

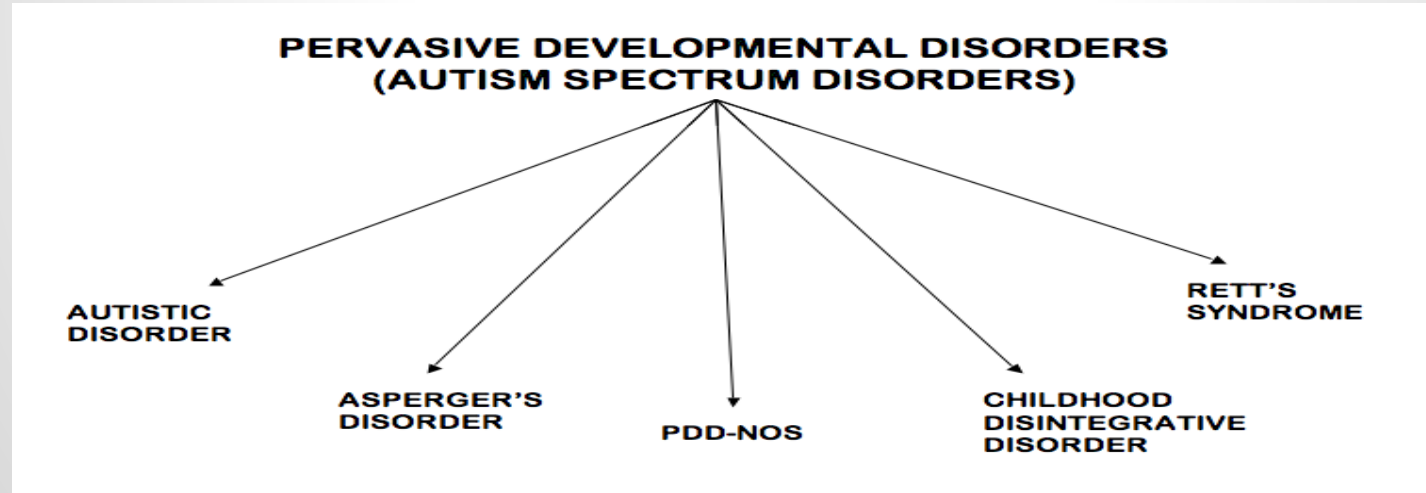
Assessment of Autism Spectrum Disorders(ASD)

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Introduction

- ❖ classify toddlers into 3 classes those who are normal, slow in learning and those who have autism.
- ❖ Restricted, repetitive patterns of behavior, interests, or activities.
- ❖ Persistent deficits in social communication and social interaction across multiple contexts.



Milestones in Diagnosis of ASD

- ❖ Speech Sample Collection using Cloud based Android Applications
- ❖ Feature Extraction from Speech Sample
- ❖ Analysis of Speech Motor Function
- ❖ Behavioural And Diagnostic Measures
- ❖ Classification of speech samples of toddlers using Random Forest

