Listen to your Heart:
Heartbeat Sound Segmentation & Classification

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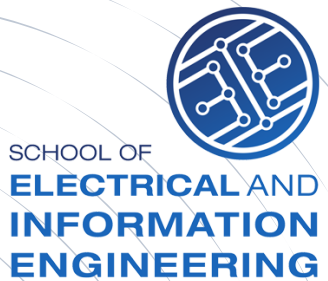
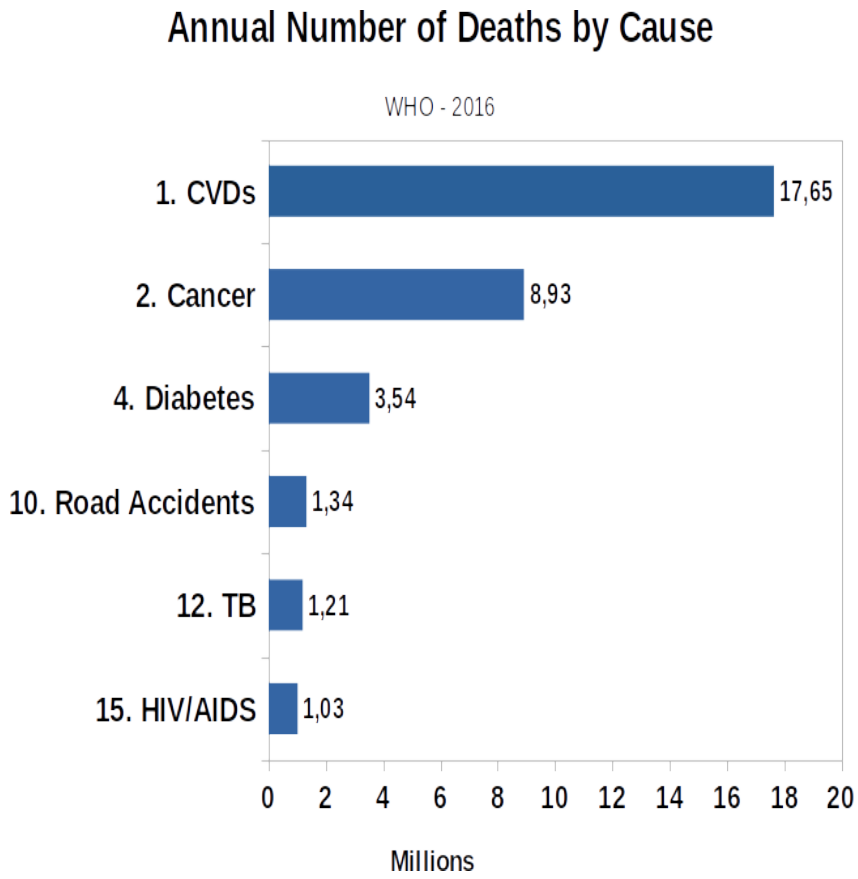


Agenda

- Introduction
- Objectives
- Background
  - Heartbeat Sounds Categories
  - Related Work
  - Project Setting
- Methodology
  - Data Acquisition
  - System Overview
  - Preprocessing
  - Segmentation
  - Feature Extraction

Introduction

- CVDs are the leading causes of death globally - WHO.



Introduction

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- Currently used method to check for CVDs is Cardiac Auscultation (CA).

