# IBM PROJECT - 6217-1658824745
# Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral ImageRepresentation

**TEAM DETAILS: TEAM ID:PNT2022TMID34108**
**COLLEGE NAME: ARUNACHALA COLLEGE OF ENGINEERING FOR WOMEN**
**DEPARTMENT: ECE**

**TEAM MEMBERS:**
**Arshitha Zeenath A (TEAM LEADER)**
**Ajinsha R**
**Aruna D**
**Abisha R**

## CONTENTS

## Introduction

### 1.1project overview

**This project is design and implementation of detection of arrhythmia detection using deep learning models Electrocardiogram (ECG) is a simple non-invasive measure to identify heart-related issues such as irregular heartbeats known as arrhythmias Deep CNN based algorithm is implemented for train the model , artificial intelligence and machine learning is being utilised in a wide range of health care related applications and dat a sets,manyarrhythmiaclassifiersusingdeeplearningmethodshavebeenproposedinrecentyears.However,sizesofthe available datasets from which to build and assess machine learning models is often verysmallandthelackofwell-annotatedpublicECGdatasetsisevident.Inthispaper,weproposea deep transfer learning framework that is aimed to perform classification on a small sizetraining dataset. The proposed method is to fine-tune a general-purpose image classifierResNet-18 with MIT-BIH arrhythmia dataset in accordance with the AAMI EC57 standard.This paper further investigates many existing deep**

**learning models that have failed to avoiddataleakageagainstAAMI recommendations**

## Literature Survey

**1. Arrhythmia Classification Techniques Using Deep Neural Network (2021):**

**Description:**

**The automated screening of arrhythmia classification using ECG beats is developed for ages. The deep learning based automated arrhythmia classification techniques are developed with high accuracy. The primary concerns that affect the success of the developed arrhythmia detection systems are (i) manual features selection, (ii) techniques used for features extraction, and (iii) algorithm used for classification and the most important is the use of imbalanced data for classification.**

**Result:**

**The major concerns that affect the success of the developed arrhythmia detection systems are (i) manual features selection, (ii) techniques used for features extraction, and (iii) algorithm used for classification and the most important is the use of imbalanced data for classification.**

**Future works:**

**The automated arrhythmia detection required the feature extraction of ECG images that required domain knowledge. Further, the balanced dataset used for classification methods is required to avoid overfitting.**

**Authors:**

**Ali Haider Khan, Muzammil Hussain and Muhammad Kamran Malik.**

**2 Classification of Arrhythmia in Heartbeat Detection Using Deep Learning (2021):**

**Description:**

**Aims to apply deep learning techniques on the publicly available dataset to classify arrhythmia. The system combines three different types of information: RR intervals, signal morphology, and higher-level statistical data. It is concluded that fuzzy-based technology is successful in the analysis of computerised ECG but needs more research.**

**Result:**

**It has the ability to produce very accurate predictions with a 99.12 percent accuracy rate for the CNN model, 99.3 percent accuracy for the CNN + LSTM model, and 99.29 percent accuracy for CNN + LSTM + Attention Model.**

**Future works:**

**This study should be conducted in binding domains like cloud and mobile systems. It is also vital to develop wearable technologies with integrated low-power consumption wearable technologies.**

**Authors:**

**Wusat Ullah, Imran Siddique, Rana Muhammad Zulqarnain, Mohammad Mahtab Alam, Irfan Ahmad and Usman Ahmad Raza.**

**3 Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation (2020):**

**Description:**

**Proposal of two-dimensional (2-D) convolutional neural network (CNN) model for the classification of ECG signals into eight classes; namely, normal beat, premature ventricular contraction beat, paced beat, right bundle branch block beat, left bundle branch block beat, atrial premature contraction beat, ventricular flutter wave beat, and ventricular escape beat.**

**The one-dimensional ECG time series signals are transformed into 2-D spectrograms through short-time Fourier transform. The 2-D CNN model consisting of four convolutional layers and four pooling layers is designed for extracting robust features from the input spectrograms.**

**Result:**

**We achieved a state-of-the-art average classification accuracy of 99.11%, which is better than those of recently reported results in classifying similar types of arrhythmias. The performance is significant in other indices as well, including sensitivity and specificity, which indicates the success of the proposed method.**

**Future work:**

**The proposed model has attained the highest sensitivity among all the compared CNN algorithms. It is pertinent to note that detecting these cardiac arrhythmias is a labour-intensive task, where a clinical expert needs to carefully observe recordings that can go for up to hours. With such automated methods, the artificially intelligent system could augment the performance of clinical experts by detecting these patterns and directing the observer to look more closely at regions of more significance. This would ultimately improve the clinical diagnosis and treatment of some of the major CVDs.**

**Authors:**

**Amin Ullah, Syed Anwar, Muhammad Bilal, Raja Majid Mehmood.**

**4 Cardiac arrhythmia detection using deep learning (2017):**

**Description:**

**An electrocardiogram is an important diagnostic tool for the assessment of cardiac arrhythmias in clinical routine. A deep learning framework previously trained on a general image data set is transferred to carry out automatic ECG arrhythmia diagnostics by classifying patient ECGs into**

**corresponding cardiac conditions. Transferred deep convolutional neural network is used as a feature extractor and the extracted features are fed into a simple back propagation neural network to carry out the final classification.**

**Result:**

**We observed that ECG Data obtained from the MIT-BIH database are pre-processed, QRS complexes are detected and features in R-T intervals are extracted. When all of the tested networks are evaluated, it is found that networks based on transferred deep learning feature extraction obtained almost 100% recognition rates and accuracies above 96% in the training phase.**

**Future works:**

**It won't be too surprising to see state-of-the-art performances from deep learning applications not only in medical signals and imaging diagnostics but also in other popular subfields of biomedical imaging and signals.**

**Authors:**

**Ali Isina, Selen Ozdalili.**

**5 A deep convolutional neural network model to classify heartbeats (2017):**

**Description:**

**The basis of arrhythmia diagnosis is the identification of normal versus abnormal individual heart beats, and their correct classification into different diagnoses, based on ECG morphology. Heartbeats can be subdivided into five categories namely non-ectopic, supraventricular ectopic, ventricular ectopic, fusion, and unknown beats. It is challenging and time-consuming to distinguish these heartbeats on ECG as these**

**signals are typically corrupted by noise. We developed a 9-layer deep convolutional neural network (CNN) to automatically identify 5 different categories of heartbeats in ECG signals. Our experiment was conducted in original and noise attenuated sets of ECG signals derived from a publicly available database.**

**Result:**

**This set was artificially augmented to even out the number of instances of the 5 classes of heartbeats and filtered to remove high-frequency noise. The CNN was trained using the augmented data and achieved an accuracy of 94.03% and 93.47% in the diagnostic classification of heartbeats in original and noise free ECGs, respectively. When the CNN was trained with highly imbalanced data (original dataset), the accuracy of the CNN reduced to 89.07%% and 89.3% in noisy and noise- free ECGs. When properly trained, the proposed CNN model can serve as a tool for screening of ECG to quickly identify different types and frequency of arrhythmic heartbeats.**

**Future works:**

**In the future studies, the authors would like to extend the proposed model by training a CNN to recognize temporal sequences of ECG heartbeat signals. The occurrence, sequential patterns and persistence of the five classes (N, S, V, F, and Q) of ECG heartbeats considered in this work can be grouped under three main categories of green, yellow, and red, which represents normal, abnormal, and potentially life-threatening conditions of heart electrical activity, respectively. The authors plan to discuss the performance of the CNN model using de-skewed data and data with added different levels of noise in the future studies.**

**Authors:**

**U. Rajendra Acharya, Shu Lih Oh, Yuki Hagiwara, Jen Hong Tan, Muhammad Adam.**

## 2.1 EXISTING PROBLEM

**In existing system machine learning based algorithm has been implemented in existing system machine learning algorithm has been implemented in existing system In the literature,the ECG analysis generally consists of the following steps: 1) ECG signal preprocessing and noise attenuation, 2)heart beat segmentation, 3)feature extraction, and 4)learning/classification Machinelearningmodelsarewidelyusedforarrhythmiaclassificationintheliterature[2,3,5, 7,8,13,14,15]. Mi Hye Song et al. proposed a support vector machine-based classifier with reduced features derived by linear discriminant analysis [5]. Inspired by the success of Hidden Markov Model (HMM)in modelling speech waveforms for automatic speech recognition, D A Coast et al. applied HMM method in ECG arrhythmia analysis. The modelcancombinethetemporalinformationandstatisticalknowledgeoftheECGsignalin one single parametric model [15]. Awni Y. Hannun et al. proposed an end-to-end deep learning approach which directly takes raw ECG signal as input and produces classifications without feature engineering or feature selection[8].Mousavi,Sajadetal.proposedanautomaticECG-based heartbeat classification approach by utilising a sequence-to-sequence deep learning method to automatically extract temporal and statistical features oftheECGsignals Our workdiffersfromthestudiesin2-fold:1)itleveragestheShort-termFourierTransform (STFT) to convert 1D ECG signal into 2D time-frequency domain data. Therefore,itisfeasibletoapplypre-trained2DConvolutionNeuralNetworkinarrhythmiaanalysis;2)itisevaluatedusingMIT- BIHdatasetwith "inter-patient" training/ testing split paradigm detailed**

