Decorrelation-Based Feature Discovery

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# Effect of GDSTM-based decorrelation on feature discovery

Here we showcase of to use BSWiMS feature selection/modeling function coupled with Goal Driven Sparse Transformation Matrix (GDSTM) as a pre-processing step to decorrelate highly correlated features. The aim is to discover decorrelate features hidden between the highly correlated features.

This demo will use:

* FRESA.CAD::GDSTMDecorrelation(). For Decorrelation of Multidimensional data sets
  + FRESA.CAD::getDerivedCoefficients(). For the extraction of the decorrelated features.
* FRESA.CAD::randomCV() For the cross-validation of the Machine Learning models
* FRESA.CAD::BSWiMS.model(). For the generation of bootstrapped logistic models
  + FRESA.CAD::summary(). For the summary description of the BSWiMS model
* FRESA.CAD::predictionStats\_binary(). For describing the performance of the model
* heatmap.2(). For displaying the correlation matrix
* vioplot::vioplot(). For the display of the z-distribution of significant features.

### Loading the libraries

library("FRESA.CAD")

## Loading required package: Rcpp

## Loading required package: stringr

## Loading required package: miscTools

## Loading required package: Hmisc

## Loading required package: lattice

## Loading required package: survival

## Loading required package: Formula

## Loading required package: ggplot2

##   
## Attaching package: 'Hmisc'

## The following objects are masked from 'package:base':  
##   
## format.pval, units

## Loading required package: pROC

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

##   
## Attaching package: 'pROC'

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

library(readxl)  
library(vioplot)

## Loading required package: sm

## Package 'sm', version 2.2-5.7: type help(sm) for summary information

## Loading required package: zoo

##   
## Attaching package: 'zoo'

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

op <- par(no.readonly = TRUE)

## Material and Methods

### Signed Log Transform

The function will be used to transform all the continuous features of the data

signedlog <- function(x) { return (sign(x)\*log(abs(x)+1.0e-12))}

## Data: The Parkinson data-set

The data to process is described in:

Erdogdu Sakar, Betul, Gorkem Serbes, and C. Okan Sakar. “Analyzing the effectiveness of vocal features in early telediagnosis of Parkinson’s disease.” *PloS one* 12, no. 8 (2017): e0182428.

The data was obtained from the UCI ML repository:

<https://archive.ics.uci.edu/ml/datasets/Parkinson%27s+Disease+Classification>

I added a column to the data identifying the repeated experiments.

pd\_speech\_features <- as.data.frame(read\_excel("~/GitHub/FCA/Data/pd\_speech\_features.xlsx",sheet = "pd\_speech\_features", range = "A2:ACB758"))  
  
trainFraction=0.65;

### The average of the three repetitions

Each subject had three repeated observations. Here I’ll use the average of the three experiments per subject.

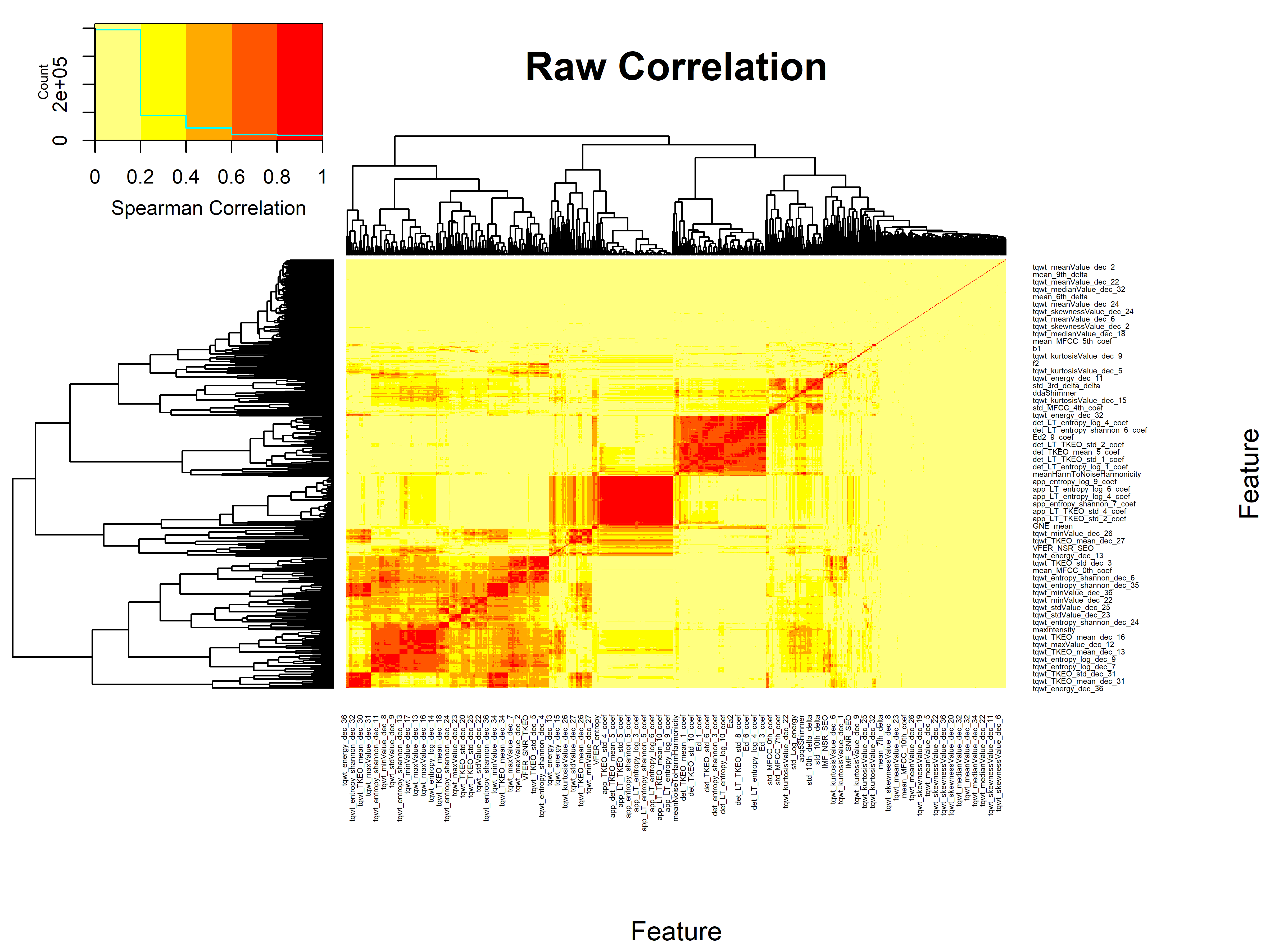
rep1Parkison <- subset(pd\_speech\_features,RID==1)  
rownames(rep1Parkison) <- rep1Parkison$id  
rep1Parkison$id <- NULL  
rep1Parkison$RID <- NULL  
rep1Parkison[,1:ncol(rep1Parkison)] <- sapply(rep1Parkison,as.numeric)  
  
rep2Parkison <- subset(pd\_speech\_features,RID==2)  
rownames(rep2Parkison) <- rep2Parkison$id  
rep2Parkison$id <- NULL  
rep2Parkison$RID <- NULL  
rep2Parkison[,1:ncol(rep2Parkison)] <- sapply(rep2Parkison,as.numeric)  
  
rep3Parkison <- subset(pd\_speech\_features,RID==3)  
rownames(rep3Parkison) <- rep3Parkison$id  
rep3Parkison$id <- NULL  
rep3Parkison$RID <- NULL  
rep3Parkison[,1:ncol(rep3Parkison)] <- sapply(rep3Parkison,as.numeric)  
  
whof <- !(colnames(rep1Parkison) %in% c("gender","class"));  
avgParkison <- rep1Parkison;  
avgParkison[,whof] <- (rep1Parkison[,whof] + rep2Parkison[,whof] + rep3Parkison[,whof])/3  
## I apply the log transform to the data  
avgParkison[,whof] <- signedlog(avgParkison[,whof])  
pander::pander(table(avgParkison$class))

| 0 | 1 |
| --- | --- |
| 64 | 188 |

### Correlation Matrix of the Parkinson Data

The heat-map of the correlation:

cormat <- cor(avgParkison,method="spearman")  
gplots::heatmap.2(abs(cormat),  
 trace = "none",  
 scale = "none",  
 mar = c(10,10),  
 col=rev(heat.colors(5)),  
 main = "Raw Correlation",  
 cexRow = 0.35,  
 cexCol = 0.35,  
 key.title=NA,  
 key.xlab="Spearman Correlation",  
 xlab="Feature", ylab="Feature",  
# srtRow = 45,  
# srtCol = 45  
)



### Training and testing set

We divided the data into training and testing sets.

set.seed(2)  
caseSet <- subset(avgParkison, class == 1)  
controlSet <- subset(avgParkison, class == 0)  
caseTrainSize <- nrow(caseSet)\*trainFraction;  
controlTrainSize <- nrow(controlSet)\*trainFraction;  
sampleCaseTrain <- sample(nrow(caseSet),caseTrainSize)  
sampleControlTrain <- sample(nrow(controlSet),controlTrainSize)  
trainSet <- rbind(caseSet[sampleCaseTrain,], controlSet[sampleControlTrain,])  
testSet <- rbind(caseSet[-sampleCaseTrain,],controlSet[-sampleControlTrain,])  
pander::pander(table(trainSet$class))

| 0 | 1 |
| --- | --- |
| 41 | 122 |

pander::pander(table(testSet$class))

| 0 | 1 |
| --- | --- |
| 23 | 66 |

#### Decorrelation of train and test set creation

I compute a decorrelated version of the training and testing sets using the *GDSTMDecorrelation()* function of FRESA.CAD. The first decorrelation will be driven by features associated with the outcome. The second decorrelation will find the GDSTM without the outcome restriction.

## The GDSTM transformation driven by the Outcome  
deTrain <- GDSTMDecorrelation(trainSet,Outcome="class",thr=0.8,verbose = TRUE)

Included: 568 , Uni p: 0.01824379 To Outcome: 297 , Base: 10 , In Included: 10 , Base Cor: 48 1 , Top: 44 < 0.8 >( 75 )[1 : 1 : 0.792](41%20,%20373%20,%200),<|>Tot Used: 414 , Added: 373 , Zero Std: 0 , Max Cor: 0.9999993 2 , Top: 72 < 0.8 >[TRUE](13)[1 : 0 : 0.792](70%20,%20227%20,%2041),<|>Tot Used: 482 , Added: 227 , Zero Std: 0 , Max Cor: 0.9999985 3 , Top: 54 < 0.8 >( 1 )[1 : 0 : 0.792](52%20,%20145%20,%20100),<|>Tot Used: 519 , Added: 145 , Zero Std: 0 , Max Cor: 0.9999451 4 , Top: 48 < 0.8 >[TRUE](9)[1 : 0 : 0.792](45%20,%2084%20,%20149),<|>Tot Used: 523 , Added: 84 , Zero Std: 0 , Max Cor: 0.9849464 5 , Top: 17 < 0.8 >( 1 )[1 : 0 : 0](17%20,%2019%20,%20185),<|>Tot Used: 523 , Added: 19 , Zero Std: 0 , Max Cor: 0.8934041 6 , Top: 4 < 0.8 >( 1 )[1 : 0 : 0](4%20,%204%20,%20198),<|>Tot Used: 523 , Added: 4 , Zero Std: 0 , Max Cor: 0.9672175 7 , Top: 1 < 0.8 >( 1 )[1 : 0 : 0.8](1%20,%201%20,%20200),<|>Tot Used: 523 , Added: 1 , Zero Std: 0 , Max Cor: 0.7998894 [ 8 ], 0.7998894 . Cor to Base: 415 , ABase: 65

deTest <- predictDecorrelate(deTrain,testSet)  
  
## The GDSTM transformation without outcome  
deTrainU <- GDSTMDecorrelation(trainSet,thr=0.8,verbose = TRUE)

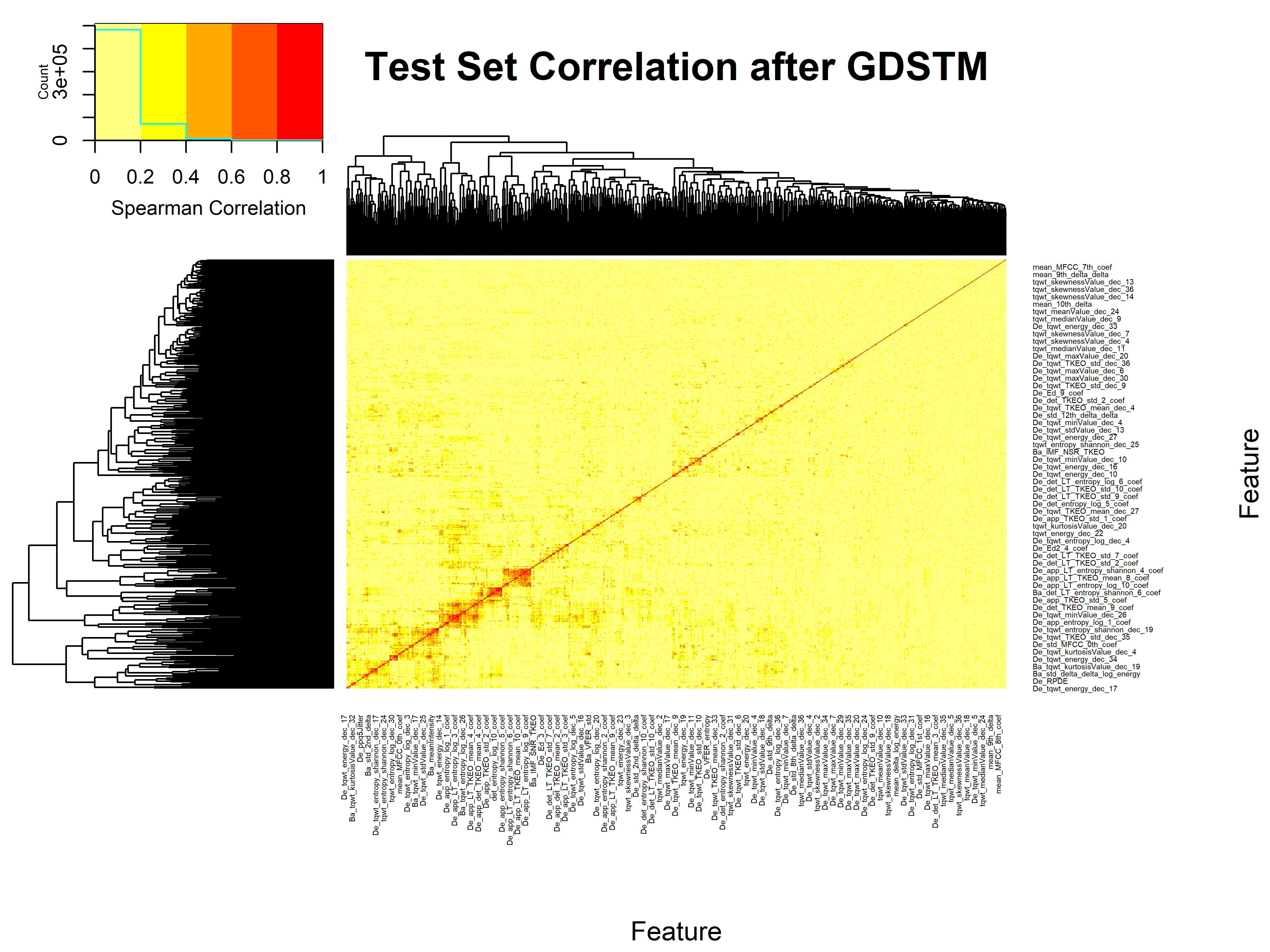
Included: 568 , Uni p: 0.01824379 To Outcome: 0 , Base: 0 , In Included: 0 , Base Cor: 0 1 , Top: 39 < 0.8 >( 75 )[1 : 0 : 0](38%20,%20397%20,%200),<|>Tot Used: 435 , Added: 397 , Zero Std: 0 , Max Cor: 0.9999993 2 , Top: 74 < 0.8 >( 18 )[1 : 0 : 0](69%20,%20247%20,%2038),<|>Tot Used: 514 , Added: 247 , Zero Std: 0 , Max Cor: 0.9999985 3 , Top: 60 < 0.8 >( 9 )[1 : 0 : 0](59%20,%20135%20,%20101),<|>Tot Used: 520 , Added: 135 , Zero Std: 0 , Max Cor: 0.9999451 4 , Top: 30 < 0.8 >( 2 )[1 : 0 : 0](27%20,%2052%20,%20157),<|>Tot Used: 521 , Added: 52 , Zero Std: 0 , Max Cor: 0.9849464 5 , Top: 11 < 0.8 >( 1 )[1 : 0 : 0](11%20,%2013%20,%20180),<|>Tot Used: 521 , Added: 13 , Zero Std: 0 , Max Cor: 0.9672175 6 , Top: 3 < 0.8 >( 1 )[1 : 0 : 0](3%20,%203%20,%20189),<|>Tot Used: 521 , Added: 3 , Zero Std: 0 , Max Cor: 0.7998894 [ 7 ], 0.7998894 . Cor to Base: 411 , ABase: 65

deTestU <- predictDecorrelate(deTrainU,testSet)