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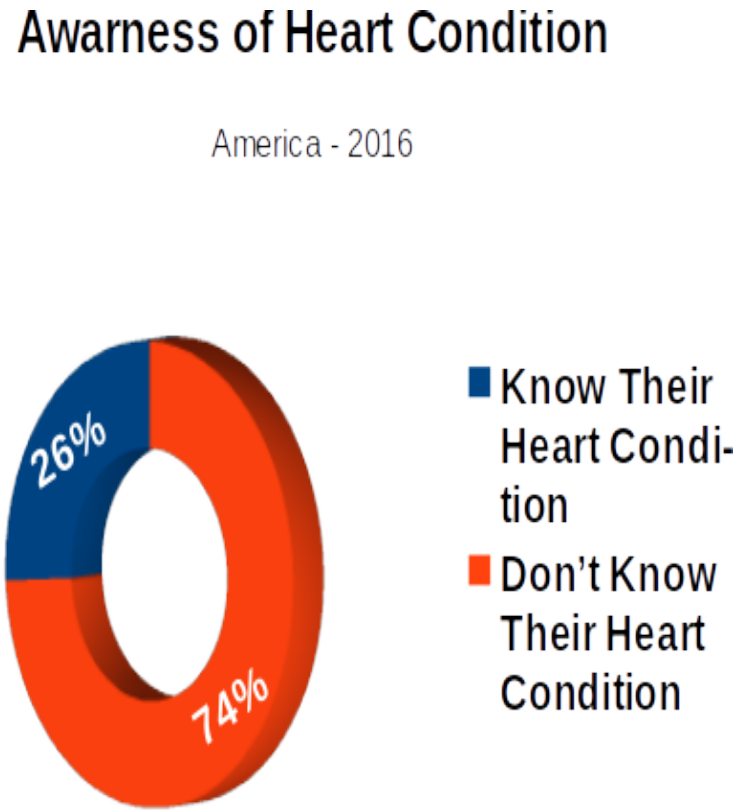
Correct diagnosis using CA in USA, Canada & UK respectively.

Introduction

- CVDs are the leading causes of death globally - WHO.
- Currently used method to check for CVDs is Cardiac Auscultation (CA).
- CA is a difficult skill to acquire.
- People are not aware of their heart conditions.

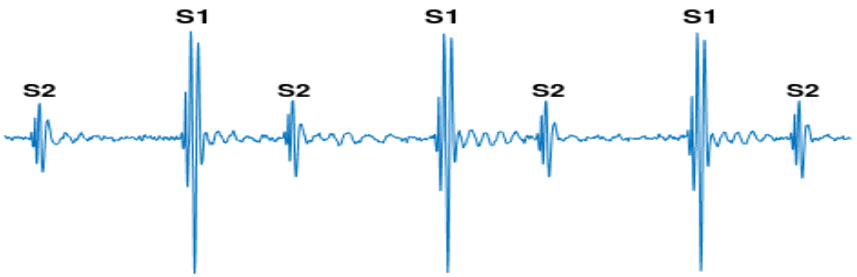


Introduction

Easily accessible & reliable heart diagnosis systems would help reduce deaths due to CVDs.

Objectives

- To segment Heartbeat sounds (HSs) based on the location of S1 (lub) S2 (dub) in Normal HSs.



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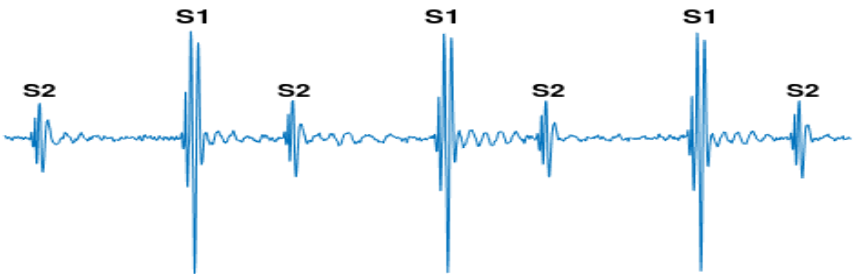
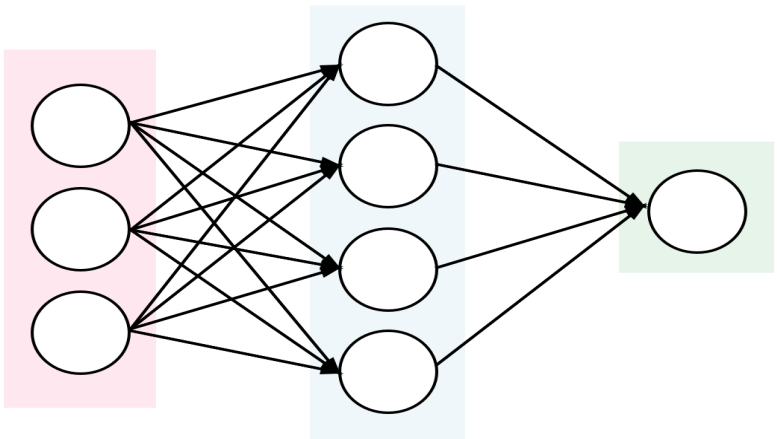