**2.2References**

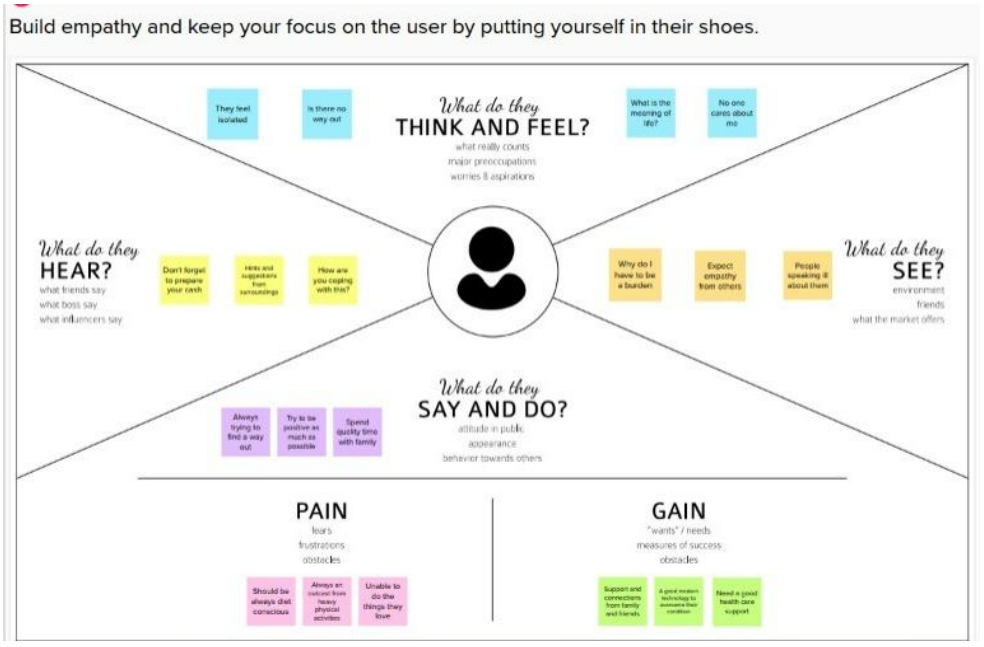

1. **Kachuee, Mohammad, Shayan Fazeli, andMajid Sarrafzadeh."Ecg heart beat classification: A deep transferable representation."2018 IEEEinternational conference on healthcare informatics (ICHI). IEEE, 2018**
2. **S.Zhang, W.Wang ,J.Ford, and F.Makedon, "Learning from in complete ratings using non- negative matrix factorization," in Proc. 6th SIAM Int. Conf. Data Mining, 2006, pp.549–553.**
3. **T.Hofmannand J.Puzicha, "Latent class models for collaborative filtering," in Proc.6th Int. Joint Conf. Artif. Intell., 1999, pp. 688–693. 4.B. M. Sarwar, G. Karypis, J. A. Konstan, and J. Reidl,**

**“Item-based collaborative filtering recommendation algorithms,”in Proc.10thInt. WorldWideWeb Conf.,2001,pp. 285–295 5.T. George and S. Merugu, “A scalable collaborative filtering framework based on co -clustering,”in Proc. 5th IEEEInt. Conf. DataMining,2005, pp. 625–628**

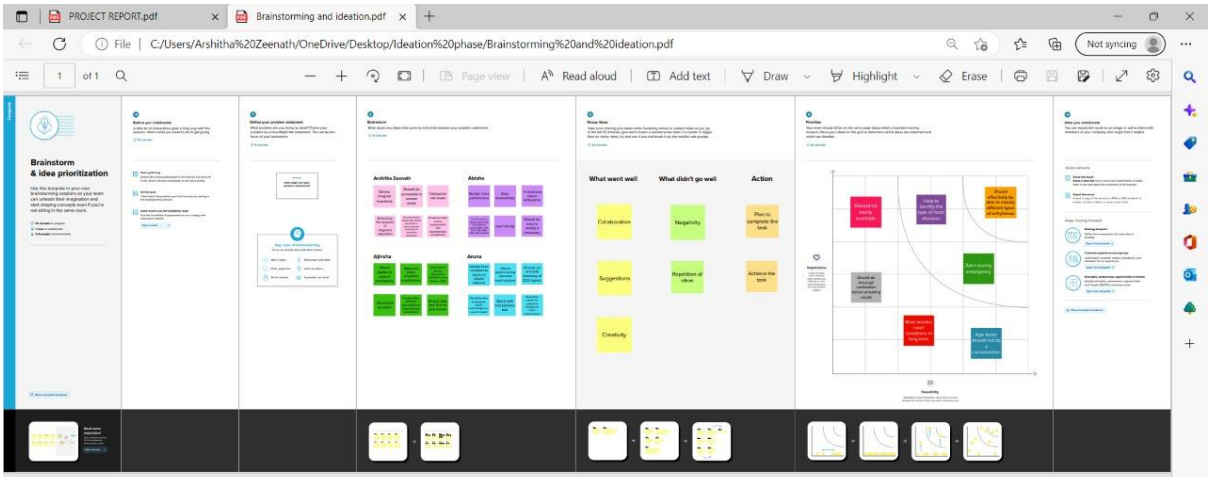
## 2.3 Problem Statement Definition

**Cardiologists by using various values which occurred during the ECG recording decide whether the heartbeat is normal or not. Since observation of these values are not always clear, the existence of an automatic ECG detection system is required Luz, Eduardo José da S., et al. "ECG-based heartbeat classification for arrhythmia detection:A Survey."Computer Methods And Programs In Biomedicine 127(2016):144-164 Romdhane, Taissir Fekih, and Mohamed Atri Pr. "Electrocardiogram heartbeat classification based on a deep convolutional neural network and focal loss."Computers in Biology and Medicine (2020):103866**

