PROJECT DOCUMENTATION

Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

TEAM ID:-PNT2022TMID27696

Submitted By:-

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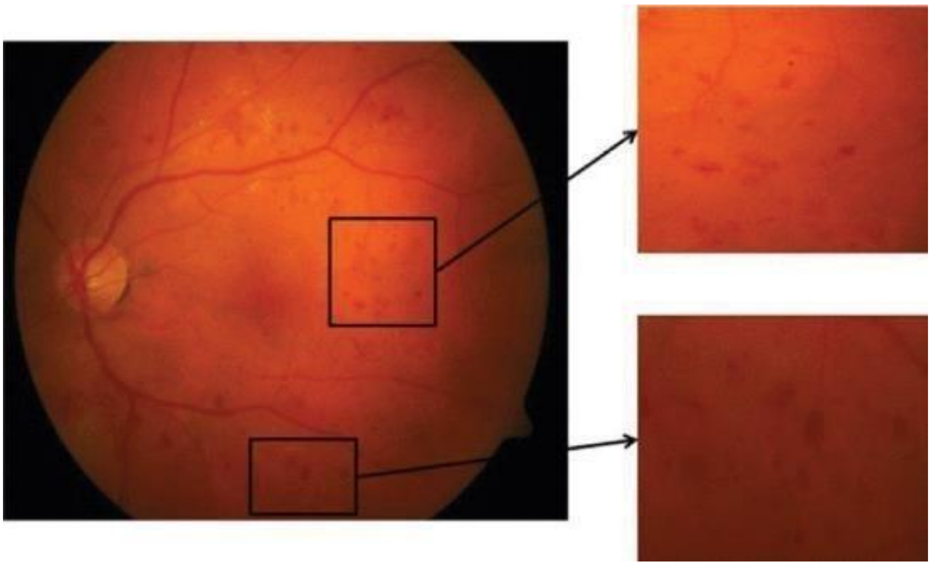
1. INTRODUCTION :-

The main causing of visual loss in the world is diabetic retinopathy. In the initial stages of this disease, the retinal microvasculature is affected by several abnormalities in the eye fundus such as the microaneurysms and/or dot hemorrhages, vascular hyper permeability signs, exudates, and capillary closures . Micro-aneurysm dynamics primarily increase the risk that the laser photo coagulation requires progression to the level . Diabetic retinopathy lesions are commonly accepted to be reversed and the progression of the retinopathy can only be slower during the early stages of the disease. The identification by repeated examination of patients affected of these initial lesions (mainly Micro aneurysms and small blood cells) is expected as a new possibility of improving retinopathy treatment. Floating and flashes, blurred vision, and loss of sudden vision can be common symptoms of diabetic retinopathy .



1.1 Project Overview :-

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not a reversible process, and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images by ophthalmologists is time, effort and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems.

Transfer learning has become one of the most common techniques that has achieved better performance in many areas, especially in medical image analysis and classification. We used Transfer Learning techniques like Inception V3,Resnet50,Xception V3 that are more widely used as a transfer learning method in medical image analysis and they are highly effective.

1.2 Purpose :-

The Proposed work intends to automate the detection and classification of diabetic retinopathyfromretinal fundusimagewhich isveryimportant inophthalmology.Most ofthe existingmethodsusehandcraftedfeaturesandthosearefedtotheclassifier fordetectionand classificationpurpose.Recentlyconvolutionalneuralnetwork(CNN)isusedforthisclassification problembutthearchitectureofCNNismanuallydesigned.Inthiswork,ageneticalgorithmbased techniqueisproposedtoautomaticallydeterminetheparametersof CNNandthenthenetworkis usedforclassificationofdiabeticretinopathy.The proposed CNNmodelconsistsof aseriesof convolutionandpoolinglayerused forfeatureextraction.Finallysupport vectormachine(SVM) isusedforclassification.Hyper-parameterslikenumberofconvolutionandpoolinglayer,number of kernel and kernel size of convolution layer are determined by using the genetic algorithm. The proposed methodology is tested on publicly available Messidor dataset. The proposed method has achieved accuracy of 0.9867 and AUC of 0.9933. Experimental result shows that proposed auto- tuned CNN performs significantly better than the existing methods. Use of CNN takes away the burden of designing the image features and on the other hand genetic algorithm based methodology automates the design of CNN hyper-parameters.

2. LITERATURE SURVEY :-

ABSTRACT

EXISITING PROBLEM:-

Diabetic Retinopathy (DR) is a degenerative disease that impacts the eyes and is a consequence of Diabetes mellitus, where high blood glucose levels induce lesions on the eye retina. Diabetic Retinopathy is regarded as the leading cause of blindness for diabetic patients, especially the working-age population in developing nations. Treatment involves sustaining the patient's current grade of vision since the disease is irreversible. Early detection of Diabetic Retinopathy is crucial in order to sustain the patient's vision effectively. The main issue involved with DR detection is that the manual diagnosis process is very time, money, and effort consuming and involves an ophthalmologist's examination of eye retinal fundus images. The latter also proves to be more difficult, particularly in the early stages of the disease when disease features are less prominent in the images. Machine learning-based medical image analysis has proven competency in assessing retinal fundus images, and the utilization of deep learning algorithms has aided the early diagnosis of Diabetic Retinopathy (DR). This paper reviews and analyzes state-of-the-art deep learning methods in supervised, self-supervised, and Vision Transformer setups, proposing retinal fundus image classification and detection. For instance, referable, nonreferable, and proliferative classifications of Diabetic Retinopathy are reviewed and summarized. Moreover, the paper discusses the available retinal fundus datasets for Diabetic Retinopathy that are used for tasks such as detection, classification, and segmentation. The paper also assesses research gaps in the area of DR detection/classification and addresses various challenges that need further study and investigation.

REFERENCES:-

DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

TEAM ID: PNT2022TMID27696

LITERATURE SURVEY

S.NO	PAPER	AUTHOR	YEAR	METHOD AND ALGORITHM	ACCURACY
1.	Deep learning algorithms for detection of diabetic retinopathy in retinal fundus photographs: A systematic review and meta-analysis	Md Mohaimenul Islam, Hsuan-Chia Yang, Tahmina Nasrin Poly, Wen-Shan Jian, Yu-Chuan	2020	A systematic review with a meta-analysis of relevant studies was performed to quantify the performance of DL algorithms to detect DR. The findings of their study showed that DL-algorithms had high sensitivity and specificity for detecting referable DR from retinal fundus photographs.	97%
2.	Diabetic Retinopathy Diagnosis Through Computer-Aided Fundus Image Analysis	Jaskirat Kaur, Deepti Mittal & Ruchi Singla	2021	Computer-aided diagnostic assistance to an expert plays a vital part by aiding in the daily tasks of diagnosis of DR. As a result, numerous methods, such as morphology and thresholding, filtering, supervised methods, hybrid methods are being used to design such systems for the qualitative examination of retinal fundus images	97.38%
3.	Deep Learning Techniques for Diabetic Retinopathy Classification	Mohammad Z. Atwany, Abdulwahab H. Sahyoun, Mohammad Yaqub	2022	Diabetic Retinopathy classification can be categorized to either binary classification which aims to detect the presence or absence of DR and multi-class classification, which determines the exact stage of DR. Consequently, Supervised, Self-	96.3%

S.NO	PAPER	AUTHOR	YEAR	METHOD AND ALGORITHM	ACCURACY
				supervised, and Transformer methods were developed to focus on lesion-based classification.	
4.	Design an Early Detection and Classification for Diabetic Retinopathy by Deep Feature Extraction based Convolution Neural Network	Akey Sungheetha Kumarasuvamy, Rajesh Sharma Rajendran	2021	They proposed research work extracts the features by incorporating deep networks through convolution neural networks (CNN). The micro aneurysm may be seen in the early stages of the transformation from normal to sick condition on the images for mild DR. The level of severity of the diabetes condition may be classified by using the confusion matrix detection results.	95.95%
5.	Deep learning architecture based on segmented fundus image features for classification of diabetic retinopathy	Sraddha Das, Krity Kharbanda, Suchetha M, Rajiv Raman, Edwin Dhas D	2021	They have used a convolution neural network (CNN) to train the classifier for performing classification. The CNN, constructed for classification, comprises a combination of squeeze and excitation and bottleneck layers, one for each class, and a convolution and pooling layer architecture for classification between the two classes. For the performance evaluation of the proposed algorithm, They use the dataset DIARETDB1, comprised of fundus scans of both affected and normal retinas.	98.7%
6.	Diagnostic assessment of deep learning algorithms for diabetic retinopathy screening	Tao Li, Yingqi Gao, Kai Wang, Song Guo, Hanruo Liu, Hong Kang	2019	They collected 13,673 fundus images from 9598 patients. These images were divided into six classes by seven graders according to image quality and DR level. Moreover, 757 images with DR were selected to	82%

S.NO	PAPER	AUTHOR	YEAR	METHOD AND ALGORITHM	ACCURACY
				annotate four types of DR-related lesions. Finally, we evaluated state-of-the-art deep learning algorithms on collected images, including image classification, semantic segmentation and object detection.	

2.3.PROBLEM STATEMENT DEFINITION:-

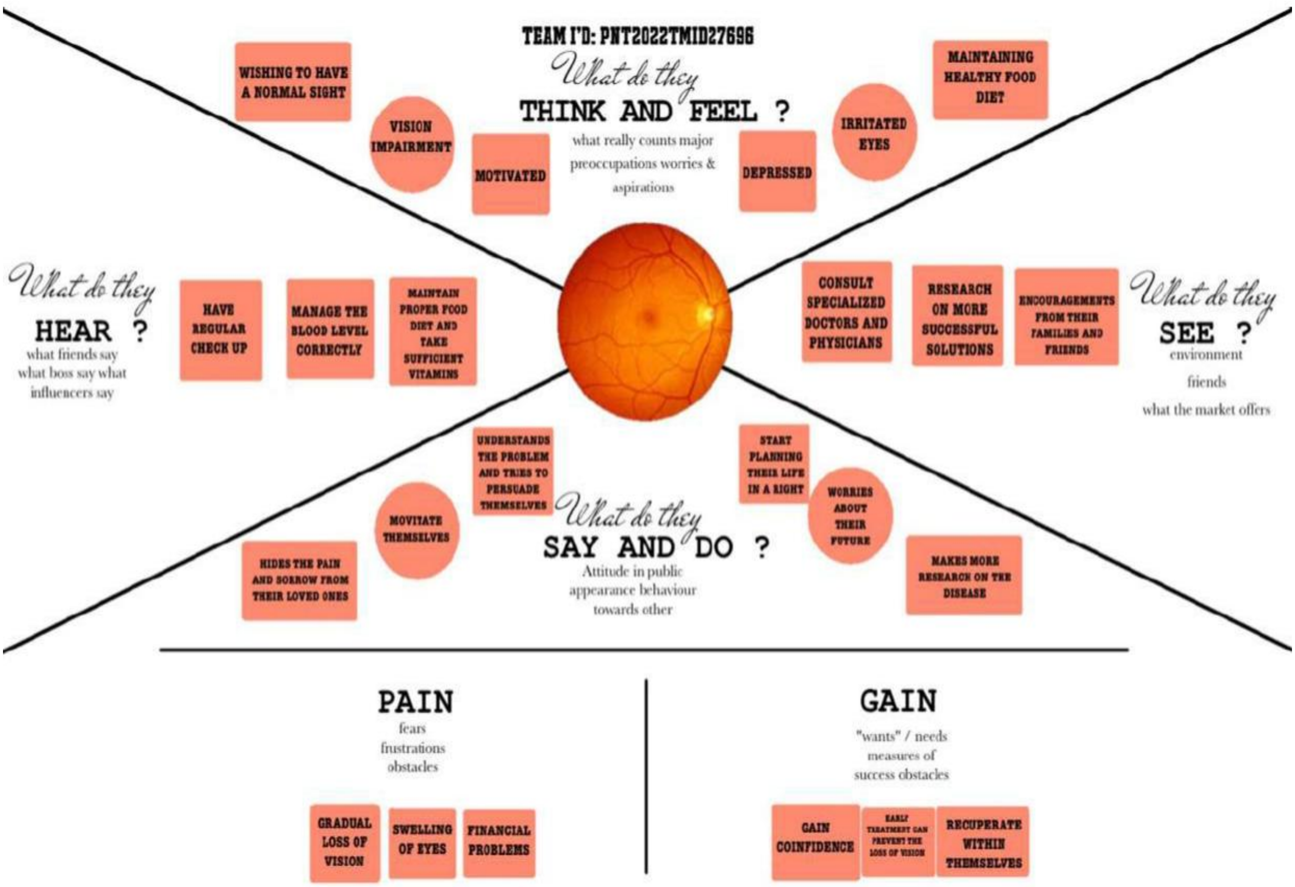
problem statement is a concise description of an issue to be addressed or a condition to be improved upon. It identifies the gap between the cur rent state and desired state of a process or product. Focusing on the facts, the problem statement should be designed to address the Five Ws.

