PROJECT REPORT

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

IBM NALAIYA THIRAN

PROJECT BASED EXPERIMENTAL LEARNING

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In partial fulfillment for the award the degree of

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IN

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IDHAYA ENGINEERING COLLEGE

BONAFIDE CERTIFICATE

Certified that this project report titled Classification of arryhthmia by 2-D deep learning with spectral image representation is the bonafide work of **SUBITHA.K**(621119106024), Azhagunila.S(621119106002), Bhavani.E(621119106004), Shalini.G(621119106021) who carried out the project work under my supervision.

ACKNOWLEDGEMENT

At the outset, we express our heartfelt gratitude to GOD, who has been our strength to bring this project to light. At this pleasing moment of having successfully completed our project,we wish to convey our sincere thanks and gratitude to our beloved Secretary **Rev.Mo.JOHN BRITTO MARY,FIHM** who has provided all the facilities to us. We would like to convey our sincere thanks to our beloved Principal **Dr.Sr.A.JENNITA,M.E.,Ph.D.**, for forwarding us to do our project and offering adequate

duration in completing our project. We express our sincere thanks to our Head of the Department **Mrs.P.POOVIZHI,ME.,**Department of Electronics and Communication Engineering for fostering the excellent academic climate in the Department. We express our pronounced sense of thanks with deepest respect and gratitude to our faculty mentor **A.SIVAPRIYA,** Assistant Professor Department of Electronics and Communication Engineering and Engineering for his valuable and precious guidance and for having amicable relation. With deep sense of gratitude, we extend our earnest and sincere thanks to our **SPOC Sr.C.JANSI SOPHIA MARY ,** Assistant Professor Department of Computer Science and Engineering for her guidance and encouragement during this project.

TABLE OF CONTENT

11.CONCLUSION

12.FUTURE SCOPE

13.APPENDIX

Source Code

GitHub & Project Demo Link

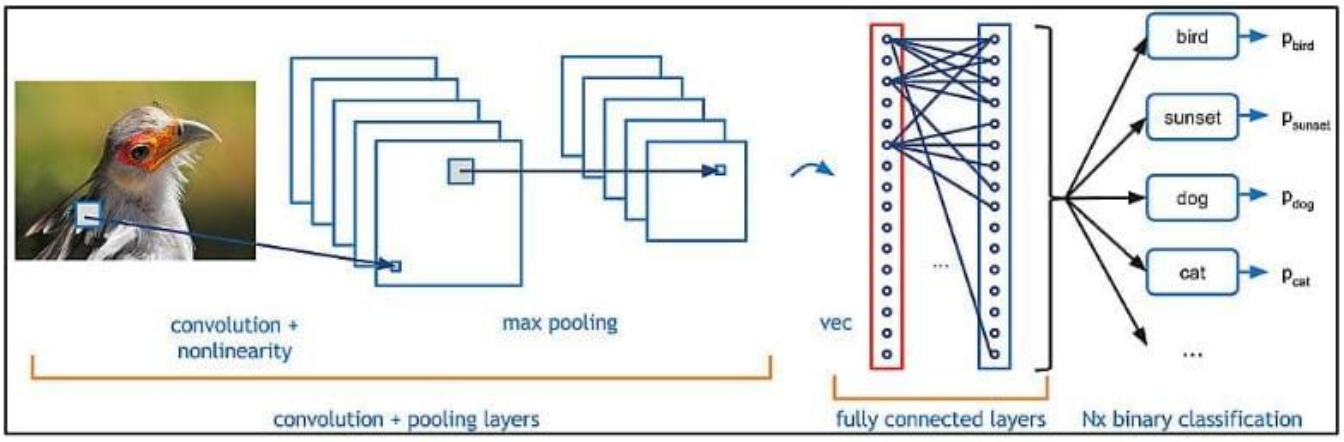
1.Introduction:

a.Overview:

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

b.Purpose:

In the past few decades,Deep Learning has proved to be a compelling toolbecause 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 AI Convolution Neural Networks.

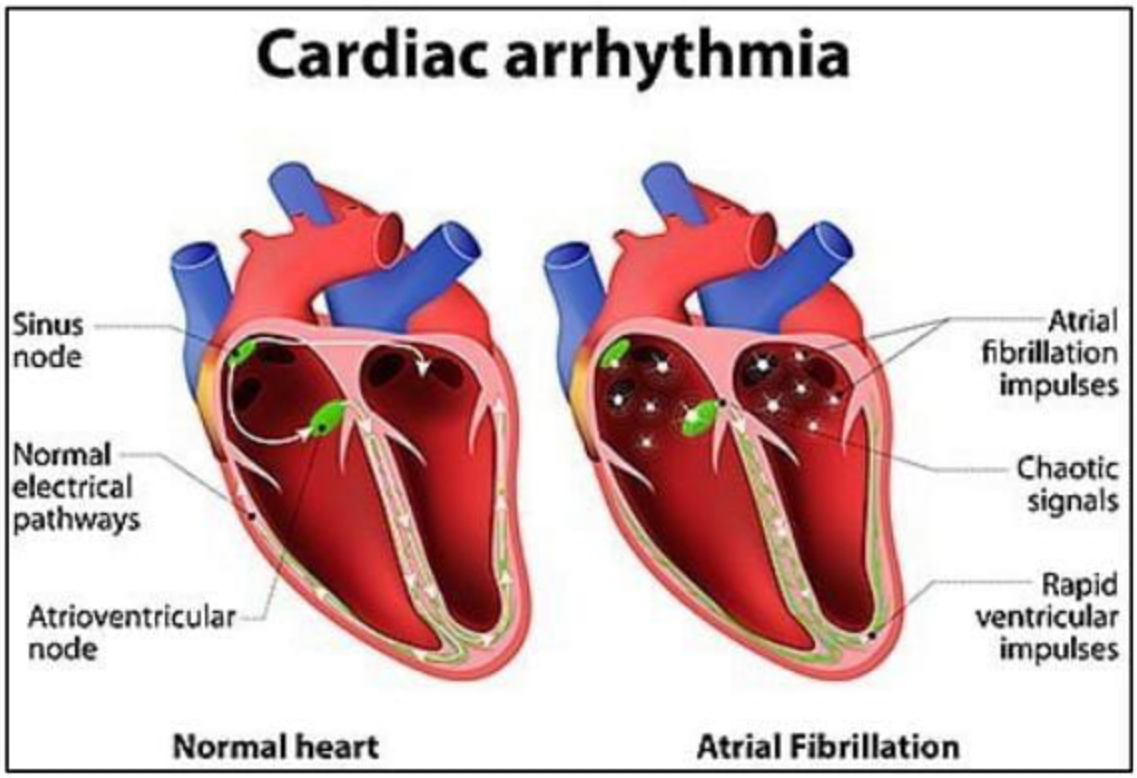


In deep learning, a convolution al neural network(CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyze visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution.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

2.Literature Survey:

a. 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 worldwhich 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 refersto any irregular change from the normalheart rhythms. There are severaltypes of arrhythmia including atrial fibrillation, prematurecontraction, ventricular fibrillation, and tachycardia.



b. REFERENCE:

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

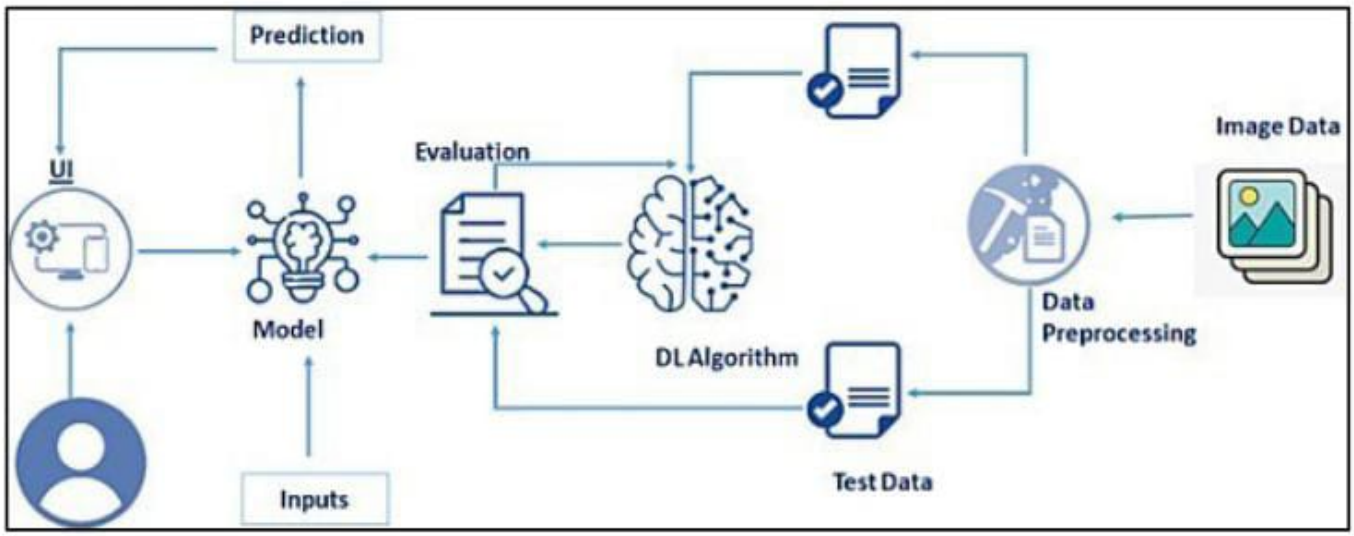
everything but shower or bathe while wearing the electrodes. After the test period, patient will go back to see your doctor.They will be downloading the information.

C.PROBLEM STATEMENT

Create a problem statement to understand your customer's point of view.In general,complications of heart arrhythmias may include stroke, sudden death and heart failure.Heart arrhythmias are associated with an increased risk of blood clots. If a clot breaks loose,it can travel from the heart to the brain, causing a stroke. In general, complications of heart arrhythmias may include stroke, sudden death and heartfailure. Heart arrhythmias are associated with an increased risk of blood clots. If a clot breaks loose, it can travel from the heart to the brain, causing a stroke.

