CLASSIFYING HEART SOUNDS

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OBJECTIVES

Challenge 1: Heart Sound Segmentation

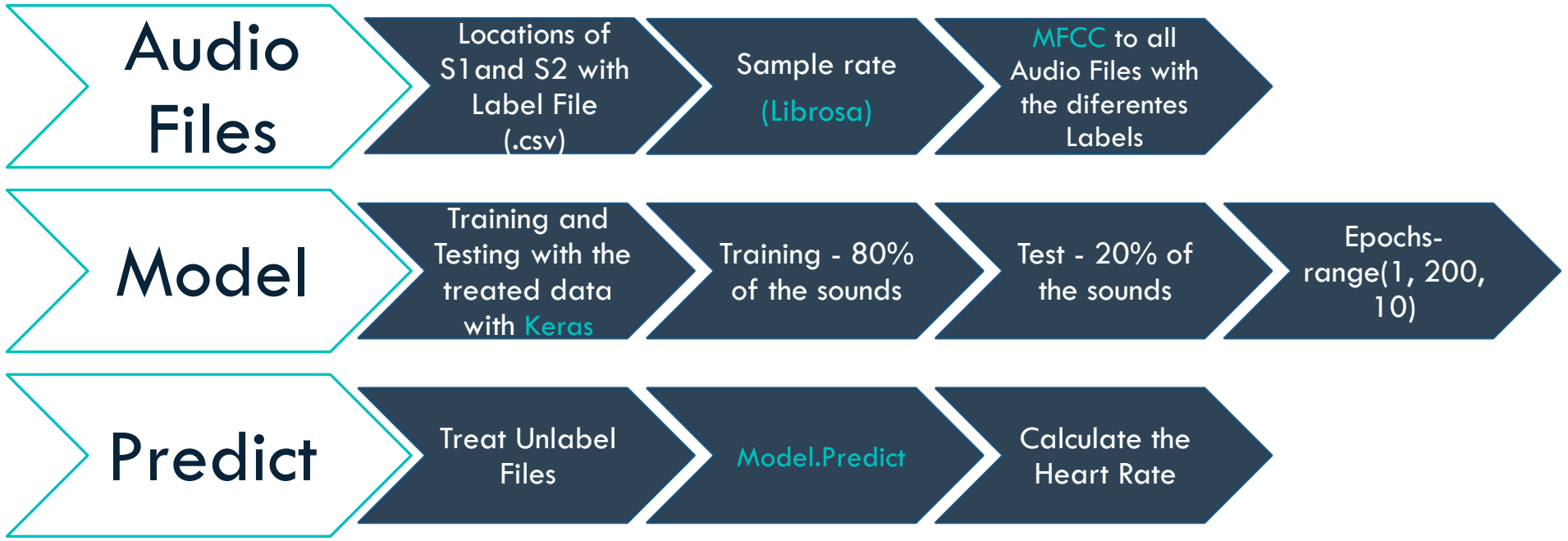
Produce a method that can locate S1(lub) and S2(dub) sounds within audio data

I. Involves segmenting the audio files in Atraining_normal.zip and Btraining_normal.zip using a training segmentations.
II. Involves correctly labelling the sounds in Aunlabelledtest.zip and Bunlabelledtest.zip