OBJECTIVES :

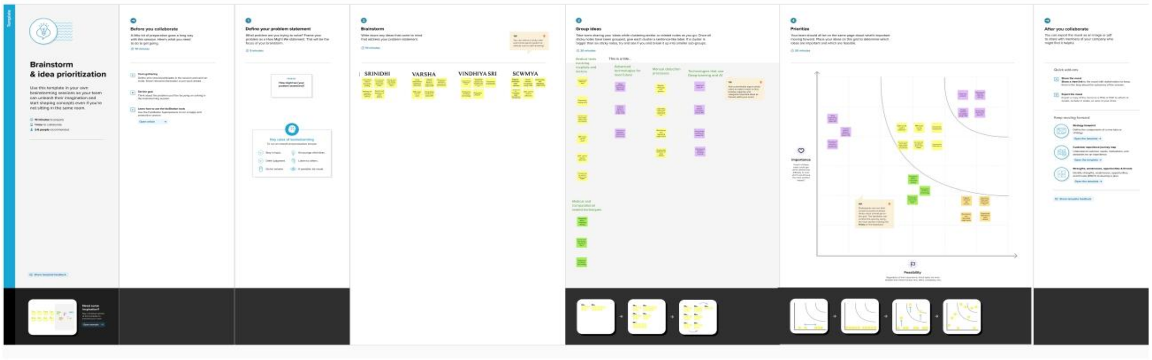
has arose as one of the most popular techniques that has enhanced performance in many areas The primary goal is to identify diabetic retinopathy by processing retinal images. Transfer learning, notably in the analysis and classification of medical images. We used transfer learning techniques that are more frequently used in medical image analysis and have been extremely effective, including such Inception V3, Resnet50, and Xception V3.

IDEATION PHASE & PROPOSED SOLUTION :

2.1 Empathy Map Canvas :


TEAM I'D: PNT2022TMID27696
What do they THINK AND FEEL ?
what really counts major preoccupations worries & aspirations
WISHING TO HAVE A NORMAL SIGHT
VISION IMPAIRMENT
MOTIVATED
DEPRESSED
IRRITATED EYES
MAINTAINING HEALTHY FOOD DIET
What do they HEAR ?
what friends say what boss say what influencers say
HAVE REGULAR CHECK UP
MANAGE THE BLOOD LEVEL CORRECTLY
MAINTAIN PROPER FOOD DIET AND TAKE SUFFICIENT VITAMINS
What do they SEE ?
environment
friends
what the market offers
CONSULT SPECIALIZED DOCTORS AND PHYSICIANS
RESEARCH ON MORE SUCCESSFUL SOLUTIONS
ENCOURAGEMENTS FROM THEIR FAMILIES AND FRIENDS
What do they SAY AND DO ?
Attitude in public appearance behaviour towards other
UNDERSTANDS THE PROBLEM AND TRIES TO PERSUADE THEMSELVES
MOVITATE THEMSELVES
HIDES THE PAIN AND SORROW FROM THEIR LOVED ONES
START PLANNING THEIR LIFE IN A RIGHT
WORRIES ABOUT THEIR FUTURE
MAKES MORE RESEARCH ON THE DISEASE
PAIN
fears
frustrations
obstacles
GRADUAL LOSS OF VISION
SWELLING OF EYES
FINANCIAL PROBLEMS
GAIN
"wants" / needs
measures of
success obstacles
GAIN COINFIDENCE
EARLY TREATMENT CAN PREVENT THE LOSS OF VISION
RECUPERATE WITHIN THEMSELVES

2.1 IDEATION AND BRAINSTORMING:-



2.3 PROPOSED SOLUTION:-

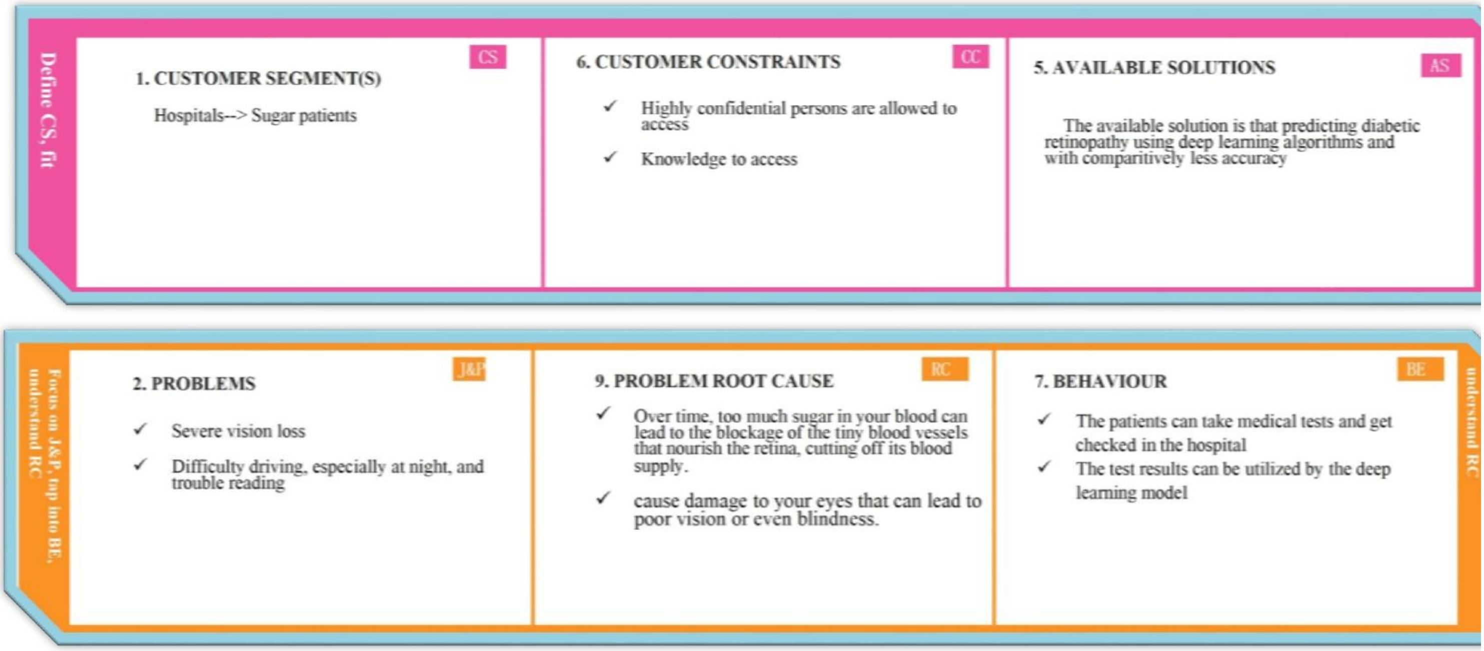
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Diabetic Retinopathy(DR) is a common complicationof diabetes mellitus, which causes lesions on the retina that effect vision .if it is not detected early,it can lead to blindness.Developement on larger and more diverse datasets,such an algorithm could enable early datasets,such an algorithm could enable earlydiagnosis and referrel to a retina specialist for more frequent monitoring and even consideration of early intervention.Moreover,it could also improve patient recruitment for clinical trials targeting DR
2.	Idea / Solution description	Many Artificial-Intelligence-powered methods have been proposed by the research community for the detection and classification of diabetic retinopathy onfundus retina images.
3.	Novelty / Uniqueness	This work considers a deep learning methodology specifically a Convolutional Neural Network(CNN),which is applied for the early detection of diabetic retinopathy.
4.	Social Impact / Customer Satisfaction	Regular dilated eye examinations are an effective approach to detecting and treating vision-threateningdiabetic retinopathy. They can help prevent blindness, and they are cost-effective. This application satisfying their requirements without spending any cost.
5.	Business Model (Revenue Model)	This can be converted as a bussiness model because it helps to prevent blindness of affected patient. Mostof the common people and the hospitals will use thisapplication.
6.	Scalability of the Solution	This application will be scalable. Once the image is classified under the five category of diabetic retinopathy then the suitable diagnosis and the healthtips(integrated with their daily life style) will be displayed.

2.4 PROPOSED SOLUTION FIT

Project Title: Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID27696



Define CS, fit

CS

1. CUSTOMER SEGMENT(S)

Hospitals--> Sugar patients

CC

6. CUSTOMER CONSTRAINTS

✓ Highly confidential persons are allowed to access

✓ Knowledge to access

AS

5. AVAILABLE SOLUTIONS

The available solution is that predicting diabetic retinopathy using deep learning algorithms and with comparitively less accuracy

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

J&P

2. PROBLEMS

✓ Severe vision loss

✓ Difficulty driving, especially at night, and trouble reading

RC

9. PROBLEM ROOT CAUSE

✓ Over time, too much sugar in your blood can lead to the blockage of the tiny blood vessels that nourish the retina, cutting off its blood supply.

✓ cause damage to your eyes that can lead to poor vision or even blindness.

BE

7. BEHAVIOUR

✓ The patients can take medical tests and get checked in the hospital

✓ The test results can be utilized by the deep learning model

understand RC

Identify strong TR & EM	**3. TRIGGERS** ✓ The longer you have diabetes and the less controlled your blood sugar is, the more likely you are to develop this eye complication.	**10. YOUR SOLUTION** Diabetic Retinopathy(DR) is a common complication of diabetes mellitus, which causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Many Artificial-Intelligence-powered methods have been proposed by the research community for the detection and classification of diabetic retinopathy on fundus retina images. Moreover, it	8. **CHANNELS of BEHAVIOUR** CH ONLINE ✓ People check with the symptoms and causes through surfing and they also check for laboratories which perform the medical tests. They can also like to get the results quickly without any delay.

