

Classification Of Arrhythmia By Using Deep Learning With 2-D ECG Spectral Image Representation

A PROJECT REPORT

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in partial fulfilment for the award of the degree

of

Bachelor of Engineering

IN

Computer Science And Engineering

KINGS ENGINEERING COLLEGE - CHENNAI

ANNA UNIVERSITY: CHENNAI 600 025

DECEMBER-2022

ANNA UNIVERSITY : CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report “**Classification Of Arrhythmia By Using Deep Learning With 2-D ECG Spectral Image Representation**” is the bonafide work of “**GIFTSON DANIEL.B, MANIKANDAN.M, IMMANUVEL.B, MOHAMED ASHIK.A**” who carried out the project work under my supervision.

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

1.INTRODUCTION:

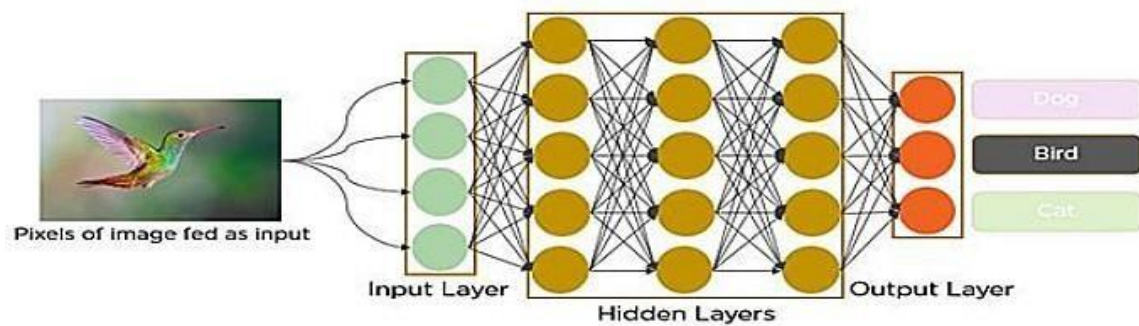
1.1. PROJECT OVERVIEW:

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are the number one cause of death today. Over 17.7 million people died from CVDs in the year 2017 all over the world which is about 31% of all deaths, and over 75% of these deaths occur in low and middle-income countries. Arrhythmia is a representative type of CVD that refers to any irregular change from the normal heart rhythms. There are several types of arrhythmia including atrial fibrillation, premature contraction, ventricular fibrillation, and tachycardia. Although a single arrhythmia heartbeat may not have a serious impact on life, continuous arrhythmia beats can result in fatal circumstances. In this project, we build an effective electrocardiogram (ECG) arrhythmia classification method using a convolutional neural network (CNN), in which we classify ECG into seven categories, one being normal and the other six being different types of arrhythmia using deep two-dimensional CNN with grayscale ECG images. We are creating a web application where the user selects the image which is to be classified. The image is fed into the model that is trained and the cited class will be displayed on the webpage.

1.2. PURPOSE:

In the past few decades, Deep Learning has 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 is

Convolutional Neural Networks.



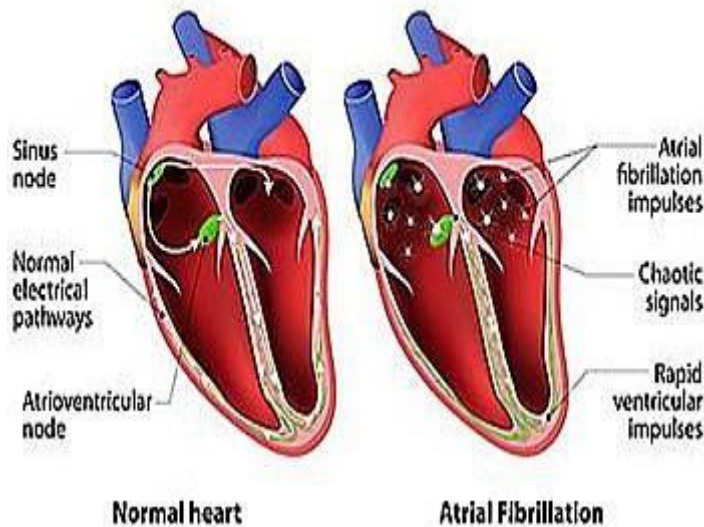
In deep learning, a convolutional neural network (CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyze visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution.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

2.LITERATURE SURVEY :

2.1. What is Heart Arrhythmia?

A heart arrhythmia is an irregular heartbeat. Heart rhythm problems (heart arrhythmias) occur when the electrical signals that coordinate the heart's beats do not work properly. The faulty signalling causes the heart to beat too fast (tachycardia), too slow (bradycardia) or irregularly. Heart arrhythmias may feel like a fluttering or racing heart and may be harmless. However, some heart arrhythmias may cause bothersome — sometimes even life-threatening — signs and symptoms. However, sometimes it is normal for a person to have a fast or slow heart rate. For example, the heart rate may increase with exercise or slow down during sleep.