Theoretical Experience:

Block Diagram



We will preparethe project by following the below steps:

i.We will be working with Sequential type of modeling

ii.We will be working with Keras capabilities

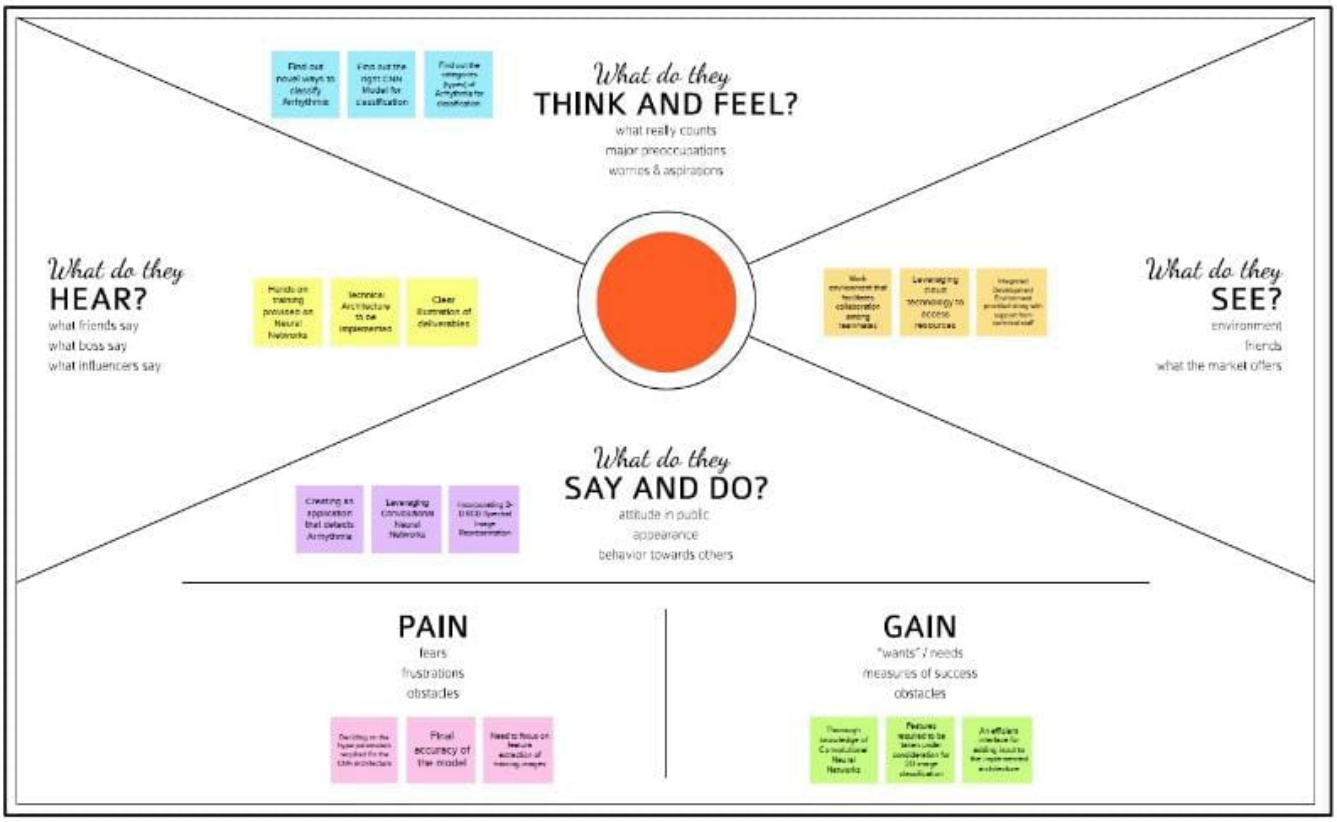
iii. We will be working with image processing techniques

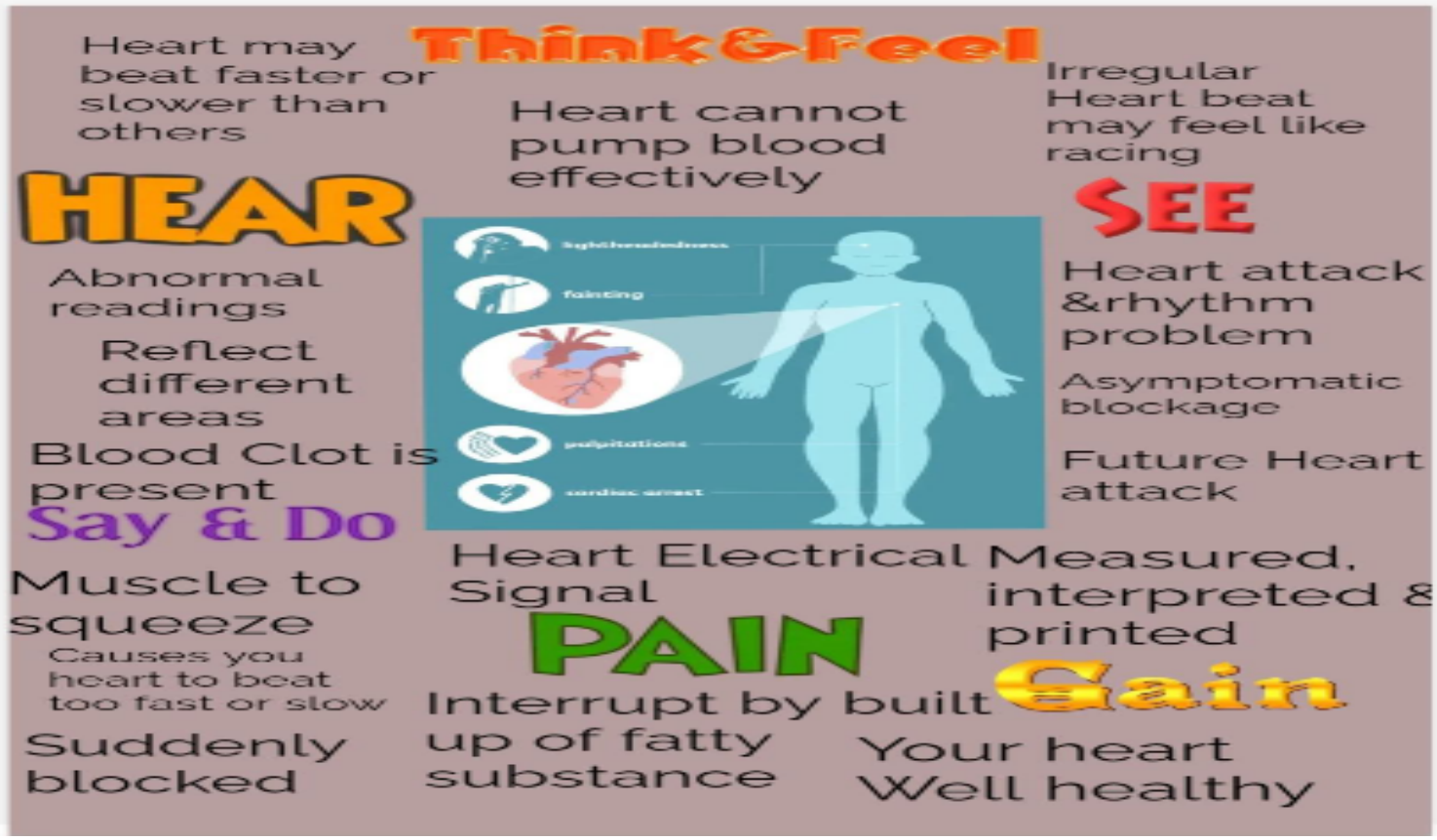
iv. Wewill build a web application using the Flaskframework.

v. Afterwards we will be training our dataset in the IBM cloud andbuilding anothermodel from IBM and we will also test it.

3.IDEATION & PROPOSED SOLUTION

a.EMPATHY MAP:





b.BRAINSTROMING

Brainstorm & idea prioritization

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

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

Before you collaborate

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

10 minutes

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

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

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

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

5 minutes

PROBLEM

How might we [your problem statement]?

