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

TEAM ID:PNT 2022TMID35787

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1.INTRODUCTION

1.1 Project overview

The electrocardiogram (ECG) is one of the most extensively employed signals used in the diagnosis and 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 crucial for precise diagnoses of patients' acute and chronic heart conditions. In this project, we propose VGG-19 model for the classification of ECG signals into six classes; namely, normal beat, premature ventricular contraction beat, premature atrial contraction beat, right bundle branch block beat, left bundle branch block beat,right bundle branch block beat,ventricular fibrillation.Our proposed methodology is evaluated on a publicly available MIT-BIH arrhythmia dataset. We achieved a state-of-the-art average classification accuracy of 91% .The performance is significant in other indices as well, including sensitivity and specificity, which indicates the success of the proposed method. It is not only used to look for pathological patterns among the heartbeats,but also used to measurethe beats regularity as other conditions like mental stress. Deep Neural Network has been widely used for classification and prediction purposes in different domains.

1.2 Purpose

It is not only used to look for pathological patterns among the heartbeats,but also used to measure the beats regularity as other conditions like mental stress.

It is used to classify six types of arrhythmia which is,

1. Left Bundle Branch Block
2.Normal
3.Premature Atrial Contraction

4. Premature Ventricular Contraction
5. Right Bundle Branch Block
6.Ventricular Fibrillation

Convolution Neural Network has been widely used for classification and prediction purposes in different domains.

2.LITERATURE SURVEY

2.1 Existing problem

The current solutions are less accurate and can predict only for a few classes of Arrhythmia.Moreover, these are not lightweight and cannot be extended to wearble applications or devices.The proposed solution aims to increase accuracy and be extended to future medical devices to predict the different types of Arrhythmia.

2.2 References

1.Lackland, D.T.; Weber, S.M.A. Global burden of cardiovascular disease and stroke: hypertension at the core. Can. J. Cardiol. 2015, 31, 569–571. [CrossRef] [PubMed]

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3. Irmakci, I.; Anwar, S.M.; Torigian, D.A.; Bagci, U. Deep Learning for Musculoskeletal Image Analysis. arXiv 2020, arXiv:2003.00541.

4. Anwar, S.M.; Majid, M.; Qayyum, A.; Awais, M.; Alnowami, M.; Khan, M.K. Medical image analysis using convolutional neural networks: A review. J. Med. Syst. 2018, 42, 226. [CrossRef]

5. Gu, J.; Wang, Z.; Kuen, J.; Ma, L.; Shahroudy, A.; Shuai, B.; Liu, T.; Wang, X.; Wang, G.; Cai, J.; et al. Recent advances in convolutional neural networks. Pattern Recognit. 2018, 77, 354–377. [CrossRef]

6. Wu, Y.; Yang, F.; Liu, Y.; Zha, X.; Yuan, S. A comparison of 1-D and 2-D deep convolutional neural networks in ECG classification. arXiv 2018, arXiv:1810.07088.

. Rajkumar, A.; Ganesan, M.; Lavanya, R. Arrhythmia classification on ECG using Deep Learning. In Proceedings of the 2019 5th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 15–16 March 2019; IEEE: Piscataway, NJ, USA, 2019; pp. 365–369.

2.3 Problem Statement Definition

1.Clinical experts might need to look at ECG recordings over a longer period of time for detecting cardiac arrhythmia. The ECG is a one-dimensional (1-D) signal representing a time series, which can be analyzed using machine learning techniques for automated detection of certain abnormalities.

2.Doctors are frequently required to evaluate and diagnose cardiac problems using single-lead or multiple-lead ECG readings in clinical applications. However, an efficient and low-complexity automatic CVD identification model is required due to the heavy burden associated with a clinical diagnosis and the disparity in doctors’

expertise levels.

3.The manifestations of cardiac disease are often complex and varied. As a result, more types of ECG data will need to be added due to this time taken for testing, training and validation will also be increased.

4.The description of the patient population in which these ECGs were obtained is lacking.It is important in interpreting the methodology and clinical utility in context.

5.The researcher puts lots of effort into developing the automated system with good accuracy results. The developed system may act as clinical support for the healthcare professionals but with few limitations.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

