1. INTRODUCTION

1.1 Project Overview

The electrocardiogram (ECG) is one of the most extensively employed signals used in the diagnosis and prediction of cardiovascular diseases (CVDs). The ECG signals can capture the heart's rhythmic irregularities, commonly known as arrhythmias. A careful study of ECG signals is crucial for precise diagnoses of patients' acute and chronic heart conditions. In this study, we propose a two-dimensional (2-D) convolutional neural network (CNN) model for the classification of ECG signals into eight classes; namely, normal beat, premature ventricular contraction beat, paced beat, right bundle branch block beat, left bundle branch block beat, atrial premature contraction beat, ventricular flutter wave beat, and ventricular escape beat. The one-dimensional ECG time series signals are transformed into 2-D spectrograms through short-time Fourier transform. The 2-D CNN model consisting of four convolutional layers and four pooling layers is designed for extracting robust features from the input spectrograms. Our proposed methodology is evaluated on a publicly available MIT-BIH arrhythmia dataset. We achieved a state-of-the-art average classification accuracy of 99.11%, which is better than those of recently reported results in classifying similar types of arrhythmias. The performance is significant in other indices as well, including sensitivity and specificity, which indicates the success of the proposed method

1.2 Purpose

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.

2. LITERATURE SURVEY

2.1 Existing problem

Previous studies on arrhythmia were used to diagnose the abnormally fast, slow, or irregular heart rhythm through ECG (Electrocardiogram), which is one of the biological signals. ECG has the form of P-QRS-T wave, and many studies have been done to extract the features of QRS-complex and R-R interval. However, in the conventional method, the P-QRS-T wave must be accurately detected, and the feature value is extracted through the P-QRS-T wave. If an error occurs in the peak detection or feature extraction process, the accuracy becomes very low. Therefore, in this paper, we implement a system that can perform PVC (Premature Ventricular Contraction) and PAC (Premature Atrial Contraction) classification by using P-QRS-T peak value without feature extraction process using deep neural network. The parameters were updated for PVC and PAC classification in the learning process using P-QRS-T peak without feature value. As a result of the performance evaluation, we could confirm higher accuracy than the previous studies and omit the process of feature extraction, and the time required for the pre-processing process to construct the input data set is relatively reduced.

2.2 References

1. *Mc Namara, K.; Alzubaidi, H.; Jackson, J.K. Cardiovascular disease as a leading cause of death: How are pharmacists getting involved? Integr. Pharm. Res. Pract. 2019, 8, 1*

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

3. *Salem, M.; Taheri, S.; Yuan, J.S. ECG arrhythmia classification using transfer learning from 2-dimensional deep CNN features. In Proceedings of the 2018 IEEE Biomedical Circuits and Systems Conference (BioCAS), Cleveland, OH, USA, 17–19 October 2018; IEEE: Piscataway, NJ, USA, 2018; pp. 1–4.*

4.*S. Hong, Y. Zhou, J. Shang, C. Xiao, and J. Sun, "Opportunities and challenges of deep learning methods for electrocardiogram data: a systematic review," Computers in Biology and Medicine, vol. 122, p. 103801, 2020.View at: Publisher Site | Google Scholar*

5. *F. Murat, O. Yildirim, M. Talo, U. B. Baloglu, Y. Demir, and U. R. Acharya, "Application of deep learning techniques for heartbeats detection using ECG signals-analysis and review," Computers in Biology and Medicine, vol. 120, p. 103726, 2020.*

View at: Publisher Site | Google Scholar

6. *Mustaqeem, A.; Anwar, S.M.; Majid, M. A modular cluster based collaborative recommender system for cardiac patients. Artif. Intell. Med. 2020, 102, 101761. [CrossRef] [PubMed]*

7. *Chen, J.; Valehi, A.; Razi, A. Smart Heart Monitoring: Early Prediction of Heart Problems Through Predictive Analysis of ECG Signals. IEEE Access 2019, 7, 120831–120839. [CrossRef]*

8. G. Nikolic, R. L. Bishop, and J. B. Singh, "Sudden death recorded during Holter monitoring," Circulation, vol. 66, no. 1, pp. 218–225, 1982.

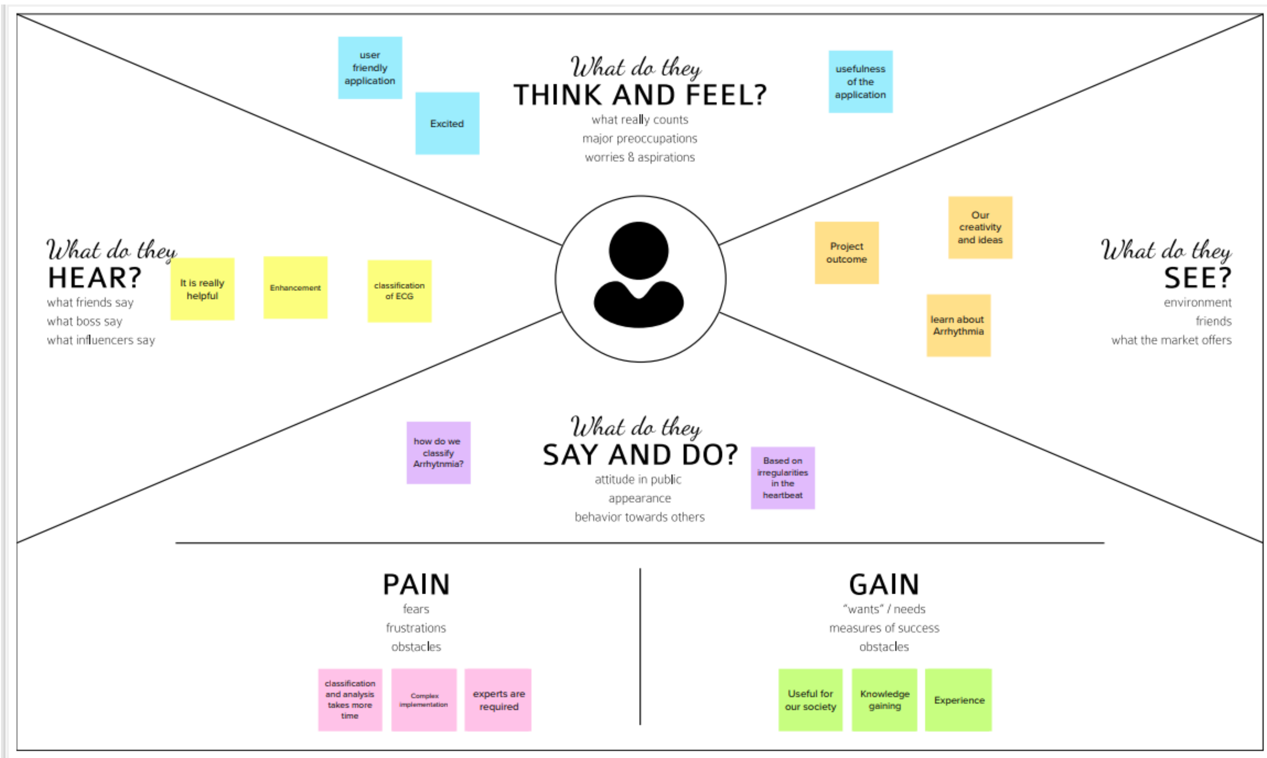
2.3 Problem Statement Definition

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,vertricular 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 side 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.

