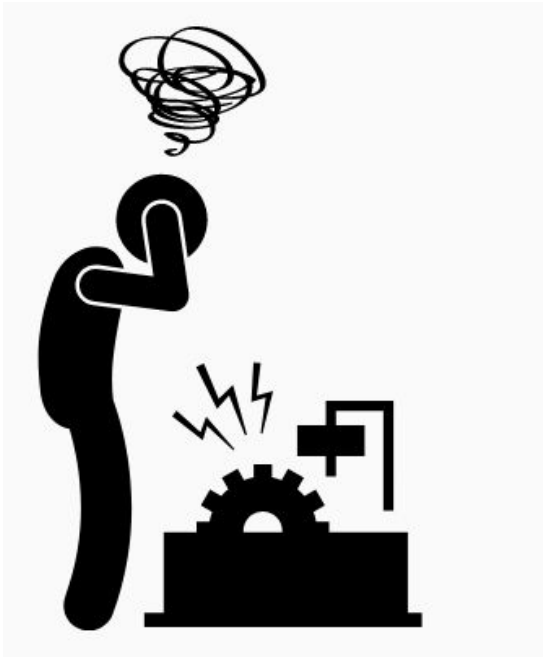
Superposition

<TESA 2024 - CU Team />

Problem Statement



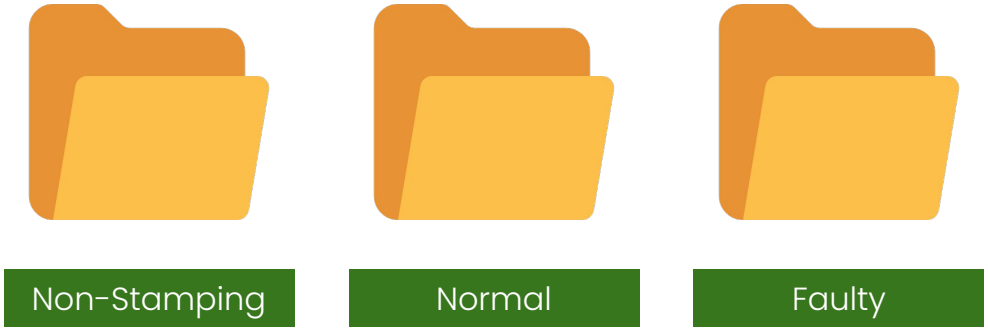
Dataset

Day 1

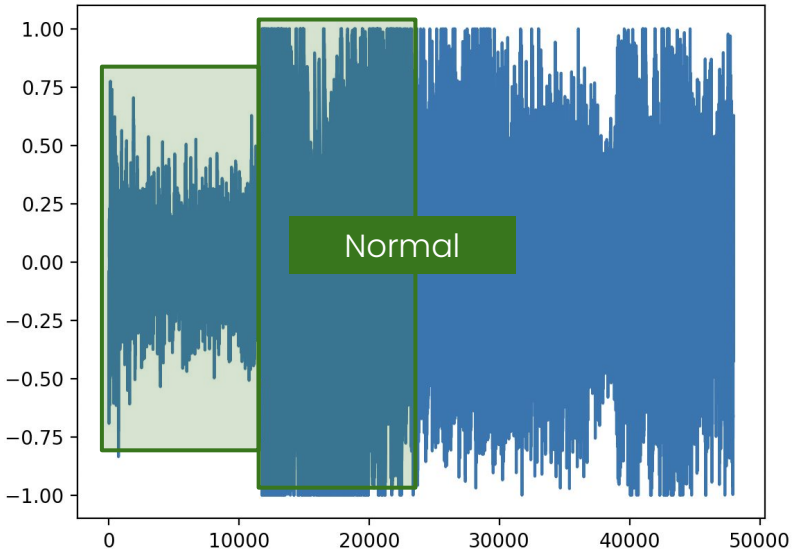
- Short-time audio files (Faulty/Normal/Non-Stamping)

Day 2

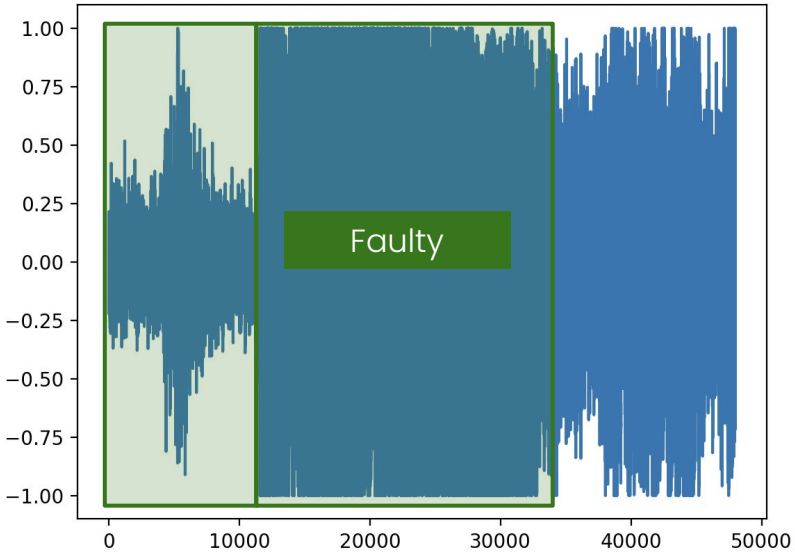
- Long-time audio files (3 Normal Files, 2 Faulty Files)