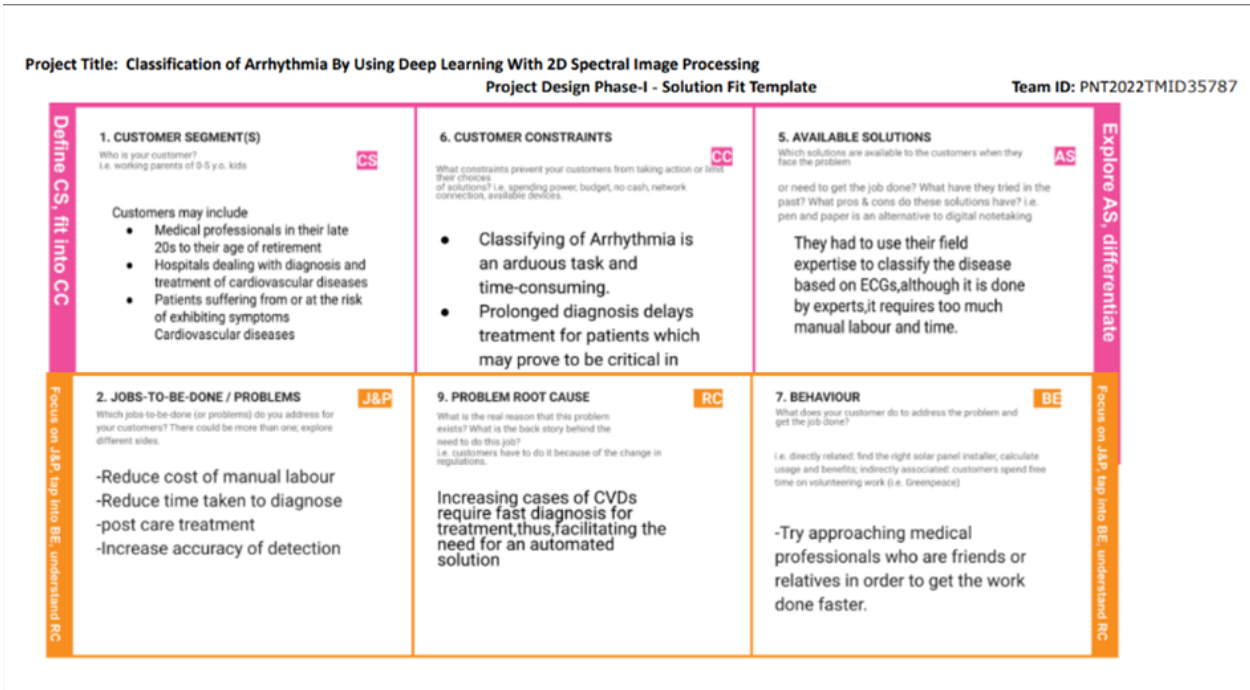
3.2 Ideation & Brainstorming

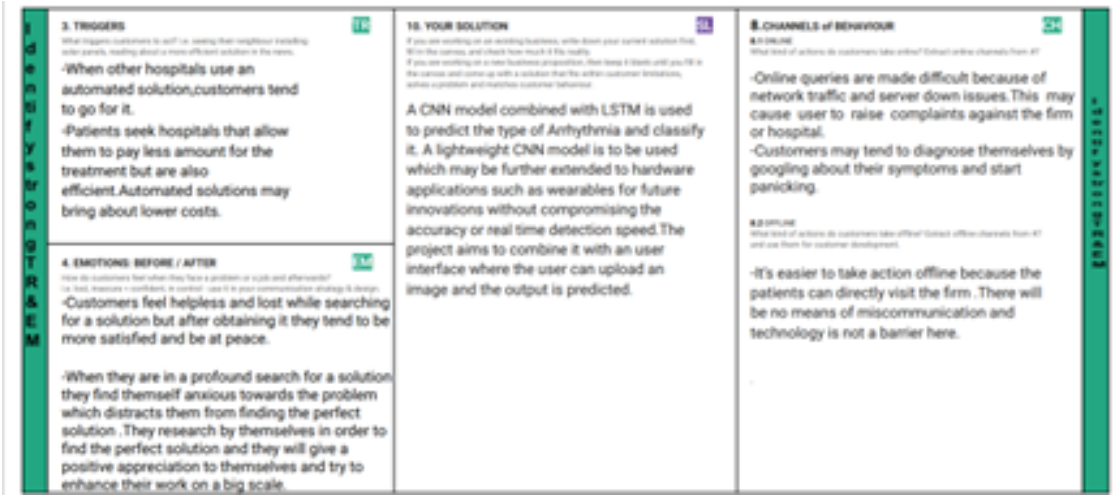
3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To classify ECG signals and detect and classify the type of Arrhythmia if present.
2.	Idea / Solution description	To develop a lightweight CNN model to classify and detect types of Arrhythmia which can later be extended to hardware solutions.
3.	Novelty / Uniqueness	A hybrid model of CNN and LSTM is to be used along with RELU activation layers, and dropout layers on the frequency domain ECG signals. This lightweight model will hopefully take less detection time and can be extended to hardware applications.
4.	Social Impact / Customer Satisfaction	The proposed solution will enable fast real-time detection of arrhythmia, leading to faster diagnosis and treatment, making the patients feel secure, and preventing them from falling prey to critical conditions. It will also help diagnose and treat some of the major CVDs. It will transform the way diseases are diagnosed and eliminate the need for time-consuming manual labor.
5.	Business Model (Revenue Model)	The model will allow fast real-time detection which will eliminate the need for manual labour thus saving time and cost. In the future perhaps it could be integrated into hardware solutions like wearable devices and sold to the

		public.
6.	Scalability of the Solution	The lightweight algorithm can be extended to be implemented in hardware solutions possibly wearables.

3.4 Problem Solution fit:





4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Upload ECG image	User has to upload ECG image onto the webpage.

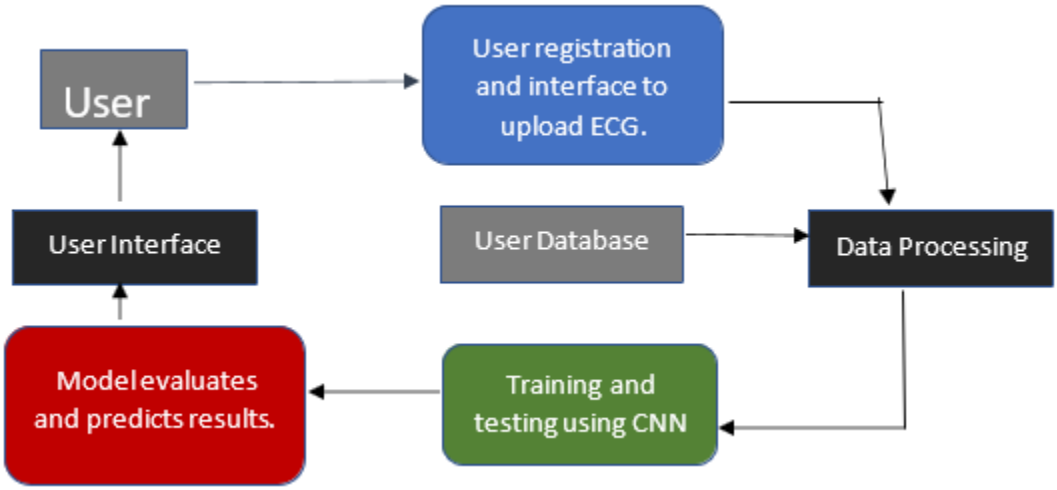
4.2 Non Functional requirement:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The application should have user friendly Graphics User Interface.
NFR-2	**Security**	Only authorized users can view the data so that user data is secured.
NFR-3	**Reliability**	User data should not be shared to any third-party applications.
NFR-4	**Performance**	The application should detect Arrythmia as fast as

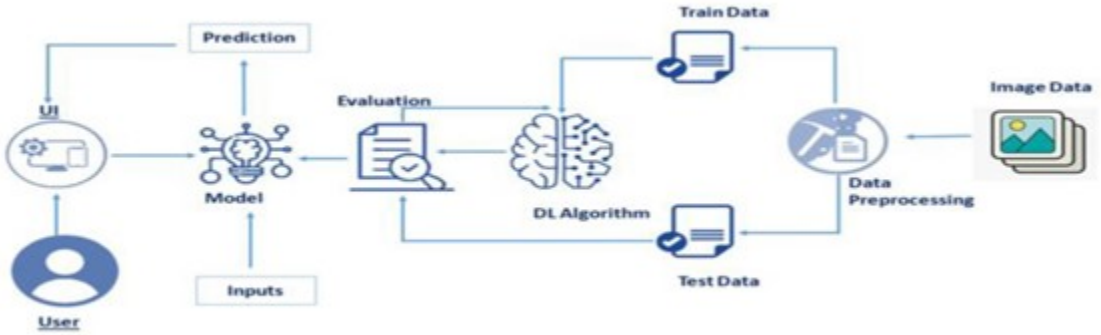
		possible with more accuracy.
NFR-5	**Availability**	The software should be available for multiple user access simultaneously.
NFR-6	**Scalability**	The application should be scalable to upload multiple images at a time for detection.