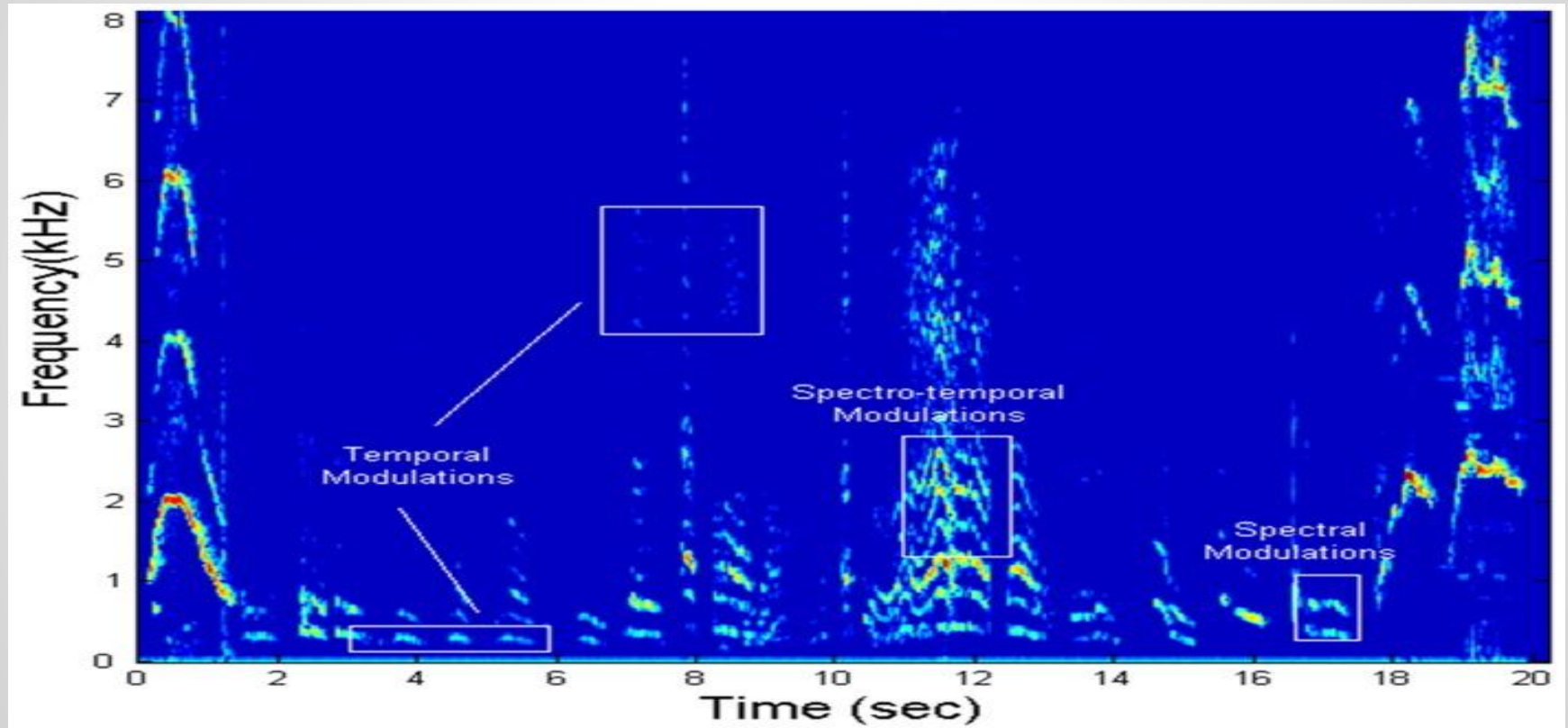
Category For Classification

- Autism Spectrum Disorder(ASD)
- Developmental Delay(DD)
- Typical Development(TD)

Speech Sampling

- ADOS
- PCI
- Speech Modulation Spectrum
- ❖ Spectral Modulations
- ❖ Temporal Modulations
- ❖ Spectro-Temporal Modulations

