

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

A PROJECT REPORT

Submitted By

KANDULA NAGA REDDAIAH

SREERAMANENI GIRISH

THOPUGUNTA PAVAN KUMAR

YALAGALA VENKATA RAMANA

in partial fulfilment for the award of the degree

of

Bachelor of Engineering

IN

Electronics and Communication Engineering

SAVEETHA ENGINEERING COLLEGE – THANDALAM

CHENNAI-602 105

DECEMBER-2022

SAVEETHA ENGINEERING COLLEGE: CHENNAI-602 105

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 “**KANDULA NAGA REDDAIAH, SREERAMANENI GIRISH, THOPUGUNTA PAVAN KUMAR, YALAGALA VENKATA RAMANA**” who carried out the project work under my supervision.

SIGNATURE

Dr. SRIGITHA S. NATH,

**HEAD OF THE DEPARTMENT
ECE DEPARTMENT,
SAVEETHA ENGINEERING COLLEGE**

SIGNATURE

Dr. S. KUMARAN

**SUPERVISOR
ECE DEPARTMENT,
SAVEETHA ENGINEERING COLLEGE**

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO.
1	INTRODUCTION	5
	1.1 Project Overview	
	1.2 Purpose	
2	LITERATURE SURVEY	6
	2.1 Existing problem	
	2.2 References	
	2.3 Problem Statement Definition	
3	IDEATION & PROPOSED SOLUTION	9
	3.1 Empathy Map Canvas	
	3.2 ideation & Brainstorming	
	3.3 Proposed Solution	
	3.4 Problem Solution fit	
4	REQUIREMENT ANALYSIS	14
	4.1 Functional requirement	
	4.2 Non-Functional requirements	
5	PROJECT DESIGN	15
	5.1 Data Flow Diagrams	
	5.2 Solution & Technical Architecture	
	5.3 User Stories	
6	PROJECT PLANNING & SCHEDULING	19
	6.1 Sprint Planning & Estimation	
	6.2 Sprint Delivery Schedule	
	6.3 Reports from JIRA	

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
7	CODING & SOLUTIONING	21
	7.1 Feature1	
	7.2 Feature 2	
	7.3 Database Schema	
8	TESTING	27
8.1	Test Cases	
	8.2 User Acceptance Testing	
9	RESULTS	28
	9.1 Performance Metrics	
10	ADVANTAGES & DISADVANTAGES	30
	10.1 Advantages	
	10.2 Disadvantages	
11	CONCLUSION	31
12	FUTURE SCOPE	31
13	APPENDIX	32
	Source Code	
	GitHub & Project Demo Lin	

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

1. INTRODUCTION:

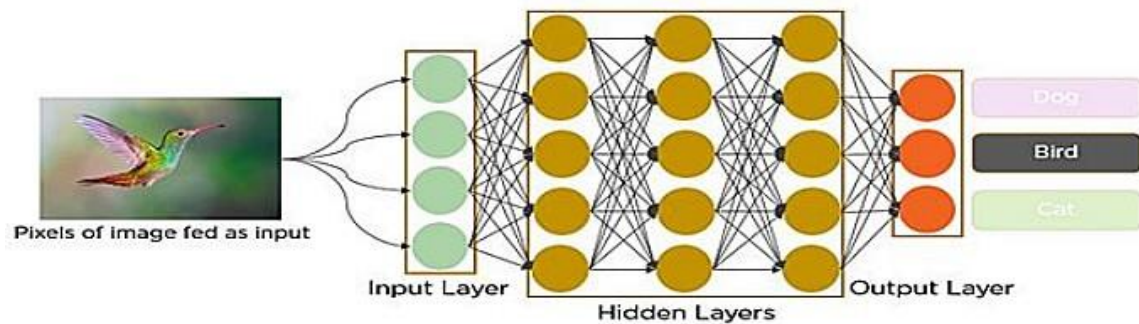
1.1. PROJECT OVERVIEW:

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.