5.PROJECT DESIGN

5.1 Data Flow Diagram



5.2 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, I 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, I will receive a confirmation email once I have registered for the application	I can receive a confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register & access the dashboard with Gmail	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering my email & password	I can access my account/dashboard	High	Sprint-1
	Dashboard	USN-6	As a user, I can see information laid out in grid format and can upload an image of my ECG for detection.	Once the image is uploaded, I get an 'Upload Successful' pop-up.	Medium	Sprint-2
		USN-7	The app should display the result.	Result is displayed.	High	Sprint-2
Customer (Web user)	Registration	USN-1	As a user, I 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, I will receive a confirmation email once I have registered for the application	I can receive a confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can log into the application by entering my email & password		High	Sprint-1

	Dashboard	USN-4	As a user, I can see information laid out in grid format and upload an image of my ECG for detection.	Once the image is uploaded, I get an 'Upload Successful' pop-up.	Medi um	Sprint-2
		USN-5	As a user, I can see the result displayed.	Result is displayed.	High	Sprint-2
Customer Care Executive	Login	USN-1	As a customer care executive, I can login with my credentials.	I can access my account and dashboard	High	Sprint-1
	Dashboard	USN-2	As a customer care executive, I can see all the information laid out in grid format.	I can see all the information in dashboard.	Low	Sprint-2
	Responsibilities	USN-3	As a customer care executive, I can manage a team of representatives and resolve customer complaints.	Manage and resolve customer complaints.	High	Sprint-2
Administrator	Login	USN-1	As an administrator, I can login with my credentials.	I can access my account and dashboard	High	Sprint-1
	Dashboard	USN-2	As an administrator, I can see all the information laid out in grid format.	I can see all the information in dashboard.	Low	Sprint-2
	Responsibilties	USN-3	As an administrator, I can implement security measures and review web content and make necessary changes.	I can implement security measures and review web content and make necessary changes.	High	Sprint-2

6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	**Functional Requirement (Epic)**	**User Story Numb er**	**User Story / Task**	**Story Points**	**Priority**	**Team Members**
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, and password, and	10	High	Amrin Fathima

			confirming my password.			
Sprint-1	E-mail confirmation	USN-2	As a user, I will receive a confirmation email once I have registered for the application	10	Medium	Srividhya Sutharsan
Sprint-2	Login	USN-3	As a user, I can log into the application by entering my email & password	5	High	Amrin Fathima ,Nivethitha K
Sprint-2	Upload Images	USN-4	As a user,I should be able to upload the image of ECG.	10	High	Nivethitha K
Sprint-2	Dashboard	USN-5	As a user, based on my requirement I can navigate through the dashboard.	5	Medium	Srividhya Sutharsan , Yuvabarathi P

Sprint-3	Train the model	Task 1	As a developer, the dataset will be uploaded and trained by developed algorithm.	20	High	Amrin Fathima,Yuvabharathi P

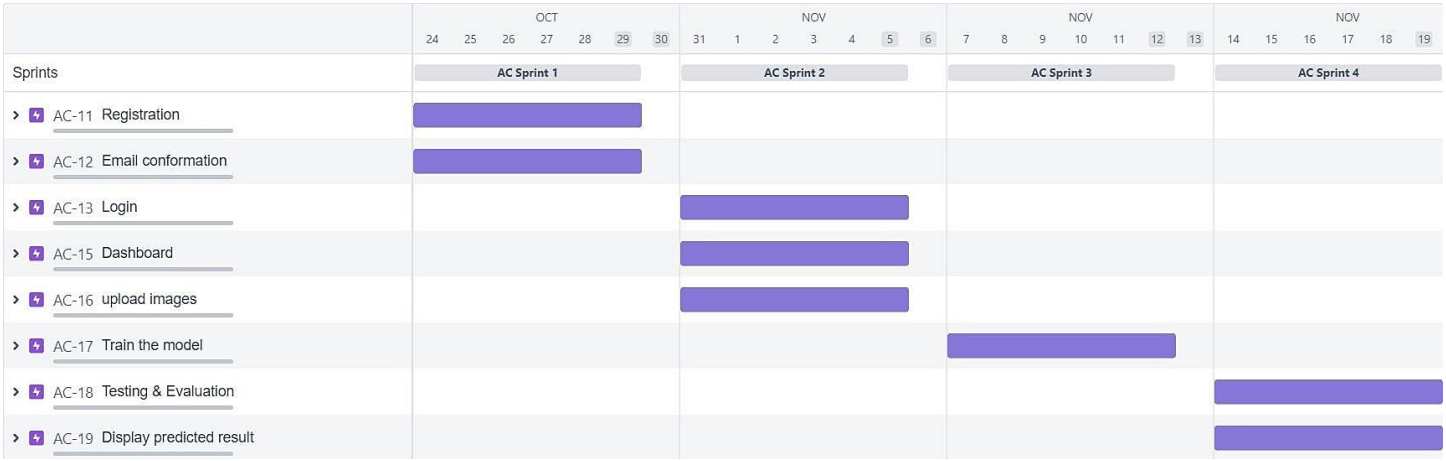
Sprint-4	Testing & Evaluation	Task 2	As a developer, we tested the trained model using the provided dataset and model will be evaluated for accurate results.	10	High	Srividhya Sutharsan , Nivethitha K
Sprint-4	Display predicted result	USN-6	As a user, I can view the predicted result in the dashboard.	10	High	Amrin Fathima, Yuvabharathi P