- Create models that will enable preliminary screening of CVDs



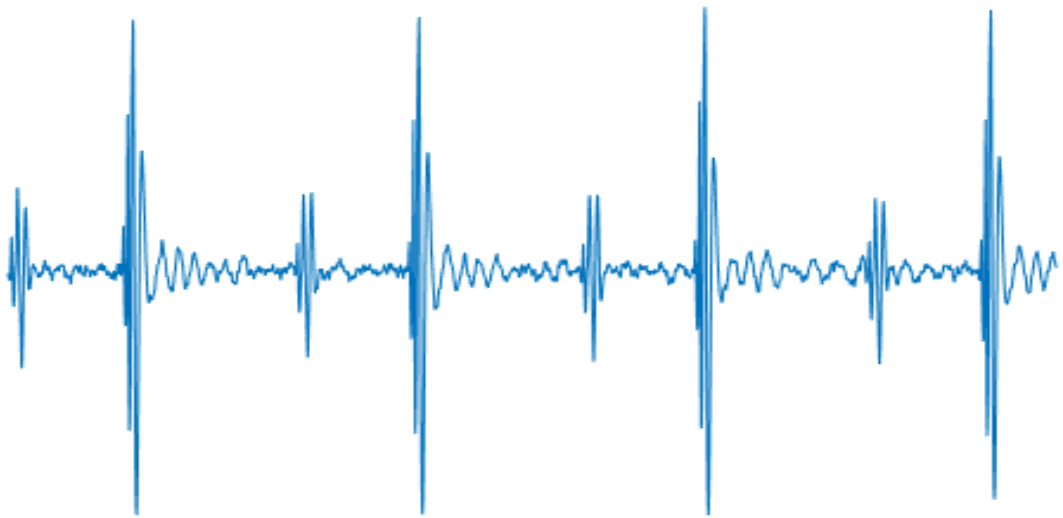
Background
Heartbeat Sounds Categories

This project deals with classifying HSs into the following categories:

1. Normal HSs
2. Murmur HSs
3. Extra Heartsounds
4. Exrasystole HSs
5. Artifact

Normal HSs

lub...dub.....lub...dub.....