Cardiac arrhythmia



2.2. REFERENCES:

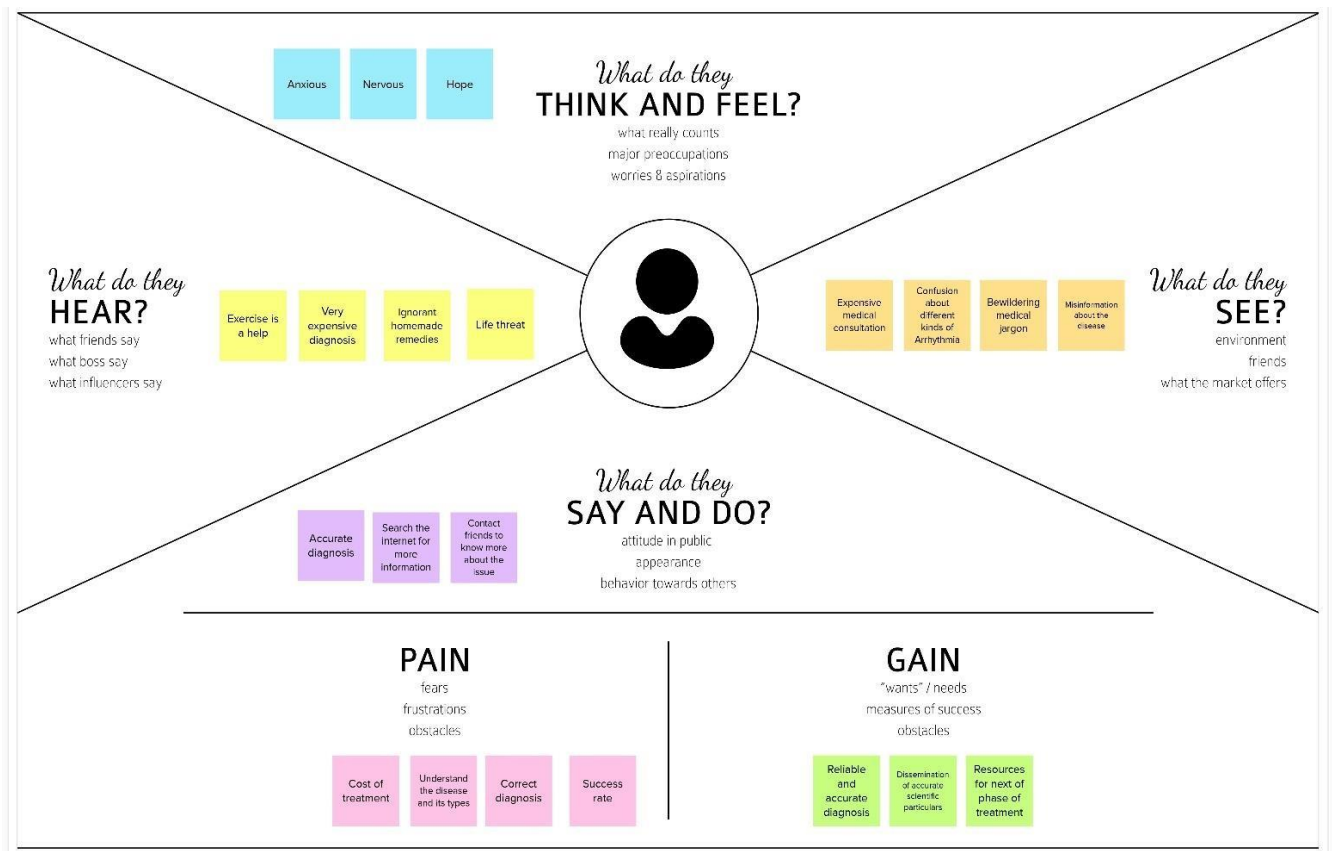
- > Amin Ullah Syed Muhammad Anwar, Muhammad Bilal, and Raja Majid Mehmood (2020)
- > Bazi, Haikel AlHichri, Naif Alajlan, Farid Melgani, Ronald R Yager (2022)
- > Faezeh Nejati Hatamian, Nishant Ravikumar, Sulaiman Vesal(2020)
- > Fatma Murat, Ozal Yildirim, Muhammed Talo, Ulas Baran Baloglu, Yakup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

2.3. 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.


3.IDEATION & PROPOSED SOLUTION :

3.1. EMPATHY MAP CANVAS :



3.2. IDEATION & BRAINSTORMING:

Template




Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

- 🕒 10 minutes to prepare
- 🕒 1 hour to collaborate
- 👥 2-8 people recommended

Share template feedback



Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

🕒 10 minutes

A

Team gathering

Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B

Set the goal

Think about the problem you'll be focusing on solving in the brainstorming session.

C

Learn how to use the facilitation tools

Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1


Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

🕒 5 minutes







PROBLEM

How might we classify arrhythmia with deep learning algorithm using ECG spectral image to help users classify the given image under a arrhythmia category



Key rules of brainstorming

To run an smooth and productive session

 Stay in topic.	 Encourage wild ideas.
 Defer judgment.	 Listen to others.
 Go for volume.	 If possible, be visual.

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 in the pencil drawer to attach it to a drawing!

Giftson daniel

This is a good idea, we can use it to help us with our work.	ECG signals are a good way to monitor heart health.	I should not have any more of these.
It is a good idea to use a smartwatch to monitor heart health.	The smartwatch can monitor heart health and give us a signal.	It is a good idea to use a smartwatch to monitor heart health.
It can also help us with our work.	It can also help us with our work.	It can also help us with our work.

Manikandan

An irregular heartbeat can be a sign of a heart problem.	Heart rate is a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.

Immanuel

Heart rate is a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.

Mohamad ashik

Heart rate is a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.
ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.	ECG signals are a good way to monitor heart health.

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

20 minutes

TIP

After a cluster is created, to clarify notes or a label, write to find, discuss, organize, and categorize together. Discuss how to make your label.

