CLASSIFICATION OF ARRHYTHMIA BY USING DEEP LEARNING WITH 2-D ECG SPECTRAL IMAGE REPRESENTATION

A UG PROJECT PHASE-1 REPORT

Submitted to

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY,HYDERABAD

In partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

Submitted by

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2019– 2023

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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2019 – 2023

CERTIFICATE OF COMPLETION
UG PROJECT PHASE-1

This is to certify that the UG Project Phase-1 entitled **" CLASSIFICATION OFARRHYTHMIA BY USING DEEP LEARNING"** is being submitted by ***G.AKSHAY REDDY*** **(H.NO:19UK1A0574),** ***P.NIHARIKA REDDY*** **(19UK1A0576),** ***T. BHOOMIKA*** **(19UK1A0573),** ***P. KARTHIK*** **(19UK1A05B1)** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** to **Jawaharlal Nehru Technological University Hyderabad** during the academic year **2022-23**, is a record of work carried out by them under the guidance and supervision.

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ABSTRACT

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.

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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 lowand 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. Purpose An electrocardiogram (ECG) measures the electric activity of the heart and has been widely used for detecting heart diseases due to its simplicity and non-invasive nature. By analyzing the electrical signal of each heartbeat, i.e., the combination of action impulse waveforms produced by different specialized cardiac tissues found in the heart, it is possible to detect some of its abnormalities

Keywords: ECG signal; classification; arrhythmia; convolution neural network; deep learning.

1.2. PURPOSE:

In the past few decades, Deep Learning has proved to be a compelling 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 isConvolution al Neural Networks.

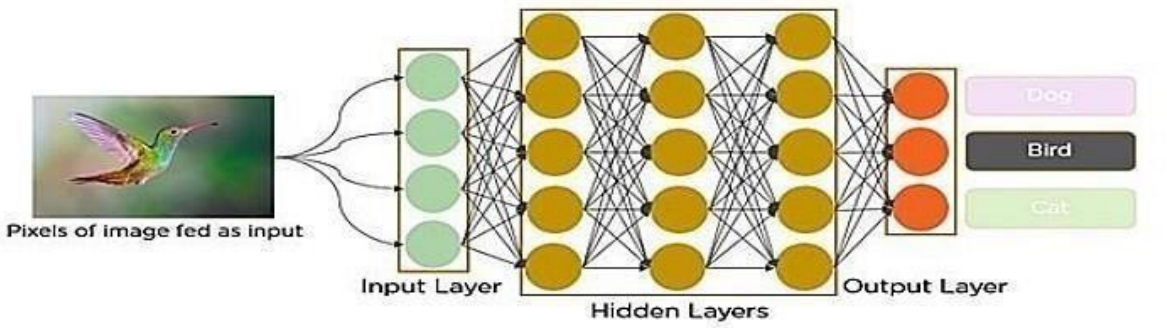

Figure 1: Neural Network Layers

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. PROBLEM STATEMENT

PROPOSED SOLUTION:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Medicines are used to control abnormal heart rhythms. Ablation procedure can cure some types of arrhythmia completely. Eat Healthy Food. Exercise Regularly.
2.	Idea / Solution description	Vitamin C. Arrythmia and other heart conditions associated oxidant stress.
3.	Novelty / Uniqueness	Users can Identify the Type of Arrhythmia.
4.	Social Impact / Customer Satisfaction	Avoid smoking, maintain a regular healthy wait, keep blood pressure and cholesterol level under control.
5.	Business Model (Revenue Model)	We can provide the application in a subscription based.
6.	Scalability of the Solution	Identify the type of heart disease. An ECG is used to how the Heart is functioning. It can give about importance of heart attack and Irregular beat.

3. LITERATURE SURVEY

3.1. EXISTING PROBLEM :

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.

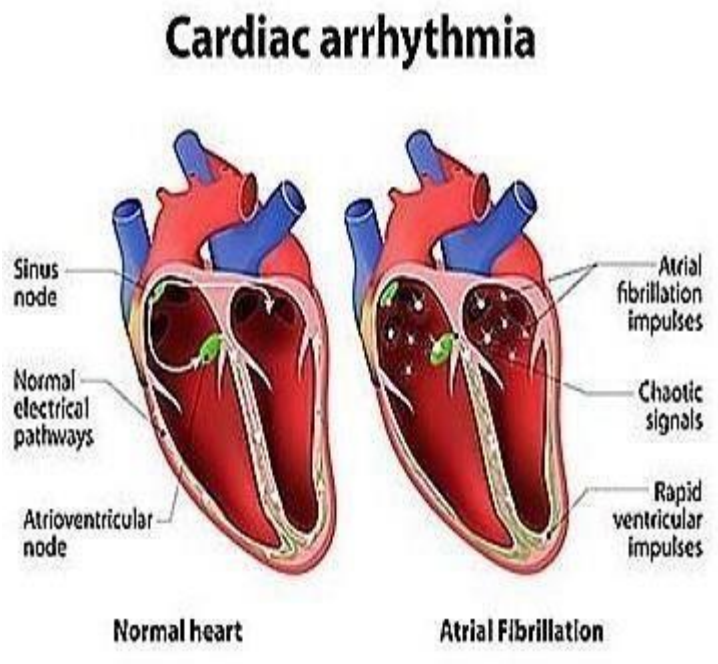

Figure 2: Cardiac Arrhythmia

3.2. PROBLEM STATEMENT DEFINITION:

More than four million of people, mostly over age sixty, are suffering from various kinds of arrhythmias that cause discomfort or even sudden cardiac death (SCD).Fast and accurate classification of large set of Electrocardiogram (ECG) beats containing both normal and arrhythmic categories is still a challenging task for the state-of-the art classification algorithms. The ECG signals can capture the heart's rhythmic irregularities, commonly known as arrhythmias. A careful study of ECG signals is crucial for precise diagnoses of patients' acute and chronic heart conditions. A two-dimensional (2-D) convolutional neural network (CNN) model is helpful for the classification of ECG signals into eight classes. 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. Using Deep Learning CNN we can enhance the accuracy of diagnosis algorithms in the fusion of medicine and modern machine learning technologies. The proposed CNN-based classification algorithm, using 2-D images, can classify eight kinds of arrhythmia.