Murmur HSs

```
lub..***..dub......lub..***..dub......
                or
lub....dub...******...lub....dub...******...
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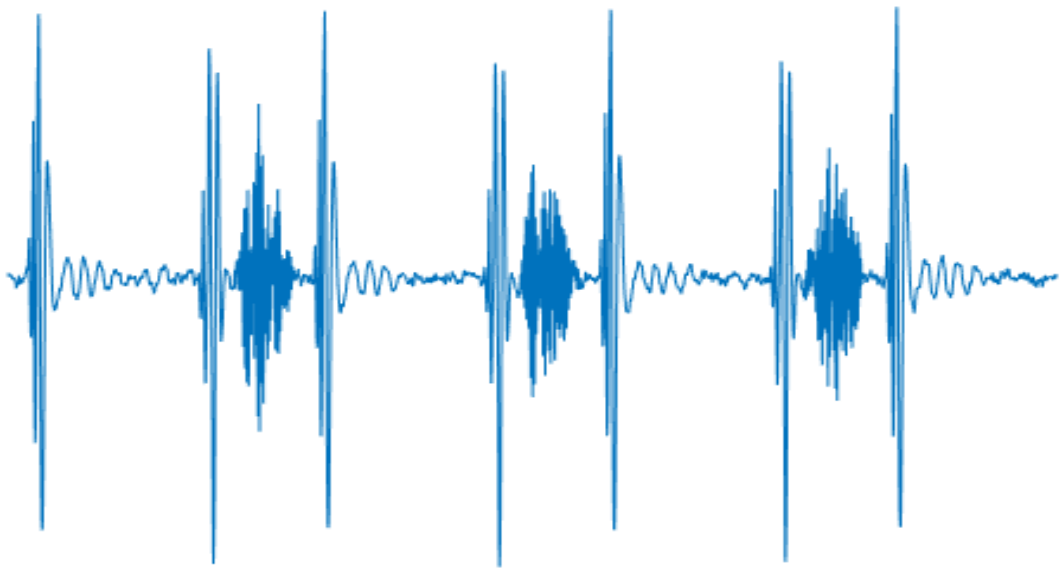


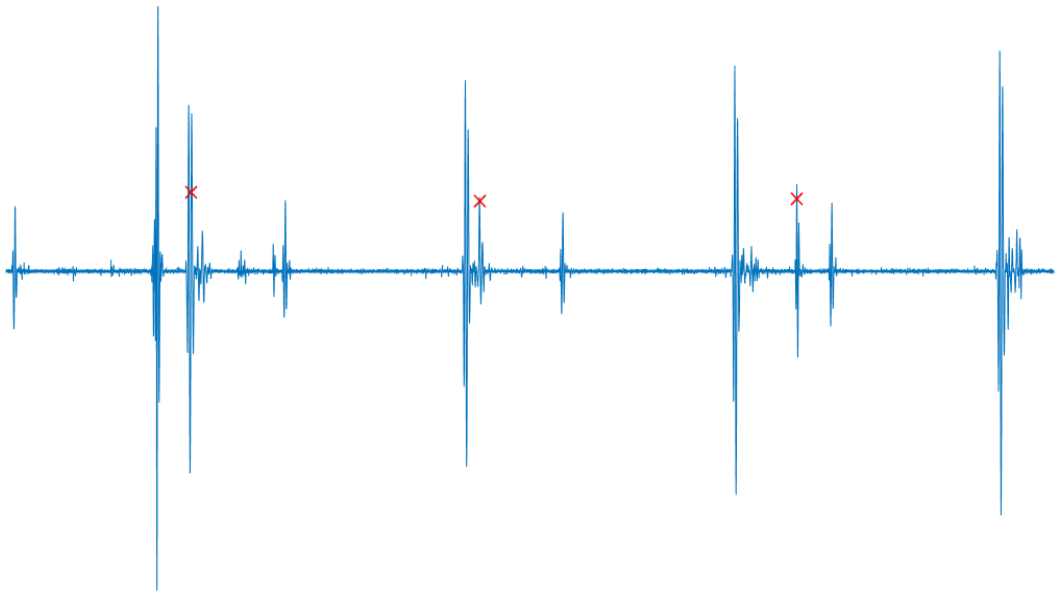
Background
Heartbeat Sounds Categories

Extra HS

lub.lub...dub.....lub.lub...dub.....

or

lub...dub.dub.....lub...dub.dub.....

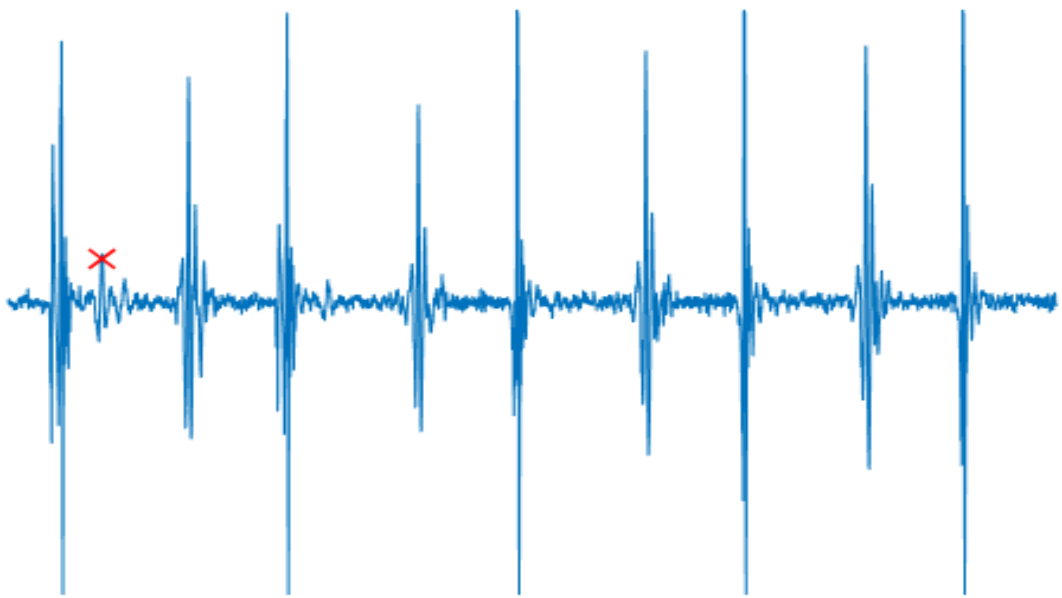


Extrasytole HSs

lub....dub.....lub.lub...dub.....lub....