Look of the site

Give professional look to the website.	Dynamic website with professional look.	Use bootstrap to have 2/3 different pages for use to navigate.
--	---	--

Non functional requirements

Check the accuracy of the data before giving an input image.	Quick response and faster reload time.	Let provide information about the previous to the user in the first page.
--	--	---

Modal training and testing

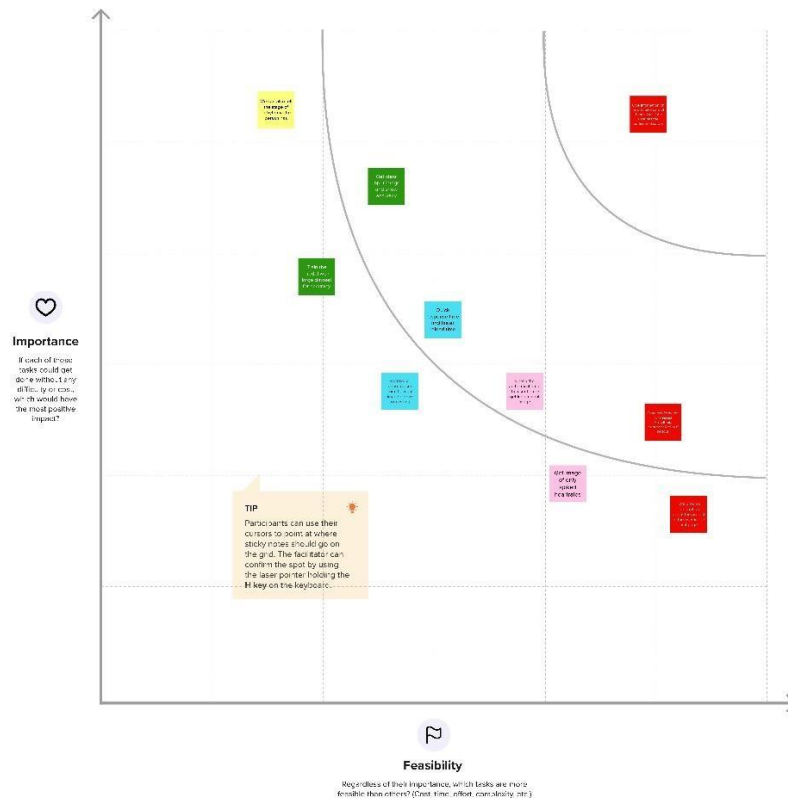
Train the model with a go dataset for accuracy.	Accurate prediction of input image.	Test the data with different categories of algorithm.
---	-------------------------------------	---

4

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



→

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A Share the mural

Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B Export the mural

Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward



Strategy blueprint

Define the components of a new idea or strategy.

[Open the template →](#)



Customer experience journey map

Understand customer needs, motivations, and obstacles for an experience.

[Open the template →](#)



Strengths, weaknesses, opportunities & threats

Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

[Open the template →](#)

[Share template feedback](#)

3.3. PROPOSED SOLUTION:

Proposed Solution Template:

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

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. Excercise Regularly.
2.	Idea / Solution description	Vitamin C. Arrythmia and other heart conditions associated oxident strees and Immplamation
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 cholestreol 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.

3.4. PROBLEM SOLUTION FIT :

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) CS 1) Patients 2) Doctors	6. CUSTOMER CONSTRAINTS CC 1) High prices of apple watches 2) Tight schedule due to work/leability to provide appointments	5. AVAILABLE SOLUTIONS AS When solutions are available to the customers when they face the problem: 1) IoT based devices for Arrhythmia detection by private medical companies 2) Prototypes of devices with such capabilities.	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEMS JBP 1) Highly accurate detection of arrhythmia 2) Cheap healthcare devices for the common people.	9. PROBLEM ROOT CAUSE RC 1) Inability to get regular heart checkups for prevention.	7. BEHAVIOUR BE 1) Ask for professional help/ other ways the problems can be solved. 2) Look for solutions in the internet. 3) Ask technicians and specialists in the field for solution to these problems.	
Focus on JBP, tap into BE, understand RC				Focus on JBP, tap into BE, understand RC

Identify strong TR & EM	3. TRIGGERS 1) Seeing other patients not be scared of what would happen next due to their condition.	TR	10. YOUR SOLUTION Create an application that is trained to see the difference between a normal ECG and an abnormal ECG or arrhythmia detected in the ECG. This will help prevent heart attacks or strokes in chronic heart patients.	SL	8. CHANNELS of BEHAVIOUR 8.1 ONLINE Online research on possible solutions and reviews of existing products.	CH	Extract online & offline CH of BE
	4. EMOTIONS: BEFORE / AFTER They feel weak since they have no control over future events - BEFORE They feel unbothered since they always can prevent the accident - AFTER	EM			8.2 OFFLINE Visit various medical device manufacturer as see if they have any device that serves the purpose or devices that could be tailor made to their problems.		

4. REQUIREMENT ANALYSIS:

4.1. FUNCTIONAL *REQUIREMENT*:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (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	Consult with Doctor
FR-6	Report Generation	Get complete Report