3. IDEATION & PROPOSED SOLUTION

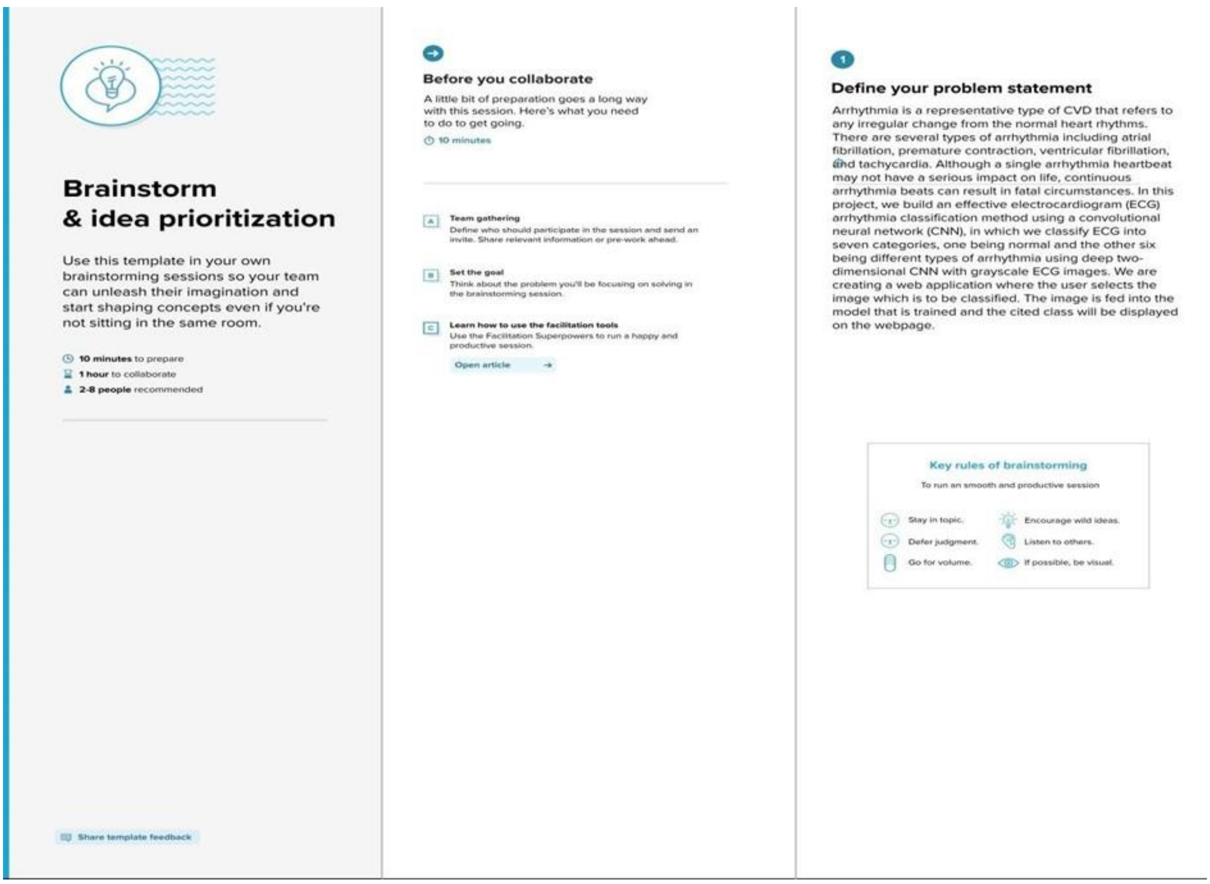
3.1 Empathy Map Canvas

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

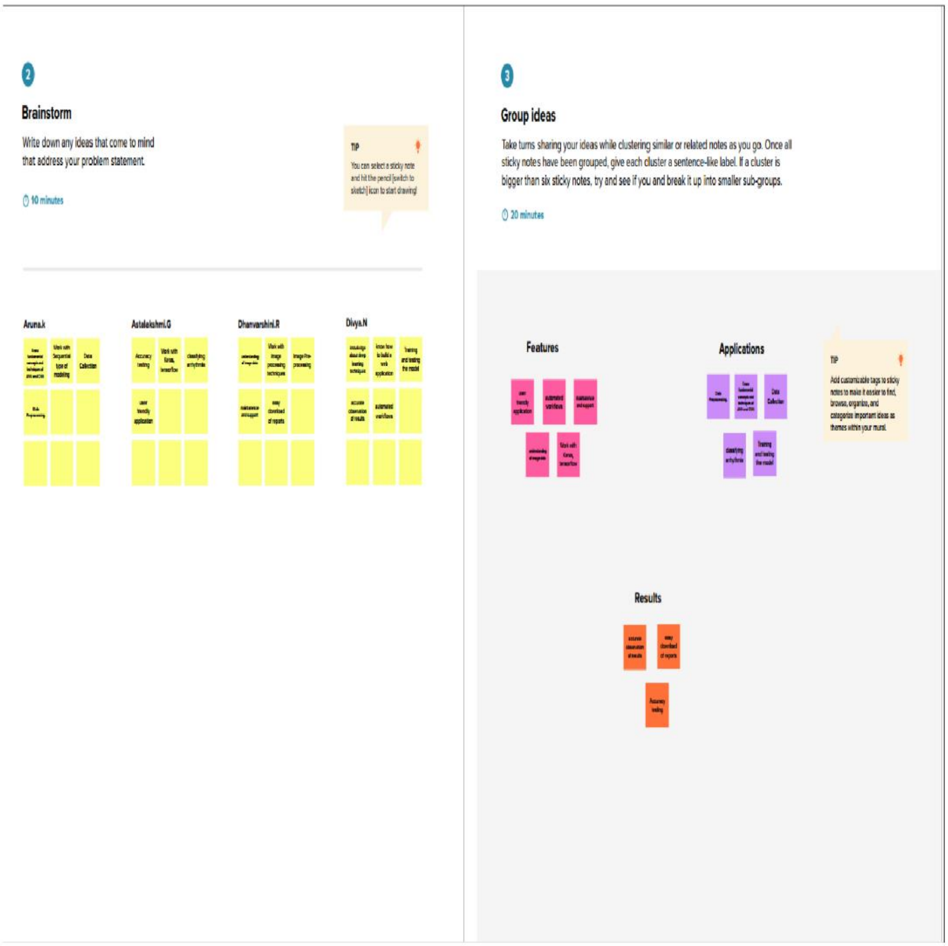


3.2 Ideation & Brainstorming

Step 1: Team Gathering , Collaboration and select the Problem statement



Step 2 : Brainstorm ,Idea Listing and Grouping



3.3Proposed Solution

Classification of arrhythmia using deep learning with 2d ECG spectral image representation.To create an application that is used to classify the arrhythmia and provide more detailed information about it. Here we use deep learning techniques and with the help of2D ECG spectral image to classify the arrhythmia.Provides accurate results and detailed information required by the users or patients.Users or customers can easily use the app because of its user friendly interface and simplicity. Can be used by anyone at any time.As this application can be very useful for the earlier and fast classification of arrhythmia it we beused by many patients suffering by it.Experts guidance is not required when we have a app that can be used by anyone. Data of the patient will be securely stored and maintained for future purposes

3.3 Problem Solution fit

Project Title: Classification of Arrhythmia By Using Deep Learning With 2-D ECG Spectral Image Representation
Team ID:PNT2022TMID00594

Project Design Phase-I - Solution Fit Template

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Patients are our customer

6. CUSTOMER CONSTRAINTS CC

Available Equipments/Devices
- have to know basic image uploading skills.
- have a cell phone / laptop
- have a Gmail / Google Account
- have proper images and medical records

5. AVAILABLE SOLUTIONS AS

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

- wearing a small portable ECG recording device for 24 hours or longer is usual of detection which is considered to be time consuming by users. -Timely treatment is not possible with using only ECG. - Traditional Clinical lab testing but does not use any automated systems related to CVDs.

-Timely treatment is not possible with using only ECG.

Explore AS, differentiat

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

- People / users / patients want to share their reports with clinical experts and their prescribed doctors for further course of action that is need to be taken

- People want do quick conformation anywhere anytime with just having only the images they have from tests.

-The problem here is classification of arrhythmia takes more time and requires experts.

9. PROBLEM ROOT CAUSE RC

-No proper maintenance of patient records in hospitals and labs and leading to privacy issues of patient documents being made publically available under health organizations.

-Arrhythmia means heart is not beating properly . This can cause anything to form cardiac arrest to death

7. BEHAVIOUR BE

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)

- People use different methods of classification techniques under the guidance of doctors and clinical experts for arrhythmia but there no automated systems been

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

- People want to make their life easier, feel safe and connected anytime, anywhere.

- Have a proper web application to make things automated and easy to detect their health with accuracy.

10. YOUR SOLUTION SL

- to propose a 2-D CNN-based classification model for automatic classification of cardiac arrhythmias using ECG signals.

-to make a web application as reliable as possible for the user/patient to feed his image into the model that is trained and the cited class is displayed on the webpage

-to help experts diagnose CVDs by referring to the automated classification of ECG signals.