Spectrogram of Vocalizations in a Speech Sample



Speech Motor Function

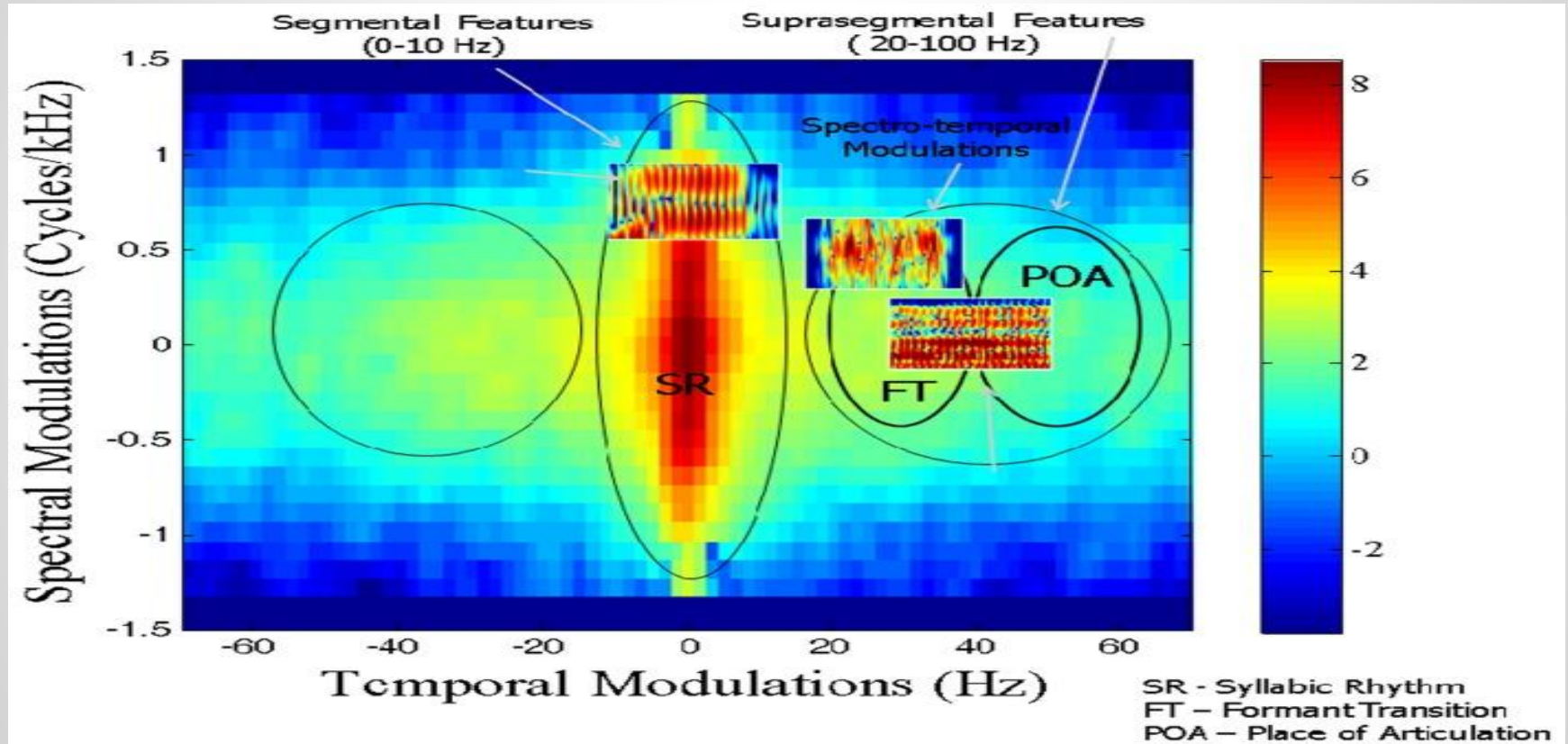
Articulatory feature

- ❖ Syllabic Rhythm - (2-10 Hz)
- ❖ Formant Transitions (25-40 Hz)
- ❖ Place Of Articulations (50-100 Hz)