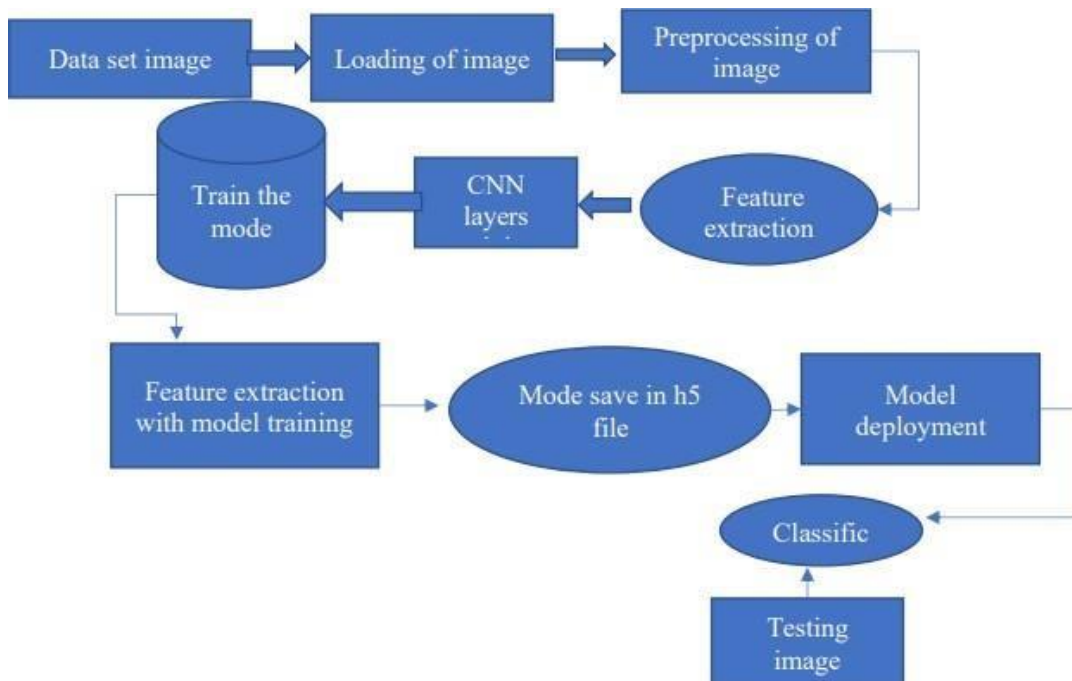
4.2. NON-FUNCTIONAL REQUIREMENTS :

Following are the non-functional requirements of the proposed solution.

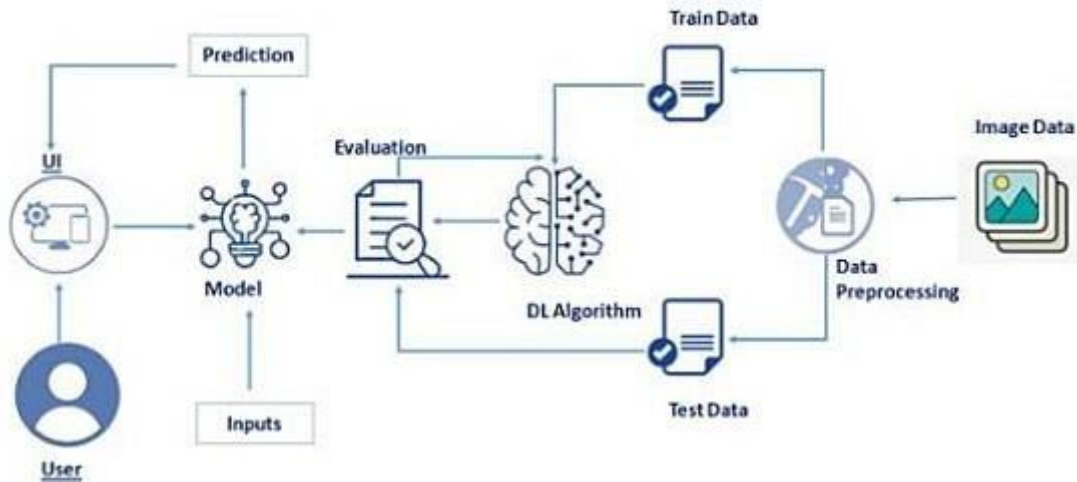
FRNo.	Non-Functional Requirement	Description
NFR-1	Usability	Classification of Arrhythmia with the help of AI.
NFR-2	Security	User's data cannot be accessed by unauthorized people.
NFR-3	Reliability	The system performs without failure.
NFR-4	Performance	High accuracy.
NFR-5	Availability	Anyone who is authorized.
NFR-6	Scalability	Does not affect the performance even though.

5. PROJECT DESIGN:

5.1. DATA FLOW DIAGRAMS:



5.2. SOLUTION & TECHNICAL ARCHITECTURE :



5.3. USER STORIES :

Use the below template to list all the user stories for the product.

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 can register for the application using gmail	I can access my account/dashboard	High	Sprint-1
	Confirmation	USN-3	As a user, I will receive confirmation email once I 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. PROJECT PLANNING & SCHEDULING:

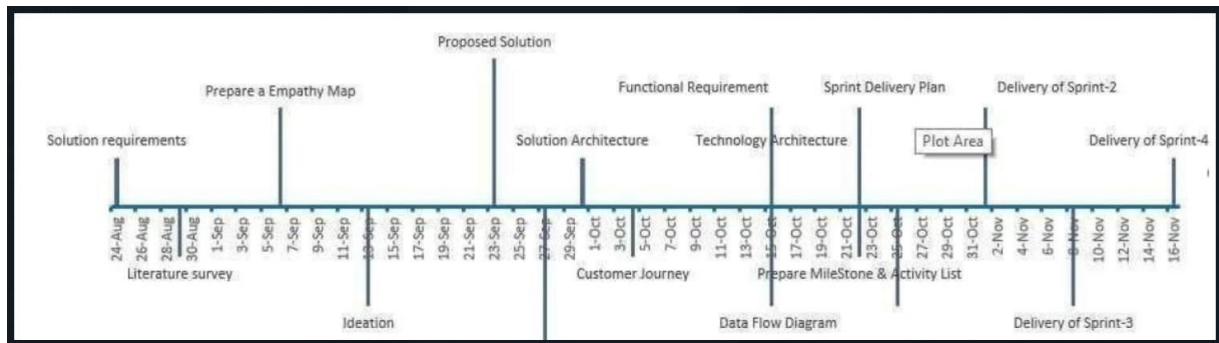
6.1. SPRINT PLANNING & ESTIMATION:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Download TheDataset	USN-1	We can download the Dataset containsSix classes	1	Low	GiftsonDaniel.B Manikandan.M
Sprint-1	Import The Image Data Generator Library	USN-2	We can import Image Data Generator	1	Low	GiftsonDaniel.B Manikandan.M
Sprint-1	Configure Image Data Generatorclass	USN-3	We can configure the Image Data Generator class	1	Low	Mohamed Ashik .A Immanuvel .B Manikandan .M
Sprint-2	Apply the Image Data Generator	USN-4	We can apply Image Data Generator tottrain dataset	2	Medium	Immanuvel.B Giftson Daniel .B

