicity[i] == 1 | COBRE$Ethnicity[i] == 2)
      COBRE$Ethnicity[i] <- 4
  }
}
COBRE$Ethnicity <- COBRE$Ethnicity - 2


table(COBRE$Ethnicity)
```

```
##
##  1  2
## 53 78
```

```r
Data <- merge(CNP,COBRE, all = TRUE) %>%
  select(-c(1))
```

```r
set.seed(4321)

# Combine Data modeling


#Random Forest variable selection

rfsrc_m5 <- rfsrc(Study~.,data = Data, na.action = c("na.omit"), ntree= 1000)


max_var <- max.subtree(rfsrc_m5, conservative = TRUE)

max_var$topvars
```

```
##  [1] "Age"
##  [2] "Education"
##  [3] "Cingulo.opercular.Cerebellar"
##  [4] "Fronto.parietal.Dorsal_Attention"
##  [5] "Subcortical.Cerebellar"
##  [6] "Visual.Fronto.parietal"
##  [7] "Uncertain.char_path_length"
##  [8] "Cingulo.opercular_Task_Control.mod"
##  [9] "Uncertain.mod"
## [10] "Subcortical.global_eff"
## [11] "Uncertain.global_eff"
## [12] "Subcortical.clust_coef"
```

```r
#delete duplicate entity


subset <- as.vector(max_var$topvars)

subset <- delete_dup(subset,Data[,c(1:5,139:152)])


#Logistic Regression model

Data_logi <- Data[,c("Study",names(Data[,c(1:5,139:152)]), subset)]

Data_logi <- na.omit(Data_logi)

#check correlation

high_cor <- findCorrelation(cor(Data_logi[,-c(1,3:4)]),cutoff = 0.75) + 3

#Remove variables to prevent multicollinearity problem
Data_logi <- Data_logi %>%
  select(-c(high_cor))

index <- sample(1:nrow(Data_logi), size = round(nrow(Data_logi)*0.7,0),replace = FALSE)

Data_train <- Data_logi[index,]
Data_test <- Data_logi[-index,]
logi_m5 <-glm(Study~. + Subject_Type*Age , data = Data_train, family = "binomial")
```

```r
summary(logi_m5)
```

```
##
## Call:
## glm(formula = Study ~ . + Subject_Type * Age, family = "binomial",
##     data = Data_train)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.7700  -0.6746  -0.3092   0.7643   2.4375
##
## Coefficients:
##                                           Estimate Std. Error z value
## (Intercept)                               -5.588445   5.284947  -1.057
## Age                                        0.033268   0.028725   1.158
## GenderMale                                 0.466691   0.436376   1.069
## Subject_TypeSchizophrenia                  0.682046   1.416228   0.482
## Ethnicity                                 -0.211211   0.442989  -0.477
## Education                                 -0.245661   0.121081  -2.029
## Auditory.global_eff                        3.586177   3.773799   0.950
## Cerebellar.global_eff                     -2.456683   1.978430  -1.242
## Cingulo.opercular_Task_Control.global_eff  5.537105   4.430513   1.250
## Default_mode.global_eff                   -2.564928   7.492391  -0.342
## Dorsal_attention.global_eff                3.932453   3.706158   1.061
## Fronto.parietal_Task_Control.global_eff    0.260275   5.777242   0.045
## Memory_retrieval.global_eff               -0.996901   1.859677  -0.536
## Salience.global_eff                        6.195572   4.527310   1.368
## Sensory.somatomotor_Hand.global_eff        0.723145   5.863066   0.123
## Sensory.somatomotor_Mouth.global_eff      -1.106020   2.288293  -0.483
## Subcortical.global_eff                     7.107391   5.190913   1.369
## Uncertain.global_eff                      -7.599795   5.411607  -1.404
## Ventral_attention.global_eff              -1.869363   3.641799  -0.513
## Visual.global_eff                         -3.431343   5.265809  -0.652
## Cingulo.opercular.Cerebellar              -4.252221   2.072418  -2.052
## Subcortical.Cerebellar                    -2.573867   2.540031  -1.013
## Visual.Fronto.parietal                     1.050864   2.183484   0.481
## Cingulo.opercular_Task_Control.mod         5.332129   3.146355   1.695
## Uncertain.mod                              6.733442   4.185818   1.609
## Subcortical.clust_coef                     6.451192   2.974812   2.169
## Age:Subject_TypeSchizophrenia             -0.008491   0.038145  -0.223
##                                           Pr(>|z|)
## (Intercept)                                 0.2903
## Age                                         0.2468
## GenderMale                                  0.2849
## Subject_TypeSchizophrenia                   0.6301
## Ethnicity                                   0.6335
## Education                                   0.0425 *
## Auditory.global_eff                         0.3420
## Cerebellar.global_eff                       0.2143
## Cingulo.opercular_Task_Control.global_eff   0.2114
## Default_mode.global_eff                     0.7321
## Dorsal_attention.global_eff                 0.2887
## Fronto.parietal_Task_Control.global_eff     0.9641
## Memory_retrieval.global_eff                 0.5919
```