## 3. Ideation And Proposed Solution empathy map Canva



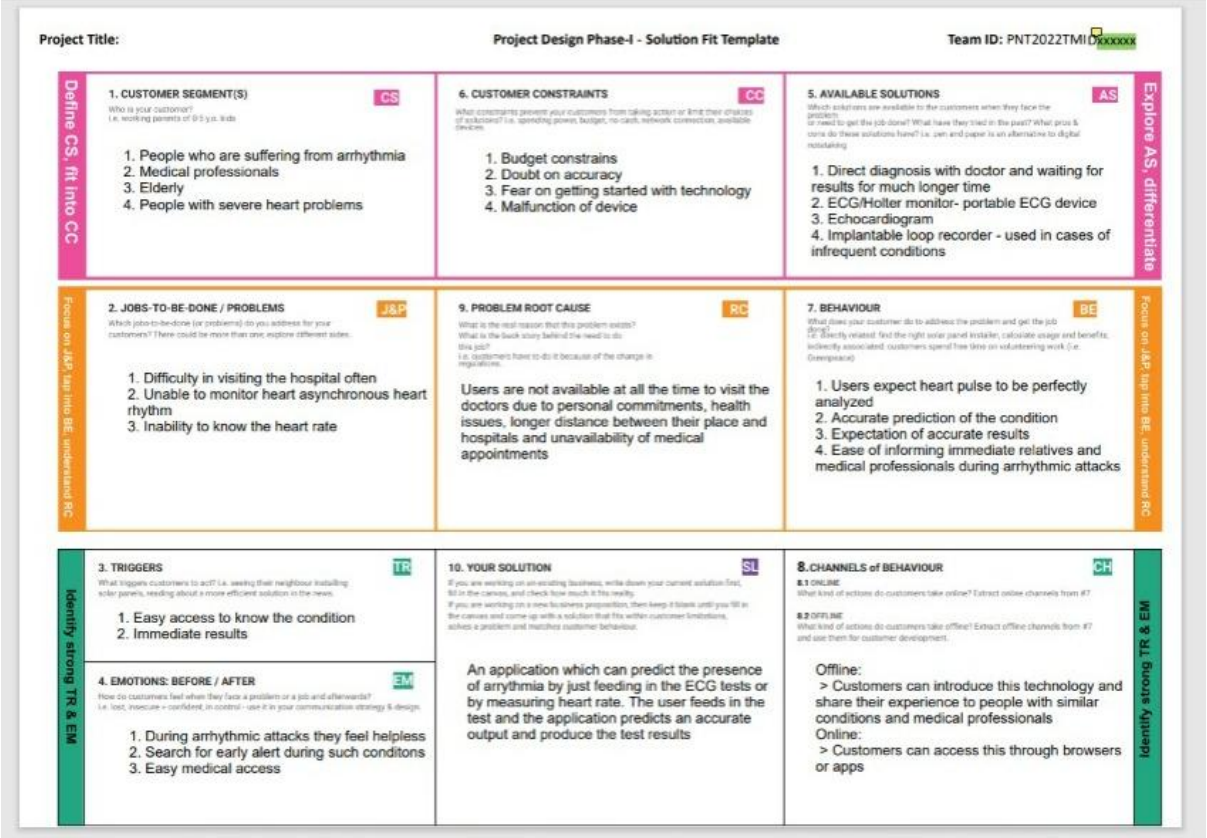
## Ideation and brainstorm




## 3.1 Proposed solutions

**Deep learning based using to train the image The MIT-BIH database, an ECG database provided by the Massachusetts Institute of Technology and based on international standards and annotated information by multiple experts (Moody and Mark, 2001) is used in this study. The MIT-BIH database has been frequently used by the academic community in research for the detection and classification of arrhythmic heartbeats. The MIT-BIH database contains 48 ECG recordings, each recording time is 30 min, the sampling frequency is 360 Hz, and each ECG record is composed of two leads. MIT- BIH database can make adjustments and corrections based on the information annotated by experts and optimization algorithms. Furthermore, it learns from existing solutions for self-optimization. This paper proposes a novel deep learning approach to identify arrhythmias in ECG signals. The proposed approach identifies arrhythmia classes using Convolutional Neural Network (CNN) trained by two-dimensional (2D) ECG beat images. Firstly, ECG signals, which consist of 5 different arrhythmias, are recemented into heartbeats which are transformed into 2D grayscale images. Afterward, the images are used as input for training a new CNN architecture to classify heart beats**

## 3.2 Problem Solution fit




## Functional and Non-functional requirements:

## Proposed Solution Template:

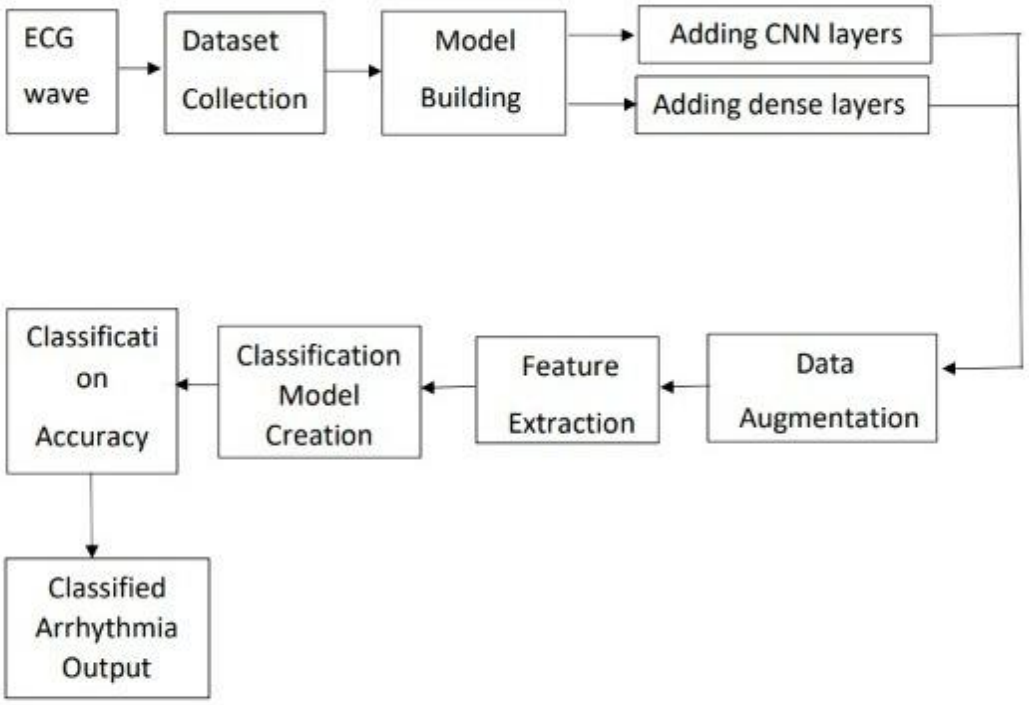
| S.No. | Parameter | Description |
|---|---|---|

| | | |
|---|---|---|
| **1.** | **Problem Statement (Problem to be solved)** | **Arrhythmia is a condition in which the heart beat with an irregular or abnormal rhythm.**<br><br>**There are several types of arrhythmias including atrial fibrillation, premature contraction, ventricular fibrillation, and tachycardia.**<br><br>**While most arrhythmias are harmless, some can be serious and life threatening.** |
| **2.** | **Idea / Solution description** | **Create a 2D CNN (Convolutional Neural Network) based classification model for automatic classification of arrhythmias using ECG signals**<br><br>**Training the model using more dataset to classify the waveforms and produce the result accurately**<br><br>**Providing accurate results to detect and prevent cardio vascular diseases** |

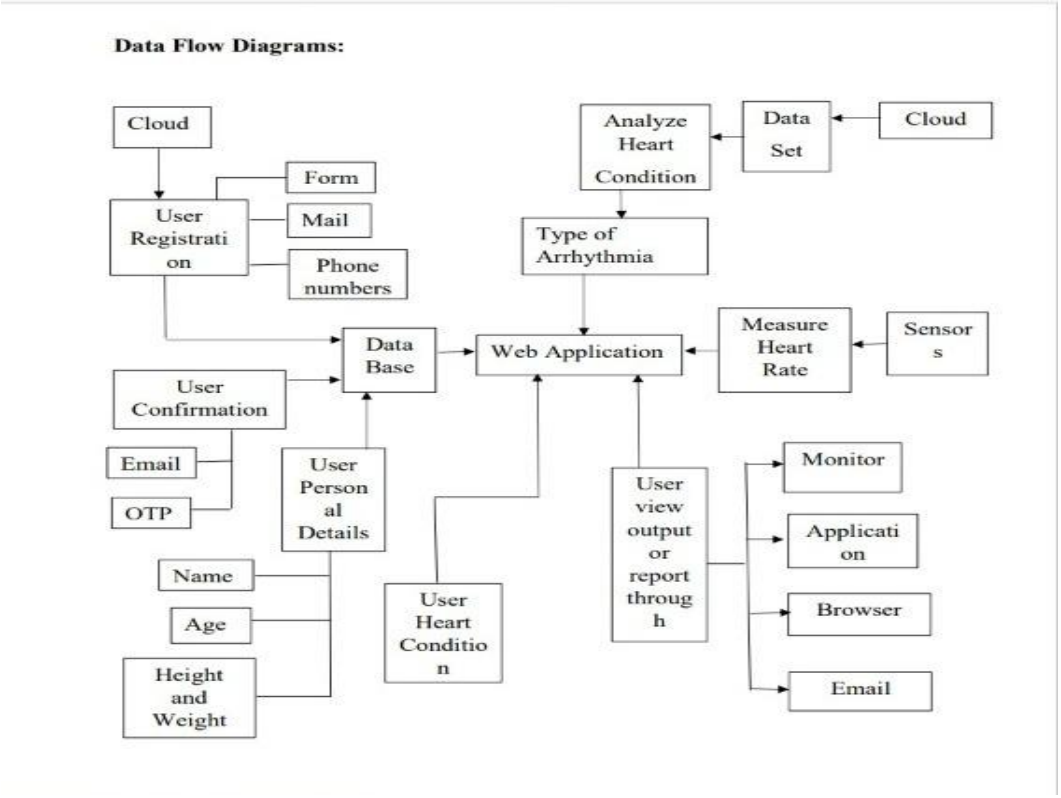
| | | |
|---|---|---|
| **3.** | **Novelty / Uniqueness** | **Providing flexibility in terms of data augmentations**<br><br>**2D CNN model can learn data variations and augmentations helping in increasing the amount of data available for training**<br><br>**Automatic classification of arrhythmias using ECG signal** |
| **4.** | **Social Impact / Customer Satisfaction** | **Ease of accessibility**<br><br>**Can be done anywhere and at any time**<br><br>**Have high accuracy thus provide accurate results**<br><br>**Since the model has already been trained with several datasets it can classify the type of arrhythmias**<br><br>**Can be easily viewed with the help of applications or browsers** |

| | | |
|---|---|---|
| **5.** | **Business Model (Revenue Model)** | **It can be easily integrated to devices like smart watches and mobile**<br><br>**It could also be integrated with medical electronic devices like Electrocardiogram, Echocardiogram, Holter monitor and Pacemaker**<br><br>**The main motive of this project is not profit oriented but user satisfaction. This should be priced in a range affordable by all common people** |
| **6.** | **Scalability of the Solution** | **The web application will be made scalable and will be made to work with any amount of data provided**<br><br>**It will be designed in a way to incorporate existing models and new models** |