6.2 Sprint Delivery Scheduling

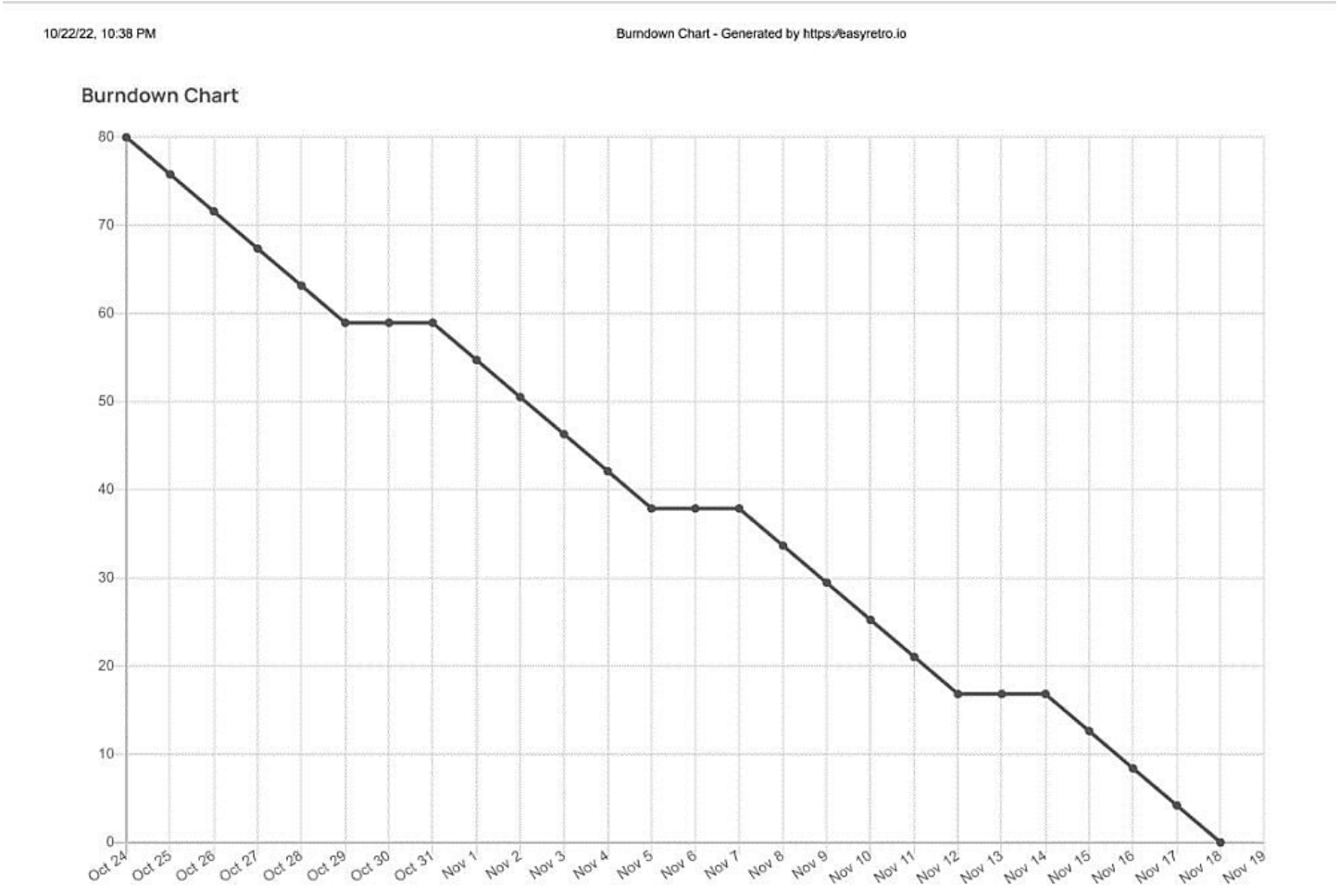
Sprint	**Total Story Points**	**Duration**	**Sprint Start Date**	**Sprint End Date (Planned)**	**Story Points Completed (as on Planned End Date)**	**Sprint Release Date (Actual)**
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022

Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA Software



Burndown Chart



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

7.1 Feature 1

We created .html files for login page, registration so that if a user is not having an account in our application they would create one so that they can directly use the application.Once the user registers, the details of the user is stored in the cloudant database for further processing.

7.2 Feature 2

When the user logins into the webpage, there will be an option to uplaod the user ECG image and our trained model would predict the result based of the training and testing on the dataset. The output would be displayed on the screen for the user to note.

8.TESTING

There are 6 types of Arrhythmia that is been classified by this application based on the trained model on these types. The 6 types are:

1. Left Bundle Branch Block

Left bundle branch block (LBBB) occurs when something blocks or disrupts the electrical Impulse that causes your heart to beat.

2. Normal

It is an irregular heartbeat that occurs occur when the electrical signals that coordinate the heart's beats don't work properly.

3. Premature Atrial Contraction

Premature atrial contractions (PACs) are extra heartbeats that begin in one of your heart's two upper chambers (atria). These extra beats disrupt your regular heart rhythm.

4. Premature Ventricular Contractions

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.

5. Right Bundle Branch Block

Right bundle branch block is an obstacle in your right bundle branch that makes your heartbeat signal late and out of sync with the left bundle branch, creating an irregular heartbeat.

6.Ventricular Fibrillation

Ventricular fibrillation is a type of irregular heart rhythm which occurs in the lower heart chambers contract in a very rapid and uncoordinated manner. As a result, the heart doesn't pump blood to the rest of the body.