Audio Segmentation v.0.5



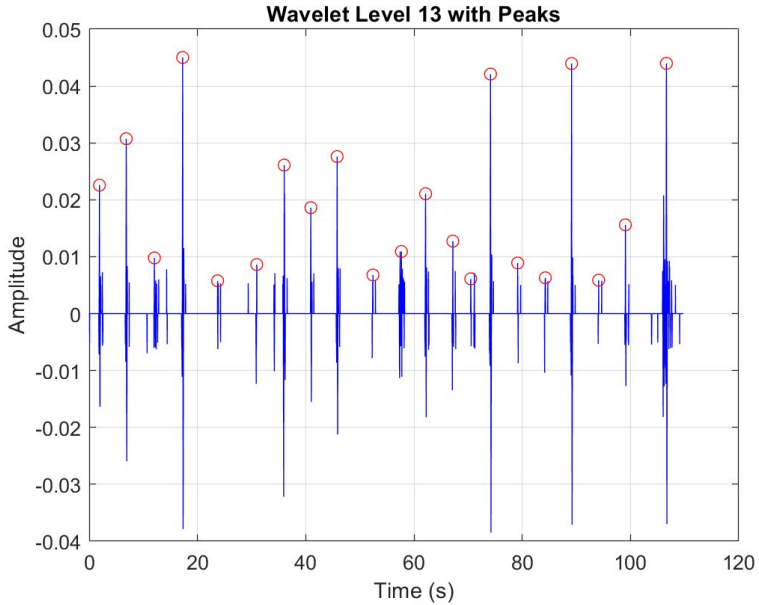
Norm_2_52_pm_3.wav



Sample_11_05_am_1.wav

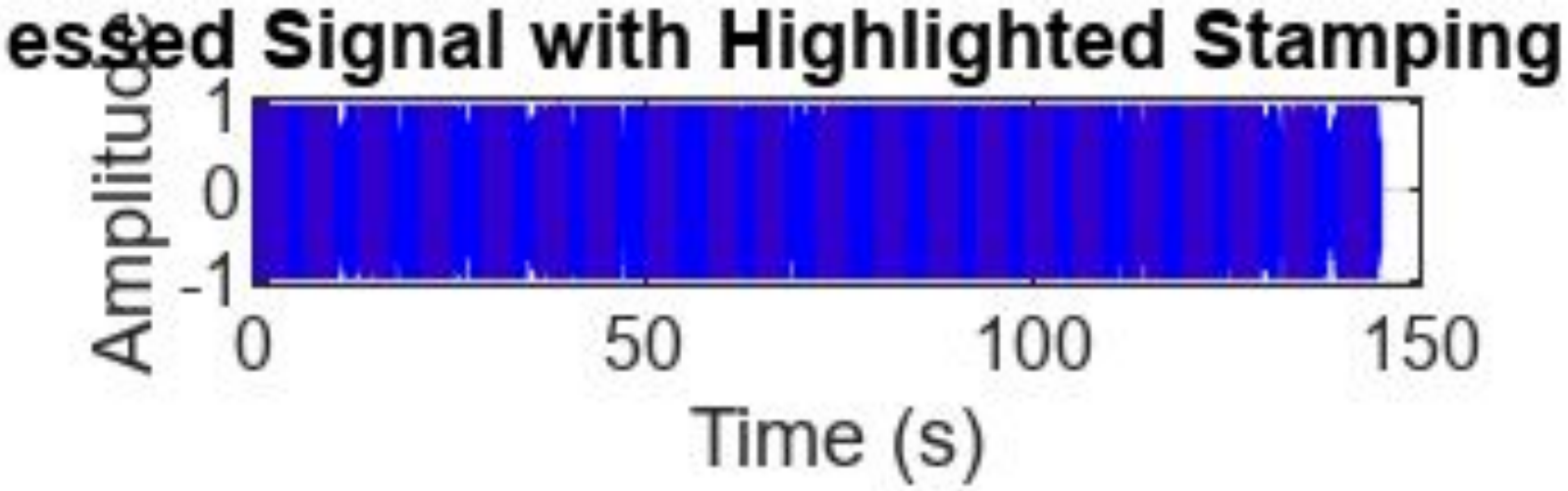
Wavelet Transform

MODWT level 13 with hard thresholding & Finding peaks



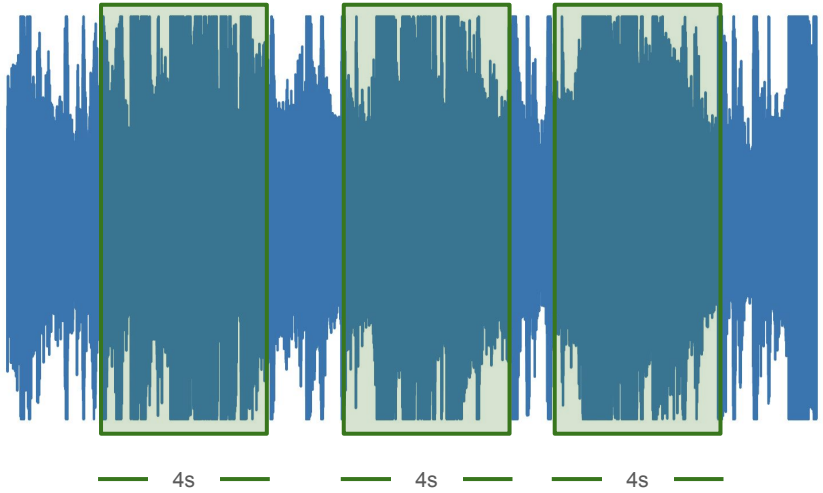
Audio Segmentation v.1.0

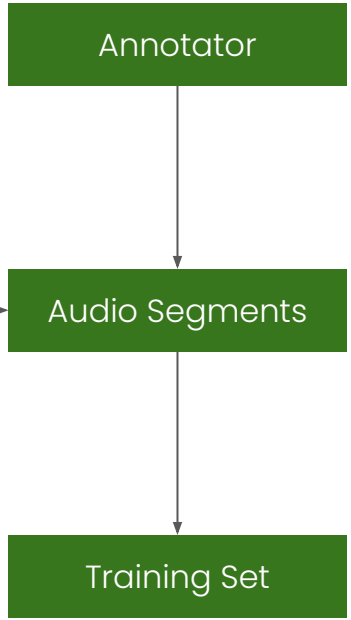
2s Pre-event time and Post-event time duration