8. CHANNELS of BEHAVIOUR CH

ONLINE:

- Social media results regarding automated web application create awareness for other users on the efficiency and reliability about the automated classification of cardiac arrhythmias and also Expert advertise online test proofs

OFFLINE:

-Patients need to undergo scan to get images of the heartbeat

Identify strong TR & EM

4. EMOTIONS: BEFORE / AFTER EM

BEFORE: People / patients / users did feel reliable and efficient with traditional ECG methods on automated systems and the web application goal is to change it!

AFTER: It is not required for the patients to wait for long time.If they have their ECG report,the work is almost done

4.REQUIREMENT ANALYSIS

4.1 Functional requirement

Functional Requirements:

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 Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Selection	Knowledge about ECG images Select the image to be classified
FR-4	User Input	Images need to be uploaded
FR-5	Save Image	Images are saved in uploads folder
FR-6	Report Generation	Make the complete report

4.2 Non-Functional requirements

Non-functional Requirements:

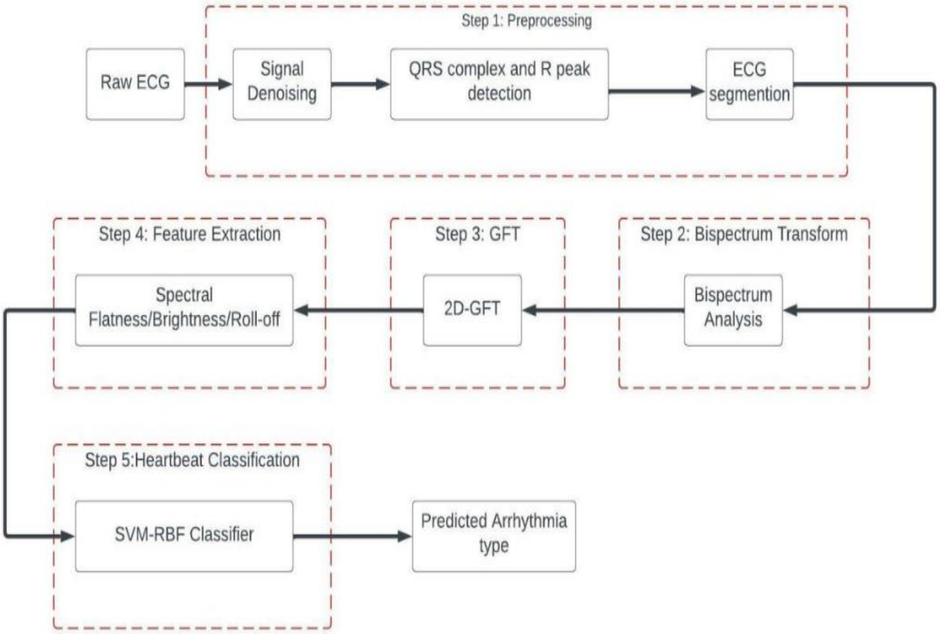
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	An user friendly and simple UI web application. Easy drag and drop options.
NFR-2	**Security**	No third party web and UI is used for prediction of data. Details about user interaction with the wed application are protected.
NFR-3	**Reliability**	Higher accuracy rate. Defect free.
NFR-4	**Performance**	Fast and quick classification of the required class is done.

5.PROJECT DESIGN

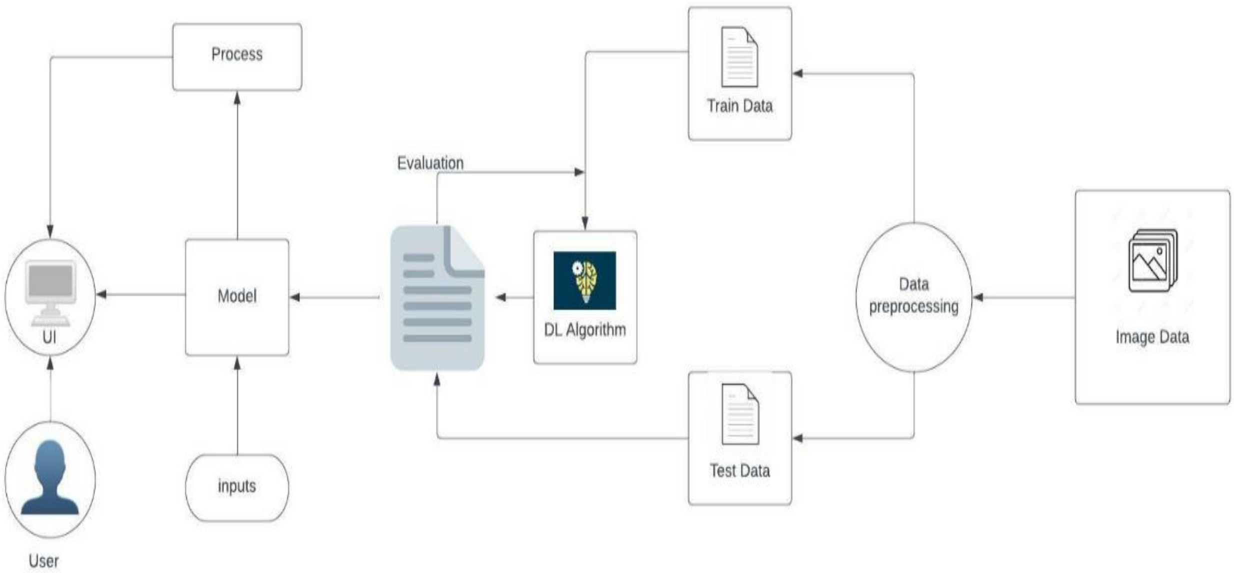
5.1Data Flow Diagrams

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and the routes between each destination.

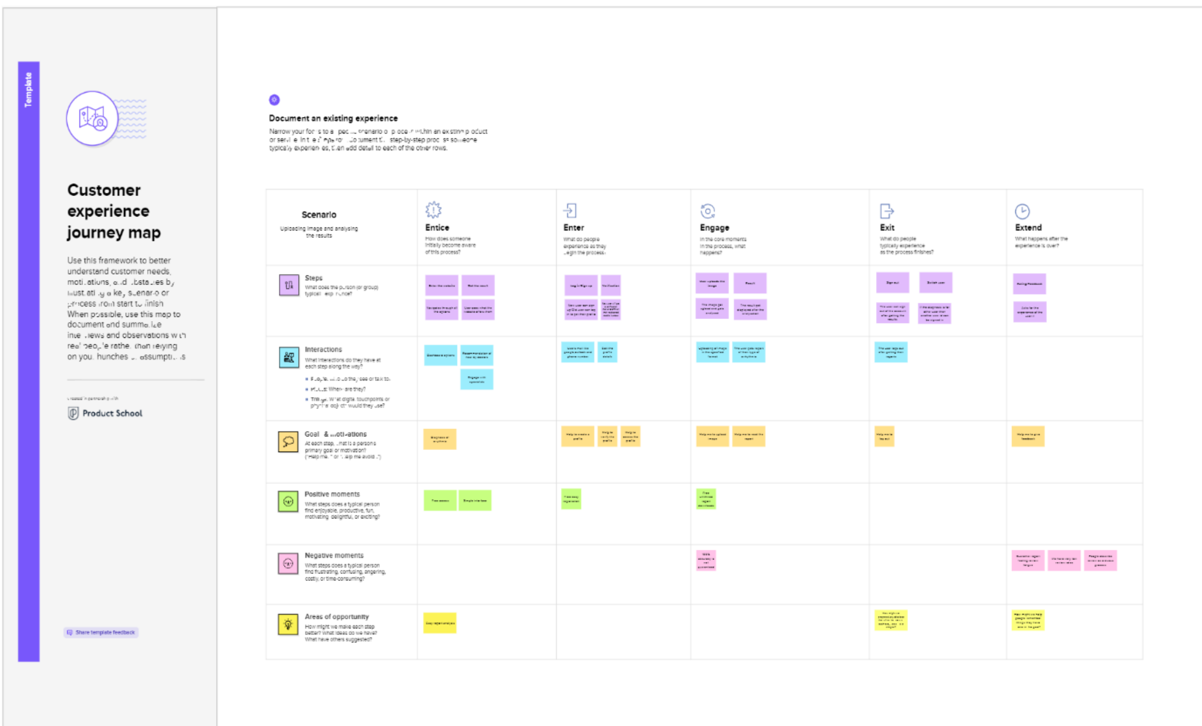


5.2Solution & Technical Architecture

Technical architecture—which is also often referred to as application architecture, IT architecture, business architecture, etc.—refers to creating a structured software solution that will meet the business needs and expectations while providing a strong technical plan for the growth of the software application through its lifetime. IT architecture is equally important to the business team and the information technology team.Technical architecture includes the major components of the system, their relationships, and the contracts that define the interactions between the components. The goal of technical architects is to achieve all the business needs with an application that is optimised for both performance and security.