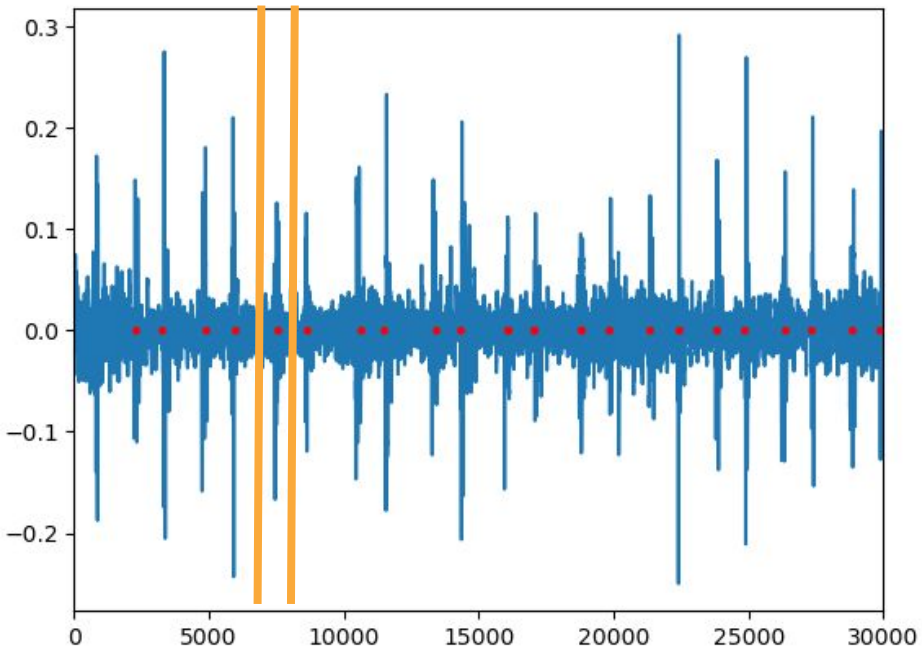
Challenge 2: Heart Sound Classification

Produce a method that can classify real heart audio into one of four categories: Normal, Murmur, Extra Heart Sound and Artifact.

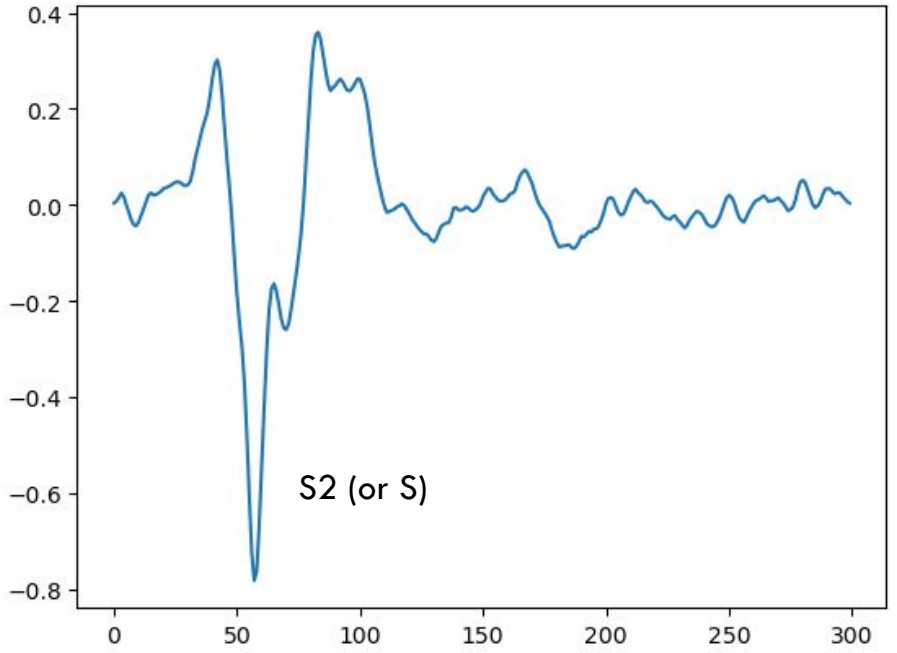
CHALLENGE 1


Audio Files
Locations of S1and S2 with Label File (.csv)
Sample rate (Librosa)
MFCC to all Audio Files with the diferentes Labels
Model
Training and Testing with the treated data with Keras
Training - 80% of the sounds
Test - 20% of the sounds
Epochs- range(1, 200, 10)
Predict
Treat Unlabel Files
Model.Predict
Calculate the Heart Rate

