

# Heart Murmur Detection using Machine Learning

## Machine Learning | MSc Artificial Intelligence

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# Outline

- 1 Introduction
- 2 Feature Extraction
  - Important Features
- 3 Heart Murmur Classification

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# Introduction

- Heart murmurs are sounds made by turbulent blood flow through the heart. The sounds can be heard with a stethoscope.
- Lately, digital stethoscopes are used, that can record heart audio signals.
- We will use ML in order to detect heart murmur using *The CirCor DigiScope Dataset*.

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# Feature Extraction Procedure

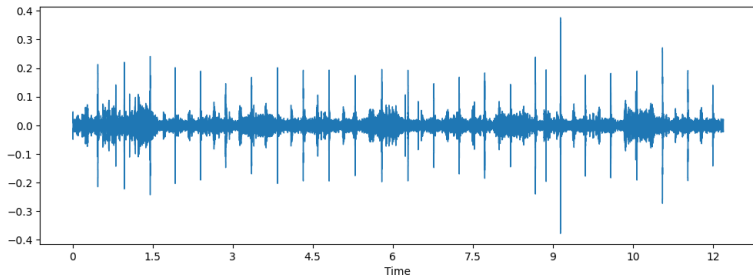


Figure: Waveform of Heart Audio Signal

# Feature Extraction Procedure

- **Time domain Features**

- *Amplitude Envelope*
- *Total Energy*
- *Root-Mean Square Energy*
- *Zero-Crossing Rate*
- *Skewness*
- *Kurtosis*

- **Cepstral domain Features**

- *MFCCs*

- **Frequency and Spectral domain Features**

- *Peak Frequency*
- *Onset Detection*
- *Band Energy Ratio*
- *Autocorrelation*
- *Spectral Centroid*
- *Spectral Bandwidth*

# Zero-Crossing Rate (ZCR)

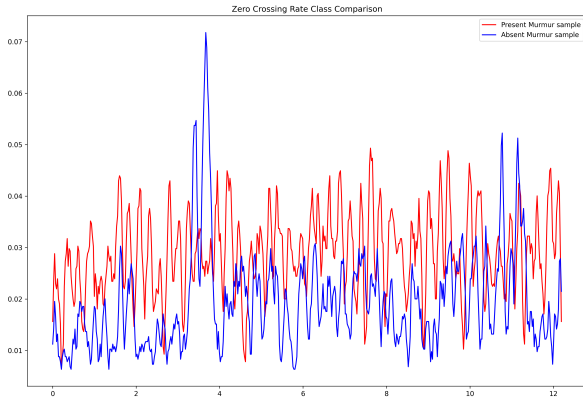


Figure: ZCR of absent and present murmur



# Kurtosis

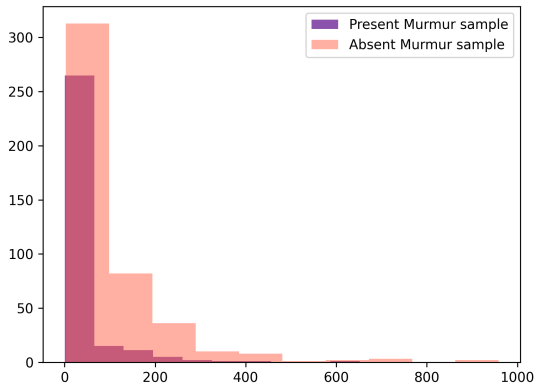


Figure: Kurtosis of signals at PV

# Onset Detection

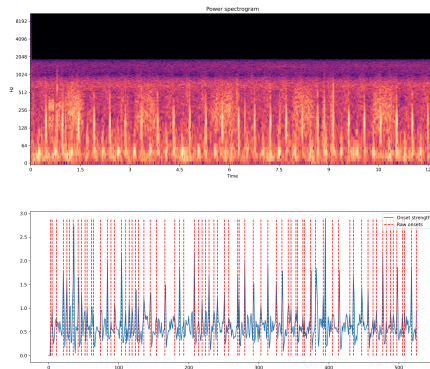


Figure: Onset detection of signals with murmur

# Onset Detection

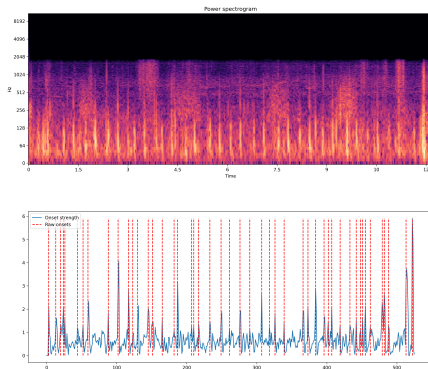


Figure: Onset detection of signals without murmur

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# Feature and Model Selection

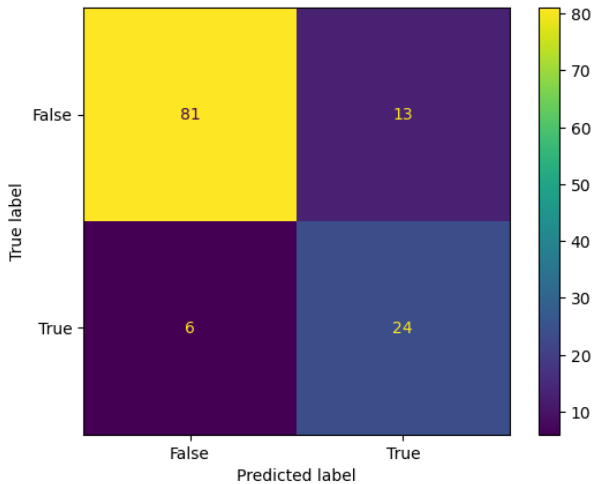
- We performed *data augmentation* on the positive samples.
- We selected features based on three feature selection methods :  
*Lasso Logistic Regression, ANOVA and Recursive Feature Elimination.*
- We divided our dataset into *training, validation* and *test* sets.
- We considered different hypotheses spaces.
- We trained our models in such a way to avoid underfitting and overfitting.

# Evaluation

Our final model is a SVM with  $C = 0.1$  and a sigmoid kernel.

Precision	0.648
Recall	0.8
F1 score	0.716
Accuracy	0.846

# Evaluation



# Evaluation

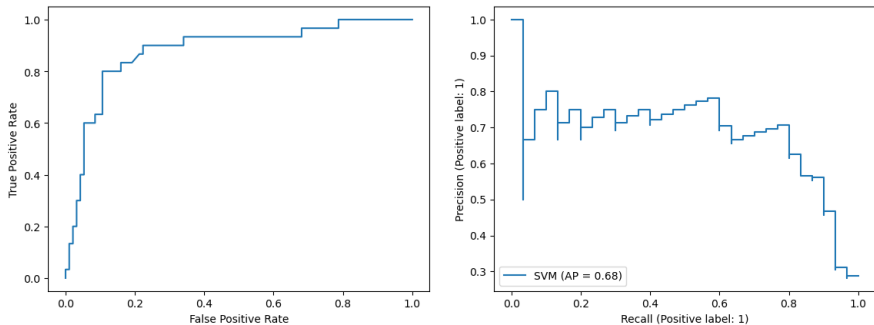


Figure: ROC and PR curves



Thank you for your attention, a short demo follows.