5.3User Stories



6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

SPRINT 1

1. Download the dataset

main

IBM-Project-3031-1658497812 / Project development phase / Sprint 1 / Download The Dataset / Dataset collection.md

Aruna569 rename History

1 contributor

7 lines (6 sloc) | 271 Bytes

Dataset Collection:

Since Zip file size more than 25MB I have shared the Google Drive Link For accessing the data been collected for the project !

Reference:

https://drive.google.com/file/d/1kkp-sPu5FzARcNgdZ_WoXSsxWqN5dBR9/view?usp=sharing

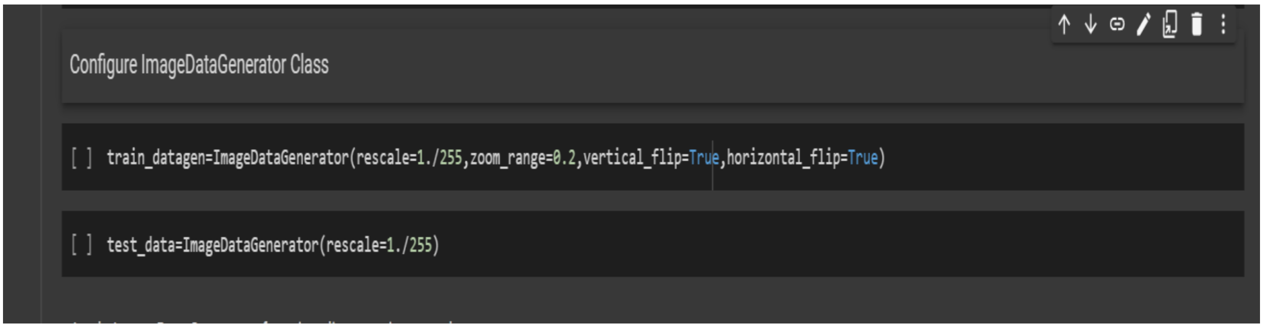
2. Image Preprocessing

a)Import the ImageDataGenerator Library

Import the ImageDataGenerator library

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

b)Configure ImageDataGenerator Class

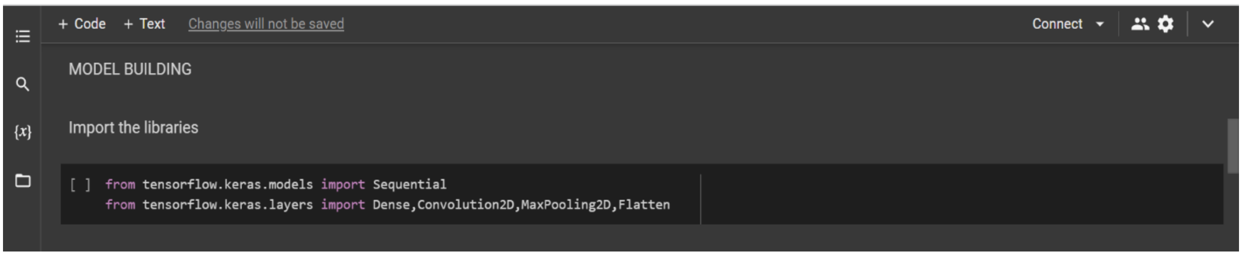


c)Apply ImageDataGenerator functionality to trainset and test set

SPRINT 2

Model Building

1. Import the libraries



2.Initialize the mode

3.Adding CNN layers

Adding CNN Layers

```
[ ] model.add(Convolution2D(32,(3,3),activation="relu",strides=(1,1),input_shape=(64,64,3)))
```

```
[ ] model.add(MaxPooling2D(pool_size=(2,2)))
```

```
[ ] model.add(Flatten())
```

```
[ ] model.summary()
```

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

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

 flatten (Flatten)           (None, 30752)             0

=================================================================
Total params: 896
Trainable params: 896
Non-trainable params: 0
_________________________________________________________________
```

4.Adding Dense layer

Adding Dense Layers

Hidden Layer

```
[14] model.add(Dense(500,activation="relu"))
```

Output Layer

```
[15] model.add(Dense(6,activation="softmax"))
```

5. Configure the learning process

Configure the learning process

```
[ ] model.compile(loss="categorical_crossentropy",optimizer="adam",metrics=['accuracy'])
```

```
[ ] len(x_train)
```

```
120
```

6 Train the model

Train the model

```
model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 5756s 48s/step - loss: 1.6898 - accuracy: 0.4805 - val_loss: 1.3704 - val_accuracy: 0.4504
Epoch 2/5
120/120 [==============================] - 125s 1s/step - loss: 0.8183 - accuracy: 0.7325 - val_loss: 0.9316 - val_accuracy: 0.6563
Epoch 3/5
120/120 [==============================] - 128s 1s/step - loss: 0.5143 - accuracy: 0.8348 - val_loss: 0.6283 - val_accuracy: 0.7804
Epoch 4/5
120/120 [==============================] - 128s 1s/step - loss: 0.3506 - accuracy: 0.8883 - val_loss: 0.6324 - val_accuracy: 0.8358
Epoch 5/5
120/120 [==============================] - 124s 1s/step - loss: 0.2488 - accuracy: 0.9226 - val_loss: 0.5860 - val_accuracy: 0.8522
<keras.callbacks.History at 0x7f528299c410>
```

```
[ ] model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 140s 1s/step - loss: 0.1920 - accuracy: 0.9401 - val_loss: 0.4968 - val_accuracy: 0.8731
Epoch 2/5
120/120 [==============================] - 147s 1s/step - loss: 0.1607 - accuracy: 0.9512 - val_loss: 0.5703 - val_accuracy: 0.8727
Epoch 3/5
120/120 [==============================] - 142s 1s/step - loss: 0.1358 - accuracy: 0.9572 - val_loss: 0.4914 - val_accuracy: 0.8831
Epoch 4/5
120/120 [==============================] - 140s 1s/step - loss: 0.1181 - accuracy: 0.9640 - val_loss: 0.5450 - val_accuracy: 0.8794
Epoch 5/5
120/120 [==============================] - 133s 1s/step - loss: 0.1109 - accuracy: 0.9666 - val_loss: 0.4703 - val_accuracy: 0.8801
<keras.callbacks.History at 0x7f527adbd750>
```

```
[ ] model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 127s 1s/step - loss: 0.1022 - accuracy: 0.9692 - val_loss: 0.5888 - val_accuracy: 0.8659
Epoch 2/5
120/120 [==============================] - 139s 1s/step - loss: 0.0934 - accuracy: 0.9710 - val_loss: 0.5789 - val_accuracy: 0.8689
Epoch 3/5
120/120 [==============================] - 128s 1s/step - loss: 0.0862 - accuracy: 0.9729 - val_loss: 0.4989 - val_accuracy: 0.8848
Epoch 4/5
120/120 [==============================] - 128s 1s/step - loss: 0.0778 - accuracy: 0.9765 - val_loss: 0.6542 - val_accuracy: 0.8759
Epoch 5/5
120/120 [==============================] - 137s 1s/step - loss: 0.0793 - accuracy: 0.9745 - val_loss: 0.5369 - val_accuracy: 0.8844
<keras.callbacks.History at 0x7f527adc0a50>
```

7 Save the model

Save the model

```
[ ] model.save('arrhythmia.h5')
```

8 Testing the model

+ Code + Text Cannot save changes Connect

Testing the model

```
[ ] import numpy as np
    from tensorflow.keras.models import load_model
    from tensorflow.keras.preprocessing import image
```