**Solution Architecture:**




## Data Flow Diagram:



## 7.Coding

```
import numpy as np
import pandas as pd
from path lib import Pathimportos.
path
importtensorflowastf
dir = Path('../input/ecg-image-data/ECG_Image_data/train')
filepaths= list(dir.glob(r'**/*.png'))
labels=list(map(lambdax:os.path.split(os.path.split(x)[0])[1],filepaths))
filepaths=pd.Series(filepaths,name='Filepath').astype(str)labels=pd.Series(l
abels,na me='Label')
dataframe=pd.concat([filepaths,labels],axis=1)dataframe
dataframe['Label'].value_counts()dataframe['Label'].unique()

samples=[]
forcategoryin['N','M','Q','S','V']:
    category_slice = dataframe.query("Label == @category")

samples.append(category_slice.sample(2223,random_state=1))
dataframe_train=pd.concat(samples,axis=0).sample(frac=1.0,random_state
=1).reset_index(drop= True) dataframe_train['Label'].value_counts()

dir=Path('../input/ecg-image-data/ECG_Image_data/train')
filepaths=list(dir.glob(r'F/*.png'))
labels=list(map(lambdax:os.path.split(os.path.split(x)[0])[1],filepaths))
filepaths=pd.Series(filepaths,name='Filepath').astype(str)labels=pd.Series(l
abels,na me='Label')
F = pd.concat([filepaths , labels] , axis=1)F %%time
dir=Path('../input/ecg-image-data/ECG_Image_data/test')
filepaths=list(dir.glob(r'**/*.png'))
labels=list(map(lambdax:os.path.split(os.path.split(x)[0])[1],filepaths))
filepaths=pd.Series(filepaths,name='Filepath').astype(str)labels=pd.Series(l
abels,na me='Label')
dataframe_test=pd.concat([filepaths,labels],axis=1)dataframe_test
```

## Preprocessing of code

```
size=64
color_mode='grayscale'
batch_size=32
train_images=train_generator.flow_from_dataframe(dataframe=dataframe
_train,
x_col='Filepath',
y_col='Label',
target_size=(size, size),
color_mode=color_mode,
cla ss_mode='categorical',
batch_size =batch_size,
shuffle=True,
seed=42,subset='training' )

val_images=train_generator.flow_from_dataframe(dataframe=dataframe_t
rain,
x_col='Filepath',
y_col='Label',
target_size=(size, size),
color_mode=color_mode,
cla ss_mode='categorical',
batch_size =batch_size,
shuffle=True,
seed=42,
subset='validation ' )
test_images=test_generator.flow_from_dataframe(dataframe=dataframe_t
est,  x_col='Filepath', y_col='Label', target_size=(size, size),
color_mode=color_mode, cla ss_mode='categorical', batch_size
=batch_size, shuffle=False )
```

## Model summary

```
size=64
color_mode='grayscale'
```

batch_size=32
train_images=train_generator.flow_from_dataframe(dataframe=dataframe_train, x_col='Filepath',y_col='Label',target_size=(size, size),color_mode=color_mode,cla ss_mode='categorical',batch_size=batch_size,shuffle=True, seed=42,subset='training' )

val_images=train_generator.flow_from_dataframe(dataframe=dataframe_train, x_col='Filepath',y_col=' Label' , target_size=(size, size),color_mode=color_mode,cla ss_mode='categorical',batch_size=batch_size,shuffle=True, seed=42,subset='validation ' )

test_images=test_generator.flow_from_dataframe(dataframe=dataframe_test, x_col='Filepath',y_col='Label', target_size=(size, size), color_mode=color_mode, class_mode='categorical', batch_size=batch_size,shuffle=False )

importkeras
checkpoint=keras.callbacks.ModelCheckpoint(filepath='best_model. H5', save_weights_only=False, monitor='val_accuracy', mode='max', save_best_only=True, verbose=1)
model.compile(optimizer='a dam', loss='categorical_crossentropy',metrics=['accuracy'] )

importmatplotlib.pyplotasplt
plt.plot(result.history['loss'])plt.plot(result.history['val_loss'] )
plt.legend(['Training', 'Validation'])plt.title('Training and Validation losses') plt.xlabel('epoch')