4. EXPERIMENTAL ANALYSIS

4.1. FUNCTIONAL REQUIREMENT:

FR No.	Functional Requirements (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form, Registration through Gmail
FR-2	User Confirmation	Confirmation via Email, Confirmation via OTP
FR-3	Get User Input	Upload image as jpeg, Upload image as png
FR-4	Save Image	Images are saved in the uploads folder
FR-5	Chat with Doctor	Consults with Doctor
FR-6	Report Generation	Get complete Report

4.2. NON-FUNCTIONAL REQUIREMENTS :

FR No.	Non-Functional Requirements	Description
NFR-1	Usability	Classification of Arrhythmia with the hel of AI.
NFR-2	Security	User's data cannot be accessedby unauthorized people.
NFR-3	Reliability	The system performs without failure.
NFR-4	Performance	High accuracy.
NFR-5	Availability	Anyone who is authorized.
NFR-6	Scalability	Does not affect the performance even though.

5. PROJECT DESIGN

5.1. DATA FLOW DIAGRAMS:

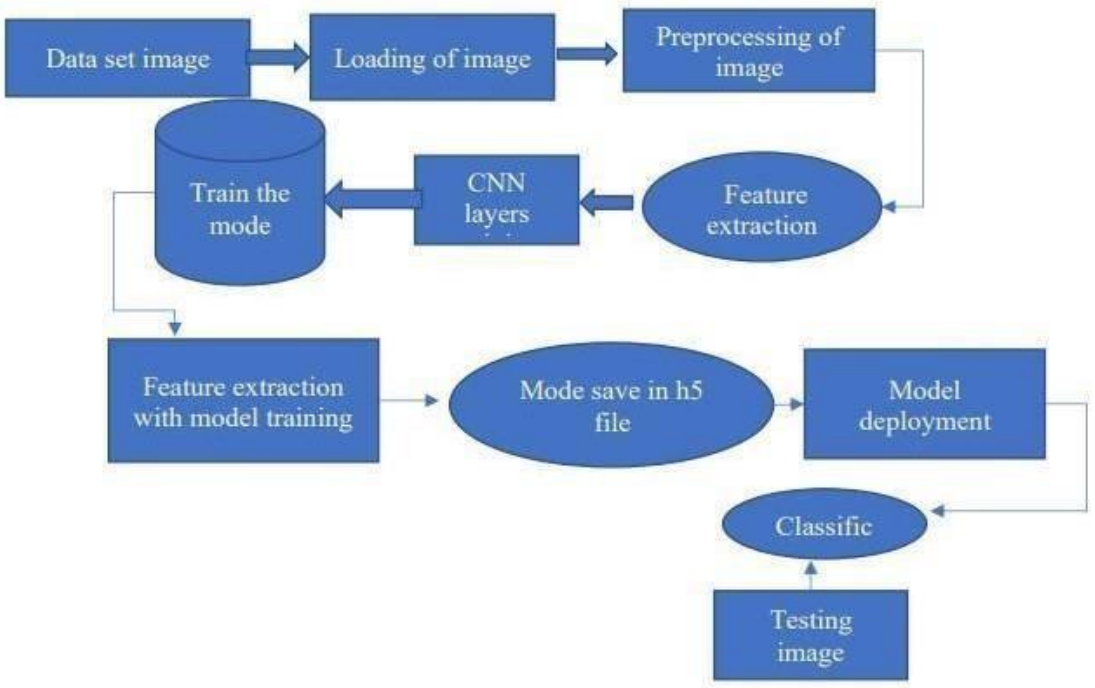

Figure 3: Data Flow Diagram

5.2. SOLUTION & TECHNICAL ARCHITECTURE :

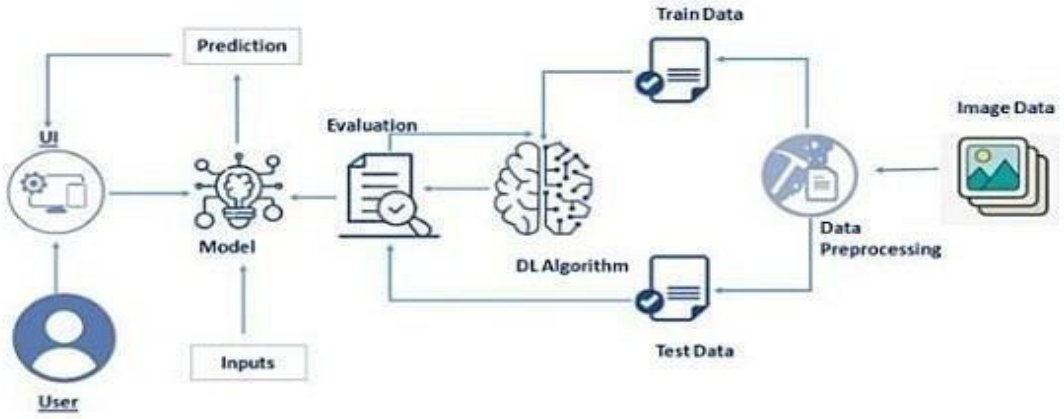

Figure 4: Solution and Technical Architecture

5.3. USER STORIES:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, | can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, | can register for the application using Gmail	I can access my account / dashboard	High	Sprint-1
	Confirmation	USN-3	As a user, | will receive confirmation email once | have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
Data Input	Getting user input	USN-4	As a user, I can share my input like the medical reports to the application	I can proceed with further steps with no error	High	Sprint-2
	Save report	USN-5	The data that is provided by the user will be saved in the application backend for future purpose	If all the data is in correct format it will be stored	High	Sprint-2
Customer Interaction	Chat with doctor	USN-6	If the customer is interested, he can consult with the doctor regarding doubts	If the doctor is free the appointment will be accepted.	Low	Sprint-1
Report Generation	Get complete report	USN-7	After the complete analysis the report will be generated	The results will be shown on the screen to the patients	High	Sprint-2