```
[ ] model=load_model('arrhythmia.h5')
```

```
[ ] img=image.load_img("/content/drive/MyDrive/Project Development Phase/data/test/Right Bundle Branch Block/fig_101.png",target_size=(64,64))
```

```
[ ] img
```

```
[ ] x=image.img_to_array(img)
```

```
[ ] x

array([[[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
```

```
x
```

```
array([[[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]],

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]],

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]],

       ...,

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
```

```
       ...,

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]],

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]],

       [[255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.],
        ...,
        [255., 255., 255.],
        [255., 255., 255.],
        [255., 255., 255.]]], dtype=float32)
```

```
[ ] x=np.expand_dims(x,axis=0)
```

```
[ ] x
```

```
[ ] x=np.expand_dims(x,axis=0)
```

```
[ ] x
```

```
array([[[[255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.],
         ...,
         [255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.]],

        [[255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.],
         ...,
         [255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.]],

        [[255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.],
         ...,
         [255., 255., 255.],
         [255., 255., 255.],
         [255., 255., 255.]],

        ...,
```

```
[ ]        [[255., 255., 255.],
            [255., 255., 255.],
            [255., 255., 255.],
            ...,
            [255., 255., 255.],
            [255., 255., 255.],
            [255., 255., 255.]]]], dtype=float32)
```

```
[ ] pred=model.predict(x)

    1/1 [==============================] - 0s 43ms/step
```

```
[ ] pred

    array([[0., 0., 0., 0., 1., 0.]], dtype=float32)
```

```
[ ] index=['Left Bundle Branch Block',
     'Normal',
     'Premature Atrial Contraction',
     'Premature Ventricular Contractions',
     'Right Bundle Branch Block',
     'Ventricular Fibrillation']
```

```
[ ] index[np.argmax(pred)]

    'Right Bundle Branch Block'
```

SPRINT 3

BUILD PYTHON CODE

app_flask.py

app_flask.py — C:\Users\aruna\Downloads\PROJECT_IBM — Atom

File Edit View Selection Find Packages Help

app_flask.py

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

app=Flask(__name__)
model=load_model('arrhythmia.h5')

@app.route("/")
def about():
    return render_template("home.html")
@app.route("/about")
def home():
    return render_template("home.html")
@app.route("/types")
def types():
    return render_template("types.html")
@app.route("/info")
def information():
    return render_template("info.html")
@app.route("/upload")
def test():
    return render_template("predict.html")
@app.route("/predict",methods=["GET","POST"])
def upload():
    if request.method == 'POST':
        f=request.files['file']
        basepath=os.path.dirname('__file__')
        filepath=os.path.join(basepath,"uploads",f.filename)
        f.save(filepath)
        img=image.load_img(filepath,target_size=(64,64))
        x=image.img_to_array(img)
        x=np.expand_dims(x,axis=0)

        pred=model.predict(x)
        y_pred = np.argmax(pred)
        print("prediction",y_pred)

        index=['Left Bundle Branch Block','Normal','Premature Atrial Contraction',
       'Premature Ventricular Contractions', 'Right Bundle Branch Block','Ventricular Fibrillation']
        result=str(index[y_pred])
```

C:\Users\aruna\Downloads\PROJECT_IBM\app_flask.py 0 0 0 6:1 CRLF UTF-8 Python GitHub Git (0)

CREATE HTML FILES

home.html

home - Notepad

File Edit View

```
<!DOCTYPE html>
<html>
<head>
<title>Home</title>
<style>
body{
  background-color:#EAFAF1;
 background-size:1700px 903px;
 background-repeat:no-repeat;
   padding:0;
   margin:0;
 font-family: Arial, Helvetiaca, scans_serif;

}

.navbar
{
margin: 0px;
padding:20px;
background-color:white;
opacity:0.6;
color:yellow;
font-family: 'Roboto',sans-serif;
font-style: italic;
border-radius:20px;
font-size:25px;
}
a
{
color:blue;
float:right;
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

home - Notepad

File Edit View

```
color:blue;
float:right;
text-decoration:none;
font-style:normal;
padding-right:20px;
}
a:hover{
background-color:black;
color:red;
border-radius:15px;0
font-size:30px;
padding-left:10px;
}
a{
color:red;
float:right;
text-decoration:none;
font-style:normal;
padding-right:20px;}
p{
font-color:"#3498eb";
font-style:italic;
font-size:30px;
font-family:Bell MT;
}
pd{
font-family:Bell MT;
font-color:"#3498eb";
}

</style>
</head>
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

home - Notepad

File Edit View

```
</style>
</head>
<body bgcolor="black">
<div class="navbar">
<a href="/upload" >Predict</a>
<a href="/info">Info</a>

<a href="/about">Home</a>
<br>
</div>
<br>

<center><class="pd"><font color="#7FB3D5 "size="15">Classification of Arrthythmia</font></center>
<center><br>

<img src="https://media.istockphoto.com/id/1141530954/photo/cardiology-and-health-care-woman-doctor-holding-red-knitted-heart-in-hands.jpg?s=612x612&w=0&k=2
     height="400px"  >
<center>
<div>
<br>
<center>
<p><b>"Identify your class of Arrhythmia in one click"</b></P>
<p><font color="black" background-color="#2596be">An arrhythmia is an irregular heartbeat. If you have an arrhythmia, your heart may beat faster or slower t
</p>
<font color="black" size="5">
<head>
<style>
div.container {
  text-align: center;


}
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

home - Notepad

File Edit View

```

}

ol.myOL {

  text-align: justify;
}
</style>
</head>
<body>

<div class="container">


    •Fainting<br>
    •Dizziness or feeling lighLightheaded<br>
    •Breathlessness<br>
    •Pain in the chest area<br>
    •Heavy sweating<br>
    •Blurry vision<br>
    •Fatigue</li><br>
    •Lightheadedness or fainting<br>
    •Anxiety<br>

</div>

</body>

  </font>
</div>
</body>
</html>
```

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info.html

info - Notepad

File Edit View

```
<!DOCTYPE html>
<html>
<head>
<title>Info</title>
<style>
body{
  background-color:#EAFAF1;
 background-size:1700px 903px;
 background-repeat:no-repeat;
   padding:0;
   margin:0;


}

.navbar
{
margin: 0px;
padding:20px;
background-color:white;
opacity:0.6;
color:yellow;
font-family: 'Roboto',sans-serif;
font-style: italic;
border-radius:20px;
font-size:25px;
}
a
{
color:red;
float:right;
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

info - Notepad

File Edit View

```
color:red;
float:right;
text-decoration:none;
font-style:normal;
padding-right:20px;
}
a:hover{
background-color:black;
color:red;
border-radius:15px;0
font-size:30px;
padding-left:10px;
}
a{
color:red;
float:right;
text-decoration:none;
font-style:normal;
padding-right:20px;}
p{
font-color:"#3498eb";
font-size:30px;
font-family:Bell MT
}
</style>
</head>
<body bgcolor="black">
<div class="navbar">
<a href="/upload">Predict</a>
<a href="/info">Info</a>

<a href="/about">Home</a>
```

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info - Notepad

File Edit View

```
<a href="/about">Home</a>
<br>
</div>
<br>
<center>
<class="pd">
        <font color="7FB3D5" size="15"><p style="font-family:'Roboto',sans-serif">Stages of Arrhythmia</font></p>
     </center>

<dl>

    <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"> <dt>1.Normal</dt> </b> </font>

<center>

<br>
      <img src="https://www.healtheuniversity.ca/EN/CardiacCollege/Disease/How_The_Heart_Works/PublishingImages/normal_and_skipped_beats.png" width="400px"


      <dd><font color="black" size="5"> A normal heart rate, when you are resting, should be between 60 and 100 beats a minute. In atrial fibrillation, it m

<br>

   <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"><dt>2.Left Bundle Branch Block</dt> </b> </font>

<center>

<br>
       <img src="https://litfl.com/wp-content/uploads/2021/01/Left-Bundle-Branch-Block-LBBB-ECG-Strip-LITFL.png" class="center" width="400px" height="200px"
```