CHALLENGE 1: AUDIO FILES



Plot 1: Audio file (with identified signals and one segment)



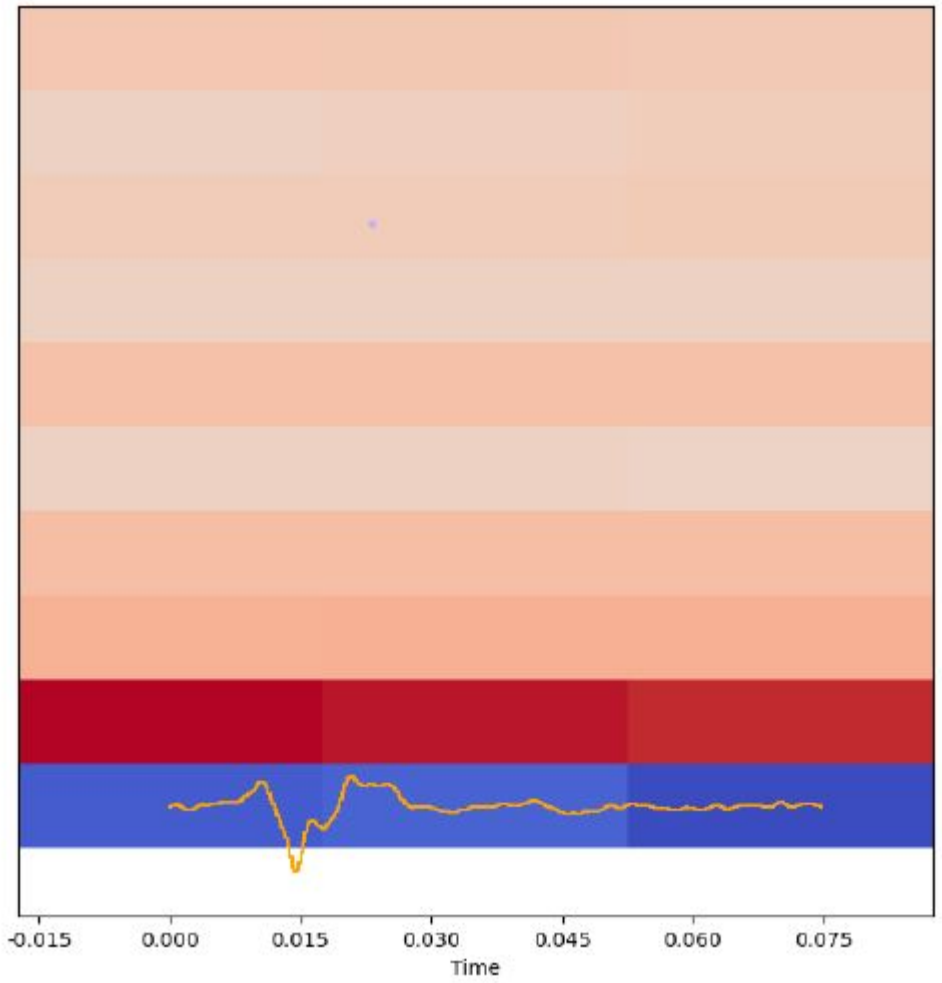
Plot 2: Previous segment

CHALLENGE 1: AUDIO FILES

Librosa

MFCCs (Mel-frequency cepstral coefficients)

→ Representation of the audio's power spectrum



Plot 3: MFCC for the previous segment

CHALLENGE 1: MODEL

Keras

Make the implementation of neural networks.
In this case the type of neural network is feedforward.

