PROJECT REPORT

Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation

TEAM ID:PNT2022TMID34634

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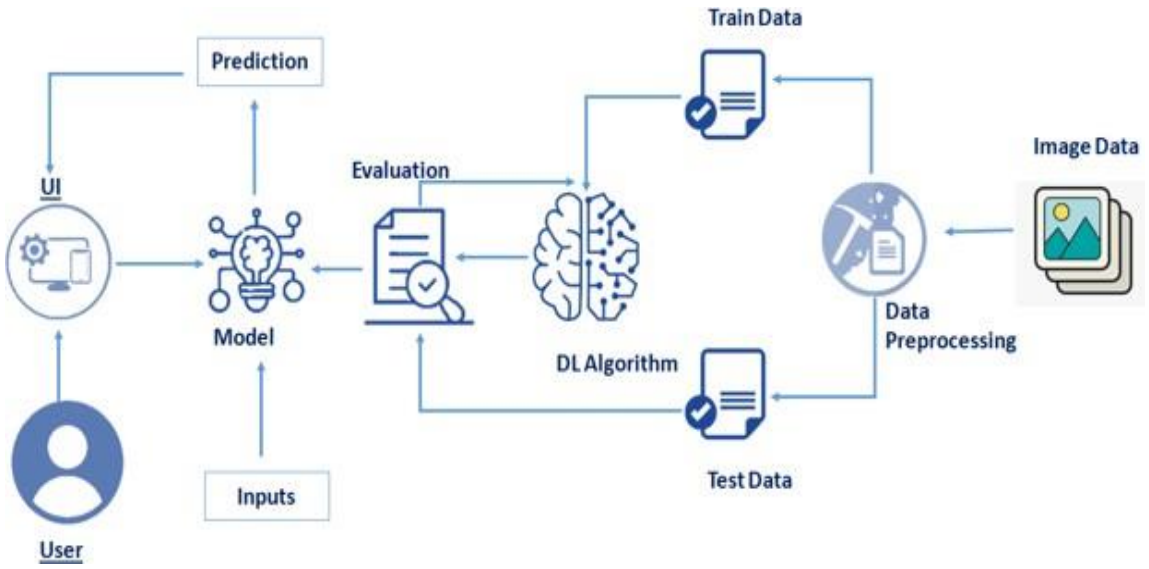
1.INTRODUCTION

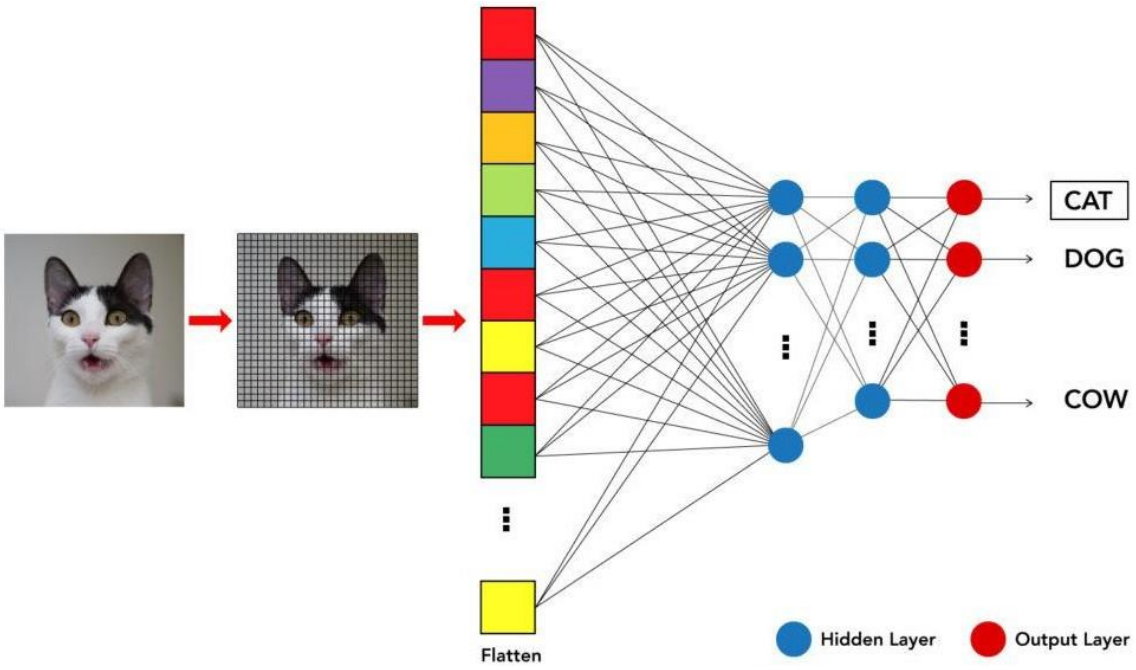
1.1 Project Overview

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. 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.



1.2 Purpose

In the past few decades, Deep Learning has provided to be a compiling tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolution al Neural Networks.



In deep learning, a convolution al neural network (CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyse visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics convolution is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other.