Key rules of brainstorming

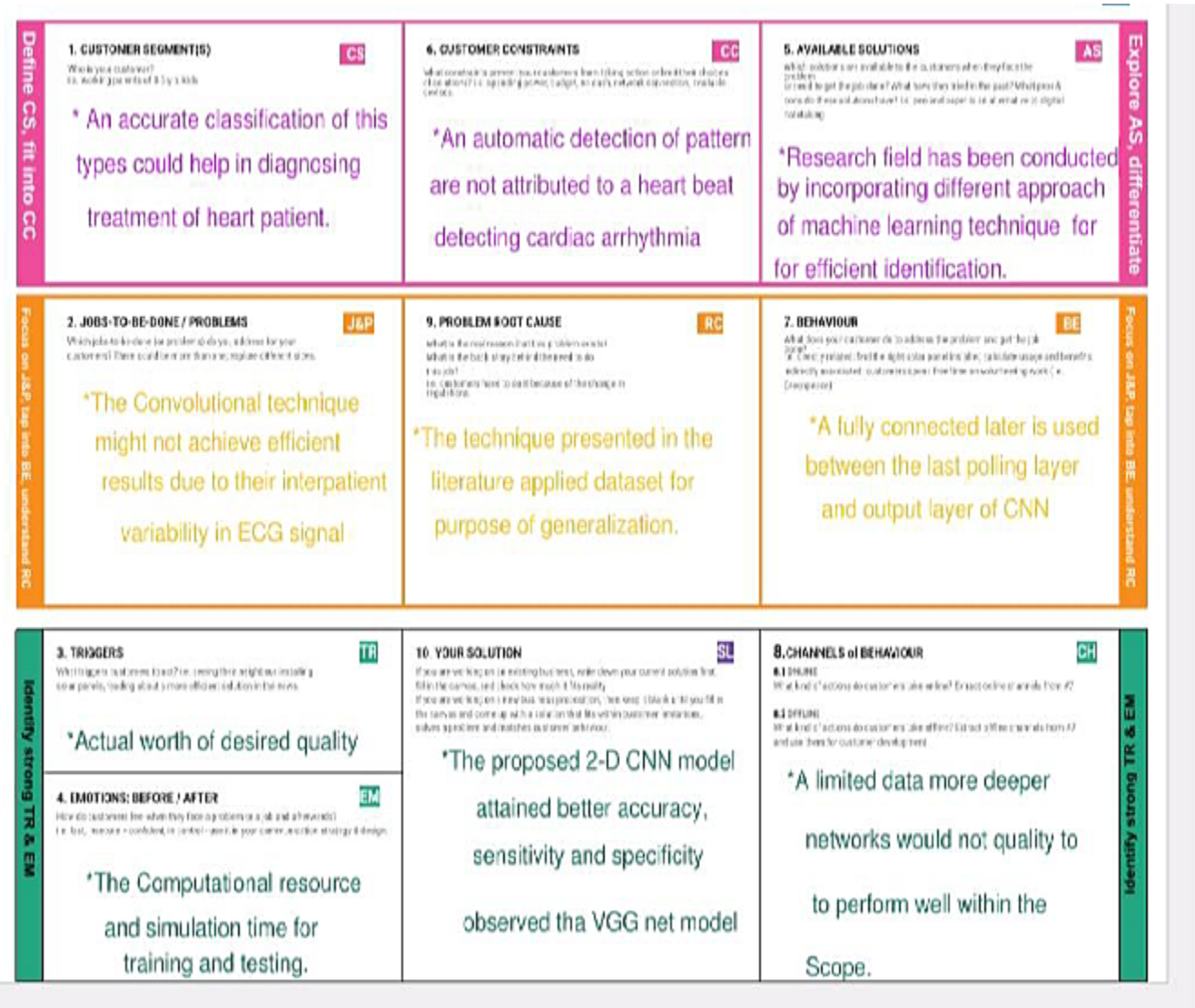
To run an smooth and productive session

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

c.PROPOSED SOLUTION

S.No	PARAMETER	DESCRIPTION
1.	Problem Statement(Problem to be Solved)	While most arrhythmias are harmless, some can be serious or even life threatening. When a heartbeat is too fast, too slow or irregular, the heart may not be able to pump enough blood to the body.
2.	Idea / Solution description	Exercising regularly and eating a healthy, low-fat diet with plenty of vegetables, fruits and other vitamin-rich foods are the cornerstones of "heart healthy" living.
3.	Novelty / Uniqueness	Treatment for heart arrhythmias may include medications, therapies such as vagal maneuvers, cardioversion, catheter procedures or heart surgery
4.	Social Impact / Customer Satisfaction	The presence of AF leads to more severe initial neurological involvement, longer hospitalization, greater disability and a lower probability of discharge to home.
5.	Business Model (Revenue Model)	Business runs in the same manner, with ups and downs and re-adaption attitude. Sometimes change management starts like heart beats
6.	Scalability of the Solution	The ECG waveform scaling properties thus suggest that reduced complexity dominates the underlying mechanisms of arrhythmias

d.PROPOSED SOLUTION FIT:



4.REQUIREMENT ANALYSIS

HardwareComponentsUsed:

Since we are using the IBM cloud as a platform to execute this project we dont need any hardwarecomponents other than our system.

Software Components Used:

We will be using Visual Studio which is installed in our system and Watsonstudio from the IBM cloud to complete the project.

VISUAL STUDIO:

Visual Studio Code, also commonly referred to as VS Code is a source-code editor made by Microsoft with the Electron Framework, for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git. Users can change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality

WATSON STUDIO:

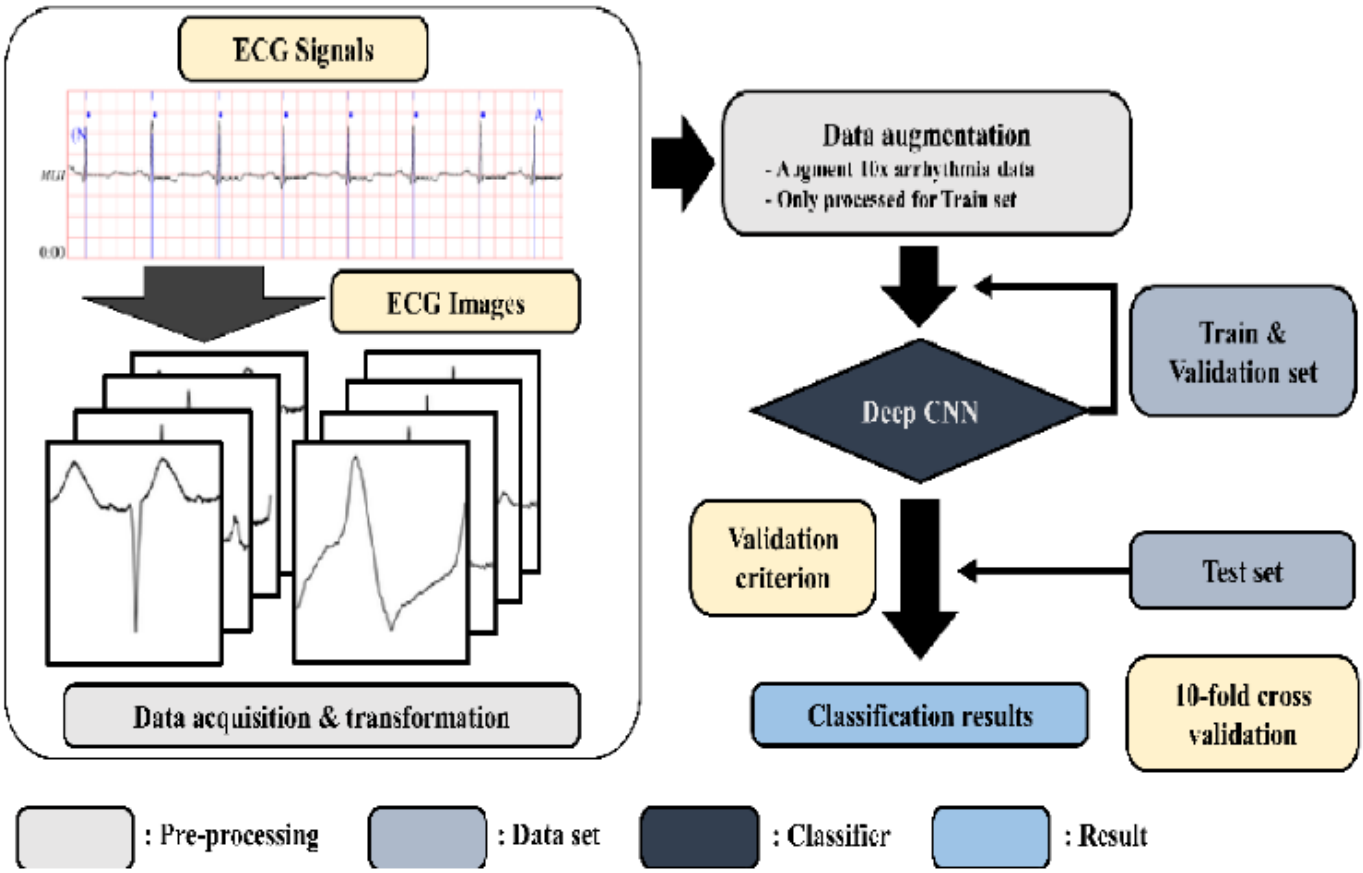
Watson Studio is one of thecore services in Cloud Pak for Data as a Service.

Watson Studio provides you with the environment and tools to solve your business problems by collaboratively workingwith data. You can choosethe tools you need to analyze and visualize data, to cleanse and shape data,

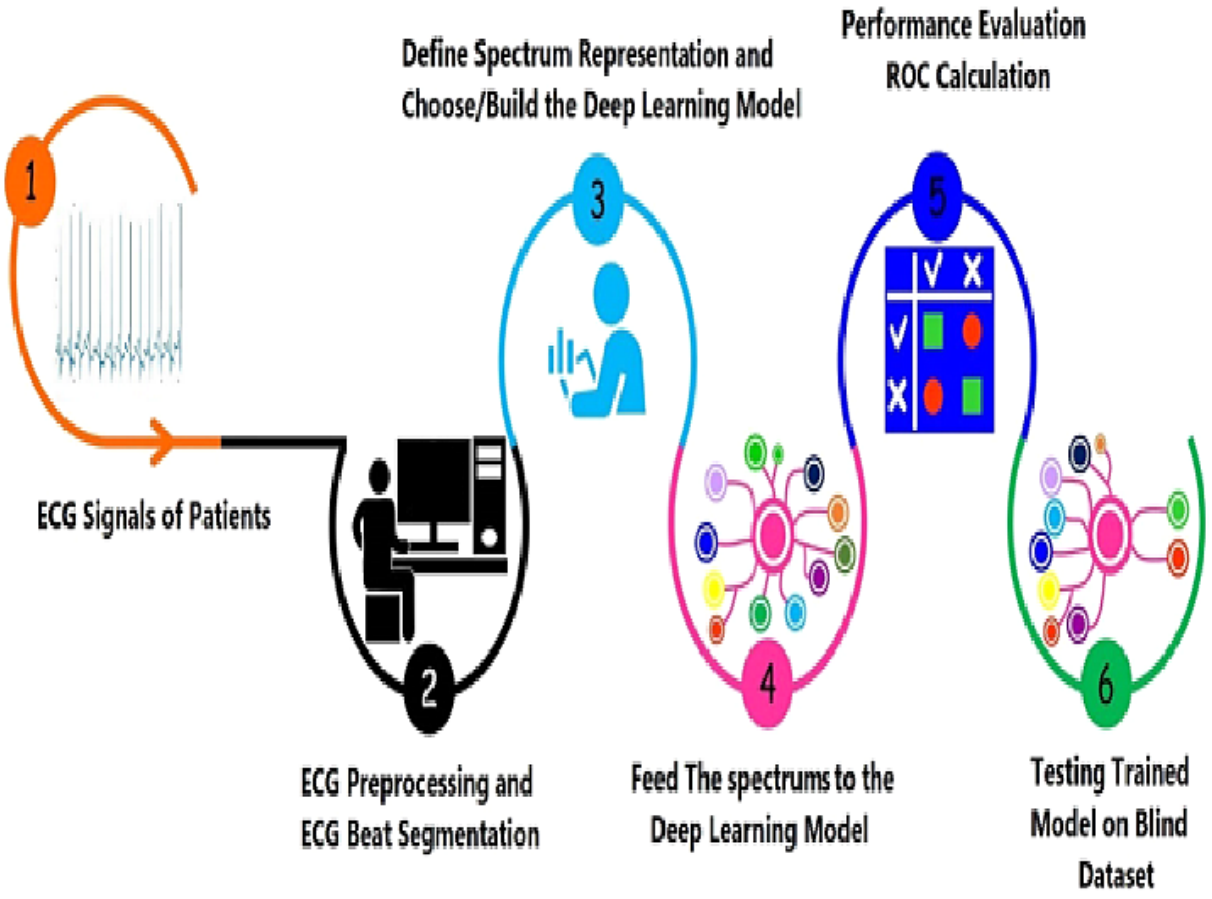
or to build machine learningmodels.This illustration shows how the architecture of Watson Studio is centeredaround the project. A project is a workspace where you organize your resources and work with data. Watson Studioprojects fully integrate with the catalogs and deployment spaces: Deployment spaces are provided by the Watson Machine Learning serviceYou can easily move assets between projects and deployment spaces.