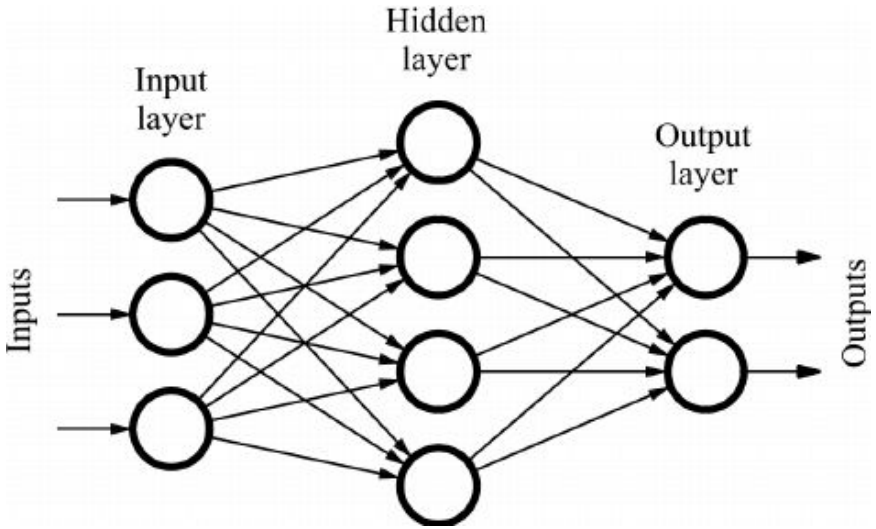
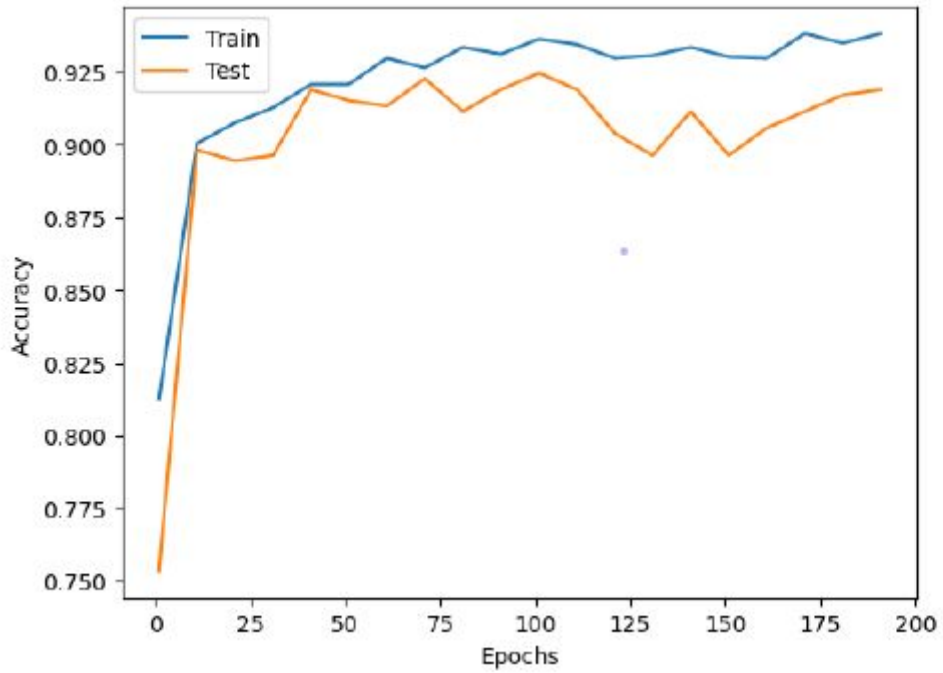


Image 1: Representation od feedforward neural network

(S1, S2, N):		(S,N):
Dense(10)	and	Dense(10)
Dense(3)		Dense(2)



Plot 4: Accuracy vs Epochs

CHALLENGE 1: MODEL

(S1, S2, N) → 101 epochs
(S, N) → 21 epochs

Training

Loss: 0.1516 - Accuracy:0.9213 (S1, S2, N)
Loss: 0.1271 - Accuracy:0.9515 (S, N)

Test

Loss: 0.1926 - Accuracy: 0.9153 (S1, S2, N)
Loss: 0.1429 - Accuracy: 0.9435 (S, N)