```
## Salience.global_eff                          0.1712
## Sensory.somatomotor_Hand.global_eff          0.9018
## Sensory.somatomotor_Mouth.global_eff         0.6289
## Subcortical.global_eff                       0.1709
## Uncertain.global_eff                         0.1602
## Ventral_attention.global_eff                 0.6077
## Visual.global_eff                            0.5146
## Cingulo.opercular.Cerebellar                 0.0402 *
## Subcortical.Cerebellar                       0.3109
## Visual.Fronto.parietal                       0.6303
## Cingulo.opercular_Task_Control.mod           0.0901 .
## Uncertain.mod                                0.1077
## Subcortical.clust_coef                       0.0301 *
## Age:Subject_TypeSchizophrenia                0.8239
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 265.96  on 193  degrees of freedom
## Residual deviance: 178.00  on 167  degrees of freedom
## AIC: 232
##
## Number of Fisher Scoring iterations: 5
```

```
round(exp(coef(logi_m5)),3)
```

```
##                                (Intercept)
##                                      0.004
##                                        Age
##                                      1.034
##                                 GenderMale
##                                      1.595
##                  Subject_TypeSchizophrenia
##                                      1.978
##                                  Ethnicity
##                                      0.810
##                                  Education
##                                      0.782
##                        Auditory.global_eff
##                                     36.096
##                      Cerebellar.global_eff
##                                      0.086
## Cingulo.opercular_Task_Control.global_eff
##                                    253.942
##                     Default_mode.global_eff
##                                      0.077
##                Dorsal_attention.global_eff
##                                     51.032
##   Fronto.parietal_Task_Control.global_eff
##                                      1.297
##                Memory_retrieval.global_eff
##                                      0.369
##                        Salience.global_eff
##                                    490.572
```

```
##       Sensory.somatomotor_Hand.global_eff
##                                     2.061
##      Sensory.somatomotor_Mouth.global_eff
##                                     0.331
##                     Subcortical.global_eff
##                                  1220.958
##                       Uncertain.global_eff
##                                     0.001
##              Ventral_attention.global_eff
##                                     0.154
##                          Visual.global_eff
##                                     0.032
##              Cingulo.opercular.Cerebellar
##                                     0.014
##                     Subcortical.Cerebellar
##                                     0.076
##                     Visual.Fronto.parietal
##                                     2.860
##        Cingulo.opercular_Task_Control.mod
##                                   206.878
##                               Uncertain.mod
##                                   840.033
##                     Subcortical.clust_coef
##                                   633.457
##             Age:Subject_TypeSchizophrenia
##                                     0.992
```