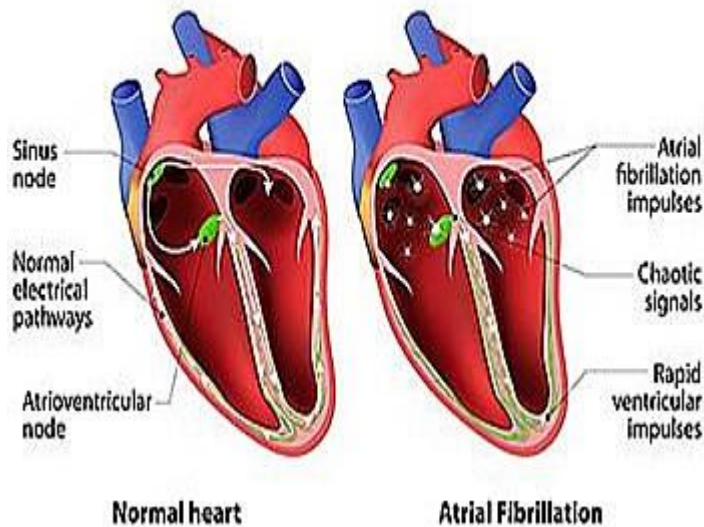
In deep learning, a convolutional neural network (CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyze visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. 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. EXISTING PROBLEM:

Cardiovascular diseases (CVDs) are the number one cause of death today. Over 17.7 million people died from CVDs in the year 2017 all over the world which is about 31% of all deaths, and over 75% of these deaths occur in low and middle-income countries. Arrhythmia is a representative type of CVD that refers to any irregular change from the normal heart rhythms. There are several types of arrhythmia including atrial fibrillation, premature contraction, ventricular fibrillation, and tachycardia.

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:

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
- 3-6 people recommended

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

Team gathering

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

Set the goal

Think about the problem you'll be focusing on looking at the brainstorming session.

Learn how to use the facilitation tools

Use the Facilitation Superpowers for such a happy and productive session.

Open article

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 (your problem statement)?

The primary goal of our study is to categorize and identify the use of various and diverse types of the most and most appropriate. Due to comprehensive opportunities, there is a need for a classification of enough more as a means for research and design decision making. The model is used to state the importance of an early stage design process, communication and management actions. Early detection, along with other preventive measures, to ensure secondary threat patterns.

Key rules of brainstorming

To run an effective and productive session

- Stay in topic
- Encourage wild ideas
- Defer judgment
- Listen to others
- Go for volume
- Be positive, be present

Need some inspiration?

See a forecast & content of this template to inspire your work.

Open example

Brainstorm

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

© 70 minutes

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



TIP
You can estimate a company's market value by multiplying its annual sales by a "multiple" (usually between 0.5 and 1.5).

3

Group Ideas

Take time 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 can break it up into smaller sub-groups.

© 20 minutes.

Retrospective

What went well...

1

1

11

What didn't went well

1

1

Action

22

Tip Add nonattributable tags to study results to make it easier to find relevant, engaging, and actionable important ideas as they arise within your record.



Brainstorm

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

© 10 minutes

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



319

These were followed by a series of further general tests (see protocol) (number of trials: 100; no. trials: 100; no. trials: 100).

Gro

Take time 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 can break it up into smaller sub-groups.

© 20 minutes

Retrospective

What went well...

What didn't went well

Action



THE

Just a reminder: make sure to study carefully to make it easier to find answers, organize, and categorize important ideas as chapters within your mind.



3.3. PROPOSED SOLUTION:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Classifying this disorder for the ECG will be the best challenge because only few dissimilar variations are there between every type of this disorder. We know that Arrhythmia is a heart related disorder and can either be curable or incurable.
2.	Idea / Solution description	Our vision is to create a model using deep learning that can read the ECG and can disperse the Arrhythmia even by those similarities.
3.	Novelty / Uniqueness	The classification is developed by using deep learning with 2-D ECG Spectral Image representation helping to diagnose the difference between each and every Arrhythmia which can be differentiated by ECG.
4.	Social Impact / Customer Satisfaction	This further helps doctors to diagnose simply and the patients do not need to be panic and worry about their living.
5.	Business Model (Revenue Model)	Artificial Intelligence is today's most heralded technologies and this model is for health care. This application is most likely to be used by income.
6.	Scalability of the Solution	Expansion of the model depends on the training and model accuracy which helps the model to train itself. More training of the model leads to a good prediction of the model.