Confusion matrix

(S1, S2, N)			
S1	127	16	12
S2	8	114	4
N	3	2	245
	S1	**S2**	**N**

True Label

Predicted Label

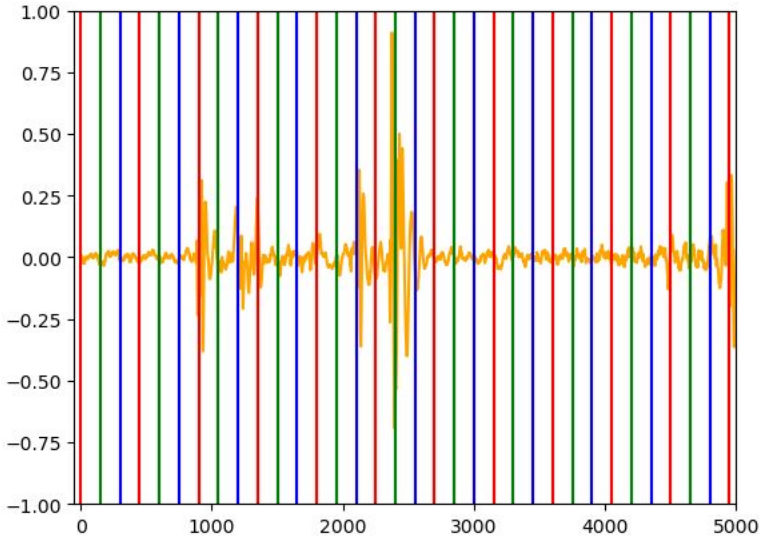
(S, N)		
S	256	25
N	5	245
	S	N

True Laabel

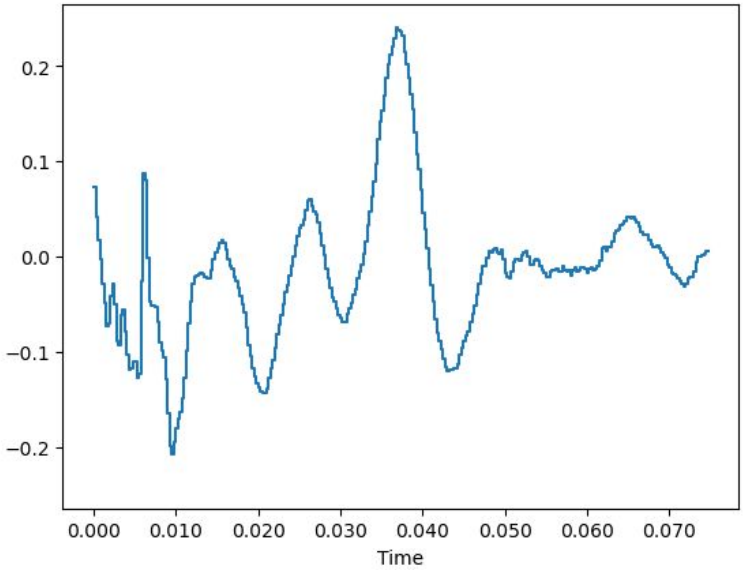
Predicted Label

A confusion matrix is a table that is used to define the performance of a classification algorithm.

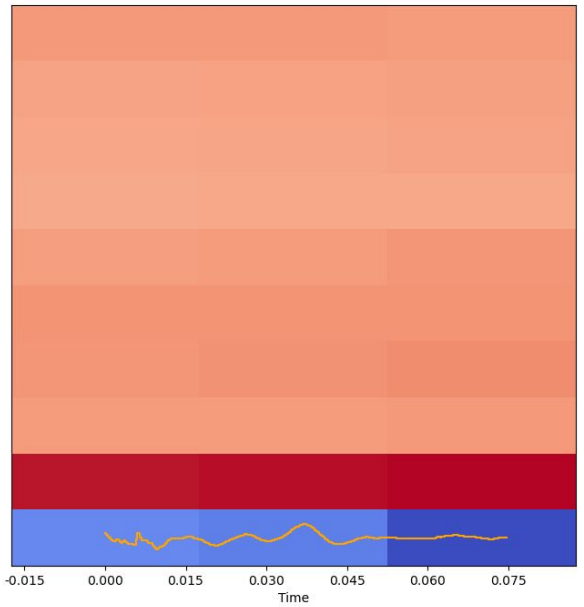
CHALLENGE 1: PREDICT



Plot 5: Segmentation of unlabelled file (range = 300, jump = 150)