```
anova(logi_m5, test = "Chisq")
```

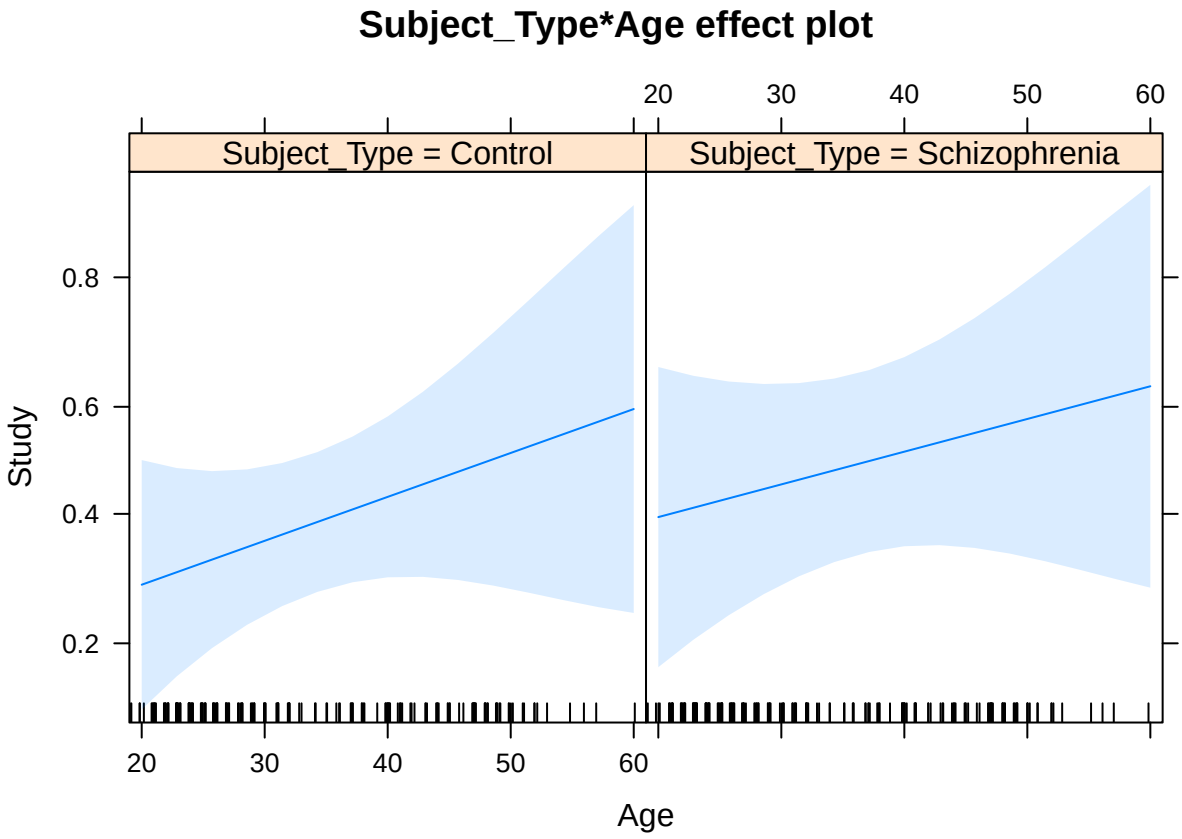
```
## Analysis of Deviance Table
##
## Model: binomial, link: logit
##
## Response: Study
##
## Terms added sequentially (first to last)
##
##
##                                           Df Deviance Resid. Df Resid. Dev
## NULL                                                        193     265.96
## Age                                        1   3.3371       192     262.63
## Gender                                     1   6.2191       191     256.41
## Subject_Type                               1   7.2228       190     249.19
## Ethnicity                                  1   0.5869       189     248.60
## Education                                  1  12.7223       188     235.88
## Auditory.global_eff                        1   3.6053       187     232.27
## Cerebellar.global_eff                      1   6.4624       186     225.81
## Cingulo.opercular_Task_Control.global_eff  1   0.2843       185     225.52
## Default_mode.global_eff                    1   3.6685       184     221.86
## Dorsal_attention.global_eff                1   1.5829       183     220.27
## Fronto.parietal_Task_Control.global_eff    1   0.0726       182     220.20
## Memory_retrieval.global_eff                1   0.0668       181     220.13
## Salience.global_eff                        1   3.7711       180     216.36
## Sensory.somatomotor_Hand.global_eff        1   0.0170       179     216.34
## Sensory.somatomotor_Mouth.global_eff       1   0.4466       178     215.90
```

