

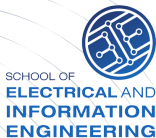
Listen to your Heart:

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

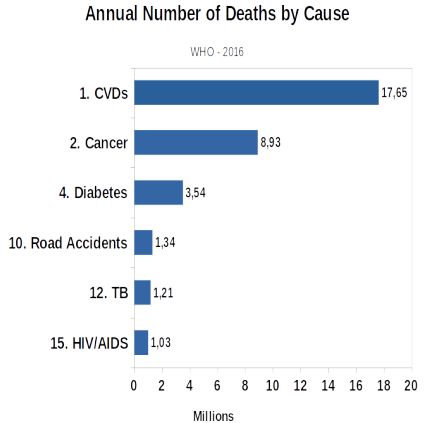
- Classification

Testing & Results

Introduction



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



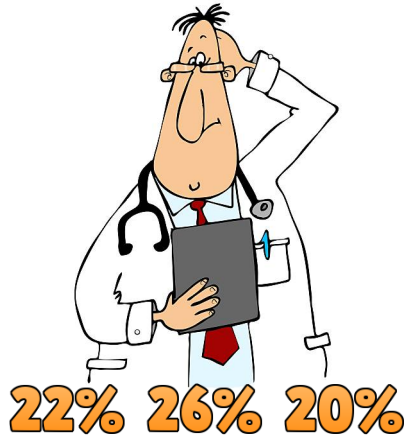


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- ▶ CA is a difficult skill to acquire.



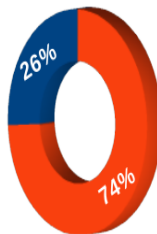
Correct diagnosis using CA in USA, Canada & UK respectively.



Awareness of Heart Condition

America - 2016

- ▶ 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.



- Know Their Heart Condition
- Don't Know Their Heart Condition

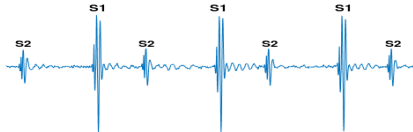


Easily accessible & reliable heart diagnosis systems would help reduce deaths due to CVDs.

Objectives



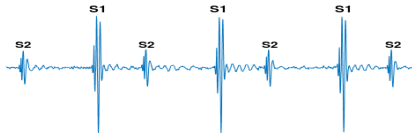
- To segment Heartbeat sounds (HSs) based on the location of S1 (lub) S2 (dub) in Normal HSs.



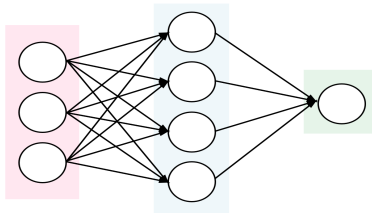
Objectives



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



- Create models that will enable preliminary screening of CVDs





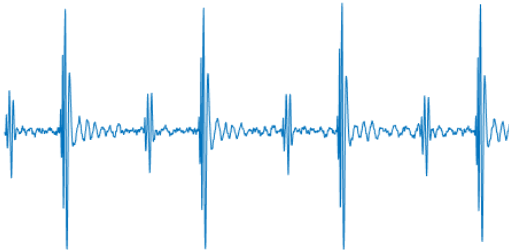
This project deals with classifying HSs into the following categories:

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



Normal HSs

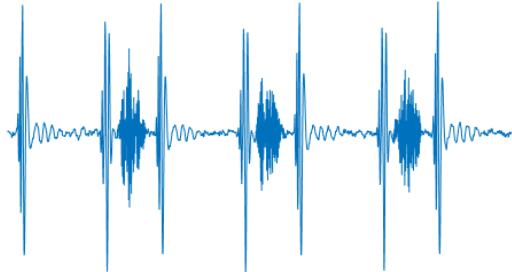
lub...dub.....lub...dub.....





Murmur HSs

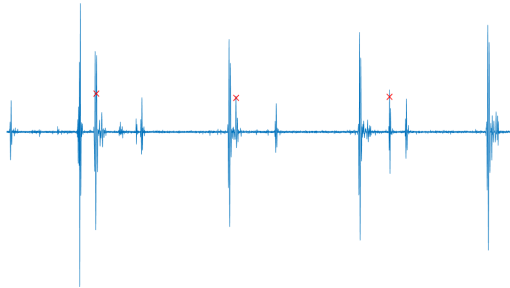
lub...***..dub.....lub...***..dub.....
or
lub....dub...***...lub....dub...***...