5.PROJECT DESIGN

a.DATAFLOW DIAGRAM:



b.SOLUTION ARCHITECTURE:



6.PROJECT PLANNING & SCHEDULING

Project Tracker, Velocity & Burndown Chart: (4 Marks)

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	7 Days	21 Oct 2022	27 Oct 2022	20	28 Oct 2022
Sprint-2	20	7 Days	29 Oct 2022	04 Nov 2022	20	04 Nov 2022
Sprint-3	20	7 Days	05 Nov 2022	11 Nov 2022	20	12 Nov 2022
Sprint-4	20	7 Days	13 Nov 2022	19 Nov 2022	20	19 Nov 2022

7.CODING & SOLUTION

Experimental Investigations:

In this project, we have deployed our training model using CNN on IBM Watson studioand in our local

machine.We are deploying 4 typesof CNN layers in a sequential manner, starting from :

● Convolutional layer 2D:A 2-D convolutional layer applies slidingconvolutionalfiltersto 2-D input. The layer convolves the input bymoving thefilters along the input vertically and horizontally and computingthe dot product of the weights and the input, and then adding a bias term.

● Pooling Layer :Pooling layers are used to reduce the dimensions of the featuremaps. Thus, it reduces the number of parameters to learnand the amount of computation performed in the network. The pooling layer summarises the features present in a region of the feature map generatedby a convolution layer.

● Fully-Connected layer :After extracting features from multiple convolution layers and pooling layers, the fully-connected layer is used to expand the connection of all features. Finally, the SoftMax layer makes a logisticregression classification. Fully-connected layertransfers the weighted sum of the output of the previous layer to the activation function.

Dropout Layer : There is usually a dropout layer beforethe fullyconnected layer. The dropout layer will temporarily disconnect some neurons from the network according to the certain probability during the trainingof the convolution neural network,which reduces the joint adaptability between neuron nodes, reduces overfitting, and enhances the generalization ability of the network.

Flow Chart & Results with Screenshots:

a.Flow Chart & Resultsby training model in localmachine:

(I) Dataset Collection:

The dataset containssix classes:

Left BundleBranch Block Normal
Premature AtrialContraction
Premature Ventricular Contractions
Right BundleBranch Block
Ventricular Fibrillation

(II) IMAGE Preprocessing:

Image Pre-processing includesthe following main tasks

1.Import ImageDataGenerator Library:

Image data augmentation is a techniquethat can be used to artificially expand the sizeof a training dataset by creating modified versions of images in the dataset.

The Keras deep learning neuralnetwork library providesthe capability to fit modelsusing image data augmentation via the ImageDataGenerator class.

```
In [5]:  1 from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

2.Configure ImageDataGenerator Class:

There are five main types of data augmentation techniques for image data; specifically:

1. Image shifts via the width_shift_range and height_shift_range arguments.
2. Imageflips via the horizontal_flip and vertical_fliparguments.
3. Image rotates via the rotation_range argument

4. Image brightness via the brightness_range argument.
5. Image zooms via the zoom_range argument.
An instance of the ImageDataGenerator class can be constructed for train and test.

```
In [5]:
train_datagen = ImageDataGenerator(rescale = 1./255,shear_range = 0.2,zoom_range = 0.2,horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
```

1. Applying ImageDataGenerator functionality to the trainset and test set:
We will apply ImageDataGenerator functionality to Trainset and Testset by using the following code This function will return batches of images from the subdirectories Left Bundle Branch Block, Normal, Premature Atrial Contraction, Premature Ventricular Contractions, Right Bundle Branch Block and Ventricular Fibrillation, together with labels 0 to 5{Left Bundle Branch Block': 0, 'Normal': 1, 'Premature Atrial Contraction': 2, 'Premature Ventricular Contractions': 3, 'Right Bundle Branch Block': 4,'Ventricular Fibrillation'

```
In [7]:
x_train = train_datagen.flow_from_directory("/content/data/train",target_size = (64,64),batch_size = 32,\
                                            class_mode = "categorical")
x_test = test_datagen.flow_from_directory("/content/data/test",target_size = (64,64),batch_size = 32,\
                                          class_mode = "categorical")
```

```
Found 15341 images belonging to 6 classes.
Found 6825 images belonging to 6 classes.
```

We can see that for training there are 15341 images belonging to 6 classes and for testing there are 6825 images belonging to 6 classes.

1.Model Building

We are ready with the augmented and pre-processed image data,we will begin our build our model by following the below steps:

Import the model building Libraries:

```
In [4]:
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import Convolution2D
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.layers import Flatten
```

- **Initializing the model: Keras has 2 ways to define a neural network:**

1. Sequential
2. Function API

The Sequential class is used to define linear initializations of network layers which then,collectively, constitute a model. In our examplebelow, we will use the Sequential constructor to create a model, which will then have layers added to it using the add ()method.
Now, will initialize our model.

1.Adding CNN Layers:

We are adding a convolution layer with an activation functionas relu and with a smallfiltersize (3,3) and a number of filters as (32) followed by a max-pooling layer.

The Max pool layer is used to downspace the input.
The flatten layer input is:

```
In [9]:  1 #MODEL BUILDING

In [10]: 1 model = Sequential()

In [11]: 1 model.add(Convolution2D(32,(3,3),input_shape = (64,64,3),activation = "relu"))

In [12]: 1 model.add(MaxPooling2D(pool_size = (2,2)))

In [13]: 1 model.add(Convolution2D(32,(3,3),activation='relu'))

In [14]: 1 model.add(MaxPooling2D(pool_size=(2,2)))

In [15]: 1 model.add(Flatten()) # ANN Input...
```

- **Adding Hidden Layers:**

Dense layer is deeply connected neuralnetwork layer. It is most common and frequently used layer

```
In [16]: 1 #Adding Dense Layers

In [17]: 1 model.add(Dense(units = 128,kernel_initializer = "random_uniform",activation = "relu"))

In [18]: 1 model.add(Dense(units = 128,kernel_initializer = "random_uniform",activation = "relu"))

In [19]: 1 model.add(Dense(units = 128,kernel_initializer = "random_uniform",activation = "relu"))

In [20]: 1 model.add(Dense(units = 128,kernel_initializer = "random_uniform",activation = "relu"))

In [21]: 1 model.add(Dense(units = 128,kernel_initializer = "random_uniform",activation = "relu"))
```

- **Adding Output Layer:**

Understanding the model is very important phase to properly use it for trainingand prediction purposes.Keras provides a simple method, summary to get the full information about the model and its layers.

```
In [22]: 1 model.add(Dense(units = 6,kernel_initializer = "random_uniform",activation = "softmax"))
```

```
In [23]: 1 model.summary()
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 62, 62, 32)        896

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

 conv2d_1 (Conv2D)           (None, 29, 29, 32)        9248

 max_pooling2d_1 (MaxPooling  (None, 14, 14, 32)       0
 2D)

 flatten (Flatten)           (None, 6272)              0

 dense (Dense)               (None, 128)               802944

 dense_1 (Dense)             (None, 128)               16512

 dense_2 (Dense)             (None, 128)               16512

 dense_3 (Dense)             (None, 128)               16512

 dense_4 (Dense)             (None, 128)               16512

 dense_5 (Dense)             (None, 6)                 774

=================================================================
Total params: 879,910
Trainable params: 879,910
Non-trainable params: 0
_________________________________________________________________
```

1. Configure the Learning Process:

1. The compilation is the final step in creating a model. Once the compilation is done, we can move on to the training phase. The loss function is used to find error or deviation in the learning process. Keras requires loss function during the model compilation process.

2.Optimization is an importantprocess that optimizesthe input weightsby comparing the prediction and the loss function. Here we are using adam optimizer

3. Metrics is used to evaluate the performance of your model. It is similar to loss function, but not used in the training process.

```
In [24]: 1 model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
```

● Training the model:

We will train our model with our image dataset. fit_generator functions used to train a deep learning neural network.

```
In [25]: model.fit_generator(generator=x_train,steps_per_epoch = len(x_train), epochs=9, validation_data=x_test,\
                             validation_steps = len(x_test))

Epoch 1/9
480/480 [==============================] - 99s 203ms/step - loss: 1.4415 - accuracy: 0.4788 - val_loss: 1.0093 - val_accurac
y: 0.3193
Epoch 2/9
480/480 [==============================] - 96s 201ms/step - loss: 0.9465 - accuracy: 0.6495 - val_loss: 1.3444 - val_accurac
y: 0.5121
Epoch 3/9
480/480 [==============================] - 97s 201ms/step - loss: 0.5540 - accuracy: 0.8018 - val_loss: 0.7785 - val_accurac
y: 0.7698
Epoch 4/9
480/480 [==============================] - 99s 205ms/step - loss: 0.2770 - accuracy: 0.9099 - val_loss: 0.5690 - val_accurac
y: 0.8296
Epoch 5/9
480/480 [==============================] - 97s 201ms/step - loss: 0.2037 - accuracy: 0.9388 - val_loss: 0.5057 - val_accurac
y: 0.8416
Epoch 6/9
 91/480 [====>.........................] - ETA: 1:09 - loss: 0.1595 - accuracy: 0.9499
```

● **Saving the model:**

The model is saved with .h5 extension as follows,

An H5 file is a data file saved in the Hierarchical Data Format (HDF).It contains multidimensional arrays of scientific data.

```
In [26]: #Saving Model.
         model.save('ECG.h5')
```

1.Testing the model:

Load necessary libraries and load the saved model using load_modelTaking an image as inputand checking the results Note: The target size should for the image that is should be the same as the target size that you have used for training.