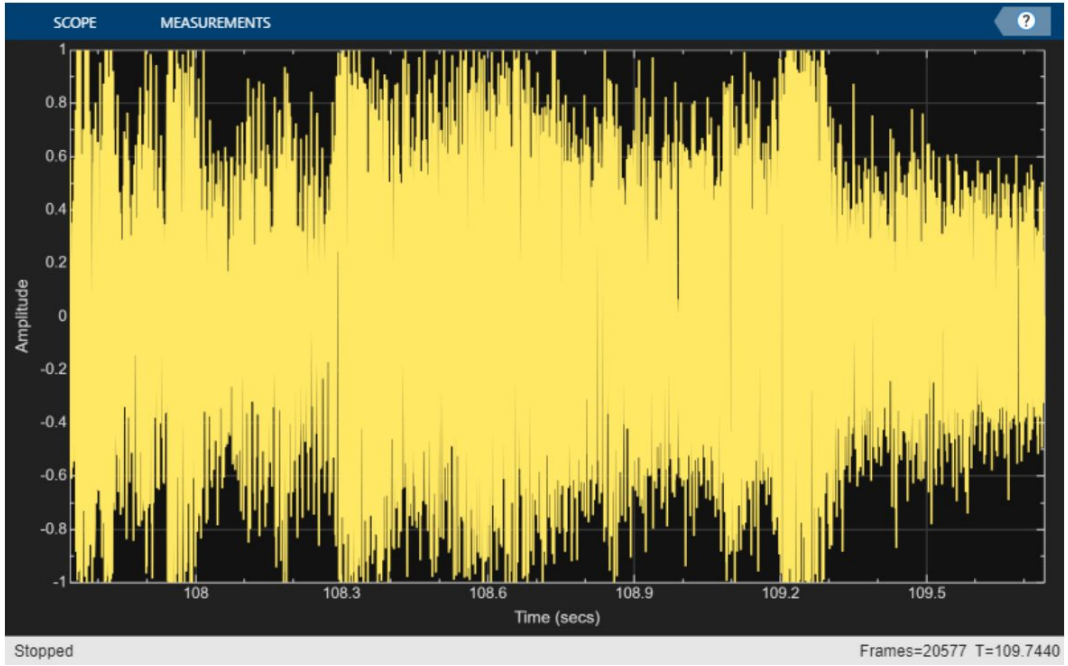
Audio Segmentation v.2.0

Use Signal-to-Noise-Based Segmenter to extract signal events from audio





Real Time analysis



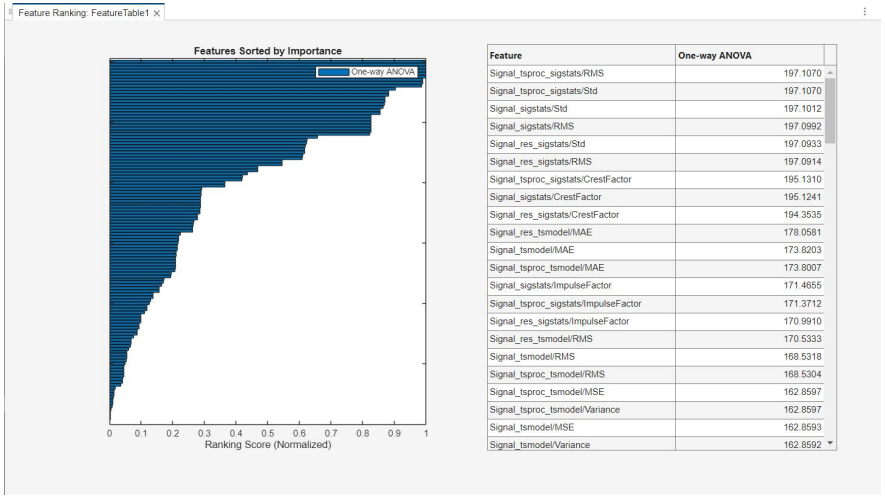
4 seconds buffer + overlap

```
Stamping at seconds 4
Stamping at seconds 8
Stamping at seconds 12
Stamping at seconds 20
Stamping at seconds 24
Stamping at seconds 28
Stamping at seconds 32
Stamping at seconds 36
Stamping at seconds 40
Stamping at seconds 44
Stamping at seconds 48
Stamping at seconds 52
Stamping at seconds 56
Stamping at seconds 60
Stamping at seconds 64
Stamping at seconds 68
Stamping at seconds 72
Stamping at seconds 76
Stamping at seconds 80
Stamping at seconds 84
Stamping at seconds 88
Stamping at seconds 92
Stamping at seconds 96
Stamping at seconds 100
Stamping at seconds 104
Stamping at seconds 108
Stamping at seconds 112
Stamping at seconds 116
Stamping at seconds 120
```

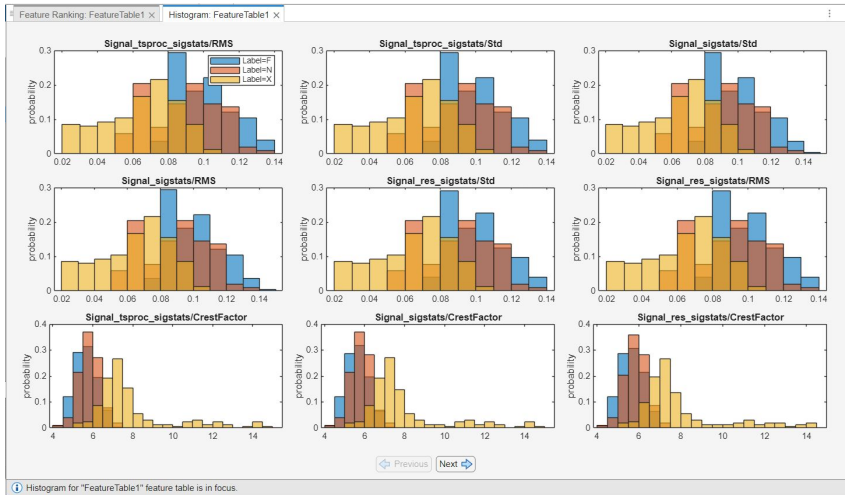
Feature Extraction

Audio → Diagnostic Feature Designer → Feature List → Choose Top 10 Features

MatLab Tools

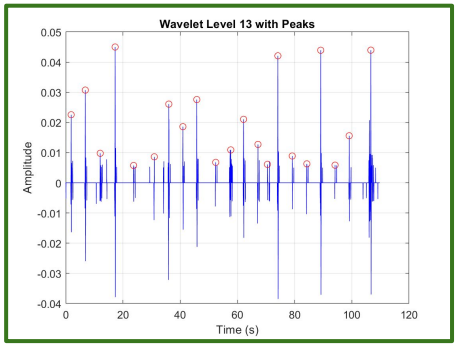


Feature	One-way ANOVA
Signal_tsproc_sigstats/RMS	197.1070
Signal_tsproc_sigstats/Std	197.1070
Signal_sigstats/Std	197.1012
Signal_sigstats/RMS	197.0992
Signal_res_sigstats/Std	197.0933
Signal_res_sigstats/RMS	197.0914
Signal_tsproc_sigstats/CrestFactor	195.1310
Signal_sigstats/CrestFactor	195.1241
Signal_res_sigstats/CrestFactor	194.3535
Signal_res_tsmodel/MAE	178.0581
Signal_tsmodel/MAE	173.8203
Signal_tsproc_tsmodel/MAE	173.8007
Signal_sigstats/ImpulseFactor	171.4655
Signal_tsproc_sigstats/ImpulseFactor	171.3712
Signal_res_sigstats/ImpulseFactor	170.9910
Signal_res_tsmodel/RMS	170.5333
Signal_tsmodel/RMS	168.5318
Signal_tsproc_tsmodel/RMS	168.5304
Signal_tsproc_tsmodel/MSE	162.8597
Signal_tsproc_tsmodel/Variance	162.8597
Signal_tsmodel/MSE	162.8593
Signal_tsmodel/Variance	162.8592



Approach 1: Filter only peak events to predict

Audio → Audio Segmentation v.1.0 → Signal Preprocessing → Feature Extraction → Model



