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

A PROJECT REPORT

Submitted by

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Team ID	PNT2022TMID03100
Title	Project - Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation

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

1. INTRODUCTION

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 convolution al neural network(CNN), in which we classify ECG intoseven 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 displayedon the webpage.

2. Purpose

Due to its ability to handle large amounts of data, Deep Learning has become an increasingly popular tool over the past few decades.The use of hidden layers has surpassed traditional techniques, especially in pattern recognition.In terms of deep neural networks, Convolutional Algorithms are among the most popular.The convolution to the neural network (CNN/ConvNet)

is a class of deep neural networks most commonly used to analyze visual imagery.ConvNet differs from neural networks in that it doesn't involve matrix multiplications like neural networks do.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

1. Existing problem

The number one cause of death today is cardiovascular diseases (CVDs).Globally, 17.7 million people died of CVDs in 2017 which is about 31% of all deaths, and over 75% of these deaths occur in low- and middle-income countries.Cardiovascular diseases, such as arrhythmia, refer to any deviation from normal heart rhythms.

Tachycardia, atrial fibrillation, premature contraction, and ventricular fibrillation are all types of arrhythmia.

2. References

1. https://github.com/Anshuman151/ECG-Image-Based-Heartbeat-Classification-for-Arrhythmia-Detection-Using-IBM-Watson-Studio/blob/main/README.md

2. https://www.analyticsvidhya.com/blog/2021/05/convolutional-neural-networks-cnn/

3. https://www.mathworks.com/help/deeplearning/ref/nnet.cnn.layer.convolution2dlay er.html;jsessionid=0a7e3bc26fabda07a5032030294b

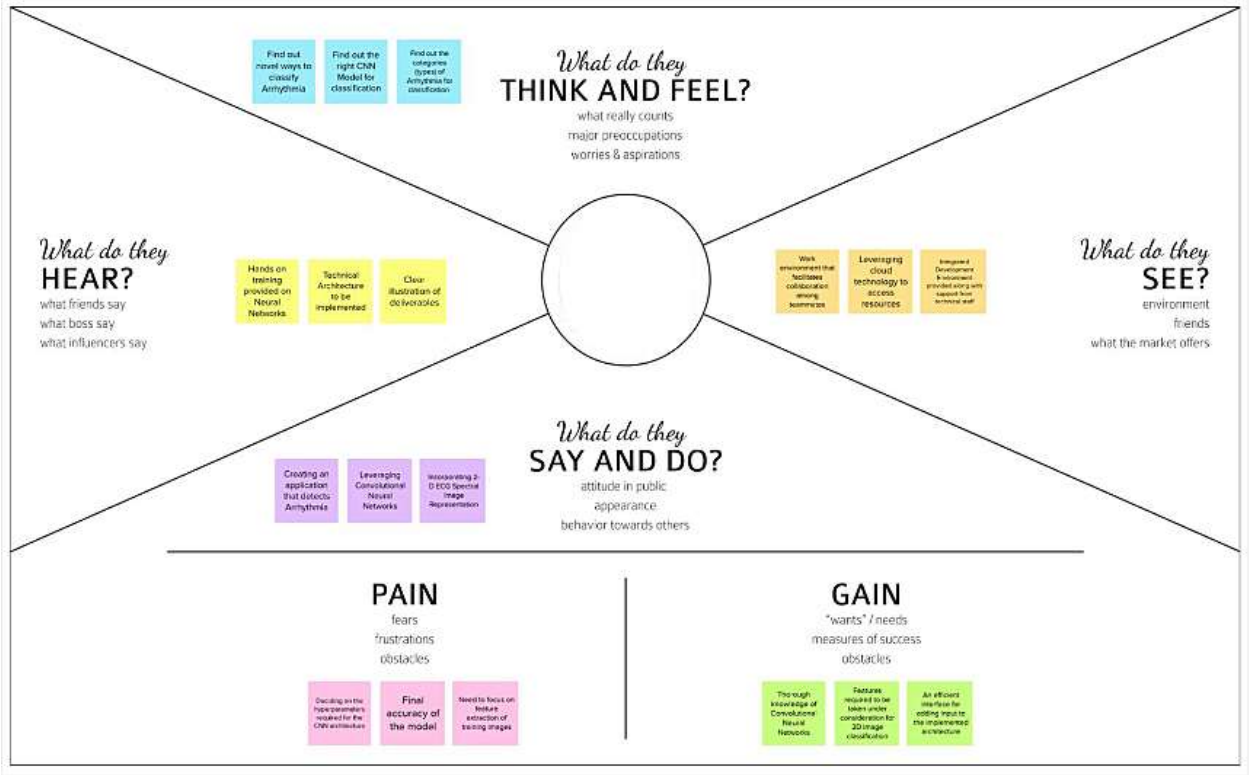
3. Problem Statement Definition

An "ambulatory electrocardiogram" or an ECG) about the size of a postcardor digital camera that the patient will be using for 1 to 2 days, or up to 2 weeks. The test measures the movement of electrical signals or waves through the heart. These signals tell the heart to contract (squeeze) and pump blood. The patient will have electrodes taped to your skin. It's painless, although some people have mild skin irritation from the tape usedto attach the electrodes to the

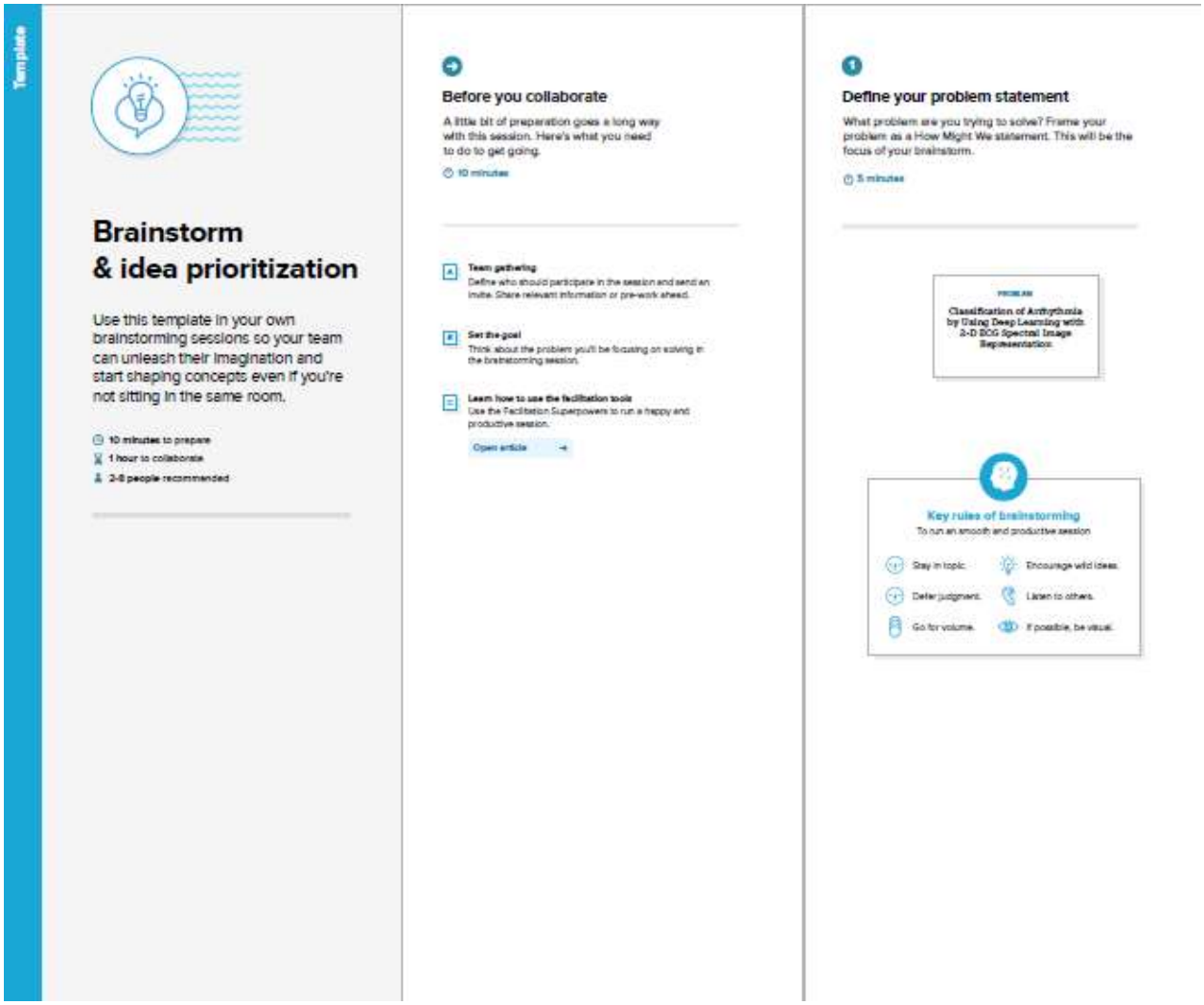
chest.They can do everything but shower or bathe while wearing the electrodes. After the test period, patient will go back to see your doctor.They will be downloading the information.