#### Correlation Matrix of the Decorrelated Test Data

The heat map of the testing set.

cormat <- cor(deTest,method="spearman")  
gplots::heatmap.2(abs(cormat),  
 trace = "none",  
 scale = "none",  
 mar = c(10,10),  
 col=rev(heat.colors(5)),  
 main = "Test Set Correlation after GDSTM",  
 cexRow = 0.35,  
 cexCol = 0.35,  
 key.title=NA,  
 key.xlab="Spearman Correlation",  
 xlab="Feature", ylab="Feature")



### Cross Validation

Before doing the feature analysis. I’ll explore BSWiMS modeling using the Holdout cross validation method of FRESA.CAD. The purpose of the cross-validation is to observe and estimate the performance gain of decorrelation.

par(op)  
par(mfrow=c(1,3))  
  
## The Raw validation  
cvBSWiMSRaw <- randomCV(avgParkison,  
 "class",  
 fittingFunction= BSWiMS.model,  
 classSamplingType = "Pro",  
 trainFraction = trainFraction,  
 repetitions = 150  
)

.[+++++++++++-++++++-]..[+++++++++++++++++-]..[+++++++++++++++++-+]..[++++++++++++++++++-]..[++++-].[++–++++-++-].[++++++++++–++-]..[+++++++++++-+++++-]..[++++++++++–]..[++++++++++++++++++++]..10 Tested: 247 Avg. Selected: 32.9 Min Tests: 1 Max Tests: 8 Mean Tests: 3.603239 . MAD: 0.3019503 .[++++++++++++++-]..[++++++++++-+++++-+]..[++++++++-].[++++++++++-+++++++-]..[++++++++++++++—]..[++++++++++++++++++++]…[+++++++++++++++-]..[++++++++++++++++++++]…[+++++++++—++++-]..[++++++++++++++++-].20 Tested: 252 Avg. Selected: 35.15 Min Tests: 2 Max Tests: 14 Mean Tests: 7.063492 . MAD: 0.3065106 .[++++++++++-++++++++]..[++++++++++++++++++++]…[++++++++++++++++++++]…[+++++++++++++-+++-]..[++++-++++++-]..[+++++++++++++++++-+]..[+++++–].[++++++++++++++++++++]…[+++-].[++++++++++++++++++-].30 Tested: 252 Avg. Selected: 35.93333 Min Tests: 4 Max Tests: 21 Mean Tests: 10.59524 . MAD: 0.3042873 .[+++++++++++++++–]..[++++++++++++++-+-+]..[+++++++++++++++++-+]..[+++-].[++++++++++++-++++-]..[+++++++++–].[+++++++++++++++++–]..[+++++–].[++++++++++++++++++++]…[+++++++++-+++++++++].40 Tested: 252 Avg. Selected: 35.075 Min Tests: 6 Max Tests: 24 Mean Tests: 14.12698 . MAD: 0.3063561 .[++++++++++++++++++++]…[+++++++++++-]..[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++-].[++++++++++++++++++++]…[+++++++++++++++++++-]..[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++++++++++]..50 Tested: 252 Avg. Selected: 35.88 Min Tests: 9 Max Tests: 29 Mean Tests: 17.65873 . MAD: 0.3084708 .[++++++++++++++++++-]..[+++++–+++–].[++++++++++++++++++++]…[++++-].[++++++++++++++++++++]…[+++++++++++-]..[++++++++++++++++++++]…[+++++++-++++-]..[++++++++++++++-]..[+++++++++-]60 Tested: 252 Avg. Selected: 35.2 Min Tests: 12 Max Tests: 33 Mean Tests: 21.19048 . MAD: 0.3077087 .[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++-+++++++–]..[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++-+++++-]..[+++++++++++++-]..[+++++++++-].[++++++++++++++++++++]..70 Tested: 252 Avg. Selected: 36.1 Min Tests: 14 Max Tests: 38 Mean Tests: 24.72222 . MAD: 0.310029 .[+++++++++++++—-]..[++++++++++++++-+-]..[++++++++++++++++++++]…[++++++++++++++++-]..[++++++++++++++++++++]…[++++++++++-++++-]..[++–++-].[+++++++++++-+++++-]..[+++++++++++++++++++-]..[+++++++++++++-+++++].80 Tested: 252 Avg. Selected: 36.25 Min Tests: 17 Max Tests: 43 Mean Tests: 28.25397 . MAD: 0.3107437 .[++++++++++++++++++++]…[++++++++++++++++++-]..[++++++++–+-].[++++++++-++++++-]..[+++++–].[+++++++++++++++-+++]..[++++++++++++++++++++]…[+++++-++++++++++-]..[+++++++++-+-]..[++++++++++++-+-++-].90 Tested: 252 Avg. Selected: 35.97778 Min Tests: 20 Max Tests: 48 Mean Tests: 31.78571 . MAD: 0.3102998 .[+++++++++++++++++++-]..[++++++++++++++++++++]…[++++++++++++++++++++]…[+++++++++-+++++-+-]..[++++++++++++++++++++]…[++++++++-+-++-]..[+++++++++++++++++++-]..[++++++++++++++++–]..[++++-+-].[++++++++++++++++++++]..100 Tested: 252 Avg. Selected: 36.33 Min Tests: 21 Max Tests: 52 Mean Tests: 35.31746 . MAD: 0.3109587 .[+++++++++++++++++++-]..[++++++++++++-+++++-]..[++++++++-+++++++–]..[+++++++++++++-]..[++++++++++++++++++++]…[++++++++++++++++-++]..[++++++++++-++++++++]..[+++++++++++++-]..[+++++++++++++++–]..[++++++-++++-+-].110 Tested: 252 Avg. Selected: 36.46364 Min Tests: 25 Max Tests: 57 Mean Tests: 38.84921 . MAD: 0.3105626 .[++++++-++++-]..[+++++++++++++-+-++]..[+++++++-+++++++++++]..[++++++++++++++++-++]..[+++++++++++++++++–]..[++++++++–].[+++++++++++-]..[++++++++++++++++++-]..[++++++++++++++++++++]…[+++++-]120 Tested: 252 Avg. Selected: 36.225 Min Tests: 30 Max Tests: 60 Mean Tests: 42.38095 . MAD: 0.3111142 .[++++++++++-]..[++++++++++++–++++]..[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++++++++++++++]…[+++++++++++++++++-]..[+++++++++++++++++-+]..[+++++++++++++-].130 Tested: 252 Avg. Selected: 36.53077 Min Tests: 33 Max Tests: 63 Mean Tests: 45.9127 . MAD: 0.3117468 .[++++++++++++++++++++]…[++-++++-].[++++++++-+-+++-]..[+++++++++++++++-]..[++++++++++++++++++++]…[++++++++++++++++++++]…[++++++++-].[++++++++++++++-++++]..[+–++++-++++-].[++++++++-+++++-+-].140 Tested: 252 Avg. Selected: 36.45 Min Tests: 38 Max Tests: 67 Mean Tests: 49.44444 . MAD: 0.3111459 .[++++++++-+++++—]..[++++++++++++++++++++]…[+++++++-+-+-].[++++++++++++++++++++]…[++++++++–++–]..[++++++-+++++-]..[++++++++++++++++++++]…[++++-++-++-].[++++++++++++++++++++]…[++++++++++++++++++++]..150 Tested: 252 Avg. Selected: 36.6 Min Tests: 41 Max Tests: 71 Mean Tests: 52.97619 . MAD: 0.3108834

bpraw <- predictionStats\_binary(cvBSWiMSRaw$medianTest,"BSWiMS RAW",cex=0.60)

BSWiMS RAW

pander::pander(bpraw$CM.analysis$tab)

|  | Outcome + | Outcome - | Total |
| --- | --- | --- | --- |
| **Test +** | 148 | 18 | 166 |
| **Test -** | 40 | 46 | 86 |
| **Total** | 188 | 64 | 252 |

pander::pander(bpraw$accc)

|  | est | lower | upper |
| --- | --- | --- | --- |
| **5** | 0.7698 | 0.7129 | 0.8203 |

pander::pander(bpraw$aucs)

| est | lower | upper |
| --- | --- | --- |
| 0.8408 | 0.7857 | 0.8958 |

pander::pander(bpraw$berror)

| 50% | 2.5% | 97.5% |
| --- | --- | --- |
| 0.2472 | 0.188 | 0.3148 |

## The validation with Outcome-driven Decorrelation  
cvBSWiMSDeCor <- randomCV(avgParkison,  
 "class",  
 trainSampleSets= cvBSWiMSRaw$trainSamplesSets,  
 fittingFunction= filteredFit,  
 fitmethod=BSWiMS.model,  
 filtermethod=NULL,  
 DECOR = TRUE,  
 DECOR.control=list(Outcome="class",thr=0.8)  
)

.[++++++-].[+++++-].[+++++++—].[++++-].[+++-].[+-+++-++–].[++++++++—].[+++++++++-].[++++++++++–]..[+++—]10 Tested: 247 Avg. Selected: 19.3 Min Tests: 1 Max Tests: 8 Mean Tests: 3.603239 . MAD: 0.2768727 .[+++-].[+++++++–].[++-].[+++-].[+++-].[++++++++++-]..[+++++-].[++++++++++++++++++++]…[+++-].[++++++++++–++-].20 Tested: 252 Avg. Selected: 19.6 Min Tests: 2 Max Tests: 14 Mean Tests: 7.063492 . MAD: 0.279814 .[++++-+++++–].[++++++++++-]..[+++++++-].[++++++-].[+++++++-].[++++++-].[++++-+-].[++++++++++++-]..[++++++++-++-]..[++++-]30 Tested: 252 Avg. Selected: 20.53333 Min Tests: 4 Max Tests: 21 Mean Tests: 10.59524 . MAD: 0.2879277 .[++++++++++—]..[+++++-].[++++++++++-]..[++++++++-+-].[++++++-].[++++-].[+++-+++-].[+++-].[+++++-+-].[++++++-]40 Tested: 252 Avg. Selected: 20.35 Min Tests: 6 Max Tests: 24 Mean Tests: 14.12698 . MAD: 0.2899609 .[+++++-+++—-].[+++++++++–].[++++++-].[+++++–++—].[+++–+++-].[+++-].[++++++++++–]..[+++++–].[++++++–++-+-].[++++++-++-]50 Tested: 252 Avg. Selected: 20.72 Min Tests: 9 Max Tests: 29 Mean Tests: 17.65873 . MAD: 0.2928319 .[++++++–+-].[++++++-].[++++++++++-]..[+++++++++–+-+-]..[++++–].[++–].[+++++++++-++-]..[++++-].[+++++++-++-].[++++++++–]60 Tested: 252 Avg. Selected: 20.88333 Min Tests: 12 Max Tests: 33 Mean Tests: 21.19048 . MAD: 0.2924493 .[+++++-].[++++++++++-+-++++-]..[++++++++-].[+++++++++–].[+—].[+++++++++-+-]..[+++++++++++-]..[+-+++-++++–].[+++++++–++++++–]..[++++++++++-+++++-+].70 Tested: 252 Avg. Selected: 21.77143 Min Tests: 14 Max Tests: 38 Mean Tests: 24.72222 . MAD: 0.294753 .[++++++++-++-]..[++++++-].[+++++-].[+++++++++-].[++++-].[+++++++–+—].[++-].[++++++++++-]..[+++++++++-].[++++-]80 Tested: 252 Avg. Selected: 21.5 Min Tests: 17 Max Tests: 43 Mean Tests: 28.25397 . MAD: 0.295001 .[++++-+-].[++++++++++-+++-+-]..[+++-].[++++-].[++++++++++++-]..[++++-++–].[+++++++++++-]..[++++++++-].[++++–].[+++++-+-]90 Tested: 252 Avg. Selected: 21.4 Min Tests: 20 Max Tests: 48 Mean Tests: 31.78571 . MAD: 0.2959592 .[++++++++++-]..[++++++-].[++++-+++-].[+++++-+–].[+++-].[+++-++–].[++++++-+-].[++++++++-++-]..[+++++++-].[+++-]100 Tested: 252 Avg. Selected: 21.07 Min Tests: 21 Max Tests: 52 Mean Tests: 35.31746 . MAD: 0.2960942 .[++++++++-].[+++++-].[++++++++++++-+-]..[+++++++-++-].[+++++++-+++-+-]..[+++++++++-++++++++-]..[++++-].[++++++–+-].[++++++++++–]..[+++–+–]110 Tested: 252 Avg. Selected: 21.47273 Min Tests: 25 Max Tests: 57 Mean Tests: 38.84921 . MAD: 0.2973174 .[+-+-].[+++++++++—].[+-++–].[+-].[+++-+-+—-].[++++++-+++-+-]..[+++++-].[+++++–].[++++++++++++++-]..[++++-++-]120 Tested: 252 Avg. Selected: 21.225 Min Tests: 30 Max Tests: 60 Mean Tests: 42.38095 . MAD: 0.296268 .[++++++++++++++++++++]…[+-].[++-+++++-].[+++++-++-].[+++++++++++-]..[+++++++-].[++++++++++++++++++-]..[++++-].[++++-].[+++-]130 Tested: 252 Avg. Selected: 21.33846 Min Tests: 33 Max Tests: 63 Mean Tests: 45.9127 . MAD: 0.2952612 .[+++++-].[++++++++++++++++++++]…[+++++++-].[+++++++-].[++++-+++-++-].[+++++-].[++++++++++++++-]..[++++-].[+++++–].[+++++-]140 Tested: 252 Avg. Selected: 21.54286 Min Tests: 38 Max Tests: 67 Mean Tests: 49.44444 . MAD: 0.2945426 .[+++++++++++-++-]..[+-].[+++++–].[++++-].[++++-].[+++-].[++++++++++++–]..[++-].[+++++-++-].[++++++-]150 Tested: 252 Avg. Selected: 21.24 Min Tests: 41 Max Tests: 71 Mean Tests: 52.97619 . MAD: 0.2938161

bpDecor <- predictionStats\_binary(cvBSWiMSDeCor$medianTest,"BSWiMS Outcome-Driven GDSTM",cex=0.60)