Test Cases

Date	17-Nov-22
Team ID	PNT2022TMID35787
Project Name	Classification of Arrhythmia by Us
Maximum Marks	4 marks

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	TC for Automation(Y/N)	BUG ID	Executed By
Landing Page_TC_OO1	Functional	Landing Page	Verify user is able to access the landing page..	-	1.Enter URL and click go 2.Click upload button 3.Choose a image from local directory or paste or drop . 4.Click predict to view result !	https://drive.google.com/file/d/1kkp-sPu5FzARcNqdZ_WoXSsxWgN5dBR9/view?usp=sharing	Predicted result should display.	Working as expected	Pass	Excellent	N	BUG-5	Amrin Fathima
Landing Page_TC_OO2	UI	Landing Page	Verify the UI elements	-	1.Sliding Banner 2.Buttons	https://drive.google.com/file/d/1kkp-sPu5FzARcNqdZ_WoXSsxWgN5dBR9/view?usp=sharing	Application should show below UI elements: a.Upload box b.Predict button box	Working as expected	Pass	Good	N	-	Amrin Fathima

User Acceptance Testing

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of theproject at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	4	1	2	0	7
Duplicate	1	0	1	0	2
External	3	2	0	1	6
Fixed	5	1	4	0	10
Not Reproduced	0	1	0	0	1
Skipped	0	0	1	1	2
Won't Fix	0	0	2	0	2
Totals	13	5	10	2	30

3.Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	10	0	0	10
Client Application	30	0	0	30
Security	2	0	0	2
Outsource Shipping	5	0	0	5
Exception Reporting	7	0	0	7
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9. RESULTS

Performance Metrics

The two significant optimization parameters in the proposed vgg-19 model are the learning rate and the batch size of the data used. To improve the performance, these two optimization parameters must be selected carefully to obtain the best accuracy in the automatic classification of arrhythmia using the ECG signals. The proposed model was evaluated in different experiments with various values of learning parameters. For a smaller value of the learning rate (i.e., less than 0.0005), the speed of the convergence was very slow. However, when the value of the learning rate was large (i.e., greater than 0.001), the speed of convergence improved. At the same time, asymmetrical changes were observed in the accuracy rate. Henceforth, we selected an optimum value of 0.001 for the learning rate, as this value can attain better accuracy for the proposed model (i.e., optimum value). Also, the basic CNN model initially trained and

10.ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

This model can be used to detect different types of arrhythmia at a faster rate so that early detection of the disease could help with proper treatment to cure the disease.

This model also predicts the result more accurately so that there is no wrong treatment done to the patient.

With the help of this application, detection is made easier and less time consuming therefore, patients need not go to the hospital for Thisdetection and still know about their health status.

Easier user interface of just uploading and knowing the result would make anyone use the application.

DISADVANTAGES:

This model would not always give 100% correct result hence we should not just take this as a final result and treat ourselves with medicine, this is just an indication of precaution.

This requires a stable network connection for running the web application which may not be available at all times.

11.CONCLUSION

we proposed a VGG-19-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 VGG-19 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 91% average accuracy.These results indicate that the prediction and classification of arrhythmia with 2-D ECG representation as spectrograms and the VGG 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.

12.FUTURE SCOPE

The effect of multiple lead ECG data to further improve experimental cases will be studied in future work.

13.APPENDIX

Source Code

login.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" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <form action="",method='POST'>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">User Login</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2"
id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
```

```
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color:
aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
      <form class="form-inline" action="/login" method="GET">
      <div class="container" style="width: 600px; height: 600px;">
        <div class="mb-3 d-flex justify-content-center"><script
src="https://cdn.lordicon.com/xdjxvujz.js"></script>
            <lord-icon
                src="https://cdn.lordicon.com/elkhjhci.json"
                trigger="hover"
                style="width:200px;height:200px">
            </lord-icon></div>
            <div class="mb-3">
                <input type="email" class="form-control" id="exampleInputEmail1"
name="mail" aria-describedby="emailHelp" placeholder="Enter Registered Mail ID">
            </div>
            <div class="mb-3">
              <input type="password" class="form-control"
id="exampleInputPassword1" name="pass" placeholder="Enter Password">
            </div>
            <div class="mb-3">
            <button type="submit form-control" class="btn btn-dark btn-primary"
style="width:100%;" type="submit">Login</button>
            </div>
            {{pred}}
      </div>
    </form>
```

```
  </body>
</html>
```

app.py

```
import numpy as np
import os
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.inception_v3 import preprocess_input
from flask import Flask, request,flash, render_template, redirect,url_for
from cloudant.client import Cloudant
from twilio.rest import Client
model = load_model(r"model.h5")
app = Flask(__name__)
app.secret_key="abc"
app.config['UPLOAD_FOLDER'] = "User_Images"
# Authenticate using an IAM API key
client = Cloudant.iam('89a3abc1-41af-4522-95b8-3663025fe6cd-bluemix',
                      'TToxPFwqG1SjqtX53rkZzOnsqRpoZPRb9VkqGdkEnzXy', connect=True)
# Create a database using an initialized client
my_database = client.create_database('my_database')
if my_database.exists():
    print("Database '{0}' successfully created.".format('my_db'))
# default home page or route


user = ""


@app.route('/')
def index():
    return render_template('index.html', pred="Login", vis ="visible")


@ app.route('/index')
def home():
    return render_template("index.html", pred="Login", vis ="visible")



# registration page
```

```
@ app.route('/register',methods=["GET","POST"])
def register():
    if request.method == "POST":
        name =  request.form.get("name")
        mail = request.form.get("emailid")
        mobile = request.form.get("num")
        pswd = request.form.get("pass")
        data = {
            'name': name,
            'mail': mail,
            'mobile': mobile,
            'psw': pswd
        }
        print(data)
        query = {'mail': {'$eq': data['mail']}}
        docs = my_database.get_query_result(query)
        print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            url = my_database.create_document(data)
            return render_template("register.html", pred=" Registration Successful ,
please login using your details ")
        else:
            return render_template('register.html', pred=" You are already a member ,
please login using your details ")
    else:
        return render_template('register.html')



@ app.route('/login', methods=['GET','POST'])
def login():
    if request.method == "GET":
        user = request.args.get('mail')
        passw = request.args.get('pass')
        print(user, passw)
        query = {'mail': {'$eq': user}}
        docs = my_database.get_query_result(query)
        print(docs)
```

```
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            return render_template('login.html', pred="")
        else:
            if ((user == docs[0][0]['mail'] and passw == docs[0][0]['psw'])):
                flash("Logged in as " + str(user))
                return render_template('index.html', pred="Logged in as "+str(user),
vis ="hidden", vis2="visible")
            else:
                return render_template('login.html', pred="The password is wrong.")
    else:
        return render_template('login.html')



@ app.route('/logout')
def logout():
    return render_template('logout.html')