```
In [26]:
#Saving Model.
model.save('ECG.h5')
```

```
In [28]:
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
```

```
In [29]:
model=load_model('ECG.h5')
```

```
In [30]:
img=image.load_img("/content/Unknown_image.png",target_size=(64,64))
```

```
In [31]:
x=image.img_to_array(img)
```

```
In [32]:
import numpy as np
```

```
In [33]:
x=np.expand_dims(x,axis=0)
```

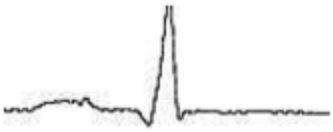
```
In [34]:
pred = model.predict(x)
y_predmp.argmax(pred)
y_pred
```

```
Out[34]: 1
```

```
In [35]:
index=['left Bundle Branch block',
       'Normal',
       'Prenature Atrial Contraction',
       'Prenature Ventricular Contraction',
       'Right Bundle Branch Block',
       'Ventricular Fibrillation']
result = str(index[y_pred])
result
```

```
Out[35]: 'Normal'
```

The unknown image uploaded is:



Here the output for the uploaded result is normal.

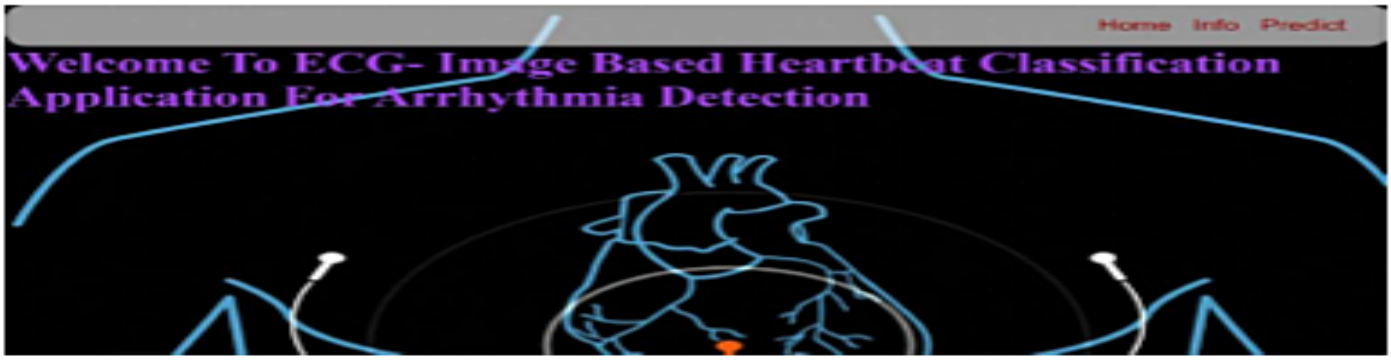
1.Application Building:

In this section, we will be building a web application that is integrated into the model we built. A UI is provided for the uses where he has uploaded an image. The uploaded image is given to the saved model and prediction is showcased on the UI. This section has the following tasks

- Building HTML Pages:
- We use HTML to create the front end part of the web page.

Here, we created 4 html pages- home.html, predict_base.html, predict.html, information.html.home.html displays the home page.

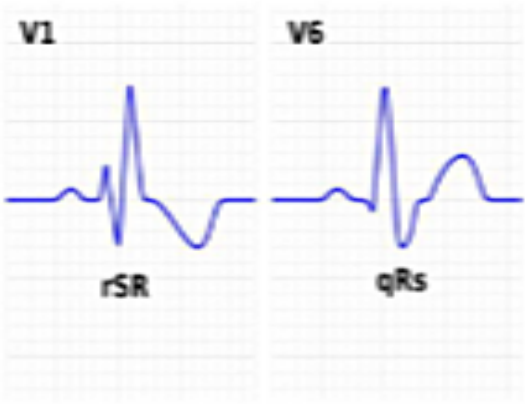
Information.html displays all important details to be known about ECG.



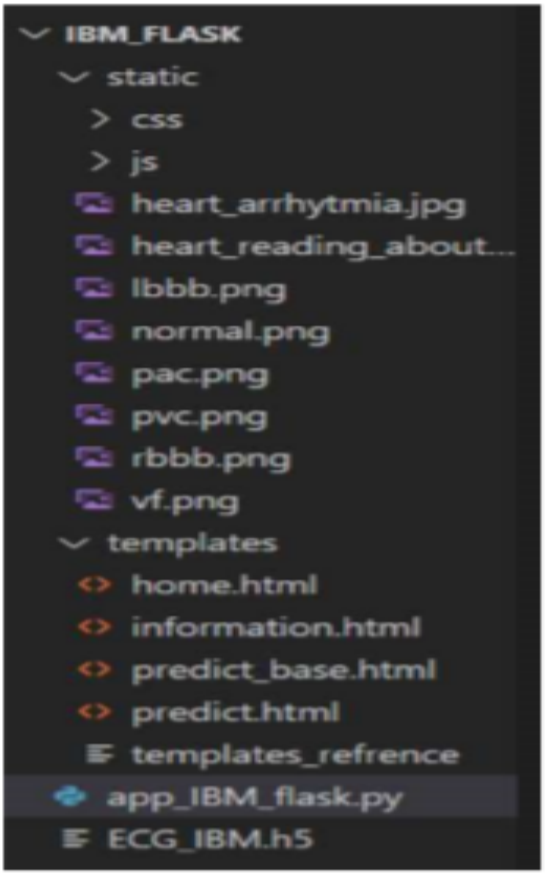
Information.html displays all important details to be known about ECG.

RIGHT BUNDLE BRANCH BLOCK

Right bundle branch block is associated with structural changes from stretch or ischemia to the myocardium. It can also occur iatrogenically from certain common cardiac procedures, such as right heart catheterization. Although there is no significant association with cardiovascular risk factors, the presence of a right bundle branch block is a predictor of mortality in myocardial infarction, heart failure, and certain heart blocks. In asymptomatic patients, isolated right bundle branch block typically does not need further evaluation.



- predict-base.html and predict.html acceptinput from the user and predicts thevalues.



● **Building server-side script:**

We will build the flask file app.py which is a web frameworkwritten in pythonfor server-side scripting.

1. The app starts running when the name constructor is called in main.
2. render_template is used to return HTML file.
3. GET method is used to take input from the user.
4. POST method is used to display the output to the user.

```python
import os
import numpy as np #used for numerical analysis
from flask import Flask,request,render_template
from tensorflow.keras.models import load_model#to load our trained model
from tensorflow.keras.preprocessing import image
app=Flask(__name__)#our flask app
model=load_model('ECG_IBM.h5')#loading the model
@app.route("/") #default route
def about():
    return render_template("home.html")#rendering html page
@app.route("/about") #default route
def home():
    return render_template("home.html")#rendering html page
@app.route("/info") #default route
def information():
    return render_template("information.html")#rendering html page
@app.route("/upload") #default route
def test():
    return render_template("predict.html")#rendering html page
@app.route("/predict",methods=["GET","POST"]) #route for our prediction
def upload():
    if request.method=='POST':
        f=request.files['file'] #requesting the file
        basepath=os.path.dirname('__file__')#storing the file directory
        filepath=os.path.join(basepath,"uploads",f.filename)#storing the file in uploads folder
        f.save(filepath)#saving the file
        img=image.load_img(filepath,target_size=(64,64)) #load and reshaping the image
        x=image.img_to_array(img)#converting image to array
        x=np.expand_dims(x,axis=0)#changing the dimensions of the image
```

Section Break(Next Page)

```python
def upload():
    if request.method=='POST':
        f=request.files['file'] #requesting the file
        basepath=os.path.dirname('__file__')#storing the file directory
        filepath=os.path.join(basepath,"uploads",f.filename)#storing the file in uploads folder
        f.save(filepath)#saving the file

        img=image.load_img(filepath,target_size=(64,64)) #load and reshaping the image
        x=image.img_to_array(img)#converting image to array
        x=np.expand_dims(x,axis=0)#changing the dimensions of the image

        pred=model.predict(x)#predicting classes
        y_pred = np.argmax(pred)
        print("prediction",y_pred)#printing the prediction

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

        return result#resturing the result
    return None

#port = int(os.getenv("PORT"))
if __name__=="__main__":
    app.run(host="127.0.1.10",debug=False)#running our app
    #app.run(host='0.0.0.0', port=8000)
```

1.Running The App: Run the file as :

python app_IBM_flask.py