BSWiMS Outcome-Driven GDSTM

pander::pander(bpDecor$CM.analysis$tab)

|  | Outcome + | Outcome - | Total |
| --- | --- | --- | --- |
| **Test +** | 167 | 15 | 182 |
| **Test -** | 21 | 49 | 70 |
| **Total** | 188 | 64 | 252 |

pander::pander(bpDecor$accc)

|  | est | lower | upper |
| --- | --- | --- | --- |
| **5** | 0.8571 | 0.8078 | 0.8979 |

pander::pander(bpDecor$aucs)

| est | lower | upper |
| --- | --- | --- |
| 0.8702 | 0.8122 | 0.9281 |

pander::pander(bpDecor$berror)

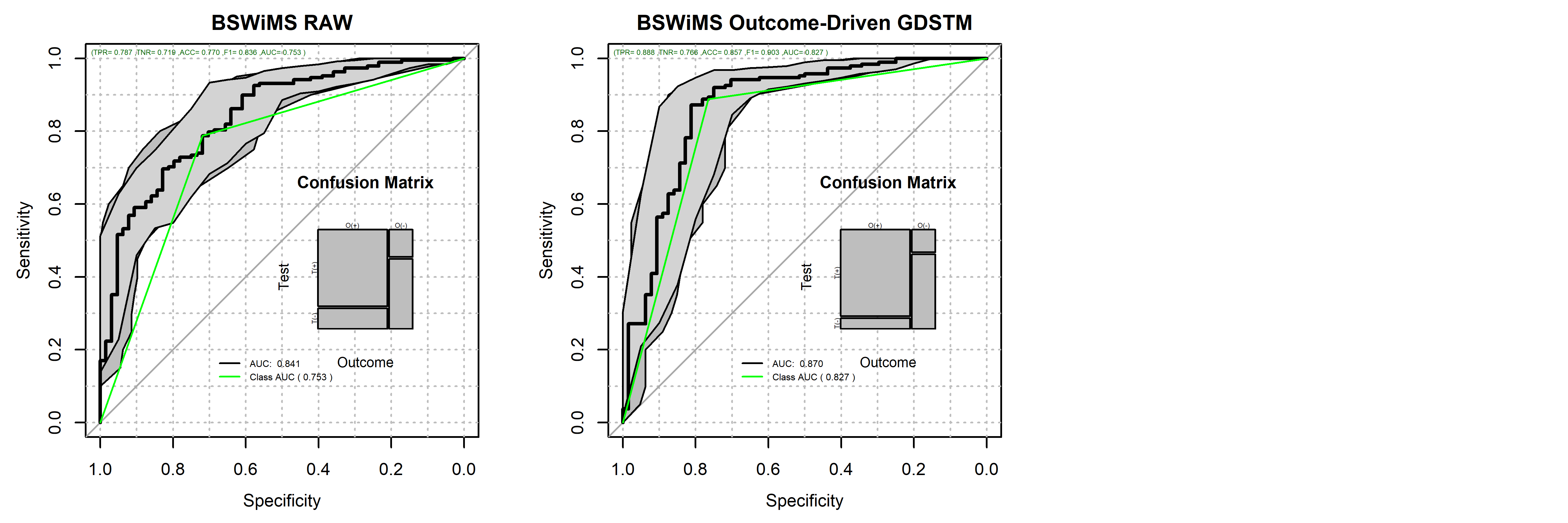
| 50% | 2.5% | 97.5% |
| --- | --- | --- |
| 0.1724 | 0.1157 | 0.2302 |

### Here we compute the probability that the outcome-driven decorrelation ROC is superior to the RAW ROC.   
pander::pander(roc.test(bpDecor$ROC.analysis$roc.predictor,bpraw$ROC.analysis$roc.predictor))

DeLong’s test for two correlated ROC curves: bpDecor$ROC.analysis$roc.predictor and bpraw$ROC.analysis$roc.predictor

| Test statistic | P value | Alternative hypothesis | AUC of roc1 | AUC of roc2 |
| --- | --- | --- | --- | --- |
| 1.934 | 0.05312 | two.sided | 0.8702 | 0.8408 |

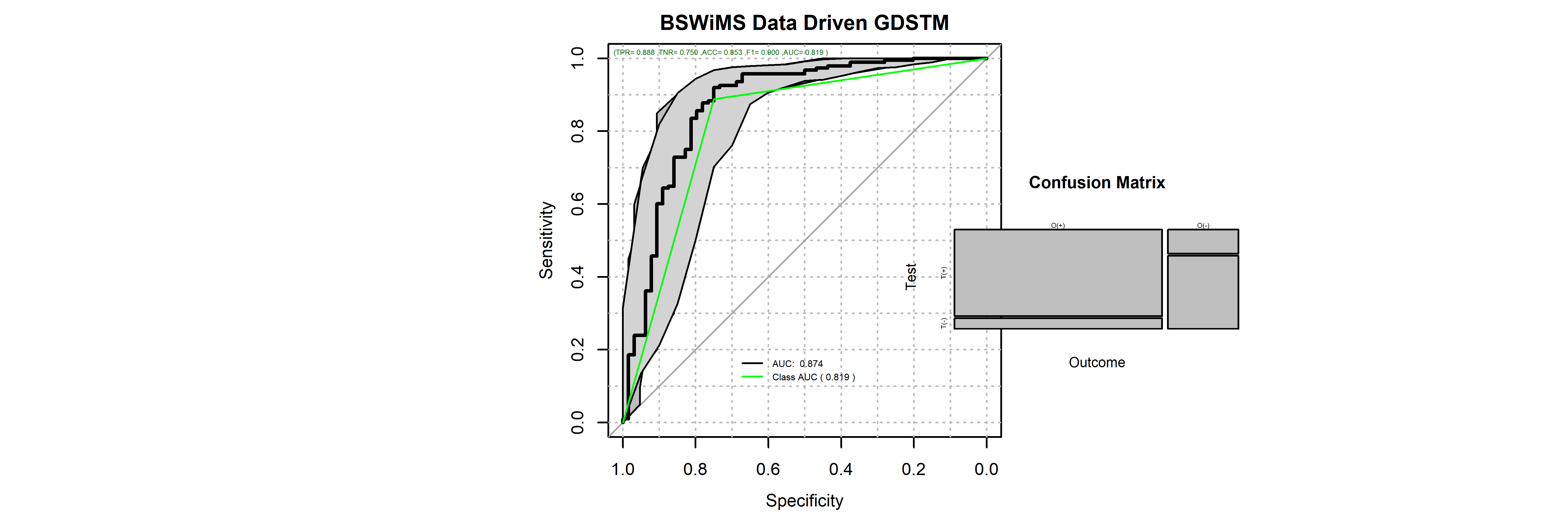
par(op)



## The validation of Decorrelation without the outcome restriction  
cvBSWiMSDeCorU <- randomCV(avgParkison,  
 "class",  
 trainSampleSets= cvBSWiMSRaw$trainSamplesSets,  
 fittingFunction= filteredFit,  
 fitmethod=BSWiMS.model,  
 filtermethod=NULL,  
 DECOR = TRUE,  
 DECOR.control=list(thr=0.8)  
)

.[++++++++++-]..[++++++–+-].[++++++-].[++++-++-].[+-].[++-].[++++++++-].[++++++++++-]..[++++++++-].[+–]10 Tested: 247 Avg. Selected: 19 Min Tests: 1 Max Tests: 8 Mean Tests: 3.603239 . MAD: 0.2668764 .[++++-++—-+-+].[++++++++++-++-]..[++++-].[+++-].[++++-].[++++++++++++++++++++]…[+++++-].[++++++++++++-+++–]..[++++-+-].[++++++++++++-].20 Tested: 252 Avg. Selected: 22.25 Min Tests: 2 Max Tests: 14 Mean Tests: 7.063492 . MAD: 0.2863027 .[++++++-].[++++++++++++-++-+-]..[++++-].[+++-].[++++—-].[++++-].[+++++-].[+++++++++++++++-++-]..[+++++-++++++++++–]..[+++++–+++–]30 Tested: 252 Avg. Selected: 23.06667 Min Tests: 4 Max Tests: 21 Mean Tests: 10.59524 . MAD: 0.2892364 .[+++-+++-+-].[+++++++++++-]..[+++++++-].[+++++++++-+++-]..[++++++-].[+++++++-+–].[+++++-].[+++-].[++++-+-].[++++-++++–]40 Tested: 252 Avg. Selected: 22.95 Min Tests: 6 Max Tests: 24 Mean Tests: 14.12698 . MAD: 0.2920775 .[+++++-].[++++–+++–+-].[+++++++++-].[++++-].[+++++-+++++-]..[+++-].[+++++++++++-]..[++++—+-].[+++++–].[+++-+++—]50 Tested: 252 Avg. Selected: 22.4 Min Tests: 9 Max Tests: 29 Mean Tests: 17.65873 . MAD: 0.2913062 .[+++++++++-].[++++-].[++++-++-++–].[++++++++-].[++++++++-+-+++++++]..[++++-].[++++++++++++++++-++]..[++++-].[+++++++++++++-]..[++++++++++++-++-].60 Tested: 252 Avg. Selected: 23.31667 Min Tests: 12 Max Tests: 33 Mean Tests: 21.19048 . MAD: 0.293701 .[+++++-].[+++++++++++++++-++-]..[++++-+++-+-].[++++-].[+++++-].[++++++++++++-]..[+++-].[++-++-+-++++-].[++++++++-].[++++++++++++-+++-+].70 Tested: 252 Avg. Selected: 23.38571 Min Tests: 14 Max Tests: 38 Mean Tests: 24.72222 . MAD: 0.2967088 .[++++++++++++++++-++]..[++++++-].[+++-].[+++++++–+-].[++++-].[+++++-].[+++-].[++++++–].[++++++++-++—-]..[+++++-]80 Tested: 252 Avg. Selected: 22.925 Min Tests: 17 Max Tests: 43 Mean Tests: 28.25397 . MAD: 0.2963374 .[+++++++++-].[++++++++-].[++++–].[+-+++-].[++++++-].[+++–].[++++-+–].[++++-+++-+-].[++-+-].[+++++++-]90 Tested: 252 Avg. Selected: 22.17778 Min Tests: 20 Max Tests: 48 Mean Tests: 31.78571 . MAD: 0.2950341 .[+++-+-+–].[+++-++-].[+++–].[+++++-+–].[+++—-].[+++++++—].[+++++-].[+++-].[++++++–].[++-+-+++–]100 Tested: 252 Avg. Selected: 21.46 Min Tests: 21 Max Tests: 52 Mean Tests: 35.31746 . MAD: 0.2937983 .[++++++–++-+-].[+++++++–].[+++++++++–].[++++++-].[++++++-+++-].[+++++++++++++-++++-]..[+++++–].[+++-++++-].[+++++-].[++++-]110 Tested: 252 Avg. Selected: 21.67273 Min Tests: 25 Max Tests: 57 Mean Tests: 38.84921 . MAD: 0.294527 .[+-++-].[++++-+-].[+-+-].[+++–].[+++++++-].[+++++++++++-+—]..[++++++++-].[+++++++-+-++–]..[++++++++-+++++++-]..[++++-]120 Tested: 252 Avg. Selected: 21.60833 Min Tests: 30 Max Tests: 60 Mean Tests: 42.38095 . MAD: 0.294734 .[++++++++-].[++-].[++++++++++++-]..[+++++++++—+–]..[+++++++++++++-]..[+++-].[++++++++++++++++++++]…[++++–].[++++-].[++++++++-]130 Tested: 252 Avg. Selected: 21.83846 Min Tests: 33 Max Tests: 63 Mean Tests: 45.9127 . MAD: 0.2962207 .[+++++++++-].[+++++++-+-].[++++++-+++-].[++++-+—].[++++-].[+++++-].[+++++++++-].[++-].[++++-].[++++++-+-]140 Tested: 252 Avg. Selected: 21.64286 Min Tests: 38 Max Tests: 67 Mean Tests: 49.44444 . MAD: 0.2949667 .[++++++++-++-+++-]..[+++-].[+++++-].[+++-].[++++–].[++++-+++-].[+++++++++++++–+-]..[++–].[++++-+-].[+++–]150 Tested: 252 Avg. Selected: 21.38 Min Tests: 41 Max Tests: 71 Mean Tests: 52.97619 . MAD: 0.2937747

bpDecorU <- predictionStats\_binary(cvBSWiMSDeCorU$medianTest,"BSWiMS Data Driven GDSTM",cex=0.60)

BSWiMS Data Driven GDSTM 

pander::pander(bpDecorU$CM.analysis$tab)

|  | Outcome + | Outcome - | Total |
| --- | --- | --- | --- |
| **Test +** | 167 | 16 | 183 |
| **Test -** | 21 | 48 | 69 |
| **Total** | 188 | 64 | 252 |

pander::pander(bpDecorU$accc)

|  | est | lower | upper |
| --- | --- | --- | --- |
| **5** | 0.8532 | 0.8033 | 0.8945 |

pander::pander(bpDecorU$aucs)

| est | lower | upper |
| --- | --- | --- |
| 0.8738 | 0.8153 | 0.9322 |

pander::pander(bpDecorU$berror)

| 50% | 2.5% | 97.5% |
| --- | --- | --- |
| 0.1789 | 0.1232 | 0.2344 |

### Here we compute the probability that the unsupervised decorrelation ROC is superior to the RAW ROC.   
pander::pander(roc.test(bpDecorU$ROC.analysis$roc.predictor,bpraw$ROC.analysis$roc.predictor))

DeLong’s test for two correlated ROC curves: bpDecorU$ROC.analysis$roc.predictor and bpraw$ROC.analysis$roc.predictor

| Test statistic | P value | Alternative hypothesis | AUC of roc1 | AUC of roc2 |
| --- | --- | --- | --- | --- |
| 2.143 | 0.03208 \* | two.sided | 0.8738 | 0.8408 |

par(op)

## The Raw Model *vs.* the Decorrelated-Based Model

After demonstrating that decorrelation is able to improve BSWiMS model performance, I’ll focus is showcasing the ability to discover new features associated with the outcome.