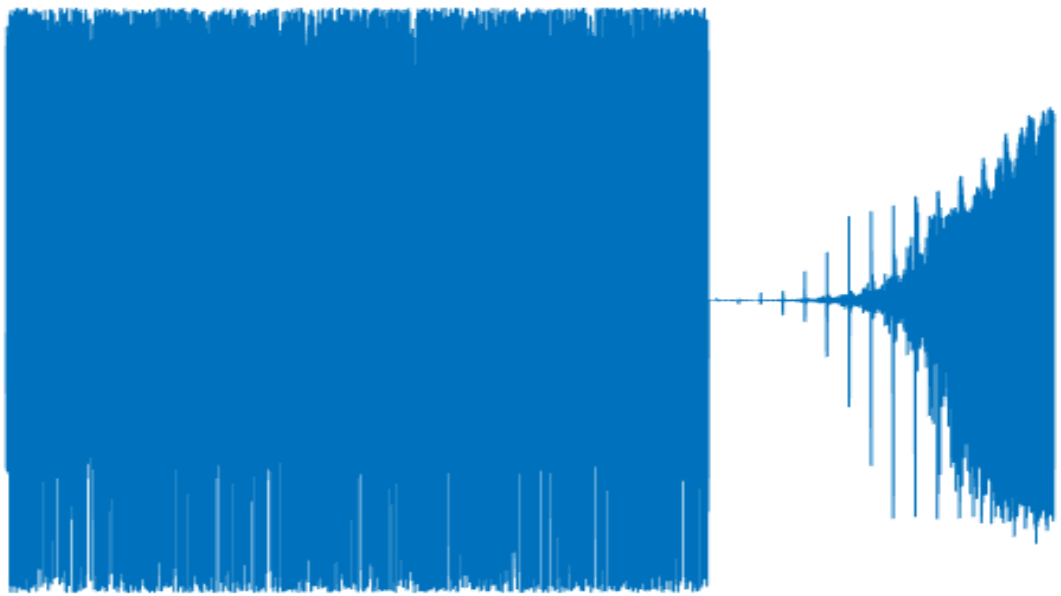
or

lub....dub.dub.....lub...dub.....lub....



Artifact Sound

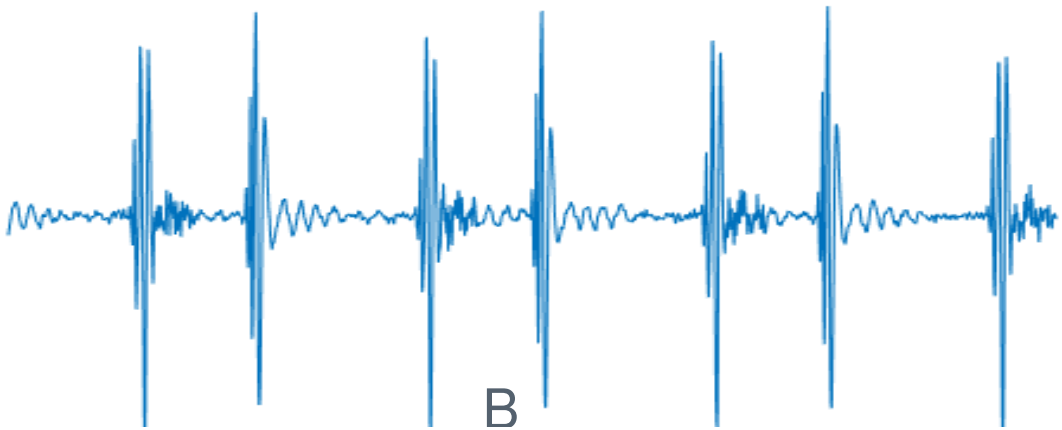
Not an actual HSs.



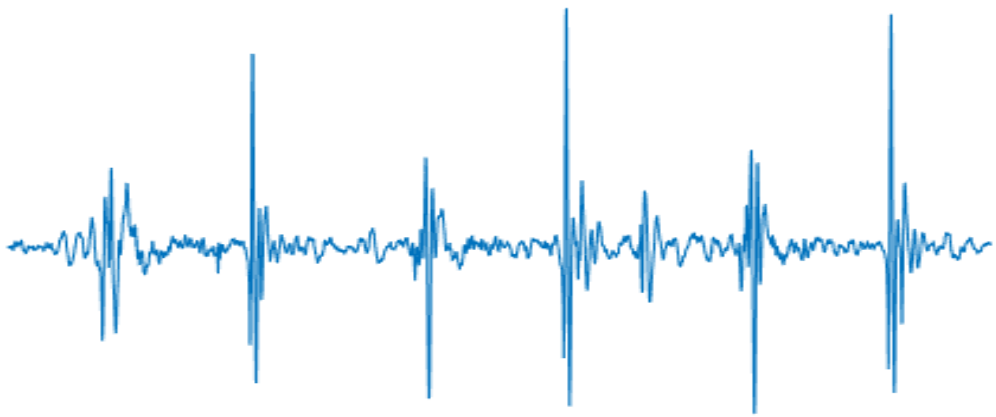
Background
Heartbeat Sounds Categories

Can you guess the categories?

A



B



Background
Related Work

Strunic's attempt to classify HSs with ANN.

85±7.4%

Accuracy when classifying simulated HSs with no noise.

48±12.7%

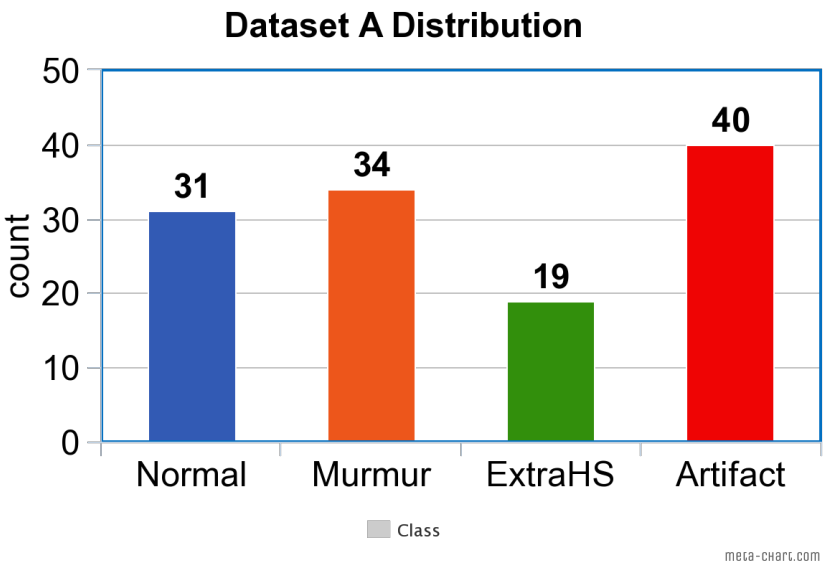