2.LITERATURE SURVEY

2.1 Existing Problem

Cardiac arrhythmia is a leading cause of cardiovascular disease, with a high fatality rate worldwide. The timely diagnosis of cardiac arrhythmias, determined by irregular and fast heart rate, may help lower the risk of strokes. Electrocardiogram signals have been widely used to identify arrhythmias due to their non-invasive approach. However, the manual process is error-prone and time-consuming. A better alternative is to utilise deep learning models for early automatic identification of cardiac arrhythmia, thereby enhancing diagnosis and treatment. In this article, a novel deep learning model, combining convolutional neural network and bi-directional long short-term memory, is proposed for arrhythmia classification. Specifically, the classification comprises five different classes: non-ectopic (N), supraventricular ectopic (S), ventricular ectopic (V), fusion (F), and unknown (Q) beats. The proposed model is trained, validated, and tested using MIT-BIH and St-Petersburg data sets separately. Also, the performance was measured in terms of precision, accuracy, recall, specificity, and f1-score. The results show that the proposed model achieves training, validation, and testing accuracies of 100%, 98%, and 98%, respectively with the MIT-BIH data set. Lower accuracies were shown for the St-Petersburg data set. The performance of the proposed model based on the MIT-BIH data set is also compared with the performance of existing models based on the MIT-BIH data set.

2.2 References

1. Alkhodari M, Fraiwan L. Convolutional and recurrent neural networks for the detection of valvular heart diseases in phonocardiogram recordings. *Comput Methods Programs Biomed* 2021; [PubMed] [Google Scholar]

2. Direito A, Rawstorn J, Mair J, et al. Multifactorial e-and health interventions for cardiovascular disease primary prevention: protocol for a systematic review and meta-analysis of randomised controlled trials.

Digital Health 2019; [PMC free article] [PubMed] [Google Scholar]

3. Tse G. Mechanisms of cardiac arrhythmias. *J Arrhythmia* 2016; 32(2): 75–81. [PMC free article] [PubMed] [Google Scholar]

2.3 Problem Statement Definition

Cardiovascular disease (CVD) is the leading cause of death globally. As per the World Health Organization (WHO), over 17.9 million humans around the world have died as a result of CVD diseases. Early diagnosis of CVD is critical to preventing sudden death from a heart attack or cardiac arrest. Cardiac arrhythmias refer to a group of disorders in which the heart's electrical impulse is abnormal, resulting in a quicker or slower beat than usual. A thorough investigation of the electrocardiogram (ECG) segment offers structural instruction about cardiac patients, widely employed in clinical procedures for arrhythmia identification. Usually, the ECG signs of cardiac disease do not appear within a short ECG recording period. They require a prolonged recording and monitoring of more than one day. This lengthens and complicates cardiologists' interpretation of ECG charts. Thus, numerous advancements in recent years have been made to ECG signals to decrease mortality and assist cardiologists in making timely, efficient, and accurate decisions. There are two processes for assessing ECG characteristics in the traditional manual method. The first stage involves extracting ECG features, while the second stage categorises ECG based on the retrieved characteristics. The process is cumbersome and error-prone for the cardiologists, and there is a need for automated ECG classification. Therefore, early recognition of cardiac arrhythmia is critical to effective investigation and treatment.

Several machine learning-based techniques for extracting heart characteristics and training models for arrhythmia identification have recently been developed. Linear predictive coding, wavelet entropy, synchro-squeezing wavelet transform, k-nearest neighbour and support vector machine models have all been utilised in predicting arrhythmia. While these non-deep learning techniques perform well, they suffer from various constraints, including poor classification performance for large data.

Thus, several deep learning methods have been applied recently to address a variety of difficult problems across all disciplines of health care

research, including ECG classification. Deep learning methods transcend the limitations of traditional disease diagnosis, enhancing performance and generalisation by reducing pre-processing and feature extraction.

In this context, only a few studies on convolutional neural networks (CNNs), recurrent neural networks (RNNs) such as long short-term memory (LSTM), and bi-directional long short-term memory (Bi-LSTM) are used for heart categorization and found significant improvement. In recent years, end-to-end training of CNN has been the dominating technique for health care image analysis. Additionally, because of its capacity to record position and shift-invariant modes, CNN is used to analyse the morphology of clinical information. Even when the input signal is noisy, CNN may also be able to retrieve valuable data. These performance characteristics are mirrored in the network structure built layer by layer. As the network's layers increase, features are learned and expressed more abstractly and concisely.