- Normalize
- Denoise using wavelet denoising

- Normal
- Faulty

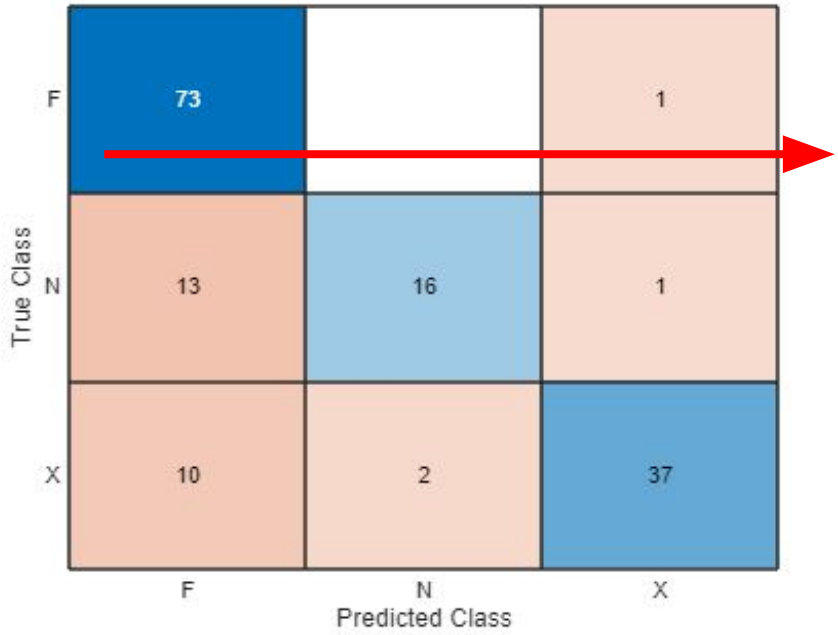
Approach 2: Put raw buffer to the model

- Normalize
- Denoise using wavelet denoising

- Non-Stamping
- Normal
- Faulty

Model Result

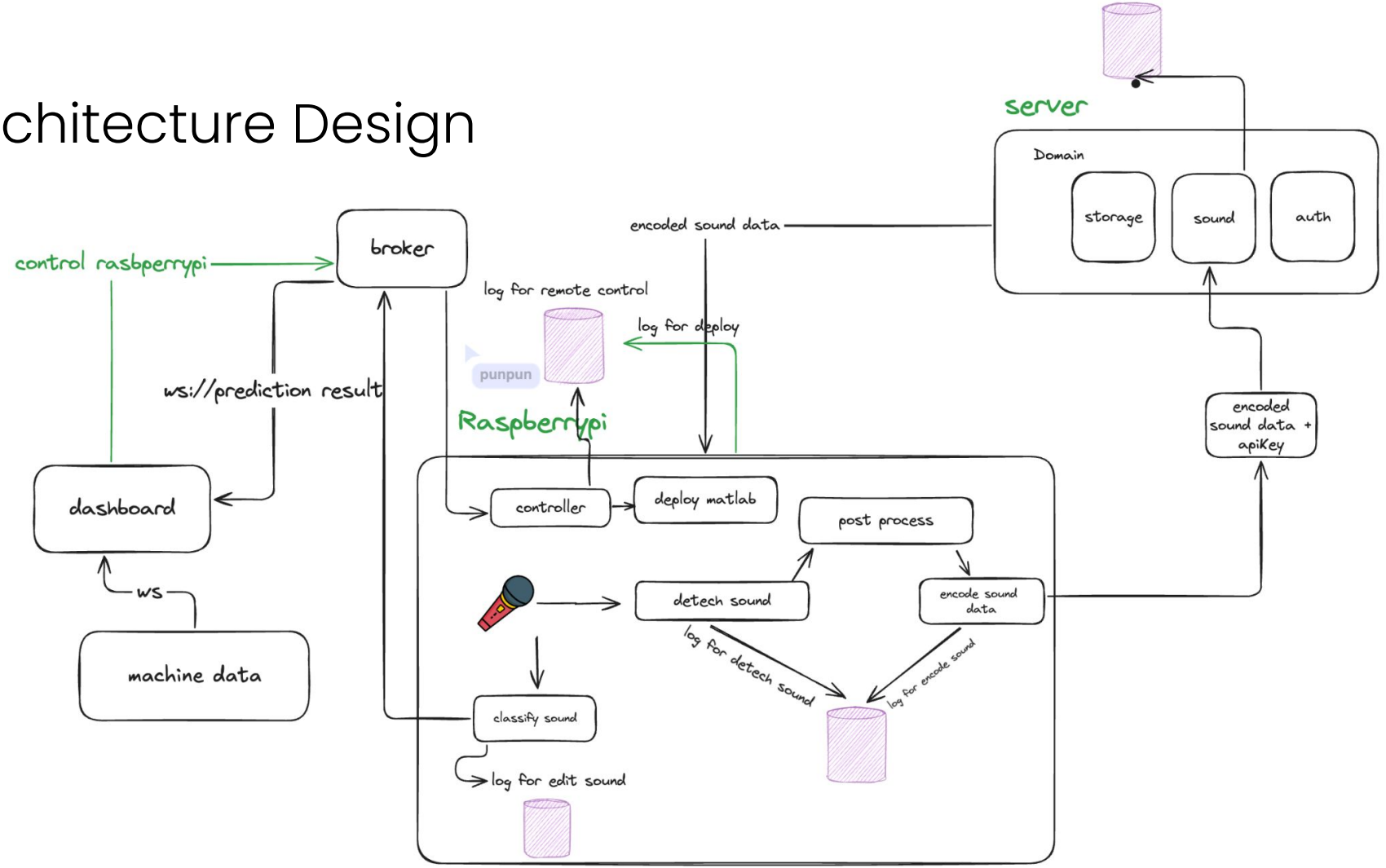
Model Accuracy: 82.35%



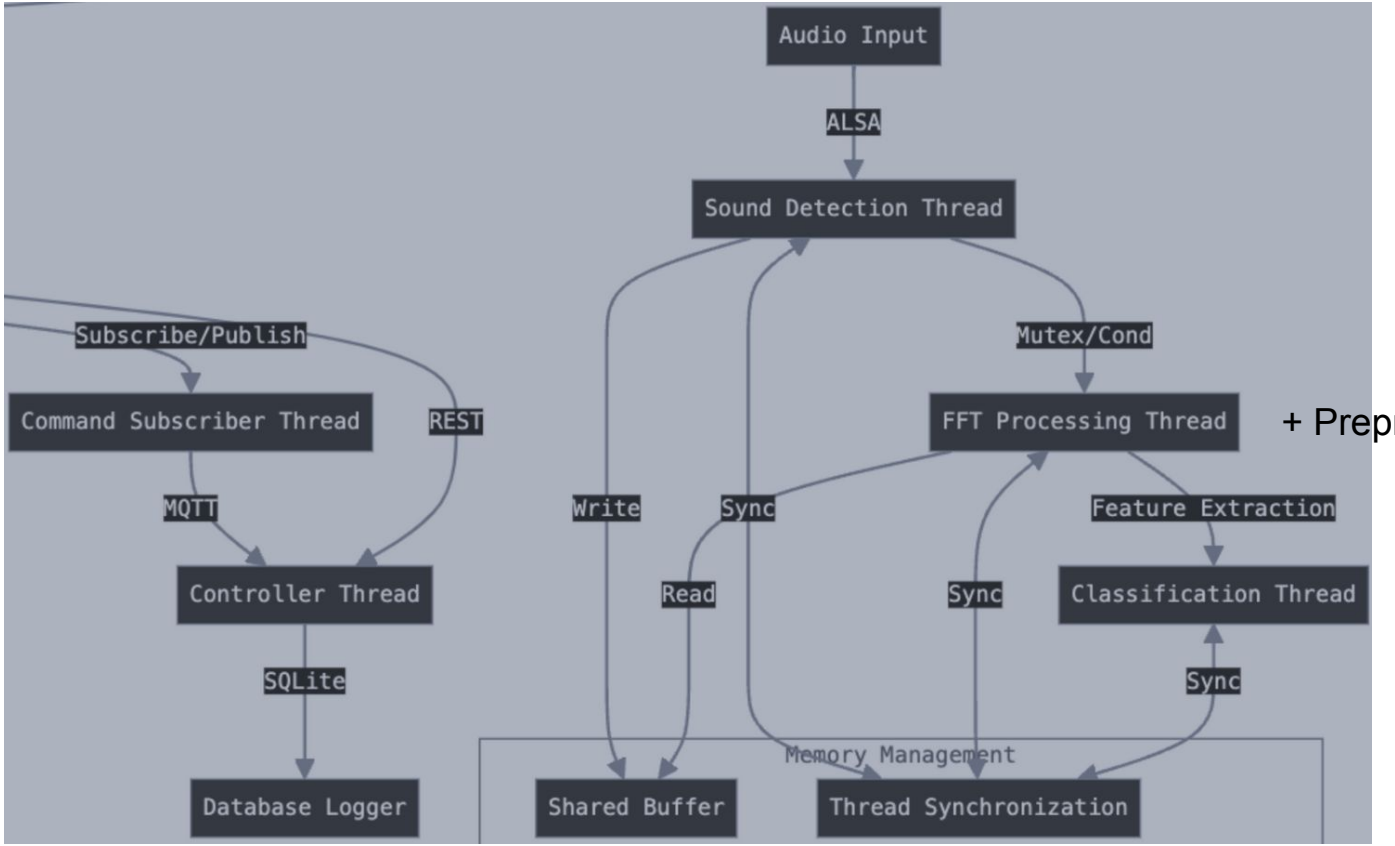
Fraud detection problem

Recall -> 73/74

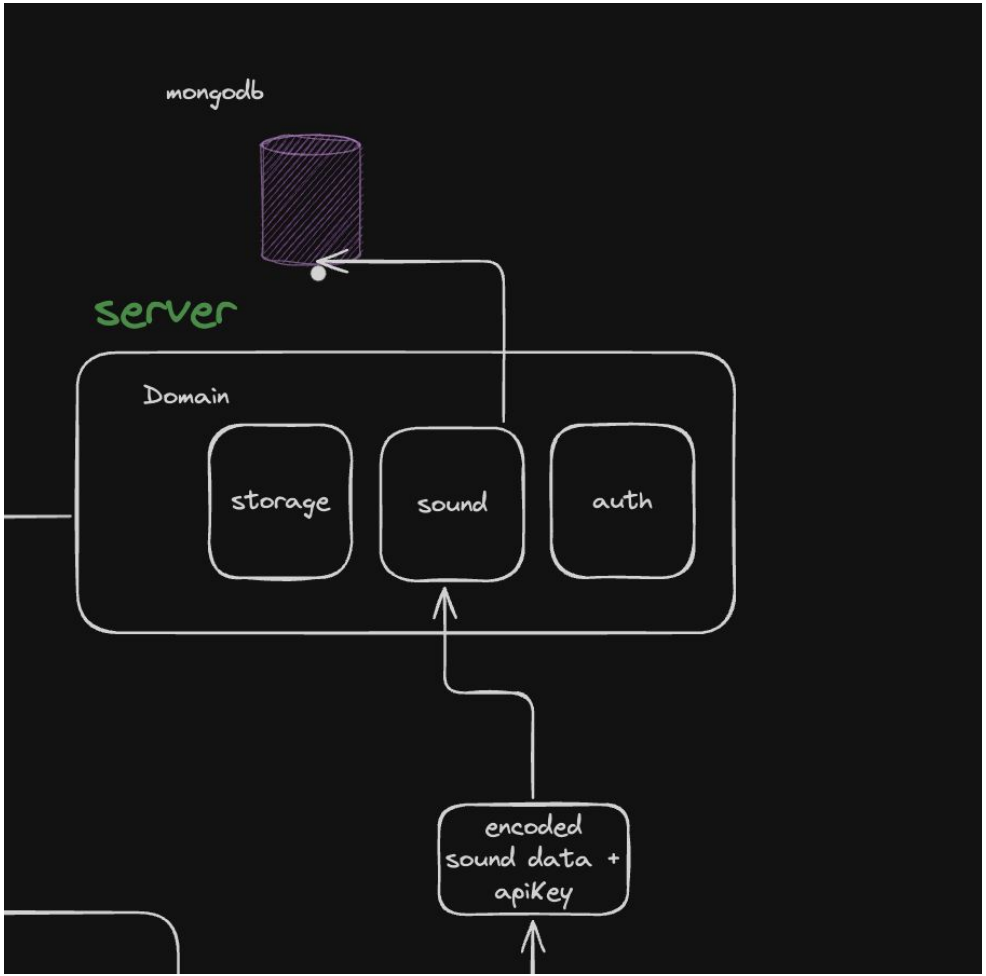
Architecture Design

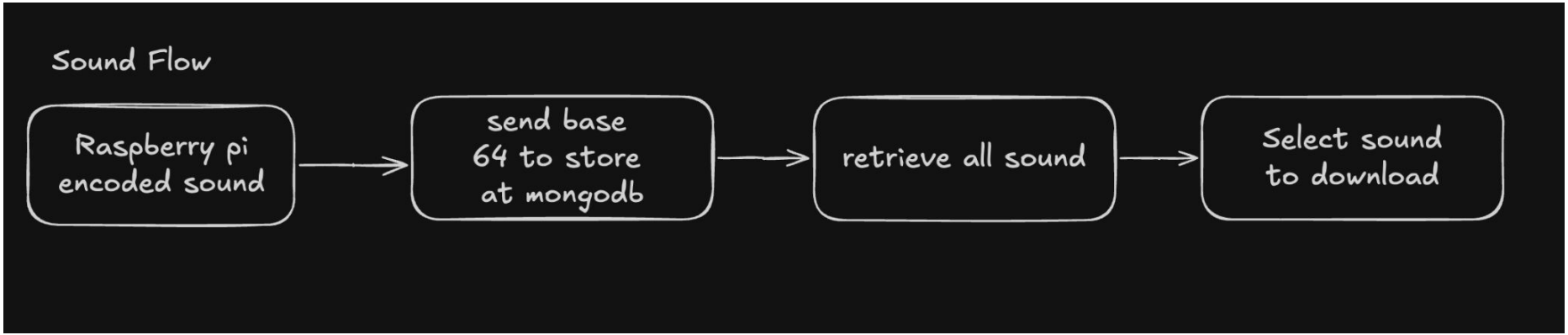


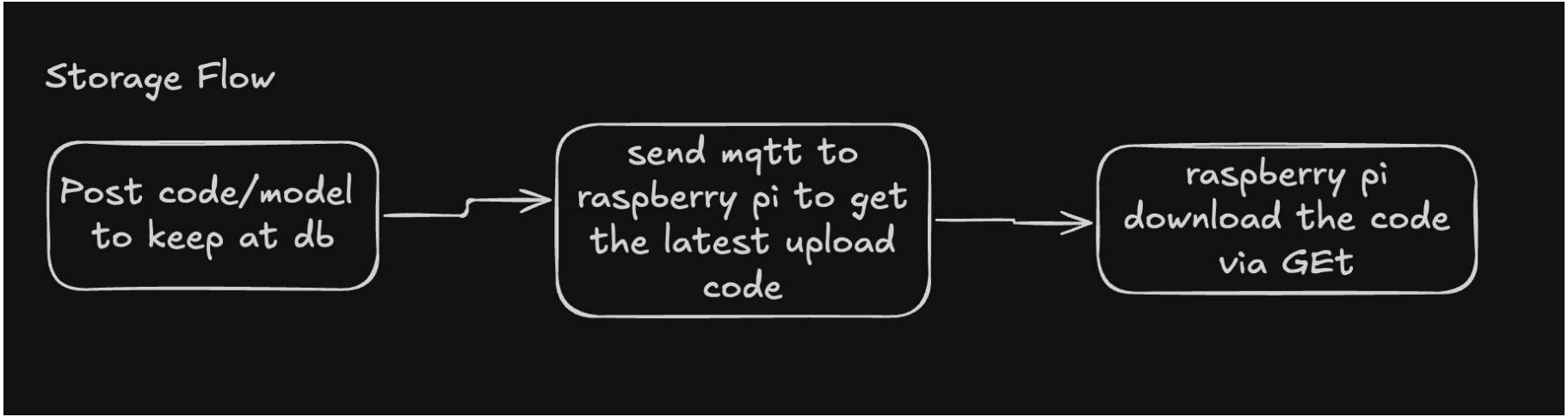
hardware design



+ Preprocessing


mongodb
server
Domain
storage
sound
auth
encoded
sound data +
apiKey


Sound Flow
Raspberry pi encoded sound
send base 64 to store at mongodb
retrieve all sound
Select sound to download


Storage Flow
Post code/model to keep at db
send mqtt to raspberry pi to get the latest upload code
raspberry pi download the code via GEt


Machine Monitoring
Live process parameters
View Historical
Pick a date range
Energy
Pressure
Force
Position
Energy Consumption
120
90
60
30
0
11:33:48 AM
11:33:49 AM
11:33:50 AM
11:33:51 AM
11:33:52 AM
11:33:52 AM
11:33:53 AM
11:33:54 AM
11:33:55 AM
11:33:56 AM
Pressure
21000
14000
7000
0
-7000
11:33:48 AM
11:33:49 AM
11:33:50 AM
11:33:51 AM
11:33:52 AM
11:33:52 AM
11:33:53 AM
11:33:54 AM
11:33:55 AM
11:33:56 AM