```
## Subcortical.global_eff                      1   3.5802       177     212.32
## Uncertain.global_eff                        1   5.7028       176     206.62
## Ventral_attention.global_eff                1   0.4207       175     206.19
## Visual.global_eff                           1   2.0756       174     204.12
## Cingulo.opercular.Cerebellar                1  14.1765       173     189.94
## Subcortical.Cerebellar                      1   1.8643       172     188.08
## Visual.Fronto.parietal                      1   0.0379       171     188.04
## Cingulo.opercular_Task_Control.mod          1   2.3040       170     185.74
## Uncertain.mod                               1   2.3636       169     183.37
## Subcortical.clust_coef                      1   5.3243       168     178.05
## Age:Subject_Type                            1   0.0495       167     178.00
##                                            Pr(>Chi)
## NULL
## Age                                       0.0677343 .
## Gender                                    0.0126379 *
## Subject_Type                              0.0071985 **
## Ethnicity                                 0.4436360
## Education                                 0.0003613 ***
## Auditory.global_eff                       0.0575963 .
## Cerebellar.global_eff                     0.0110179 *
## Cingulo.opercular_Task_Control.global_eff 0.5938826
## Default_mode.global_eff                   0.0554491 .
## Dorsal_attention.global_eff               0.2083497
## Fronto.parietal_Task_Control.global_eff   0.7875658
## Memory_retrieval.global_eff               0.7959919
## Salience.global_eff                       0.0521457 .
## Sensory.somatomotor_Hand.global_eff       0.8961752
## Sensory.somatomotor_Mouth.global_eff      0.5039533
## Subcortical.global_eff                    0.0584732 .
## Uncertain.global_eff                      0.0169375 *
## Ventral_attention.global_eff              0.5165702
## Visual.global_eff                         0.1496697
## Cingulo.opercular.Cerebellar              0.0001664 ***
## Subcortical.Cerebellar                    0.1721237
## Visual.Fronto.parietal                    0.8457015
## Cingulo.opercular_Task_Control.mod        0.1290434
## Uncertain.mod                             0.1241928
## Subcortical.clust_coef                    0.0210304 *
## Age:Subject_Type                          0.8239025
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#R-squared