3. IDEATION & PROPOSED SOLUTION

1. Empathy Map Canvas



2. Ideation & Brainstorming



2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil (switch to sketch) icon to start drawing!

JEYA SUNDARI

- Helps to identify the types of Arrythmia
- It should not have any limited amount of users or data
- It should have full protection and security over the compesencity
- People must feel ease to use this model
- No age limits of patients for diagnosis
- Can give suggestion for patients also for obesity
- It should always have two step verification for correct results
- It should gain the satisfaction of both doctors and patients
- What will happen if the results are not accurate?

JOTHILAKSHMI M

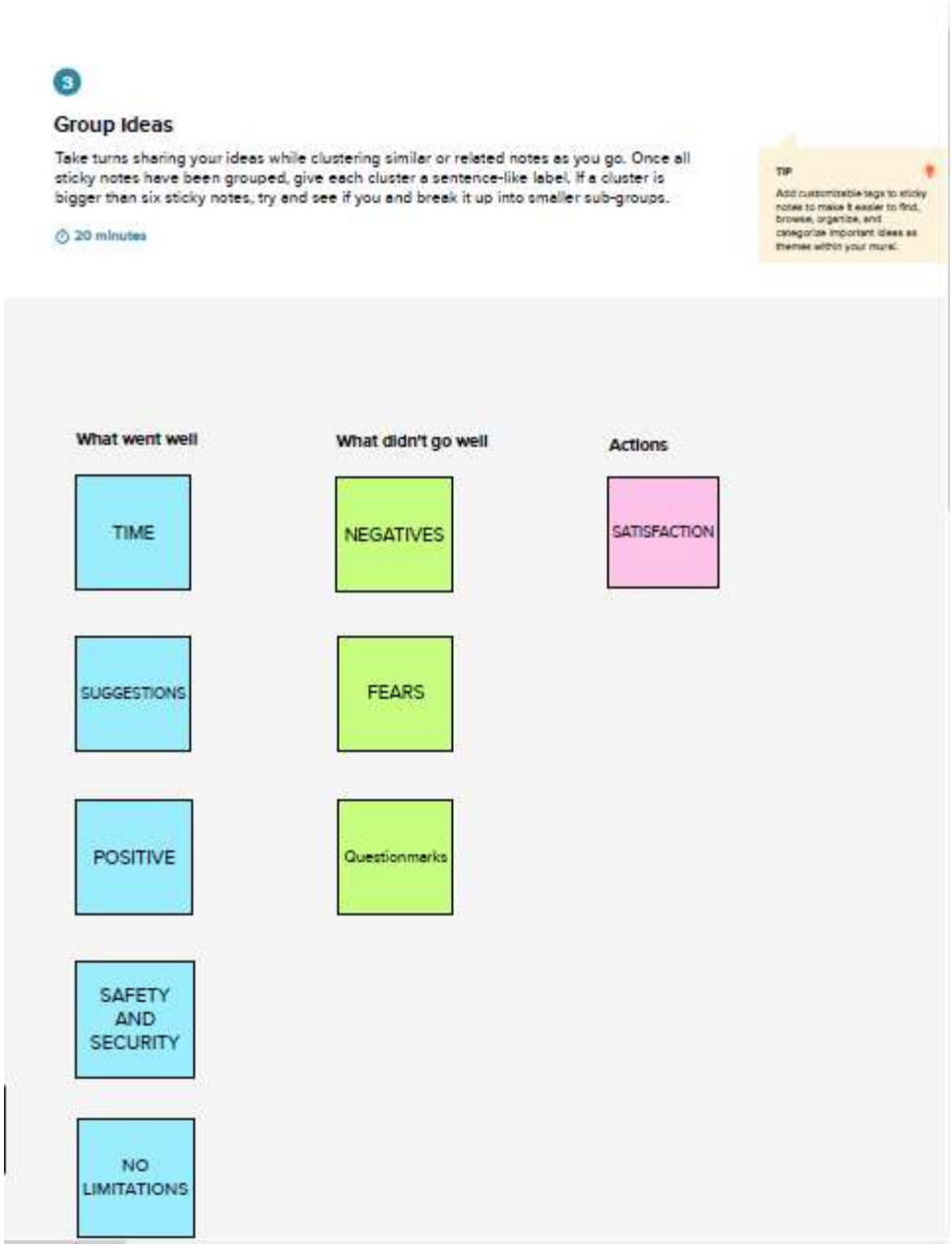
- Effective internal communication
- [illegible]
- It should always have patients care safety
- Adjust according to each patient
- Delivering more preventive care
- Remote access and availability
- Must be user constraint
- Provides more efficient management for the professionals
- Lifetime must be long

AHASH RAM R L

- Safe and Painless
- ECG test is cheap in cost
- Quick access
- Detection of various heart problems
- Less time consumption
- Doctors need to know about the patients medical history
- Measures outcome performance and metrices
- Must categorize the disease according to risk levels
- Must do more analysis for effective results

BUVANESH K K

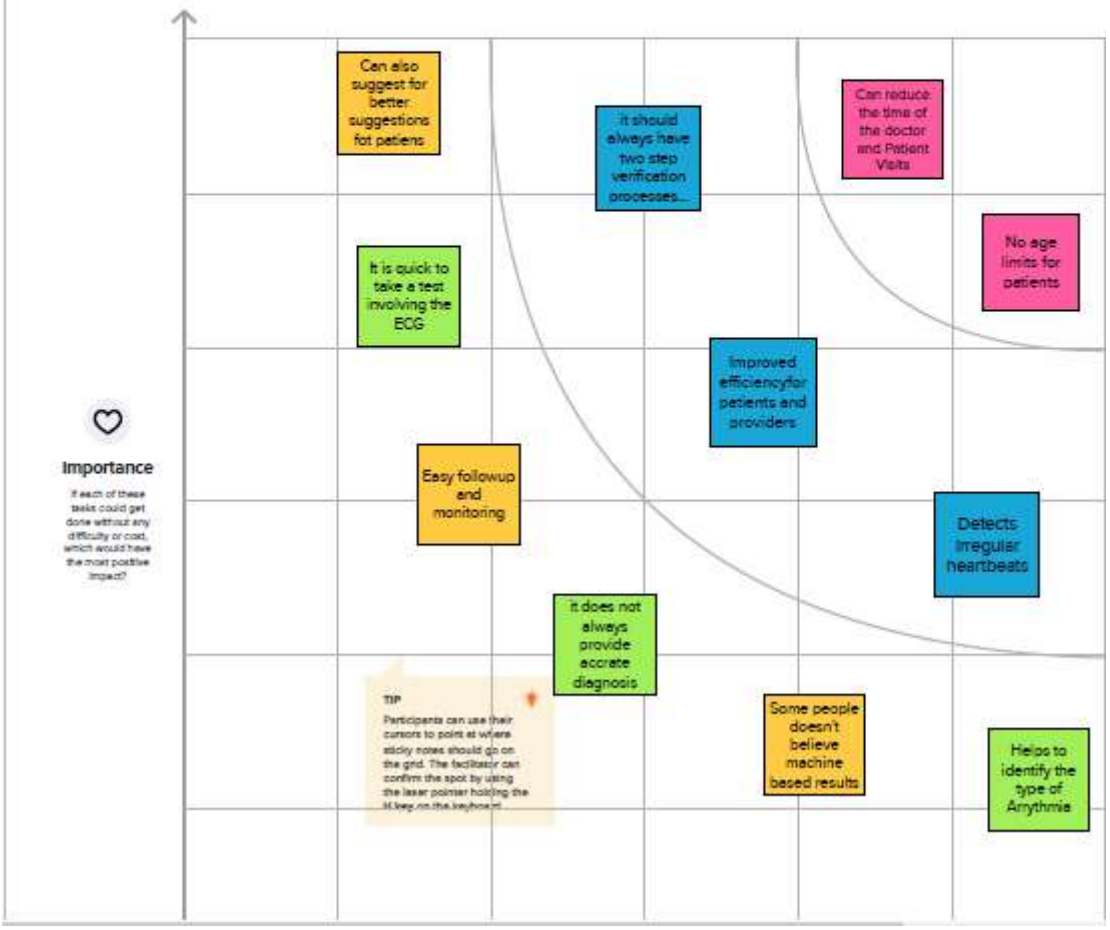
- Detection of irregular heartbeats
- Long term monitoring
- Checking the environment to the ECG to avoid meaningless alarm
- Multiple cardiac cycle available during data acquisition
- Poor electrodes can give poor results
- ECG uses wires and probes for testing, it may restrict the body movements
- Results can be obtained anytime
- Cheap in cost and efficient
- A life can be saved by early detection of disease


3
Group Ideas
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.
20 minutes
TIP
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.
What went well
What didn't go well
Actions
TIME
NEGATIVES
SATISFACTION
SUGGESTIONS
FEARS
POSITIVE
Questionmarks
SAFETY AND SECURITY
NO LIMITATIONS