Mock Mode

Amplitude History

Real-time amplitude monitoring

Falsy Normal Nonstamp Current: 11.57

Acoustic Predictions

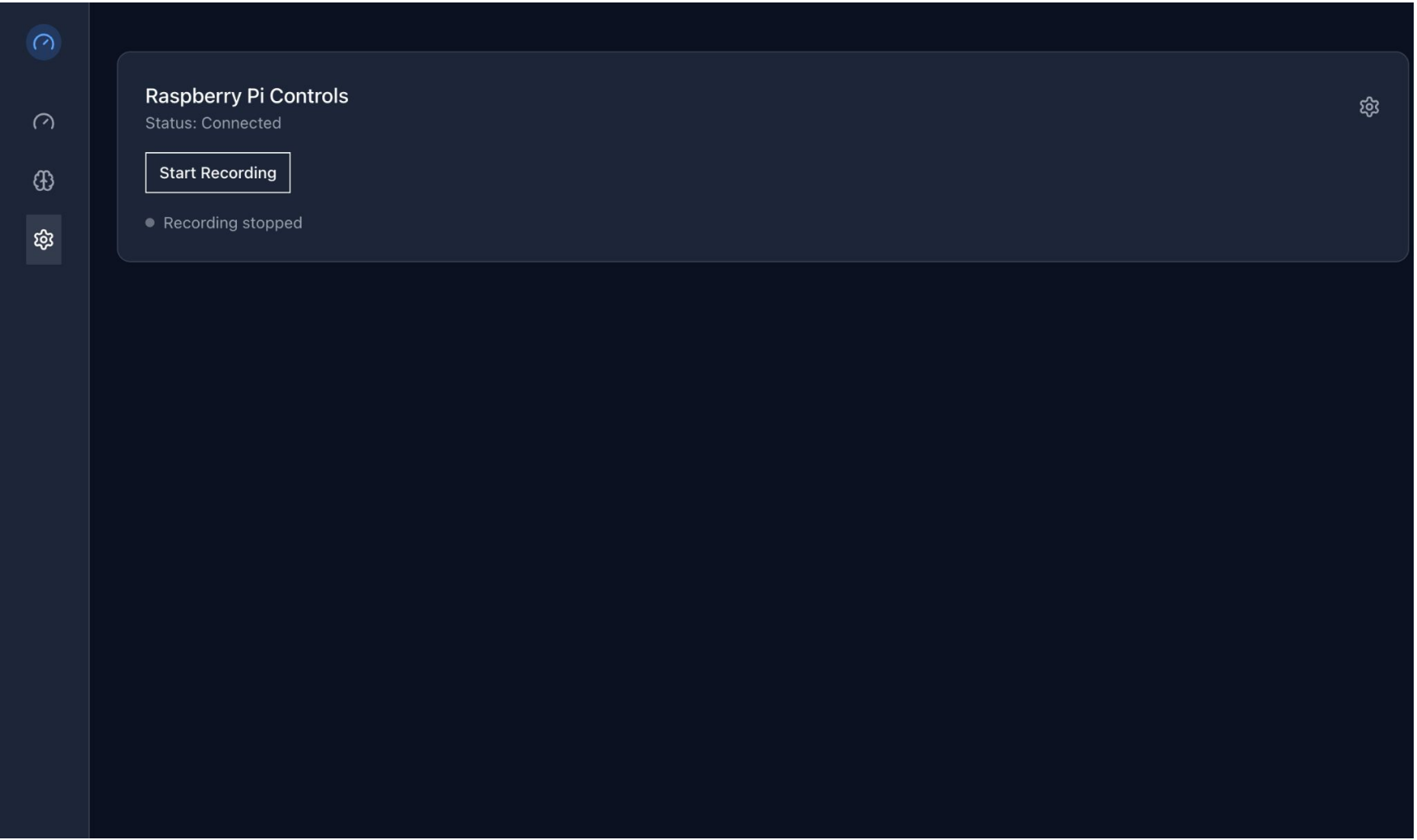
Real-time analysis results

Nonstamp 00:20
Confidence: 95.8%

Falsy 00:18
Confidence: 81.7%

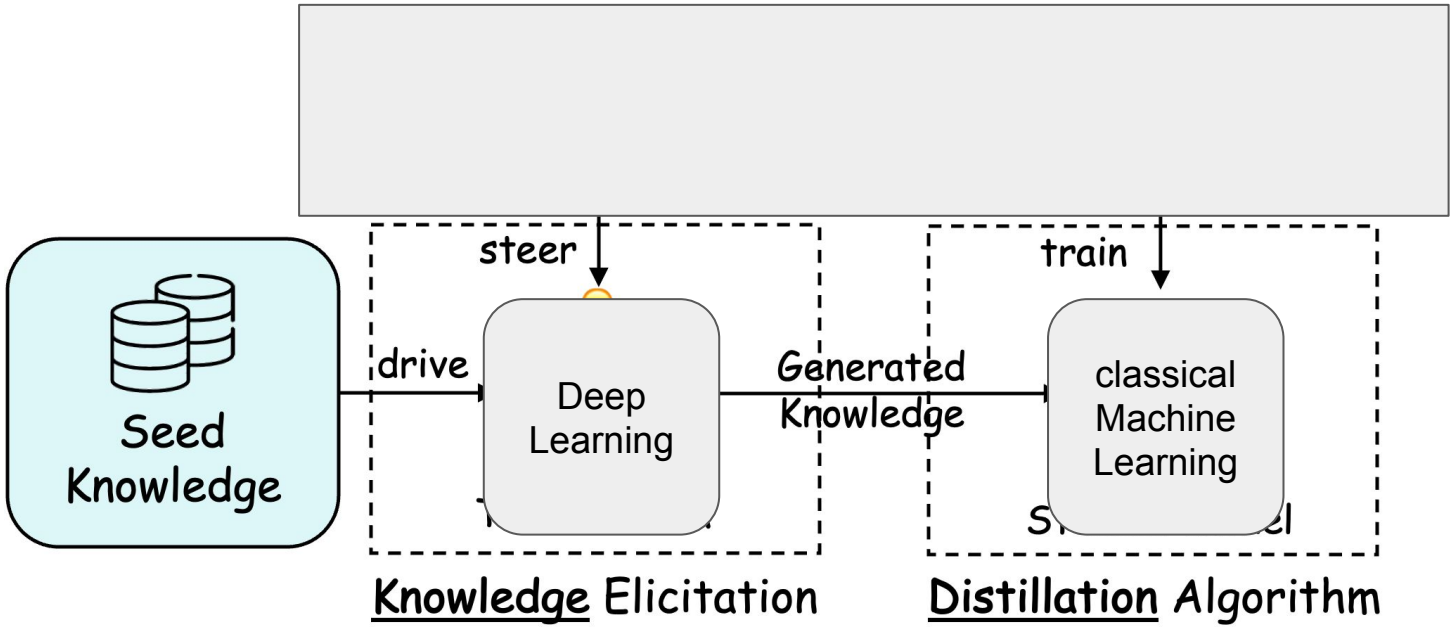
Falsy 00:16
Confidence: 85.8%

Falsy 00:14
Confidence: 99.6%


Raspberry Pi Controls
Status: Connected
Start Recording
Recording stopped

Feature plans

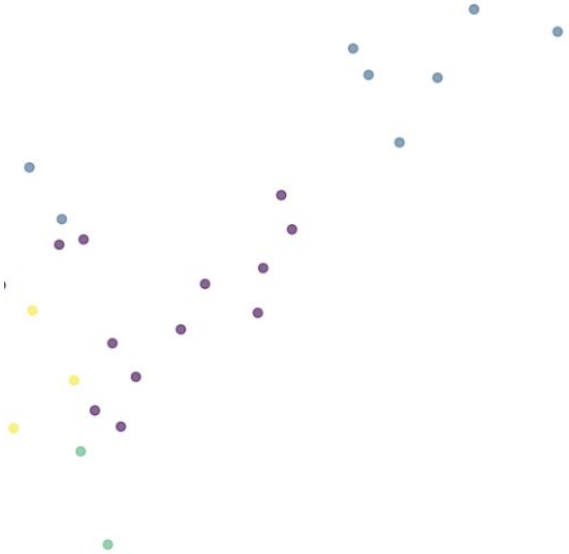
Deep Learning can transfer knowledge to other by knowledge distillation