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File Edit View

```
        <img src="https://litfl.com/wp-content/uploads/2021/01/Left-Bundle-Branch-Block-LBBB-ECG-Strip-LITFL.png" class="center" width="400px" height="200px"

      <dd><font color="black" size="5"> Left bundle branch block (LBBB) occurs when something blocks or disrupts the electrical impulse that causes your hea
<br>
      <b><font color="black" size="6" font-family="Comic Sans MS" align="left"> <dt>3.Premature Atrial Contraction</dt> </b></font>
<center>
<br>
      <img src="https://i.pinimg.com/736x/81/cc/52/81cc52f96fa4c52caeb4b46a8a4ad002--premature-atrial-contractions-ecg.jpg" class="center" width="500px" hei

      <dd><font color="black" size="5">Premature atrial contractions (PACs) are extra heartbeats that start in the upper chambers of your heart. When the pr
<br>
     <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"><dt>4.Premature Ventricular Contraction</dt> </b></font>
<center>
<br>
      <img src="https://i0.wp.com/bossrn.com/wp-content/uploads/2018/06/pvcmulti1-2222600908-1529972389106.jpg?resize=868%2C303&ssl=1" class="center" width=


      <dd><font color="black" size="5">Premature ventricular contractions (PVCs) are extra heartbeats that begin in one of the heart's two lower pumping cha
<br>
```

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info - Notepad

File Edit View

```
      <dd><font color="black" size="5">Premature ventricular contractions (PVCs) are extra heartbeats that begin in one of the heart's two lower pumping cha
<br>
     <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"> <dt>5. Right Bundle Branch Block</dt> </b> </font>
<center>
<br>
      <img src="https://litfl.com/wp-content/uploads/2018/08/Right-Bundle-Branch-Block-RBBB-ECG-Strip-LITFL.png" class="center" width="400px" height="200px"

      <dd><font color="black" size="5"> Right bundle branch block is a problem with your right bundle branch that keeps your heart’s electrical signal from
<br>
      <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"><dt>6.Ventricular Fibrillation</dt> </b></font>
<center>
<br>
      <img src="https://img.medscapestatic.com/pi/meds/ckb/50/42650tn.jpg" class="center" width="400px" height="200px"  > </center>

      <dd><font color="black" size="5"> Ventricular fibrillation is a type of irregular heart rhythm (arrhythmia). During ventricular fibrillation, the lowe

</dl>
```

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info - Notepad

File Edit View


```
     <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"> <dt>5. Right Bundle Branch Block</dt> </b> </font>
<center>
<br>
      <img src="https://litfl.com/wp-content/uploads/2018/08/Right-Bundle-Branch-Block-RBBB-ECG-Strip-LITFL.png" class="center" width="400px" height="200px"

      <dd><font color="black" size="5"> Right bundle branch block is a problem with your right bundle branch that keeps your heart’s electrical signal from
<br>
      <b> <font color="black" size="6" font-family="Comic Sans MS" align="left"><dt>6.Ventricular Fibrillation</dt> </b></font>
<center>
<br>
      <img src="https://img.medscapestatic.com/pi/meds/ckb/50/42650tn.jpg" class="center" width="400px" height="200px"  > </center>

      <dd><font color="black" size="5"> Ventricular fibrillation is a type of irregular heart rhythm (arrhythmia). During ventricular fibrillation, the lowe

</dl>
```


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

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predict_base.html

*predict_base - Notepad

File Edit View

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

<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <meta http-equiv="X-UA-Compatible" content="ie=edge">
    <title>Predict</title>
    <link href="https://cdn.bootcss.com/bootstrap/4.0.0/css/bootstrap.min.css" rel="stylesheet">
    <script src="https://cdn.bootcss.com/popper.js/1.12.9/umd/popper.min.js"></script>
    <script src="https://cdn.bootcss.com/jquery/3.3.1/jquery.min.js"></script>
    <script src="https://cdn.bootcss.com/bootstrap/4.0.0/js/bootstrap.min.js"></script>
    <link href="{{ url_for('static', filename='css/flask_main_style.css') }}" rel="stylesheet">
<style>

.bar
{
margin: 0px;
padding:20px;
background-color:white;
opacity:0.6;
color:black;
font-family:'Roboto',sans-serif;
font-style: italic;
border-radius:20px;
font-size:25px;
}
a
{
color:red;
float:right;
text-decoration:none;
font-style:normal;
```

Ln 76, Col 1 100% Windows (CRLF) UTF-8

*predict_base - Notepad

File Edit View

```html
color:red;
float:right;
text-decoration:none;
font-style:normal;
padding-right:20px;
}
a:hover{
background-color:black;
color:white;
border-radius:15px;0
font-size:30px;
padding-left:10px;
}

</style>
</head>

<body>
      <div class="bar">
<a href="/upload" >Predict</a>
<a href="/info">Info</a>

<a href="/about">Home</a>
<br>
</div>

    <body style="background-color:#EAFAF1">
<div id="maintext" style="position:absolute; margin:auto; width:700px; height:200px; text-align:center; top:0; bottom: 200; left: 0; right: 0;">
  <h1 class="text mb-2" > <font color="7FB3D5"> Upload your image for Classification! </h1></font>


         <div class="wrapingimage">
```

Ln 76, Col 1 100% Windows (CRLF) UTF-8

*predict_base - Notepad

File Edit View

```
        <div class="wrapingimage">

      <img src="https://static8.depositphotos.com/1526816/1065/v/450/depositphotos_10654934-stock-illustration-young-woman.jpg" class="right"
      width="150"
    height="300" align="right">


    <br>
    <div style="border:green; border-width:2px; border-style:solid;">
    <p align="left"class="text mb-2"> <img src="https://c.tenor.com/A4iBZ-oMD-oAAAAM/thinking-emoji.gif" width=20 height=20 >
     Wanna analyse your heart beat pattern?</p>
    <p align="left" ><img src="https://emojipedia-us.s3.amazonaws.com/source/noto-emoji-animations/344/hundred-points_1f4af.gif" width=22 height=20>
     A high accuracy result</p>
    <p align="left"><img src="https://emojipedia-us.s3.amazonaws.com/source/microsoft-teams/337/index-pointing-up_261d-fe0f.png" width=20 height=22>
     In a single click</p>
<p align="left"><img src="https://media0.giphy.com/media/gHQiRVOSnGXEY2Ntqv/200w.gif?cid=82a1493bcme7g0vp248h5as66tkrfmnw478uahprxu0mar2o&rid=200w.gif&ct=s"
     width=20 height=20>To know more about your result click 'Info'</p>
    </div>
    <br>
    <br>

    <div class="container">
       <center>

      <div id="content" style="margin-top:2em">
      <img src="https://dctacademy.com/wp-content/uploads/2016/12/Upload-icon-512x430.png" width="45" height="40">
{% block content%}{% endblock %}</div> </center>
</div>
</body>
<footer>

<script src="{{ url_for('static', filename='js/flask_main_js.js') }}" type="text/javascript"></script>
```

Ln 76, Col 1 100% Windows (CRLF) UTF-8

*predict_base - Notepad

File Edit View

```
      width="150"
    height="300" align="right">


    <br>
    <div style="border:green; border-width:2px; border-style:solid;">
    <p align="left"class="text mb-2"> <img src="https://c.tenor.com/A4iBZ-oMD-oAAAAM/thinking-emoji.gif" width=20 height=20 >
     Wanna analyse your heart beat pattern?</p>
    <p align="left" ><img src="https://emojipedia-us.s3.amazonaws.com/source/noto-emoji-animations/344/hundred-points_1f4af.gif" width=22 height=20>
     A high accuracy result</p>
    <p align="left"><img src="https://emojipedia-us.s3.amazonaws.com/source/microsoft-teams/337/index-pointing-up_261d-fe0f.png" width=20 height=22>
     In a single click</p>
<p align="left"><img src="https://media0.giphy.com/media/gHQiRVOSnGXEY2Ntqv/200w.gif?cid=82a1493bcme7g0vp248h5as66tkrfmnw478uahprxu0mar2o&rid=200w.gif&ct=s"
     width=20 height=20>To know more about your result click 'Info'</p>
    </div>
    <br>
    <br>

    <div class="container">
       <center>

      <div id="content" style="margin-top:2em">
      <img src="https://dctacademy.com/wp-content/uploads/2016/12/Upload-icon-512x430.png" width="45" height="40">
{% block content%}{% endblock %}</div> </center>
</div>
</body>
<footer>