First, I’ll compute the BSWiMS models for the original data, and for the decorrelated data-set. The model estimation will be done using the training set and tested on the holdout test set, and repeated 10 times. After that, I’ll compare the statistical difference of both ROC curves.

par(op)  
par(mfrow=c(1,3))  
  
bm <- BSWiMS.model(class~.,trainSet,NumberofRepeats = 20)

[++++++++++++++++++-+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-+++++++++++++++++++++++++++++++++++++++++++-++++++++++++++++++++-++++++++++++++++++++++++++++++++++++++++++++++++++++++++++-+++++++++++++++++++++++++++++++++++++++-]………………………………..

bpraw <- predictionStats\_binary(cbind(testSet$class,predict(bm,testSet)),"BSWiMS RAW",cex=0.60)

BSWiMS RAW

bmd <- BSWiMS.model(class~.,deTrain,NumberofRepeats = 20)

[+++++++—++++-+++-+++++-++++++++-+++++++—+++++++-+++++-++++++-+++++++++-++++-+++–+++++++-+++++++++-++++–++++++++-+++++++++-+++–+-+–++++-+-++++++-++++-+-+–+++++++–+++++++++-]…………..

bpdecor <- predictionStats\_binary(cbind(deTest$class,predict(bmd,deTest)),"BSWiMS Outcome-Driven Decor",cex=0.60)

BSWiMS Outcome-Driven Decor

pander::pander(roc.test(bpraw$ROC.analysis$roc.predictor,bpdecor$ROC.analysis$roc.predictor))

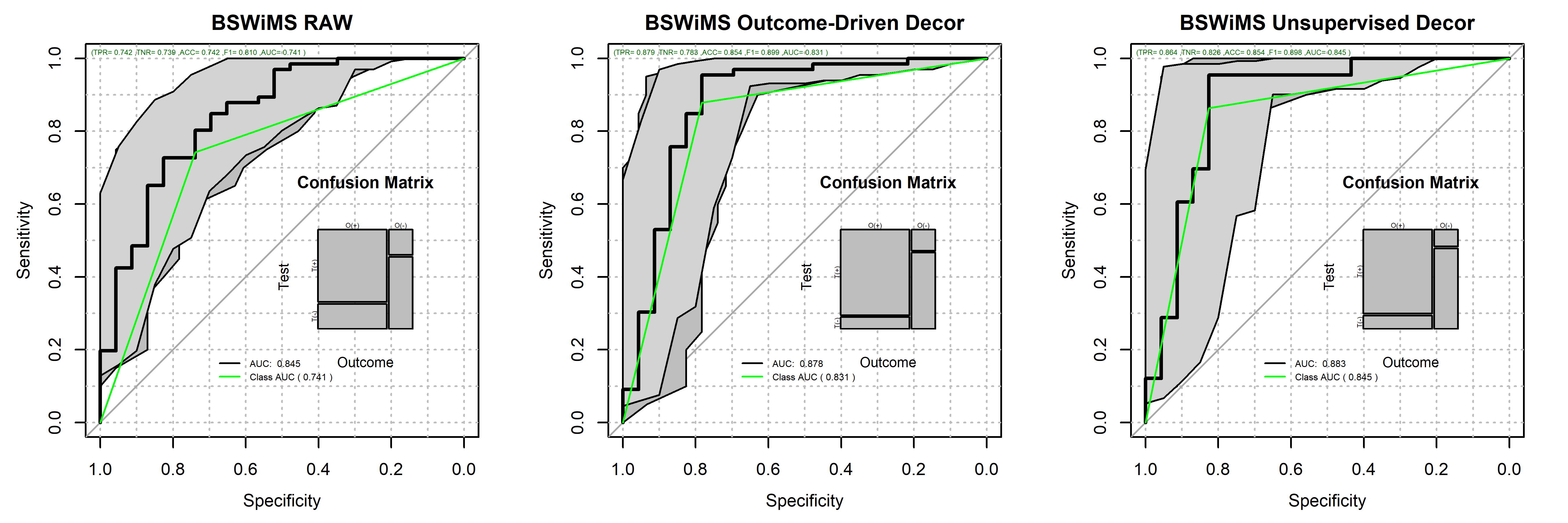
DeLong’s test for two correlated ROC curves: bpraw$ROC.analysis$roc.predictor and bpdecor$ROC.analysis$roc.predictor

| Test statistic | P value | Alternative hypothesis | AUC of roc1 | AUC of roc2 |
| --- | --- | --- | --- | --- |
| -1.409 | 0.159 | two.sided | 0.8452 | 0.8781 |

bmdU <- BSWiMS.model(class~.,deTrainU,NumberofRepeats = 20)

[+++++++–+-+++-++-+++-+++-+-+++++++++-+++-++++-+++-+–+++–+++–++++++++—++++++-+++–+++–+++-+-++++-+++–++++-++++++-+++-++–+++++++-+++-++-+++–]……….

bpdecorU <- predictionStats\_binary(cbind(deTest$class,predict(bmdU,deTestU)),"BSWiMS Unsupervised Decor",cex=0.60)

BSWiMS Unsupervised Decor 

pander::pander(roc.test(bpraw$ROC.analysis$roc.predictor,bpdecorU$ROC.analysis$roc.predictor))

DeLong’s test for two correlated ROC curves: bpraw$ROC.analysis$roc.predictor and bpdecorU$ROC.analysis$roc.predictor

| Test statistic | P value | Alternative hypothesis | AUC of roc1 | AUC of roc2 |
| --- | --- | --- | --- | --- |
| -1.483 | 0.1381 | two.sided | 0.8452 | 0.8827 |

par(op)

### Feature Analysis of Both Models

The analysis of the features required to predict the outcome will use the following:

1. Analysis of the BSWiMS bagged model using the summary function.
2. Analysis of the sparse GDSMT
3. Analysis of the univariate association of the model features of both models
4. Report the new features not found by the Original data analysis

par(op)  
par(mfrow=c(1,1))  
## 1 Get the Model Features  
smOriginal <- summary(bm)  
rawnames <- rownames(smOriginal$coefficients)  
smDecor <- summary(bmd)  
decornames <- rownames(smDecor$coefficients)  
## 2 Get the decorrelation matrix formulas  
dc <- getDerivedCoefficients(deTrain)  
### 2a Get only the ones that were decorrelated by the decorrelation-based model  
deNames\_in\_dc <- decornames[decornames %in% names(dc)]  
selectedlist <- dc[deNames\_in\_dc]  
pander::pander(selectedlist)

* **De\_tqwt\_energy\_dec\_33**:

| * tqwt\_energy\_dec\_31 | * tqwt\_energy\_dec\_33 |
| --- | --- |
| * -0.907 | * 1 |

* **De\_tqwt\_TKEO\_mean\_dec\_17**:

| * tqwt\_TKEO\_mean\_dec\_17 | * tqwt\_minValue\_dec\_17 |
| --- | --- |
| * 1 | * 2.316 |

* **De\_std\_MFCC\_2nd\_coef**:

| * std\_MFCC\_2nd\_coef | * std\_2nd\_delta |
| --- | --- |
| * 1 | * -0.8278 |

* **De\_locDbShimmer**:

| * locDbShimmer | * ddaShimmer |
| --- | --- |
| * 1 | * -0.9626 |

* **De\_tqwt\_stdValue\_dec\_33**:

| * tqwt\_TKEO\_mean\_dec\_35 | * tqwt\_stdValue\_dec\_32 | * tqwt\_stdValue\_dec\_33 |
| --- | --- | --- |
| * -0.131 | * -0.7154 | * 1 |

* **De\_std\_12th\_delta\_delta**:

| * std\_MFCC\_12th\_coef | * std\_12th\_delta\_delta |
| --- | --- |
| * -0.9139 | * 1 |

* **De\_tqwt\_kurtosisValue\_dec\_33**:

| * tqwt\_kurtosisValue\_dec\_32 | * tqwt\_kurtosisValue\_dec\_33 |
| --- | --- |
| * -0.8834 | * 1 |

* **De\_tqwt\_maxValue\_dec\_29**:

| * tqwt\_stdValue\_dec\_28 | * tqwt\_maxValue\_dec\_29 |
| --- | --- |
| * -0.5549 | * 1 |

* **De\_tqwt\_TKEO\_std\_dec\_11**:
* Table continues below

| * tqwt\_TKEO\_mean\_dec\_10 | * tqwt\_TKEO\_mean\_dec\_11 | * tqwt\_TKEO\_std\_dec\_11 |
| --- | --- | --- |
| * 0.7128 | * -0.6442 | * 1 |

| * tqwt\_stdValue\_dec\_10 | * tqwt\_minValue\_dec\_17 |
| --- | --- |
| * -1.64 | * 0.3142 |

* **De\_tqwt\_TKEO\_std\_dec\_36**:

| * tqwt\_TKEO\_mean\_dec\_35 | * tqwt\_TKEO\_std\_dec\_36 |
| --- | --- |
| * -0.9259 | * 1 |

* **De\_tqwt\_minValue\_dec\_7**:

| * tqwt\_minValue\_dec\_7 | * tqwt\_minValue\_dec\_17 | * tqwt\_maxValue\_dec\_8 |
| --- | --- | --- |
| * 1 | * -0.01864 | * 0.967 |

* **De\_tqwt\_entropy\_shannon\_dec\_17**:

| * tqwt\_entropy\_shannon\_dec\_17 | * tqwt\_minValue\_dec\_17 |
| --- | --- |
| * 1 | * 1.616 |

* **De\_tqwt\_kurtosisValue\_dec\_2**:

| * tqwt\_kurtosisValue\_dec\_2 | * tqwt\_kurtosisValue\_dec\_3 |
| --- | --- |
| * 1 | * -0.9796 |

* **De\_tqwt\_TKEO\_std\_dec\_7**:

| * tqwt\_TKEO\_std\_dec\_7 | * tqwt\_stdValue\_dec\_7 | * tqwt\_minValue\_dec\_17 |
| --- | --- | --- |
| * 1 | * -1.662 | * 0.1454 |

* **De\_det\_LT\_TKEO\_mean\_3\_coef**:

| * Ed2\_3\_coef | * det\_LT\_TKEO\_mean\_1\_coef | * det\_LT\_TKEO\_mean\_3\_coef |
| --- | --- | --- |
| * -0.8897 | * -0.08343 | * 1 |

* **De\_minIntensity**:

| * minIntensity | * meanIntensity |
| --- | --- |
| * 1 | * -1.213 |

* **De\_tqwt\_minValue\_dec\_11**:

| * tqwt\_minValue\_dec\_11 | * tqwt\_minValue\_dec\_17 |
| --- | --- |
| * 1 | * -0.9183 |

* **De\_tqwt\_entropy\_log\_dec\_35**:

| * tqwt\_entropy\_log\_dec\_35 | * tqwt\_TKEO\_mean\_dec\_35 |
| --- | --- |
| * 1 | * -0.1063 |

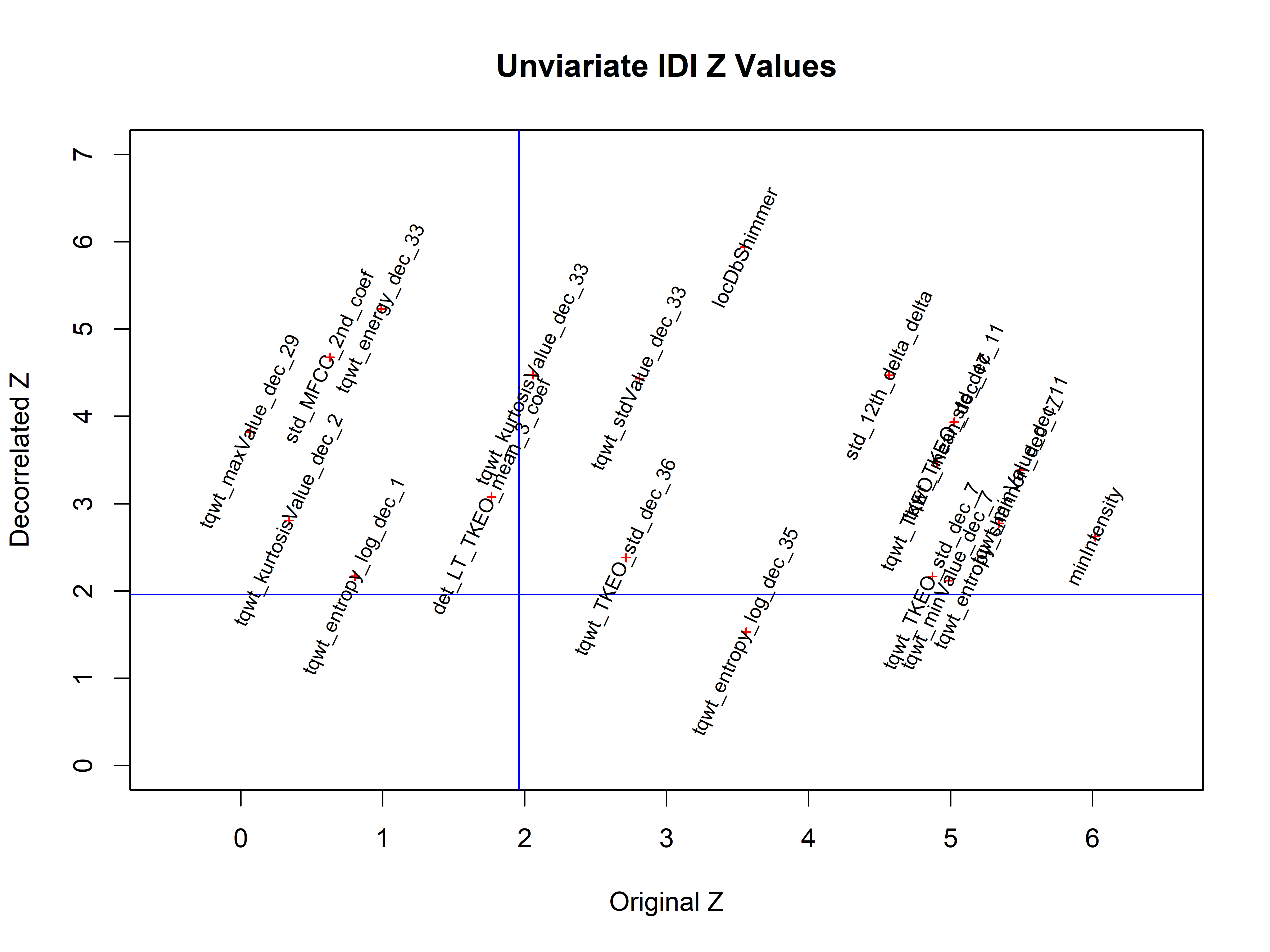
* **De\_tqwt\_entropy\_log\_dec\_1**:

| * tqwt\_entropy\_log\_dec\_1 | * tqwt\_entropy\_log\_dec\_2 |
| --- | --- |
| * 1 | * -0.8485 |

names(selectedlist) <- NULL  
### 2b Get the the names of the orignial features  
allDevar <- unique(c(names(unlist(selectedlist)),decornames))  
allDevar <- allDevar[!str\_detect(allDevar,"De\_")]  
allDevar <- str\_remove(allDevar,"Ba\_")  
  
### 2c Get only the new feautres not found in the original analysis  
dvar <- allDevar[!(allDevar %in% rawnames)]   
  
### 2d Get the decorrelated variables that have new features  
newvars <- character();  
for (cvar in deNames\_in\_dc)  
{  
 lvar <- dc[cvar]  
 names(lvar) <- NULL  
 lvar <- names(unlist(lvar))  
 if (length(lvar[lvar %in% dvar]) > 0)  
 {  
 newvars <- append(newvars,cvar)  
 }  
}  
  
## 3 Here is the univariate z values of the orignal set  
#pander::pander(bm$univariate[dvar,])  
## 4 Here is the univariate z values of the decorrelated set  
#pander::pander(bmd$univariate[newvars,])  
  
## 4a The scater plot of the decorrelated vs original Univariate values  
  
zvalueNew <- bmd$univariate[newvars,]  
rownames(zvalueNew) <- str\_remove(rownames(zvalueNew),"De\_")  
rownames(zvalueNew) <- str\_remove(rownames(zvalueNew),"Ba\_")  
  
zvaluePrePost <- bm$univariate[rownames(zvalueNew),c(1,3)]  
zvaluePrePost$Name <- NULL  
zvaluePrePost$NewZ <- zvalueNew[rownames(zvaluePrePost),"ZUni"]  
pander::pander(zvaluePrePost)

|  | ZUni | NewZ |
| --- | --- | --- |
| **tqwt\_energy\_dec\_33** | 0.9895 | 5.23 |
| **tqwt\_TKEO\_mean\_dec\_17** | 4.905 | 3.471 |
| **std\_MFCC\_2nd\_coef** | 0.6278 | 4.676 |
| **locDbShimmer** | 3.548 | 5.94 |
| **tqwt\_stdValue\_dec\_33** | 2.81 | 4.433 |
| **std\_12th\_delta\_delta** | 4.566 | 4.471 |
| **tqwt\_kurtosisValue\_dec\_33** | 2.06 | 4.48 |
| **tqwt\_maxValue\_dec\_29** | 0.06766 | 3.821 |
| **tqwt\_TKEO\_std\_dec\_11** | 5.025 | 3.935 |
| **tqwt\_TKEO\_std\_dec\_36** | 2.714 | 2.384 |
| **tqwt\_minValue\_dec\_7** | 4.986 | 2.116 |
| **tqwt\_entropy\_shannon\_dec\_17** | 5.34 | 2.776 |
| **tqwt\_kurtosisValue\_dec\_2** | 0.3412 | 2.809 |
| **tqwt\_TKEO\_std\_dec\_7** | 4.872 | 2.165 |
| **det\_LT\_TKEO\_mean\_3\_coef** | 1.767 | 3.076 |
| **minIntensity** | 6.019 | 2.623 |
| **tqwt\_minValue\_dec\_11** | 5.493 | 3.383 |
| **tqwt\_entropy\_log\_dec\_35** | 3.561 | 1.531 |
| **tqwt\_entropy\_log\_dec\_1** | 0.8049 | 2.169 |

plot(zvaluePrePost,  
 xlim=c(-0.5,6.5),  
 ylim=c(0,7),  
 xlab="Original Z",  
 ylab="Decorrelated Z",  
 main="Unviariate IDI Z Values",  
 pch=3,cex=0.5,  
 col="red")  
abline(v=1.96,col="blue")  
abline(h=1.96,col="blue")  
text(zvaluePrePost$ZUni,zvaluePrePost$NewZ,rownames(zvaluePrePost),srt=65,cex=0.75)