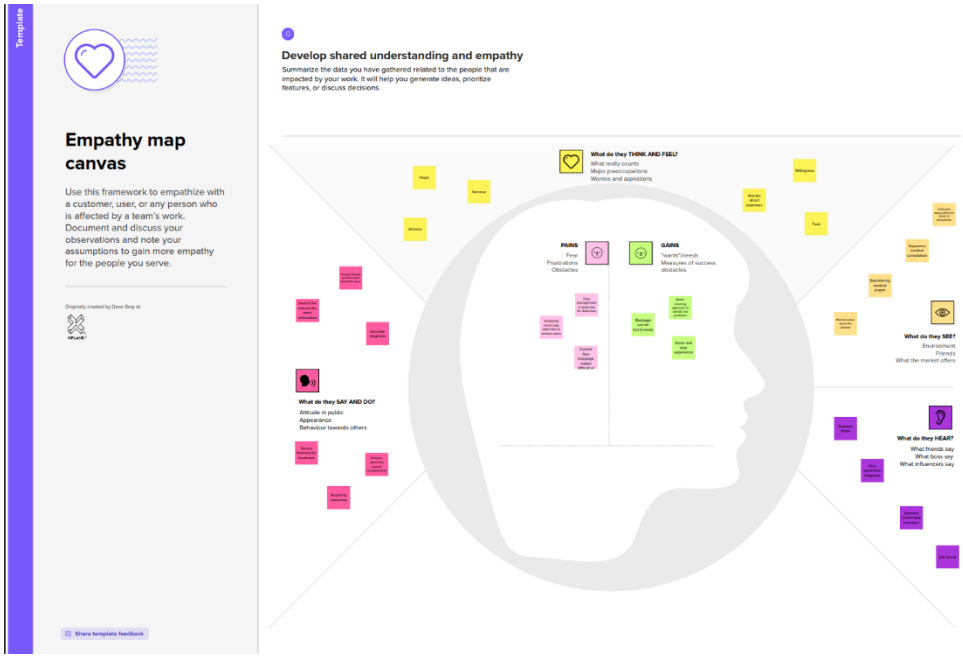
Moreover, LSTM is a kind of artificial RNN, which is suitable for classifying sequences and time-series data. LSTM only preserves the previous data because the only inputs it has received are from the past. The Bi-LSTM is a variant of the traditional LSTM capable of learning from both past and future states. It enables the network to learn representations of the characteristics and the temporal connection between the features.

This work evaluates a deep learning model that combines CNN and Bi-LSTM on two data sets (MIT-BIH and St-Petersburg data sets) for autonomously detecting arrhythmia illness from ECG signals.

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

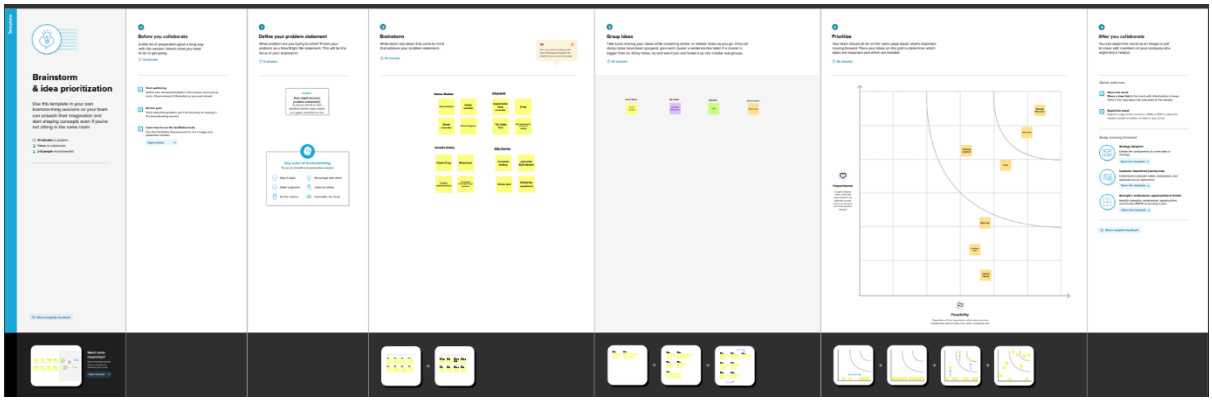
3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged collaborate, helping each other develop a rich amount of creative solutions.

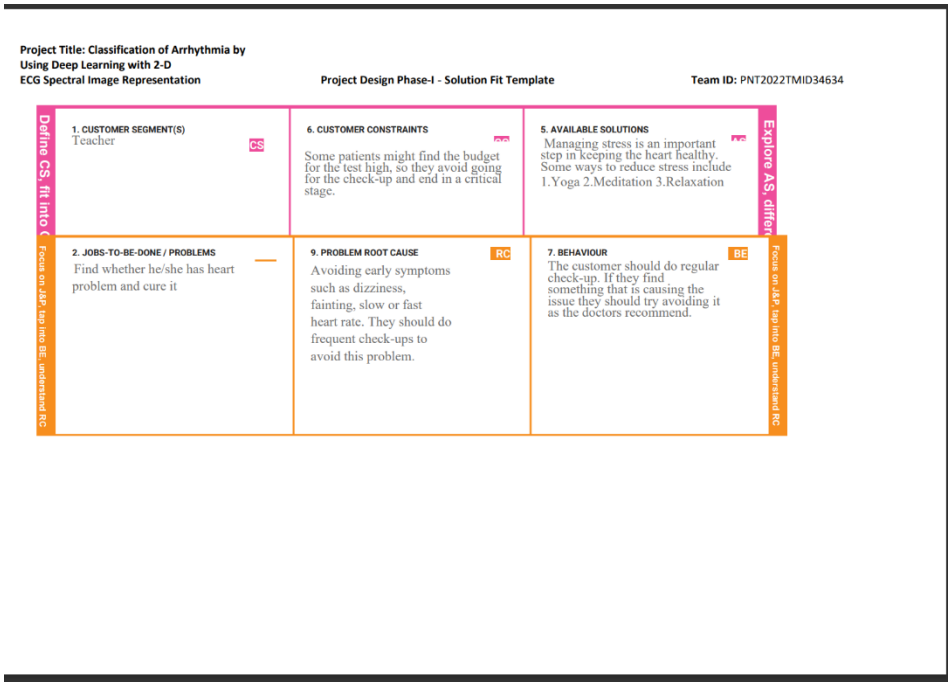


3.3 Proposed Solution

Project team shall fill the following information in the proposed solution template.