@app.route("/predict",methods=["GET", "POST"])
def predict():
    if request.method == "POST":
        f = request.files['file']
        # getting the current path 1.e where app.py is present
        basepath = os.path.dirname(__file__)
        #print ( " current path " , basepath )
        # from anywhere in the system we can give image but we want that
        filepath = os.path.join(str(basepath), 'User_Images', str(f.filename))
        print("**************************")
        print(filepath)
        #print ( " upload folder is " , filepath )
        f.save(filepath)
        img = image.load_img(filepath, target_size=(224, 224))
        x = image.img_to_array(img)  # ing to array
        x = np.expand_dims(x, axis=0)  # used for adding one more dimension
        #print ( x )
        img_data = preprocess_input(x)
        prediction = np.argmax(model.predict(img_data), axis=1)
        index = ['Left_Bundle_Branch_Block','Normal','Premature atrial
```

```
contraction','Ventricular Fibrillations','Premature ventricular Contractions','Right
Bundle Brach Block']
        result = str(index[prediction[0]])
        print(result)
        account_sid = 'ACfa41da717c7b394e9003eb17e367eaed'
        auth_token = '0f2cf267bbf74ccbee1517ba7817551c'

        client = Client(account_sid, auth_token)

        ''' Change the value of 'from' with the number
        received from Twilio and the value of 'to'
        with the number in which you want to send message.'''
        message = client.messages.create(
                                    from_='+18658003576',
                                    body ='Results: '+ result,
                                    to ='+919361101167'
                                )
        return render_template('prediction.html', prediction=result, fname = filepath)
    else:
        return render_template("prediction.html")

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

msg.py

```
import requests
result = "1"
url = "https://www.fast2sms.com/dev/bulkV2"
querystring = {

"authorization":"ucDxAe7hgIFqnOS5EQBdt4lYJmsX6pj2VPzka3wHZ0fNyU1b8iGfqYlXFceBIEDMAOo2
UJhTV6PdWQns",
        "sender_id":"DR-PREDICTION",
        "message":"Results: "+ result,
        "language":"english",
        "route":"q",
        "numbers": "9361079005, 9445979800"
```

```
    }
headers = {
        'cache-control': "no-cache"
    }

print(querystring)
res = requests.request("GET",url,headers=headers,params=querystring)
print(res.text)
```

style.css

```
.image{
    text-align: center;
  }
  h1{
    text-align: center;
  }
  .reg-box{
    width: 40%;
    margin:auto;
    border-style: solid;
  }
  .register{
    margin-top: 10%;
  }
  .input1{
    margin: 20px;
  }
  p{
    margin-left: 20px;
  }
  .upload{
    padding: 7% 10%;
    text-align: center;
  }

  .logout{
    margin-top: 10%;
```

```
    text-align: center;
  }
```

index.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>Classification of arrhythmia</title>
  </head>
  <body>
```

```
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">Arrhythmia
Classification</a>
        </div>
        {{msg}}
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2"
id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item" style="visibility:{{ vis2 }}">
              <a class="nav-link" href="predict" style="color:
aliceblue;">Prediction</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">{{pred}}</a>
            </li>
            <li class="nav-item" style="visibility:{{ vis }}">
              <a class="nav-link" href="register" style="color:
aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
        <div class="jumbotron container">
          <img src="static/images/eye1.jpg" style="width: 90%">
          <hr>
          <br>
          <h1 class="display-4"><center>ABOUT PROJECT</center></h1>
          <br><br>
          <table>
            <thead>
              <tr>
                <th>Problem</th>
                <th>Solution</th>
```

```
                </tr>
              </thead>
              <tbody>
                <tr>
                  <td> <p class="lead">A heart arrhythmia (uh-RITH-me-uh) is an
irregular heartbeat. Heart rhythm problems (heart arrhythmias) occur when the
electrical signals that coordinate the heart's beats don't work properly. The faulty
signaling causes the heart to beat too fast (tachycardia), too slow (bradycardia) or
irregularly.</p></td>
                  <td><p class="lead">In this project we will be building a VGG-19
model that can detect and classify types of Arrhythmia.A web application is
integrated with the model from where the user can upload an ECG image and see the
analyzed results on the interface</p></td>
                </tr>
              </tbody>
            </table>
            <hr class="my-4">
            <div class="d-flex justify-content-center">
              
            </div>
          </div>
    </body>
</html>
```

logout.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" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
```

```
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <body>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color:
```

```
aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
      <div class="d-flex justify-content-center">
        <div class="row d-flex display-3 justify-content-center">
            Successfully Logged Out!
            <br><br>
            <a href="login" class="btn btn-lg btn-dark">Login for more
Information</a>
              </div>
        </div>
  </body>
</html>
```

register.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" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
```

```
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;

        }
        .navbar-brand{
            padding-left:15px;
        }
    </style>
    <title>DR Predcition</title>
  </head>
  <form action="{{url_for('register')}}" method="post" >
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
        <div>
        <a class="navbar-brand" href="#" style="color:aliceblue">Registration</a>
        </div>
        <div class="navbar-collapse collapse w-100 order-3 dual-collapse2"
id="navbarNav">
          <ul class="navbar-nav mr-auto text-center" id="navbarRight">
            <li class="nav-item active">
              <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="register"style="color:
aliceblue;">Register</a>
            </li>
          </ul>
        </div>
      </nav>
      <br><br>
      <form class="form-inline" method ="POST">
      <div class="container" style="width: 600px; height: 600px;">
        <div class="mb-3 d-flex justify-content-center"><script
```