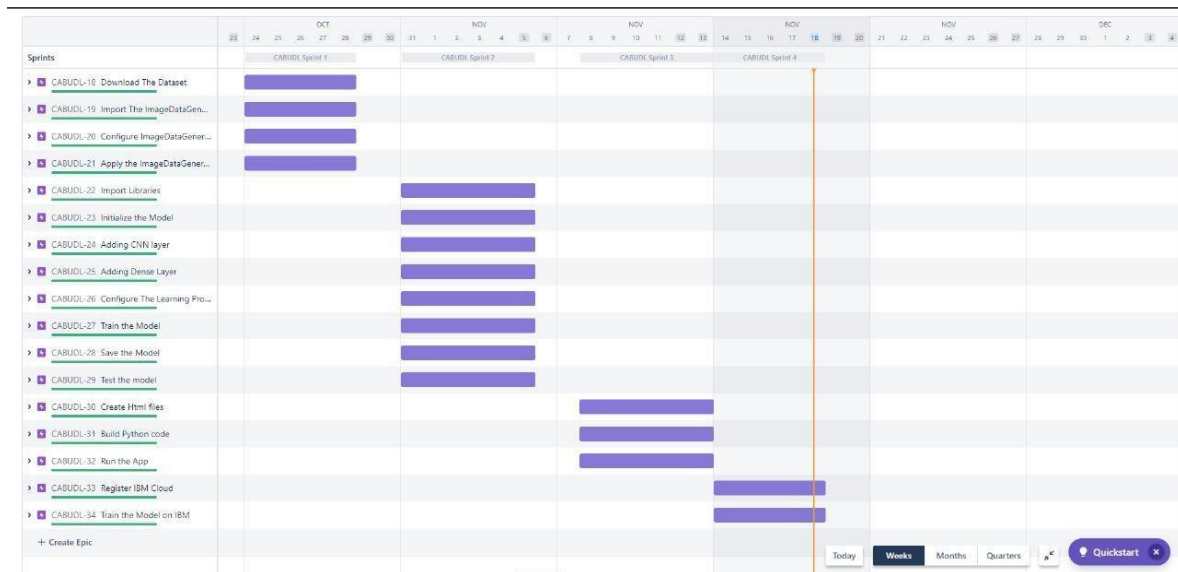
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
	functionality to Trainset and Dataset					GiftsonDaniel.B
Sprint-1	Import Libraries	USN-5	We can import required Libraries	1	Low	GiftsonDaniel.B
Sprint-1	Initialize the Model	USN-6	Initializing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

6.2. SPRINT DELIVERY SCHEDULE:

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:



7.CODING & SOLUTIONING:

7.1. FEATURE 1:

7.1.1 App.py

```
1  import os
2  import numpy as np # used for numerical analysis
3  from flask import Flask, request, render_template
4  # Flask-It is our framework which we are going to use to run/serve our application.
5  # request-for accessing file which was uploaded by the user on our application.
6  # render_template- used for rendering the html pages
7  from tensorflow.keras.models import load_model # to load our trained model
8  from tensorflow.keras.preprocessing import image
9
10 app = Flask(__name__) # our flask app
11 model = load_model('ECG.h5') # loading the model
12
13 @app.route("/") #default route
14 @app.route("/home") #Home page set to default page
15 def default():
16     return render_template('index.html') #rendering index.html
17
18 @app.route("/info") #route to info page
19 def information():
20     return render_template("info.html") #rendering info.html
21
22 @app.route("/about") #route to about us page
23 def about_us():
24     return render_template('about.html') #rendering about.html
25
26 @app.route("/contact") #route to contact us page
27 def contact_us():
28     return render_template('contact.html') #rendering contact.html
29
30 @app.route("/upload") #default route
31 def test():
32     return render_template("predict.html") #rendering contact.html
33
34 @app.route("/predict",methods=["GET","POST"]) #route for our prediction
35 def upload():
36     if request.method == 'POST':
37         f = request.files['file'] # requesting the file
38         basepath = os.path.dirname('__file__') # storing the file directory
39         filepath = os.path.join(basepath, "uploads", f.filename) # storing the file in uploads folder
40         f.save(filepath) # saving the file
41
42         img = image.load_img(filepath, target_size=(64, 64)) # load and reshaping the image
43         x = image.img_to_array(img) # converting image to array
44         x = np.expand_dims(x, axis=0) # changing the dimensions of the image
45
46         preds = model.predict(x) # predicting classes
47         pred = np.argmax(preds, axis=1) # predicting classes
48         print("prediction", pred) # printing the prediction
```

```

47     pred = np.argmax(preds, axis=1) # predicting classes
48     print("prediction", pred) # printing the prediction
49
50     index = ['Left Bundle Branch Block', 'Normal', 'Premature Atrial Contraction',
51             'Premature Ventricular Contractions', 'Right Bundle Branch Block', 'Ventricular Fibrillation']
52     result = str(index[pred[0]])
53     return result # restoring the result
54
55     return None
56
57 # port = int(os.getenv("PORT"))
58 if __name__ == "__main__":
59     app.run(debug=False) # running our app
60     # app.run(host='0.0.0.0', port=8000)