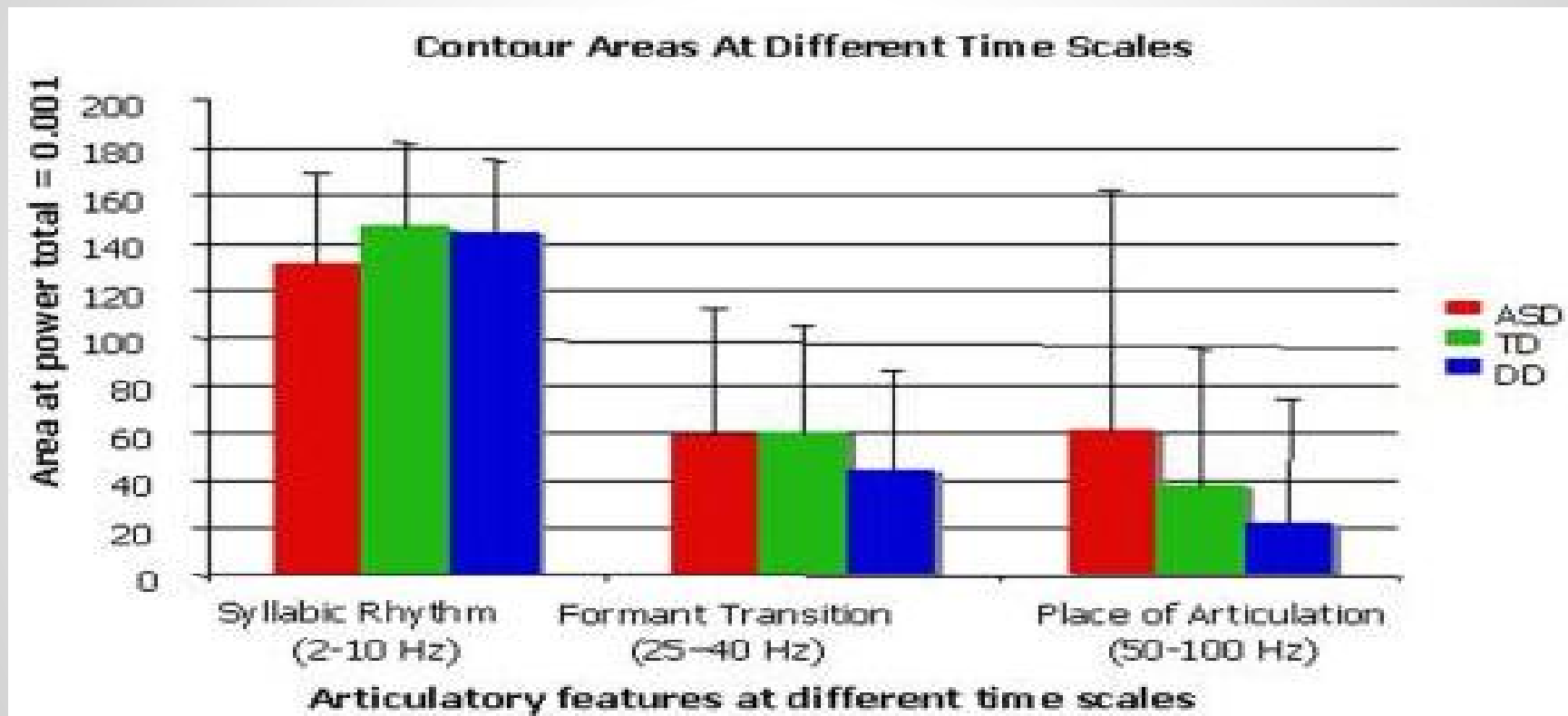
Number of Vocalizations

- ❖ no of continuous speech sounds

Articulatory Features in Spectro-Temporal Modulations



Energy Distribution as function of contour Area



Behavioural And Diagnostic Measure

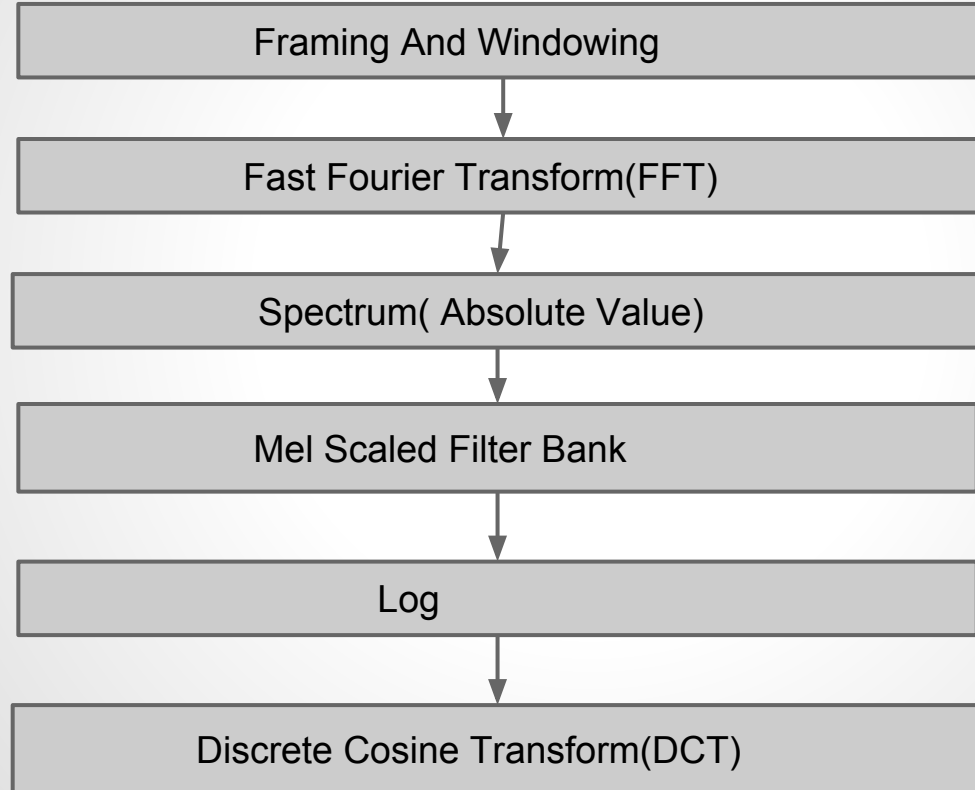
- Autism diagnostic interview-revised (ADI-R)
- Autism Diagnostic Observation Schedule (ADOS)
- Mullen Scales of early Learning