2.5 FUNCTIONAL AND NON FUNCTIONAL REQUIREMENTS:-

FUNCTIONAL REQUIREMENTS:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Identifying the population eligible for screening	Use registries to ensure that people's details are collected and current, and decide which group needs to be tested based on the best available evidence.
FR-2	Invitation and information	Invite the entire cohort to the screening, and provide information that is appropriate for each group. To facilitate participation with knowledge
FR-3	Testing	Conduct screening test(s) using agreed/recommended Methods
FR-4	Referral of screen positives and reporting of screen-negative results	Send all positive findings from the screen to the appropriate services.additionally, ensure that screen negatives are communicated to People who continue to participate in the screening program
FR-5	Diagnosis	Diagnose true cases and identify false positives
FR-6	Treatment	Correctly intervene and treat situations; in some circumstances, surveillance or follow-up may also be necessary
FR-7	Outcomes	Identify false negatives and increase the performance and cost-efficiency of the screening program by gathering, analyzing, and reporting results.

NON FUNCTIONAL REQUIREMENTS:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	New findings for five distinct screening and clinical grading systems for diabetic retinopathy are presented. incorporating cutting-edge outcomes for precisely identifying photographs based on clinical five-grade diabetic retinopathy
NFR-2	**Security**	AI-powered deep learning can increase precision around delicate organs and tissues, minimize blood

		loss, infection risk, and discomfort during detection and screening.
NFR-3	**Reliability**	Deep Learning's capability to do pattern recognition by building complex associations based on input data and comparing them to performance standards is a significant advancement.
NFR-4	**Performance**	Simply said, AI is the ability to complete a task. primarily performed by a robot or computer, with the involvement of people. common templates for illustrating retinal findings that could be improved accuracy of results recorded.
NFR-5	**Availability**	Health care affordability, quality, and accessibility Can be amplified using this technology.
NFR-6	**Scalability**	In order to make high-quality systematic diabetic retinopathy screening a universal Offer to all persons with diabetes, it is possible to expand on existing systems and use a stepwise approach to enhancing the efficacy of present techniques.

3. PROJECT DESIGN:-

3.1 DATA FLOW DIAGRAM:-

Data Flow Diagrams:

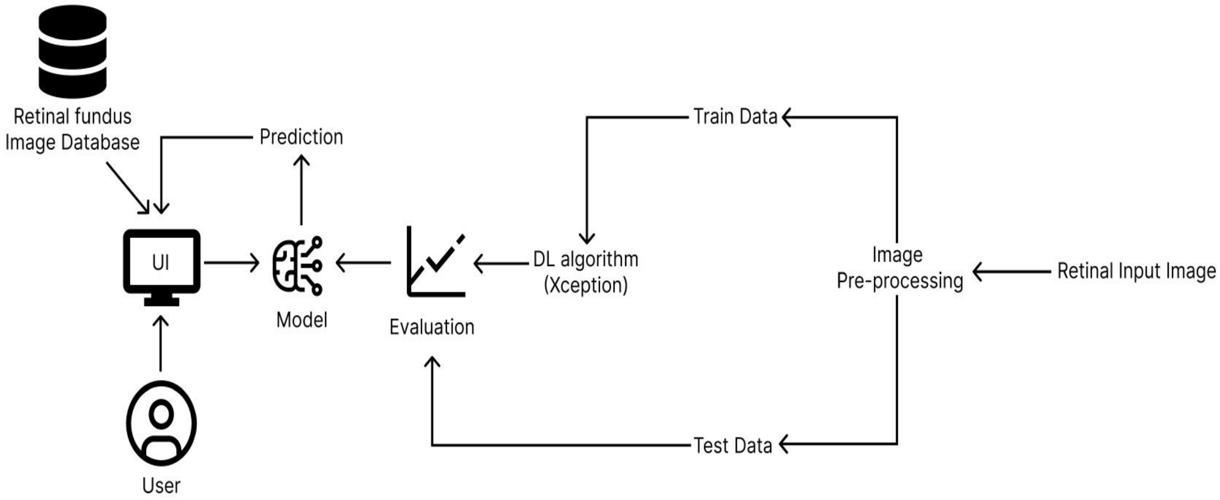
Date	10 October 2022
Team ID	PNT2022TMID27696
Project Name	Project - Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy
Maximum Marks	4 Marks

The classic visual representation of how information moves through a system is a data flow diagram (DFD). The ideal amount of the system needs can be graphically represented by a tidy and understandable DFD. It demonstrates how information enters and exits the system, whatmodifies the data, and where information is kept.

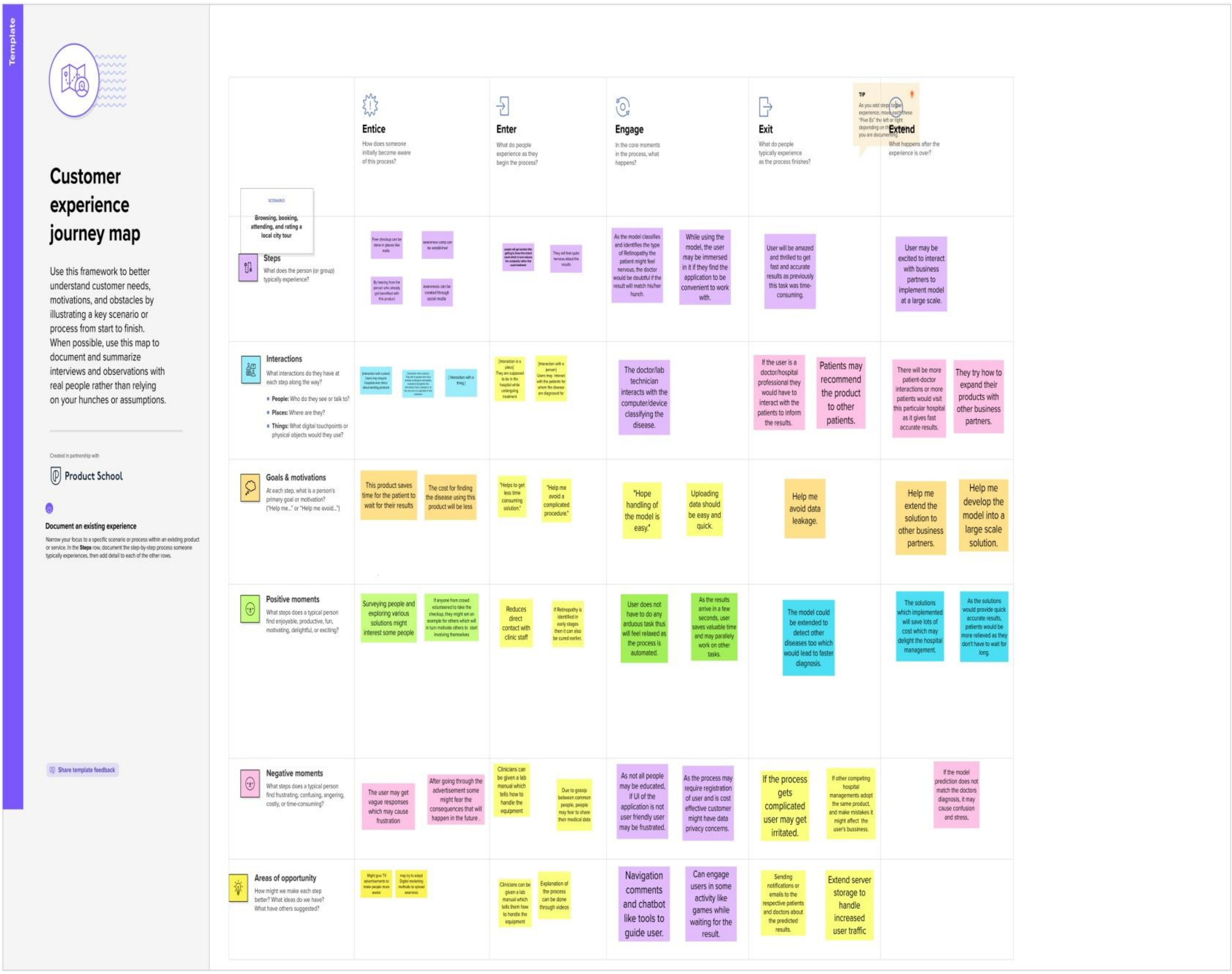
- Diabetic retinopathy diseaseis frequently detected and examined using retinal fundus Pre-processing of raw retinal fundus images isperformed using extraction of the green channel, histogramequalization, image enhancement,and resizing techniques.

- One of the main tasks in retinalimage processing is thesegmentation of the retinal vasculature from images of the eye fundus.
- By omitting the optic disc (OD) regionof the retina, the computer-assisted automatic recognition and segmentation of blood vessels.
- Mathematicalbinary morphological techniques are used to identify the retinal bloodvessels.
- The term "feature extraction from the fundus images for the diagnosis of Diabetic Retinopathy" refers to a sophisticated eye screeningtechnique that allows for the early detection of eye-related disorders.

3.2 TECHNOLOGY ARCHITECTURE:-



3.3 CUSTOMER JOURNEY MAP:-



Customer experience journey map

Use this framework to better understand customer needs, motivations, and obstacles by illustrating a key scenario or process from start to finish. When possible, use this map to document and summarize interviews and observations with real people rather than relying on your hunches or assumptions.

Created in partnership with

Product School

Document an existing experience

Narrow your focus to a specific scenario or process within an existing product or service. In the **Steps** row, document the step-by-step process someone typically experiences, then add detail to each of the other rows.

SCENARIO

Browsing, booking, attending, and rating a local city tour

TIP

As you add steps to the experience, move each these "Five Es" the left or right depending on the [illegible] you are documenting.