## HTML Coding

```
<!DOCTYPE html>
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width,
initial-scale=1.0">
```

```
    <link rel="shortcut icon" href="{{url_for('static',
filename='images/fevicon.png' )}}" type="image/x-icon">
    <title>HealthDoc - About Us</title>
    <link rel="stylesheet" href="{{url_for('static',
filename='css/about.css')}}">
    <link rel="stylesheet" href="{{url_for('static',
filename='css/style.css')}}">
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
    <link
href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@60
0&display=swap" rel="stylesheet" />
    <link
href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/5.10.0/css/al
l.min.css" rel="stylesheet">
</head>
<style>
    .footer {
        margin-bottom: 20px;
    }

    h1 {
        margin: 21.44px 0px;
    }
</style>

<body>
    <div class="wrapper">
        <!--Navigation Bar-->
        <div class="nav">
            <div class="logo">
                <a href="/"><img src="static/images/logo.png"
alt="Website Title" style="width:190px" /></a>
            </div>
            <div class="links">
                <a href="/">Home</a>
                <a href="/info">Info</a>
                <a href="/about" class="mainLink">About Us</a>
                <a href="/contact">Contact Us</a>
                <a href="/upload" class="btn1">Predict</a>
            </div>
        </div>
        <div class="landing">
```

```
            <div class="landingText" data-aos="fade-up"
data-aous-duration="1000">
                <h1>
                    We are a team of
                    <span style="color: #e0501b; font-size:
4vw">Arrthymia Prediction</span>
                </h1>
                <h3>
                    In this project, we build an effective
electrocardiogram (ECG) arrhythmia classification method
                    using a convolutional
                    neural network (CNN), in which we classify ECG into
seven categories, one being normal and the other
                    six being different
                    types of arrhythmia using deep two-dimensional CNN
with grayscale ECG images. We are creating a web
                    application where
                    the user selects the image which is to be
classified. The image is fed into the model that is
                    trained and the cited
                    class will be displayed on the webpage.
                </h3>
            </div>
            <div class="landingImage" data-aos="fade-down"
data-aous-duration="2000">
                <img src="static/images/about_us.png" alt="aboutImg"
style="width: 450px; height:450px" />
            </div>
        </div>
        <div class="main">
            <div class="profile-card">
                <div class="img">
                    <img src="static/images/profile_avatar.png">
                </div>
                <div class="caption">
                    <h3>Arshitha Zeenath A</h3>
                    <p>Professional Deep Learning Engineer, Back End
Developer</p>
                    <div class="social-links">
                        <a href="#"><i class="fab fa-facebook"></i></a>
                        <a href="#"><i class="fab
fa-instagram"></i></a>
                        <a href="#"><i class="fab fa-twitter"></i></a>
```

```
                    </div>
                </div>
            </div>
            <div class="profile-card">
                <div class="img">
                    <img src="static/images/profile_avatar.png">
                </div>
                <div class="caption">
                    <h3>Ajinsha R</h3>
                    <p>Full Stack Developer, Web Designer, Deep
Learning Engineer</p>
                    <div class="social-links">
                        <a href="#"><i class="fab fa-facebook"></i></a>
                        <a
href="https://www.instagram.com/the_._._champ/"><i class="fab
fa-instagram"></i></a>
                        <a href="#"><i class="fab fa-twitter"></i></a>
                    </div>
                </div>
            </div>
            <div class="profile-card">
                <div class="img">
                    <img src="static/images/profile_avatar.png">
                </div>
                <div class="caption">
                    <h3>Abisha R</h3>
                    <p>Back End Developer</p>
                    <div class="social-links">
                        <a href="#"><i class="fab fa-facebook"></i></a>
                        <a href="#"><i class="fab
fa-instagram"></i></a>
                        <a href="#"><i class="fab fa-twitter"></i></a>
                    </div>
                </div>
            </div>
            <div class="profile-card">
                <div class="img">
                    <img src="static/images/profile_avatar.png">
                </div>
                <div class="caption">
                    <h3>Aruna D</h3>
                    <p>Front End Developer</p>
                    <div class="social-links">
```

```
                        <a href="#"><i class="fab fa-facebook"></i></a>
                        <a href="#"><i class="fab
fa-instagram"></i></a>
                        <a href="#"><i class="fab fa-twitter"></i></a>
                    </div>
                </div>
            </div>
        </div>
        <div class="footer">
            <h1>HealthDoc</h1>
            <div class="footerlinks">
                <a href="/home">Home</a>
                <a href="/info">Info</a>
                <a href="/about">About Us</a>
                <a href="/contact">Contact Us</a>
            </div>
        </div>
    </div>

    </div>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>

</html>
```

```
<!DOCTYPE html>
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width,
initial-scale=1.0">
    <link rel="shortcut icon" href="{{url_for('static',
filename='images/fevicon.png' )}}" type="image/x-icon">
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
```

```
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/5.15.3/css/al
l.min.css" />
    <link
href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@60
0&display=swap" rel="stylesheet" />
    <link rel="stylesheet" href="{{url_for('static',
filename='css/contact.css' )}}" />
    <link rel="stylesheet" href="{{url_for('static',
filename='css/style.css' )}}" />
    <title>Life Care - Contact US</title>
</head>

<body>
    <div class="wrapper">
        <div class="nav">
            <div class="logo">
                <a href="/">
                    <img src="static\images\logo.png"
style="width:190px" />
                </a>
            </div>
            <div class="links">
                <a href="/home" class="mainLink">Home</a>
                <a href="/info">Info</a>
                <a href="/about">About Us</a>
                <a href="/contact">Contact Us</a>
                <a href="/upload" class="btn1">Predict</a>
            </div>
        </div>
        <div class="container" data-aos="fade-down"
data-aous-duration="1000">
            <div class="image" data-aos="fade-right"
data-aous-duration="6000">
                <img src="static/images/contact.png" alt="">
            </div>
            <div class="form-area">
                <h2>Contact US</h2>
                <form action="">
                    <input type="text" placeholder="Full Name">
                    <input type="email" placeholder="Email">
                    <input type="text" placeholder="Subject">
```

```
                    <textarea cols="30" rows="3" placeholder="Your
Message"></textarea>
                    <button type="submit">Send Message</button>
                </form>
            </div>
        </div>
    </div>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>

</html>
```

```
<!DOCTYPE html>
<html lang="en">

<head>
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0"
/>
  <title>HealthDoc - Heart Prediction Online</title>
  <link rel="shortcut icon" href="{{url_for('static',
filename='images/fevicon.png' )}}" type="image/x-icon">
  <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
  <link
href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@60
0&display=swap" rel="stylesheet" />
  <link rel="stylesheet" href="{{url_for('static',
filename='css/style.css' )}}" />
  <script src="https://kit.fontawesome.com/64d58efce2.js"
crossorigin="anonymous">
  </script>
</head>

<body>
  <div class="wrapper">
    <!--Navigation Bar-->
    <div class="nav">
```

```
      <div class="logo">
        <a href="/">
          <img src="static\images\logo.png" style="width:190px" />
        </a>
      </div>
      <div class="links">
        <a href="/home" class="mainLink">Home</a>
        <a href="/info">Info</a>
        <a href="/about">About Us</a>
        <a href="/contact">Contact Us</a>
        <a href="/upload" class="btn1">Predict</a>
      </div>
    </div>
    <!--Landing Page-->
    <div class="landing">
      <div class="landingText" data-aos="fade-up"
data-aous-duration="1000">
        <h1>
          Classification of Arrhythmia
          <span style="color: #e0501b; font-size:
4vw">Prediction</span>
        </h1>
        <h3>
          According to the World Health Organization (WHO),
cardiovascular diseases (CVDs) are the number one cause of
          death today. Over 17.7 million people died from CVDs in the
          year 2017 all over the world which...
        </h3>

        <div class="btn2"><a href="/info">Read more</a>
        </div>
      </div>
      <div class="landingImage" data-aos="fade-down"
data-aous-duration="2000">
        <img src="static/images/banner_img.jpg" alt="bannerImg"
style="width: 500px; height:360px" />
      </div>
    </div>

    <!--Service Section-->
    <div class="about">
      <div class="aboutText" data-aos="fade-up"
data-aous-duration="1000">
```

```
        <h1 style="margin: 20px;">
          Our Patients Are at Centre
          <span style="color: #2f8be0; font-size: 3vw">of Every We
Do</span>
        </h1>
        <div class="image-container">
          <img src="/static/images/connsultPationt.png"
alt="consultPationt"
            style="width:400px; margin:100px 0px 0px 90px;"></img>
        </div>
      </div>
      <div class="aboutList" data-aos="fade-left"
data-aous-duration="1000">
        <ol>
          <li>
            <span>01</span>
            <p>99.8% accurate result.</p>
          </li>
          <li>
            <span>02</span>
            <p>No need to go hospital.</p>
          </li>
          <li>
            <span>03</span>
            <p>No need to login</p>
          </li>
          <li>
            <span>04</span>
            <p>24/7 Support.</p>
          </li>
        </ol>
      </div>
    </div>

    <!--Info Section-->
    <div class="infoSection">
      <div class="infoHeader" data-aos="fade-up"
data-aous-duration="1000">
        <h1>
          We Analyse Youe Health states <br /><span style="color:
#e0501b">In Order to Top Service.</span>
        </h1>
      </div>
```

```
      <div class="infoCards">
        <div class="card one" data-aos="fade-up"
data-aous-duration="1000">
          <img src="static/images/banner_1.svg" class="cardoneImg"
alt="" data-aos="fade-up"
            data-aous-duration="1100" />
          <div class="cardbgone"></div>
          <div class="cardContent">
            <h2>Health State</h2>
            <p>
              Easy to know Health state
            </p>
            <a href="/">
              <div class="cardBtn">
                <img src="static/images/next.png" alt=""
class="cardIcon" />
              </div>
            </a>
          </div>
        </div>
        <div class="card two" data-aos="fade-up"
data-aous-duration="1300">
          <img src="static/images/banner_1.svg" class="cardtwoImg"
alt="" data-aos="fade-up"
            data-aous-duration="1200" />
          <div class="cardbgtwo"></div>
          <div class="cardContent">
            <h2>User Friendly</h2>
            <p>
              Easy for people to use, prediction
            </p>
            <a href="/">
              <div class="cardBtn">
                <img src="static/images/next.png" alt=""
class="cardIcon" />
              </div>
            </a>
          </div>
        </div>
        <div class="card three" data-aos="fade-up"
data-aous-duration="1600">
          <img src="static/images/banner_1.svg" class="cardthreeImg"
alt="" data-aos="fade-up"
```

```
            data-aous-duration="1000" />
          <div class="cardbgthree"></div>
          <div class="cardContent">
            <h2>Classification of Arrhythmia</h2>
            <p>
              Prediction Classification of Arrhythmia
            </p>
            <a href="/upload">
              <div class="cardBtn">
                <img src="static/images/next.png" alt=""
class="cardIcon" />
              </div>
            </a>
          </div>
        </div>
      </div>
    </div>

    <!--Banner And Footer-->
    <div class="banner">
      <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
        <h1>
          Download the HealthDoc App Today <br /><span
style="font-size: 1.6vw; font-weight: normal"
            class="bannerInnerText">Stay Updated and get all your
medical needs taken care of!</span>
        </h1>
        <a href="/"><img src="static/images/AndroidPNG.png" alt=""
/></a>
        <a href="/"><img src="static/images/iosPNG.png" alt="" /></a>
      </div>
      <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
        <img src="static/images/app.png" alt="" />
      </div>
    </div>

    <div class="footer">
      <h1>HealthDoc</h1>
      <div class="footerlinks">
        <a href="/home" class="mainLink">Home</a>
        <a href="/info">Info</a>
```

```
        <a href="/about">About Us</a>
        <a href="/contact">Contact Us</a>
      </div>
    </div>
  </div>
  <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
  <script>
    AOS.init();
  </script>
</body>

</html>
```

```
<!DOCTYPE html>
<html lang="en">

<head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width,
initial-scale=1.0" />
    <title>HealthDoc - About Classification of Arrhythmia</title>