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

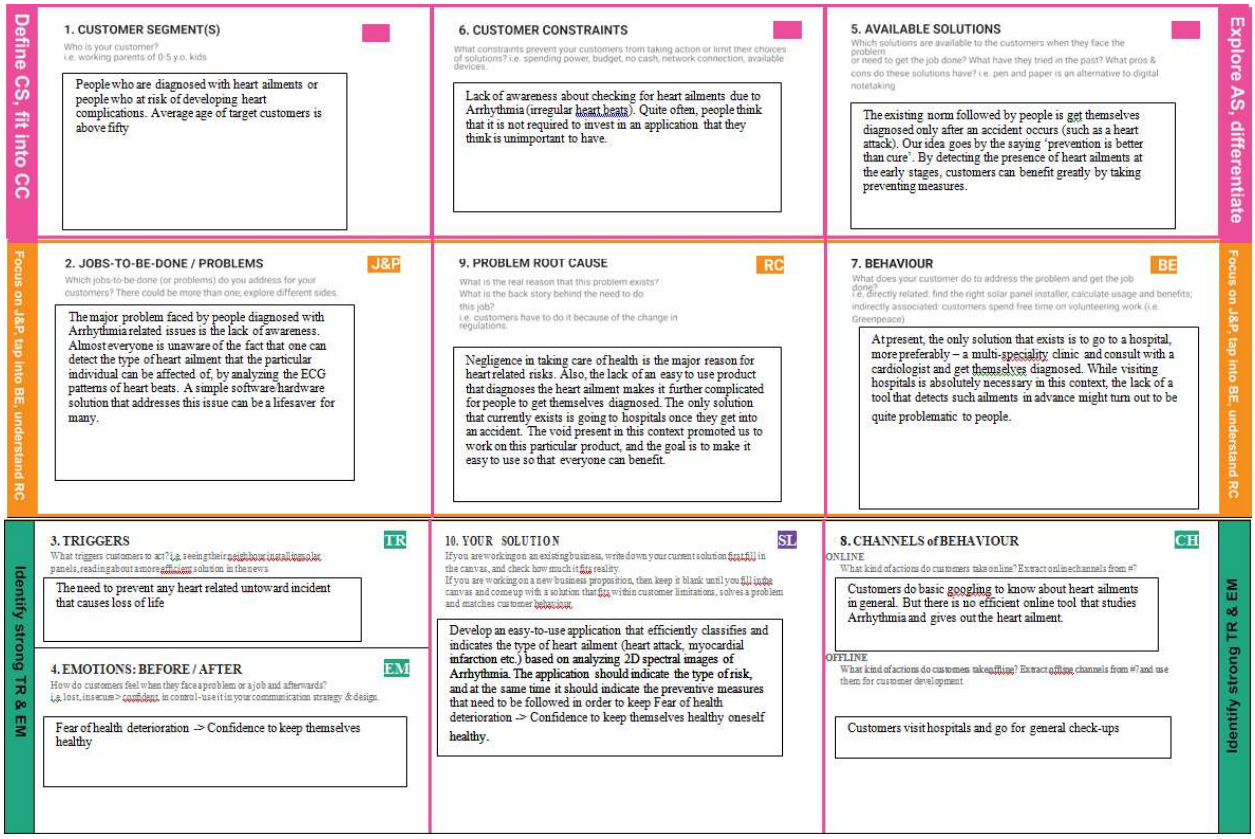
20 minutes



3. Proposed Solution

S.No. S.No	Parameter	Description
1.. 1.	Problem Statement (Problem to be solved)	A Deep Learning Model for analyzing 2-D ECG Spectral Images to classify various typesof arrhythmia.
2. 2.	Idea / Solution description	The ECG signals are pre processed by removing electromyographic noise using wavelet-based thresholding. An ECG signal isthen transformed into a 2-D representation using a 2D CNN model. Various architectures are analyzed in order to implement an efficientCNN model. This CNN model is intended to classify different types of Arrhythmias.
3. 3.	Novelty / Uniqueness	Our goal is to create an API that will be capable of handling inputs and producing the appropriate Arrhythmia class. Using thisAPI,you will be able to simulate a seamless user experience that is interactive.
4. 4.	Social Impact / Customer Satisfaction	Senior citizens represent the largest stakeholder group in this project. Customer's can benefit greatly from early diagnosis of heart ailments by learning about irregularitiesin ECG signals.
5. 5.	Business Model(Revenue Model)	The market does not contain any applicationsthat detect arrhythmia. The integration of ournovel product with a smart wearable device will enable us to launch a new line of smart devices that trackone's health.
6.6.	Scalability of the Solution	We can make our idea a reality by pitching it to AngelInvestors and Venture Capitalists and launching a full-fledged startup to market it.

4. Problem Solution fit



4. REQUIREMENT ANALYSIS

1. Functional requirement

FR No.	Functional Requirement(Epic)	Sub Requirement (Story/ Sub-Task)
FR-1	User Registration	Registration through FormRegistration via Gmail
FR-2	User Confirmation	Confirmation via e-mailConfirmation via OTP
FR-3	User selection	select the ECG image to be classified
FR-4	User input	Images need to be uploaded
FR-5	Save image	Images are saved in a folder for future reference
FR-6	Predict ECG image	User ECG images in our web application Collectionof data setsDatabase read ECGimages

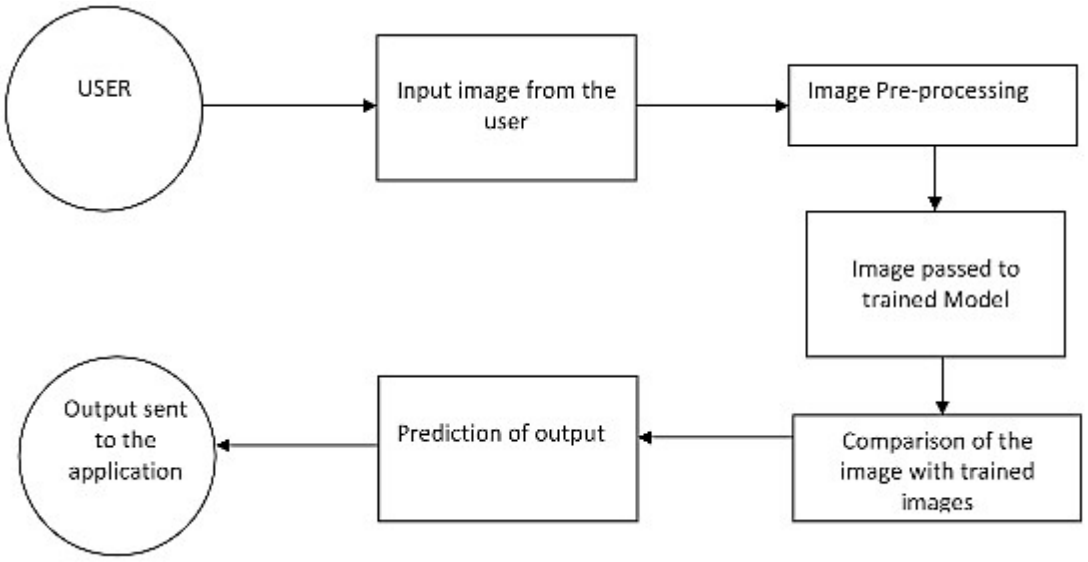
2. Non-Functional requirements

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	An user friendly and simple UI Webapplication . Easy drag and drop options
NFR-2	**Security**	No third party web and UI is used for predictio n of data Details about user interaction with the web application areprotected

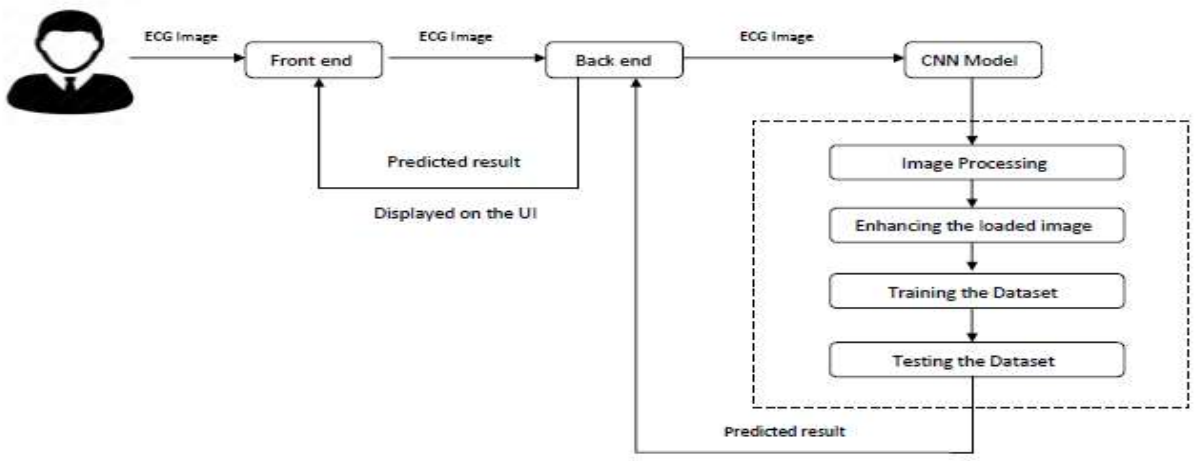
NFR-3	**Reliability**	Higher accuracy rateDefect free
NFR-4	**Performance**	Fast and quick classification of the requiredclass is done
NFR-5	**Availability**	Availability describes how likely the system is accessible to a user at a givenpoint in time and the periodically for a solutions.
NFR-6	**Scalability**	The ability of the user problem in arrhythmia disease to handle an increase in workload without performance degradation