3.4. PROBLEM SOLUTION FIT:

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) <small>Who is your customer? i.e. working parents of 0-5 y.o. kids</small>	6. CUSTOMER CONSTRAINTS <small>What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.</small>	5. AVAILABLE SOLUTIONS <small>Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking</small>	Explore AS, differentiate
	<div>1. Patients</div> <div>2. Medical practitioner</div>	<div>1. Easy to use</div> <div>2. Best Quality</div>	<div>1. Using ECG spectrum AI model predicts cardiovascular disease.</div>	
Focus on J&P, tap into BE, understand RC	2. JOBS-TO-BE-DONE / PROBLEMS <small>Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.</small>	9. PROBLEM ROOT CAUSE <small>What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.</small>	7. BEHAVIOUR <small>What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)</small>	Focus on J&P, tap into BE, understand RC
	<div>1. Clear vision for doctors</div> <div>2. Approach from hospitals</div>	<div>1. It is not easy to diagnose similarities between arrhythmia through ECG.</div>	<div>1. It is the easy way to find the classification of this disorder.</div>	
Identify strong TR & EM	3. TRIGGERS <small>What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.</small>	10. YOUR SOLUTION <small>If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.</small>	8. CHANNELS of BEHAVIOUR 8.1 ONLINE <small>What kind of actions do customers take online? Extract online channels from #7</small> 8.2 OFFLINE <small>What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.</small>	Identify strong TR & EM
	<div>1. This would be more effective because, due to lack of correct diagnose some people loose their life.</div>	<div>1. classification is done based on the treatment accordingly can be diagnosis easily comparing to manual.</div>	<div>1. This model can predict future disease saving life's of many people.</div>	
	4. EMOTIONS: BEFORE / AFTER <small>How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design.</small>			
	<div>1. Decrease in anxiety.</div> <div>2. Proper treatment for proper diagnosis.</div> <div>3. Decrease in doctors pressure.</div>			

4. REQUIREMENT ANALYSIS:

4.1. FUNCTIONAL *REQUIREMENT*:

Functional Requirements:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration is done through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation through OTP
FR-3	Image upload	The user can be able to upload the pictures on the web application.
FR-4	Results	The user should be able to view the results i.e the type of arrhythmia when they upload the image of ECG.
FR-5	Authentication	The website should authenticate the users once they sign in.
FR-6	Data pre-processing	The data should be pre-processed.

4.2. **NON-FUNCTIONAL REQUIREMENTS:**

Non-functional Requirements:

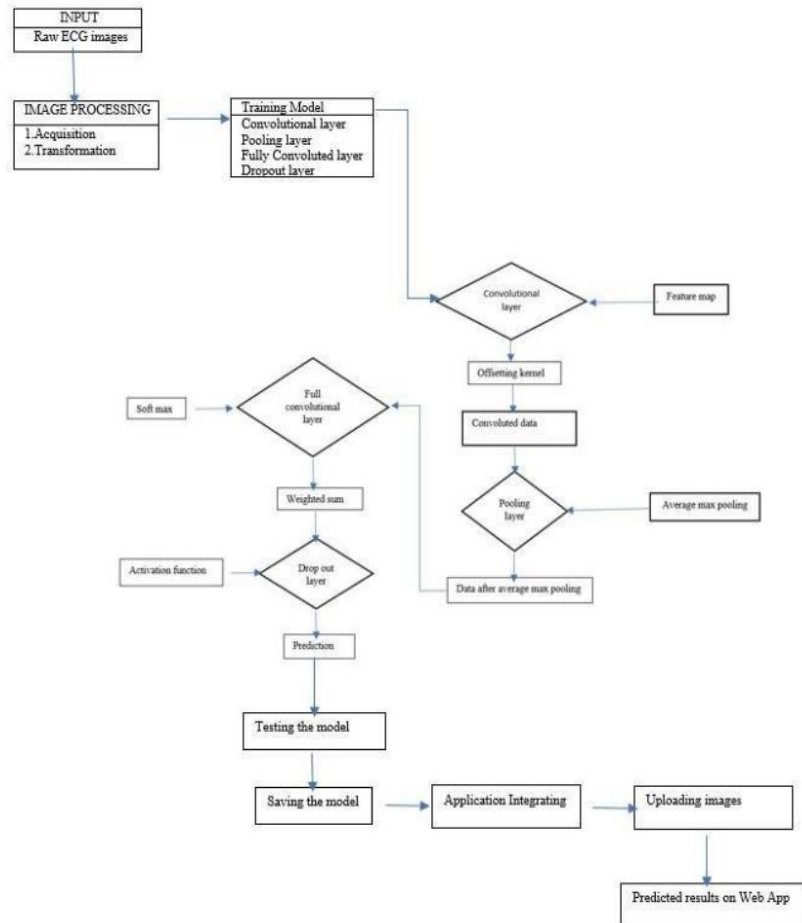
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The web app should be easy to learn, navigate, use and it should be user-friendly and error tolerant.
NFR-2	Security	The web application should be enough to protect the images uploaded by the users and should protect the personal details provided by the users when they sign-up.
NFR-3	Reliability	The web application should be consistent thought the results over time between users and it should provide the accurate results to each and every user.