SI.NO	PARAMETER	DESCRIPTION
1	Problem Statement (Problem to be solved)	Build an effective electrocardiogram (ECG) arrhythmia classification method using a convolutional neural network (CNN)
2	Idea / Solution description	Classify ECG using deep two dimensional(2-D) CNN with grayscale ECG images
3	Novelty / Uniqueness	When the image is fed into the model, the cited class will be displayed on the webpage
4	Social Impact / Customer Satisfaction	Using this Method, We can get classification accurate
5	Business Model (Revenue Model)	Creating a web application where the user selects the image which is to be classified
6	Scalability of the Solution	It can classify into seven categories, one being normal and the other six being different types of arrhythmia

3.4 Problem fit solution



Project Title: Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID34634

Define CS, fit into C

1. CUSTOMER SEGMENT(S)
Teacher
CS

6. CUSTOMER CONSTRAINTS
Some patients might find the budget for the test high, so they avoid going for the check-up and end in a critical stage.

5. AVAILABLE SOLUTIONS
Managing stress is an important step in keeping the heart healthy. Some ways to reduce stress include 1.Yoga 2.Meditation 3.Relaxation

Explore AS, differ

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS
Find whether he/she has heart problem and cure it

9. PROBLEM ROOT CAUSE
RC
Avoiding early symptoms such as dizziness, fainting, slow or fast heart rate. They should do frequent check-ups to avoid this problem.

7. BEHAVIOUR
BE
The customer should do regular check-up. If they find something that is causing the issue they should try avoiding it as the doctors recommend.

Focus on J&P, tap into BE, understand RC

4.REQUIREMENT ANALYSIS

4.1 Functional Requirement

FR.NO	**Functional Requirement (Epic)**	**Sub Requirement (Story / Sub-Task)**
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User interface	Check your profile Choose your file Sign Out your account account and change your password
FR-4	Data processing	Evaluating the model using test data Training DL algorithm for a accuracy result Trained CNN model using Tensorflow,Kearas
FR-5	Predict ECG image	Use ECG images in our web application Collection of datasets Database read ECG images

4.2 Non-Functional Requirements

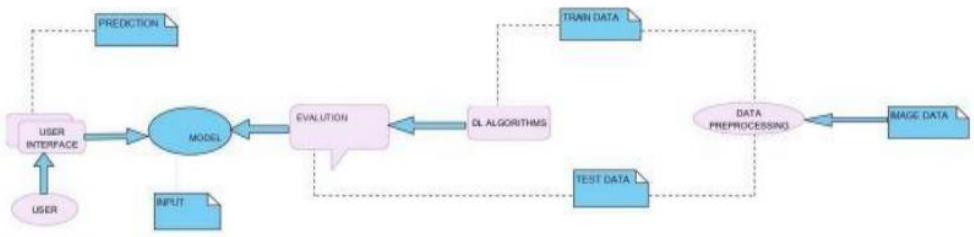
NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	Wireless ECG body sensor Savvy is a feasible solution for reliable and accurate long-term heart rhythm monitoring. However, there were no studies dealing with usability of this sensor in field testing.
NFR-2	Security	The work presented in this paper is applicable for encrypting and decrypting personalised Electrocardiograph ECG signals for secure transmission.
NFR-3	Reliability	The extent to the consistently performs the specified functions without failure
NFR-4	Performance	It essentially specifies how the system should behave and that it constrains the ECG wavelength of accurate disease information gathering
NFR-5	Availability	Availability describes how likely the system is accessible to a user at a given point in time and periodically for a solution.
NFR-6	Scalability	Scalability The ability of the user problem in arrhythmia disease to

		handle an increase in workload without performance degradation, or its ability to quickly enlarge.

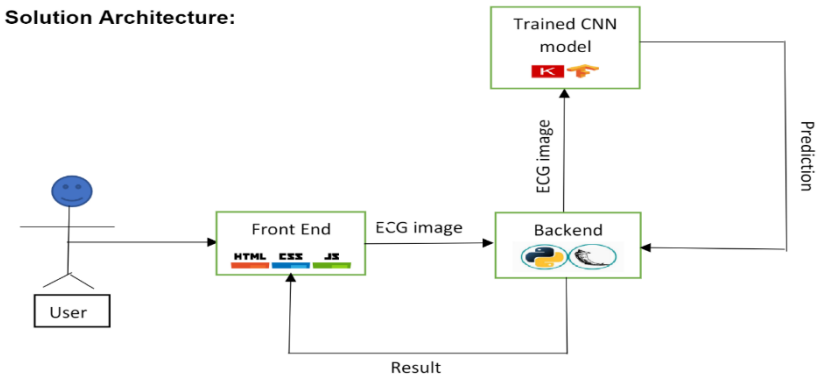
5.PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architect