### The Summary of the Decorrelated-based model

Here I will print the summary statistics of the Logistic models found by BSWiMS, using the original and transformed dataset. After that, I will show the characteristics of the features not found by the original analysis.

pander::pander(smOriginal$coefficients)

Table continues below

|  | Estimate | lower | OR | upper |
| --- | --- | --- | --- | --- |
| **tqwt\_entropy\_shannon\_dec\_17** | -0.008832 | 0.9891 | 0.9912 | 0.9933 |
| **std\_12th\_delta\_delta** | 0.02803 | 1.021 | 1.028 | 1.036 |
| **tqwt\_stdValue\_dec\_11** | -0.0196 | 0.9755 | 0.9806 | 0.9857 |
| **minIntensity** | -0.7183 | 0.3977 | 0.4876 | 0.5977 |
| **tqwt\_kurtosisValue\_dec\_28** | -0.01547 | 0.9798 | 0.9847 | 0.9895 |
| **std\_6th\_delta\_delta** | 0.301 | 1.229 | 1.351 | 1.486 |
| **std\_delta\_delta\_log\_energy** | 0.1131 | 1.08 | 1.12 | 1.161 |
| **tqwt\_entropy\_shannon\_dec\_16** | -0.02329 | 0.9705 | 0.977 | 0.9835 |
| **std\_delta\_log\_energy** | 0.1144 | 1.079 | 1.121 | 1.165 |
| **tqwt\_maxValue\_dec\_10** | -0.02312 | 0.9695 | 0.9771 | 0.9848 |
| **tqwt\_TKEO\_mean\_dec\_12** | -0.02302 | 0.9706 | 0.9772 | 0.984 |
| **std\_Log\_energy** | 0.1106 | 1.079 | 1.117 | 1.157 |
| **std\_7th\_delta** | 0.224 | 1.161 | 1.251 | 1.348 |
| **std\_6th\_delta** | 0.2553 | 1.184 | 1.291 | 1.408 |
| **tqwt\_maxValue\_dec\_11** | -0.0675 | 0.9131 | 0.9347 | 0.9569 |
| **tqwt\_maxValue\_dec\_12** | -0.06275 | 0.9193 | 0.9392 | 0.9595 |
| **tqwt\_kurtosisValue\_dec\_27** | -0.008303 | 0.9888 | 0.9917 | 0.9947 |
| **std\_7th\_delta\_delta** | 0.2574 | 1.192 | 1.294 | 1.404 |
| **tqwt\_TKEO\_std\_dec\_11** | -0.01839 | 0.9758 | 0.9818 | 0.9878 |
| **std\_9th\_delta\_delta** | 0.2115 | 1.146 | 1.235 | 1.332 |
| **std\_12th\_delta** | 0.05648 | 1.037 | 1.058 | 1.08 |
| **tqwt\_entropy\_shannon\_dec\_12** | -0.0241 | 0.9681 | 0.9762 | 0.9843 |
| **IMF\_SNR\_entropy** | 0.01964 | 1.013 | 1.02 | 1.026 |
| **locAbsJitter** | 0.01237 | 1.008 | 1.012 | 1.017 |
| **tqwt\_entropy\_log\_dec\_12** | -0.178 | 0.7858 | 0.837 | 0.8914 |
| **tqwt\_kurtosisValue\_dec\_17** | 0.0192 | 1.012 | 1.019 | 1.027 |
| **tqwt\_TKEO\_std\_dec\_7** | -0.01823 | 0.9754 | 0.9819 | 0.9885 |
| **tqwt\_entropy\_log\_dec\_11** | -0.1902 | 0.7712 | 0.8268 | 0.8864 |
| **tqwt\_maxValue\_dec\_13** | -0.02369 | 0.9691 | 0.9766 | 0.9842 |
| **tqwt\_kurtosisValue\_dec\_16** | 0.01835 | 1.012 | 1.019 | 1.025 |
| **std\_9th\_delta** | 0.1655 | 1.11 | 1.18 | 1.254 |
| **std\_8th\_delta\_delta** | 0.223 | 1.151 | 1.25 | 1.357 |
| **tqwt\_TKEO\_std\_dec\_12** | -0.02254 | 0.9699 | 0.9777 | 0.9856 |
| **tqwt\_entropy\_log\_dec\_35** | -0.01332 | 0.9819 | 0.9868 | 0.9916 |
| **tqwt\_entropy\_log\_dec\_13** | -0.1647 | 0.8024 | 0.8482 | 0.8966 |
| **std\_8th\_delta** | 0.2227 | 1.155 | 1.249 | 1.352 |
| **std\_MFCC\_6th\_coef** | 0.1179 | 1.077 | 1.125 | 1.176 |
| **std\_MFCC\_8th\_coef** | 0.1335 | 1.091 | 1.143 | 1.197 |
| **tqwt\_energy\_dec\_6** | -0.006235 | 0.9915 | 0.9938 | 0.9961 |
| **tqwt\_energy\_dec\_12** | -0.01475 | 0.9799 | 0.9854 | 0.9909 |
| **std\_11th\_delta\_delta** | 0.1849 | 1.125 | 1.203 | 1.286 |
| **std\_5th\_delta** | 0.1433 | 1.098 | 1.154 | 1.213 |
| **std\_10th\_delta\_delta** | 0.1738 | 1.114 | 1.19 | 1.271 |
| **tqwt\_maxValue\_dec\_7** | -0.03688 | 0.9502 | 0.9638 | 0.9776 |
| **std\_10th\_delta** | 0.09336 | 1.058 | 1.098 | 1.139 |
| **tqwt\_kurtosisValue\_dec\_26** | -0.03286 | 0.9551 | 0.9677 | 0.9804 |
| **tqwt\_kurtosisValue\_dec\_18** | 0.1025 | 1.064 | 1.108 | 1.154 |
| **tqwt\_TKEO\_std\_dec\_6** | -0.002327 | 0.9967 | 0.9977 | 0.9986 |
| **tqwt\_kurtosisValue\_dec\_34** | 0.004937 | 1.003 | 1.005 | 1.007 |
| **tqwt\_meanValue\_dec\_11** | 0.0001821 | 1 | 1 | 1 |
| **IMF\_NSR\_TKEO** | -0.07464 | 0.9001 | 0.9281 | 0.9569 |
| **tqwt\_entropy\_log\_dec\_33** | -0.01973 | 0.9725 | 0.9805 | 0.9885 |
| **tqwt\_entropy\_log\_dec\_34** | -0.01355 | 0.981 | 0.9865 | 0.9921 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.1785 | 1.109 | 1.195 | 1.288 |
| **tqwt\_entropy\_shannon\_dec\_13** | -0.01433 | 0.9801 | 0.9858 | 0.9915 |
| **tqwt\_maxValue\_dec\_6** | -0.005238 | 0.9926 | 0.9948 | 0.997 |
| **tqwt\_kurtosisValue\_dec\_36** | 0.03735 | 1.022 | 1.038 | 1.055 |
| **tqwt\_kurtosisValue\_dec\_35** | 0.05824 | 1.034 | 1.06 | 1.087 |
| **tqwt\_maxValue\_dec\_1** | -0.008939 | 0.9872 | 0.9911 | 0.995 |
| **mean\_delta\_log\_energy** | 0.001019 | 1.001 | 1.001 | 1.001 |
| **tqwt\_entropy\_log\_dec\_16** | -0.06336 | 0.9125 | 0.9386 | 0.9655 |

Table continues below

|  | u.Accuracy | r.Accuracy | full.Accuracy |
| --- | --- | --- | --- |
| **tqwt\_entropy\_shannon\_dec\_17** | 0.6319 | 0.7423 | 0.692 |
| **std\_12th\_delta\_delta** | 0.6577 | 0.7086 | 0.6742 |
| **tqwt\_stdValue\_dec\_11** | 0.6642 | 0.637 | 0.7196 |
| **minIntensity** | 0.6077 | 0.7009 | 0.6937 |
| **tqwt\_kurtosisValue\_dec\_28** | 0.6796 | 0.6597 | 0.717 |
| **std\_6th\_delta\_delta** | 0.6715 | 0.7168 | 0.7528 |
| **std\_delta\_delta\_log\_energy** | 0.7169 | 0.7044 | 0.7508 |
| **tqwt\_entropy\_shannon\_dec\_16** | 0.6764 | 0.7069 | 0.6899 |
| **std\_delta\_log\_energy** | 0.7103 | 0.7109 | 0.745 |
| **tqwt\_maxValue\_dec\_10** | 0.6594 | 0.6888 | 0.7117 |
| **tqwt\_TKEO\_mean\_dec\_12** | 0.7264 | 0.6742 | 0.7165 |
| **std\_Log\_energy** | 0.6614 | 0.708 | 0.7091 |
| **std\_7th\_delta** | 0.6748 | 0.7008 | 0.7151 |
| **std\_6th\_delta** | 0.6354 | 0.7169 | 0.7307 |
| **tqwt\_maxValue\_dec\_11** | 0.6906 | 0.7001 | 0.7485 |
| **tqwt\_maxValue\_dec\_12** | 0.7175 | 0.6988 | 0.7442 |
| **tqwt\_kurtosisValue\_dec\_27** | 0.6892 | 0.6501 | 0.7149 |
| **std\_7th\_delta\_delta** | 0.6887 | 0.7184 | 0.7222 |
| **tqwt\_TKEO\_std\_dec\_11** | 0.6706 | 0.6558 | 0.712 |
| **std\_9th\_delta\_delta** | 0.6902 | 0.7063 | 0.7291 |
| **std\_12th\_delta** | 0.6556 | 0.6775 | 0.7059 |
| **tqwt\_entropy\_shannon\_dec\_12** | 0.7202 | 0.6656 | 0.7155 |
| **IMF\_SNR\_entropy** | 0.6221 | 0.6745 | 0.7298 |
| **locAbsJitter** | 0.6395 | 0.6479 | 0.6935 |
| **tqwt\_entropy\_log\_dec\_12** | 0.7401 | 0.691 | 0.741 |
| **tqwt\_kurtosisValue\_dec\_17** | 0.6325 | 0.6521 | 0.7037 |
| **tqwt\_TKEO\_std\_dec\_7** | 0.6413 | 0.6643 | 0.7102 |
| **tqwt\_entropy\_log\_dec\_11** | 0.6976 | 0.6634 | 0.7202 |
| **tqwt\_maxValue\_dec\_13** | 0.6817 | 0.6916 | 0.6998 |
| **tqwt\_kurtosisValue\_dec\_16** | 0.6515 | 0.6307 | 0.6994 |
| **std\_9th\_delta** | 0.6664 | 0.6953 | 0.7132 |
| **std\_8th\_delta\_delta** | 0.6899 | 0.7026 | 0.7294 |
| **tqwt\_TKEO\_std\_dec\_12** | 0.7252 | 0.6787 | 0.7294 |
| **tqwt\_entropy\_log\_dec\_35** | 0.6589 | 0.6822 | 0.7147 |
| **tqwt\_entropy\_log\_dec\_13** | 0.711 | 0.6706 | 0.7144 |
| **std\_8th\_delta** | 0.6633 | 0.7042 | 0.7158 |
| **std\_MFCC\_6th\_coef** | 0.5801 | 0.6703 | 0.7346 |
| **std\_MFCC\_8th\_coef** | 0.656 | 0.6988 | 0.6949 |
| **tqwt\_energy\_dec\_6** | 0.5967 | 0.6847 | 0.7337 |
| **tqwt\_energy\_dec\_12** | 0.6708 | 0.6784 | 0.7144 |
| **std\_11th\_delta\_delta** | 0.6875 | 0.6731 | 0.7261 |
| **std\_5th\_delta** | 0.6228 | 0.6824 | 0.7098 |
| **std\_10th\_delta\_delta** | 0.6782 | 0.6933 | 0.7112 |
| **tqwt\_maxValue\_dec\_7** | 0.638 | 0.6726 | 0.6956 |
| **std\_10th\_delta** | 0.6563 | 0.6894 | 0.7099 |
| **tqwt\_kurtosisValue\_dec\_26** | 0.7613 | 0.6491 | 0.7117 |
| **tqwt\_kurtosisValue\_dec\_18** | 0.6525 | 0.6368 | 0.6809 |
| **tqwt\_TKEO\_std\_dec\_6** | 0.6589 | 0.6571 | 0.7178 |
| **tqwt\_kurtosisValue\_dec\_34** | 0.6233 | 0.6859 | 0.7264 |
| **tqwt\_meanValue\_dec\_11** | 0.6135 | 0.6748 | 0.716 |
| **IMF\_NSR\_TKEO** | 0.6164 | 0.7323 | 0.7674 |
| **tqwt\_entropy\_log\_dec\_33** | 0.6393 | 0.6859 | 0.735 |
| **tqwt\_entropy\_log\_dec\_34** | 0.6779 | 0.6828 | 0.727 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.6696 | 0.6572 | 0.7145 |
| **tqwt\_entropy\_shannon\_dec\_13** | 0.6867 | 0.6722 | 0.7014 |
| **tqwt\_maxValue\_dec\_6** | 0.6577 | 0.6798 | 0.711 |
| **tqwt\_kurtosisValue\_dec\_36** | 0.6784 | 0.7138 | 0.7505 |
| **tqwt\_kurtosisValue\_dec\_35** | 0.6443 | 0.6888 | 0.7342 |
| **tqwt\_maxValue\_dec\_1** | 0.6365 | 0.6837 | 0.727 |
| **mean\_delta\_log\_energy** | 0.7423 | 0.6421 | 0.6933 |
| **tqwt\_entropy\_log\_dec\_16** | 0.6888 | 0.6685 | 0.7109 |