Extra HS

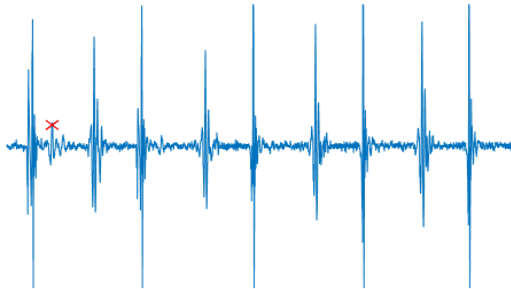
lub.lub...dub.....lub.lub...dub.....
or
lub...dub.dub.....lub...dub.dub.....





Extrasystole HSs

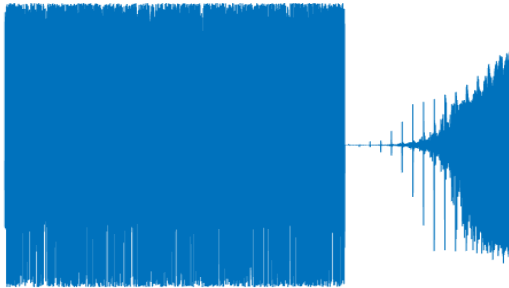
lub...dub.....lub.lub...dub.....lub...
or
lub...dub.dub.....lub...dub.....lub...





Artifact Sound

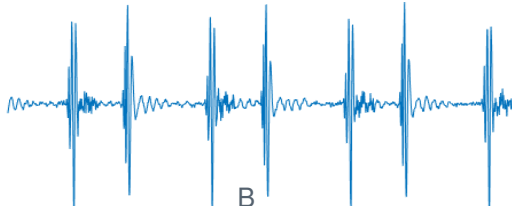
Not an actual HSs.



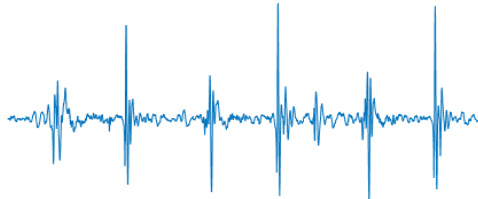


Can you guess the categories?

A



B





Strunic's attempt to classify HSs with ANN.

85±7.4%

Accuracy when classifying simulated HSs with no noise.

48±12.7%

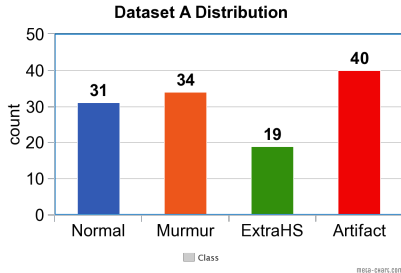
Accuracy when classifying real life HSs with noise.



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.



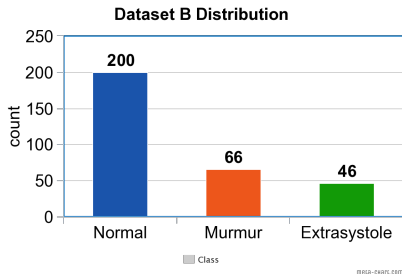
Dataset A



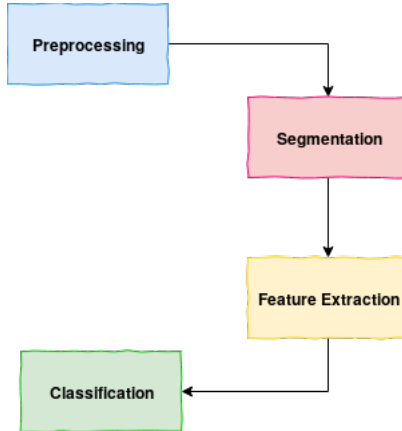
- ▶ Recorded by the general public
- ▶ Device - iStethoscope Pro Iphone app
- ▶ Sampling Freq - 44100Hz
- ▶ Contains excessive background noise



Dataset B

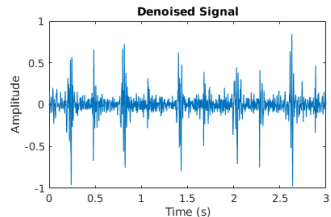
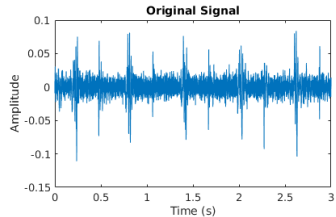


- ▶ Recorded from a hospital by Medical Practitioners
- ▶ Device - Digital Stethoscope
- ▶ Sampling Freq - 4000Hz
- ▶ Contains background noise