(RL,EL,FM)

- Vineland Adaptive behaviour Scales:

Receptive Language Subdomain (RL,EL)

Feature Extraction using MFCC



Decision Trees

- ❖ Decision trees are individual learners that are combined. They are one of the most popular learning methods commonly used for data exploration.
- ❖ One type of decision tree is called CART... classification and regression tree.
- ❖ CART ... greedy, top-down binary, recursive partitioning, that divides feature space into sets of disjoint rectangular regions.
- ❖ Regions should be pure wrt response variable
- ❖ Simple model is fit in each region – majority vote for classification, constant value for regression

Random Forest

- ❖ Classification and regression
- ❖ Random forest is an ensemble classifier that consists of many decision trees and outputs the class that is the mode of the class's output by individual trees.
- ❖ The method combines "bagging" idea and the random selection of features.

Random Forest

- ❖ Bootstrap Aggregation of classification of trees-(Reduce bias of single tree)
- ❖ Permutation to determine variable importance.
- ❖ Seek to estimate $E[Y|A,W]$, i.e. prediction of Y given set of covariates(A,W)
- ❖ assumption-- all trees are independent draws from an identical distribution, minimizing loss function at each node in a given tree.

Algorithm of Random Forest

- ❖ Bootstrap sample of data
- ❖ Using 2/3 of the sample, fit a tree to its greatest depth determining the split at each node through minimizing the loss function considering a random sample of covariates.

For each tree.

- ❖ Predict classification of the leftover 1/3 using the tree, and calculate the misclassification rate = out of bag error rate.
- ❖ For each variable in the tree, permute the variables values and compute the out-of-bag error, compare to the original oob error, the increase is a indication of the variable's importance
- ❖ Aggregate oob error and importance measures from all trees to determine overall oob error rate and Variable Importance measure.
- ❖ Oob Error Rate: Calculate the overall percentage of misclassification
- ❖ Variable Importance: Average increase in oob error over all trees and assuming a normal distribution of the increase among the trees, determine an associated p-value.