6. CONCLUSION

Arrhythmia or cardiac disorder is the most lethal disease that kills people. To assist physicians annually, the researcher proposed numerous classification systems for arrhythmias. Healthcare professionals have not yet adopted automated systems for accurately identifying arrhythmias. Time-series data that cannot be adapted to a variety of application settings was employed in recent studies, which may have contributed to the lack of acceptance. Moreover, time-series data from an EKG with signal leads should not be used if there are stable baseline wandering, muscular contractions, or power line interface.The practical approaches that a cardiologist employs to screen cardiac patients often use ECG pictures based on twelve leads.The developed arrhythmia detection systems face a number of issues exist, with the use of unbalanced data for classification constituting the biggest one, followed bymanual feature selection, methods for feature extraction, as well as classification algorithms. It took specialised knowledge to extract the features from ECG images for the automated arrhythmia identification. Additionally, in order to prevent overfitting, the balanced dataset utilized by classification methods must be used. Deep learning systems have emerged as a powerful tool in healthcare, enabling automated extraction of high-level features without the need for time-consuming human feature creation.In addition, the researcher can benefit from this study by enhancing their comprehension categorization of arrhythmias and the use of deep learning techniques to build automated systems.

7. FUTURE SCOPE

UG Project Phase-2 is the extension of UG Project Phase-1. UG Project Phase-2 involves all the coding and implementation of the design which we have retrieved from UG Project Phase1.All the implementation is done and conclusions will be retrieved in the phase. We will also work on the applications, advantages, and disadvantages of the project in this phase. Future scope of the project will be also discussed in the UG Project Phase-2.

8. BIBLIOGRAPHY

1. Amin Ullah Syed Muhammad Anwar, Muhammad Bilal, and Raja Majid Mehmood (2020)
2. Bazi, Haikel AlHichri, Naif Alajlan, Farid Melgani, Ronald R Yager (2022)
3. Faezeh Nejati Hatamian, Nishant Ravikumar, Sulaiman Vesal(2020)
4. Fatma Murat, Ozal Yildirim, Muhammed Talo, Ulas Baran Baloglu, Yakup Demir, U Rajendra Acharya (2020)
5. Han Lia, Xinpei Wanga, Changchun Liua, Peng Lib Yu Jiaoa (2021)
6. Jagdeep Rahul Lakhan Devi Sharma (2022)
7. Kurniawan, I Ketut Eddy Purnama, Mpu Hambyah Syah Bagaskara Aji (2021)
8. Ozal Yildirima, MuhammedTaloa, BetulAybUlas BaranBalogluc,
    a. GalipAydinbU, RajendraAcharya (2020)
9. Rashidah Funke Olanrewaju, S. Noorjannah Ibrahim, Ani Liza Asnawi, Hunain Altaf (2021)
10. Rui Hu, Jie Chen, Li Zhou (2022)

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1. INTRODUCTION

The electrocardiogram (ECG) is one of the most extensively employed signals used in the diagnosisand prediction of cardiovascular diseases (CVDs). The ECG signals can capture the heart's rhythmic irregularities, commonly known as arrhythmias. A careful study of ECG signals is crucialfor precise diagnoses of patients' acute and chronic heart conditions. In this study, we propose a 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 CNNmodel consisting of four convolutional layers and four pooling layers is designed for extracting robust features from the input spectrograms. Our proposed methodology is evaluated on a publiclyavailable MIT-BIH arrhythmia dataset. 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 sensitivityand specificity, which indicates the success of the proposed method.

1.1. Related Works

The ECG signal detects abnormal conditions and malfunctions by recording the potential bio-electric variation of the human heart. Accurately detecting the clinical condition presented by an ECG signal is a challenging task. Therefore, cardiologists need to accurately predict and identify the right kind of abnormal heartbeat ECG wave before recommending a particular treatment. This might require observing and analyzing ECG recordings that might continue for hours (patients in critical care). To overcome this challenge for the visual and physical explanation of the ECG signal, computer-aided diagnostic systems have been developed to automatically identify such signals automatically. Most of the research in this field has been conducted by incorporating different approaches of machine learning (ML) techniques for the efficient identification and accurate examination of ECG signals. The ECG signal classification based on different approaches has been presented in the literature including frequency analysis, artificial neural networks (ANNs), heuristic-based methods, statistical methods, support vector machines (SVMs), wavelet transform, filter banks, hidden Markov models, and mixture-of-expert methods. An artificial neural networkbased method obtained an average accuracy of 90.6% for the classification of ECG wave into six classes. Meanwhile, a feed-forward neural network was used as a classifier for the detection

of four types of arrhythmia classes and achieved an average accuracy of 96.95% Machine learning is a subset of artificial intelligence used with high-end diagnostic tools for the prediction and diagnosis of different types of illnesses Deep learning, as a subset of ML, has many applications in the prediction and prevention of fatal sicknesses, particularly CVDs. Different techniques of deep learning used for the analysis of bioinformatics signals have been presented in A recurrent neural network (RNN) was used for feature extraction and achieved an average accuracy of 98.06% for detecting four types of arrhythmia. For the classification and extraction of features from a 1-D ECG signal, a 1-D convolutional neural network model was proposed and yielded a classification accuracy of 96.72%. Another deeper 1-D CNN model was proposed for the classification of the ECG dataset and obtained an average accuracy of 97.03%. In both instances, a large ECG dataset was used, but the ECG signals were represented as a 1-D time series. A nine-layer 2-D CNN model was applied for an automatic classification of five different heartbeat arrhythmia types achieving an accuracy of 94.03%