Table continues below

|  | u.AUC | r.AUC | full.AUC | IDI |
| --- | --- | --- | --- | --- |
| **tqwt\_entropy\_shannon\_dec\_17** | 0.6926 | 0.6578 | 0.719 | 0.1533 |
| **std\_12th\_delta\_delta** | 0.6717 | 0.5851 | 0.6844 | 0.1596 |
| **tqwt\_stdValue\_dec\_11** | 0.6774 | 0.6131 | 0.7431 | 0.1467 |
| **minIntensity** | 0.6814 | 0.6573 | 0.7339 | 0.1409 |
| **tqwt\_kurtosisValue\_dec\_28** | 0.673 | 0.6654 | 0.7302 | 0.1342 |
| **std\_6th\_delta\_delta** | 0.7023 | 0.7277 | 0.7752 | 0.1346 |
| **std\_delta\_delta\_log\_energy** | 0.7238 | 0.7202 | 0.7651 | 0.1301 |
| **tqwt\_entropy\_shannon\_dec\_16** | 0.7341 | 0.5851 | 0.7376 | 0.1235 |
| **std\_delta\_log\_energy** | 0.7139 | 0.7195 | 0.766 | 0.1225 |
| **tqwt\_maxValue\_dec\_10** | 0.6915 | 0.6613 | 0.7165 | 0.1179 |
| **tqwt\_TKEO\_mean\_dec\_12** | 0.7065 | 0.6717 | 0.7235 | 0.1204 |
| **std\_Log\_energy** | 0.6871 | 0.6636 | 0.7197 | 0.1222 |
| **std\_7th\_delta** | 0.7091 | 0.6928 | 0.7303 | 0.1208 |
| **std\_6th\_delta** | 0.6654 | 0.7156 | 0.7514 | 0.119 |
| **tqwt\_maxValue\_dec\_11** | 0.7046 | 0.7137 | 0.7744 | 0.1043 |
| **tqwt\_maxValue\_dec\_12** | 0.7337 | 0.7129 | 0.765 | 0.105 |
| **tqwt\_kurtosisValue\_dec\_27** | 0.6628 | 0.6821 | 0.7054 | 0.1098 |
| **std\_7th\_delta\_delta** | 0.7157 | 0.707 | 0.7338 | 0.1163 |
| **tqwt\_TKEO\_std\_dec\_11** | 0.6794 | 0.6668 | 0.7361 | 0.1076 |
| **std\_9th\_delta\_delta** | 0.7193 | 0.7099 | 0.7447 | 0.1109 |
| **std\_12th\_delta** | 0.6849 | 0.6723 | 0.7169 | 0.1071 |
| **tqwt\_entropy\_shannon\_dec\_12** | 0.7184 | 0.6916 | 0.7302 | 0.1062 |
| **IMF\_SNR\_entropy** | 0.6091 | 0.7077 | 0.7332 | 0.1081 |
| **locAbsJitter** | 0.653 | 0.6854 | 0.7088 | 0.1061 |
| **tqwt\_entropy\_log\_dec\_12** | 0.7302 | 0.7115 | 0.7516 | 0.1016 |
| **tqwt\_kurtosisValue\_dec\_17** | 0.6719 | 0.6818 | 0.73 | 0.09889 |
| **tqwt\_TKEO\_std\_dec\_7** | 0.6754 | 0.6828 | 0.7342 | 0.1041 |
| **tqwt\_entropy\_log\_dec\_11** | 0.6945 | 0.693 | 0.7392 | 0.09751 |
| **tqwt\_maxValue\_dec\_13** | 0.7149 | 0.6389 | 0.7291 | 0.1027 |
| **tqwt\_kurtosisValue\_dec\_16** | 0.6981 | 0.6534 | 0.7144 | 0.1017 |
| **std\_9th\_delta** | 0.7056 | 0.6948 | 0.7299 | 0.1076 |
| **std\_8th\_delta\_delta** | 0.712 | 0.7164 | 0.7478 | 0.1087 |
| **tqwt\_TKEO\_std\_dec\_12** | 0.7201 | 0.7029 | 0.7511 | 0.1018 |
| **tqwt\_entropy\_log\_dec\_35** | 0.6442 | 0.6744 | 0.7325 | 0.1013 |
| **tqwt\_entropy\_log\_dec\_13** | 0.7128 | 0.6841 | 0.7321 | 0.1027 |
| **std\_8th\_delta** | 0.6843 | 0.7065 | 0.736 | 0.1102 |
| **std\_MFCC\_6th\_coef** | 0.6034 | 0.6898 | 0.7574 | 0.09998 |
| **std\_MFCC\_8th\_coef** | 0.6736 | 0.6496 | 0.7195 | 0.1034 |
| **tqwt\_energy\_dec\_6** | 0.6324 | 0.7041 | 0.7503 | 0.1009 |
| **tqwt\_energy\_dec\_12** | 0.6734 | 0.6665 | 0.7231 | 0.09578 |
| **std\_11th\_delta\_delta** | 0.7061 | 0.6933 | 0.7436 | 0.09905 |
| **std\_5th\_delta** | 0.6573 | 0.6981 | 0.7377 | 0.09807 |
| **std\_10th\_delta\_delta** | 0.6924 | 0.7036 | 0.7304 | 0.0994 |
| **tqwt\_maxValue\_dec\_7** | 0.6786 | 0.6872 | 0.7185 | 0.09412 |
| **std\_10th\_delta** | 0.6795 | 0.7013 | 0.7354 | 0.09319 |
| **tqwt\_kurtosisValue\_dec\_26** | 0.662 | 0.6904 | 0.7122 | 0.08978 |
| **tqwt\_kurtosisValue\_dec\_18** | 0.6774 | 0.674 | 0.703 | 0.09042 |
| **tqwt\_TKEO\_std\_dec\_6** | 0.6653 | 0.6875 | 0.741 | 0.0855 |
| **tqwt\_kurtosisValue\_dec\_34** | 0.6431 | 0.6922 | 0.7379 | 0.08347 |
| **tqwt\_meanValue\_dec\_11** | 0.6527 | 0.6727 | 0.709 | 0.08336 |
| **IMF\_NSR\_TKEO** | 0.59 | 0.7447 | 0.781 | 0.07956 |
| **tqwt\_entropy\_log\_dec\_33** | 0.6198 | 0.7027 | 0.7468 | 0.08175 |
| **tqwt\_entropy\_log\_dec\_34** | 0.6626 | 0.6845 | 0.7358 | 0.08203 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.6884 | 0.7026 | 0.7457 | 0.07904 |
| **tqwt\_entropy\_shannon\_dec\_13** | 0.7156 | 0.6799 | 0.7295 | 0.07829 |
| **tqwt\_maxValue\_dec\_6** | 0.6968 | 0.6897 | 0.7236 | 0.08336 |
| **tqwt\_kurtosisValue\_dec\_36** | 0.7098 | 0.7283 | 0.7626 | 0.08039 |
| **tqwt\_kurtosisValue\_dec\_35** | 0.668 | 0.7093 | 0.75 | 0.07558 |
| **tqwt\_maxValue\_dec\_1** | 0.6746 | 0.6952 | 0.7375 | 0.0741 |
| **mean\_delta\_log\_energy** | 0.6578 | 0.6891 | 0.7157 | 0.06911 |
| **tqwt\_entropy\_log\_dec\_16** | 0.6975 | 0.6948 | 0.7375 | 0.06997 |

|  | NRI | z.IDI | z.NRI | Frequency |
| --- | --- | --- | --- | --- |
| **tqwt\_entropy\_shannon\_dec\_17** | 0.7426 | 6.74 | 6.597 | 0.1 |
| **std\_12th\_delta\_delta** | 0.759 | 6.622 | 6.479 | 0.1 |
| **tqwt\_stdValue\_dec\_11** | 0.6902 | 6.475 | 5.845 | 0.3 |
| **minIntensity** | 0.6801 | 6.243 | 5.963 | 0.9 |
| **tqwt\_kurtosisValue\_dec\_28** | 0.7295 | 6.061 | 6.18 | 0.4 |
| **std\_6th\_delta\_delta** | 0.7003 | 6.052 | 5.908 | 1 |
| **std\_delta\_delta\_log\_energy** | 0.6756 | 5.941 | 5.667 | 1 |
| **tqwt\_entropy\_shannon\_dec\_16** | 0.7433 | 5.818 | 6.613 | 0.65 |
| **std\_delta\_log\_energy** | 0.6121 | 5.777 | 5.106 | 1 |
| **tqwt\_maxValue\_dec\_10** | 0.6807 | 5.713 | 5.752 | 0.4 |
| **tqwt\_TKEO\_mean\_dec\_12** | 0.7279 | 5.667 | 6.209 | 1 |
| **std\_Log\_energy** | 0.5688 | 5.589 | 4.797 | 0.95 |
| **std\_7th\_delta** | 0.7867 | 5.583 | 6.822 | 1 |
| **std\_6th\_delta** | 0.6062 | 5.561 | 5.036 | 1 |
| **tqwt\_maxValue\_dec\_11** | 0.5328 | 5.541 | 4.394 | 1 |
| **tqwt\_maxValue\_dec\_12** | 0.6475 | 5.523 | 5.459 | 1 |
| **tqwt\_kurtosisValue\_dec\_27** | 0.6317 | 5.448 | 5.271 | 0.3 |
| **std\_7th\_delta\_delta** | 0.6938 | 5.435 | 5.921 | 1 |
| **tqwt\_TKEO\_std\_dec\_11** | 0.5703 | 5.412 | 4.762 | 0.7 |
| **std\_9th\_delta\_delta** | 0.6536 | 5.383 | 5.495 | 1 |
| **std\_12th\_delta** | 0.6743 | 5.354 | 5.73 | 0.3 |
| **tqwt\_entropy\_shannon\_dec\_12** | 0.6962 | 5.345 | 5.894 | 1 |
| **IMF\_SNR\_entropy** | 0.6336 | 5.34 | 5.345 | 0.2 |
| **locAbsJitter** | 0.4997 | 5.33 | 4.092 | 0.25 |
| **tqwt\_entropy\_log\_dec\_12** | 0.7131 | 5.3 | 6.1 | 1 |
| **tqwt\_kurtosisValue\_dec\_17** | 0.5934 | 5.257 | 4.992 | 0.1 |
| **tqwt\_TKEO\_std\_dec\_7** | 0.5731 | 5.255 | 4.747 | 0.75 |
| **tqwt\_entropy\_log\_dec\_11** | 0.6915 | 5.251 | 5.84 | 0.95 |
| **tqwt\_maxValue\_dec\_13** | 0.6709 | 5.247 | 5.714 | 0.55 |
| **tqwt\_kurtosisValue\_dec\_16** | 0.7727 | 5.247 | 6.829 | 0.15 |
| **std\_9th\_delta** | 0.6824 | 5.235 | 5.784 | 0.85 |
| **std\_8th\_delta\_delta** | 0.6836 | 5.227 | 5.772 | 1 |
| **tqwt\_TKEO\_std\_dec\_12** | 0.6564 | 5.225 | 5.556 | 1 |
| **tqwt\_entropy\_log\_dec\_35** | 0.6049 | 5.217 | 5.014 | 0.1 |
| **tqwt\_entropy\_log\_dec\_13** | 0.7311 | 5.212 | 6.241 | 1 |
| **std\_8th\_delta** | 0.6859 | 5.208 | 5.777 | 1 |
| **std\_MFCC\_6th\_coef** | 0.5279 | 5.178 | 4.362 | 0.45 |
| **std\_MFCC\_8th\_coef** | 0.63 | 5.15 | 5.24 | 0.65 |
| **tqwt\_energy\_dec\_6** | 0.6372 | 5.093 | 5.309 | 0.15 |
| **tqwt\_energy\_dec\_12** | 0.6265 | 5.053 | 5.207 | 0.65 |
| **std\_11th\_delta\_delta** | 0.5475 | 5.044 | 4.541 | 1 |
| **std\_5th\_delta** | 0.4967 | 5.021 | 4.079 | 0.7 |
| **std\_10th\_delta\_delta** | 0.5718 | 4.969 | 4.765 | 1 |
| **tqwt\_maxValue\_dec\_7** | 0.6749 | 4.967 | 5.745 | 0.7 |
| **std\_10th\_delta** | 0.4249 | 4.895 | 3.457 | 0.6 |
| **tqwt\_kurtosisValue\_dec\_26** | 0.5485 | 4.824 | 4.908 | 1 |
| **tqwt\_kurtosisValue\_dec\_18** | 0.6104 | 4.781 | 5.082 | 0.6 |
| **tqwt\_TKEO\_std\_dec\_6** | 0.5492 | 4.771 | 4.498 | 0.1 |
| **tqwt\_kurtosisValue\_dec\_34** | 0.577 | 4.71 | 4.764 | 0.1 |
| **tqwt\_meanValue\_dec\_11** | 0.6311 | 4.703 | 5.376 | 0.1 |
| **IMF\_NSR\_TKEO** | 0.51 | 4.638 | 4.237 | 0.65 |
| **tqwt\_entropy\_log\_dec\_33** | 0.4574 | 4.613 | 3.747 | 0.1 |
| **tqwt\_entropy\_log\_dec\_34** | 0.5918 | 4.595 | 4.905 | 0.1 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.6292 | 4.574 | 5.249 | 1 |
| **tqwt\_entropy\_shannon\_dec\_13** | 0.6152 | 4.527 | 5.171 | 0.8 |
| **tqwt\_maxValue\_dec\_6** | 0.7492 | 4.524 | 6.425 | 0.1 |
| **tqwt\_kurtosisValue\_dec\_36** | 0.7211 | 4.443 | 6.158 | 1 |
| **tqwt\_kurtosisValue\_dec\_35** | 0.6141 | 4.432 | 5.125 | 1 |
| **tqwt\_maxValue\_dec\_1** | 0.5607 | 4.36 | 4.671 | 0.2 |
| **mean\_delta\_log\_energy** | 0.6426 | 4.289 | 5.643 | 0.15 |
| **tqwt\_entropy\_log\_dec\_16** | 0.5251 | 4.261 | 4.327 | 0.9 |

pander::pander(smDecor$coefficients)

Table continues below

|  | Estimate | lower | OR | upper |
| --- | --- | --- | --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 0.4241 | 1.374 | 1.528 | 1.699 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 0.1329 | 1.105 | 1.142 | 1.18 |
| **Ba\_locAbsJitter** | 0.02448 | 1.018 | 1.025 | 1.032 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | -0.5613 | 0.4941 | 0.5705 | 0.6587 |
| **De\_tqwt\_energy\_dec\_33** | -0.1948 | 0.7767 | 0.823 | 0.872 |
| **Ba\_tqwt\_energy\_dec\_12** | -0.05198 | 0.9343 | 0.9494 | 0.9646 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | -0.03736 | 0.9513 | 0.9633 | 0.9755 |
| **De\_std\_MFCC\_2nd\_coef** | -1.314 | 0.1757 | 0.2687 | 0.411 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | -0.05167 | 0.935 | 0.9496 | 0.9646 |
| **Ba\_meanIntensity** | -1.552 | 0.1307 | 0.2118 | 0.3433 |
| **De\_tqwt\_TKEO\_mean\_dec\_11** | -0.04639 | 0.9401 | 0.9547 | 0.9695 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.5128 | 1.413 | 1.67 | 1.974 |
| **De\_locDbShimmer** | 0.9748 | 1.944 | 2.651 | 3.614 |
| **De\_tqwt\_stdValue\_dec\_33** | -0.7762 | 0.3533 | 0.4602 | 0.5993 |
| **De\_std\_12th\_delta\_delta** | 0.7864 | 1.669 | 2.196 | 2.888 |
| **De\_std\_MFCC\_6th\_coef** | 0.2757 | 1.196 | 1.317 | 1.452 |
| **std\_MFCC\_8th\_coef** | 0.6001 | 1.47 | 1.822 | 2.259 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | -0.03397 | 0.9545 | 0.9666 | 0.9788 |
| **Ba\_std\_5th\_delta** | 0.4185 | 1.302 | 1.52 | 1.774 |
| **Ba\_IMF\_SNR\_entropy** | 0.01108 | 1.007 | 1.011 | 1.015 |
| **f1** | -0.04369 | 0.9416 | 0.9573 | 0.9731 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.5497 | 1.414 | 1.733 | 2.124 |
| **De\_tqwt\_maxValue\_dec\_29** | -0.02078 | 0.9717 | 0.9794 | 0.9872 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | -0.06968 | 0.9076 | 0.9327 | 0.9585 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 0.08532 | 1.054 | 1.089 | 1.126 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 0.01438 | 1.009 | 1.014 | 1.02 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.1074 | 1.067 | 1.113 | 1.161 |
| **De\_tqwt\_minValue\_dec\_7** | 0.1517 | 1.095 | 1.164 | 1.237 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | -0.08493 | 0.8875 | 0.9186 | 0.9507 |
| **mean\_MFCC\_12th\_coef** | -0.01205 | 0.9832 | 0.988 | 0.9929 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | -0.04452 | 0.9386 | 0.9565 | 0.9746 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | -0.1446 | 0.8143 | 0.8654 | 0.9197 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | -0.2511 | 0.6993 | 0.7779 | 0.8654 |
| **De\_minIntensity** | -1.442 | 0.1278 | 0.2363 | 0.437 |
| **De\_tqwt\_minValue\_dec\_11** | 0.01698 | 1.009 | 1.017 | 1.025 |
| **tqwt\_meanValue\_dec\_11** | 0.001518 | 1.001 | 1.002 | 1.002 |
| **De\_tqwt\_entropy\_log\_dec\_35** | -0.1161 | 0.8428 | 0.8904 | 0.9407 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.2338 | 1.124 | 1.263 | 1.42 |
| **tqwt\_skewnessValue\_dec\_28** | 0.002661 | 1.001 | 1.003 | 1.004 |