5.2.1 Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	Web UI, Mobile UI.	HTML, CSS, JavaScript / React
2.	Application Logic-1	Python is used for backend	Python
3.	Application Logic-2	It's a symbolic math toolkit that performs a variety of tasks including deep neural network training and inference using dataflow and differentiable programming	Tensorflow
4.	Cloud Database	A global technology company that provides hardware, software, cloud-based services and cognitive computing.	IBM Cloud
5.	Cloud Database	Breaks up data into blocks and then stores those blocks as separate pieces, each with a unique identifier.	IBM Block
6.	External API-1	Purpose of External API used in the application	IBM Weather API, etc.
7.	External API-2	Purpose of External API used in the application	Aadhar API, etc.
8.	Machine Learning Model	Object recognition is a subfield of computer vision, artificial intelligence, and machine learning	Object Recognition Model
9.	Deep learning Model	The images from the created dataset are fed into a neural network algorithm.	Image Recognition Model

5.2.2 User Stories

User Type	User Story Number	User Story / Task	Priority	Release
Customer	USN-1	Registration	High	Sprint-1
	USN-2	Confirmation	High	Sprint-1
	USN-3	Login	Low	Sprint-2
	USN-4	Dashboard	High	Sprint-1
Administrator	USN-5	Login	Low	Sprint-2
	USN-6	Dashboard	High	Sprint-1

6 Project planning & scheduling

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Download The Dataset	USN-1	We can download the Dataset contains Six classes	1	Low	4
Sprint-1	Import The ImageDataGenerator Library	USN-2	We can import ImageDataGenerator	1	Low	4
Sprint-1	Configure ImageDataGenerator class	USN-3	We can configure the ImageDataGenerator class	1	Low	4
Sprint-2	Apply the ImageDataGenerator	USN-4	We can apply ImageDataGenerator to train dataset	2	Medium	4

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
	functionality to Trainset and Dataset					
Sprint-1	Import Libraries	USN-5	We can import required Libraries	1	Low	4
Sprint-1	Initialize the Model	USN-6	Initializing the Image recognition model	2	Medium	4
Sprint-4	Adding CNN layer	USN-7	We can add Convolutional Neural Network(CNN) used for image/object recognition and classification	4	High	4
Sprint-4	Adding Dense Layer	USN-8	We can add Dense Layer in which each neuron receives input from all the neurons of previous layer	4	High	4
Sprint-4	Configure The Learning Process	USN-9	We can configure The Learning process which is a method, mathematical logic or algorithm that improves the network's performance and/or training time.	4	High	4
Sprint-3	Train the Model	USN-10	We can train our model with our image dataset. fit_generator functions used to train a deep learning neural network	3	High	4
Sprint-1	Save the Model	USN-11	We can save The model with .h5 extension	2	Medium	4
Sprint-2	Test the model	USN-12	We can Test the model through Loaded necessary libraries, the saved model	2	Medium	4

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Create Html files	USN-13	We use HTML to create the front end part of the web page.	3	High	4
Sprint-4	Build Python code	USN-14	We build the flask file 'app.py' which is a web framework written in python for server-side scripting.	4	High	4
Sprint-1	Run the App	USN-15	We can run the App	2	Medium	4
Sprint-2	Register IBM Cloud	USN-16	We can register IBM Cloud	2	Medium	4
Sprint-3	Train the model on IBM	USN-17	We can Train Out model on IBM	3	High	4

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	4 Days	15 Nov 2022	18 Nov 2022	20	19 Nov 2022
Sprint-2	20	4 Days	15 Nov 2022	18 Nov 2022	20	19 Nov 2022
Sprint-3	20	7 Days	19 Nov 2022	25 Nov 2022	20	25 Nov 2022
Sprint-4	20	7 Days	19 Nov 2022	18 Nov 2022	20	25 Nov 2022

Velocity:

To calculate the team's **average velocity (AV)** per iteration unit

$$Av = \frac{Velocity}{Sprint\ duration}$$

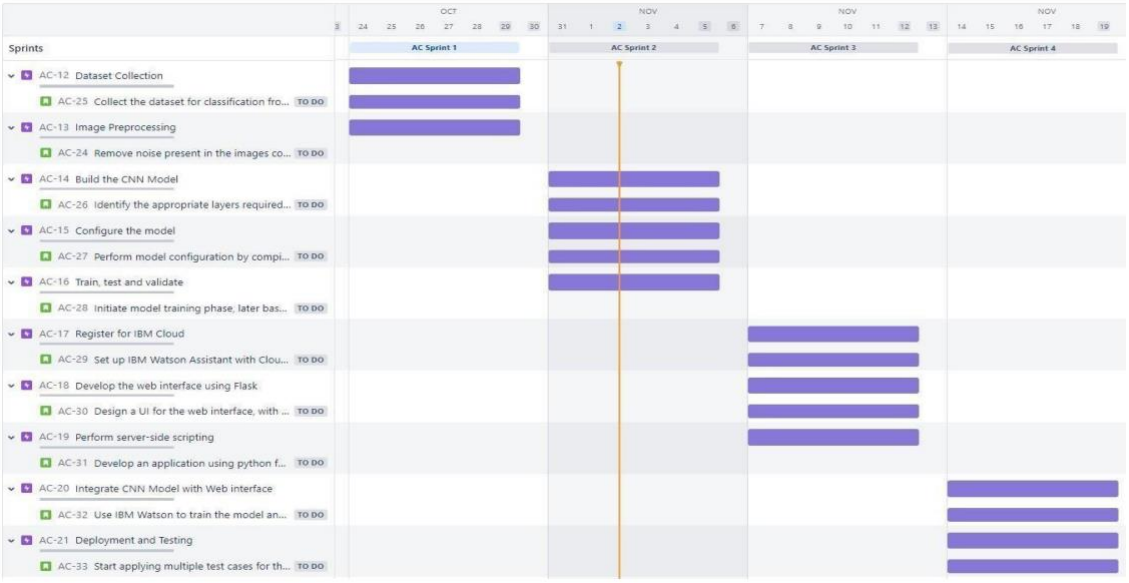
Where,

Average Velocity - Story points per day
Sprint duration - Number of days (Duration) for Sprints
Velocity - Points per Sprint