The conventional techniques might not achieve efficient results due to the inter-patient variability in ECG signals Additionally, the efficiency and accuracy of traditional methods could be negatively affected by the increasing size of data The techniques presented in literature have been applied to smaller datasets; however, for the purpose of generalization, the performance should be tested on larger datasets. There are methods reported that use 2-D ECG signals; however, to the best of our knowledge, there are not clear details on how the 1-D ECG signal is converted to 2-D images for using 2-D CNN models. Most methods have been tested on only a few types of arrhythmia and must be evaluated on all major types of arrhythmia. It should be noted that the performance of methods developed for 1-D ECG signals can be further improved. Towards this end, the major contributions of our proposed work are:

1. Spectrograms (2-D images) are employed, which are generated from the 1-D ECG signal using STFT. In addition, data augmentation was used for the 2-D image representation of ECG signals.
2. A state-of-the-art performance was achieved in ECG arrhythmia classification by using the proposed CNN-based method with 2-D spectrograms as input. The rest of the paper is organized as follows. The proposed algorithm is presented in detail in Section 2. The experiments conducted for the validation of the proposed scheme is presented in Section 3. Classification results are presented in Section 4, and conclusions in Section 5.

2. CODE SNIPPETS

2.1 MODEL CODE:

```
In [1]: import numpy as np#used for numerical analysis
        import tensorflow #open source used for both ML and DL for computation
        from tensorflow.keras.models import Sequential #it is a plain stack of layers
        from tensorflow.keras import layers #A layer consists of a tensor-in tensor-out computation function
        #Dense layer is the regular deeply connected neural network layer
        from tensorflow.keras.layers import Dense,Flatten
        #Faltten-used fot flattening the input or change the dimension
        from tensorflow.keras.layers import Conv2D,MaxPooling2D #Convolutional layer
        #MaxPooling2D-for downsampling the image
        from keras.preprocessing.image import ImageDataGenerator
```

Figure 1: .ipynb code describing importing the required libraries

```
In [2]: #setting parameter for Image Data agumentation to the traing data
        train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)

In [3]: #Image Data agumentation to the testing data
        test_datagen=ImageDataGenerator(rescale=1./255)
```

Figure 2: .ipynb code describing Configure ImageDataGenerator Class

```
In [6]: #performing data agumentation to train data
        x_train=train_datagen.flow_from_directory('C:/Users/srihi/Downloads/Arrythmia/Final Deliverables/Dataset/train',target_size=(64,6
        #performing data agumentation to test data
        x_test=test_datagen.flow_from_directory('C:/Users/srihi/Downloads/Arrythmia/Final Deliverables/Dataset/test',target_size=(64,64),

        Found 15341 images belonging to 6 classes.
        Found 6825 images belonging to 6 classes.
```

Figure 3: .ipynb code describing Apply ImageDataGenerator Functionality To Trainset And Testset

```
In [9]: # create model
        model=Sequential()
        # adding model layer
        model.add(Conv2D(32,(3,3),input_shape=(64,64,3),activation='relu'))#convolutional layer
        model.add(MaxPooling2D(pool_size=(2,2))) #MaxPooling2D-for downsampling the input

        model.add(Conv2D(32,(3,3),activation='relu'))
        model.add(MaxPooling2D(pool_size=(2,2)))

        model.add(Flatten())#flatten the dimension of the image
        model.add(Dense(32))#deeply connected neural network layers.
        model.add(Dense(6,activation='softmax'))#output layer with 6 neurons
```

Figure 4: .ipynb code describing Adding CNN Layers and Dense layers

```
In [10]: model.summary()#summary of our model
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 62, 62, 32)        896

 max_pooling2d (MaxPooling2D  (None, 31, 31, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 29, 29, 32)        9248

 max_pooling2d_1 (MaxPooling  (None, 14, 14, 32)       0
 2D)

 flatten (Flatten)           (None, 6272)              0

 dense (Dense)               (None, 32)                200736

 dense_1 (Dense)             (None, 6)                 198

=================================================================
Total params: 211,078
Trainable params: 211,078
Non-trainable params: 0
_________________________________________________________________
```

Figure 5: .ipynb code describing Summary to get full information

```
In [11]: # Compile model
         model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
```

Figure 6: .ipynb code describing Compiling the model

```
In [*]: # Fit the model
model.fit_generator(generator=x_train,steps_per_epoch = len(x_train),
                    epochs=10, validation_data=x_test,validation_steps = len(x_test))
```

```
C:\Users\srihi\AppData\Local\Temp\ipykernel_12424\1916141677.py:2: UserWarning: `Model.fit_generator` is deprecated and will be
removed in a future version. Please use `Model.fit`, which supports generators.
  model.fit_generator(generator=x_train,steps_per_epoch = len(x_train),
Epoch 1/10
480/480 [==============================] - 258s 536ms/step - loss: 1.1477 - accuracy: 0.5935 - val_loss: 0.8861 - val_accuracy:
0.6859
Epoch 2/10
480/480 [==============================] - 154s 322ms/step - loss: 0.3551 - accuracy: 0.8899 - val_loss: 0.3801 - val_accuracy:
0.8648
Epoch 3/10
480/480 [==============================] - 138s 287ms/step - loss: 0.2324 - accuracy: 0.9305 - val_loss: 0.4036 - val_accuracy:
0.8673
Epoch 4/10
480/480 [==============================] - 62s 129ms/step - loss: 0.2016 - accuracy: 0.9419 - val_loss: 0.4374 - val_accuracy:
0.8658
Epoch 5/10
480/480 [==============================] - 258s 538ms/step - loss: 0.1735 - accuracy: 0.9469 - val_loss: 0.3010 - val_accuracy:
0.9020
Epoch 6/10
480/480 [==============================] - 85s 176ms/step - loss: 0.1487 - accuracy: 0.9544 - val_loss: 0.3032 - val_accuracy:
0.9068
```

Figure 7: .ipynb code describing Fitting the Model

```
In [13]: # Save the model
from tensorflow.keras.models import load_model
model.save('ECG.h5')
```

Figure 8: .ipynb code describing Saving our model

2.1 PYTHON CODE AND HTML CODE:

1. app.py code:

```python
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("/contact") #route to contact us page
def contact_us():
    return render_template('contact.html')  #rendering contact.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
        filepath = os.path.join(basepath, "uploads", f.filename)  # storing the file in uploads folder
        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  # resturing 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)
```