5. PROJECT DESIGN

Data Flow Diagrams



2. Solution & Technical Architecture



3. User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Patient/Doctor (Web User)	Web interface	USN-1	As a user, I can access the web interface	I can login to my account	High	Sprint-1
Patient/Doctor (Web User)	Dashboard	USN-2	As a user, I can access the dashboard/homepage	I can view the homepage	High	Sprint-1
Patient/Doctor (Web User)	Types of Arrhythmia	USN-3	As a user, I can view various articles about different kinds of Arrhythmia	I can view the articles	Low	Sprint-1
Patient/Doctor (Web User)	Page Navigation	USN-4	As a user, I can access several tabs and pages on the interface	I can view different pages and navigate	Medium	Sprint-2
Patient/Doctor (Web User)	Info and About Page	USN-5	As a user, I can see the info and about pagefor the web interface	I can view the info and about page	Medium	Sprint-2
Patient/Doctor (Web User)	Page to send input	USN-6	As a user, I can see an option to upload input image of ECG	I can view the input page	High	Sprint-3
Patient/Doctor (Web User)	Prediction result page	USN-7	As a user, I can see the predicted result forthe given ECG image	I can view the prediction	High	Sprint-3
Patient/Doctor (Web User)	Type of Arrhythmia	USN-8	As a user, I can see the type of Arrhythmia	I can view the type of Arrhythmia page	High	Sprint-3
Patient/Doctor (Web User)	Side-effects page	USN-9	As a user, I can see the various side effects ofthe predicted Arrhythmia	I can view the side effects page	Low	Sprint-4
Patient/Doctor (Web User)	Prediction history page	USN-10	As a user, I can see the various predictions done in the past	I can view the prediction history page	Medium	Sprint-4
Patient/Doctor (Web User)	Type of CVD page	USN-11	As a user, I can see the predicted type ofCVD based on predicted arrhythmia	I can view the type of CVD page	High	Sprint-4
Administrator	Performance metrics	USN-12	As an administrator, I can see the number of people who are using the developed interface	I can view the performance metrics	Medium	Sprint-4

6. PROJECT PLANNING & SCHEDULING

1. Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Dataset Collection	USN-1	Collect the dataset for classification from sources available on the internet.	10	High	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-1	Image Preprocessing	USN-2	Remove noise present in the images collected and perform data pre-processing	10	High	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-2	Build the CNN Model	USN-3	Identify the appropriate layers required for the model and determine the model parameters	2	High	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-2	Configure the model	USN-4	Perform model configuration by compiling it and implement techniques for loss reduction	5	Medium	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-2	Train, test and validate	USN-5	Initiate model training phase, later based on modeland validation loss values, start test phase	13	High	Jeya Sundari Jothilakshmi M
Sprint-3	Register for IBM Cloud	USN-6	Set up IBM Watson Assistant with Cloud Service	2	High	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-3	Develop the web interface using Flask	USN-7	Design a UI for the web interface, with login, registration and input adding features	5	High	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K
Sprint-3	Perform server-side scripting	USN-8	Develop an application using python for back-end functions	13	Medium	Jeya Sundari Jothilakshmi M Ahash Ram R L Buvanesh K K

2. Sprint Delivery Plan

2.	Ideation Phase	Literature Survey	29 Aug 2022 - 03 Sept 2022
		Empathy Map	05 Sept 2022 - 7 Sept 2022
		Problem Statement	08 Sept 2022 - 10 Sept2022
		Ideation	12 Sept 2022 - 16 Sept 2022
3.	Project Design Phase -I	Proposed Solution	19 Sept 2022 - 23 Sept 2022
		Problem Solution Fit	24 Sept 2022 - 26 Sept 2022
		Solution Architecture	27 Sept 2022 - 30 Sept 2022
4.	Project Design Phase -II	Customer Journey	03 Oct 2022 - 08 Oct 2022
		Requirement Analysis	09 Oct 2022 - 11 Oct 2022
		Data Flow Diagrams	11 Oct 2022 - 14 Oct 2022
		Technology Architecture	15 Oct 2022 - 16 Oct 2022
5.	Project Planning Phase	Milestones & Tasks	17 Oct 2022 - 18 Oct 2022
		Sprint Schedules	19 Oct 2022 - 22 Oct 2022
6.	Project Development Phase	Sprint-1	24 Oct 2022 - 28 Oct 2022
		Sprint-2	30 Oct 2022 - 04 Nov 2022
		Sprint-3	06 Nov 2022- 11 Nov 2022
		Sprint-4	13 Nov 2022 - 18 Nov 2022
	Sprint-1	• Download The Dataset • Import Image-DataGenerator Library • Configure Image-DataGenerator class	24 Oct 2022 – 28 Oct 2022
	Sprint – 2	• Configure The LearningProcess • Build Python code • Adding Dense Layer • Adding CNN layer	30 Oct 2022 – 04 Nov 2022
	Sprint – 3	• Register IBM Cloud • Develop the web interface using Flask • Perform server-sidescripting	06 Nov 2022 –11 Nov 2022
	Sprint – 4	• Train the model on IBM • Create Html files • Integrate CNN Modelwith Web interface • Deployment and Testing	13 Nov 2022 –18 Nov 2022

7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**

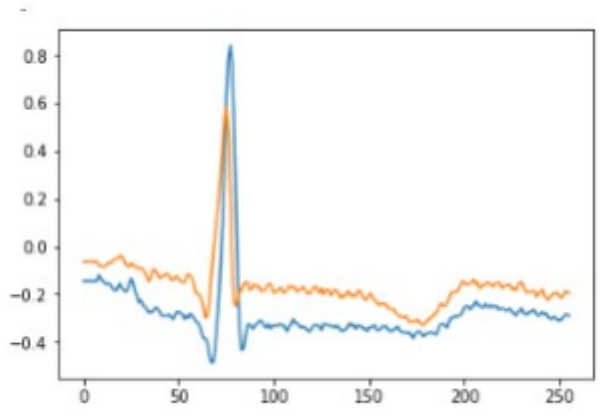
ROUTING FOR HTML PAGES

```
import os
import numpy as np
from flask import Flask, request, render_template, send_from_directory, make_response
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image

app = Flask(__name__,template_folder='template') #initializing a flask app
model=load_model('ECG.h5')

@app.route("/")
@app.route("/index.html")

def home():
    return render_template("index.html")
@app.route("/info.html")
def info():
    return render_template("info.html")
@app.route("/predict.html", methods=['GET', 'POST'])
def upload():
    if request.method=="POST":
        f=request.files['file']
        basepath=os.path.dirname('__file__')
        filepath=os.path.join(basepath,"uploads",f.filename)
        f.save(filepath)
        img=load_img(filepath,target_size=(64,64))
```

```
        x=img_to_array(img)
        x=np.expand_dims(x,axis=0)
        pred=model.predict_classes(x)
        print("prediction",pred)
        index=['Left Bundle Branch Block','Normal','Premature Atrial Contraction','Premature Ventricular Contraction','Right Bundle Branch Block','Ventricular Fibrillation']
        result=str(index[pred[0]])
        return result
        return render_template("predict.html")
def favicon():
    return send_from_directory(os.path.join(app.root_path, 'static'),
                               'favicon.ico', mimetype='image/vnd.microsoft.icon')


if __name__ == "__main__":
   app.run(debug=True)
```

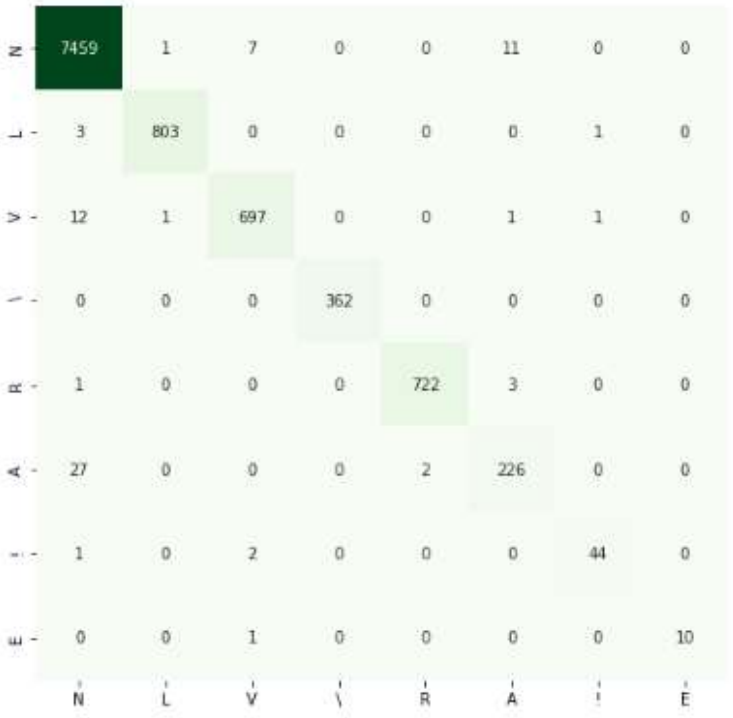
8. RESULTS

ACCURACY OF THE TRAINED MODEL



1. Confusion Matrix:

```
In [22]: ax = sns.heatmap(confusion_matrix(gt, preds), annot=True, cmap="Greens", fmt='g',
                          xticklabels=mapping.keys(), yticklabels=mapping.keys(), cbar=False, square=False)
```



9. ADVANTAGES

1. The proposed model predictsArrhythmia in images with a highaccuracy rate of nearly 86%
2. The early detection of Arrhythmia gives better understanding ofdisease causes, initiates therapeutic interventions and enablesdeveloping appropriate treatments.