```
* Serving Flask app "app_IBM_flask" (lazy loading)
* Environment: production
  WARNING: This is a development server. Do not use it in a production deployment.
  Use a production WSGI server instead.
* Debug mode: off
* Running on http://127.0.1.10:5000/ (Press CTRL+C to quit)
```

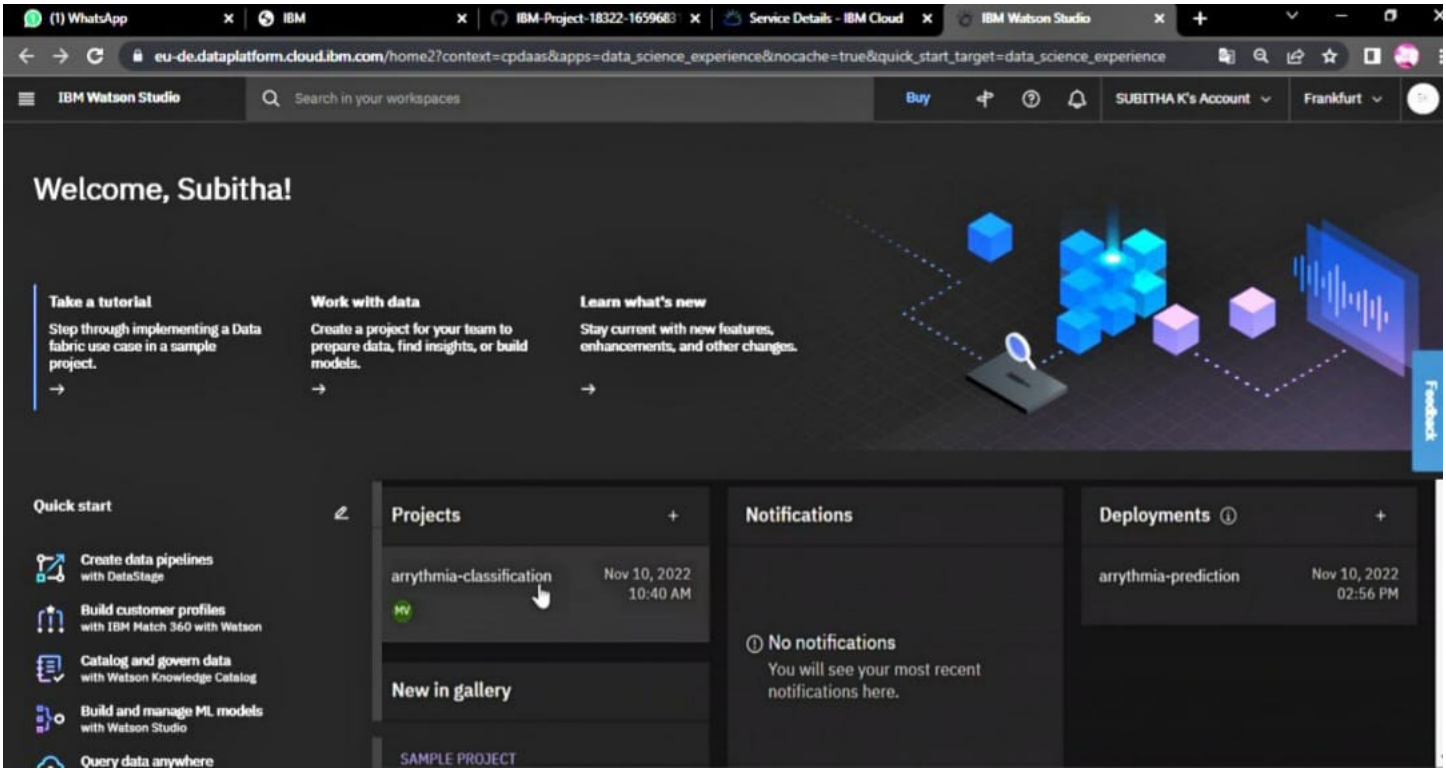
Navigate to the localhost (http://127.0.1.10:5000/)where you can view your web page.

Flow Chart & Results by training model in IBM WATSON STUDIO:

CreatingIBM cloud account:

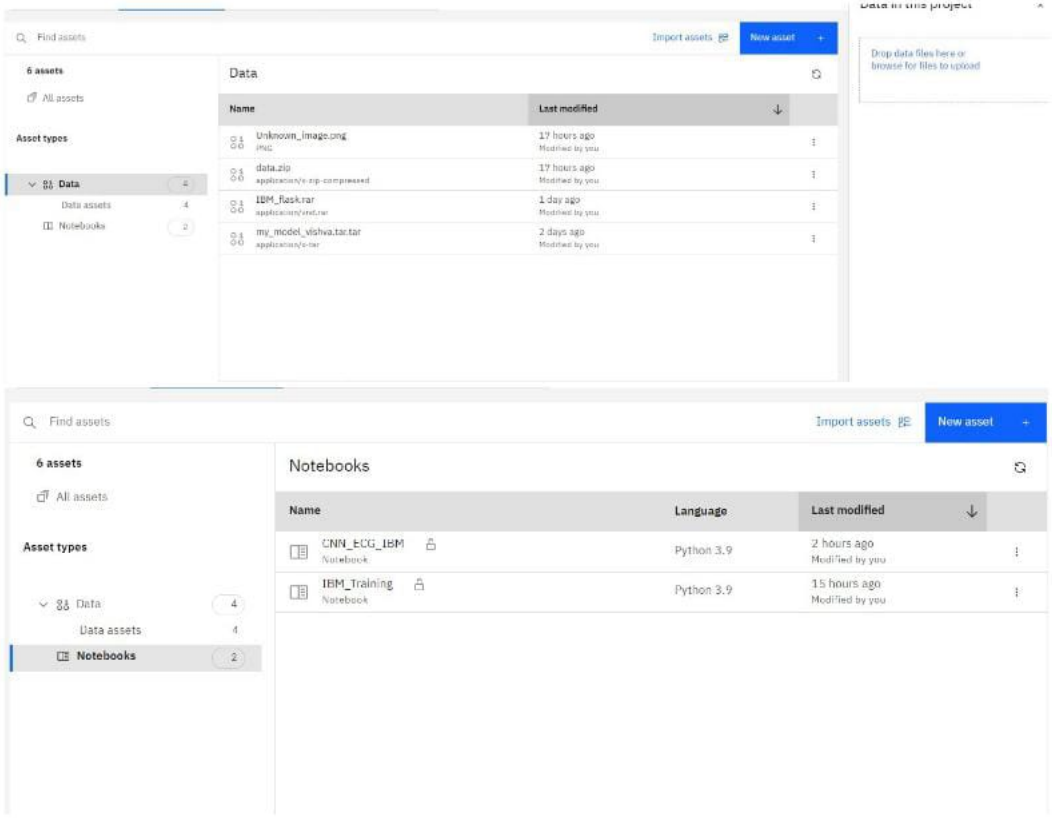
We have to create an IBM Cloud Account and should log in.

Creating Watson Studio Service & Machine Learning Service:



● Upload The datasetand create a jupytersource file in the created project:

- Upload The datasetand create a jupytersource file in the created project:



Apply CNN algorithmand save the model and deploy it using API key generated:

Section Break(Next Page)

```
In [77]: model.save('ECG_IBM.h5')

In [109]: !tar -zcvf ECG-arrhythmia-classification-model_new.tgz ECG_IBM.h5

          ECG_IBM.h5

In [110]: ls -1

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

```
Successfully installed watson-machine-learning-client-1.0.391

In [25]: from ibm_watson_machine_learning import APIClient
         wml_credentials={
             "url":"https://us-south.ml.cloud.ibm.com",
             "apikey":"E9NcSkM6K_G7Uqd-S6Hz2TSYeVUkOsgsrOQMOq0Iea5Z"
         }
         client=APIClient(wml_credentials)

In [26]: client.spaces.list()

         Note: 'limit' is not provided. Only first 50 records will be displayed if the number of records exceed 50
         ------------------------------------  ------------------  ------------------------
         ID                                    NAME                CREATED
         e3662a1b-04df-46ed-9550-b081d08af72f  ECG_Classification  2022-11-16T15:33:42.493Z
         ------------------------------------  ------------------  ------------------------

In [27]: space_uid="e3662a1b-04df-46ed-9550-b081d08af72f"

In [28]: client.set.default_space(space_uid)

Out[28]: 'SUCCESS'

In [29]: client.set.default_space(space_uid)

Out[29]: 'SUCCESS'

In [30]: client.software_specifications.list()

         ------------------------------  ------------------------------------  ----
         NAME                            ASSET_ID                              TYPE
         default_py3.6                   0062b8c9-8b7d-44a0-a9b9-46c416adcbd9  base
         kernel-spark3.2-scala2.12       020d69ce-7ac1-5e68-ac1a-31189867356a  base
         pytorch-onnx_1.3-py3.7-edt      069ea134-3346-5748-b513-49120e15d288  base

In [32]: model_details = client.repository.store_model(model="ECG-arrhythmia-classification-model_new.tgz",meta_props={
             client.repository.ModelMetaNames.NAME:"ECG_IBM",
             client.repository.ModelMetaNames.TYPE:"tensorflow_2.7",
             client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_spec_uid})
         model_id=client.repository.get_model_uid(model_details)

         This method is deprecated, please use get_model_id()
         /opt/conda/envs/Python-3.9/lib/python3.9/site-packages/ibm_watson_machine_learning/repository.py:1453: UserWarning: This method is deprecated, please use get_model_id()
           warn("This method is deprecated, please use get_model_id()")

In [33]: model_id

Out[33]: 'f5de404a-f12f-414f-9ea2-65185753e484'

In [34]: # @hidden_cell
         # The following code contains the credentials for a file in your IBM Cloud Object Storage.
         # You might want to remove those credentials before you share your notebook.
         metadata_1 = {
             'IAM_SERVICE_ID': 'iam-ServiceId-dd7ca75c-7f0e-4f4a-aa8e-3b9f6ba759e1',
             'IBM_API_KEY_ID': 'EGYWPJJPVCTSQFPKXX2CqCb5gr05YOzh2kN-_W802asR',
             'ENDPOINT': 'https://s3.private.us.cloud-object-storage.appdomain.cloud',
             'IBM_AUTH_ENDPOINT': 'https://iam.cloud.ibm.com/oidc/token',
             'BUCKET': 'classificationofarrhythmiabyusing-donotdelete-pr-jviatmq4bscjnh',
             'FILE': 'Unknown_image.png'
         }
         client.repository.download(model_id,'my_model_vishva.tar.tar')

         Successfully saved model content to file: 'my_model_vishva.tar.tar'

Out[34]: '/home/spuser/work/my_model_vishva.tar.tar'
```

<u>For downloading the model we have to run the last part of the above codein the local jupyternotebook:</u>

```
client.repository.download('2702a906-fdce-41d7-94d6-bfe8f920aca8','my_model_vishva.tar.gz')

Successfully saved model content to file: 'my_model_vishva.tar.gz'

'd:\\Jithu Pgm working\\Jithu\\Vishva_programs\\IBM_nalayathiran\\IBM_training/my_model_vishva.tar.gz'
```

CNN_ECG_IBM.ipynb	06-07-2022 09:03	IPYNB File	24 KB
ECG_IBM.h5	06-07-2022 09:03	H5 File	10,385 KB
IBM_Training.ipynb	16-11-2022 22:24	IPYNB File	11 KB
IBM_training_reference	06-07-2022 09:03	File	1 KB
my_model_subitha.tar.gz	17-11-2022 09:29	WinRAR archive	2,913 KB
my_model_subitha.tar.tar	06-07-2022 09:03	WinRAR archive	10,390 KB

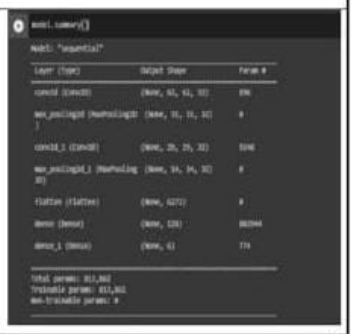
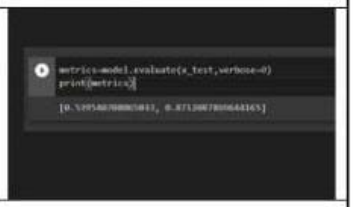
Now we will extractthe .h5 modelfile and will do the app deploymentusing

8.TESTING

a. PERFORMANCE TESTING:

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 – 0.539540708065 Validation Accuracy -0.871208786964	
3.	Confidence Score (Only Yolo Projects)	Class Detected - Confidence Score -	-

b. USER ACCEPTANCE TESTING

This report shows the count of the bugs at each severity level, and how they were fixed.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	5	4	2	3	14
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	9	2	4	15	30
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	17	14	13	21	65

Section Break(Next Page)

9.RESULT

a. PERFORMANCE METRICS:

```
metrics=model.evaluate(x_test,verbose=0)
print(metrics)

[0.539540708065033, 0.8712087869644165]
```

10.Advantages & Disadvantages:

a.Advantages:

i.The proposed modelpredicts Arrhythima in images with a highaccuracy rate 96%. The early detection of Arrhythmia gives better understanding of disease causes, initiates therapeutic interventions and enablesdeveloping appropriate treatments.

b.Disadvantages:

i.Notuseful for identifying the different stagesof Arrhythmia disease.

ii.Notuseful in monitoring motor symptoms

Applications :

i. It is useful for identifying the arrhythmia diseaseat an early stage. ii. It is usefulin detecting cardiovascular disorders

11.Conclusion:

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

2.Unfortunately, the expert level of medicalresources is rare, visually identify the ECG signalis challenging and time-consuming.