Table continues below

|  | u.Accuracy | r.Accuracy | full.Accuracy |
| --- | --- | --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 0.7177 | 0.7531 | 0.8105 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 0.679 | 0.6955 | 0.7675 |
| **Ba\_locAbsJitter** | 0.6405 | 0.6474 | 0.7301 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | 0.7404 | 0.6931 | 0.7703 |
| **De\_tqwt\_energy\_dec\_33** | 0.7477 | 0.7245 | 0.7831 |
| **Ba\_tqwt\_energy\_dec\_12** | 0.6722 | 0.6911 | 0.7615 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.6485 | 0.7141 | 0.711 |
| **De\_std\_MFCC\_2nd\_coef** | 0.7029 | 0.7774 | 0.8152 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 0.6773 | 0.7147 | 0.7525 |
| **Ba\_meanIntensity** | 0.6095 | 0.7021 | 0.7401 |
| **De\_tqwt\_TKEO\_mean\_dec\_11** | 0.6426 | 0.6695 | 0.738 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.6721 | 0.7024 | 0.7559 |
| **De\_locDbShimmer** | 0.7164 | 0.7539 | 0.7883 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6894 | 0.711 | 0.7831 |
| **De\_std\_12th\_delta\_delta** | 0.6942 | 0.7307 | 0.7682 |
| **De\_std\_MFCC\_6th\_coef** | 0.5797 | 0.6848 | 0.7389 |
| **std\_MFCC\_8th\_coef** | 0.6573 | 0.6979 | 0.7494 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | 0.7648 | 0.705 | 0.7737 |
| **Ba\_std\_5th\_delta** | 0.622 | 0.7209 | 0.7421 |
| **Ba\_IMF\_SNR\_entropy** | 0.6209 | 0.6601 | 0.7153 |
| **f1** | 0.5951 | 0.6423 | 0.7092 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.692 | 0.7677 | 0.8139 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6325 | 0.6798 | 0.7405 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7018 | 0.7067 | 0.7586 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 0.6249 | 0.7264 | 0.7599 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 0.6061 | 0.7 | 0.7589 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6423 | 0.7111 | 0.7633 |
| **De\_tqwt\_minValue\_dec\_7** | 0.5654 | 0.722 | 0.7654 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.5943 | 0.6753 | 0.7121 |
| **mean\_MFCC\_12th\_coef** | 0.5552 | 0.7663 | 0.8025 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6847 | 0.7377 | 0.769 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.5958 | 0.7059 | 0.7489 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.6036 | 0.6919 | 0.7313 |
| **De\_minIntensity** | 0.5534 | 0.7184 | 0.7448 |
| **De\_tqwt\_minValue\_dec\_11** | 0.6344 | 0.7074 | 0.7325 |
| **tqwt\_meanValue\_dec\_11** | 0.6135 | 0.7112 | 0.7511 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.5521 | 0.7356 | 0.7748 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.6055 | 0.7387 | 0.7515 |
| **tqwt\_skewnessValue\_dec\_28** | 0.6018 | 0.7466 | 0.7687 |

Table continues below

|  | u.AUC | r.AUC | full.AUC | IDI |
| --- | --- | --- | --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 0.7247 | 0.7459 | 0.8106 | 0.1616 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 0.7123 | 0.7002 | 0.7659 | 0.1505 |
| **Ba\_locAbsJitter** | 0.6465 | 0.6576 | 0.7365 | 0.1455 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | 0.7307 | 0.7082 | 0.7742 | 0.1412 |
| **De\_tqwt\_energy\_dec\_33** | 0.7344 | 0.7392 | 0.78 | 0.1337 |
| **Ba\_tqwt\_energy\_dec\_12** | 0.6735 | 0.6976 | 0.7751 | 0.121 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.6656 | 0.609 | 0.7228 | 0.1167 |
| **De\_std\_MFCC\_2nd\_coef** | 0.6862 | 0.7735 | 0.8152 | 0.1193 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 0.6714 | 0.7171 | 0.7613 | 0.1232 |
| **Ba\_meanIntensity** | 0.6902 | 0.6937 | 0.7689 | 0.1176 |
| **De\_tqwt\_TKEO\_mean\_dec\_11** | 0.647 | 0.6793 | 0.7599 | 0.1153 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.6901 | 0.7203 | 0.7696 | 0.1152 |
| **De\_locDbShimmer** | 0.736 | 0.7421 | 0.7828 | 0.09856 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6884 | 0.7347 | 0.7757 | 0.1066 |
| **De\_std\_12th\_delta\_delta** | 0.6747 | 0.7352 | 0.7737 | 0.1126 |
| **De\_std\_MFCC\_6th\_coef** | 0.6041 | 0.688 | 0.7567 | 0.1124 |
| **std\_MFCC\_8th\_coef** | 0.6727 | 0.7042 | 0.7598 | 0.1019 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | 0.6643 | 0.7215 | 0.7757 | 0.09932 |
| **Ba\_std\_5th\_delta** | 0.6579 | 0.717 | 0.7575 | 0.1029 |
| **Ba\_IMF\_SNR\_entropy** | 0.6099 | 0.6693 | 0.7289 | 0.09438 |
| **f1** | 0.5935 | 0.6607 | 0.724 | 0.1007 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.6789 | 0.7643 | 0.8142 | 0.08706 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6582 | 0.697 | 0.7643 | 0.0921 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7016 | 0.7142 | 0.7646 | 0.08947 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 0.6728 | 0.7292 | 0.7813 | 0.08949 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 0.6332 | 0.7154 | 0.7725 | 0.08358 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6085 | 0.7197 | 0.7672 | 0.08115 |
| **De\_tqwt\_minValue\_dec\_7** | 0.5811 | 0.742 | 0.7821 | 0.08945 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.6134 | 0.694 | 0.731 | 0.08757 |
| **mean\_MFCC\_12th\_coef** | 0.5596 | 0.7653 | 0.7992 | 0.0803 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6359 | 0.7483 | 0.7825 | 0.07777 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.5986 | 0.7289 | 0.7673 | 0.0798 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.6194 | 0.7114 | 0.7466 | 0.07541 |
| **De\_minIntensity** | 0.585 | 0.7382 | 0.768 | 0.08075 |
| **De\_tqwt\_minValue\_dec\_11** | 0.6051 | 0.7057 | 0.7395 | 0.07266 |
| **tqwt\_meanValue\_dec\_11** | 0.6527 | 0.7159 | 0.7632 | 0.06353 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.5591 | 0.7481 | 0.7929 | 0.05515 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.6328 | 0.7606 | 0.7717 | 0.05873 |
| **tqwt\_skewnessValue\_dec\_28** | 0.6344 | 0.7684 | 0.7929 | 0.03933 |

|  | NRI | z.IDI | z.NRI | Frequency |
| --- | --- | --- | --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 0.8172 | 6.888 | 7.081 | 1 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 0.8326 | 6.618 | 7.349 | 1 |
| **Ba\_locAbsJitter** | 0.6568 | 6.529 | 5.509 | 0.15 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | 0.839 | 6.285 | 7.352 | 1 |
| **De\_tqwt\_energy\_dec\_33** | 0.763 | 6.022 | 6.55 | 1 |
| **Ba\_tqwt\_energy\_dec\_12** | 0.6749 | 5.958 | 5.67 | 0.6 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.7852 | 5.722 | 6.853 | 0.1 |
| **De\_std\_MFCC\_2nd\_coef** | 0.7482 | 5.719 | 6.436 | 1 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 0.739 | 5.715 | 6.327 | 0.5 |
| **Ba\_meanIntensity** | 0.6893 | 5.674 | 6.034 | 0.6 |
| **De\_tqwt\_TKEO\_mean\_dec\_11** | 0.64 | 5.657 | 5.368 | 0.8 |
| **tqwt\_kurtosisValue\_dec\_20** | 0.7455 | 5.629 | 6.383 | 0.8 |
| **De\_locDbShimmer** | 0.8082 | 5.607 | 7.099 | 1 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6798 | 5.531 | 5.734 | 1 |
| **De\_std\_12th\_delta\_delta** | 0.6709 | 5.495 | 5.646 | 0.8 |
| **De\_std\_MFCC\_6th\_coef** | 0.6122 | 5.479 | 5.119 | 0.55 |
| **std\_MFCC\_8th\_coef** | 0.6585 | 5.26 | 5.51 | 0.95 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | 0.6052 | 5.202 | 5.424 | 0.35 |
| **Ba\_std\_5th\_delta** | 0.5336 | 5.178 | 4.432 | 0.8 |
| **Ba\_IMF\_SNR\_entropy** | 0.5951 | 5.165 | 4.922 | 0.1 |
| **f1** | 0.418 | 5.164 | 3.353 | 0.1 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.5349 | 5.071 | 4.438 | 1 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6131 | 5.051 | 5.149 | 0.1 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7656 | 4.95 | 6.513 | 0.2 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 0.6536 | 4.94 | 5.51 | 0.15 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 0.6574 | 4.927 | 5.496 | 0.1 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6489 | 4.886 | 5.471 | 0.55 |
| **De\_tqwt\_minValue\_dec\_7** | 0.7508 | 4.799 | 6.398 | 0.25 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.7148 | 4.765 | 6.055 | 0.15 |
| **mean\_MFCC\_12th\_coef** | 0.6951 | 4.762 | 5.858 | 0.1 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6123 | 4.588 | 5.221 | 0.2 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.6386 | 4.543 | 5.351 | 0.45 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.617 | 4.512 | 5.144 | 0.5 |
| **De\_minIntensity** | 0.6508 | 4.49 | 5.481 | 0.1 |
| **De\_tqwt\_minValue\_dec\_11** | 0.5656 | 4.315 | 4.711 | 0.1 |
| **tqwt\_meanValue\_dec\_11** | 0.5931 | 4.091 | 4.99 | 0.45 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.6574 | 4.065 | 5.572 | 0.1 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.4656 | 3.814 | 3.82 | 0.1 |
| **tqwt\_skewnessValue\_dec\_28** | 0.4623 | 3.568 | 3.8 | 0.1 |

## Let focus on the new features  
  
decorCoeff <- smDecor$coefficients[newvars,];  
ncoef <- dc[newvars]  
cnames <- lapply(ncoef,names)  
names(cnames) <- NULL;  
decorCoeff$Elements <- lapply(cnames,paste,collapse="+")  
pander::pander(decorCoeff)

Table continues below

|  | Estimate | lower | OR | upper |
| --- | --- | --- | --- | --- |
| **De\_tqwt\_energy\_dec\_33** | -0.1948 | 0.7767 | 0.823 | 0.872 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | -0.03736 | 0.9513 | 0.9633 | 0.9755 |
| **De\_std\_MFCC\_2nd\_coef** | -1.314 | 0.1757 | 0.2687 | 0.411 |
| **De\_locDbShimmer** | 0.9748 | 1.944 | 2.651 | 3.614 |
| **De\_tqwt\_stdValue\_dec\_33** | -0.7762 | 0.3533 | 0.4602 | 0.5993 |
| **De\_std\_12th\_delta\_delta** | 0.7864 | 1.669 | 2.196 | 2.888 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.5497 | 1.414 | 1.733 | 2.124 |
| **De\_tqwt\_maxValue\_dec\_29** | -0.02078 | 0.9717 | 0.9794 | 0.9872 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | -0.06968 | 0.9076 | 0.9327 | 0.9585 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.1074 | 1.067 | 1.113 | 1.161 |
| **De\_tqwt\_minValue\_dec\_7** | 0.1517 | 1.095 | 1.164 | 1.237 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | -0.08493 | 0.8875 | 0.9186 | 0.9507 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | -0.04452 | 0.9386 | 0.9565 | 0.9746 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | -0.1446 | 0.8143 | 0.8654 | 0.9197 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | -0.2511 | 0.6993 | 0.7779 | 0.8654 |
| **De\_minIntensity** | -1.442 | 0.1278 | 0.2363 | 0.437 |
| **De\_tqwt\_minValue\_dec\_11** | 0.01698 | 1.009 | 1.017 | 1.025 |
| **De\_tqwt\_entropy\_log\_dec\_35** | -0.1161 | 0.8428 | 0.8904 | 0.9407 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.2338 | 1.124 | 1.263 | 1.42 |

Table continues below

|  | u.Accuracy | r.Accuracy | full.Accuracy |
| --- | --- | --- | --- |
| **De\_tqwt\_energy\_dec\_33** | 0.7477 | 0.7245 | 0.7831 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.6485 | 0.7141 | 0.711 |
| **De\_std\_MFCC\_2nd\_coef** | 0.7029 | 0.7774 | 0.8152 |
| **De\_locDbShimmer** | 0.7164 | 0.7539 | 0.7883 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6894 | 0.711 | 0.7831 |
| **De\_std\_12th\_delta\_delta** | 0.6942 | 0.7307 | 0.7682 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.692 | 0.7677 | 0.8139 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6325 | 0.6798 | 0.7405 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7018 | 0.7067 | 0.7586 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6423 | 0.7111 | 0.7633 |
| **De\_tqwt\_minValue\_dec\_7** | 0.5654 | 0.722 | 0.7654 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.5943 | 0.6753 | 0.7121 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6847 | 0.7377 | 0.769 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.5958 | 0.7059 | 0.7489 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.6036 | 0.6919 | 0.7313 |
| **De\_minIntensity** | 0.5534 | 0.7184 | 0.7448 |
| **De\_tqwt\_minValue\_dec\_11** | 0.6344 | 0.7074 | 0.7325 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.5521 | 0.7356 | 0.7748 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.6055 | 0.7387 | 0.7515 |

Table continues below

|  | u.AUC | r.AUC | full.AUC | IDI |
| --- | --- | --- | --- | --- |
| **De\_tqwt\_energy\_dec\_33** | 0.7344 | 0.7392 | 0.78 | 0.1337 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.6656 | 0.609 | 0.7228 | 0.1167 |
| **De\_std\_MFCC\_2nd\_coef** | 0.6862 | 0.7735 | 0.8152 | 0.1193 |
| **De\_locDbShimmer** | 0.736 | 0.7421 | 0.7828 | 0.09856 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6884 | 0.7347 | 0.7757 | 0.1066 |
| **De\_std\_12th\_delta\_delta** | 0.6747 | 0.7352 | 0.7737 | 0.1126 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.6789 | 0.7643 | 0.8142 | 0.08706 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6582 | 0.697 | 0.7643 | 0.0921 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7016 | 0.7142 | 0.7646 | 0.08947 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6085 | 0.7197 | 0.7672 | 0.08115 |
| **De\_tqwt\_minValue\_dec\_7** | 0.5811 | 0.742 | 0.7821 | 0.08945 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.6134 | 0.694 | 0.731 | 0.08757 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6359 | 0.7483 | 0.7825 | 0.07777 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.5986 | 0.7289 | 0.7673 | 0.0798 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.6194 | 0.7114 | 0.7466 | 0.07541 |
| **De\_minIntensity** | 0.585 | 0.7382 | 0.768 | 0.08075 |
| **De\_tqwt\_minValue\_dec\_11** | 0.6051 | 0.7057 | 0.7395 | 0.07266 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.5591 | 0.7481 | 0.7929 | 0.05515 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.6328 | 0.7606 | 0.7717 | 0.05873 |