DISADVANTAGES

1. Not useful for identifying the different stagesof Arrhythmia disease.
2. Not useful in monitoring motor symptoms

10. CONCLUSION

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

2. Unfortunately, the expert level of medical resources is rare, visuallyidentify the ECG signalis challenging and time-consuming.
3. The advantages of the proposedCNN network have been put toevidence.
4. It is endowed with an ability to effectively process the non-filtered dataset with its potential anti-noise features. Besides that, ten-foldcross-validation is implemented in this work to further demonstratethe robustness of the network.

11. 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 and we believe that with the implementation of the optimization, it will be able to further elevate the performance of the proposedsolution to the next level.

12. APPENDIX

Source Code

MODEL BUILDING:

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator

train_datagen = ImageDataGenerator(rescale = 1./255, horizontal_flip = True, vertical_flip = True, zoom_range = 0.2)

test_datagen = ImageDataGenerator(rescale = 1./255)

x_train = train_datagen.flow_from_directory("C:/Users/Admin/Desktop/data/train", target_size = (64,64), batch_size = 100, class_mode = "categorical")


x_test = test_datagen.flow_from_directory("C:/Users/Admin/Desktop/data/test", target_size = (64,64), batch_size = 100, class_mode = "categorical")
```

```
x_train.class_indices
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Convolution2D
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Dense
```

Initializing the Model

```
model = Sequential()

model.add(Convolution2D(32, (3,3), input_shape = (64,64,3), activation = "relu"))

model.add(MaxPooling2D(pool_size = (2,2)))

model.add(Convolution2D(32, (3,3), activation = "relu"))

model.add(MaxPooling2D(pool_size = (2,2)))

model.add(Flatten())

model.add(Dense(units=128, kernel_initializer='random_uniform', activation="relu"))

model.add(Dense(units=128, kernel_initializer='random_uniform', activation="relu"))

model.add(Dense(units=128, kernel_initializer='random_uniform', activation="relu"))

model.add(Dense(units=128, kernel_initializer='random_uniform', activation="relu"))

model.add(Dense(units=128, kernel_initializer='random_uniform', activation="relu"))
```

```
model.add(Dense(units=6, kernel_initializer='random_uniform', activation="softmax"))


model.summary()

model.compile(optimizer = "Adam", loss = "categorical_crossentropy", metrics = ["accuracy"])

model.fit(x_train, steps_per_epoch = len(x_train), epochs=9, validation_data=x_test,\
          validation_steps = len(x_test))

model.save('ECG.h5')

from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image


model = load_model("ECG.h5")
img = image.load_img("C:/Users/Admin/Desktop/data/prediction/fig_2114-n.png", target_size =
(64,64))

x = image.img_to_array(img)

import numpy as np


x = np.expand_dims(x,axis = 0)


pred = model.predict(x)
y_pred=np.argmax(pred)
y_pred
index=['Left Bundle Branch Block',
    'Normal',
    'Premature Atrial Contraction',
    'Premature Ventricular Contractions',
    'Right Bundle Branch Block',
    'Ventricular Fibrillation']
```

result = str(index[y_pred])

result

TRAINING THE MODEL ON IBM:

In [29]:
```
!tar -zcvf ECG-arrhythmia-classification-model_new.tgz ECG.h5
```

```
ECG.h5
```

In [30]:
```
ls -1
```

```
data/
ECG-arrhythmia-classification-model_new.tgz
ECG.h5
```

In [31]:
```
!pip install watson-machine-learning-client --upgrade
```

```
Collecting watson-machine-learning-client
  Downloading watson_machine_learning_client-1.0.391-py3-none-any.whl (538 kB)
```

In [33]:
```
from ibm_watson_machine_learning import APIClient
wml_credentials={
    "url":"https://us-south.ml.cloud.ibm.com",
    "apikey":"XKr8dWsa1JPjnDh8Xf5E--Uv3Ef_vdN2deYyEdj2rEth"
}
client=APIClient(wml_credentials)
```

In [34]:
```
client=APIClient(wml_credentials)
```

In [36]:
```
def guid_from_space_name(client, space_name):
    space = client_spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']["name"] == space_name)['metadata']['id'])
```

In [37]:
```
client.spaces.list()
```

```
Note: 'limit' is not provided. Only first 50 records will be displayed if the number of records exceed 50
------------------------------------  --------------  ------------------------
ID                                    NAME            CREATED
1a6dcfa8-a632-4da1-b2e3-1e28f2cc97a3  Classification  2022-11-15T13:02:02.173Z
------------------------------------  --------------  ------------------------
```

In [38]:
```
space_uid='1a6dcfa8-a632-4da1-b2e3-1e28f2cc97a3'
```

In [39]:
```
client.set.default_space(space_uid)
```

Out[39]:
```
'SUCCESS'
```

In [40]:
```
client.software_specifications.list()
```

```
In [43]: model_id

Out[43]: '0f611e10-dcf0-4a70-b8c8-6c5269bde33c'

In [44]: client.repository.download(model_id,'my_model.tar.gz')

         Successfully saved model content to file: 'my_model.tar.gz'
Out[44]: '/home/wsuser/work/my_model.tar.gz'
```

HTML CODES:

INDEX.HTML:

```
<!DOCTYPE html>
<html lang="en">
<head>
   <meta charset="UTF-8">
   <title>Home</title>
   <link rel="stylesheet" href="index.css">
   <link rel="preconnect" href="https://fonts.googleapis.com">
<link rel="preconnect" href="https://fonts.gstatic.com" cross origin>
<link
href="https://fonts.googleapis.com/css2?family=Dancing+Script&family=Edu+NSW+ACT+Fou
ndation:wght@500&display=swap" rel="stylesheet">
   <script src="predict.js"></script>
   <link rel="shortcut icon" href="favicon.ico">

<style>

a{
   text-decoration: None;
}

body{
```

```
    background-image:
url('https://images.hindustantimes.com/img/2022/06/30/550x309/6b242762-f891-11ec-8608-
e101559032f3_1656606499620.jpg');
    background-repeat: no-repeat;
    background-size: 1560px 800px;
}
a:visited{
    color: black;
}
.nav-div{
    margin: 0;
    background: #ffffff;
    border-radius: 5px;

}
nav{
    display: flex;
    justify-content: flex-end;
}

.active{
    color: blue;
}

.nav-tab{
    margin-top: 15px;
    margin-bottom: 15px;
    margin-left: 20px;
    cursor: pointer;
}
.nav-tab-last{
```

```
    margin-right: 50px;
}

.home-heading{
    display: flex;
    color: #000000;
    margin: 0;
    justify-content: center;
    font-family: 'Gabriola', sans-serif;
}