Accuracy when classifying real life HSs with noise.

Background
Project Setting

To make this project applicable to real world situations, two datasets recorded in real life settings will be used. Both datasets contain excessive background noise.

Methodology
Data Acquisition

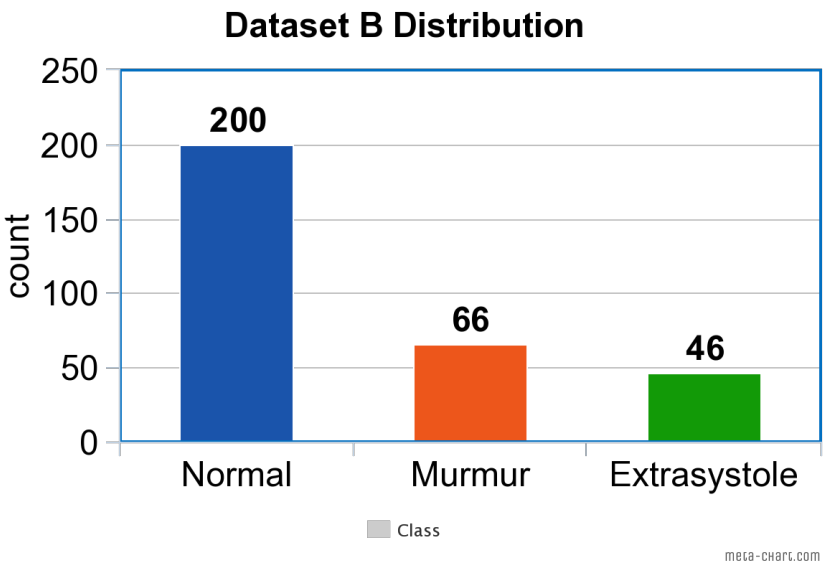
Dataset A



- Recorded by the general public
- Device - iStethoscope Pro Iphone app
- Sampling Freq - 44100Hz
- Contains excessive background noise