```
src="https://cdn.lordicon.com/xdjxvujz.js"></script>
            <lord-icon
                src="https://cdn.lordicon.com/elkhjhci.json"
                trigger="hover"
                style="width:200px;height:200px">
            </lord-icon></div>
      <div class="mb-3">
                <input type="text" class="form-control" id="exampleInputName" name =
"name" aria-describedby="nameHelp" placeholder="Enter Name">
              </div>
              <div class="mb-3">
                <input type="email" class="form-control" id="exampleInputEmail1"
name="emailid" aria-describedby="emailHelp" placeholder="Enter Mail ID">
              </div>
              <div class="mb-3">
                <input type="number" class="form-control" id="exampleInputNumber1"
name="num" aria-describedby="numberHelp" placeholder="Enter Mobile number">
              </div>
              <div class="mb-3">
                <input type="password" class="form-control"
id="exampleInputPassword1" name="pass" placeholder="Enter Password">
              </div>
              <div class="mb-3">
              <button type="submit form-control" class="btn btn-dark btn-primary"
style="width:100%;">Register</button>
            </div>
      <div class="mb-3 d-flex justify-content-center">
      <a href="login" class="nav-link"> Already Registered: Login Here</a>
      </div>
      {{pred}}
      </div>
    </form>
  </body>
</html> -->
```

Register.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" />
  <!-- CSS only -->
  <link
href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
rel="stylesheet"
    integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
crossorigin="anonymous" />
  <!-- JavaScript Bundle with Popper -->
  <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
    integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"></script>
  <style>
    #navbarRight {
      margin-left: auto;
      padding-right: 10px;
    }

    .navbar-brand {
      padding-left: 15px;
    }

    .row {
      width: 90%;
    }
  </style>
  <title>DR Predcition</title>
</head>

<body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy
```

```
Classification</a>
    </div>
    <div class="navbar-collapse collapse w-100 order-3 dual-collapse2"
id="navbarNav">
      <ul class="navbar-nav mr-auto text-center" id="navbarRight">
        <li class="nav-item active">
          <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
        </li>
        <li class="nav-item">
          <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>
        </li>
      </ul>
    </div>
  </nav>
  <br><br>
  <div class="container justify-content-center" style="width:700px">
    <form action = "/predict" method = "POST" enctype="multipart/form-data">
    <label for="formFileLg" class="form-label">Upload Image</label>
    <input class="form-control form-control-lg" name ="file" type="file" />
    <br>
    <button class="btn btn-lg btn-dark" type = "submit">Predict</button>
    </form>
    <br>
    <h1>{{prediction}}</h1>
  </div>
  <br><br><br>
  <div class="d-flex justify-content-center" >
      <img src="static/images/cases1.jpg" style="width: 90%">
  </div>

</body>
</html>
```

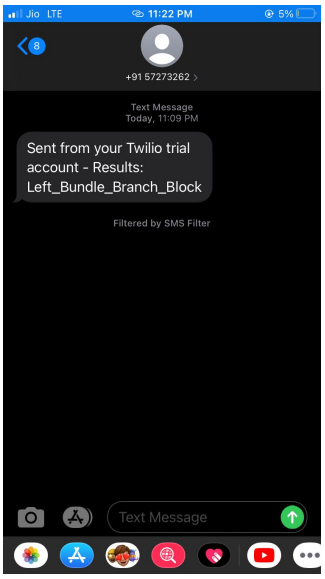
prediction.html:

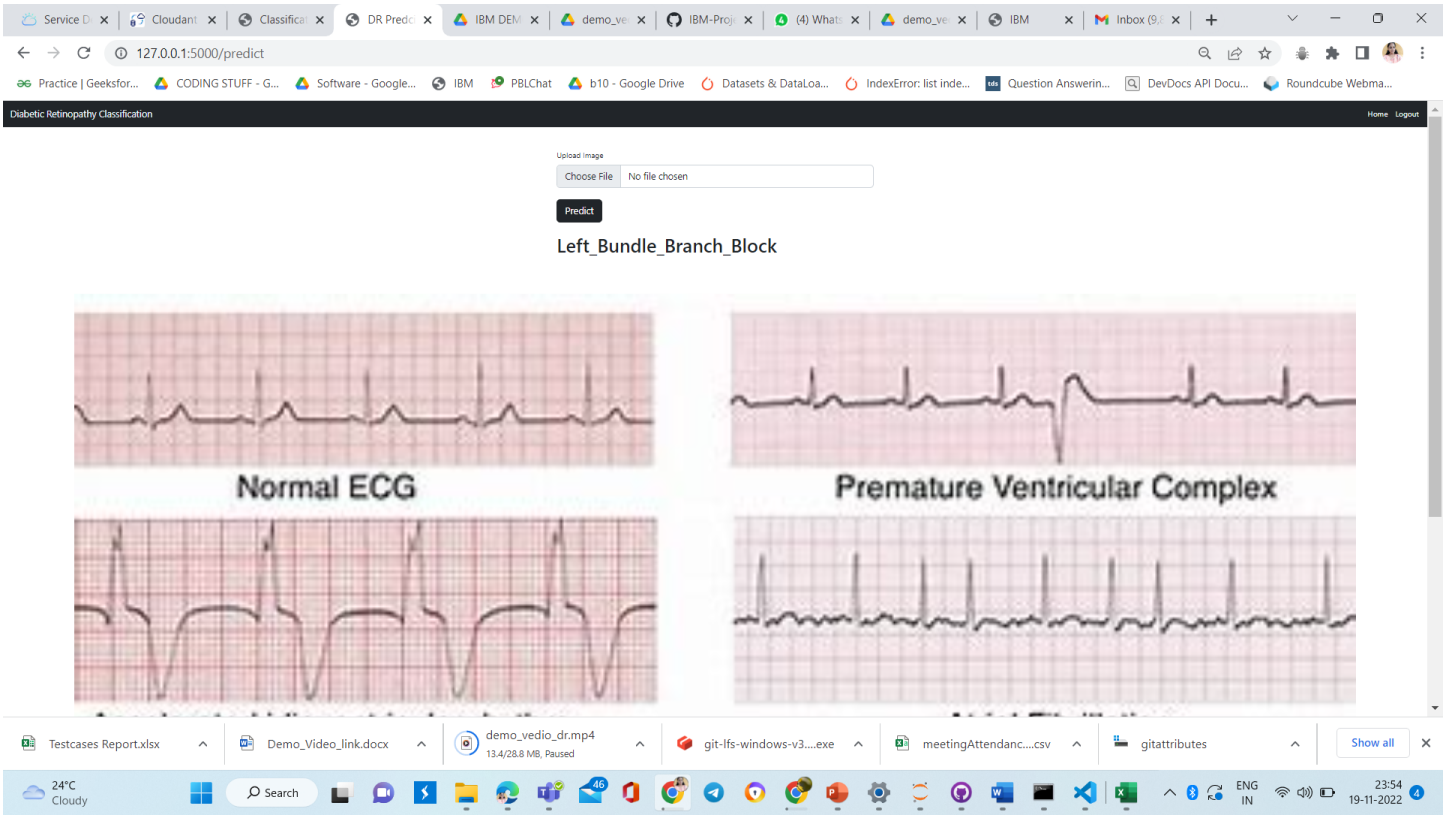
```
<!DOCTYPE html>
<html lang="en">

<head>
```