.home-content-para{
    display: flex;
    color: white;
    margin: 0;
    align-items: center;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 26px;
}
.home-content{
    margin: 50px;
    background-color: rgb(79, 78, 78);
    border: 1px solid black;
    border-radius: 16px;
    opacity: 93%;
}
.predict-content{
    display: flex;
```

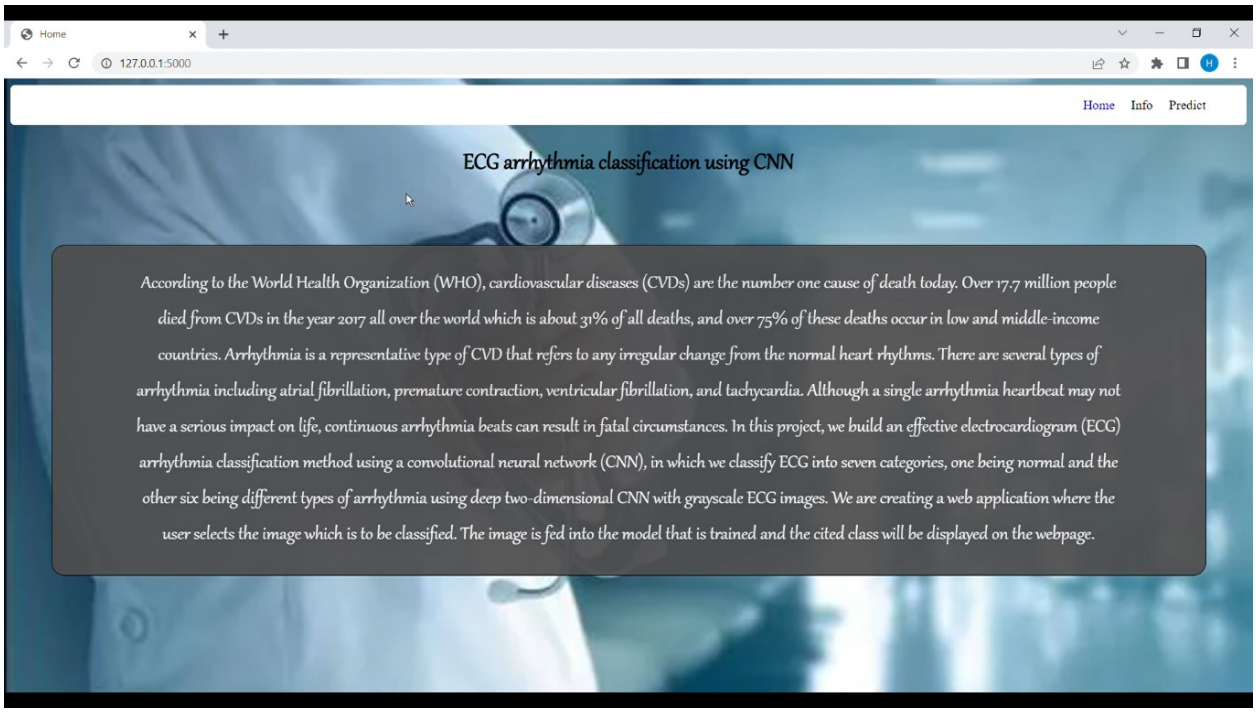
```
    color: white;
    margin-left: 500px;
    margin-right: 500px;
    border-radius: 16px;
    opacity: 70%;
    justify-content: center;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 20px;
    background: #595858;
}
.btn {
    border: none;
    color: black;
    padding: 15px 32px;
    text-align: center;
    text-decoration: none;
    display: inline-block;
    font-size: 16px;
    cursor: pointer;
    margin: 20px;
    border-radius: 16px;
}
.btn-choose {
    background-color: white;
}
.btn-predict{
    color: white;
    background-color: palevioletred;
}
```

```
.info-content{
    margin : 30px;
    padding: 10px;
    background-color: rgb(66, 66, 66);
    opacity: 0.8;
    display: flex;
    border-radius: 16px;
}


.content,.image{
    flex: 50%;
    margin: 30px;
}

.image{
    display: flex;
    flex-direction: row;
    justify-content: space-around;
    align-items: center;
    padding: 30px;
}

.info-content-heading{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 30px;
    margin: 0 0 20px;
```

```
}
.info-content-para{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: justify;
    font-size: 26px;
}
.info-content-picture{
    margin:0;
}
</style>
</head>
<body>
<div class="bg_image_body"></div>
<div class="nav-div">
    <nav class="index-nav">
    <a class="active nav-tab">Home</a>
    <a class="nav-tab" href="info.html">Info</a>
    <a class="nav-tab nav-tab-last" href="predict.html">Predict</a>
    </nav>
</div>
<div class="home-heading">
    <h1>ECG arrhythmia classification using CNN</h1>
</div>
<div class="home-content">
    <div class="home-content-para">
        <p>
            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.

```
      </p>
   </div>
</div>
</body>
</html>
```



INFO.HTML:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <title>Info</title>
  <link rel="stylesheet" href="index.css">
<style>
a{
    text-decoration: None;
}
body{
  background-image:
url('https://images.hindustantimes.com/img/2022/06/30/550x309/6b242762-f891-11ec-8608-
e101559032f3_1656606499620.jpg');
    background-repeat: no-repeat;
    background-size: 1560px 2800px;
}
a:visited{
    color: black;
}
.nav-div{
    margin: 0;
    background: #ffffff;
    border-radius: 5px;

}
nav{
    display: flex;
    justify-content: flex-end;
}
```

```
.active{
    color: blue;
}

.nav-tab{
    margin-top: 15px;
    margin-bottom: 15px;
    margin-left: 20px;
    cursor: pointer;
}
.nav-tab-last{
    margin-right: 50px;
}

.home-heading{
    display: flex;
    color: #000000;
    margin: 0;
    justify-content: center;
    font-family: 'Gabriola', sans-serif;
}

.home-content-para{
    display: flex;
    color: white;
    margin: 0;
    align-items: center;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
```

```
    text-align: center;
    font-size: 26px;
}
.home-content{
    margin: 50px;
    background-color: rgb(79, 78, 78);
    border: 1px solid black;
    border-radius: 16px;
    opacity: 93%;
}
.predict-content{
    display: flex;
    color: white;
    margin-left: 500px;
    margin-right: 500px;
    border-radius: 16px;
    opacity: 70%;
    justify-content: center;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 20px;
    background: #595858;
}
.btn {
    border: none;
    color: black;
    padding: 15px 32px;
    text-align: center;
    text-decoration: none;
    display: inline-block;
```

```
    font-size: 16px;
    cursor: pointer;
    margin: 20px;
    border-radius: 16px;
}
.btn-choose {
    background-color: white;
}
.btn-predict{
    color: white;
    background-color: palevioletred;
}
.info-content{
    margin : 30px;
    padding: 10px;
    background-color: rgb(66, 66, 66);
    opacity: 0.8;
    display: flex;
    border-radius: 16px;
}


.content,.image{
    flex: 50%;
    margin: 30px;
}

.image{
    display: flex;
    flex-direction: row;
    justify-content: space-around;
```

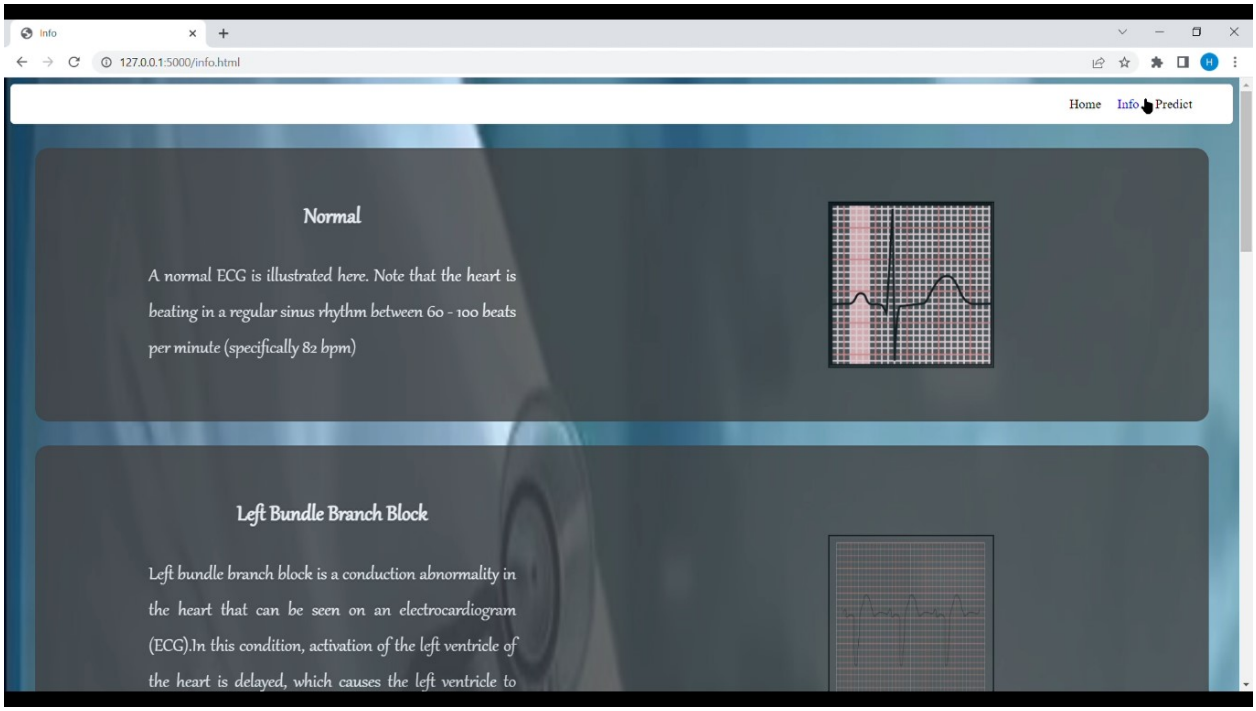
```
    align-items: center;
    padding: 30px;
}

.info-content-heading{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 30px;
    margin: 0 0 20px;
}
.info-content-para{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: justify;
    font-size: 26px;
}
.info-content-picture{
    margin:0;
}