	Entice How does someone initially become aware of this process?	**Enter** What do people experience as they begin the process?	**Engage** In the core moments in the process, what happens?	**Exit** What do people typically experience as the process finishes?	**Extend** What happens after the experience is over?
Steps What does the person (or group) typically experience?	Free checkup can be done in places like malls awareness camp can be established By hearing from the person who already got benefited with this product awareness can be created through social media	people will get excited after getting to know the instant result which in turn reduces the complexity rather that usual treatment They will feel quite nervous about the results	As the model classifies and identifies the type of Retinopathy the patient might feel nervous, the doctor would be doubtful if the result will match his/her hunch. While using the model, the user may be immersed in it if they find the application to be convenient to work with.	User will be amazed and thrilled to get fast and accurate results as previously this task was time-consuming.	User may be excited to interact with business partners to implement model at a large scale.
Interactions What interactions do they have at each step along the way? ▪ **People:** Who do they see or talk to? ▪ **Places:** Where are they? ▪ **Things:** What digital touchpoints or physical objects would they use?	[Interaction with a place] Users may enquire hospitals and clinics about existing products [Interaction with a person] [illegible] [Interaction with a thing]	[Interaction in a place] They are supposed to be in the hospital while undergoing treatment [Interaction with a person] Users may interact with the patients for whom the disease are diagnosed for	The doctor/lab technician interacts with the computer/device classifying the disease.	If the user is a doctor/hospital professional they would have to interact with the patients to inform the results. Patients may recommend the product to other patients.	There will be more patient-doctor interactions or more patients would visit this particular hospital as it gives fast accurate results. They try how to expand their products with other business partners.
Goals & motivations At each step, what is a person's primary goal or motivation? ("Help me..." or "Help me avoid...")	This product saves time for the patient to wait for their results The cost for finding the disease using this product will be less	"Helps to get less time consuming solution." "Help me avoid a complicated procedure."	"Hope handling of the model is easy." Uploading data should be easy and quick.	Help me avoid data leakage.	Help me extend the solution to other business partners. Help me develop the model into a large scale solution.
Positive moments What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?	Surveying people and exploring various solutions might interest some people If anyone from crowd volunteered to take the checkup, they might set an example for others which will in turn motivate others to start involving themselves	Reduces direct contact with clinic staff If Retinopathy is identified in early stages then it can also be cured earlier.	User does not have to do any arduous task thus will feel relaxed as the process is automated. As the results arrive in a few seconds, user saves valuable time and may parallely work on other tasks.	The model could be extended to detect other diseases too which would lead to faster diagnosis.	The solutions which implemented will save lots of cost which may delight the hospital management. As the solutions would provide quick accurate results, patients would be more relieved as they don't have to wait for long.
Negative moments What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?	The user may get vague responses which may cause frustration After going through the advertisement some might fear the consequences that will happen in the future .	Clinicians can be given a lab manual which tells how to handle the equipment Due to gossip between common people, people may fear to share their medical data	As not all people may be educated, if UI of the application is not user friendly user may be frustrated. As the process may require registration of user and is cost effective customer might have data privacy concerns.	If the process gets complicated user may get irritated. If other competing hospital managements adopt the same product, and make mistakes it might affect the user's bussiness.	If the model prediction does not match the doctors diagnosis, it may cause confusion and stress.
Areas of opportunity How might we make each step better? What ideas do we have? What have others suggested?	Might give TV advertisements to make people more aware may try to adopt Digital marketing methods to spread awareness	Clinicians can be given a lab manual which tells them how to handle the equipment Explanation of the process can be done through videos	Navigation comments and chatbot like tools to guide user. Can engage users in some activity like games while waiting for the result.	Sending notifications or emails to the respective patients and doctors about the predicted results. Extend server storage to handle increased user traffic	

4. PROJECT PLANNING AND SCHEDULING:-

4.1 SPRINT PLANNING AND ESTIMATION:-

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, and password, andconfirming my password.	10	High	Srinidhi M
Sprint-1	E-mail confirmation	USN-2	As a user, I will receive a confirmation emailonce I have registered for the application	10	Medium	Sowmya M
Sprint-2	Login	USN-3	As a user, I can log into the application byentering my email & password	5	High	Srinidhi M Vindhiya Sri U
Sprint-2	Upload Images	USN-4	As a user,I should be able to upload the image of ECG.	5	High	Sowmya M Vindhiya sri U
Sprint-2	Dashboard	USN-5	As a user, based on my requirement I cannavigate through the dashboard.	5	Medium	varsha

Sprint-3	Train the model	Task 1	As a developer, the dataset will be uploadedand trained by developed algorithm.	20	High	Srinidhi M Sowmya M
Sprint-4	Testing & Evaluation	Task 2	As a developer, we tested the trained model using the provided dataset and model will be evaluated for accurate results.	10	High	Varsha H Vindhiya Sri U
Sprint-4	Display predicted result	USN-6	As a user, I can view the predicted result inthe dashboard.	10	High	Srinidhi M Vindhiya Sri U

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

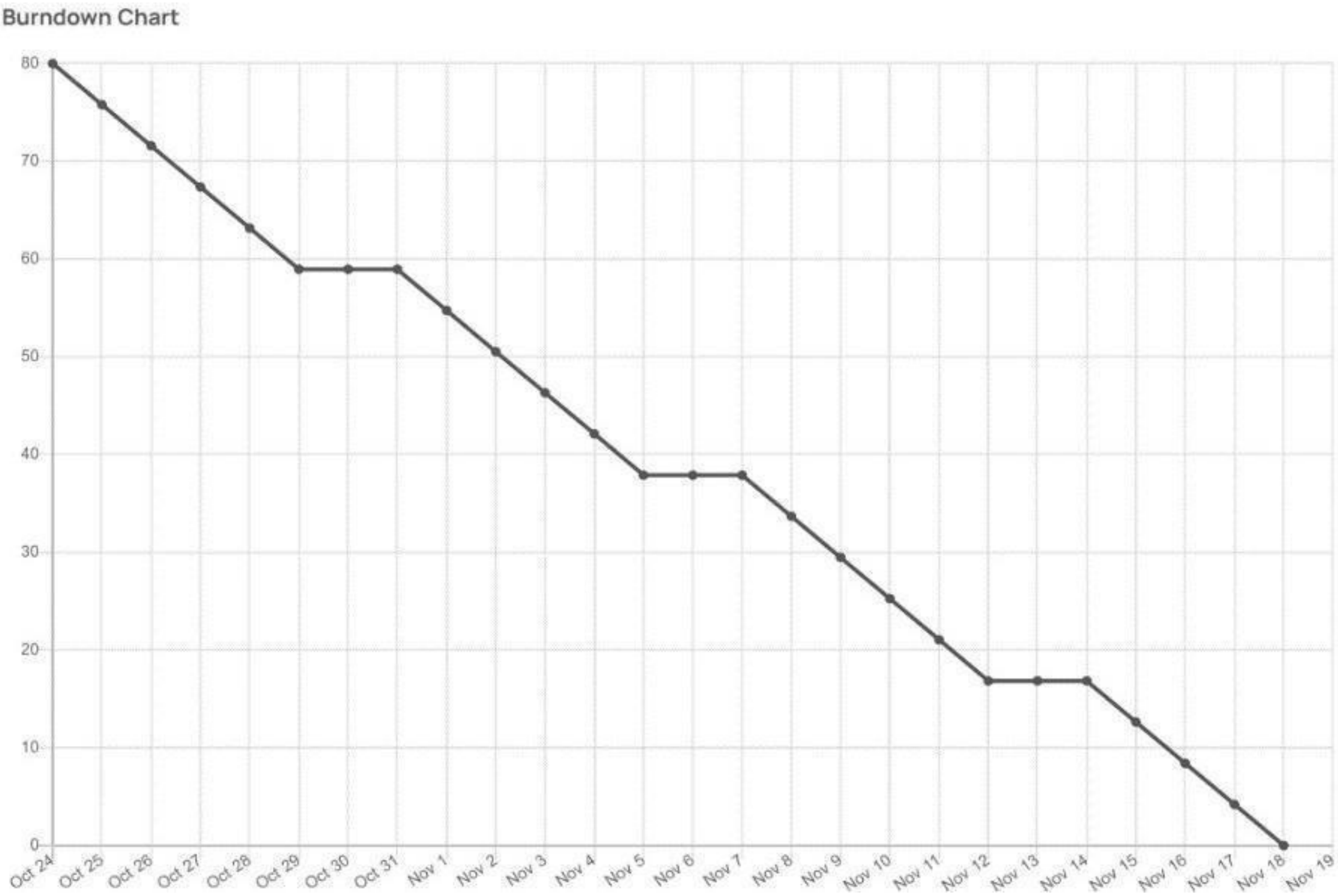
Velocity:

(AV) per iteration Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let’s calculate the team’s average velocity unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

AV=20/6=3.33points per day

BURNDOWN CHART



A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies suchas Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

https://www.visual-paradigm.com/scrum/scrum-burndown-chart
https://www.atlassian.com/agile/tutorials/burndown-charts

5. CODING AND SOLUTIONING:-

Feature 1:-

We have devloped a website which authenticates users and help them upload and check the seriousness of the diabetics.

Feature 2:-

We have devloped a multilayer deep convolutional nueral network that classifies the user image of a eye to which extense has the disease diabetics has been affected.The model will classify the images into 5 categories of diabetics and report them on asking for prediction. We have also devloped a messaging service for recieiving message for the type of diabetics.

6. TESTING:-

6.1 TEST CASES:-

6.2 USER ACCEPTANCE TESTING:-

1. Purpose of Document:-

This document serves as a quick reference for the Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy project's test coverage and open issues as
of the project's release for user acceptance testing.

2. Defect Analysis:-

This shows how many bugs were fixed or closed at each severity level and how they were fixed.

Resolution	Severity 1	Severity 2	Severity 3	Severity4	Subtotal
By Design	2	3	2	3	10
Duplicate	1	0	2	0	3
External	2	3	0	1	6
Fixed	8	2	5	9	24

Not Reproduced	0	1	1	0	2
Skipped	0	0	1	1	2
Won'tFix	0	4	1	1	6
Totals	13	13	12	15	53

3. Test-CaseAnalysis

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

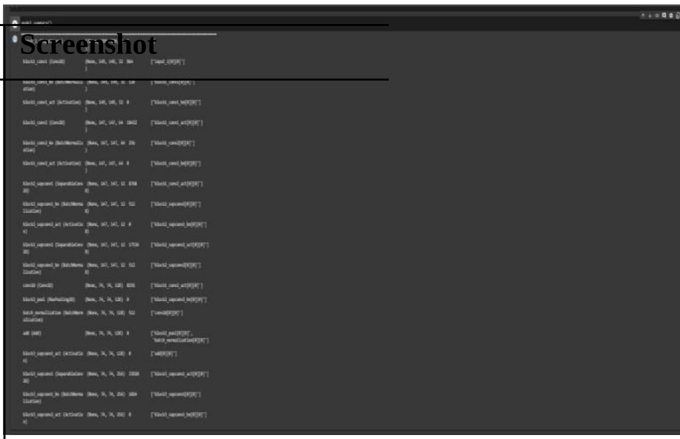
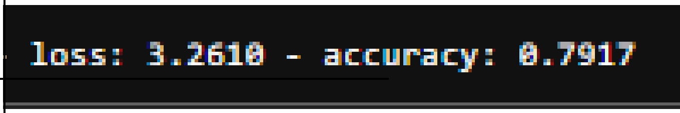
Section	TotalCases	Not Tested	Fail	Pass
PrintEngine	9	0	0	9
ClientApplication	45	0	0	45
Security	2	0	0	2
Out-sourceShipping	3	0	0	3
ExceptionReporting	9	0	0	9
FinalReportOutput	4	0	0	4
VersionControl	2	0	0	2

9. RESULTS:-

9.1 Performance Metrics:-

Model Performance

Testing:

S. NO	Parameter	Values	Screenshot
1.	Model Summary	**Total params: 21,885,485** **Trainable params: 1,024,005** **Non-trainable params: 20,861,480**	
2.	Accuracy	Training Accuracy – **3.2610** Validation Accuracy – **loss 0.7917**	 loss: 3.2610 - accuracy: 0.7917
3.	Confidence Score(Only Yolo Projects)	Class Detected - Confidence Score -	-- -- -- --

10. ADVANTAGES AND DISADVANTAGES:-

10.1 ADVANTAGES:-

There are several advantages of using deep learning for fundus image analysis for early detection of diabetic retinopathy.