3.The advantages of the proposed CNN network have been put toevidence.

4.It is endowed with an ability to effectively process the non-filtered dataset with its potential anti-noisefeatures. Besides that, ten- foldcross-validation is implemented in this work to furtherdemonstratethe robustness of the network.

12.Future Scope:

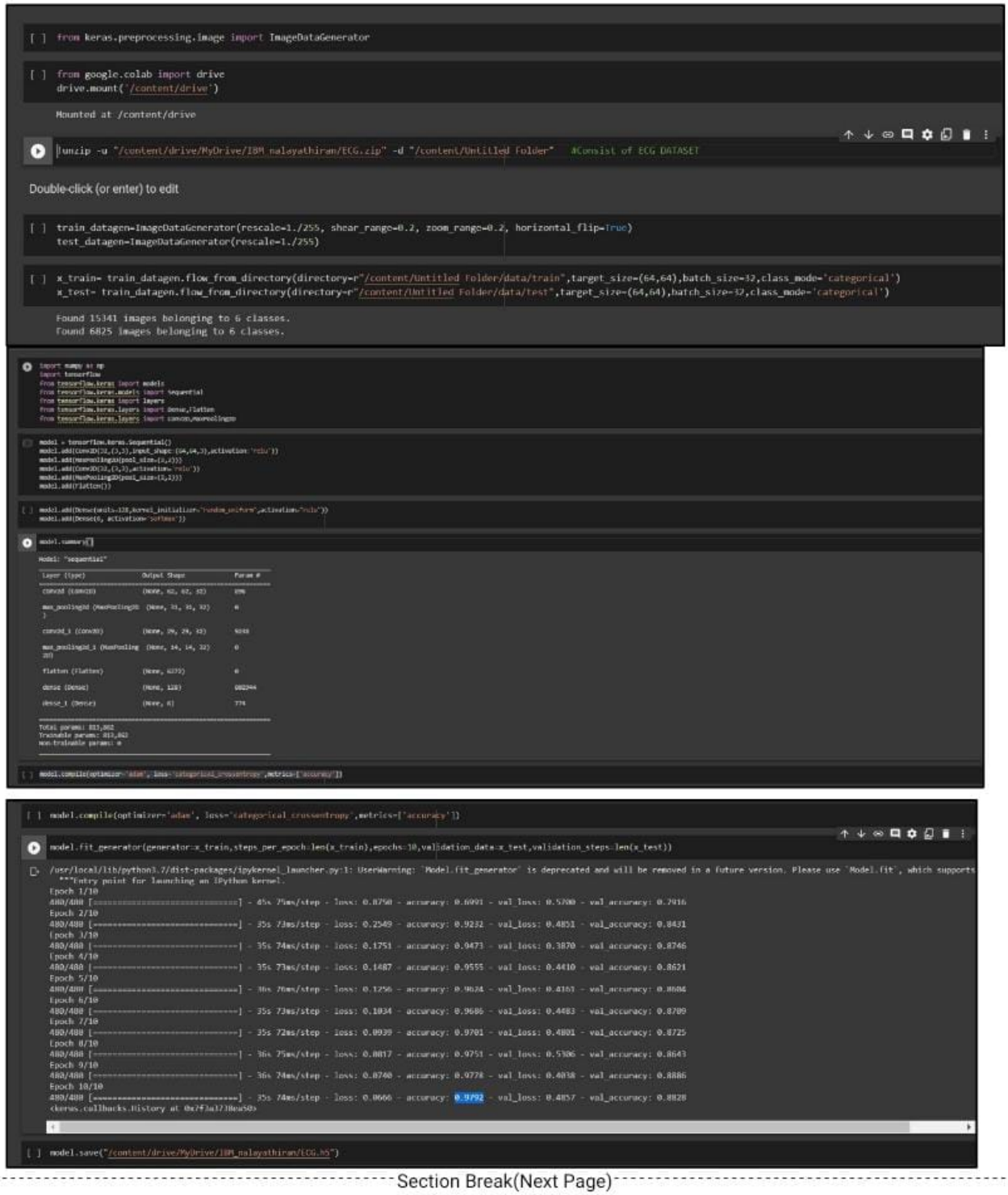
For future work, it would be interesting to explore the use of optimization techniques to find a feasibledesign and solution. The limitation of our studyis that we have yet to apply any optimization techniques to optimize the model parameters and we believe that with the implementation of the optimization,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

level.

13.APPENDIX:

SOURCE CODE:

MODEL GENERATOR



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

[ ] from google.colab import drive
    drive.mount('/content/drive')

    Mounted at /content/drive

!unzip -u "/content/drive/MyDrive/IBM nalayathiran/ECG.zip" -d "/content/Untitled Folder"   #Consist of ECG DATASET

Double-click (or enter) to edit

[ ] train_datagen=ImageDataGenerator(rescale=1./255, shear_range=0.2, zoom_range=0.2, horizontal_flip=True)
    test_datagen=ImageDataGenerator(rescale=1./255)

[ ] x_train= train_datagen.flow_from_directory(directory=r"/content/Untitled Folder/data/train",target_size=(64,64),batch_size=32,class_mode='categorical')
    x_test= train_datagen.flow_from_directory(directory=r"/content/Untitled Folder/data/test",target_size=(64,64),batch_size=32,class_mode='categorical')

    Found 15341 images belonging to 6 classes.
    Found 6825 images belonging to 6 classes.
```

```
import numpy as np
import tensorflow
from tensorflow.keras import models
from tensorflow.keras.models import Sequential
from tensorflow.keras import layers
from tensorflow.keras.layers import Dense,Flatten
from tensorflow.keras.layers import Convolution2D,MaxPooling2D

model = tensorflow.keras.Sequential()
model.add(Convolution2D(32,(3,3),input_shape=(64,64,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Convolution2D(32,(3,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())

model.add(Dense(units=128,kernel_initializer='random_uniform',activation='relu'))
model.add(Dense(6, activation='softmax'))

model.summary()
```

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

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

conv2d_1 (Conv2D)            (None, 29, 29, 32)        9248

max_pooling2d_1 (MaxPooling  (None, 14, 14, 32)        0
2D)

flatten (Flatten)            (None, 6272)              0

dense (Dense)                (None, 128)               802944

dense_1 (Dense)              (None, 6)                 774

=================================================================
Total params: 813,862
Trainable params: 813,862
Non-trainable params: 0
_________________________________________________________________
```

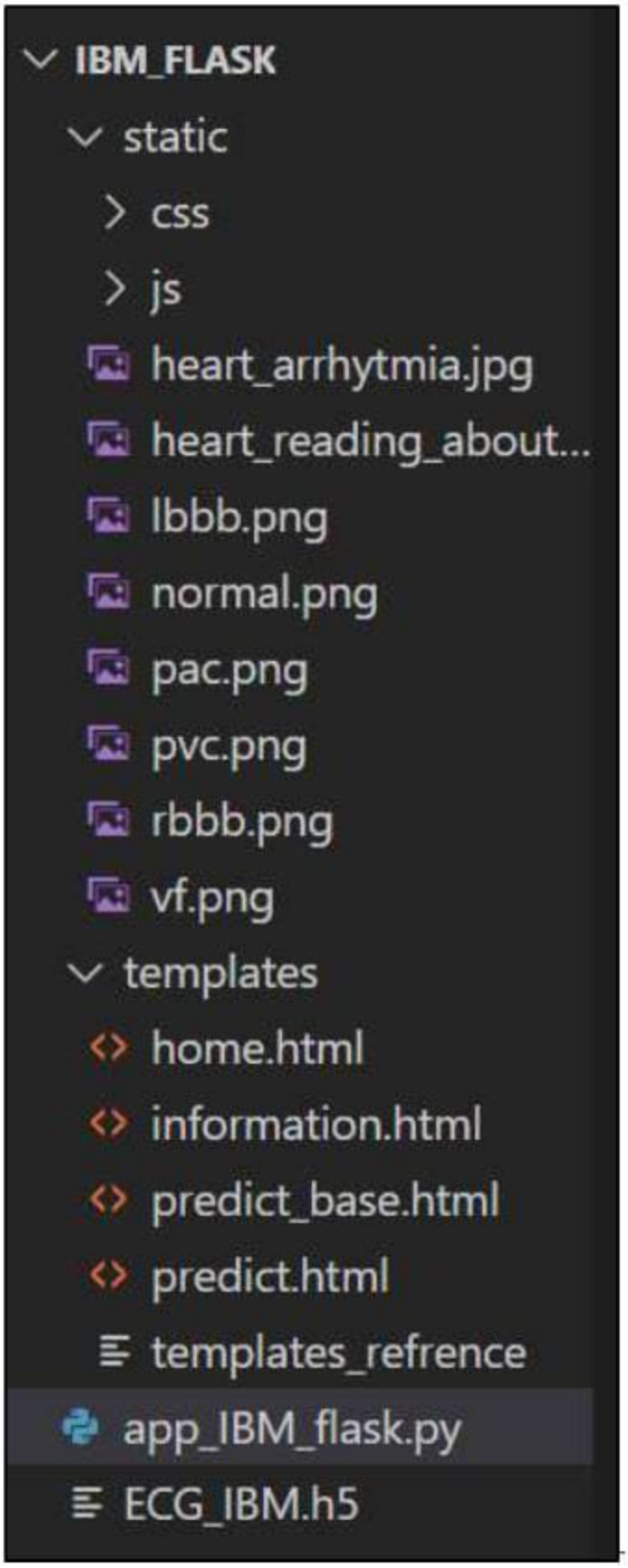
```
[ ] model.compile(optimizer='adam', loss='categorical_crossentropy',metrics=['accuracy'])
```

```
model.fit_generator(generator=x_train,steps_per_epoch=len(x_train),epochs=10,validation_data=x_test,validation_steps=len(x_test))

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports
  """Entry point for launching an IPython kernel.
Epoch 1/10
480/480 [==============================] - 45s 75ms/step - loss: 0.8750 - accuracy: 0.6091 - val_loss: 0.5700 - val_accuracy: 0.7916
Epoch 2/10
480/480 [==============================] - 35s 73ms/step - loss: 0.2549 - accuracy: 0.9232 - val_loss: 0.4051 - val_accuracy: 0.8431
Epoch 3/10
480/480 [==============================] - 35s 74ms/step - loss: 0.1751 - accuracy: 0.9473 - val_loss: 0.3870 - val_accuracy: 0.8746
Epoch 4/10
480/480 [==============================] - 35s 73ms/step - loss: 0.1487 - accuracy: 0.9555 - val_loss: 0.4410 - val_accuracy: 0.8621
Epoch 5/10
480/480 [==============================] - 36s 76ms/step - loss: 0.1256 - accuracy: 0.9624 - val_loss: 0.4161 - val_accuracy: 0.8684
Epoch 6/10
480/480 [==============================] - 35s 73ms/step - loss: 0.1034 - accuracy: 0.9686 - val_loss: 0.4483 - val_accuracy: 0.8709
Epoch 7/10
480/480 [==============================] - 35s 72ms/step - loss: 0.0930 - accuracy: 0.9701 - val_loss: 0.4801 - val_accuracy: 0.8725
Epoch 8/10
480/480 [==============================] - 36s 75ms/step - loss: 0.0817 - accuracy: 0.9751 - val_loss: 0.5306 - val_accuracy: 0.8643
Epoch 9/10
480/480 [==============================] - 36s 74ms/step - loss: 0.0740 - accuracy: 0.9778 - val_loss: 0.4838 - val_accuracy: 0.8886
Epoch 10/10
480/480 [==============================] - 35s 74ms/step - loss: 0.0666 - accuracy: 0.9792 - val_loss: 0.4857 - val_accuracy: 0.8828
<keras.callbacks.History at 0x7f3a173bea50>
```

```
[ ] model.save("/content/drive/MyDrive/IBM_nalayathiran/ECG.h5")
```