Figure 9: .python code used for rendering all the HTML pages

2. about.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">
    <title>Self Care - 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@600&display=swap" rel="stylesheet" />
    <link href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/5.10.0/css/all.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/SELF1 11.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/vjaavatar.jpg">
                </div>
                <div class="caption">
                    <h3>Vijay Anand </h3>
                    <p>Web Developer, Full Stack Developer, AI Learning Engineer</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">
```

```
    </div>
    <div class="caption">
        <h3>Pritha V </h3>
        <p>Front End Developer, Machine 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>Ruhie N</h3>
        <p>Back End Developer, AI Learning Engineer</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/sh.jpg">
    </div>
    <div class="caption">
        <h3>Shyam Praveen Singh</h3>
        <p>Full Stack Developer, Machine Learning Engineer</p>
        <div class="social-links">
            <a href="#"><i class="fab fa-facebook"></i></a>
            <a href="#"><i class="fab fa-instagram"></i></a>
```

```
            <div class="profile-card">
                <div class="img">
                    <img src="static/images/sh.jpg">
                </div>
                <div class="caption">
                    <h3>Shyam Praveen Singh</h3>
                    <p>Full Stack Developer, Machine Learning Engineer</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>SelfCare</h1>
            <div class="footerlinks">
                <a href="/home">Home</a>
                <a href="/info">Info</a>
                <a href="/about" class="mainLink">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>
```

Figure 10 : about.html page is the code which displays our Web Application

3. contact.html

```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/all.min.css" />
    <link href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@600&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\SELF1 11.png" style="width:190px" />
                </a>
            </div>
            <div class="links">
                <a href="/home" >Home</a>
                <a href="/info">Info</a>
                <a href="/about">About Us</a>
                <a href="/contact" class="mainLink">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>
```

Figure 11 : contact.html page is the code which displays contact page

4. index.html

```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>Self 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&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\SELF1 11.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>
```

```html
    <!--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>
```

```
            </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 SelfCare 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>SelfCare</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>
```

Figure 12 : index.html page is the code which displays index page

5. 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>Self 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&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/SELF1 11.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>
```

```
                    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>SelfCare</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>
```

Figure 13 : info.html page is the code which displays info page

6. 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>Self 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&display=swap" rel="stylesheet" />
    <script src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></script>
    <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"></script>
    <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\SELF1 11.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>SelfCare</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>
```

Figure 14 : predict_base.html page is the code which displays predict_base page

7. 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;
        Predict</div>
    <div class="loader" style="display:none;"></div>
</center>

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

</div>

</div>



{% endblock %}
```

Figure 15 : predict.html page is the code which displays predict page

3. CONCLUSION

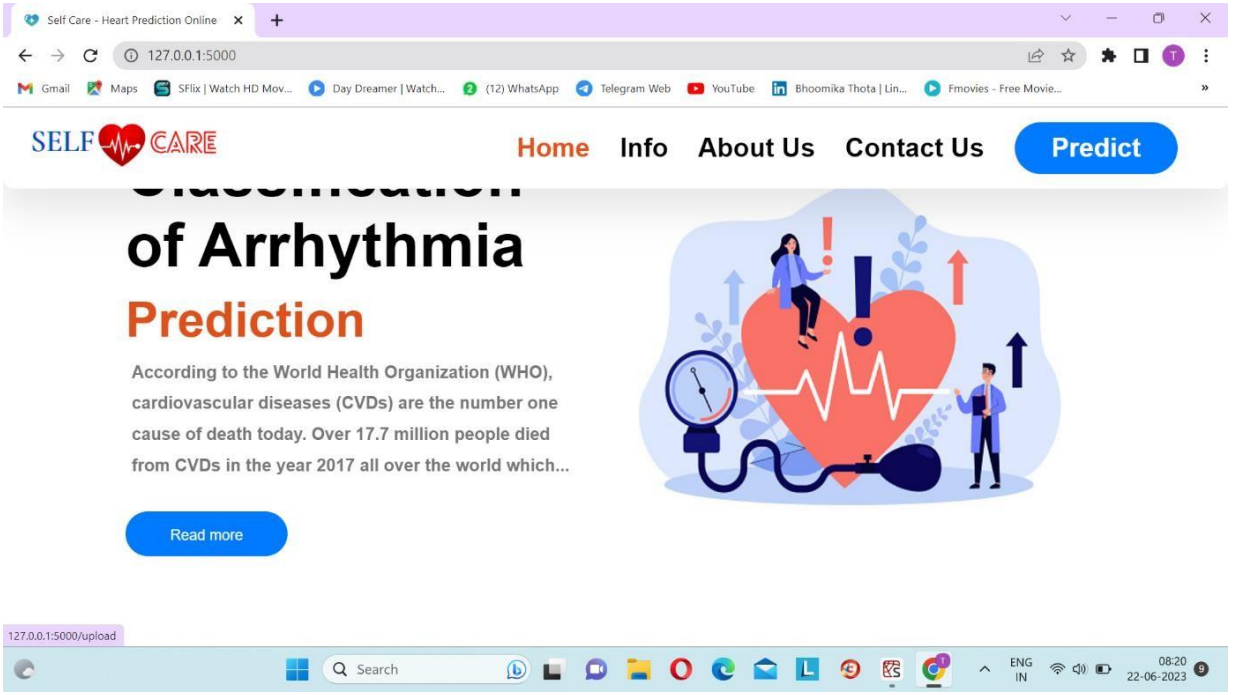

Figure 16: Home Page (which gives introduction to Classification of Arrhythmia)