</style>


</head>
<body>
<div class="nav-div">
```

```
    <nav class="index-nav">
    <a class="nav-tab" href="index.html">Home</a>
    <a class="active nav-tab">Info</a>
    <a class="nav-tab nav-tab-last" href="predict.html">Predict</a>
    </nav>
</div>
<div class="info-content">
  <div class="content">
    <h2><p class="info-content-heading">Normal</p></h2>
    <p class="info-content-para">
      A normal ECG is illustrated here. Note that the heart
      is beating in a regular sinus rhythm between 60 - 100
      beats per minute (specifically 82 bpm)
    </p>
  </div>
  <div class="image info-content-picture">
    <img
src="https://upload.wikimedia.org/wikipedia/commons/thumb/e/ed/Normal_P_wave_%28ECG
%29.svg/1024px-Normal_P_wave_%28ECG%29.svg.png"     height="200px"     width="200px"
style="border: 2px solid black;"/>
  </div>
</div>
<div class="info-content">
  <div class="content">
    <h2><p class="info-content-heading">Left Bundle Branch Block</p></h2>
    <p class="info-content-para">
      Left bundle branch block is a conduction abnormality in the heart
      that can be seen on an electrocardiogram (ECG).In this condition,
      activation of the left ventricle of the heart is delayed, which
      causes the left ventricle to contract later than the image ventricle.
    </p>
```

```
 </div>
 <div class="image info-content-picture">
  <img
src="https://upload.wikimedia.org/wikipedia/commons/thumb/a/af/Left_bundle_branch_block.svg/1200px-Left_bundle_branch_block.svg.png" height="200px" width="200px" style="border: 2px solid black;"/>
 </div>
</div>
<div class="info-content">
 <div class="content">
  <h2><p class="info-content-heading">Premature Atrial Contraction</p></h2>
  <p class="info-content-para">
   Premature atrial contractions are extra heartbeats that begin in one of
   your heart's two upper chambers (atria). These extra beats disrupt your
   regular heart rhythm.
  </p>
 </div>
 <div class="image info-content-picture">
  <img src="https://www.wikidoc.org/images/5/55/Rhythm_premature.png" height="200px"
width="200px" style="border: 2px solid black;"/>
 </div>
</div>
<div class="info-content">
 <div class="content">
  <h2><p class="info-content-heading">Premature Ventricular Contractions</p></h2>
  <p class="info-content-para">
   Premature ventricular contractions (PVCs) are extra heartbeats that begin
   in one of the heart's two lower pumping chambers (ventricles). These extra
   beats disrupt the regular heart rhythm, sometimes causing a sensation of a
   fluttering or a skipped beat in the chest.
  </p>
```

```
 </div>
 <div class="image info-content-picture">
  <img src="https://images.saymedia-content.com/.image/t_share/MTc2MjcwMTkzMjk3NzI4Njg1/cardiac-arrhythmias-premature-ventricular-contraction-the-skipped-beat.png" height="200px" width="200px" style="border: 2px solid black;"/>
 </div>
</div>
<div class="info-content">
 <div class="content">
  <h2><p class="info-content-heading">Right Bundle Branch Block</p></h2>
  <p class="info-content-para">
   A right bundle branch block (RBBB) is a heart block in the right bundle branch
   of the electrical conduction system. During a right bundle branch block, the
   right ventricle is not directly activated by impulses travelling through the
   right bundle branch. The left ventricle, however, is still normally activated
   by the left bundle branch.
  </p>
 </div>
 <div class="image info-content-picture">
  <img src="https://ddxof.com/wp-content/uploads/2017/11/Right-Bundle-Branch-Block-Part-2.png" height="200px" width="200px" style="border: 2px solid black;"/>
 </div>
</div>
<div class="info-content">
 <div class="content">
  <h2><p class="info-content-heading">Ventricular Fibrillation</p></h2>
  <p class="info-content-para">
   Ventricular fibrillation is a type of abnormal heart rhythm (arrhythmia). During
    ventricular fibrillation, disorganized heart signals cause the lower heart chambers
    (ventricles) to twitch (quiver) uselessly. As a result, the heart doesn't pump
```

```
        blood to the rest of the body.
    </p>
  </div>
  <div class="image info-content-picture">
    <img        src="https://image.shutterstock.com/image-vector/ecg-line-ventricular-fibrillation-6-
260nw-2176606289.jpg" height="200px" width="200px" style="border: 2px solid black;"/>
  </div>
</div>
</body>
</html>
```



PREDICT.HTML:

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="UTF-8">
        <title>Predict</title>
    <link rel="stylesheet" href="index.css">
    <script src="predict.js"></script>

    <style>

a{
    text-decoration: None;
}

body{
    background-image:
url('https://images.hindustantimes.com/img/2022/06/30/550x309/6b242762-f891-11ec-8608-
e101559032f3_1656606499620.jpg');
    background-repeat: no-repeat;
    background-size: 1560px 800px;
}
a:visited{
    color: black;
}
.nav-div{
    margin: 0;
    background: #ffffff;
    border-radius: 5px;
```

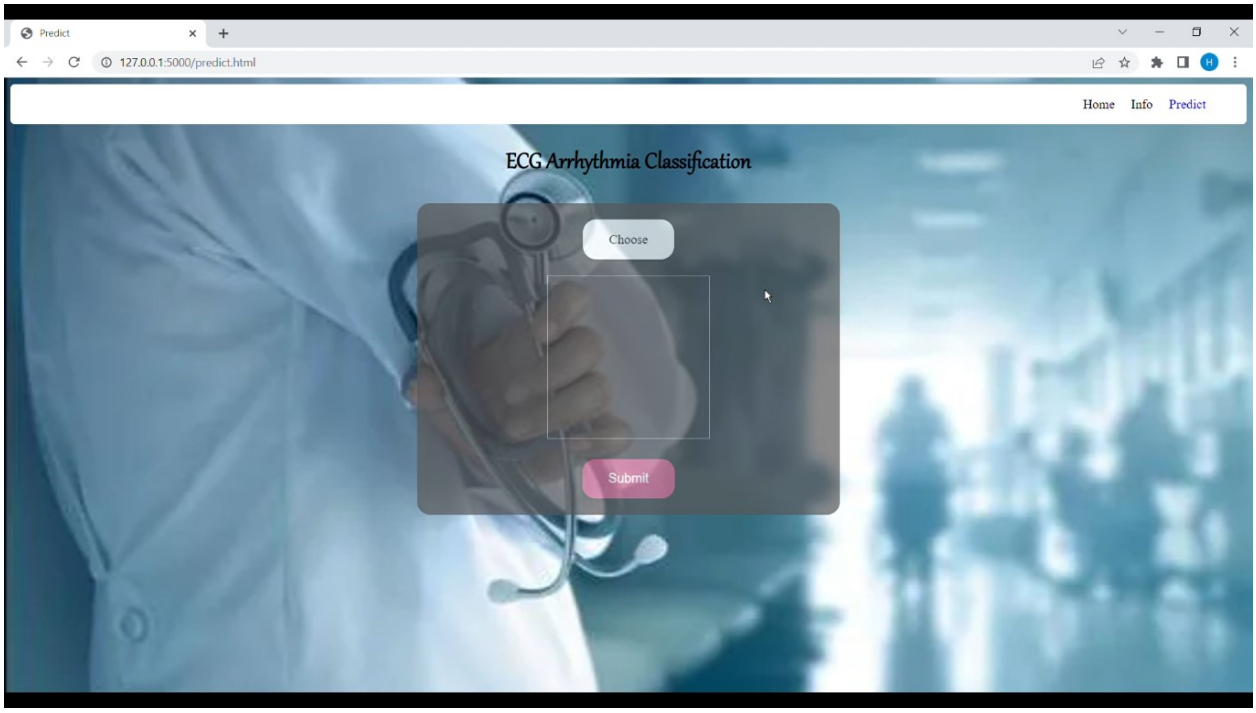
```
}
nav{
    display: flex;
    justify-content: flex-end;
}

.active{
    color: blue;
}

.nav-tab{
    margin-top: 15px;
    margin-bottom: 15px;
    margin-left: 20px;
    cursor: pointer;
}
.nav-tab-last{
    margin-right: 50px;
}

.home-heading{
    display: flex;
    color: #000000;
    margin: 0;
    justify-content: center;
    font-family: 'Gabriola', sans-serif;
}

.home-content-para{
    display: flex;
```

```
    color: white;
    margin: 0;
    align-items: center;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 26px;
}
.home-content{
    margin: 50px;
    background-color: rgb(79, 78, 78);
    border: 1px solid black;
    border-radius: 16px;
    opacity: 93%;
}
.predict-content{
    display: flex;
    color: white;
    margin-left: 500px;
    margin-right: 500px;
    border-radius: 16px;
    opacity: 70%;
    justify-content: center;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 20px;
    background: #595858;
}
.btn {
```

```
    border: none;
    color: black;
    padding: 15px 32px;
    text-align: center;
    text-decoration: none;
    display: inline-block;
    font-size: 16px;
    cursor: pointer;
    margin: 20px;
    border-radius: 16px;
}
.btn-choose {
    background-color: white;
}
.btn-predict{
    color: white;
    background-color: palevioletred;
}
.info-content{
    margin : 30px;
    padding: 10px;
    background-color: rgb(66, 66, 66);
    opacity: 0.8;
    display: flex;
    border-radius: 16px;
}
.content,.image{
    flex: 50%;
    margin: 30px;
}
.image{
```

```
    display: flex;
    flex-direction: row;
    justify-content: space-around;
    align-items: center;
    padding: 30px;
}

.info-content-heading{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: center;
    font-size: 30px;
    margin: 0 0 20px;
}
.info-content-para{
    color: #ffffff;
    font-family: 'Gabriola', sans-serif;
    padding-left: 100px;
    padding-right: 100px;
    text-align: justify;
    font-size: 26px;
}
.info-content-picture{
    margin:0;
}
    </style>
    </head>
    <body>
        <div class="nav-div">
```

```
        <nav class="index-nav">
        <a class="nav-tab" href="index.html">Home</a>
        <a class="nav-tab" href="info.html">Info</a>
        <a class="active nav-tab nav-tab-last">Predict</a>
        </nav>
      </div>
      <div class="home-heading">
        <h1>ECG Arrhythmia Classification</h1>
      </div>
      <div class="predict-content">
        <form id="predict_form" action="premature_atrial_contraction.html"
enctype="multipart/form-data">
          <input type="file" accept="image/*" name="image"
id="file" onchange="loadFile(event)" style="display: none;" />
          <label for="file" class="btn btn-choose">Choose</label><br/>
          <img id="output" width="200" height="200" style="border: none;"/><br/>
          <input class="btn btn-predict" type="submit" onclick="clickEvent()">
          <script>
     function clickEvent(){
     }
   let loadFile = function(event) {
   const image = document.getElementById('output');
   image.src = URL.createObjectURL(event.target.files[0]);
      };
          </script>
        </form>
      </div>
   </body>
</html>
```