```

7.2. FEATURE 2:

7.2.1 Homepage.html

```

1 <!DOCTYPE html>
2 <html lang="en">
3
4 <head>
5     <meta charset="UTF-8" />
6     <meta http-equiv="X-UA-Compatible" content="IE=edge" />
7     <meta name="viewport" content="width=device-width, initial-scale=1.0" />
8     <title>Self Care - Heart Prediction Online</title>
9     <link rel="shortcut icon" href="{{url_for('static', filename='images/fevicon.png')}}" type="image/x-icon">
10    <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
11    <link href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@600&display=swap" rel="stylesheet" />
12    <link rel="stylesheet" href="{{url_for('static', filename='css/style.css')}}" />
13    <script src="https://kit.fontawesome.com/64d58efce2.js" crossorigin="anonymous">
14    </script>
15 </head>
16
17 <body>
18     <div class="wrapper">
19         <!--Navigation Bar-->
20         <div class="nav">
21             <div class="logo">
22                 <a href="/">
23                     
24                 </a>
25             </div>
26             <div class="links">
27                 <a href="/home" class="mainLink">Home</a>
28                 <a href="/info">Info</a>
29                 <a href="/about">About Us</a>
30                 <a href="/contact">Contact Us</a>
31                 <a href="/upload" class="btn1">Predict</a>
32             </div>
33         </div>
34         <!--Landing Page-->
35         <div class="landing">
36             <div class="landingText" data-aos="fade-up" data-aos-duration="1000">
37                 <h1>
38                     Classification of Arrhythmia
39                     <span style="color: #e0501b; font-size: 4vw">Prediction</span>
40                 </h1>
41                 <h3>
42                     According to the World Health Organization (WHO), cardiovascular diseases (CVDs) are the number one cause of
43                     death today. Over 17.7 million people died from CVDs in the
44                     year 2017 all over the world which...
45                 </h3>
46                 <div class="btn2"><a href="/info">Read more</a>
47             </div>

```

```

49     </div>
50     <div class="landingImage" data-aos="fade-down" data-aos-duration="2000">
51         
52     </div>
53 </div>
54
55 <!--Service Section-->
56 <div class="about">
57     <div class="aboutText" data-aos="fade-up" data-aos-duration="1000">
58         <h1 style="margin: 20px;">
59             Our Patients Are at Centre
60             <span style="color: #2f8be0; font-size: 3vw">of Every We Do</span>
61         </h1>
62         <div class="image-container">
63             </img>
65         </div>
66     </div>
67     <div class="aboutList" data-aos="fade-left" data-aos-duration="1000">
68         <ol>
69             <li>
70                 <span>01</span>
71                 <p>99.8% accurate result.</p>
72             </li>
73             <li>
74                 <span>02</span>
75                 <p>No need to go hospital.</p>
76             </li>
77             <li>
78                 <span>03</span>
79                 <p>No need to login</p>
80             </li>
81             <li>
82                 <span>04</span>
83                 <p>24/7 Support.</p>
84             </li>
85         </ol>
86     </div>
87 </div>
88
89 <!--Info Section-->
90 <div class="infoSection">
91     <div class="infoHeader" data-aos="fade-up" data-aos-duration="1000">
92         <h1>
93             We Analyse Your Health states <br /><span style="color: #e0501b">In Order to Top Service.</span>
94         </h1>
95     </div>
96     <div class="infoCards">

```



```

142 |         </a>
143 |     </div>
144 | </div>
145 | </div>
146 | </div>
147 |
148 | <!--Banner And Footer-->
149 | <div class="banner">
150 |     <div class="bannerText" data-aos="fade-right" data-aos-duration="1000">
151 |         <h1>
152 |             Download the SelfCare App Today <br /><span style="font-size: 1.6vw; font-weight: normal"
153 |                 class="bannerInnerText">Stay Updated and get all your medical needs taken care of!</span>
154 |         </h1>
155 |         <a href="/"></a>
156 |         <a href="/"></a>
157 |     </div>
158 |     <div class="bannerImg" data-aos="fade-up" data-aos-duration="1000">
159 |         
160 |     </div>
161 | </div>
162 |
163 | <div class="footer">
164 |     <h1>SelfCare</h1>
165 |     <div class="footerlinks">
166 |         <a href="/home" class="mainLink">Home</a>
167 |         <a href="/info">Info</a>
168 |         <a href="/about">About Us</a>
169 |         <a href="/contact">Contact Us</a>
170 |     </div>
171 | </div>
172 | </div>
173 | <script src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
174 | <script>
175 |     AOS.init();
176 | </script>
177 | </body>
178 |
179 | </html>