Firstly, deep learning is well-suited for image analysis tasks. This is because deep learning algorithms can automatically learn features from images, which is essential for accurate image analysis.

Secondly, deep learning is efficient at handling large amounts of data. This is important for medical image analysis, as medical images are often very large.

Thirdly, deep learning is scalable. This means that it can be used to train models on very large datasets, which is important for medical image analysis tasks where data is often limited.

Fourthly, deep learning is able to learn from data with little supervision. This is important for medical image analysis, as often there is limited labeled data available.

Finally, deep learning is robust. This means that it is less likely to overfit to the data, which is important for medical image analysis where data is often limited.

10.2 DISADVANTAGES:-

There are several disadvantages of deep learning for early detection of diabetic retinopathy.
One disadvantage is that deep learning requires a large amount of data to train the models. This can be a challenge for researchers who do not have access to a large dataset.
Another challenge is that deep learning models can be very complex, which can make them difficult to interpret.
Finally, deep learning models can be computationally intensive, which can make them difficult to deploy in resource-limited settings.

11. CONCLUSION:-

Diabetic retinopathy (DR) is a leading cause of blindness in the United States. Early detection and treatment of DR is critical to preventing vision loss. However, DR is often asymptomatic in its early stages, making it difficult to detect.

Deep learning (DL) is a type of artificial intelligence that can be used to automatically detect patterns in data. DL has been shown to be effective for detecting DR in images of the retina.

In this study, a DL algorithm was used to automatically detect DR in fundus images. The algorithm was able to accurately detect DR in early stages, before it is symptomatic. This could potentially lead to earlier diagnosis and treatment of DR, which could help to prevent vision loss.

12. FUTURE SCOPE:-

There is a great potential for deep learning in fundus image analysis for early detection of diabetic retinopathy. However, there are a few challenges that need to be addressed. First, the current data sets are small and lack diversity. Second, the images are often low quality and need to be pre-processed before they can be used for deep learning.

Third, the ground truth labels for the images are often not available. Finally, the current deep learning models are not able to generalize well to real-world data.

13. APPENDIX:-

app.ipynb:-

```
          import numpy as np
import os
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.inception_v3 import preprocess_input
from cloudant.client import  Cloudant
from werkzeug.utils import secure_filename
from flask import Flask, request, render_template, redirect, url_for,session

app=Flask(__name__)

client=Cloudant.iam('f17a994d-760b-40dc-baff-83fc3b995d7b-
bluemix','69W0Zt5eGFE1LX4qtysIXCC4Xm-qG1l8ZyfpkpiS10oF',connect=True)
my_database = client['db']
app.secret_key="SECRET_KEY"
model=load_model(r"inception-diabetic.h5")

image_folder=os.path.join('static','images')
app.config['UPLOAD_FOLDER'] = image_folder


@app.route('/')
def index():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'drimage.jpg')
    return render_template('index.html',image=full_filename)

@app.route('/index')
def home():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'drimage.jpg')
    return render_template('index.html',image=full_filename)

@app.route('/register')
def register():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'registerimg.jpg')
    return render_template('register.html',image=full_filename)

@app.route('/afterreg',methods=['POST','GET'])
def afterreg():
    x=[x for x in request.form.values()]
    data={
        '_id':x[2],
        'name':x[0],
        'pwd':x[4],
        'email':x[1],
        'location':x[3],
        'securityquestion':x[5],
        'logintype':x[6]
    }
    query={'_id':{'$eq':data['_id']}}
    docs=my_database.get_query_result(query)
    if(len(docs.all())==0):
        url=my_database.create_document(data)
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
        return render_template('login.html',predict="Registration successfull please login
using your credentials",image=full_filename)
    else:
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'registerimg.jpg')
        return render_template('register.html',pred="You are already a member login using your
credentials",image=full_filename)

@app.route('/login')
def login():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
    return render_template('login.html',image=full_filename)

@app.route('/afterlogin', methods=['POST','GET'])
def afterlogin():
    user=request.form['phoneno']
    session['pn']=user
    passw=request.form['pwd']
    lgnas=request.form['loginas']

    query={'_id':{'$eq':user}}
    docs=my_database.get_query_result(query)

    if(len(docs.all())==0):
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
        return render_template('login.html',predict="Phone number/id not
found",image=full_filename)
    else:
        if((user==docs[0][0]['_id'] and passw==docs[0][0]['pwd'] and
lgnas==docs[0][0]['logintype'] )):
            if(docs[0][0]['logintype']=='user'):
                full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'retina.jpg')
                full_filename1 = os.path.join(app.config['UPLOAD_FOLDER'], 'image6.png')
                return
render_template('prediction.html',image=full_filename,image2=full_filename1)
            if(docs[0][0]['logintype']=='admin'):
                full_filename2 = os.path.join(app.config['UPLOAD_FOLDER'], 'adminimg.jpg')
                return render_template('admin.html',image=full_filename2)
        if(lgnas!=docs[0][0]['logintype']):
            full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
            return render_template('login.html',image=full_filename,predict="Incorrect
Logintype")
        if(passw!=docs[0][0]['pwd']):
            full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
            return render_template('login.html',image=full_filename,predict="Incorrect
password")


@app.route('/respond')
def respond():
    my_database_query = client['my_database_query']

    dt=[]
    for document in my_database_query:
        dt.append(document['who'])
        dt.append(document['phoneno'])
        dt.append(document['query'])
    return render_template('respond.html',data=dt)

@app.route('/afterrespond', methods=['POST','GET'])
def afterrespond():
    my_database_query = client['my_database_query']
    x=[x for x in request.form.values()]
    data1={
        '_id':x[0],
        'who':x[1],
        'phoneno':x[2],
        'query':x[3]
    }
    query={'_id':{'$eq':data1['_id']}}
    docs=my_database_query.get_query_result(query)
    if(len(docs.all())==0):
        url=my_database_query.create_document(data1)
        my_database_query = client['my_database_query']
        dt=[]
        for document in my_database_query:
            dt.append(document['who'])
            dt.append(document['phoneno'])
            dt.append(document['query'])
        return render_template('respond.html',predict="Response posted Successfully",data=dt)
    else:
        url=my_database_query.create_document(data1)
        my_database_query = client['my_database_query']
        dt=[]
        for document in my_database_query:
            dt.append(document['who'])
            dt.append(document['phoneno'])
            dt.append(document['query'])
        return render_template('respond.html',predict="Response posted Successfully",data=dt)



@app.route('/fp')
def fp():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'],'forgotpw.png')
    return render_template('fp.html',image=full_filename)

@app.route('/afterfp', methods=['POST','GET'])
def afterfp():
    pn=request.form['phoneno']
    securityques=request.form['secques']
    npassw=request.form['npwd']
    cpassw=request.form['cpwd']


    docs=my_database[pn]


    if(npassw==cpassw and securityques==docs['securityquestion']):
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'],'loginimg.jpg')
        docs['pwd'] = cpassw
        docs.save()
        return render_template('login.html',predict="Successfully 
updated",image=full_filename)
```

```
    if(securityques!=docs['securityquestion']):
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'],'forgotpw.png')
        return render_template('fp.html',predict="Incorrect answer to security 
question",image=full_filename)
    if(npassw!=cpassw):
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'],'forgotpw.png')
        return render_template('fp.html',predict="New and confirm password does not 
match",image=full_filename)



@app.route('/prediction')
def prediction():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'retina.jpg')
    full_filename1 = os.path.join(app.config['UPLOAD_FOLDER'], 'image6.png')
    return render_template('prediction.html',image=full_filename,image2=full_filename1)

@app.route('/afterpred',methods=["GET","POST"])
def aftepred():
    if request.method=="POST":
        full_filename2 = os.path.join(app.config['UPLOAD_FOLDER'], 'retina.jpg')
        full_filename1 = os.path.join(app.config['UPLOAD_FOLDER'], 'image6.png')
        f=request.files['pfile']
        print("yes")
        filepath=os.path.join('static','uploads',f.filename)
        f.save(filepath)
        print("saved")
        img=image.load_img(filepath,target_size=(224,224))
        x=image.img_to_array(img)
        x=np.expand_dims(x,axis=0)
        img_data=preprocess_input(x)
        prediction=np.argmax(model.predict(img_data),axis=1)
        index=["no dr","mild dr","moderate dr","severe dr","proliferate"]
        result=str(index[prediction[0]])
        print(result)
        return 
render_template('prediction.html',prediction=result,image=full_filename2,image2=full_filename1
)
    else:
        full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'loginimg.jpg')
        return render_template('login.html',pred="Please login using your 
credentials",image=full_filename)


@app.route('/query')
def query():
    my_database_query = client['my_database_query']

    dt=[]
    for document in my_database_query:
        dt.append(document['who'])
        dt.append(document['phoneno'])
        dt.append(document['query'])
    return render_template('query1.html',data=dt)

@app.route('/afterquery', methods=['POST','GET'])
def afterquery():
    my_database_query = client['my_database_query']
    x=[x for x in request.form.values()]
    data1={
        '_id':x[0],
        'who':x[1],
        'phoneno':x[2],
        'query':x[3],
    }
    query={'_id':{'$eq':data1['_id']}}
    docs=my_database_query.get_query_result(query)
    if(len(docs.all())==0):
        url=my_database_query.create_document(data1)
        my_database_query = client['my_database_query']
        dt=[]
        for document in my_database_query:
            dt.append(document['who'])
            dt.append(document['phoneno'])
            dt.append(document['query'])
        return render_template('query1.html',predict="Query submitted Successfully",data=dt)
    else:
        url=my_database_query.create_document(data1)
        my_database_query = client['my_database_query']
        dt=[]
        for document in my_database_query:
            dt.append(document['who'])
            dt.append(document['phoneno'])
            dt.append(document['query'])
        return render_template('query1.html',predict="Query submitted Successfully",data=dt)

@app.route('/admin')
def admin():
    full_filename2 = os.path.join(app.config['UPLOAD_FOLDER'], 'adminimg.png')
    return render_template('admin.html',image=full_filename2)

@app.route('/locsugges')
def locsugess():
    print("location")
    dbl=client['db1']
    dbu=client['db']
    print("good")
    pn=session['pn']
    doc1=dbu[pn]
    location=doc1["location"]
    print("new")
    docs=dbl[location.upper()]
    hospital=[]
    location=[]
    for h in range(len(docs["hospitals"])):
        hospital.append(docs['hospitals'][h])
    for l in range(len(docs["locations"])):
        location.append(docs['locations'][l])
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'])
    return render_template('locsugges.html',hospital=hospital,location=location)
@app.route('/uploc')
def uploc():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'])
    return render_template('uploc.html')

@app.route('/afteruploc',methods=["GET","POST"])
def afteruploc():
    loc=request.form['loch']
    hname=request.form['hname']
    lname=request.form['lname']
    contact=request.form['contact']
    dbl=client['db1']
    docs=dbl[loc.upper()]
    hn=hname.strip().upper()
    count=0
    for i in range(len(docs['hospitals'])):
       if docs['hospitals'][i].strip().upper()==hn:
          docs['contacts'][i]=contact
          docs['locations'][i]=lname
          count=1
          docs.save()
          break
    if(count==0):
        docs['hospitals'].append(hn)
        docs['contacts'].append(contact)
        docs.save()
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'])
    return render_template('uploc.html',predict="Updated or added successfully")


@app.route('/modify',methods=["GET","POST"])
def modify():
    full_filename = os.path.join(app.config['UPLOAD_FOLDER'])
    return render_template('modify.html',predict="Please enter your new location")

@app.route('/aftermodify',methods=["GET","POST"])
def aftermodify():
    if request.method=="POST":
        user=session['pn']
        pwd=request.form['pwd']
        nloc=request.form['location']
        docs=my_database[user]
        if (pwd==docs['pwd']):
            full_filename = os.path.join(app.config['UPLOAD_FOLDER'],'pimg.jpg')
            docs['location'] = nloc
            docs.save()
            return render_template('modify.html',predict="Successfully updated")
        else:
           full_filename = os.path.join(app.config['UPLOAD_FOLDER'], 'retina.jpg')
           full_filename1 = os.path.join(app.config['UPLOAD_FOLDER'], 'image6.png')
           return render_template('prediction.html',image=full_filename,image2=full_filename1)



@app.route('/logout')
def logout():
    session.pop('pn', None)
    return render_template('logout.html',)

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

cloudcreation.ipynb