$$Av = \frac{20}{5} = 5$$

Average Velocity is **4** points per Sprint

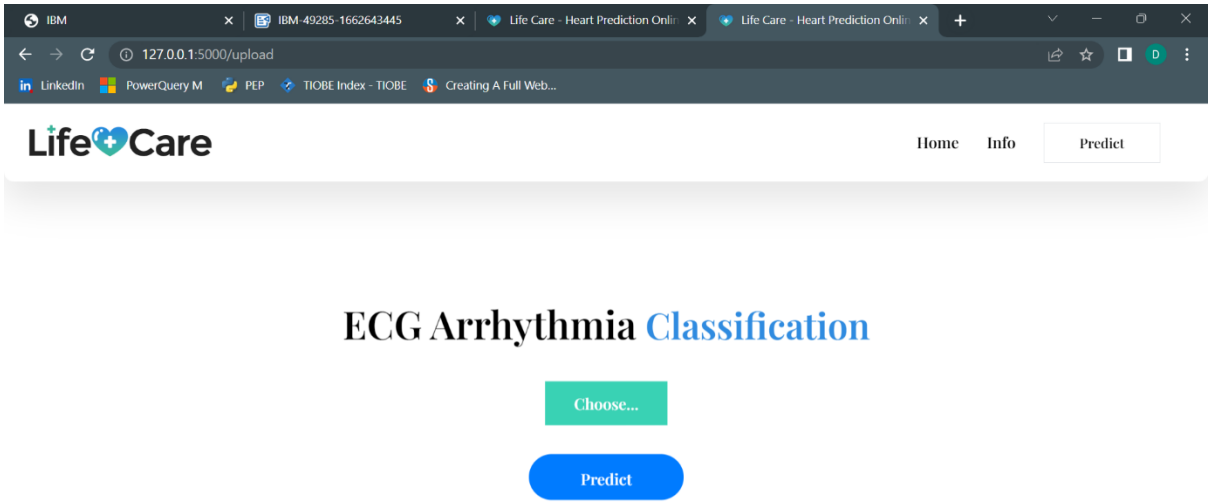
6.1 JIRA

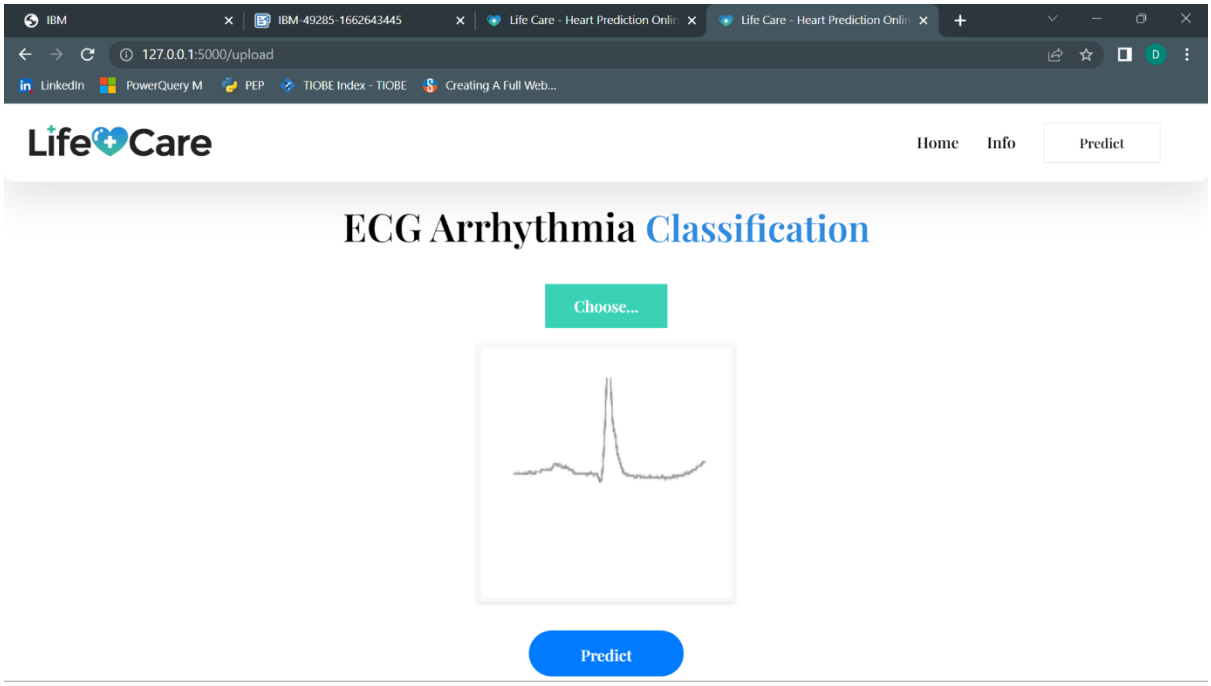


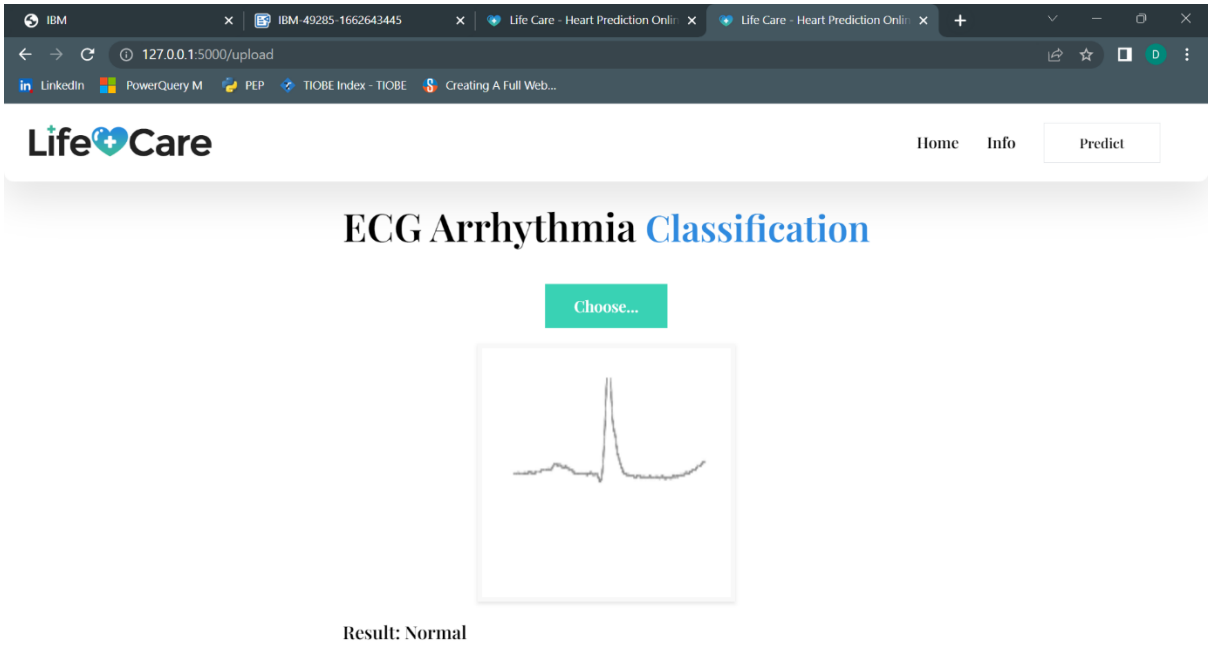
7 CODING AND SOLUTION

- IBM WATSON
- PYTHON
- CNN
- IBM CLOUD
- IBM CLOUDANT DB
- DEEP LEARNING
- HTML
- CSS
- JS

8. TESTING AND RESULTS







9.RESULTS

Two hundred forty-two patients with arrhythmia who met the inclusion criteria were enrolled in this study. Of the enrolled patients, 14 were excluded because of detachment of an ECG electrode (N=5) or photoplethysmography sensor (N=3) or because their recordings lasted <10 minutes (N=6). Two hundred twenty-eight pairs of photoplethysmography and ECG recordings were obtained from the consenting patients (N=228; 1 recording for each patient). The 228 photoplethysmography recordings were divided into 158 355 10-second photoplethysmography segments; 127 562 of these were retained, whereas another 30 793 (19.4%) were removed because of their poor signal quality or the poor signal quality of their ECG reference data. Among the 127 562 clean photoplethysmography segments, 118 217 (92.7%) were labeled as having a definite rhythm by the 2 cardiologists. The remaining segments were unclassified, because the 2 cardiologists could not provide the correct category.

Specifically, the segments numbered the following for each label: 38 081 for sinus rhythm (SR), 11 372 for PVC, 11 248 for PAC, 5783 for VT (3 or more consecutive PVCs at a rate of >100 beats per minute), 12 539 for SVT (3 or more consecutive PACs at a rate of >100 beats per minute), and 39 194 for AF. To train the model accurately, we removed unclassified segments.