<script src="{{ url_for('static', filename='js/flask_main_js.js') }}" type="text/javascript"></script>
```

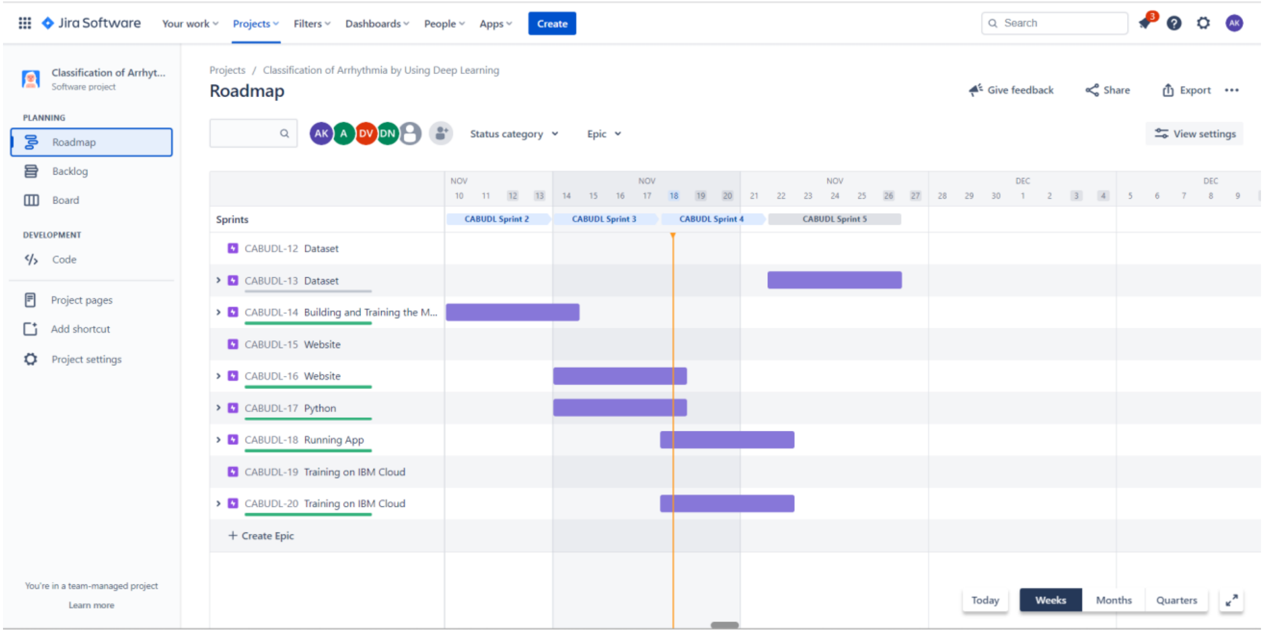

```
</footer>

</html>
```

Ln 76, Col 1 100% Windows (CRLF) UTF-8

6.2Sprint Delivery Schedule

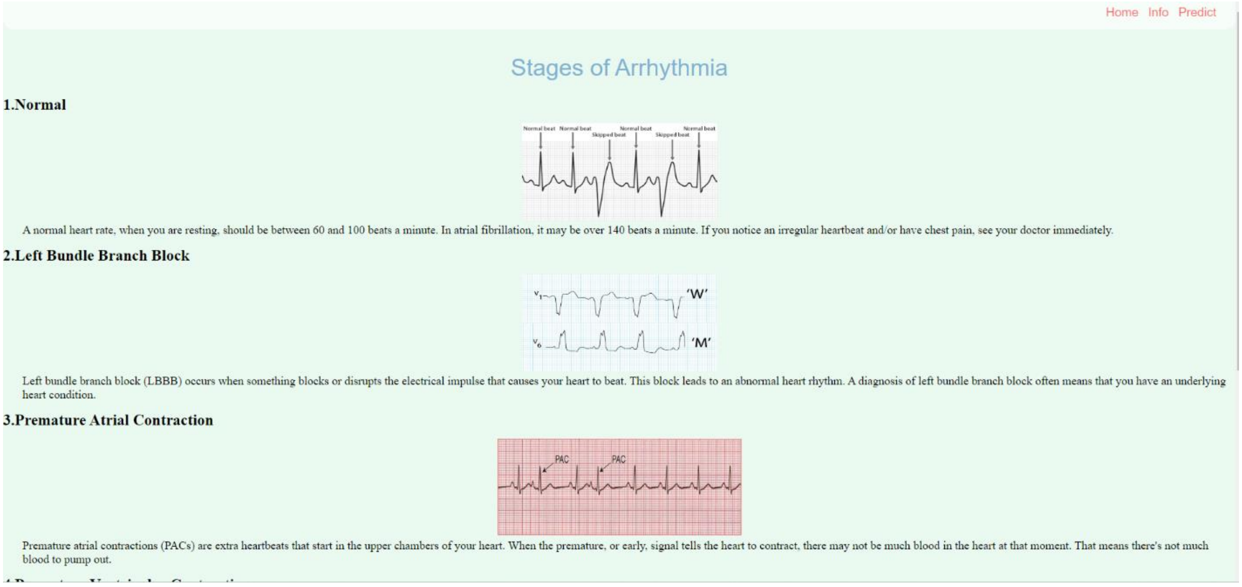
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	4 Days	06 Nov 2022	10 Nov 2022	20	10 Nov 2022
Sprint-2	20	4 Days	10 Oct 2022	14 Nov 2022	20	14 Nov 2022
Sprint-3	20	4 Days	14 Nov 2022	18 Nov 2022	20	18 Nov 2022
Sprint-4	20	4 Days	18 Nov 2022	22 Nov 2022	20	22 Nov 2022

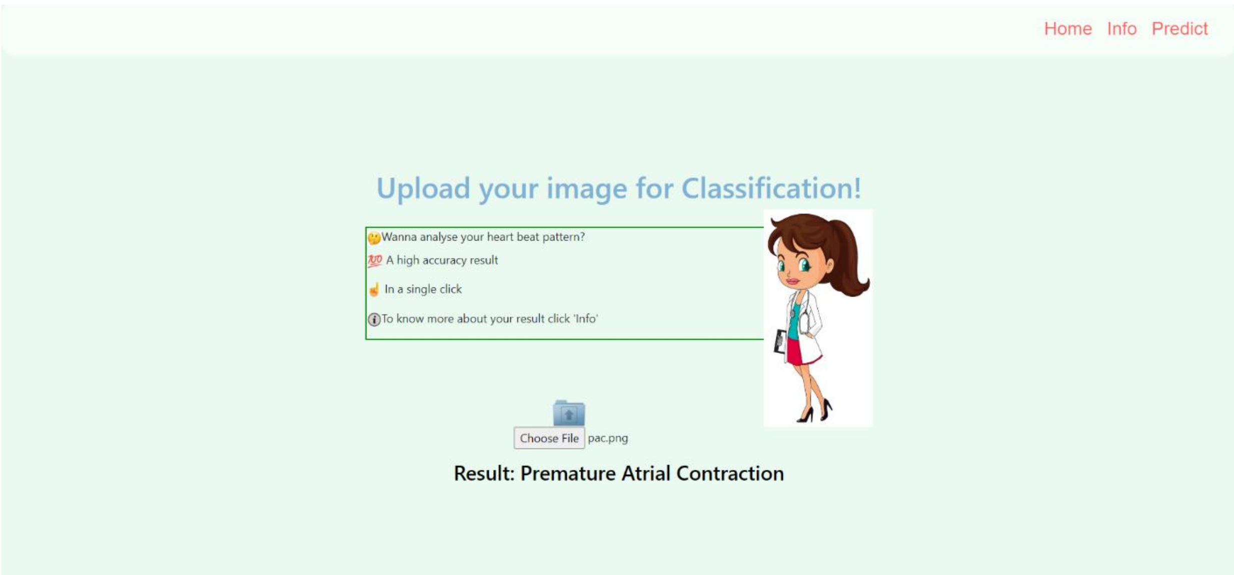
6.3Reports from JIRA



7.CODING & SOLUTIONING

7.1 Feature 1





8.TESTING

8.1 Test Cases

8.2 User Acceptance Testing

9.RESULTS

9.1 Performance metrics

Train the model