    <link rel="shortcut icon" href="{{url_for('static',
filename='images/fevicon.png' )}}" type="image/x-icon">
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
    <link
href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@60
0&display=swap" rel="stylesheet" />
    <link rel="stylesheet" href="{{url_for('static',
filename='css/style.css' )}}" />
    <script src="https://kit.fontawesome.com/64d58efce2.js"
crossorigin="anonymous">
    </script>
    <style>
        .banner {
            margin: 60px;
            width: auto;
            height: 300px;
            /* Setup */
            background-color: #fff;
            box-shadow: rgba(0, 0, 0, 0.15) 2.4px 2.4px 3.2px;
```

```
            display: flex;
            flex-direction: row;
            padding: 50px;
        }

        .bannerText h1 {
            font-size: 3vw;
            color: #007bff;
            font-weight: 600;
        }

        .bannerText p {
            text-indent: 50px;
            color: #777777;
            font-size: 1.2vw;
            font-weight: normal
        }

        .bannerText img {
            width: 10vw;
            margin-right: 20px;
        }

        .bannerImg img {
            margin-left: 90px;
            width: 350px;
        }
    </style>
</head>

<body>
    <div class="wrapper">
        <!--Navigation Bar-->
        <div class="nav">
            <div class="logo">
                <a href="/"><img src="static/images/logo.png"
alt="Website Title" style="width:190px" /></a>
            </div>
            <div class="links">
                <a href="/home">Home</a>
                <a href="/info" class="mainLink">info</a>
                <a href="/about">About Us</a>
                <a href="/contact">Contact Us</a>
```

```
                <a href="/upload" class="btn1">Predict</a>
            </div>
        </div>
        <!--Landing Page-->
        <div class="landing">
            <div class="landingText" data-aos="fade-up"
data-aous-duration="1000">
                <h1>
                    Classification of Arrhythmia
                    <span style="color: #e0501b; font-size:
4vw">Prediction</span>
                </h1>
                <h3>
                    According to the World Health Organization (WHO),
cardiovascular diseases (CVDs) are the number one
                    cause of death
                    today. Over 17.7 million people died from CVDs in
the year 2017 all over the world which is about
                    31% of all deaths, and
                    over 75% of these deaths occur in low and
middle-income countries. Arrhythmia is a representative
                    type of CVD that
                    refers to any irregular change from the normal
heart rhythms. There are several types of arrhythmia
                    including atrial
                    fibrillation, premature contraction, ventricular
fibrillation, and tachycardia. Although a single
                    arrhythmia heartbeat
                    may not have a serious impact on life, continuous
arrhythmia beats can result in fatal
                    circumstances.
                </h3>
            </div>
            <div class="landingImage" data-aos="fade-down"
data-aous-duration="2000">
                <img src="static/images/banner_img.jpg" alt="bannerImg"
style="width: 500px; height:360px" />
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
```

```
                    Left Bundle Branch
                </h1>
                <p>A delay blockage of electrical impulses
                    to the left of the heart. Left bundle brach block
sometimes
                    makes it harder for the heart to pump
                    blood efficiently through the circulatory
                    system.</p>
                <p>Most people don't have symptoms. If
                    symtoms occur, they inlcude fainting or
                    a slow heart rate.</p>
                <p>If there's an underlying condition, such
                    as heart disease, that condition needs
                    treatment. In patients with heart failure,
                    a pacemaker can also relieve symptoms as
                    well as prevent death.</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/LBB.svg" alt="" />
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
                    Normal
                </h1>
                <p>Note that the heart is beating
                    in a regular sinus rhythm
                    between 60-100 beats per
                    minute (specifically 82 bpm).</p>
                <p>All the important intervals
                    on this recording are within
                    normal ranges.</p>
                <p>The normal ECG
                    patterns seen in children
                    differ considerably from those
                    in adults.</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/normal.svg" alt="" />
```

```
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
                    Premature Atrial Contraction
                </h1>
                <p>usually, premature artial contraction have
                    no clear cause and no health risks. In most
                    cases, premature artrial contractions aren't a
                    sign of heart disease and just happen
                    naturally.</p>
                <p>But some people who have PACs turn out to
                    have related heart conditions, such as
                    Cardiomyopathy (a weakend heart muscle)
                    Caronary heart disease (fatty deposits in you blood
vessels)</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/PAC.jpg" alt="" />
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
                    Premature Ventricular Contractions
                </h1>
                <p>Extra, abnorma heartbeats that begininone of the
                    Heart's two lower chambers.</p>
                <p>Premature ventricular contractions (PVCs) occur
                    in most people at some point. Causes may include
certain
                    medication, alcohol, some illegal drugs, caffeine,
                    tobacco, excercise or anxiety.</p>
                <p>
                    PVCs often cause no symtoms. When symptoms do
                    occur, they feel like a flip-flop or skipped-beat
                    sensation in the chest.
                </p>
                <p>Most people with isolated PVCs and an otherwise
```

```
                    normal heart don't need treatment. PVCs occurring
                    continuously serious cardiac than 30 seconds is a
                    potentially serious cardiac condition known as
                    ventriclular tachycardia.</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/PVC.jpg" alt="" />
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
                    Right Bundle Branch
                </h1>
                <p>Right bundle branch block is associated with
                    structural changes from strech or ischemia to
                    the myocardium. It can also occur
                    iatorgenically from certain common cardiac
                    precedures, such as right heart
catheterization.</p>
                <p>Although there is no significant association
                    with cardiovascular risk factors, the presence
                    with cardiovascular risk factors, the presence
                    of a right bundle branch block is a predictor of
                    mortality in myocardial infarction, heart
                    failure, and certain heart blocks.</p>
                <p>In asymptomatic patients, isolated right bundle
                    brach block typically does not need further
                    evaluation.</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/RBB.svg" alt="" />
            </div>
        </div>
        <div class="banner">
            <div class="bannerText" data-aos="fade-right"
data-aous-duration="1000">
                <h1>
                    Ventricular Fibrillation
                </h1>
```

```
                <p>A life-threatening heart rhythm that results in a
                    rapid, inadeuate heartbeat.</p>
                <p>Ventricular fibrillation (VF) is a rapid,
                    Life-threatening heart rhythm starting in the
bottom
                    chambers of the heart. It can be triggered by a
heart attack.</p>
                <p>Because the heart doesn't pump adequately during
                    ventricular fibrillation, sustained VF can cause
                    low blood pressure, losso f consciousness of
death.</p>
                <p>Emergency treatment includes immediate
                    defibrillation with a n automated external
                    defibrillator (AED) and cardiopulmonary
                    resuscitation(CPR). Long-term therapy includes
                    implantable defibrillators and medcations to
                    prevent recurrence.</p>
            </div>
            <div class="bannerImg" data-aos="fade-up"
data-aous-duration="1000">
                <img src="static/images/VF.png" alt="" />
            </div>
        </div>
        <div class="footer">
            <h1>LifeCare</h1>
            <div class="footerlinks">
                <a href="/home">Home</a>
                <a href="/info" class="mainLink">Info</a>
                <a href="/about">About Us</a>
                <a href="/conduct">Contact Us</a>
            </div>
        </div>
    </div>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>

</html>
```

```
{% extends "predict_base.html" %} {% block content %}
```

```
<center>
    <h2 style="font-size: 40px;">
        ECG Arrhythmia
        <span style="color: #2f8be0; font-size:
3vw">Classification</span>
    </h2>
</center>

<div>
    <form id="upload-file" method="post" enctype="multipart/form-data">
        <center> <label for="imageUpload" class="upload-label">
                Choose...
            </label>
            <input type="file" name="file" id="imageUpload"
accept=".png, .jpg, .jpeg">
        </center>
    </form>

    <center>
        <div class="image-section" style="display:none;">
            <div class="img-preview">
                <div id="imagePreview">
                </div>
            </div>
        </div>
    </center>
</div>
<center>
    <div class="btn3" id="btn-predict"
        style="padding: 8px 34px; width: 120px; margin-top: 30px;
padding: 14px 20px 12px 20px; background-color: #007bff; border-radius:
45px; text-align: center; color: #fff; cursor: pointer;">
        Predict</div>
    <div class="loader" style="display:none;"></div>
</center>

<h3 style="color:Black" id="result">
    <span> </span>
</h3>

</div>
```

```
</div>



{% endblock %}
```

```
<!DOCTYPE html>
<html lang="en">

<head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width,
initial-scale=1.0" />
    <title>HealthDoc - Heart Prediction Online</title>
    <link rel="shortcut icon" href="{{url_for('static',
filename='images/fevicon.png' )}}" type="image/x-icon">
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
    <link
href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@60
0&display=swap" rel="stylesheet" />
    <script
src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></scri
pt>
    <script
src="https://cdn.bootcss.com/jquery/3.3.1/jquery.min.js"></script>
    <script
src="https://cdn.bootcss.com/bootstrap/4.0.0/js/bootstrap.min.js"></scr
ipt>
    <link href="{{ url_for('static', filename='css/main.css') }}"
rel="stylesheet">
    <link rel="stylesheet" href="{{url_for('static',
filename='css/style.css' )}}" />
    <script src="https://kit.fontawesome.com/64d58efce2.js"
crossorigin="anonymous">
    </script>
</head>

<body>
    <div class="wrapper">
```

```
        <!--Navigation Bar-->
        <div class="nav">
            <div class="logo">
                <a href="/">
                    <img src="static\images\logo.png"
style="width:190px" />
                </a>
            </div>
            <div class="links">
                <a href="/">Home</a>
                <a href="/info">Info</a>
                <a href="/about">About Us</a>
                <a href="/contact">Contact Us</a>
                <a href="/upload" class="btn1">Predict</a>
            </div>
        </div>
        <!--Landing Page-->
        <div class="landing">
            <div class="landingText" data-aos="fade-up"
data-aous-duration="10000">
                <h1>
                    Classification of Arrhythmia
                    <span style="color: #e0501b; font-size:
4vw">Prediction</span>
                </h1>
                <h3>
                    According to the World Health Organization (WHO),
cardiovascular diseases (CVDs) are the number one
                    cause of
                    death today. Over 17.7 million people died from
CVDs in the
                    year 2017 all over the world which...
                </h3>

                <div class="btn2"><a href="/info">Read more</a>
                </div>
            </div>
            <div class="landingImage" data-aos="fade-down"
data-aous-duration="2000">
                <img src="static/images/banner_img.jpg" alt="bannerImg"
style="width: 500px; height:360px" />
            </div>
        </div>
```

```
        <div class="about">
            <div class="aboutText" data-aos="fade-up"
data-aous-duration="1000">
                {% block content %}{% endblock %}
            </div>
        </div>

        <div class="footer">
            <h1>LifeCare</h1>
            <div class="footerlinks">
                <a href="/home">Home</a>
                <a href="/info">Info</a>
                <a href="/about">About Us</a>
                <a href="/contact">Contact Us</a>
            </div>
        </div>
    </div>

    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>
<footer>
    <script src="{{ url_for('static', filename='js/main.js') }}"
type="text/javascript"></script>
</footer>

</html>
```