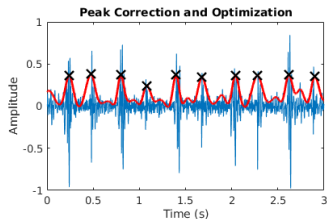
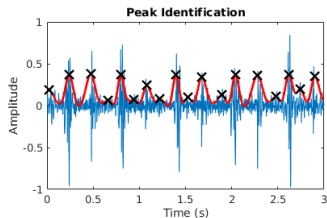


1. Downsample to 2kHz
2. Bandpass Chebyshev filter [30Hz-195Hz]
3. Normalization [-1 1]
4. Wavelet Decomposition (db7 level 5)
5. Refilter with LPF [195Hz]





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





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

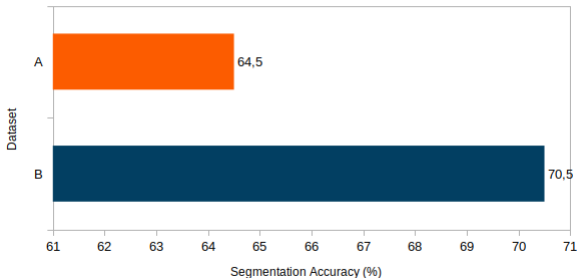


1. ANN (Artificial Neural Network)
2. SVM (Support Vector Machine)
3. XGBoost (XGradient Boost)



Segmentation

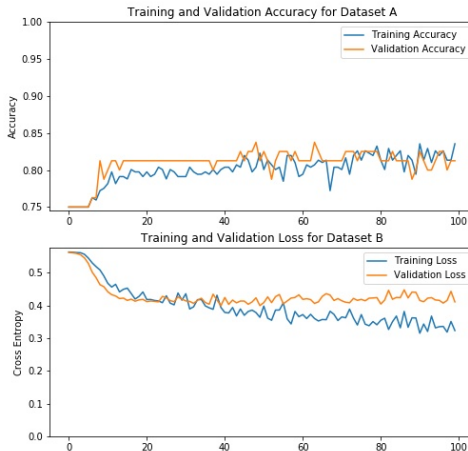
Correct Location Accuracy for S1 and S2 - Normal Heart Sounds



Testing & Results

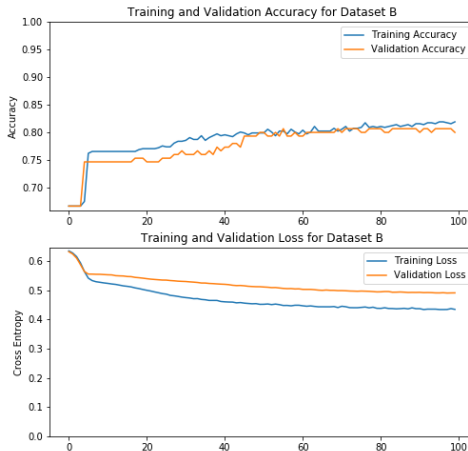


Dataset A - ANN Performance





Dataset B - ANN Performance





Classification

Table: Classification Performance Dataset-A

| Class (A) | ANN (%) | SVM (%) | XGB (%) | Literature (%) |
|----------------------|--------------------|--------------------|--------------------|---------------------------|
| Normal | 27 | 80 | 71 | 45 |
| Murmur | 88 | 78 | 86 | 31 |
| ExtraHS | 67 | 25 | 57 | 11 |
| Artifact | 100 | 57 | 50 | 58 |
| Overall Accuracy | 81 | 64 | 68 | 46 |



Classification

Table: Classification Performance Dataset-B

| Class (B) | ANN (%) | SVM (%) | XGB (%) | Literature (%) |
|----------------------|--------------------|--------------------|--------------------|---------------------------|
| Normal | 80 | 77 | 89 | 78 |
| Murmur | 90 | 87 | 75 | 37 |
| Extrasys | 15 | 0 | 17 | 17 |
| Overall Accuracy | 80 | 78 | 79 | 77 |

Improvements and Future Work



- Increase dataset

Improvements and Future Work



- ▶ Increase dataset
- ▶ Use equally distributed dataset

Improvements and Future Work



- ▶ Increase dataset
- ▶ Use equally distributed dataset
- ▶ Improve recording techniques

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- ▶ Increase dataset
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- ▶ Improve location of S1 and S2

Improvements and Future Work



- ▶ Increase dataset
- ▶ Use equally distributed dataset
- ▶ Improve recording techniques
- ▶ Improve location of S1 and S2
- ▶ Distinguishing features between Extra HS and Extrasystole