```

7.2.2. about.html

```

1  <!DOCTYPE html>
2  <html lang="en">
3
4  <head>
5      <meta charset="UTF-8">
6      <meta http-equiv="X-UA-Compatible" content="IE=edge">
7      <meta name="viewport" content="width=device-width, initial-scale=1.0">
8      <link rel="shortcut icon" href="{url_for('static', filename='images/fevicon.png')}" type="image/x-icon">
9      <title>Self Care - About Us</title>
10     <link rel="stylesheet" href="{url_for('static', filename='css/about.css')}">
11     <link rel="stylesheet" href="{url_for('static', filename='css/style.css')}">
12     <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.css" />
13     <link href="https://fonts.googleapis.com/css2?family=Playfair+Display:wght@600&display=swap" rel="stylesheet" />
14     <link href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/5.10.0/css/all.min.css" rel="stylesheet">
15 </head>
16 <style>
17     .footer {
18         margin-bottom: 20px;
19     }
20
21     h1 {
22         margin: 21.44px 0px;
23     }
24 </style>
25
26 <body>
27     <div class="wrapper">
28         <!--Navigation Bar-->
29         <div class="nav">
30             <div class="logo">
31                 <a href="/"></a>
32             </div>
33             <div class="links">
34                 <a href="/">Home</a>
35                 <a href="/info">Info</a>
36                 <a href="/about" class="mainLink">About Us</a>
37                 <a href="/contact">Contact Us</a>
38                 <a href="/upload" class="btn1">Predict</a>
39             </div>
40         </div>
41         <div class="landing">
42             <div class="landingText" data-aos="fade-up" data-aos-duration="1000">
43                 <h1>
44                     We are a team of
45                     <span style="color: #e0501b; font-size: 4vw">Arrhythmia Prediction</span>
46                 </h1>
47                 <h3>
48                     In this project, we build an effective electrocardiogram (ECG) arrhythmia classification method

```

```

49         using a convolutional
50         neural network (CNN), in which we classify ECG into seven categories, one being normal and the other
51         six being different
52         types of arrhythmia using deep two-dimensional CNN with grayscale ECG images. We are creating a web
53         application where
54         the user selects the image which is to be classified. The image is fed into the model that is
55         trained and the cited
56         class will be displayed on the webpage.
57     </h3>
58 </div>
59 <div class="landingImage" data-aos="fade-down" data-aos-duration="2000">
60     
61 </div>
62 </div>
63 <div class="main">
64     <div class="profile-card">
65         <div class="img">
66             
67         </div>
68         <div class="caption">
69             <h3>Vijay Anand </h3>
70             <p>Web Developer, Full Stack Developer, AI Learning Engineer</p>
71             <div class="social-links">
72                 <a href="#"><i class="fab fa-facebook"></i></a>
73                 <a href="#"><i class="fab fa-instagram"></i></a>
74                 <a href="#"><i class="fab fa-twitter"></i></a>
75             </div>
76         </div>
77     </div>
78     <div class="profile-card">
79         <div class="img">
80             
81         </div>
82         <div class="caption">
83             <h3>Pritha V </h3>
84             <p>Front End Developer, Machine Learning Engineer</p>
85             <div class="social-links">
86                 <a href="#"><i class="fab fa-facebook"></i></a>
87                 <a href="https://www.instagram.com/the_..._champ/"><i class="fab fa-instagram"></i></a>
88                 <a href="#"><i class="fab fa-twitter"></i></a>
89             </div>
90         </div>
91     </div>
92     <div class="profile-card">
93         <div class="img">
94             
95         </div>
96         <div class="caption">

```

```

96     <div class="caption">
97         <h3>Ruhie N</h3>
98         <p>Back End Developer, AI Learning Engineer</p>
99         <div class="social-links">
100             <a href="#"><i class="fab fa-facebook"></i></a>
101             <a href="#"><i class="fab fa-instagram"></i></a>
102             <a href="#"><i class="fab fa-twitter"></i></a>
103         </div>
104     </div>
105 </div>
106 <div class="profile-card">
107     <div class="img">
108         
109     </div>
110     <div class="caption">
111         <h3>Shyam Praveen Singh</h3>
112         <p>Full Stack Developer, Machine Learning Engineer</p>
113         <div class="social-links">
114             <a href="#"><i class="fab fa-facebook"></i></a>
115             <a href="#"><i class="fab fa-instagram"></i></a>
116             <a href="#"><i class="fab fa-twitter"></i></a>
117         </div>
118     </div>
119 </div>
120 </div>
121 <div class="footer">
122     <h1>SelfCare</h1>
123     <div class="footerlinks">
124         <a href="/home">Home</a>
125         <a href="/info">Info</a>
126         <a href="/about" class="mainLink">About Us</a>
127         <a href="/contact">Contact Us</a>
128     </div>
129 </div>
130 </div>
131
132 </div>
133 <script src="https://cdnjs.cloudflare.com/ajax/libs/aos/2.3.1/aos.js"></script>
134 <script>
135     AOS.init();
136 </script>
137 </body>
138
139 </html>

```

7.2.3. Predict.html

```

1  {% extends "predict_base.html" %} {% block content %}
2
3  <center>
4      <h2 style="font-size: 48px;">
5          ECG Arrhythmia
6          <span style="color: #2f8b00; font-size: 3vw;">Classification</span>
7      </h2>
8  </center>
9
10 <div>
11     <form id="upload-file" method="post" enctype="multipart/form-data">
12         <center> <label for="imageUpload" class="upload-label">
13             Choose...
14         </label>
15         <input type="file" name="file" id="imageUpload" accept=".png, .jpg, .jpeg">
16     </center>
17 </form>
18
19 <center>
20     <div class="image-section" style="display:none;">
21         <div class="img-preview">
22             <div id="imagePreview">
23             </div>
24         </div>
25     </div>
26 </center>
27 </div>
28 <center>
29     <div class="btn3" id="btn-predict"
30         style="padding: 8px 34px; width: 120px; margin-top: 30px; padding: 14px 20px 12px 20px; background-color: #007bff; border-radius: 45px; text-align: center; color: #fff; cu
31         Predict</div>
32     <div class="loader" style="display:none;"></div>
33 </center>
34
35 <h3 style="color: black" id="result">
36     <span> </span>
37 </h3>
38
39 </div>
40
41 </div>
42
43
44
45 {% endblock %}