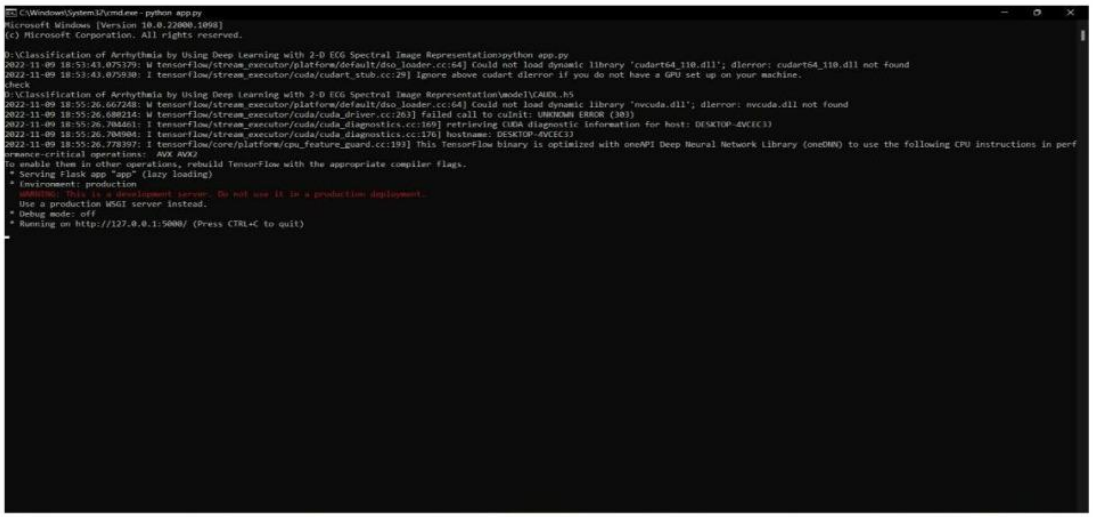
# 7. SYSTEM TESTING

**The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There**

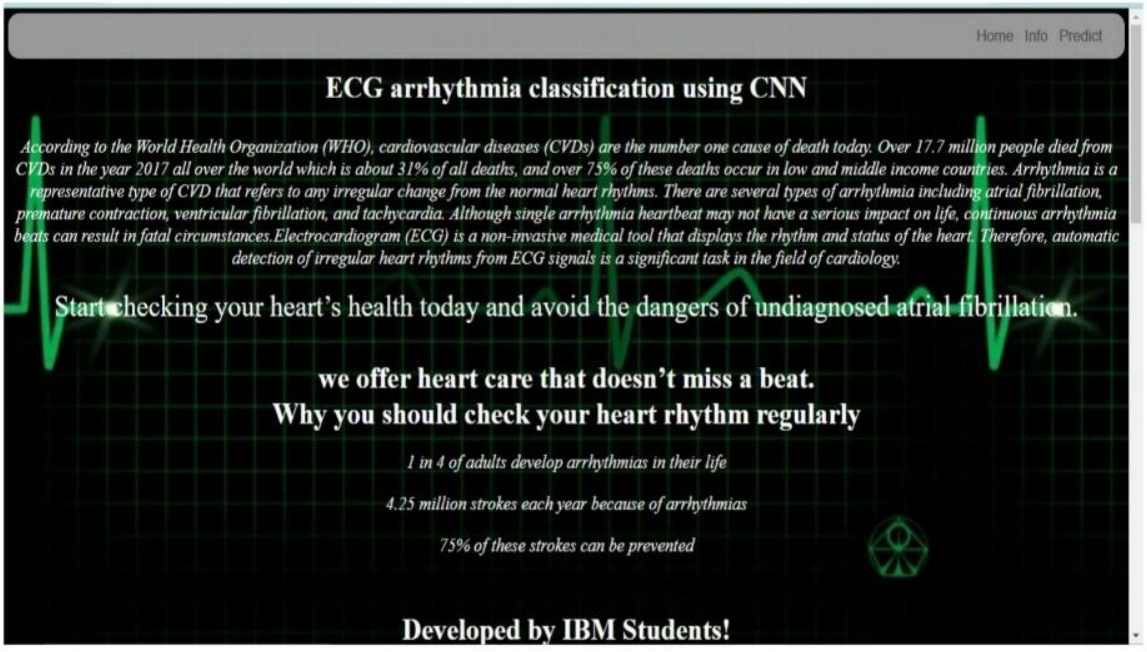
**are various types oftest. Each test type addresses a specific testing requirement.**