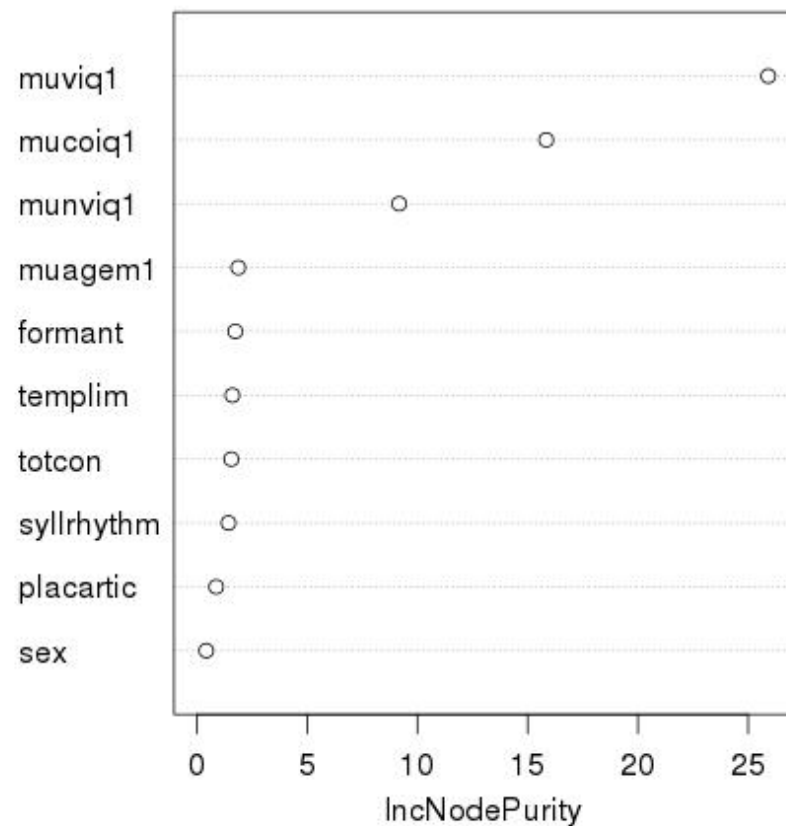
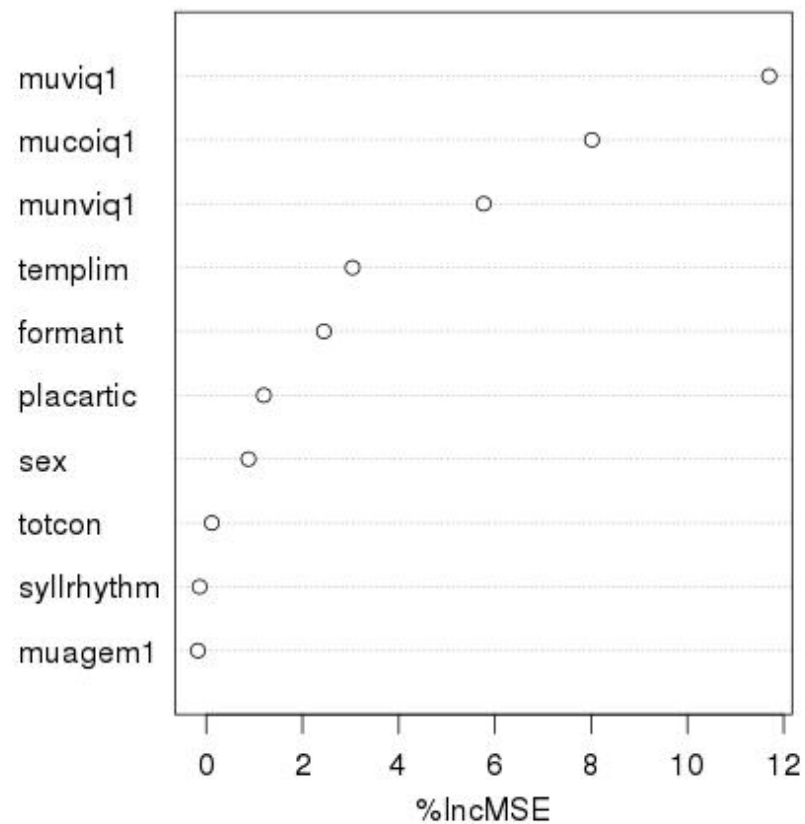
Advantages using Random Forest

- ❖ highly accurate.
- ❖ efficient for large databases.
- ❖ handling thousands of input variables without variable deletion.
- ❖ estimates of what variables are important in the classification.
- ❖ generates an internal unbiased estimate of the generalization error as the forest builds
- ❖ balance between high variance and high bias.
- ❖ estimating missing data and maintains accuracy when a large proportion of the data are missing.