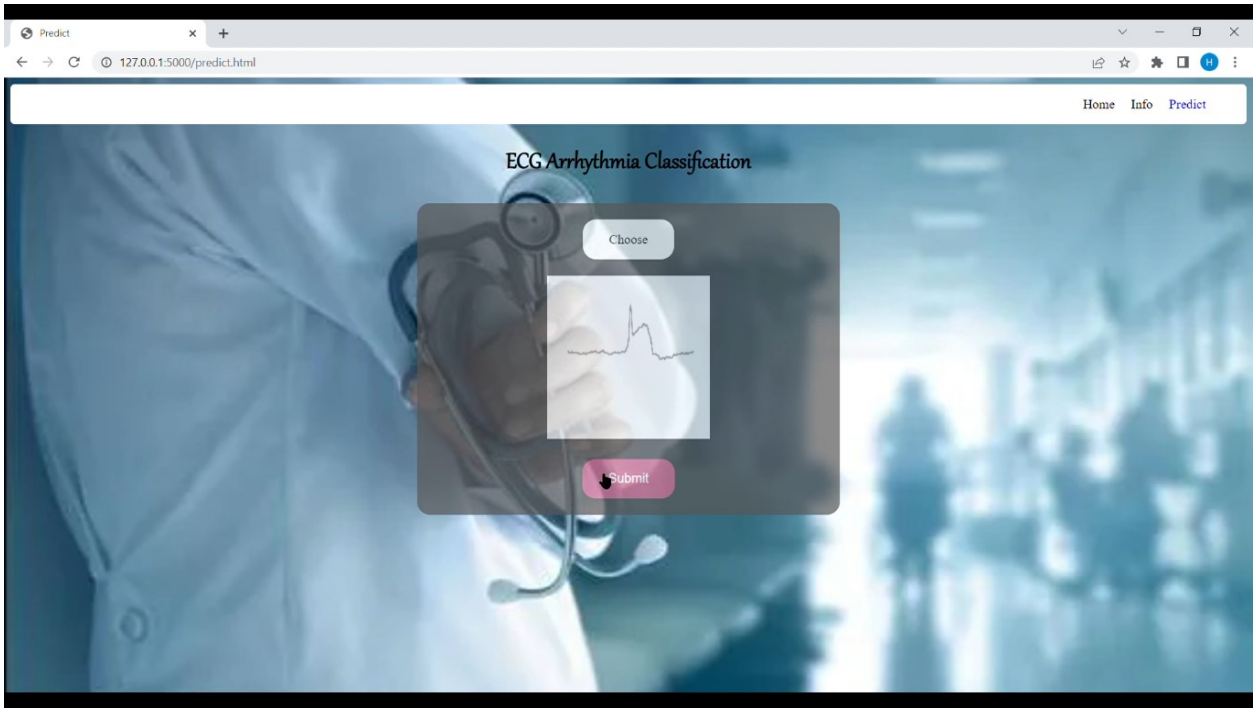


app.py file:

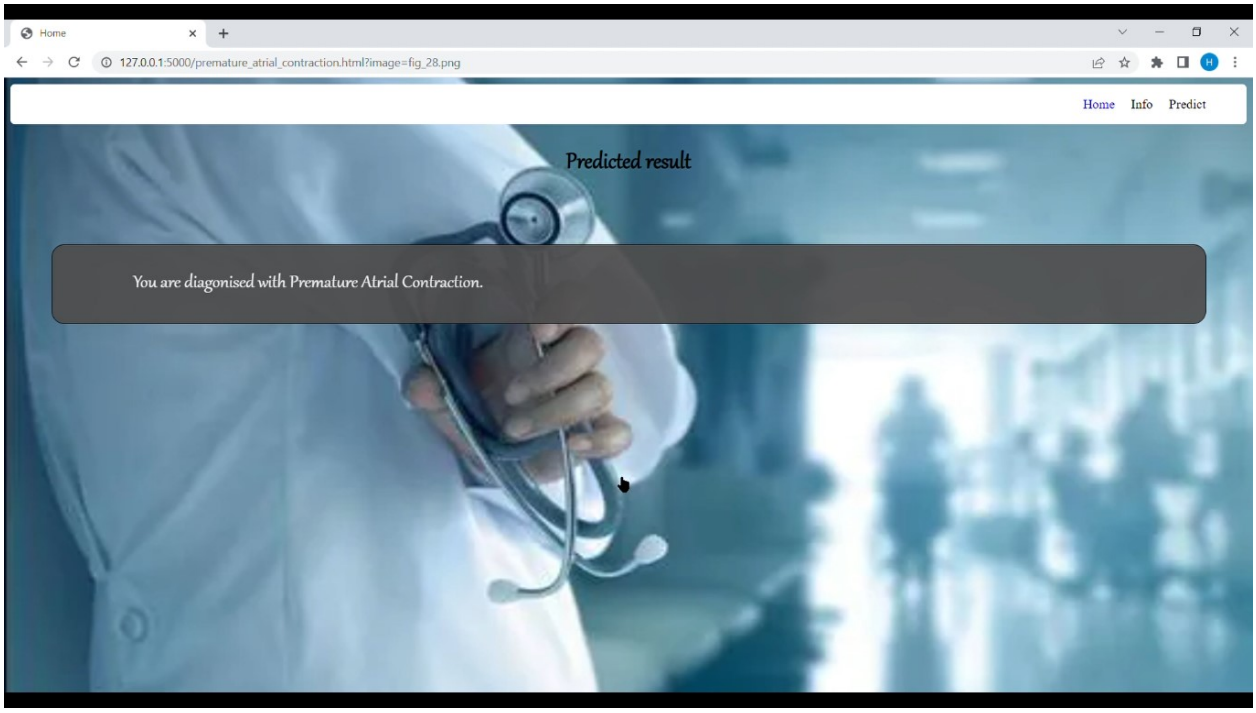
```
import os
import numpy as np
from flask import Flask, request, render_template, send_from_directory, make_response
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image

app = Flask(__name__,template_folder='template') #initializing a flask app
model=load_model('ECG.h5')

@app.route("/")
@app.route("/index.html")

def home():
    return render_template("index.html")
@app.route("/info.html")
```

```
def info():
    return render_template("info.html")
@app.route("/predict.html", methods=['GET', 'POST'])
def upload():
    if request.method=="POST":
        f=request.files['file']
        basepath=os.path.dirname('__file__')
        filepath=os.path.join(basepath,"uploads",f.filename)
        f.save(filepath)
        img=load_img(filepath,target_size=(64,64))
        x=img_to_array(img)
        x=np.expand_dims(x,axis=0)
        pred=model.predict_classes(x)
        print("prediction",pred)
        index=['Left Bundle Branch Block','Normal','Premature Atrial Contraction','Premature Ventricular Contraction','Right Bundle Branch Block','Ventricular Fibrillation']
        result=str(index[pred[0]])
        return result
        return render_template("predict.html")
def favicon():
    return send_from_directory(os.path.join(app.root_path, 'static'),
                               'favicon.ico', mimetype='image/vnd.microsoft.icon')


if __name__ == "__main__":
    app.run(debug=True)
```

GIVING USER INPUT:


Predict
127.0.0.1:5000/predict.html
Home
Info
Predict
ECG Arrhythmia Classification
Choose
Submit

OUTPUT:



GitHub Repository Link:

https://github.com/IBM-EPBL/IBM-Project-19183-1659694105

Project Demo Link:

https://drive.google.com/file/d/1aMzy28m1vW0lh9aTJCfN6odTEB9kUaYe/view?usp=share_link