R_squared <- 1 - (summary(logi_m5)[[4]]/summary(logi_m5)[[8]])
R_squared
```

```
## [1] 0.3307403
```

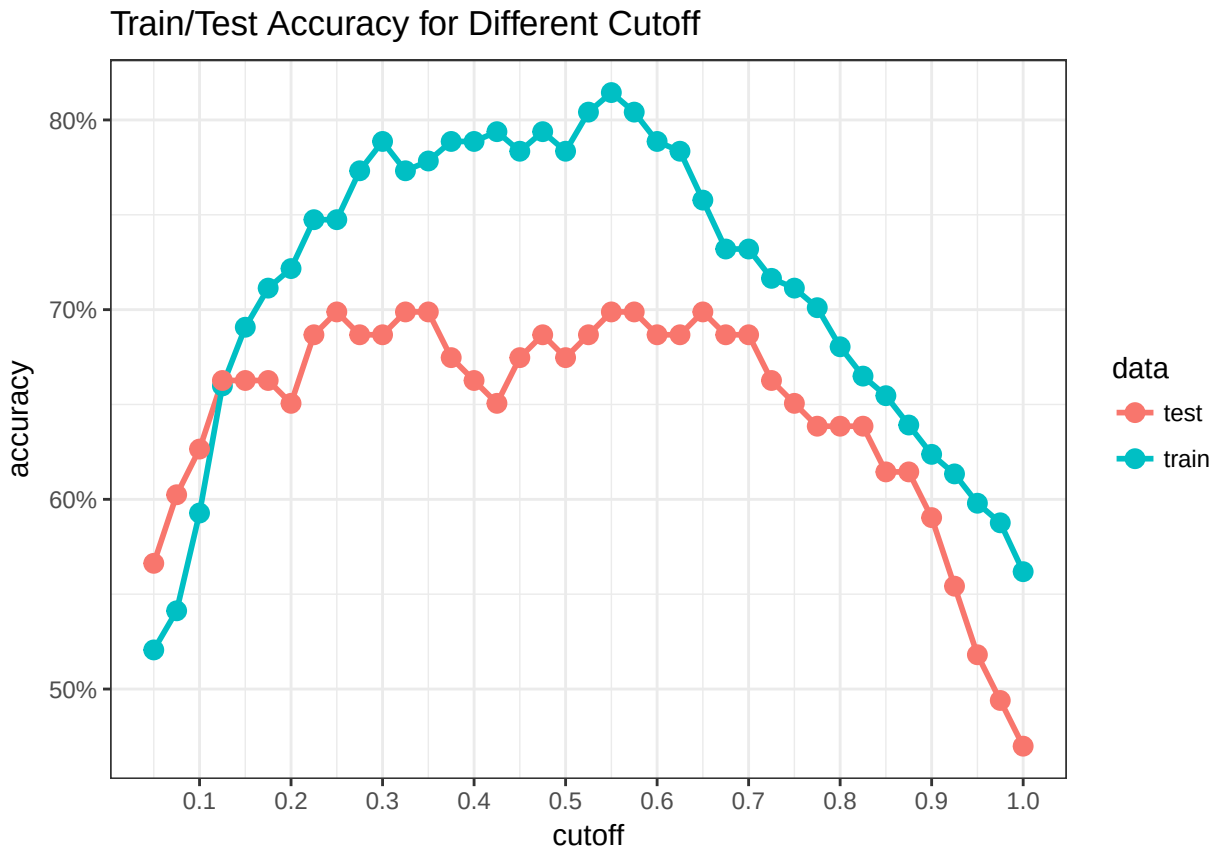
```
#Effect plot
plot(Effect(c("Subject_Type", "Age"), logi_m5),ask = FALSE)
```




```
#70/30 CV check

#Train
Data_train$prediction <- predict(logi_m5, Data_train, type = "response")


#Test
Data_test$prediction <- predict(logi_m5, Data_test, type = "response")

prop.table(table(COBRE$Subject_Type))
```

```
##
##       Control Schizophrenia
##     0.5070423     0.4929577
```

```
accuracy_info <- AccuracyCutoffInfo( train = Data_train, test = Data_test,
                                     predict = "prediction", actual = "Study" )

accuracy_info$plot
```




```
Classify(Data_train, Data_train$prediction,"Study", 0.5)
```

```
##         prediction
##          CNP COBRE
##   CNP     89    20
##   COBRE   22    63
## [1] "The accuracy is 78.351 %"
```

```
Classify(Data_test, Data_test$prediction,"Study", 0.5)
```

```
##         prediction
##          CNP COBRE
##   CNP     25    14
##   COBRE   13    31
## [1] "The accuracy is 67.47 %"
```

```
#Combine data model k fold CV check
set.seed(4321)

Accuracy.k <- cv.error(Data_logi, "Study", cut_off = 0.5)
Accuracy.k
```

```
##  [1] 0.7142857 0.7500000 0.8148148 0.8928571 0.7500000 0.8214286 0.7777778
##  [8] 0.6296296 0.6785714 0.6071429
```

```
mean(Accuracy.k)
```

```
## [1] 0.7436508
```