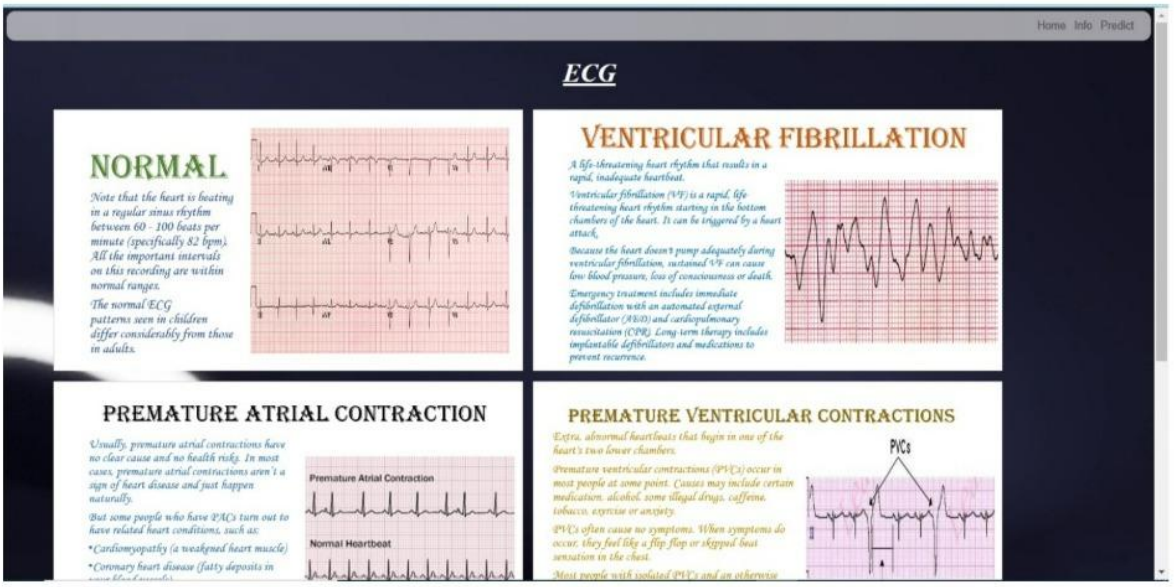
# Output

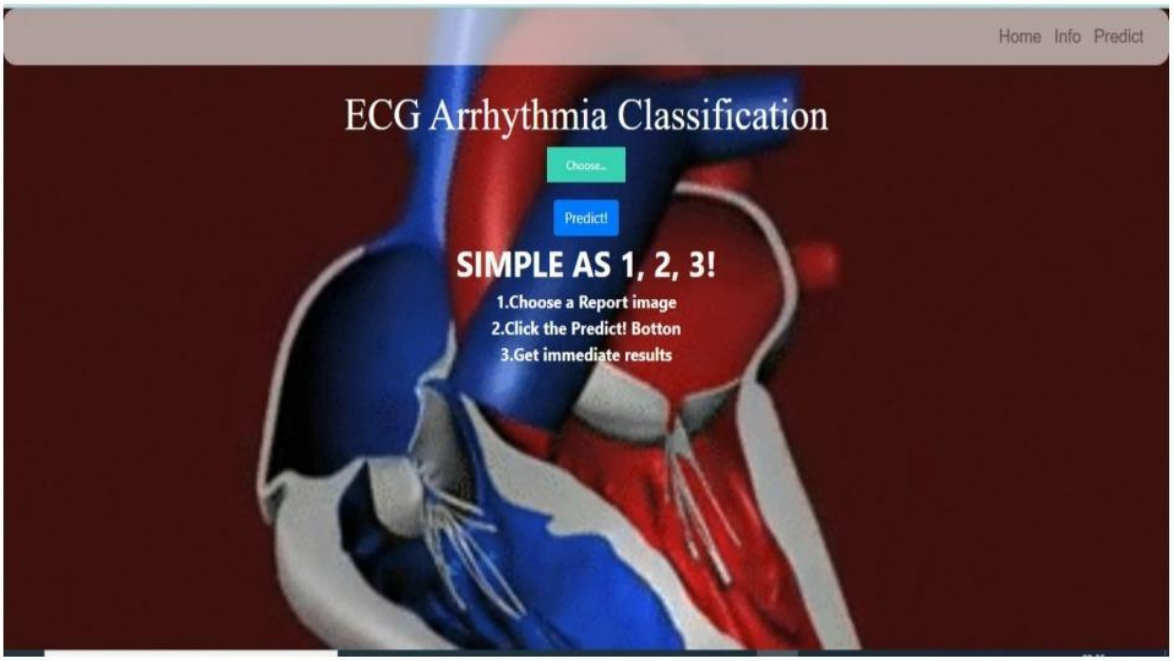
LocalDeployment:

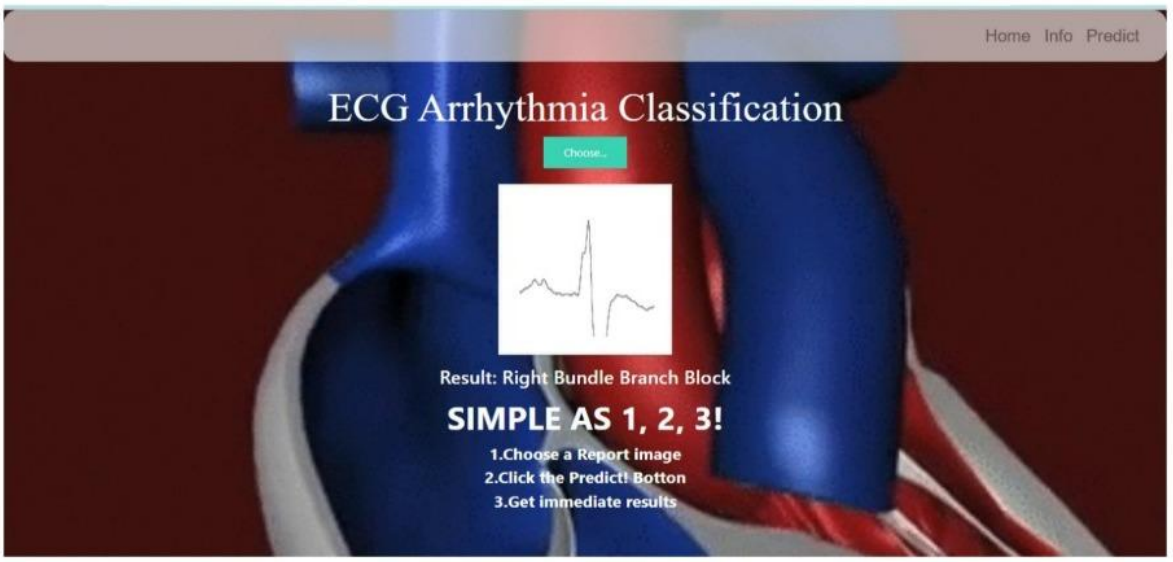



(RunningApp!– Flask)




Home Info Predict
ECG
NORMAL
Note that the heart is beating in a regular sinus rhythm between 60 - 100 beats per minute (specifically 82 bpm). All the important intervals on this recording are within normal ranges.
The normal ECG patterns seen in children differ considerably from those in adults.
VENTRICULAR FIBRILLATION
A life-threatening heart rhythm that results in a rapid, inadequate heartbeat.
Ventricular fibrillation (VF) is a rapid, life threatening heart rhythm starting in the bottom chambers of the heart. It can be triggered by a heart attack.
Because the heart doesn't pump adequately during ventricular fibrillation, sustained VF can cause low blood pressure, loss of consciousness or death.
Emergency treatment includes immediate defibrillation with an automated external defibrillator (AED) and cardiopulmonary resuscitation (CPR). Long-term therapy includes implantable defibrillators and medications to prevent recurrence.
PREMATURE ATRIAL CONTRACTION
Usually, premature atrial contractions have no clear cause and no health risks. In most cases, premature atrial contractions aren't a sign of heart disease and just happen naturally.
But some people who have PACs turn out to have related heart conditions, such as:
•Cardiomyopathy (a weakened heart muscle)
•Coronary heart disease (fatty deposits in
Premature Atrial Contraction
Normal Heartbeat
PREMATURE VENTRICULAR CONTRACTIONS
Extra, abnormal heartbeats that begin in one of the heart's two lower chambers.
Premature ventricular contractions (PVCs) occur in most people at some point. Causes may include certain medication, alcohol, some illegal drugs, caffeine, tobacco, exercise or anxiety.
PVCs often cause no symptoms. When symptoms do occur, they feel like a flip-flop or skipped beat sensation in the chest.
Most people with isolated PVCs and an otherwise
PVCs


Home Info Predict
ECG Arrhythmia Classification
Choose...
Predict!
SIMPLE AS 1, 2, 3!
1.Choose a Report image
2.Click the Predict! Botton
3.Get immediate results




(TheUploadedImageIsStoredIn!!)

## 9. Advantages and disadvantages

**1. High accuracy**
**2. High reliability**
**3. Reduced loss**

## 10. Conclusions

**This project is designed In using the MIT-BIH arrhythmia database, we haveproposedasystemfortheautomaticprocessingoftheECGfortheclassification of arrhythmia images. The database of MIT-BIH is processed visually and a waveform detection method is proposed for detecting the QRS waveform. A CNN model was built to train and classify theECG images. Experimental results show that according to the ANSI/AAMI EC57 evaluation criteria, The accuracy rate of ventricular ectopic beat can reach 95.9% and the sensitivity evaluation is 93.0%. For the supra ventricular ectopic beat class, the accuracy rate is 93.2% and the sensitivity evaluation is 81.**

## 11. futurework

**In future work we designed real time implementation of process or design of arrhythmia classification**

# 12. JIRA Results