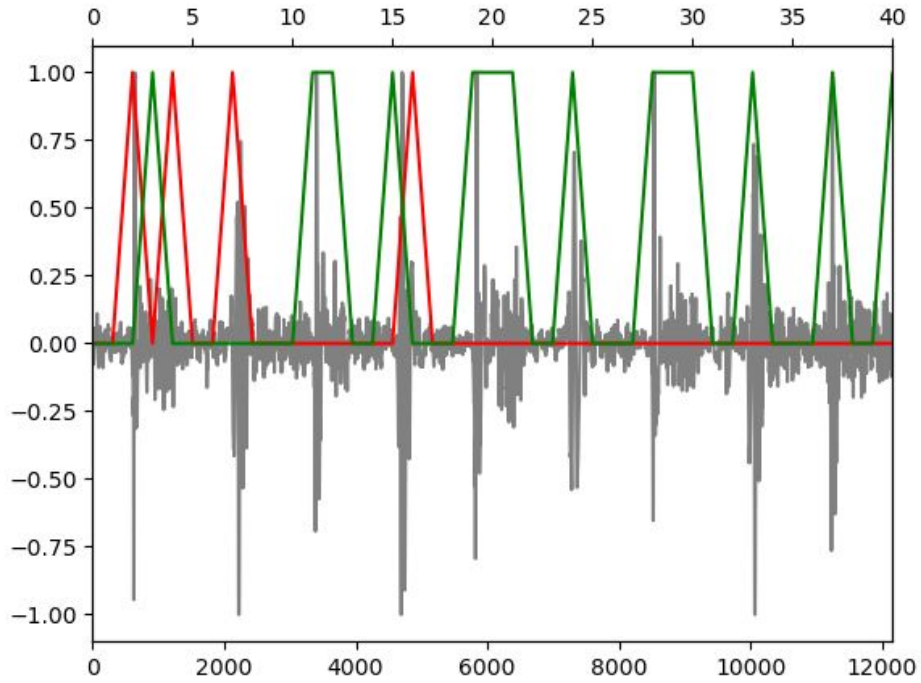


Plot 6: One of the segments

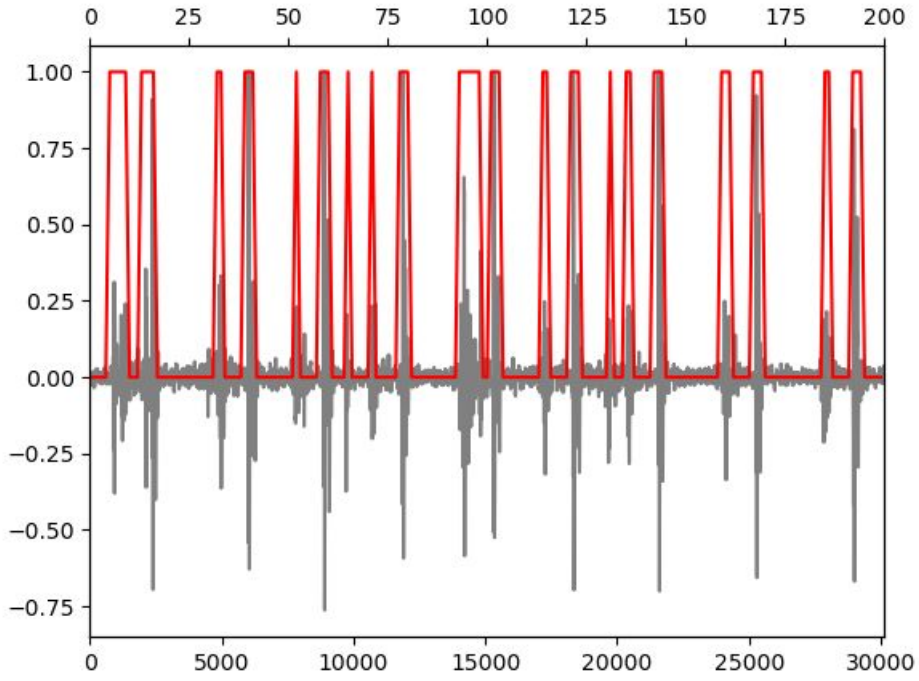


Plot 7: MFCC of the previous segment

CHALLENGE 1: PREDICT

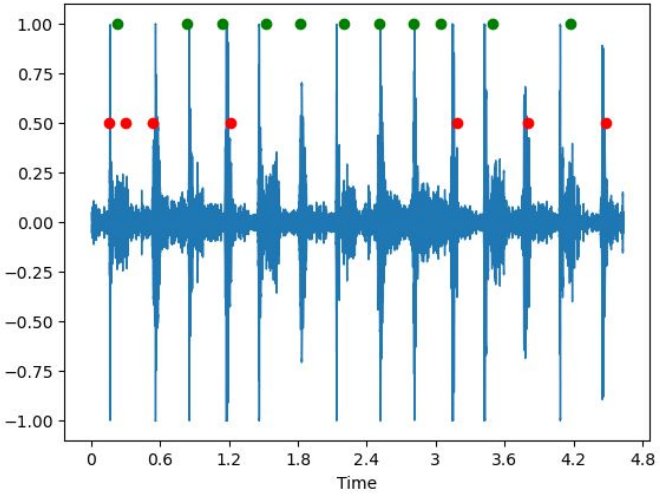


Plot 8: Signal identification (probabilities) (S1, S2, N)

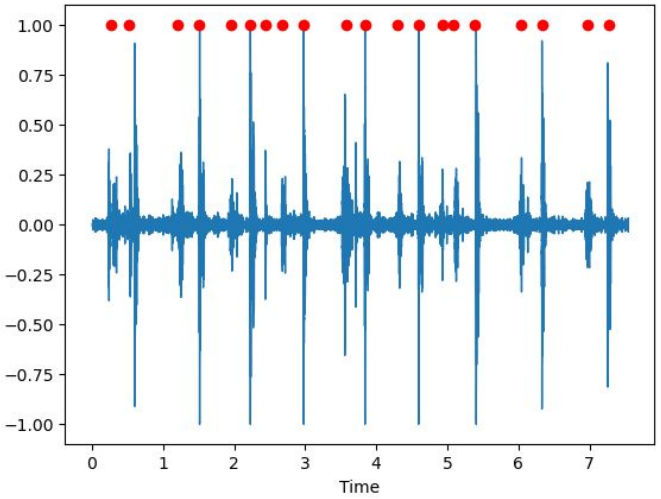


Plot 9: Signal identification (probabilities) (S, N)

CHALLENGE 1: PREDICT



Plot 10: Signal identification (S1 and S2)



Plot 11: Signal identification (S)

Equations

$$\text{Heart\_rate (S1, S2, N)} = = \frac{60}{Mean(\sum_{time}(S1 - S2))}$$

$$\text{Heart\_rate (S, N)} = = \left(\frac{60}{Mean(\sum_{time}(St1 - St2))}\right)/2$$

Results (bpm)

Heart_rate (S1, S2, N)= 66.7376792853355
Heart_rate (S, N)= 81.3273479258851

CHALLENGE 2 (Future)

→ Improve the NN: train it to classify real heart audio into one of four categories: Normal, Murmur, Extra Heart Sound and Artifact.