```
from cloudant.client import  Cloudant

pip install cloudant
Collecting cloudantNote: you may need to restart the kernel to use updated packages.
  Downloading cloudant-2.15.0-py3-none-any.whl (80 kB)
Requirement already satisfied: requests<3.0.0,>=2.7.0 in d:\anaconda3\lib\site-packages (from
cloudant) (2.27.1)
Requirement already satisfied: idna<4,>=2.5 in d:\anaconda3\lib\site-packages (from
requests<3.0.0,>=2.7.0->cloudant) (3.3)
```

```
Requirement already satisfied: certifi>=2017.4.17 in d:\anaconda3\lib\site-packages (from
requests<3.0.0,>=2.7.0->cloudant) (2021.10.8)
Requirement already satisfied: charset-normalizer~=2.0.0 in d:\anaconda3\lib\site-packages
(from requests<3.0.0,>=2.7.0->cloudant) (2.0.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in d:\anaconda3\lib\site-packages (from
requests<3.0.0,>=2.7.0->cloudant) (1.26.9)
Installing collected packages: cloudant
Successfully installed cloudant-2.15.0
```

```
client=Cloudant.iam('username','apikey',connect=True)

my_database=client.create_database('my_database')
```

querydb.ipynb

```
from cloudant.client import  Cloudant

client=Cloudant.iam('username','apikey',connect=True)

my_database=client.create_database('my_database_query')
```

trainingmodel.ipynb

```
imageSize = [299,299]
trainPath = r"C:\Users\deepa\Dropbox\My PC (LAPTOP-BPNC1U20)\Desktop\IBM\preprocessed
dataset\preprocessed dataset\training"
testPath = r"C:\Users\deepa\Dropbox\My PC (LAPTOP-BPNC1U20)\Desktop\IBM\preprocessed
dataset\preprocessed dataset\testing"

from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img
from tensorflow.keras.applications.xception import Xception,preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt

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

training_set = train_datagen.flow_from_directory(r"E:\GCT\SEM
7\nalaiyathiran\dataset\preprocessed dataset\preprocessed dataset\training",
                                                 target_size = (299,299),
                                                 batch_size = 32,
                                                 class_mode = 'categorical')
test_set = test_datagen.flow_from_directory(r"E:\GCT\SEM 7\nalaiyathiran\dataset\preprocessed
dataset\preprocessed dataset\training",
                                                 target_size = (299,299),
                                                 batch_size = 32,
                                                 class_mode = 'categorical')
Found 3662 images belonging to 5 classes.
Found 3662 images belonging to 5 classes.

xception=Xception(input_shape = imageSize + [3], weights = 'imagenet', include_top= False)
Downloading data from https://storage.googleapis.com/tensorflow/keras-
applications/xception/xception_weights_tf_dim_ordering_tf_kernels_notop.h5
```

```
83683744/83683744 [==============================] - 82s 1us/step
```

```
for layer in xception.layers:
    layer.trainable = False

x = Flatten()(xception.output)

prediction = Dense(5, activation = 'softmax')(x)

model = Model(inputs=xception.input, outputs=prediction)

model.summary()
```

```
Model: "model"
______________________________________________________________________________________________
____
 Layer (type)                   Output Shape         Param #     Connected to
==============================================================================================
====
 input_1 (InputLayer)           [(None, 299, 299, 3  0           []
                                )]

 block1_conv1 (Conv2D)          (None, 149, 149, 32  864         ['input_1[0][0]']
                                )

 block1_conv1_bn (BatchNormaliz  (None, 149, 149, 32  128        ['block1_conv1[0][0]']
 ation)                         )

 block1_conv1_act (Activation)  (None, 149, 149, 32  0           ['block1_conv1_bn[0][0]']
                                )

 block1_conv2 (Conv2D)          (None, 147, 147, 64  18432       ['block1_conv1_act[0][0]']
                                )

 block1_conv2_bn (BatchNormaliz  (None, 147, 147, 64  256        ['block1_conv2[0][0]']
 ation)                         )

 block1_conv2_act (Activation)  (None, 147, 147, 64  0           ['block1_conv2_bn[0][0]']
                                )

 block2_sepconv1 (SeparableConv  (None, 147, 147, 12  8768       ['block1_conv2_act[0][0]']
 2D)                            8)

 block2_sepconv1_bn (BatchNorma  (None, 147, 147, 12  512        ['block2_sepconv1[0][0]']
 lization)                      8)

 block2_sepconv2_act (Activatio  (None, 147, 147, 12  0          ['block2_sepconv1_bn[0][0]']
 n)                             8)

 block2_sepconv2 (SeparableConv  (None, 147, 147, 12  17536      ['block2_sepconv2_act[0][0]']
 2D)                            8)

 block2_sepconv2_bn (BatchNorma  (None, 147, 147, 12  512        ['block2_sepconv2[0][0]']
 lization)                      8)

 conv2d (Conv2D)                (None, 74, 74, 128)  8192        ['block1_conv2_act[0][0]']

 block2_pool (MaxPooling2D)     (None, 74, 74, 128)  0           ['block2_sepconv2_bn[0][0]']

 batch_normalization (BatchNorm  (None, 74, 74, 128)  512        ['conv2d[0][0]']
 alization)
 add (Add)                      (None, 74, 74, 128)  0           ['block2_pool[0][0]',
                                                                  'batch_normalization[0][0]']

 block3_sepconv1_act (Activatio  (None, 74, 74, 128)  0          ['add[0][0]']
 n)

 block3_sepconv1 (SeparableConv  (None, 74, 74, 256)  33920      ['block3_sepconv1_act[0][0]']
 2D)

 block3_sepconv1_bn (BatchNorma  (None, 74, 74, 256)  1024       ['block3_sepconv1[0][0]']
 lization)

 block3_sepconv2_act (Activatio  (None, 74, 74, 256)  0          ['block3_sepconv1_bn[0][0]']
 n)

 block3_sepconv2 (SeparableConv  (None, 74, 74, 256)  67840      ['block3_sepconv2_act[0][0]']
 2D)

 block3_sepconv2_bn (BatchNorma  (None, 74, 74, 256)  1024       ['block3_sepconv2[0][0]']
 lization)

 conv2d_1 (Conv2D)              (None, 37, 37, 256)  32768       ['add[0][0]']

 block3_pool (MaxPooling2D)     (None, 37, 37, 256)  0           ['block3_sepconv2_bn[0][0]']

 batch_normalization_1 (BatchNo  (None, 37, 37, 256)  1024       ['conv2d_1[0][0]']
 rmalization)

 add_1 (Add)                    (None, 37, 37, 256)  0           ['block3_pool[0][0]',

'batch_normalization_1[0][0]']

 block4_sepconv1_act (Activatio  (None, 37, 37, 256)  0          ['add_1[0][0]']
 n)

 block4_sepconv1 (SeparableConv  (None, 37, 37, 728)  188672     ['block4_sepconv1_act[0][0]']
 2D)

 block4_sepconv1_bn (BatchNorma  (None, 37, 37, 728)  2912       ['block4_sepconv1[0][0]']
 lization)

 block4_sepconv2_act (Activatio  (None, 37, 37, 728)  0          ['block4_sepconv1_bn[0][0]']
 n)

 block4_sepconv2 (SeparableConv  (None, 37, 37, 728)  536536     ['block4_sepconv2_act[0][0]']
 2D)

 block4_sepconv2_bn (BatchNorma  (None, 37, 37, 728)  2912       ['block4_sepconv2[0][0]']
 lization)

 conv2d_2 (Conv2D)              (None, 19, 19, 728)  186368      ['add_1[0][0]']

 block4_pool (MaxPooling2D)     (None, 19, 19, 728)  0           ['block4_sepconv2_bn[0][0]']

 batch_normalization_2 (BatchNo  (None, 19, 19, 728)  2912       ['conv2d_2[0][0]']
 rmalization)

 add_2 (Add)                    (None, 19, 19, 728)  0           ['block4_pool[0][0]',

'batch_normalization_2[0][0]']
```

```
block5_sepconv1_act (Activatio  (None, 19, 19, 728)  0          ['add_2[0][0]']
n)

block5_sepconv1 (SeparableConv  (None, 19, 19, 728)  536536     ['block5_sepconv1_act[0][0]']
2D)

block5_sepconv1_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block5_sepconv1[0][0]']
lization)

block5_sepconv2_act (Activatio  (None, 19, 19, 728)  0          ['block5_sepconv1_bn[0][0]']
n)

block5_sepconv2 (SeparableConv  (None, 19, 19, 728)  536536     ['block5_sepconv2_act[0][0]']
2D)

block5_sepconv2_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block5_sepconv2[0][0]']
lization)

block5_sepconv3_act (Activatio  (None, 19, 19, 728)  0          ['block5_sepconv2_bn[0][0]']
n)

block5_sepconv3 (SeparableConv  (None, 19, 19, 728)  536536     ['block5_sepconv3_act[0][0]']
2D)

block5_sepconv3_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block5_sepconv3[0][0]']
lization)

add_3 (Add)                    (None, 19, 19, 728)  0           ['block5_sepconv3_bn[0][0]',
                                                                 'add_2[0][0]']

block6_sepconv1_act (Activatio  (None, 19, 19, 728)  0          ['add_3[0][0]']
n)

block6_sepconv1 (SeparableConv  (None, 19, 19, 728)  536536     ['block6_sepconv1_act[0][0]']
2D)

block6_sepconv1_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block6_sepconv1[0][0]']
lization)

block6_sepconv2_act (Activatio  (None, 19, 19, 728)  0          ['block6_sepconv1_bn[0][0]']
n)

block6_sepconv2 (SeparableConv  (None, 19, 19, 728)  536536     ['block6_sepconv2_act[0][0]']
2D)

block6_sepconv2_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block6_sepconv2[0][0]']
lization)

block6_sepconv3_act (Activatio  (None, 19, 19, 728)  0          ['block6_sepconv2_bn[0][0]']
n)