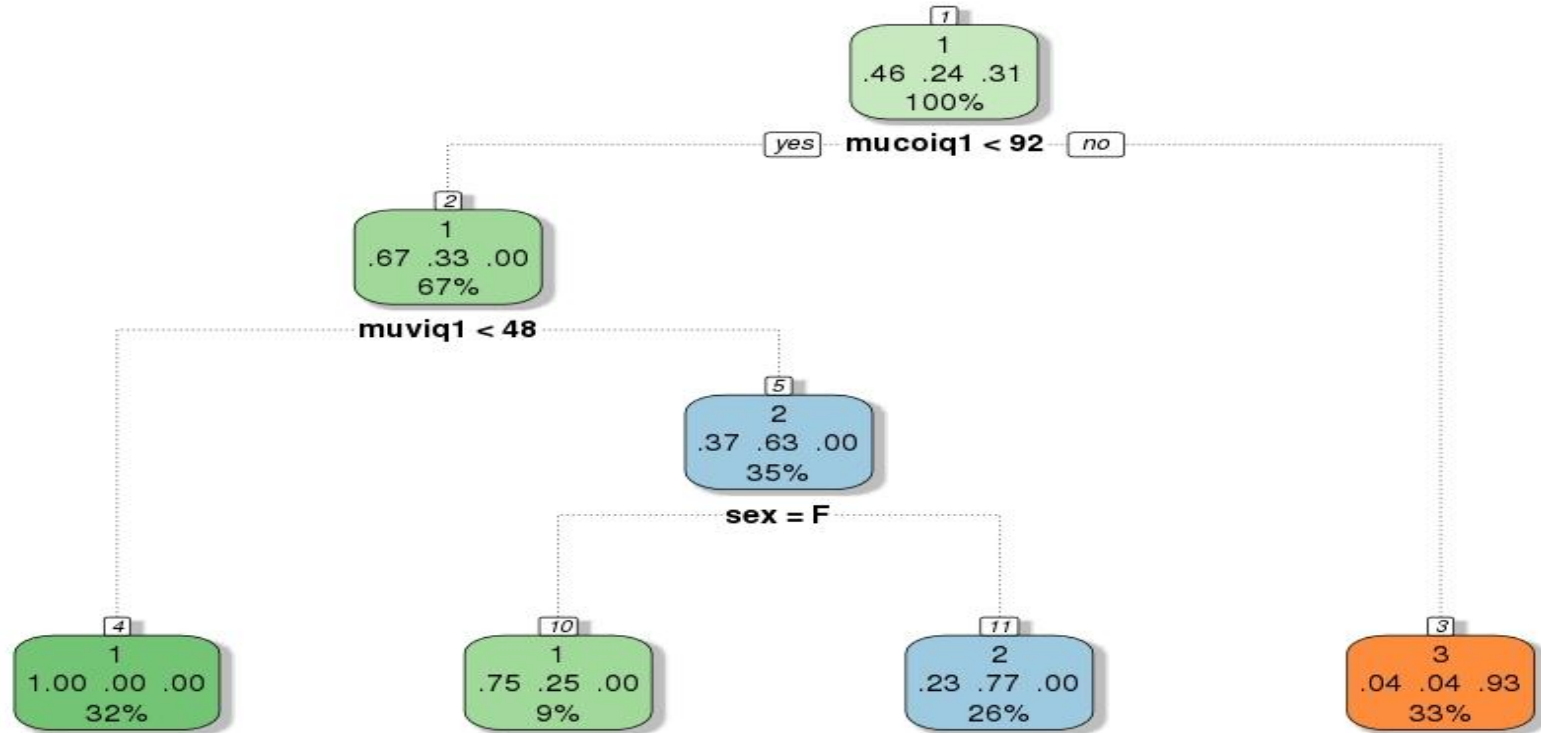
Disadvantages of Random Forest

- ❖ Random forests have been observed to overfit for some datasets with noisy classification/regression tasks.
- ❖ For data including categorical variables with different number of levels, random forests are biased in favor of those attributes with more levels. Therefore, the variable importance scores from random forest are not reliable for this type of data.

Feature_Importance



Classification using Random Forest



Result

Classifier: RandomForestClassifier
n_estimators=50

Cross-Validation: LeaveOneOut

Estimated score: 0.83529 (+/- 0.18546)

Future Work

- Features Extraction using Wavelet Transformation

- 1- well localised function both in the time and frequency domain.

- 2- overcome the resolution problem of the STFT for analyzing nonstationary signals.

- Analysis of Pitch patterns in speech

- 1- Mean Pitch Value

- 2- Pitch Range

- 3- Pitch Excursion

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