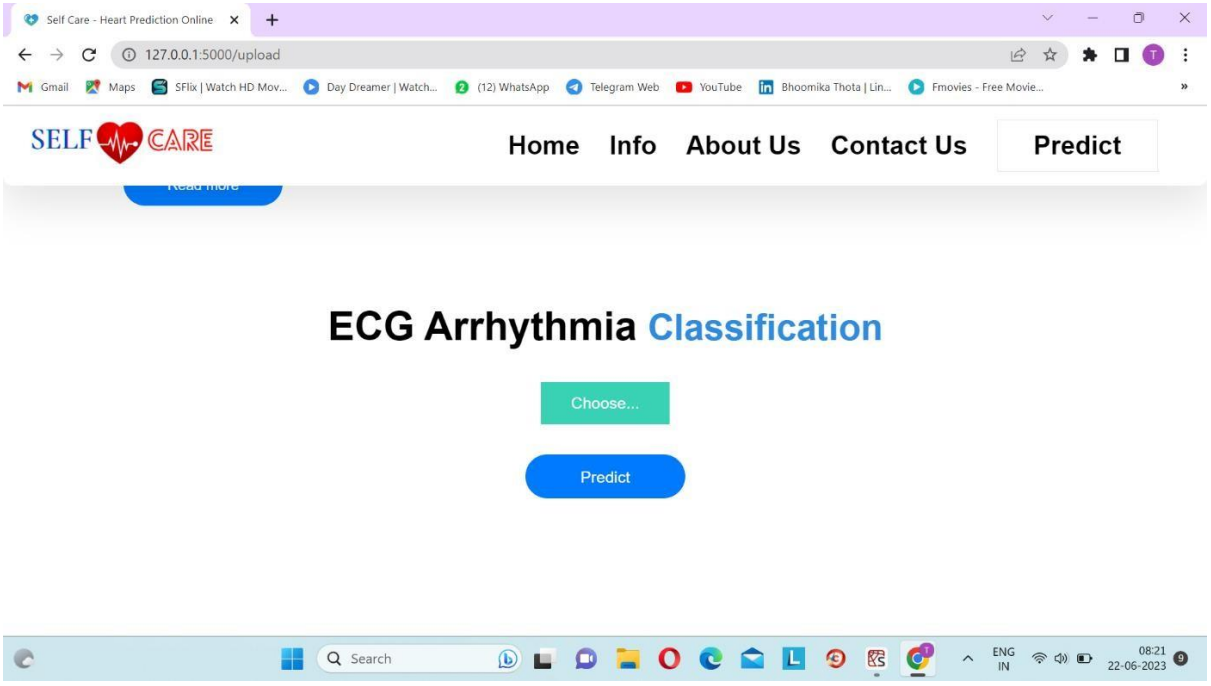

Figure 17: Input page (which takes input from the user)

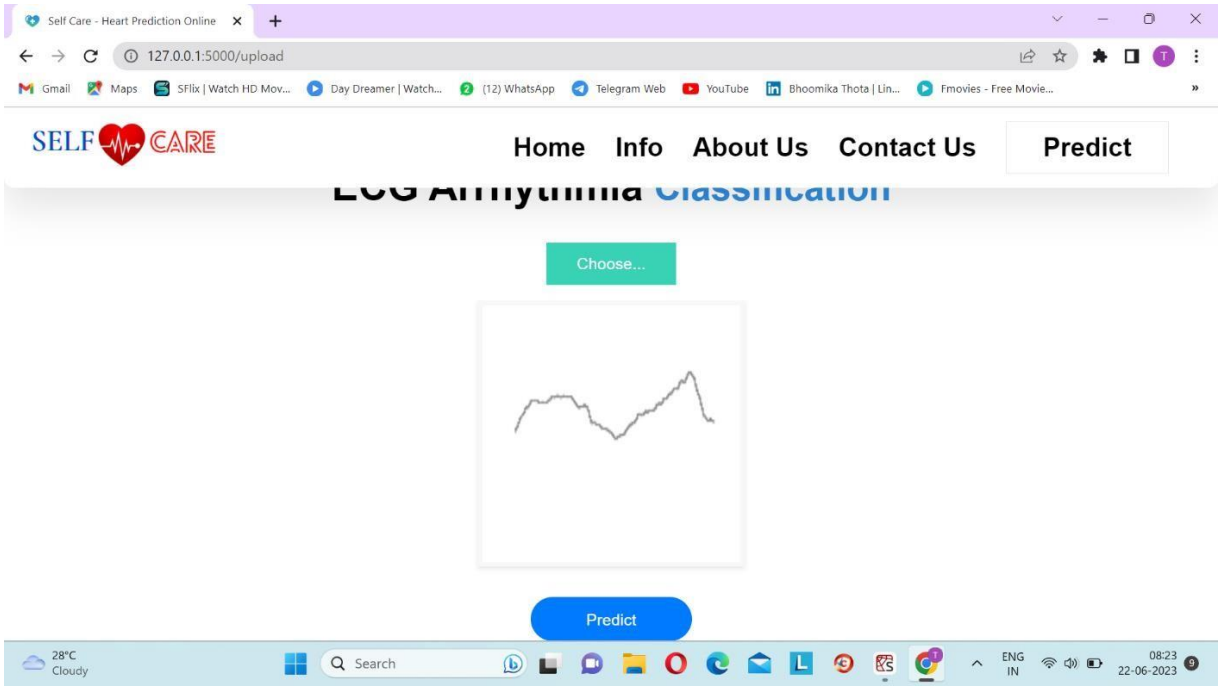

Figure 18: Input page (which takes input from the user)