block6_sepconv3 (SeparableConv  (None, 19, 19, 728)  536536     ['block6_sepconv3_act[0][0]']
2D)

block6_sepconv3_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block6_sepconv3[0][0]']
lization)

add_4 (Add)                    (None, 19, 19, 728)  0           ['block6_sepconv3_bn[0][0]',
                                                                 'add_3[0][0]']

block7_sepconv1_act (Activatio  (None, 19, 19, 728)  0          ['add_4[0][0]']
n)

block7_sepconv1 (SeparableConv  (None, 19, 19, 728)  536536     ['block7_sepconv1_act[0][0]']
2D)

block7_sepconv1_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block7_sepconv1[0][0]']
lization)

block7_sepconv2_act (Activatio  (None, 19, 19, 728)  0          ['block7_sepconv1_bn[0][0]']
n)

block7_sepconv2 (SeparableConv  (None, 19, 19, 728)  536536     ['block7_sepconv2_act[0][0]']
2D)

block7_sepconv2_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block7_sepconv2[0][0]']
lization)

block7_sepconv3_act (Activatio  (None, 19, 19, 728)  0          ['block7_sepconv2_bn[0][0]']
n)

block7_sepconv3 (SeparableConv  (None, 19, 19, 728)  536536     ['block7_sepconv3_act[0][0]']
2D)

block7_sepconv3_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block7_sepconv3[0][0]']
lization)

add_5 (Add)                    (None, 19, 19, 728)  0           ['block7_sepconv3_bn[0][0]',
                                                                 'add_4[0][0]']

block8_sepconv1_act (Activatio  (None, 19, 19, 728)  0          ['add_5[0][0]']
n)

block8_sepconv1 (SeparableConv  (None, 19, 19, 728)  536536     ['block8_sepconv1_act[0][0]']
2D)

block8_sepconv1_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block8_sepconv1[0][0]']
lization)

block8_sepconv2_act (Activatio  (None, 19, 19, 728)  0          ['block8_sepconv1_bn[0][0]']
n)

block8_sepconv2 (SeparableConv  (None, 19, 19, 728)  536536     ['block8_sepconv2_act[0][0]']
2D)

block8_sepconv2_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block8_sepconv2[0][0]']
lization)

block8_sepconv3_act (Activatio  (None, 19, 19, 728)  0          ['block8_sepconv2_bn[0][0]']
n)

block8_sepconv3 (SeparableConv  (None, 19, 19, 728)  536536     ['block8_sepconv3_act[0][0]']
2D)

block8_sepconv3_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block8_sepconv3[0][0]']
lization)

add_6 (Add)                    (None, 19, 19, 728)  0           ['block8_sepconv3_bn[0][0]',
                                                                 'add_5[0][0]']

block9_sepconv1_act (Activatio  (None, 19, 19, 728)  0          ['add_6[0][0]']
n)
```

```
 block9_sepconv1 (SeparableConv  (None, 19, 19, 728)  536536     ['block9_sepconv1_act[0][0]']
 2D)

 block9_sepconv1_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block9_sepconv1[0][0]']
 lization)

 block9_sepconv2_act (Activatio  (None, 19, 19, 728)  0          ['block9_sepconv1_bn[0][0]']
 n)

 block9_sepconv2 (SeparableConv  (None, 19, 19, 728)  536536     ['block9_sepconv2_act[0][0]']
 2D)

 block9_sepconv2_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block9_sepconv2[0][0]']
 lization)

 block9_sepconv3_act (Activatio  (None, 19, 19, 728)  0          ['block9_sepconv2_bn[0][0]']
 n)

 block9_sepconv3 (SeparableConv  (None, 19, 19, 728)  536536     ['block9_sepconv3_act[0][0]']
 2D)

 block9_sepconv3_bn (BatchNorma  (None, 19, 19, 728)  2912       ['block9_sepconv3[0][0]']
 lization)

 add_7 (Add)                    (None, 19, 19, 728)  0           ['block9_sepconv3_bn[0][0]',
                                                                  'add_6[0][0]']

 block10_sepconv1_act (Activati  (None, 19, 19, 728)  0          ['add_7[0][0]']
 on)

 block10_sepconv1 (SeparableCon  (None, 19, 19, 728)  536536
['block10_sepconv1_act[0][0]']
 v2D)

 block10_sepconv1_bn (BatchNorm  (None, 19, 19, 728)  2912       ['block10_sepconv1[0][0]']
 alization)

 block10_sepconv2_act (Activati  (None, 19, 19, 728)  0          ['block10_sepconv1_bn[0][0]']
 on)

 block10_sepconv2 (SeparableCon  (None, 19, 19, 728)  536536
['block10_sepconv2_act[0][0]']
 v2D)

 block10_sepconv2_bn (BatchNorm  (None, 19, 19, 728)  2912       ['block10_sepconv2[0][0]']
 alization)

 block10_sepconv3_act (Activati  (None, 19, 19, 728)  0          ['block10_sepconv2_bn[0][0]']
 on)

 block10_sepconv3 (SeparableCon  (None, 19, 19, 728)  536536
['block10_sepconv3_act[0][0]']
 v2D)

 block10_sepconv3_bn (BatchNorm  (None, 19, 19, 728)  2912       ['block10_sepconv3[0][0]']
 alization)

 add_8 (Add)                    (None, 19, 19, 728)  0           ['block10_sepconv3_bn[0][0]',
                                                                  'add_7[0][0]']
 block11_sepconv1_act (Activati   (None, 19, 19, 728)  0           ['add_8[0][0]']
 on)

 block11_sepconv1 (SeparableCon   (None, 19, 19, 728)  536536
['block11_sepconv1_act[0][0]']
 v2D)

 block11_sepconv1_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block11_sepconv1[0][0]']
 alization)

 block11_sepconv2_act (Activati   (None, 19, 19, 728)  0           ['block11_sepconv1_bn[0][0]']
 on)

 block11_sepconv2 (SeparableCon   (None, 19, 19, 728)  536536
['block11_sepconv2_act[0][0]']
 v2D)

 block11_sepconv2_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block11_sepconv2[0][0]']
 alization)

 block11_sepconv3_act (Activati   (None, 19, 19, 728)  0           ['block11_sepconv2_bn[0][0]']
 on)

 block11_sepconv3 (SeparableCon   (None, 19, 19, 728)  536536
['block11_sepconv3_act[0][0]']
 v2D)

 block11_sepconv3_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block11_sepconv3[0][0]']
 alization)

 add_9 (Add)                     (None, 19, 19, 728)  0           ['block11_sepconv3_bn[0][0]',
                                                                   'add_8[0][0]']

 block12_sepconv1_act (Activati   (None, 19, 19, 728)  0           ['add_9[0][0]']
 on)

 block12_sepconv1 (SeparableCon   (None, 19, 19, 728)  536536
['block12_sepconv1_act[0][0]']
 v2D)

 block12_sepconv1_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block12_sepconv1[0][0]']
 alization)

 block12_sepconv2_act (Activati   (None, 19, 19, 728)  0           ['block12_sepconv1_bn[0][0]']
 on)

 block12_sepconv2 (SeparableCon   (None, 19, 19, 728)  536536
['block12_sepconv2_act[0][0]']
 v2D)

 block12_sepconv2_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block12_sepconv2[0][0]']
 alization)

 block12_sepconv3_act (Activati   (None, 19, 19, 728)  0           ['block12_sepconv2_bn[0][0]']
 on)

 block12_sepconv3 (SeparableCon   (None, 19, 19, 728)  536536
['block12_sepconv3_act[0][0]']
 v2D)

 block12_sepconv3_bn (BatchNorm   (None, 19, 19, 728)  2912        ['block12_sepconv3[0][0]']
 alization)

 add_10 (Add)                   (None, 19, 19, 728)  0           ['block12_sepconv3_bn[0][0]',
                                                                  'add_9[0][0]']

 block13_sepconv1_act (Activati  (None, 19, 19, 728)  0          ['add_10[0][0]']
 on)

 block13_sepconv1 (SeparableCon  (None, 19, 19, 728)  536536
['block13_sepconv1_act[0][0]']
 v2D)

 block13_sepconv1_bn (BatchNorm  (None, 19, 19, 728)  2912       ['block13_sepconv1[0][0]']
 alization)

 block13_sepconv2_act (Activati  (None, 19, 19, 728)  0          ['block13_sepconv1_bn[0][0]']
 on)

 block13_sepconv2 (SeparableCon  (None, 19, 19, 1024  752024
['block13_sepconv2_act[0][0]']
 v2D)                           )

 block13_sepconv2_bn (BatchNorm  (None, 19, 19, 1024  4096       ['block13_sepconv2[0][0]']
 alization)                     )

 conv2d_3 (Conv2D)              (None, 10, 10, 1024  745472      ['add_10[0][0]']
                                )

 block13_pool (MaxPooling2D)    (None, 10, 10, 1024  0           ['block13_sepconv2_bn[0][0]']
                                )

 batch_normalization_3 (BatchNo  (None, 10, 10, 1024  4096       ['conv2d_3[0][0]']
 rmalization)                   )

 add_11 (Add)                   (None, 10, 10, 1024  0           ['block13_pool[0][0]',
                                )
'batch_normalization_3[0][0]']

 block14_sepconv1 (SeparableCon  (None, 10, 10, 1536  1582080    ['add_11[0][0]']
 v2D)                           )

 block14_sepconv1_bn (BatchNorm  (None, 10, 10, 1536  6144       ['block14_sepconv1[0][0]']
 alization)                     )

 block14_sepconv1_act (Activati  (None, 10, 10, 1536  0          ['block14_sepconv1_bn[0][0]']
 on)                            )

 block14_sepconv2 (SeparableCon  (None, 10, 10, 2048  3159552
['block14_sepconv1_act[0][0]']
 v2D)                           )

 block14_sepconv2_bn (BatchNorm  (None, 10, 10, 2048  8192       ['block14_sepconv2[0][0]']
 alization)                     )

 block14_sepconv2_act (Activati  (None, 10, 10, 2048  0          ['block14_sepconv2_bn[0][0]']
 on)                            )

 flatten (Flatten)              (None, 204800)       0
['block14_sepconv2_act[0][0]']

 dense (Dense)                  (None, 5)            1024005     ['flatten[0][0]']
```

```
==============================================================================================
====
Total params: 21,885,485
Trainable params: 1,024,005
Non-trainable params: 20,861,480
______________________________________________________________________________________________
____