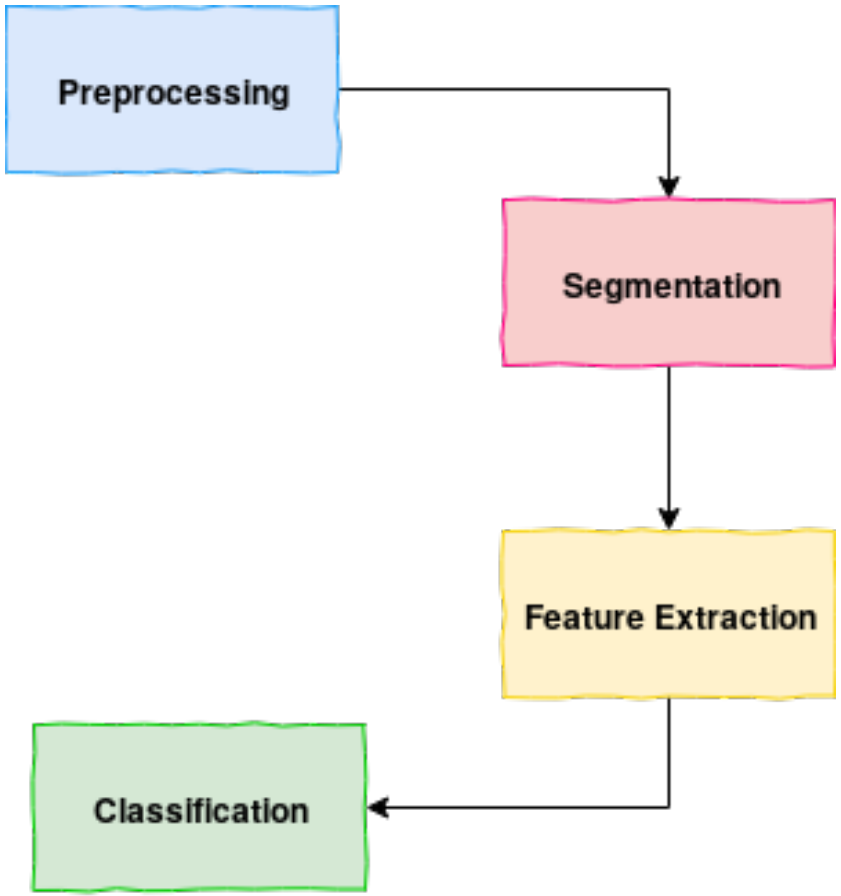
Methodology
Data Acquisition

Dataset B



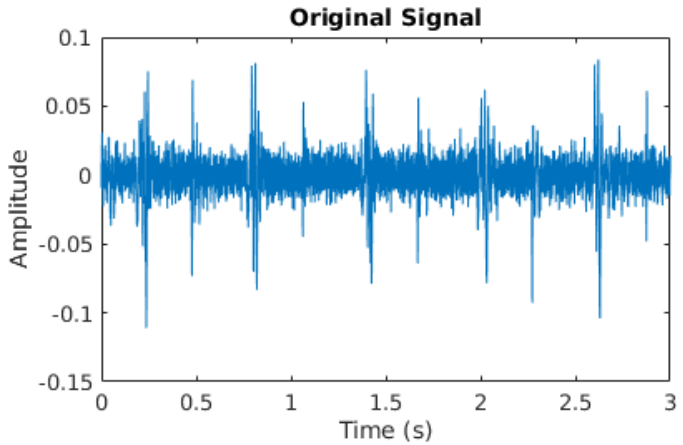
- Recorded from a hospital by Medical Practitioners
- Device - Digital Stethoscope
- Sampling Freq - 4000Hz
- Contains background noise

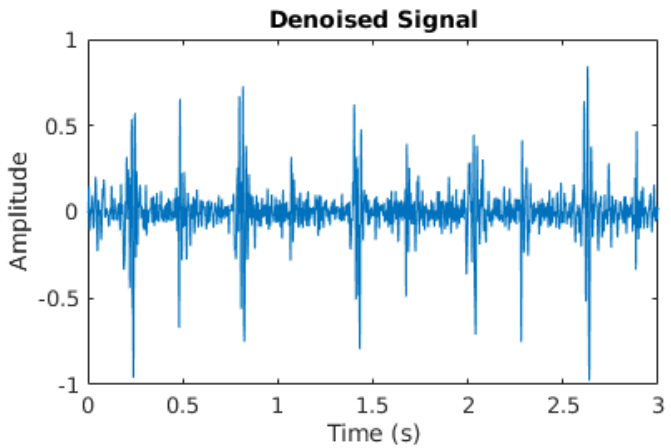
Methodology
System Overview



Methodology
Preprocessing

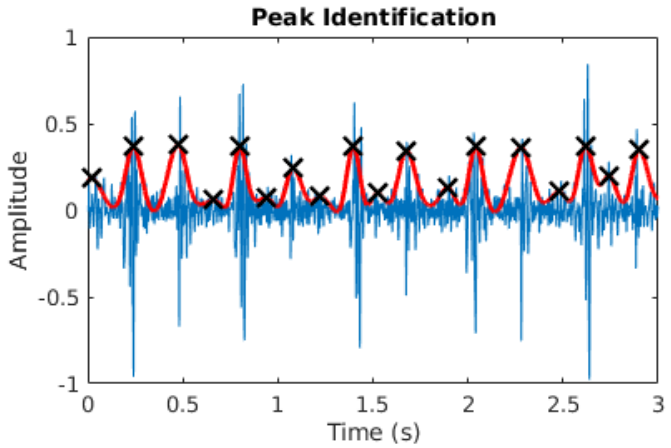
1. Downsample to 2kHz
2. Bandpass Chebyshev filter [30Hz-195Hz]
3. Normalization [-1 1]