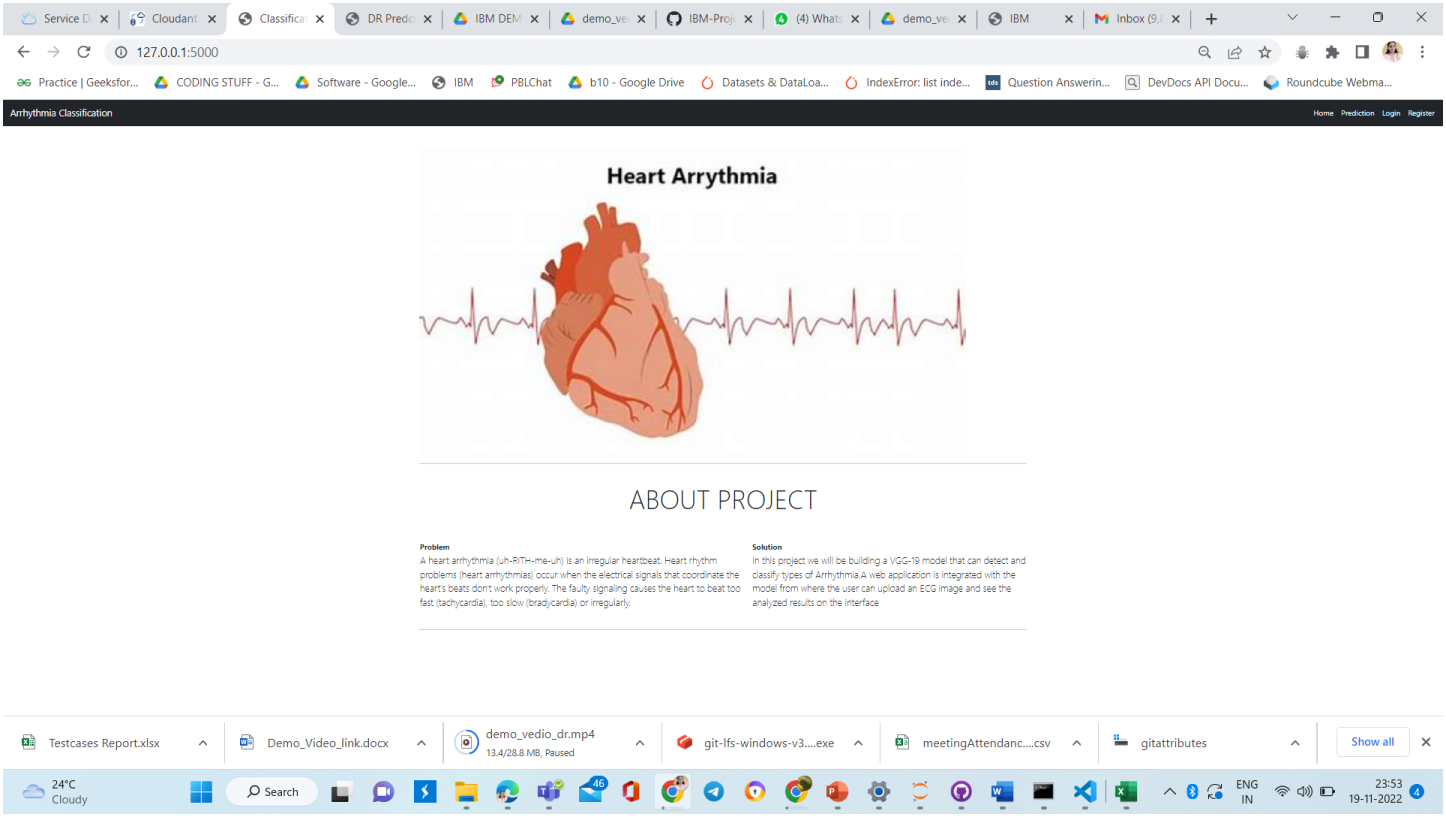
```
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <!-- CSS only -->
  <link
href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
rel="stylesheet"
    integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
crossorigin="anonymous" />
  <!-- JavaScript Bundle with Popper -->
  <script
src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
    integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"></script>
  <style>
    #navbarRight {
      margin-left: auto;
      padding-right: 10px;
    }

    .navbar-brand {
      padding-left: 15px;
    }

    .row {
      width: 90%;
    }
  </style>
  <title>DR Predcition</title>
</head>

<body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy
Classification</a>
```

```
    </div>
    <div class="navbar-collapse collapse w-100 order-3 dual-collapse2"
id="navbarNav">
      <ul class="navbar-nav mr-auto text-center" id="navbarRight">
        <li class="nav-item active">
          <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
        </li>
        <li class="nav-item">
          <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>
        </li>
      </ul>
    </div>
  </nav>
  <br><br>
  <div class="container justify-content-center" style="width:700px">
    <form action = "/predict" method = "POST" enctype="multipart/form-data">
    <label for="formFileLg" class="form-label">Upload Image</label>
    <input class="form-control form-control-lg" name ="file" type="file" />
    <br>
    <button class="btn btn-lg btn-dark" type = "submit">Predict</button>
    </form>
    <br>
    <h1>{{prediction}}</h1>
  </div>
  <br><br><br>
  <div class="d-flex justify-content-center" >
      <img src="static/images/cases.png" style="width: 90%">
  </div>

</body>
</html>
```

Output:


Jio LTE
11:22 PM
5%
+91 57273262
Text Message
Today, 11:09 PM
Sent from your Twilio trial account - Results: Left_Bundle_Branch_Block
Filtered by SMS Filter
Text Message


127.0.0.1:5000/predict
Diabetic Retinopathy Classification
Home
Logout
Upload Image
Choose File
No file chosen
Predict
Left_Bundle_Branch_Block
Normal ECG
Premature Ventricular Complex
Testcases Report.xlsx
Demo_Video_link.docx
demo_vedio_dr.mp4
13.4/28.8 MB, Paused
git-lfs-windows-v3....exe
meetingAttendanc....csv
gitattributes
Show all
24°C
Cloudy
Search
ENG
IN
23:54
19-11-2022



GitHub & Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-469-1658302857

https://drive.google.com/file/d/1pjv98Ht5eETH54LtA1NCS2iZZY5R5dCj/view?usp=share_link