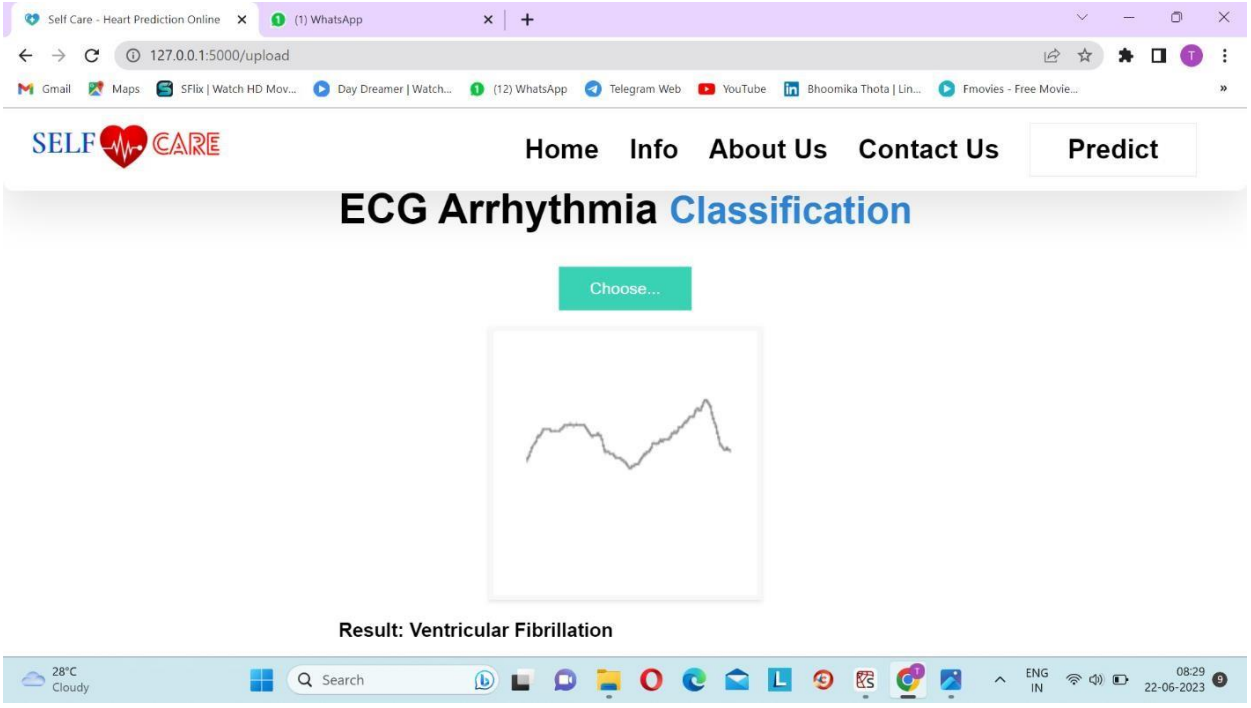

Figure 19: Output page (which displays the patient having Arrhythmia or not)

4. APPLICATIONS

Arrhythmias, which are irregular heart rhythms, can have various applications in different fields. Here are some of the key applications of arrhythmia:

1. Medical Diagnosis: Arrhythmias can be used as an indicator of underlying cardiovascular conditions. Detecting and analyzing abnormal heart rhythms can help doctors diagnose heart diseases and other related conditions.

2. Risk Stratification: Certain types of arrhythmias, such as ventricular arrhythmias, can indicate an increased risk of sudden cardiac arrest or other life-threatening events. Identifying these high-risk individuals allows for targeted interventions, such as implantable cardioverter-defibrillators (ICDs), to prevent sudden cardiac death.

3. Cardiac Research: Studying arrhythmias helps researchers gain insights into the mechanisms and causes of various heart rhythm disorders. This research can lead to the development of new treatments, therapies, and preventive measures for arrhythmias and associated cardiovascular conditions.

Medical Device Development: Arrhythmias drive the development of medical devices that monitor and treat abnormal heart rhythms. For example, implantable pacemakers and ICDs are used to regulate heart rhythms and deliver therapies when necessary.

4. Pharmacological Research: Investigating arrhythmias allows scientists to study the effects of medications and develop anti-arrhythmic drugs. These drugs aim to restore normal heart rhythm and prevent complications associated with arrhythmias.

5. Remote Monitoring and Telemedicine: With advancements in technology, arrhythmia monitoring can be done remotely using wearable devices and mobile applications. This enables patients to track their heart rhythm and transmit data to healthcare providers for analysis and evaluation, facilitating telemedicine and remote patient care.

6. Training and Education: Arrhythmias play a crucial role in medical training and education. Medical students, residents, and cardiologists learn to recognize and interpret different types of arrhythmias through electrocardiogram (ECG) analysis, enhancing their diagnostic skills and understanding of cardiac conditions.

7. It's important to note that while arrhythmias have these applications, they can also be potentially life-threatening and require appropriate medical attention and treatment. If you suspect you have an arrhythmia or any heart-related concerns, it is recommended to consult a healthcare professional for proper evaluation and guidance.

5. ADVANTAGES

Improved Understanding of Heart Function: Studying arrhythmias helps researchers and healthcare professionals gain a deeper understanding of the complexities of heart function and the electrical signaling within the heart. This knowledge contributes to advancements in cardiology and can lead to better diagnostic techniques and treatment strategies for various cardiovascular conditions.

1. Development of Treatment Strategies: Research on arrhythmias contributes to the development of new treatment strategies and interventions. This includes the advancement of anti-arrhythmic medications, implantable devices (such as pacemakers and implantable cardioverter-defibrillators), and minimally invasive procedures (such as catheter ablation). These advancements can improve patient outcomes and quality of life.

2. Risk Stratification and Prevention: Identifying and diagnosing arrhythmias can help healthcare professionals assess the risk of potential complications, such as sudden cardiac arrest or stroke. This allows for risk stratification and implementation of preventive measures, such as medication, lifestyle modifications, and implantable devices, to reduce the likelihood of adverse events.

3. Advancements in Remote Monitoring and Telemedicine: Arrhythmias have driven innovations in remote monitoring technologies. Wearable devices and mobile applications enable patients to monitor their heart rhythms remotely and share data with healthcare providers. This facilitates early detection of arrhythmias, timely interventions, and improved management, especially in remote or underserved areas.

4. Training and Education: Arrhythmias play a critical role in medical training and education. Medical students, residents, and healthcare professionals learn to recognize and interpret different types of arrhythmias through ECG analysis and clinical experience. This knowledge enhances their skills in diagnosing and managing various cardiac conditions.

It's important to reiterate that while there may be benefits associated with the understanding and management of arrhythmias, the condition itself can be potentially harmful and should be addressed by healthcare professionals.