4. Wavelet Decomposition (db7 level 5)
5. Refilter with LPF [195Hz]

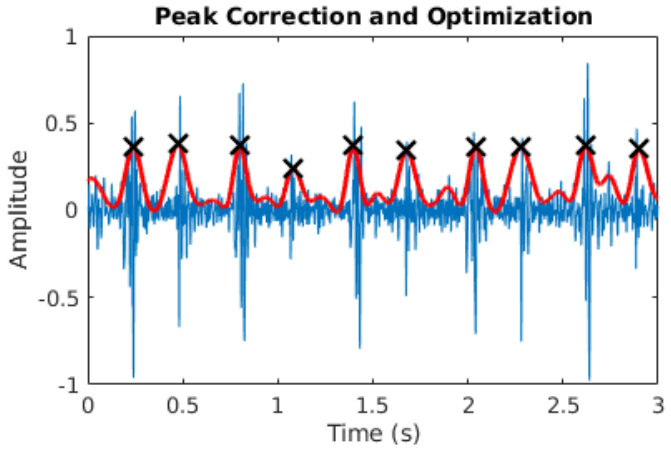




Methodology
Segmentation

1. Envelope Detection
2. Peak Detection
3. Extra Peak Rejection
4. Peak Correction & Optimization
5. Location of S1 and S2





Methodology
Feature Extraction

1. Time Domain
2. Frequency Domain
3. Wavelet
4. Ceptrum

Methodology
Classification

1. ANN (Atrificial Neural Network)
2. SVM (Support Vector Machine)
3. XGBoost (XGradient Boost)