Consequently, 228 recordings with 118 217 clean 10-second photoplethysmography segments collected from 228 patients (age, 52.3±11.3 years; 133 men) were retained in the final analysis. Each segment has only 1 identified rhythm type. Of the remaining

228 patients, we randomly separated 60% (N=137) into the training set, 20% (N=46) into the validation set, and 20% (N=45) into the test set. The segments included in the training, validation, and test sets were 71 390, 23 443, and 23 384, respectively. The baseline characteristics and the distribution of rhythm classes were similar among the 3 data sets. Examples of 10-second synchronous I-lead ECG and photoplethysmography signal segments for various rhythm types are presented.

10.ADVANTAGES & DISADVANTAGES

ADVANTAGES

- The proposed model predicts Arrhythmia in images with a high accuracy rate of nearly 96%.
- The early detection of Arrhythmia gives better understanding of disease causes, initiates therapeutic interventions and enables developing appropriate treatments.
- It is useful for identifying the arrhythmia disease at an early stage.
- It is useful in detecting cardiovascular disorders.
- There is no need to go to the hospital.

DISADVANTAGES

- Not useful for identifying the different stages of Arrhythmia disease.
- Not useful in monitoring motor symptoms.

- There are two major drawbacks of existing machine-learning approaches:
    - (a) they require extensive training time.
    - (b) they require manual feature selection.

11.CONCLUSION

➢ Cardiovascular disease is a major health problem in today's world. The early diagnosis of cardiac arrhythmia highly relies on the ECG.

➢ Unfortunately, the expert level of medical resources is rare, visually identify the ECG signal is challenging and time-consuming.

➢ The advantages of the proposed CNN network have been put to evidence.

➢ It is endowed with an ability to effectively process the non-filtered dataset with its potential anti-noise features.

➢ Besides that, ten-fold cross-validation is implemented in this work to further demonstrate the robustness of the network.

➢ The framework used two deep neural networks in conjunction and merged them in a hierarchical layered structure to form a single robust model. The proposed approach was tested on the UCI Arrhythmia and MIT-BIH Arrhythmia datasets and benchmarked with the state-of-the-art approaches.

➢ The comparison of the selected evaluation metrics revealed the superior performance of the proposed approach over modern approaches.

➢ A comparison in terms of the execution time was also carried out to exhibit that the approach not only far outclasses the modern works in

terms of accuracy, sensitivity, and specificity, but overall model execution time as well.

12.FUTURE SCOPE

➢ For future work, it would be interesting to explore the use of optimization techniques to find a feasible design and solution.

➢ The limitation of our study is that we have yet to apply any optimization techniques to optimize the model parameters

➢ We believe that with the implementation of the optimization, it will be able to further elevate the performance of the proposed solution to the next level.

13. APPENDIX

13.1 APP.PY

```
import os
import numpy as np  # used for numerical analysis
from flask import Flask, request, render_template
# Flask-It is our framework which we are going to use to run/serve our
application.
# request-for accessing file which was uploaded by the user on our
application.
# render_template- used for rendering the html pages
from tensorflow.keras.models import load_model  # to load our trained model
from tensorflow.keras.preprocessing import image

app = Flask(__name__)  # our flask app
model = load_model('ECG.h5')  # loading the model


@app.route("/")  # default route
@app.route("/home")  # Home page set to default page
def default():
    return render_template('index.html')  # rendering index.html


@app.route("/info")  # route to info page
def information():
```

```
    return render_template("info.html")  # rendering info.html


@app.route("/about")  # route to about us page
def about_us():
    return render_template('about.html')  # rendering about.html

@app.route("/upload")  # default route
def test():
    return render_template("predict.html")  # rendering contact.html


@app.route("/predict", methods=["GET", "POST"])  # route for our prediction
def upload():
    if request.method == 'POST':
        f = request.files['file']  # requesting the file
        basepath = os.path.dirname('__file__')  # storing the file directory
        # storing the file in uploads folder
        filepath = os.path.join(basepath, "uploads", f.filename)
        f.save(filepath)  # saving the file

        img = image.load_img(filepath, target_size=(
            64, 64))  # load and reshaping the image
        x = image.img_to_array(img)  # converting image to array
        x = np.expand_dims(x, axis=0)  # changing the dimensions of the image

        preds = model.predict(x)  # predicting classes
        pred = np.argmax(preds, axis=1)  # predicting classes
        print("prediction", pred)  # printing the prediction

        index = ['Left Bundle Branch Block', 'Normal', 'Premature Atrial
Contraction',
                 'Premature Ventricular Contractions', 'Right Bundle Branch
Block', 'Ventricular Fibrillation']
        result = str(index[pred[0]])
        return result  # returning the result
    return None


# port = int(os.getenv("PORT"))
if __name__ == "__main__":
    app.run(debug=False)  # running our app
    # app.run(host='0.0.0.0', port=8000)
```

Index.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>Life Care - 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@600&displ
ay=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="/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="bannerImg" data-aos="fade-up" data-aous-duration="1000">
        <img src="static/images/app.png" alt="" />
      </div>
    </div>

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

Info.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>Life Care - 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@600&displ
ay=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="/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>
            </div>
        </div>
    </div>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>

</html>
```

Predict_base.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>Life Care - 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@600&displ
ay=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="/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>
            </div>
        </div>
    </div>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
    <script>
        AOS.init();
    </script>
</body>

</html>
```

Predict.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 %}
```

13.2 GITHUB

https://github.com/IBM-EPBL/IBM-Project-49285-1660817459