```


8. TESTING:

8.1. TEST CASES:

Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status
EditorPage_TC_OO_1	Functional	Visual Studio Editor	Open the Visual Studio Editor and click the app.py	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		Working correctly	Working as expected	Pass
Navigation_TC_OO_2	Functional	Home Page	Validate all the tabs in the navigator	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		All the 3 tabs should visible	Working as expected	Pass
Home_TC_OO3	Functional	Home page	Verify the Visibility of the image	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		User should able to see the image	Working as expected	Pass
HomePage_TC_OO_4	Functional	Home page	Validate the description of the image	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		Description should be visible on the window	Working as expected	Pass
HomePage_TC_OO_5	Functional	Home page	Verify the user is able to navigate	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		It should redirect the user to the same window	Working as expected	Pass
InfoPage_TC_OO_1	Functional	Info Page	Verify the user is in the introduction	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		User should be in the introduction	Working as expected	Pass
InfoPage_TC_OO_2	Functional	Info Page	verify the page title and information	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		User should able to view the page	Working as expected	Pass
PredictPage	Functional	Predict	verify the working of predict page	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		User should be able to visit the page	Working as expected	Pass
PredictPage	Functional	Predict	verify the upload image option	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		Make sure the option works	Working as expected	Pass
Predict	Functional	Predict	Verify the choose button is enable	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		The Choose button option should	Working as expected	Pass
Predict	Functional	Predict	Verify the user is able to access	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		Image should be Uploaded	Working as expected	Pass
Predict	Functional	Predict	verify the selected image is same	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		Selected image should be ECG 2D array structure	Working as expected	Pass
Predict	Functional	Predict	verify the working condition	Knowledge about Python, keras, tensorflow	1.Enter URL and click go		The Type of Arrhythmia should be found and result is displayed in the predict window	Working as expected	Pass

8.2. USER ACCEPTANCE TESTING :

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project 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	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

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
Predict Page	7	0	0	7
Different Types of ECG Images	10	0	0	10
Further Classification	4	0	0	4
Home Page	3	0	0	3
Info Page	6	0	0	6
Final Report Output	1	0	0	1

9.RESULTS:

9.1. PERFORMANCE METRICS :

The two significant optimization parameters in the proposed 2-D CNN 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).

Batch sizes and average accuracy for a learning rate of 0.001.

Learning Rate	Batch Size	Average Accuracy
0.001	2800	99.11
0.001	2000	98.96
0.001	1000	99.00
0.001	500	98.95
0.001	100	98.93

Learning rate and average accuracy for a batch size of 2800.

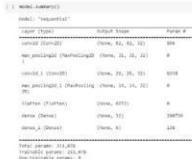


Batch Size	Learning Rate	Average Accuracy
2800	0.001	99.11
2000	0.001	98.96
1000	0.001	99.00
500	0.001	98.95
100	0.001	98.93

We compared the proposed CNN-based model with recent techniques for the automatic classification of arrhythmia where the algorithm achieved 97.88% average sensitivity, 99.61% specificity, 99.11% average accuracy, and 98.59% positive predictive value (precision). These values indicate improved performance when compared with recent methods using of 1-D and 2-D CNNs, given the same arrhythmia classification. The results also show that the proposed CNN algorithm has better results in terms of accuracy with both the augmented and without augmented data.

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

Model Performance Testing:

Project team shall fill the following information in model performance testing template.

S.No.	Parameter	Values	Screenshot
1.	Model Summary	-	
2.	Accuracy	Training Accuracy - Validation Accuracy -	
3.	Confidence Score (Only Yolo Projects)	Class Detected - Confidence Score -	

10.ADVANTAGES & DISADVANTAGES:

10.1. ADVANTAGES :

- 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.
- To overcome the challenge for the visual and physical explanation of the ECG signal, computer-aided study has been developed to automatically identify such signals automatically.
- A careful study of ECG signals is crucial for precise diagnoses of patients' acute and chronic heart conditions.
- The performance is significant in other indices as well, including sensitivity and specificity, which indicates the success of the proposed method.
- A simple User Interface for the users to classify their ECG report.
- Great User Experience to make is simple and easy to use for users and patients while accessing the website

10.2 DISADVANTAGES:

- The efficiency and accuracy of could be negatively affected by the increasing size of data.
- The techniques presented been applied to smaller datasets.
- For the purpose of generalization, the performance should betested on larger datasets.
- 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.

11. CONCLUSION:

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 heart diseases. 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 seven kinds of arrhythmia. 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 heart diseases. The proposed scheme can help experts diagnose heart diseases 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.

12. FUTURE SCOPE :

For future work, it would be interesting to explore the use of optimization techniques to find a feasible design and solution. The limitation of our study is that we have yet to apply any optimization techniques to optimize the model parameters and we believe that with the implementation of the optimization, it will be able to further elevate the performance of the proposed solution to the next level.

These are the further improvements that can be made in the future:-

- Further classification for up to 8-10 different types of arrhythmia will be possible.

- > Improved accuracy for bigger data size.
- > The techniques presented been applied to smaller datasets can be made much faster and efficient.
- > Improved UI & UX for the users.

13. APPENDIX:

SOURCE CODE LINK: <https://github.com/IBM-EPBL/IBM-Project-46075-1660736167/tree/main/Final%20Deliverable>

PROJECT DEMO LINK:

https://drive.google.com/file/d/1zl8Pe2i4ERehoGdL7C_weJvFyIJI4d7D/view?usp=share_link

GITHUB LINK: <https://github.com/IBM-EPBL/IBM-Project-46075-1660736167>