6. DISADVANTAGES

Arrhythmias themselves are not advantageous but rather a medical condition with potential disadvantages. Here are some of the disadvantages associated with arrhythmias:

1. Health Risks: Certain types of arrhythmias, particularly those that cause the heart to beat too fast or too slow, can have serious health implications. They may result in decreased blood flow to vital organs, leading to symptoms like dizziness, fainting, shortness of breath, and even life-threatening complications such as stroke or cardiac arrest.

2. Reduced Quality of Life: Arrhythmias can significantly impact a person's quality of life. Symptoms such as palpitations, chest discomfort, fatigue, and anxiety can affect daily activities, work performance, and overall well-being. Frequent doctor visits, medication regimens, and potential lifestyle restrictions can also add to the burden.

3. Increased Risk of Complications: Some arrhythmias, particularly those that are persistent or untreated, can lead to long-term complications. These may include the development of blood clots, heart failure, weakened heart muscle, or structural heart abnormalities. Such complications can further exacerbate symptoms and require additional medical interventions.

4. Diagnostic Challenges: Arrhythmias can sometimes be challenging to diagnose due to their intermittent nature. They may not always present during routine medical evaluations, making it difficult to capture the abnormal heart rhythm on an electrocardiogram (ECG). This can delay diagnosis and appropriate management.

5. Treatment Side Effects: Treatment for arrhythmias often involves medications, procedures, or devices. While these interventions can be effective, they may come with potential side effects and risks. For example, anti-arrhythmic medications can cause adverse reactions, and invasive procedures such as catheter ablation or cardiac surgery carry inherent risks.

6. Emotional and Psychological Impact: Living with arrhythmias can take a toll on a person's emotional well-being. Fear, anxiety, and uncertainty about the condition and its potential consequences may lead to psychological distress, affecting mental health and overall quality of life.

It's important to note that not all arrhythmias are equally concerning, and the severity of disadvantages can vary depending on the type and underlying cause of the arrhythmia. Proper diagnosis, treatment, and regular follow-up with healthcare professionals are essential to minimize the disadvantages and manage arrhythmias effectively.

7. FUTURE SCOPE

In this study, we proposed a 2-D CNN-based classification model for automatic classification of cardiac arrhythmias using ECG signals. An accurate taxonomy of ECG signals is extremely helpful in the prevention and diagnosis of CVDs. Deep CNN has proven useful in enhancing the accuracy of diagnosis algorithms in the fusion of medicine and modern machine learning technologies. The proposed CNN-based classification algorithm, using 2-D images, can classify eight kinds of arrhythmia, namely, NOR, VFW, PVC, VEB, RBB, LBB, PAB, and APC, and it achieved 97.91% average sensitivity, 99.61% specificity, 99.11% average accuracy, and 98.59% positive predictive value (precision). These results indicate that the prediction and classification of arrhythmia with 2-D ECG representation as spectrograms and the CNN model is a reliable operative technique in the diagnosis of CVDs. The proposed scheme can help experts diagnose CVDs by referring to the automated classification of ECG signals. The present research uses only a single-lead ECG signal. The effect of multiple lead ECG data to further improve experimental cases will be studied in future work..

8. BIBLIOGRAPHY

11. Amin Ullah Syed Muhammad Anwar, Muhammad Bilal, and Raja Majid Mehmood (2020)
12. Bazi, Haikel AlHichri, Naif Alajlan, Farid Melgani, Ronald R Yager (2022)
13. Faezeh Nejati Hatamian, Nishant Ravikumar, Sulaiman Vesal(2020)
14. Fatma Murat, Ozal Yildirim, Muhammed Talo, Ulas Baran Baloglu, Yakup Demir, U Rajendra Acharya (2020)
15. Han Lia, Xinpei Wanga, Changchun Liua, Peng Lib Yu Jiaoa (2021)
16. Jagdeep Rahul Lakhan Devi Sharma (2022)
17. Kurniawan, I Ketut Eddy Purnama, Mpu Hambyah Syah Bagaskara Aji (2021)
18. Ozal Yildirima, MuhammedTaloa, BetulAybUlas BaranBalogluc,
    a. GalipAydinbU, RajendraAcharya (2020)
19. Rashidah Funke Olanrewaju, S. Noorjannah Ibrahim, Ani Liza Asnawi, Hunain Altaf (2021)
20. Rui Hu, Jie Chen, Li Zhou (2022)

9. HELP FILE

PROJECT EXECUTION:

STEP-1: Go to Start, search and launch **ANACONDA NAVIGATOR.**

STEP-2: After launching of **ANACONDA NAVIGATOR**, launch **JUPYTER NOTEBOOK.**

STEP-3: Open "**Major project code**" **IPYNB** file.

STEP-4: Then run all the cells.

STEP-5: All the data preprocessing, training and testing, model building, accuracy of the model can be showcased.

STEP-6: And a pickle file will be generated.

STEP-7: Create a Folder named **FLASK** on the **DESKTOP**. Extract the pickle file into this **Flask Folder.**

STEP-8: Extract all the html files (home.html, index.html, chance.html, nochance.html) and python file(app.py) into the **FLASK Folder.**

STEP-9: Then go back to **ANACONDA NAVIGATOR** and the launch the **SPYDER.**

STEP-10: After launching Spyder, give the path of **FLASK FOLDER** which you have created on the **DESKTOP.**

STEP-11: Open all the app.py and html files present in the Flask Folder.

STEP-12: After running of the app.py, open **ANACONDA PROMPT** and follow the belowsteps:

cd File Path →click enter

python app.py → click enter (We could see running of files).

STEP-13: Then open **BROWSER**, at the **URL** area type **—localhost:5000**".

STEP-14: Home page of the project will be displayed.

STEP-15: Click on **—Go to Predict**". Directly it will be navigated to index page.

STEP-16: A index page will be displayed where the user needs to give the inputs and then click on **Predict**". Output will be generated whether a person is having liver disease or not.