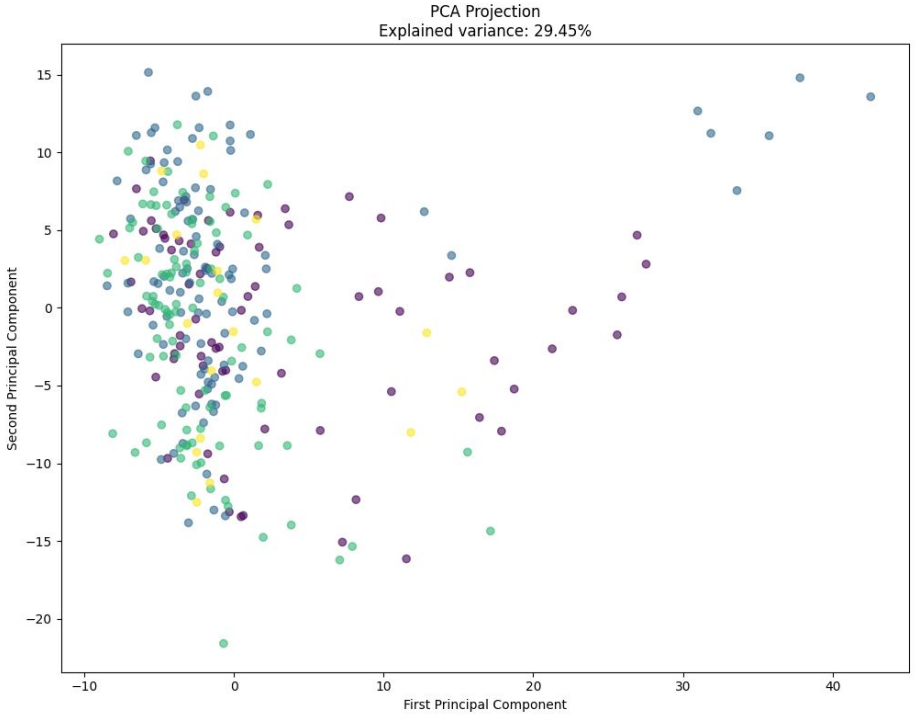
If data is not labeled (unsupervised problem)

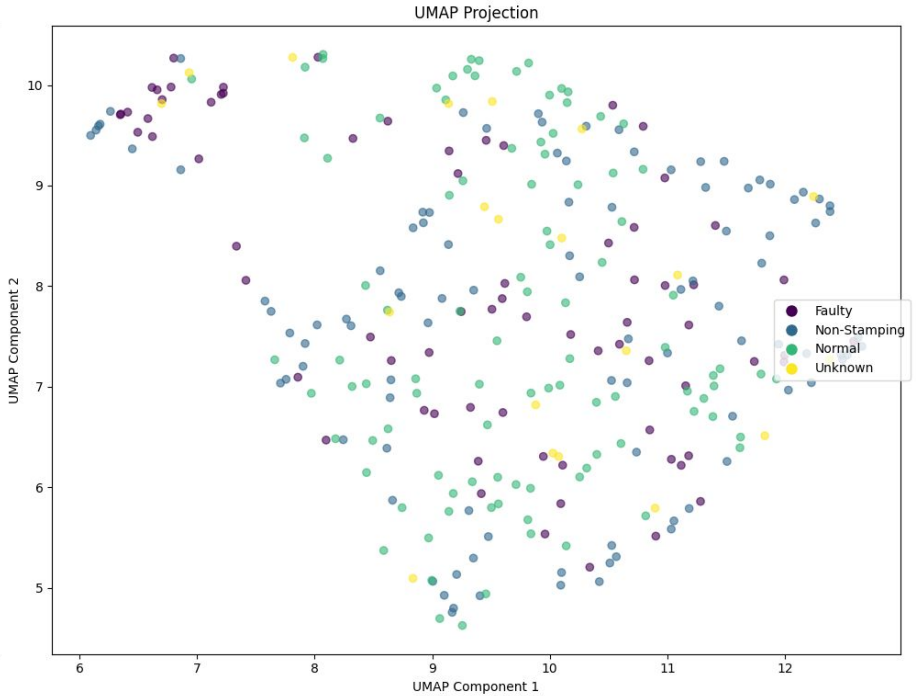
preprocess

Signal encoder
(whisper v3 openai)