Table continues below

|  | NRI | z.IDI | z.NRI | Frequency |
| --- | --- | --- | --- | --- |
| **De\_tqwt\_energy\_dec\_33** | 0.763 | 6.022 | 6.55 | 1 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | 0.7852 | 5.722 | 6.853 | 0.1 |
| **De\_std\_MFCC\_2nd\_coef** | 0.7482 | 5.719 | 6.436 | 1 |
| **De\_locDbShimmer** | 0.8082 | 5.607 | 7.099 | 1 |
| **De\_tqwt\_stdValue\_dec\_33** | 0.6798 | 5.531 | 5.734 | 1 |
| **De\_std\_12th\_delta\_delta** | 0.6709 | 5.495 | 5.646 | 0.8 |
| **De\_tqwt\_kurtosisValue\_dec\_33** | 0.5349 | 5.071 | 4.438 | 1 |
| **De\_tqwt\_maxValue\_dec\_29** | 0.6131 | 5.051 | 5.149 | 0.1 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | 0.7656 | 4.95 | 6.513 | 0.2 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | 0.6489 | 4.886 | 5.471 | 0.55 |
| **De\_tqwt\_minValue\_dec\_7** | 0.7508 | 4.799 | 6.398 | 0.25 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | 0.7148 | 4.765 | 6.055 | 0.15 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | 0.6123 | 4.588 | 5.221 | 0.2 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | 0.6386 | 4.543 | 5.351 | 0.45 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | 0.617 | 4.512 | 5.144 | 0.5 |
| **De\_minIntensity** | 0.6508 | 4.49 | 5.481 | 0.1 |
| **De\_tqwt\_minValue\_dec\_11** | 0.5656 | 4.315 | 4.711 | 0.1 |
| **De\_tqwt\_entropy\_log\_dec\_35** | 0.6574 | 4.065 | 5.572 | 0.1 |
| **De\_tqwt\_entropy\_log\_dec\_1** | 0.4656 | 3.814 | 3.82 | 0.1 |

|  | Elements |
| --- | --- |
| **De\_tqwt\_energy\_dec\_33** | tqwt\_energy\_dec\_31+tqwt\_energy\_dec\_33 |
| **De\_tqwt\_TKEO\_mean\_dec\_17** | tqwt\_TKEO\_mean\_dec\_17+tqwt\_minValue\_dec\_17 |
| **De\_std\_MFCC\_2nd\_coef** | std\_MFCC\_2nd\_coef+std\_2nd\_delta |
| **De\_locDbShimmer** | locDbShimmer+ddaShimmer |
| **De\_tqwt\_stdValue\_dec\_33** | tqwt\_TKEO\_mean\_dec\_35+tqwt\_stdValue\_dec\_32+tqwt\_stdValue\_dec\_33 |
| **De\_std\_12th\_delta\_delta** | std\_MFCC\_12th\_coef+std\_12th\_delta\_delta |
| **De\_tqwt\_kurtosisValue\_dec\_33** | tqwt\_kurtosisValue\_dec\_32+tqwt\_kurtosisValue\_dec\_33 |
| **De\_tqwt\_maxValue\_dec\_29** | tqwt\_stdValue\_dec\_28+tqwt\_maxValue\_dec\_29 |
| **De\_tqwt\_TKEO\_std\_dec\_11** | tqwt\_TKEO\_mean\_dec\_10+tqwt\_TKEO\_mean\_dec\_11+tqwt\_TKEO\_std\_dec\_11+tqwt\_stdValue\_dec\_10+tqwt\_minValue\_dec\_17 |
| **De\_tqwt\_TKEO\_std\_dec\_36** | tqwt\_TKEO\_mean\_dec\_35+tqwt\_TKEO\_std\_dec\_36 |
| **De\_tqwt\_minValue\_dec\_7** | tqwt\_minValue\_dec\_7+tqwt\_minValue\_dec\_17+tqwt\_maxValue\_dec\_8 |
| **De\_tqwt\_entropy\_shannon\_dec\_17** | tqwt\_entropy\_shannon\_dec\_17+tqwt\_minValue\_dec\_17 |
| **De\_tqwt\_kurtosisValue\_dec\_2** | tqwt\_kurtosisValue\_dec\_2+tqwt\_kurtosisValue\_dec\_3 |
| **De\_tqwt\_TKEO\_std\_dec\_7** | tqwt\_TKEO\_std\_dec\_7+tqwt\_stdValue\_dec\_7+tqwt\_minValue\_dec\_17 |
| **De\_det\_LT\_TKEO\_mean\_3\_coef** | Ed2\_3\_coef+det\_LT\_TKEO\_mean\_1\_coef+det\_LT\_TKEO\_mean\_3\_coef |
| **De\_minIntensity** | minIntensity+meanIntensity |
| **De\_tqwt\_minValue\_dec\_11** | tqwt\_minValue\_dec\_11+tqwt\_minValue\_dec\_17 |
| **De\_tqwt\_entropy\_log\_dec\_35** | tqwt\_entropy\_log\_dec\_35+tqwt\_TKEO\_mean\_dec\_35 |
| **De\_tqwt\_entropy\_log\_dec\_1** | tqwt\_entropy\_log\_dec\_1+tqwt\_entropy\_log\_dec\_2 |

## Differences between Unsupervised vs Outcome-Drive Decorrelation

In this section I will show the differences in unaltered basis vectors between the Outcome driven Transformation vs the unsupervised decorrelated transformation

par(op)  
par(mfrow=c(1,1))  
  
  
smDecorU <- summary(bmdU)  
decornamesU <- rownames(smDecorU$coefficients)  
  
get\_De\_names <- decornames[!str\_detect(decornames,"De\_")]  
get\_De\_namesU <- decornamesU[!str\_detect(decornamesU,"De\_")]  
  
unn <- bmd$univariate[,3]  
names(unn) <- rownames(bmd$univariate)  
pander::pander(as.matrix(unn[get\_De\_names]))

|  |  |
| --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 6.152 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 5.826 |
| **Ba\_locAbsJitter** | 4.114 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | 5.376 |
| **Ba\_tqwt\_energy\_dec\_12** | 4.446 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 4.511 |
| **Ba\_meanIntensity** | 5.337 |
| **tqwt\_kurtosisValue\_dec\_20** | 4.85 |
| **std\_MFCC\_8th\_coef** | 4.397 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | 3.877 |
| **Ba\_std\_5th\_delta** | 4.277 |
| **Ba\_IMF\_SNR\_entropy** | 3.218 |
| **f1** | 4.022 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 4.265 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 3.584 |
| **mean\_MFCC\_12th\_coef** | 1.827 |
| **tqwt\_meanValue\_dec\_11** | 3.67 |
| **tqwt\_skewnessValue\_dec\_28** | 1.808 |

pander::pander(summary(unn[get\_De\_names]))

| Min. | 1st Qu. | Median | Mean | 3rd Qu. | Max. |
| --- | --- | --- | --- | --- | --- |
| 1.808 | 3.722 | 4.271 | 4.198 | 4.766 | 6.152 |

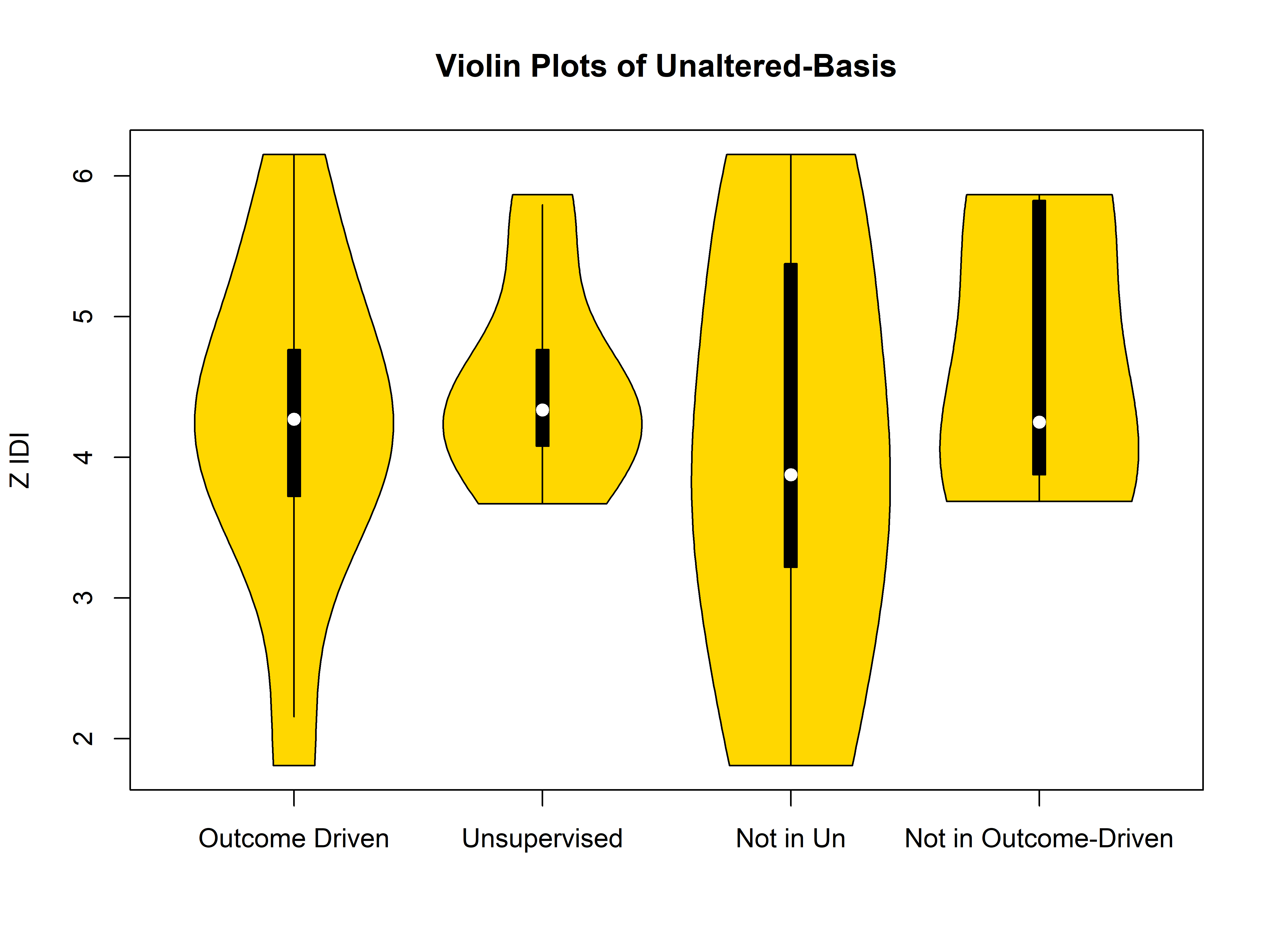
unnU <- bmdU$univariate[,3]  
names(unnU) <- rownames(bmdU$univariate)  
pander::pander(as.matrix(unnU[get\_De\_namesU]))

|  |  |
| --- | --- |
| **Ba\_std\_5th\_delta** | 4.277 |
| **tqwt\_kurtosisValue\_dec\_36** | 5.826 |
| **tqwt\_kurtosisValue\_dec\_27** | 4.25 |
| **Ba\_std\_delta\_log\_energy** | 5.867 |
| **tqwt\_kurtosisValue\_dec\_26** | 3.877 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 4.265 |
| **std\_MFCC\_8th\_coef** | 4.397 |
| **tqwt\_kurtosisValue\_dec\_20** | 4.85 |
| **Ba\_tqwt\_energy\_dec\_12** | 4.446 |
| **Ba\_meanIntensity** | 5.337 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 4.511 |
| **f1** | 4.022 |
| **tqwt\_meanValue\_dec\_11** | 3.67 |
| **Ba\_tqwt\_stdValue\_dec\_5** | 3.686 |

pander::pander(summary(unnU[get\_De\_namesU]))

| Min. | 1st Qu. | Median | Mean | 3rd Qu. | Max. |
| --- | --- | --- | --- | --- | --- |
| 3.67 | 4.079 | 4.337 | 4.52 | 4.766 | 5.867 |

#boxplot(unn[get\_De\_names],unnU[get\_De\_namesU],xlab=c("Method"),ylab="Z",main="Z Values of Basis Features")  
  
x1 <- unn[get\_De\_names]  
x2 <- unnU[get\_De\_namesU]  
X3 <- x1[!(get\_De\_names %in% get\_De\_namesU)]  
X4 <- x2[!(get\_De\_namesU %in% get\_De\_names)]  
vioplot(x1, x2, X3,X4, names=c("Outcome Driven", "Unsupervised","Not in Un","Not in Outcome-Driven"),ylab="Z IDI",  
 col="gold")  
title("Violin Plots of Unaltered-Basis")



sameFeatures <- get\_De\_names[get\_De\_names %in% get\_De\_namesU]  
pander::pander(as.matrix(unn[sameFeatures]))

|  |  |
| --- | --- |
| **Ba\_tqwt\_energy\_dec\_12** | 4.446 |
| **Ba\_tqwt\_kurtosisValue\_dec\_28** | 4.511 |
| **Ba\_meanIntensity** | 5.337 |
| **tqwt\_kurtosisValue\_dec\_20** | 4.85 |
| **std\_MFCC\_8th\_coef** | 4.397 |
| **Ba\_std\_5th\_delta** | 4.277 |
| **f1** | 4.022 |
| **Ba\_tqwt\_kurtosisValue\_dec\_17** | 4.265 |
| **tqwt\_meanValue\_dec\_11** | 3.67 |

## The features by Outcome Drive not in Unsupervised  
pander::pander(as.matrix(x1[!(get\_De\_names %in% get\_De\_namesU)]))

|  |  |
| --- | --- |
| **Ba\_std\_delta\_delta\_log\_energy** | 6.152 |
| **Ba\_tqwt\_kurtosisValue\_dec\_36** | 5.826 |
| **Ba\_locAbsJitter** | 4.114 |
| **Ba\_tqwt\_entropy\_log\_dec\_12** | 5.376 |
| **Ba\_tqwt\_kurtosisValue\_dec\_26** | 3.877 |
| **Ba\_IMF\_SNR\_entropy** | 3.218 |
| **Ba\_tqwt\_kurtosisValue\_dec\_34** | 3.584 |
| **mean\_MFCC\_12th\_coef** | 1.827 |
| **tqwt\_skewnessValue\_dec\_28** | 1.808 |

## The features not in outcome driven  
pander::pander(as.matrix(x2[!(get\_De\_namesU %in% get\_De\_names)]))

|  |  |
| --- | --- |
| **tqwt\_kurtosisValue\_dec\_36** | 5.826 |
| **tqwt\_kurtosisValue\_dec\_27** | 4.25 |
| **Ba\_std\_delta\_log\_energy** | 5.867 |
| **tqwt\_kurtosisValue\_dec\_26** | 3.877 |
| **Ba\_tqwt\_stdValue\_dec\_5** | 3.686 |

#### Saving all the generated data

save.image("~/GitHub/FCA/ParkinsonDemo.RData")