NFR-4	Performance	The web page is to load within three seconds and be able to shoe the results within two thirds of the second after the images are uploaded by the users.
NFR-5	Availability	The web application should be able to show output at each all times of the day. It can be accessed through the globe.
NFR-6	Scalability	The web app should be able sustain the rapid growth for the user count and also showing in time.

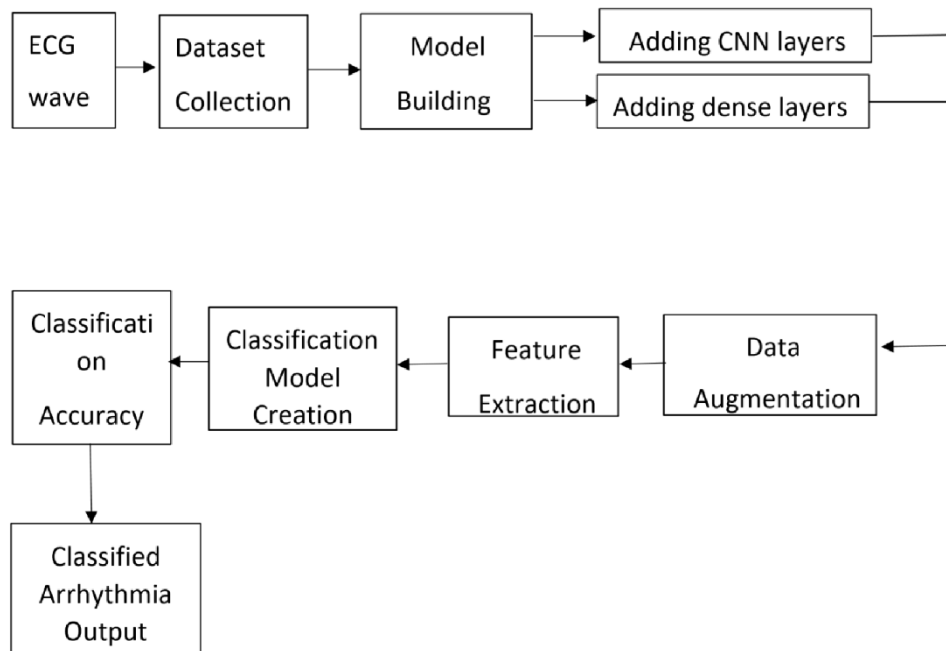
5. PROJECT DESIGN:

5.1. DATA FLOW DIAGRAMS:



5.2. SOLUTION & TECHNICAL ARCHITECTURE:

Solution Architecture:



5.3. USER STORIES :

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 (Web user)	Registration	USN-1	As a web 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 web user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a web user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a web 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 web user, I can log into the application by entering email & password	I can access my account	High	Sprint-1
	Dashboard	USN-6	As a web user, I can view the picture on the webpage once I uploaded it.	I get and "Upload Successful" pop-up	Medium	Sprint-1
		USN-7	As a web user, I can view the results for the image I uploaded.	Result is displayed.	High	Sprint-1
Customer Care Executive	Login	USN-1	As a Customer Care Executive, I can login with my credentials.	I can access my account	High	Sprint-1
	Dashboard	USN-2	As a Customer Care Executive, I can see all the information, I can view the picture on the webpage once I uploaded it	I get and "Upload Successful" pop-up	High	Sprint-1
	Responsibilities	USN-3	As a Customer Care Executive, I am able to resolve the customers' complaints.	Manage and resolve complaints	High	Sprint-1
Administrator	Login	USN-1	As an administrator, I can login with my credentials.	I can access my account/dashboard	High	Sprint-1
	Dashboard	USN-2	As an administrator, I can see all the information, I can view the picture on the webpage once I uploaded it.	I can see all the information in the dashboard.	Low	Sprint-2