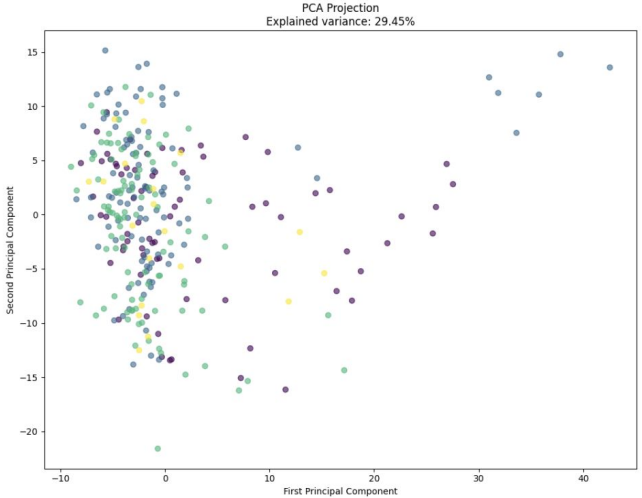


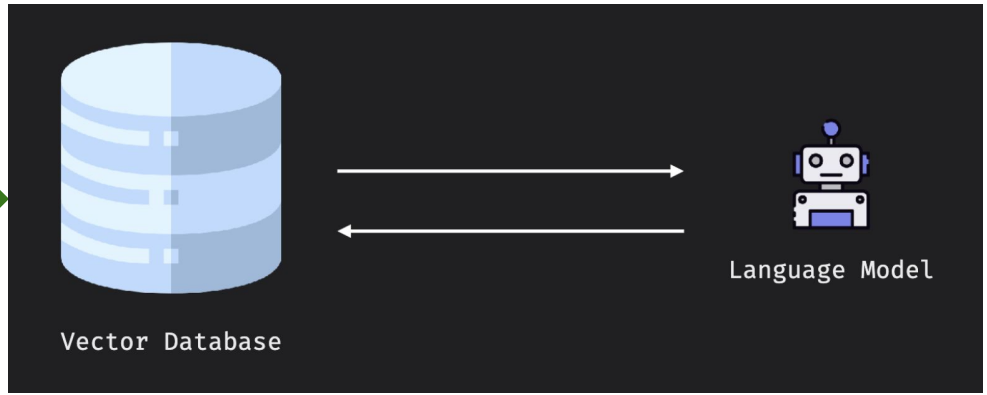
If data is not labeled





Grow over with datasets



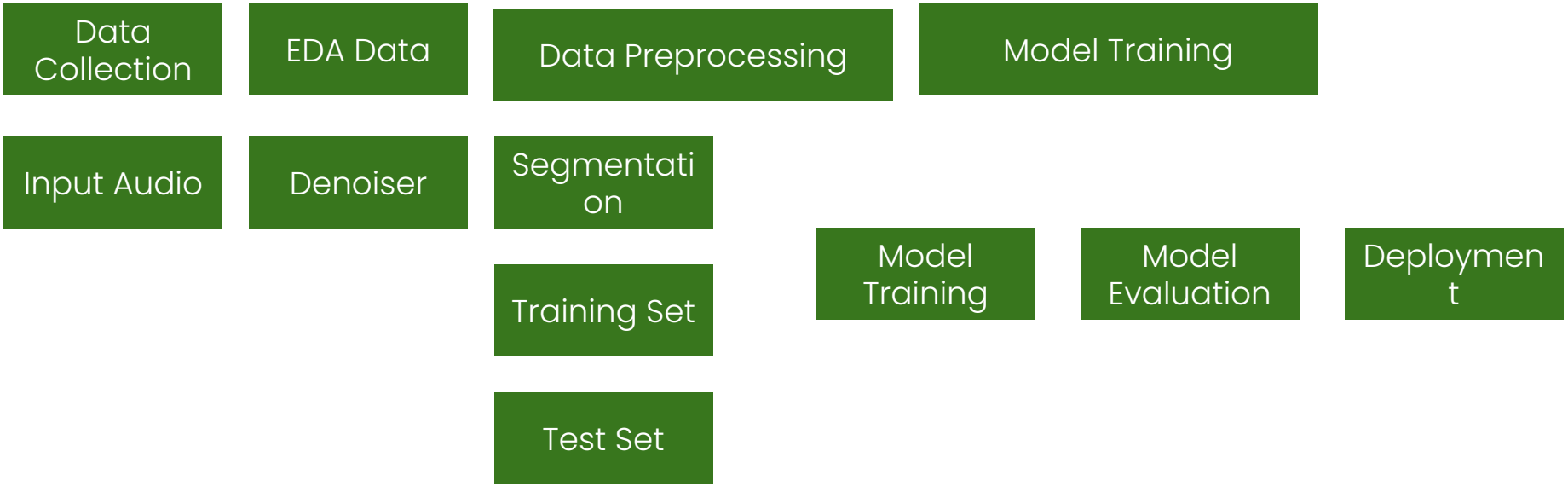


(Database for LLM)

Thanks for your Attention

Appendix

Overall Process



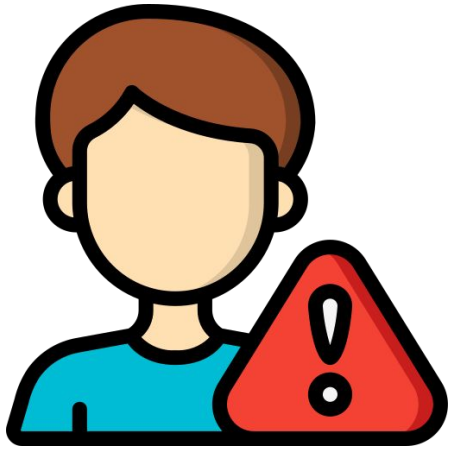
Dataset

1. Normal1.wav
2. Normal2.wav
3. Normal3.wav
4. Faulty1.wav
5. Faulty2.wav

Audio Segmentation

1. Version 0.5 - Waveform Classification
2. Version 1.0 - Wavelet Transform
3. Version 2.0 - Segmentation Algorithm

Costs Calculation



Human error rate 1 - 5%

(7 work hours x 60 minutes x 60 seconds) / 8 seconds = 3150 times per day

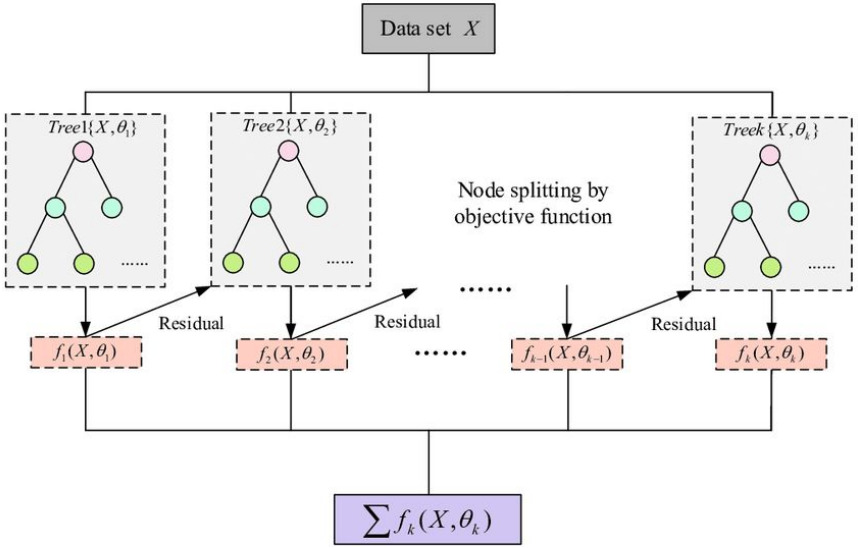
3150 * 2.5% = 78 times (actual 78.75)

Source: http://procurement.rid.go.th/admin/eauction_doc/0700300113_R_11052015133745_0b21c_refprice.pdf

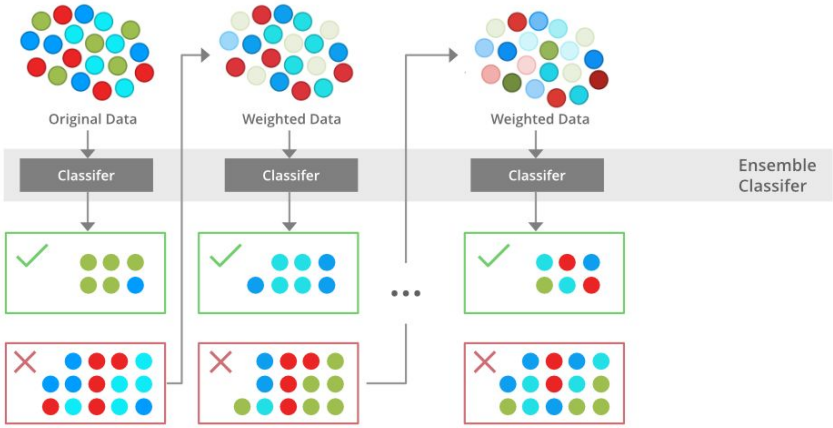
Source: https://integrationmadeeasy.com/resources/impact-of-human-error-rates/

Classification Model

Gradient Boosting Model

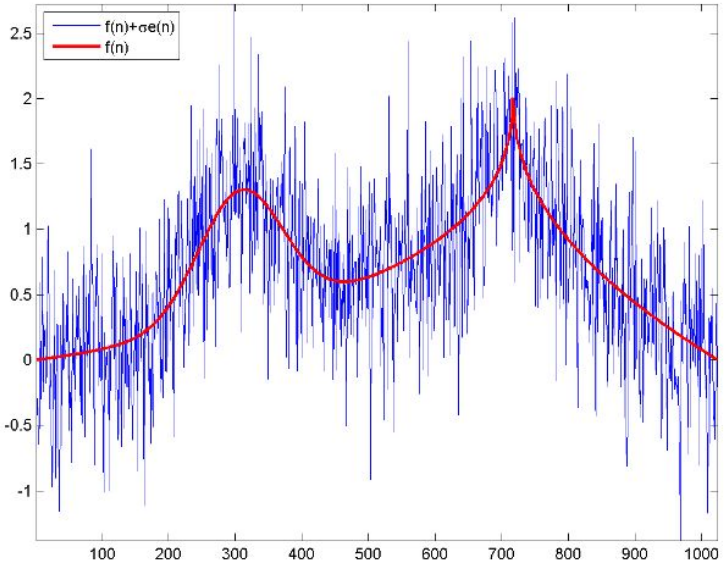


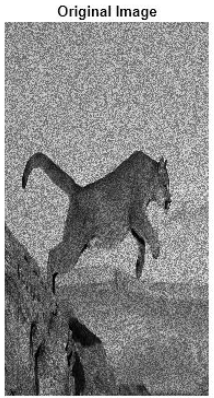
XGboost Algorithm



Denoise Algorithm

We use wavelet denoising to reduce noise in signals.





Segmentation Algorithm (Signal-to-Noise-based)

Model Training