```
model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 5756s 48s/step - loss: 1.6898 - accuracy: 0.4805 - val_loss: 1.3704 - val_accuracy: 0.4504
Epoch 2/5
120/120 [==============================] - 125s 1s/step - loss: 0.8183 - accuracy: 0.7325 - val_loss: 0.9316 - val_accuracy: 0.6563
Epoch 3/5
120/120 [==============================] - 128s 1s/step - loss: 0.5143 - accuracy: 0.8348 - val_loss: 0.6283 - val_accuracy: 0.7804
Epoch 4/5
120/120 [==============================] - 128s 1s/step - loss: 0.3506 - accuracy: 0.8883 - val_loss: 0.6324 - val_accuracy: 0.8358
Epoch 5/5
120/120 [==============================] - 124s 1s/step - loss: 0.2488 - accuracy: 0.9226 - val_loss: 0.5860 - val_accuracy: 0.8522
<keras.callbacks.History at 0x7f528299c410>
```

```
[ ] model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 140s 1s/step - loss: 0.1920 - accuracy: 0.9401 - val_loss: 0.4968 - val_accuracy: 0.8731
Epoch 2/5
120/120 [==============================] - 147s 1s/step - loss: 0.1607 - accuracy: 0.9512 - val_loss: 0.5703 - val_accuracy: 0.8727
Epoch 3/5
120/120 [==============================] - 142s 1s/step - loss: 0.1358 - accuracy: 0.9572 - val_loss: 0.4914 - val_accuracy: 0.8831
Epoch 4/5
120/120 [==============================] - 140s 1s/step - loss: 0.1181 - accuracy: 0.9640 - val_loss: 0.5450 - val_accuracy: 0.8794
Epoch 5/5
120/120 [==============================] - 133s 1s/step - loss: 0.1109 - accuracy: 0.9666 - val_loss: 0.4703 - val_accuracy: 0.8801
<keras.callbacks.History at 0x7f527adbd750>
```

```
[ ] model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test))

Epoch 1/5
120/120 [==============================] - 127s 1s/step - loss: 0.1022 - accuracy: 0.9692 - val_loss: 0.5888 - val_accuracy: 0.8659
Epoch 2/5
120/120 [==============================] - 139s 1s/step - loss: 0.0934 - accuracy: 0.9710 - val_loss: 0.5789 - val_accuracy: 0.8689
Epoch 3/5
120/120 [==============================] - 128s 1s/step - loss: 0.0862 - accuracy: 0.9729 - val_loss: 0.4989 - val_accuracy: 0.8848
Epoch 4/5
120/120 [==============================] - 128s 1s/step - loss: 0.0778 - accuracy: 0.9765 - val_loss: 0.6542 - val_accuracy: 0.8759
Epoch 5/5
120/120 [==============================] - 137s 1s/step - loss: 0.0793 - accuracy: 0.9745 - val_loss: 0.5369 - val_accuracy: 0.8844
<keras.callbacks.History at 0x7f527adc0a50>
```

10.ADVANTAGES & DISADVANTAGES

ADVANTAGES

- The timely diagnosis of cardiac arrhythmias, determined by irregular and fast heart rate, **may help lower the risk of strokes**.
- Data of the patient will be securely stored and maintained for future purposes.
- Provides accurate results and detailed information required by the users or patients
- It can be used by anyone at any time

DISADVANTAGES

10. CONCLUSION

Arrhythmia is a severe CVD that can be predicted via ECG segment processing. Arrhythmia must be accurately diagnosed and prevented early to reduce cardiac disease. Our proposed system model met the study's primary goal of assisting doctors in swiftly determining the kind of ECG or verifying their diagnostics in a medical context while maintaining a high level of precision and cost. In this work, a CNN-Bi-LSTM model is proposed to categorise five categories of ECG fragments to construct an effective and resilient autonomous computer-aided diagnosis system. The developed network achieved maximum accuracies of 100%, 98.0%, and 98.0% of training, validation, and testing using MIT-BIH data set.

In comparison, the St-Petersburg data set achieved 98.0%, 95.0%, and 95.0% accuracies of training, validation, and testing in identifying arrhythmia. This research showed many advantages, including its ability to help clinicians reliably make ECG recording-related clinical decisions. Moreover, it was intended to be as simple as possible while delivering the most significant performance. The described method is straightforward for health professionals and does not involve signal modification or feature extraction.

12.FUTURE SCOPE

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https://arxiv.org/abs/2005.06902

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https://ieeexplore.ieee.org/document/9344372

13.APPENDIX

Source Code

Import The ImageDataGenerator Library

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

Configure ImageDataGenerator Class

```
train_datagen=ImageDataGenerator(rescale=1./255,zoom_range=0.2,vertical_f
lip=True,horizontal_flip=True)

test_data=ImageDataGenerator(rescale=1./255)
```

Apply ImageDataGenerator Functionality To Trainset and Testset

---

[ ]

```
x_train=train_datagen.flow_from_directory(r"/home/wsuser/work/data/train"
,target_size=(64,64),class_mode="categorical",batch_size=128)

x_test=test_data.flow_from_directory(r"/home/wsuser/work/data/test",targe
t_size=(64,64),class_mode="categorical",batch_size=128)

x_train.class_indices
```

MODEL BUILDING

Import The Libraries

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense,Convolution2D,MaxPooling2D,Flat
ten
```

Initialize the model

```
model=Sequential()
```

Adding CNN Layers

```
model.add(Convolution2D(32,(3,3),activation="relu",strides=(1,1),input_sh
ape=(64,64,3)))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.summary()
```

Adding Dense LayerS

Hidden Layer

```
model.add(Dense(500,activation="relu"))
```

Output Layer

```
model.add(Dense(6,activation="softmax"))
```

Configure The Learning Process

```
model.compile(loss="categorical_crossentropy",optimizer="adam",metrics=['
accuracy'])
len(x_train)
```

Train The Model

```
model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x
_test,validation_steps=len(x_test))

model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x
_test,validation_steps=len(x_test))

model.fit(x_train,epochs=5,steps_per_epoch=len(x_train),validation_data=x
_test,validation_steps=len(x_test))
```

Save The Model

```
model.save('arrhythmia.h5')
```

Testing The Model

```
!tar -zcvf arrhythmia.tgz arrhythmia.h5
ls
pip install watson-machine-learning-client --upgrade
from ibm_watson_machine_learning import APIClient
wml_credentials={
    "url":"https://eu-de.ml.cloud.ibm.com",
    "apikey":"z5rJUUtf-ait7_j9iavWwTkl29jIwdg7BbIxwD7EedAy"
}
client=APIClient(wml_credentials)
def guid_from_space(client,space_name):
    space=client.spaces.get_details()
    return next(item for item in space['resources'] if item['entity']['na
me']==space_name)['metadata']['id']
space_uid=guid_from_space(client,'Classification of Arrhythmia')
print("spaceid"+" "+space_uid)
client.set.default_space(space_uid)
client.software_specifications.list()
software_spec_id=client.software_specifications.get_uid_by_name('tensorfl
ow_rt22.1-py3.9')
software_spec_id
model_details=client.repository.store_model(model="arrhythmia.tgz",meta_p
rops={
    client.repository.ModelMetaNames.NAME:"CNN",
    client.repository.ModelMetaNames.TYPE:"tensorflow_2.7",
    client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_spec_id})
model_id=client.repository.get_model_uid(model_details)
model_id
client.repository.download(model_id,'Classification of Arrhythmia.tar.gz'
)
import numpy as np
from tensorflow.keras.models import load_model
```

```
from tensorflow.keras.preprocessing import imag
model=load_model('arrhythmia.h5')
import os, types
import pandas as pd
from botocore.client import Config
import ibm_boto3

def __iter__(self): return 0

from io import BytesIO
import zipfile
unzip=zipfile.ZipFile(BytesIO(streaming_body_2.read()),'r')
file_paths=unzip.namelist()
for path in file_paths:
    unzip.extract(path)
ls
img=image.load_img('/home/wsuser/work/fig_991.png',target_size=(64,64))
import numpy as np
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
pred=model.predict(x)
pred[0]
index=['Left Bundle Branch Block',
 'Normal',
 'Premature Atrial Contraction',
 'Premature Ventricular Contractions',
 'Right Bundle Branch Block',
 'Ventricular Fibrillation']
index[np.argmax(pred)]
```

GitHub

Project Demo Link