6. PROJECT PLANNING & SCHEDULING:

6.1. SPRINT PLANNING & ESTIMATION:

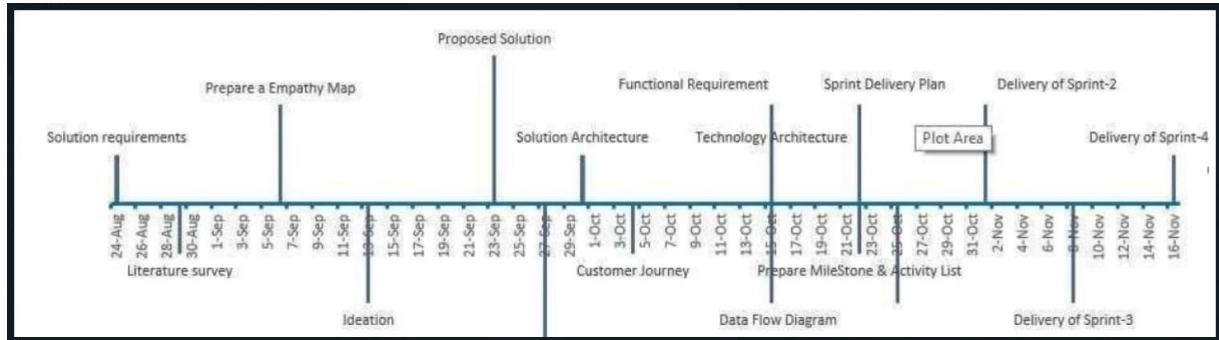
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Download The Dataset	USN-1	We can download the Dataset contains Six classes	4	Low	Pritha R
Sprint-1	Import The ImageDataGenerator Library	USN-2	We can import ImageDataGenerator	4	Low	Ruhie N
Sprint-1	Configure ImageDataGenerator class	USN-3	We can configure the ImageDataGenerator class	6	Medium	Shyam Praveen Singh
Sprint-1	Apply the ImageDataGenerator functionality to Train Set and Dataset	USN-4	We can apply ImageDataGenerator to train dataset	6	Medium	Vijay Anand M

Sprint-2	Import Libraries	USN-5	We can import required Libraries	1	Low	Pritha R
Sprint-2	Initialize the Model	USN-6	Initializing the Image recognition model	2	Medium	Ruhie N
Sprint-2	Adding CNN layer	USN-7	We can add Convolutional Neural Network(CNN) used for image/object recognition and classification	3	High	Shyam Praveen Singh
Sprint-2	Adding Dense Layer	USN-8	We can add Dense Layer in which each neuron receives input from all the neurons of previous layer	3	High	Vijay Anand M
Sprint-2	Configure The Learning Process	USN-9	We can configure The Learning process which is a method, mathematical logic or algorithm that improves the network's performance and/or training time.	4	High	Pritha R
Sprint-2	Train the Model	USN-10	We can train our model with our image dataset. fit_generator functions used to train a deep learning neural network	4	High	Vijay Anand M
Sprint-2	Save the Model	USN-11	We can save The model with .h5 extension	2	Medium	Shyam Praveen Singh
Sprint-2	Test the model	USN-12	We can Test the model through Loaded necessary libraries, the saved model	1	Medium	Ruhie N
Sprint-3	Create Html files	USN-13	We use HTML to create the front end part of the web page.	8	High	Pritha R
Sprint-3	Build Python code	USN-14	We build the flask file 'app.py' which is a web framework written in python for server-side scripting.	8	High	Vijay Anand M
Sprint-3	Run the App	USN-15	We can run the App	4	Medium	Shyam Praveen Singh
Sprint-4	Register IBM Cloud	USN-16	We can register IBM Cloud	8	Medium	Vijay Anand M