Section Break(Next Page)


IBM_FLASK
static
css
js
heart_arrhytmia.jpg
heart_reading_about...
lbbb.png
normal.png
pac.png
pvc.png
rbbb.png
vf.png
templates
home.html
information.html
predict_base.html
predict.html
templates_refrence
app_IBM_flask.py
ECG_IBM.h5

app IBM flask.py

```
import os
import numpy as np #used for numerical analysis
from flask import Flask,request,render_template
from tensorflow.keras.models import load_model#to load our trained model
from tensorflow.keras.preprocessing import image
app=Flask(__name__)#our flask app
model=load_model('ECG_IBM.h5')#loading the model
@app.route("/") #default route
def about():
    return render_template("home.html")#rendering html page
@app.route("/about") #default route
def home():
    return render_template("home.html")#rendering html page
@app.route("/info") #default route
def information():
    return render_template("information.html")#rendering html page
@app.route("/upload") #default route
def test():
    return render_template("predict.html")#rendering html page
@app.route("/predict",methods=["GET","POST"]) #route for our prediction
def upload():
    if request.method=='POST':
        f=request.files['file'] #requesting the file
        basepath=os.path.dirname('__file__')#storing the file directory
        filepath=os.path.join(basepath,"uploads",f.filename)#storing the file in uploads folder
        f.save(filepath)#saving the file
        img=image.load_img(filepath,target_size=(64,64)) #load and reshaping the image
        x=image.img_to_array(img)#converting image to array
        x=np.expand_dims(x,axis=0)#changing the dimensions of the image
```

```
def upload():
    if request.method=='POST':
        f=request.files['file'] #requesting the file
        basepath=os.path.dirname('__file__')#storing the file directory
        filepath=os.path.join(basepath,"uploads",f.filename)#storing the file in uploads folder
        f.save(filepath)#saving the file

        img=image.load_img(filepath,target_size=(64,64)) #load and reshaping the image
        x=image.img_to_array(img)#converting image to array
        x=np.expand_dims(x,axis=0)#changing the dimensions of the image

        pred=model.predict(x)#predicting classes
        y_pred = np.argmax(pred)
        print("prediction",y_pred)#printing the prediction

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

        return result#resturing the result
    return None

if __name__=="__main__":
    app.run(host="127.0.1.10",debug=False)#running our app
```

home.html

```
<html>
<head>
<title>Home</title>
<style>
body{
    background-image: url('https://rh.gatech.edu/sites/default/files/images/research_horizons/BrokenHeart/solution_6_
    background-size:1300px 1000px;
    background-repeat:no-repeat;
    padding:0;
    margin:0;
}
.pd{
padding-bottom:100%;}
.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;
text-decoration:none;
font-style:normal;
padding-right:20px;
}
a:hover{
background-color: blue;
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
```

```html
</style>
</head>
<body>
<div class="navbar">
<a href="/upload" >Predict</a>
<a href="/info">Info</a>
<a href="/about">Home</a>
<br>
</div>
<b class="pd"><font color="#aa42f5" size="50" font-family="Comic Sans MS" >

    Welcome To ECG- Image Based Heartbeat Classification Application For Arrhythmia Detection

</font></b>
<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>
<center><b class="pd"><font color="Black" size="15" font-family="Comic Sans MS" >ECG arrhythmia classification using
<div>
<br>
<center>
<p><font color="#3498eb" background-color="#2596be">According to the World Health Organization (WHO), cardiovascular
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.
```

```html
Although single arrhythmia heartbeat may not have a serious impact on life, continuous
arrhythmia beats can result in fatal circumstances.Electrocardiogram (ECG) is a non-invasive medical tool that displa
of the heart. Therefore, automatic detection of irregular heart rhythms from ECG signals is a
significant task in the field of cardiology.
A heart arrhythmia (uh-RITH-me-uh) is an irregular heartbeat. Heart rhythm problems (heart arrhythmias) occur when th

Heart arrhythmias may feel like a fluttering or racing heart and may be harmless. However, some heart arrhythmias may

However, sometimes it's normal for a person to have a fast or slow heart rate. For example, the heart rate may increa

Heart arrhythmia treatment may include medications, catheter procedures, implanted devices or surgery to control or e
</font></p>
<img src="static\heart_arrhytmia.jpg" height=640 width=1200></img>
</center>
<img src="https://media.giphy.com/media/WnIu6vAWt5ul3EVcUE/giphy.gif" width=1260></img>
<p align="center"><font size="1000px">.....THANK YOU.....</font></p>
</div>
</body>
</html>
```

information.html

```
<br>
</div>
<div>
<h1><u>ECG- Image Based Heartbeat Classification Information Guide</u></h1>
<div>
<span><img src="/static/normal.png" title="normal" ></span>
<span><img src="/static/vf.png" title="vf" ></span>
<span><img src="/static/pac.png" title="pac" ></span>
<span><img src="/static/pvc.png" title="pvc" ></span>
<span><img src="/static/rbbb.png" title="rbbb" ></span>
<span><img src="/static/lbbb.png" title="lbbb" ></span>
<div>
</body>
</html>
```

predict.html

```
{% extends "predict_base.html" %} {% block content %}
<h2 style="color:#fc4e03;font-family:Times New Roman;font-size:60">ECG Arrhythmia Classification</h2>
<div>
    <form id="upload-file" method="post" enctype="multipart/form-data">
    <center>    <label for="imageUpload" class="upload-label">
            Choose...
        </label>
        <input type="file" name="file" id="imageUpload" accept=".png, .jpg, .jpeg">
    </center></form>
   <center> <div class="image-section" style="display:none;">
        <div class="img-preview">
            <div id="imagePreview">
            </div></center>
        </div>
        <center><div>
            <button type="button" class="btn btn-primary btn-lg " id="btn-predict">Predict!</button>
        </div></center>
    </div>
    <div class="loader" style="display:none;"></div>
    <h3 style="color:Black" id="result">
        <span> </span>
    </h3>
</div></div>

{% endblock %}
```

predict base.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: grey;
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;
}
body
{
    background-image: url("https://media.tenor.com/uFB7tkZq3QYAAAAd/heart-heartbeat.gif");
    background-size:cover;
}
</style>
</head>
```

```
<body>
<div class="bar">
<a href="/upload" >Predict</a>
<a href="/info">Info</a>
<a href="/about">Home</a>
<br>
</div>
    <div class="container">
      <center> <div id="content" style="margin-top:2em">{% 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>
```

flask main.js

```
$(document).ready(function () {
    // Init
    $('.image-section').hide();
    $('.loader').hide();
    $('#result').hide();

    // Upload Preview
    function readURL(input) {
        if (input.files && input.files[0]) {
            var reader = new FileReader();
            reader.onload = function (e) {
                $('#imagePreview').css('background-image', 'url(' + e.target.result + ')');
                $('#imagePreview').hide();
                $('#imagePreview').fadeIn(650);
            }
            reader.readAsDataURL(input.files[0]);
        }
    }
    $("#imageUpload").change(function () {
        $('.image-section').show();
        $('#btn-predict').show();
        $('#result').text('');
        $('#result').hide();
        readURL(this);
    });
```

```
    $('#btn-predict').click(function () {
        var form_data = new FormData($('#upload-file')[0]);

        // Show loading animation
        $(this).hide();
        $('.loader').show();

        // Make prediction by calling api /predict
        $.ajax({
            type: 'POST',
            url: '/predict',
            data: form_data,
            contentType: false,
            cache: false,
            processData: false,
            async: true,
            success: function (data) {
                // Get and display the result
                $('.loader').hide();
                $('#result').fadeIn(600);
                $('#result').text(' Result:  ' + data);
                console.log('Success!');
            },
        });
    });
});
```

flask main style .CSS

```css
.img-preview {
    width: 256px;
    height: 256px;
    position: relative;
    border: 5px solid #F8F8F8;
    box-shadow: 0px 2px 4px 0px rgba(0, 0, 0, 0.1);
    margin-top: 1em;
    margin-bottom: 1em;
}

.img-preview>div {
    width: 100%;
    height: 100%;
    background-size: 256px 256px;
    background-repeat: no-repeat;
    background-position: center;
}

input[type="file"] {
    display: none;
}

.upload-label{
    display: inline-block;
    padding: 12px 30px;
    background: #39D2B4;
```

```
    background: #39D2B4;
    color: #fff;
    font-size: 1em;
    transition: all .4s;
    cursor: pointer;
}

.upload-label:hover{
    background: #34495E;
    color: #39D2B4;
}

.loader {
    border: 8px solid #f3f3f3; /* Light grey */
    border-top: 8px solid #3498db; /* Blue */
    border-radius: 50%;
    width: 50px;
    height: 50px;
    animation: spin 1s linear infinite;
}

@keyframes spin {
    0% { transform: rotate(0deg); }
    100% { transform: rotate(360deg); }
}
```

GITHUBLINK

https://github.com/IBM-EPBL/IBM-Project-18322-1659683190

PROJECT VIDEO LINK

https://youtu.be/L2P9ztT-8HU

THE END