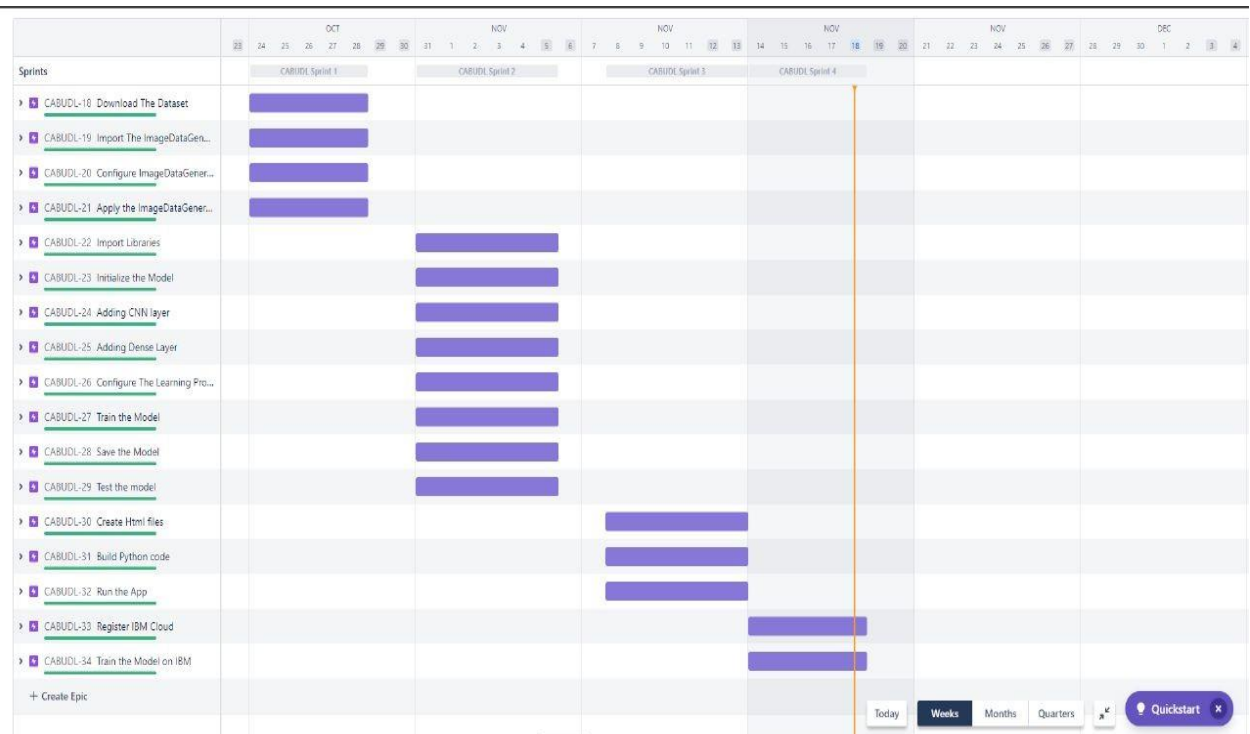
Sprint-4	Train the model on IBM	USN-17	We can Train Out model on IBM	12	High	Ruhie N
----------	------------------------	--------	-------------------------------	----	------	---------

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>
48     </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 Youe 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: 40px;">
5          ECG Arrhythmia
6          <span style="color: #2f8be0; 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
29 <center>
30     <div class="btn3" id="btn-predict"
31         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
32         Predict</div>
33     <div class="loader" style="display:none;"></div>
34 </center>
35
36 <h3 style="color: Black" id="result">
37     <span> </span>
38 </h3>
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.

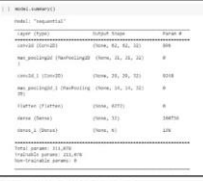


Batch Size	Learning Rate	Average Accuracy
2800	0.001	99.11
2000	0.001	98.96
1000	0.001	99.00
500	0.001	98.95
100	0.001	98.93

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 further study, 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 upto 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-23797-1659930232/tree/main/Final%20Deliverables>

PROJECT DEMO LINK:

<https://youtu.be/PUv5gO0hMpU>

GITHUB LINK:

<https://github.com/IBM-EPBL/IBM-Project-23797-1659930232>