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

r = model.fit_generator(training_set,
                       validation_data=test_set,
                       epochs=30,
                       steps_per_epoch=len(training_set)//32,
                       validation_steps=len(test_set)//32
                       )
```

admin.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
                            height:100%;
                            font-family:Roboto;
                            display: flex;
                            flex-direction: column;
                            }
                            .header{
                            position: fixed;
                            top: 0px;
                            width:100%;
                            height:100px;
                            background-color:dimgrey;
                            display: flex;
                            flex-direction: row;
                            align-items: center;
                            justify-content: space-between;
                            }
                            #heading{
                            padding:10px;
                            color:white;
                            font-size:25px;
                            font-style: italic
                            }
```

```css
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.container{
margin-top: 100px;
display: flex;
flex-direction: row;
align-items: center;
justify-content: center;
border:2px solid black;
}
#imgs{
margin-top:50px;
height: 300px;
width: 300px;
}
#subhead{
font-size: 30px;
color: coral;
text-align: center;
text-decoration-line: underline;
}
th, td {
width:40vw;
padding: 15px;
}
th{
color:darkgreen;
text-decoration-line: underline;
}
td{
color:brown;
text-align:justify;
}
```

```
                </style>
        <body>
                <div class="header">
                        <p id="heading">Welcome Admin</p>
                        <div class="options">
                                <p id="option1"><a href="respond">Respond Queries</a></p>
                                <p id="option1"><a href="uploc">Update locations</a></p>
                                <p id="option1"><a href="logout">Logout</a></p>
                        </div>
                </div>
                <div class="container">
                        <img id="imgs", src="{{image}}",alt="DR Image"><br>
                </div>
                <div>
                                <p id="subhead">About Project</p>
                </div>
                <table>
                        <tr><th>Problem</th>
                                <th>Solution</th>
                        <tr><td><br>Diabetic Retinopathy (DR) is a common complication of diabetes
mellitus, which causes lesions on the
                                retina that affect vision. If it is not detected early, it can lead to
blindness. Unfortunately, DR is not
                                a reversible process, and treatment only sustains vision. DR early
detection and treatment can
                                significantly reduce the risk of vision loss. The manual diagnosis
process of DR retina fundus images by
                                ophthalmologists is time, effort and cost-consuming and prone to
misdiagnosis unlike computer-aided
                                diagnosis systems.</td>
                                <td>Transfer learning has become one of the most common techniques that
has achieved better
                                performance in many areas, especially in medical image analysis and
classification. We used Transfer
                                Learning techniques like Inception V3,Resnet50,Xception V3 that are more
widely used as a transfer
                                learning method in medical image analysis and they are highly
effective.</td>
                </table>



        </body>
</html>
```

fp.html

```
<!DOCTYPE
html>
            <html>
```

```
        <head>
                <title>Deep learning fundus image analysis for early detection of Diabetic
Retinopathy</title>
                <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
        </head>
        <style>
                html,body{
                margin:0;
                width:100%;
                height:100%;
                font-family:Roboto;
                display: flex;
                flex-direction: column;
                }
                .header{
                position: fixed;
                top: 0px;
                width:100%;
                height:100px;
                background-color:dimgrey;
                display: flex;
                flex-direction: row;
                align-items: center;
                justify-content: space-between;
                }
                #heading{
                padding:10px;
                color:white;
                font-size:25px;
                font-style: italic
                }
                #option1{
                margin-right:2px;
                padding:10px;
                color:white;
                font-size:20px;
                }
                .options{
                display: flex;
                }
                a{
                text-decoration:none;
                color:white;
                }
                #option1:hover{
                border:1px solid white;
                border-radius:10px;
                background-color:black;
                }
                .content{
                margin:auto;
                }
                .frm{
                margin-top: 100px;
                border:2px solid black;
                padding:30px;
                border-radius:5px;
                }
                .inputs{
                padding:10px;
                border-radius:5px;
                outline:0;
                width:250px;
                }
                .btn{
                cursor: pointer;
                width:-webkit-fill-available;
                }
                .si:hover{
                        color:white;
                        background-color:dimgrey;
                }
                img{
                height:90px;
                width:90px;
                border-radius:50%;
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">FORGOT PASSWORD</p>
                        <div class="options">
                                <p id="option1"><a href="index">Home</a></p>
                        </div>
                </div>

                <div class="content">
                <center><p style="color: blue;margin-top: 100px;">{{predict}}</p></center><br>
                        <form class="frm" action="http://127.0.0.1:5000/afterfp" method="POST">
                                        <h3><center><img src="{{image}}"alt="forgotpw"></center></h3>
                                        <input type="text" class="inputs" placeholder="Phone number"
name="phoneno" required><br><br>
                                        <input type="text" class="inputs" placeholder="Your favourite
pet(Security Question)" name="secques" required><br><br>
                                        <input type="password" class="inputs" placeholder="New Password"
name="npwd"  required><br><br>
                                        <input type="password" class="inputs" placeholder="Confirm
Password" name="cpwd"  required><br><br>
```

```
                                        <button type="submit" class="inputs btn si" >Submit</button>
                                        <br><br>

                                </form>
                        </div>



                </body>
        </html>
```

index.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
                            height:100%;
                            font-family:Roboto;
                            display: flex;
                            flex-direction: column;
                            }
                            .header{
                            position: fixed;
                            top: 0px;
                            width:100%;
                            height:100px;
                            background-color:dimgrey;
                            display: flex;
                            flex-direction: row;
                            align-items: center;
                            justify-content: space-between;
                            }
                            #heading{
                            padding:10px;
                            color:white;
                            font-size:25px;
                            font-style: italic
                            }
                            #option1{
                            margin-right:2px;
                            padding:10px;
                            color:white;
```

```
                font-size:20px;
                }
                .options{
                display: flex;
                }
                a{
                text-decoration:none;
                color:white;
                }
                #option1:hover{
                border:1px solid white;
                border-radius:10px;
                background-color:black;
                }
                .container{
                display:flex;
                justify-content:center;
                align-items: center
                flex-direction:row;
                }
                #imgs{
                margin-top:100px;
                height: 300px;
                width: 60vw;
                }
                #subhead{
                font-size: 30px;
                color: coral;
                text-align: center;
                text-decoration-line: underline;
                }
                th, td {
                width:40vw;
                padding: 15px;
                }
                th{
                color:darkgreen;
                text-decoration-line: underline;
                }
                td{
                color:brown;
                text-align:justify;
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">Deep learning fundus image analysis for early detection of
diabetic retinopathy</p>
                        <div class="options">
```

```
                              <p id="option1"><a href="index">Home</a></p>
                              <p id="option1"><a href="register">Register</a></p>
                              <p id="option1"><a href="login">Login</a></p>
                              <p id="option1"><a href="query">Query</a></p>
                       </div>
                </div>
                <div class="container">
                       <img id="imgs", src="{{image}}",alt="DR Image"><br>
                </div>
                <div>
                              <p id="subhead">About Project</p>
                </div>
                <table>
                       <tr><th>Problem</th>
                              <th>Solution</th>
                       <tr><td><br>Diabetic Retinopathy (DR) is a common complication of diabetes
mellitus, which causes lesions on the
                              retina that affect vision. If it is not detected early, it can lead to
blindness. Unfortunately, DR is not
                              a reversible process, and treatment only sustains vision. DR early
detection and treatment can
                              significantly reduce the risk of vision loss. The manual diagnosis
process of DR retina fundus images by
                              ophthalmologists is time, effort and cost-consuming and prone to
misdiagnosis unlike computer-aided
                              diagnosis systems.</td>
                              <td>Transfer learning has become one of the most common techniques that
has achieved better
                              performance in many areas, especially in medical image analysis and
classification. We used Transfer
                              Learning techniques like Inception V3,Resnet50,Xception V3 that are more
widely used as a transfer
                              learning method in medical image analysis and they are highly
effective.</td>
                </table>


         </body>
  </html>
```

locsugges.html

```
<!DOCTYPE
html>
        <html>
               <head>
                      <title>Deep learning fundus image analysis for early detection of Diabetic
        Retinopathy</title>
                      <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
```

```
       </head>
       <style>
              html,body{
              margin:0;
              width:100%;
              height:100%;
              font-family:Roboto;
              display: flex;
              flex-direction: column;
              }
              th{
  padding-top: 10px;
  padding-bottom: 20px;
  padding-left: 30px;
  padding-right: 40px;
  color:black;
}
 td {
  padding-top: 10px;
  padding-bottom: 20px;
  padding-left: 30px;
  padding-right: 40px;
  color:teal;
}

              .header{
              position: fixed;
              top: 0px;
              width:100%;
              height:100px;
              background-color:dimgrey;
              display: flex;
              flex-direction: row;
              align-items: center;
              justify-content: space-between;
              }
              #heading{
              padding:10px;
              color:white;
              font-size:25px;
              font-style: italic
              }
              #option1{
              margin-right:2px;
              padding:10px;
              color:white;
              font-size:20px;
              }
              .options{
```

```
        display: flex;
        }
        a{
        text-decoration:none;
        color:white;
        }
        #option1:hover{
        border:1px solid white;
        border-radius:10px;
        background-color:black;
        }
        .content{
        margin:auto;
        }
        .frm{
        margin-top: 100px;
        border:2px solid black;
        padding:30px;
        border-radius:5px;
        }
        .inputs{
        padding:10px;
        border-radius:5px;
        outline:0;
        width:250px;
        }
        .btn{
        cursor: pointer;
        width:-webkit-fill-available;
        }
        .si:hover{
                color:white;
                background-color:dimgrey;
        }

        </style>
<body>
        <div class="header">
                <p id="heading">Hospitals Near You</p>
                <div class="options">
                        <p id="option1"><a href="index">Home</a></p>
                        <p id="option1"><a href="prediction">Back</a></p>
                </div>
        </div>

        <div class="content">
        <table>
        {% set i=0 %}
                <tr>
```

```
                                <th>HOSPITALS</th>
                                <th>LOCATIONS</th>
                                <th>CONTACTS</th>
                                </tr>
                                {% for i in range(hospital|length)%}
                                <tr><td>{{hospital[i]}}</td>
                                <td>{{location[i] }}</td>
                                <td>{{contact[i] }}</td></tr>
                                {% set i=i+1 %}
                                {% endfor %}
                                </table>

                        </div>



                </body>
        </html>
```

Login.html

```
<!DOCTYPE
html>
        <html>
                <head>
                        <title>Deep learning fundus image analysis for early detection of Diabetic
        Retinopathy</title>
                        <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                </head>
                <style>
                        html,body{
                        margin:0;
                        width:100%;
                        height:100%;
                        font-family:Roboto;
                        display: flex;
                        flex-direction: column;
                        }
                        .header{
                        position: fixed;
                        top: 0px;
                        width:100%;
                        height:100px;
                        background-color:dimgrey;
                        display: flex;
                        flex-direction: row;
                        align-items: center;
                        justify-content: space-between;
                        }
                        #heading{
                        padding:10px;
```

```
color:white;
font-size:25px;
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.content{
margin:auto;
}
.frm{
margin-top: 30px;
border:2px solid black;
padding:30px;
border-radius:5px;
}
.inputs{
padding:10px;
border-radius:5px;
outline:0;
width:250px;
}
.btn{
cursor: pointer;
width:-webkit-fill-available;
}
.si:hover{
       color:white;
       background-color:dimgrey;
}
img{
height:60px;
width:60px;
border-radius:50%;
```

```
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">Login</p>
                        <div class="options">
                                <p id="option1"><a href="index">Home</a></p>
                        </div>
                </div>

                <div class="content">
                <center><p style="color: blue;width:250px;margin-top:100px">{{predict}}</p></center><br>
                        <form class="frm" action="http://127.0.0.1:5000/afterlogin" method="POST">
                                <h3><center><img src="{{image}}"alt="loginimg"></center></h3>
                                        <input type="text" class="inputs" placeholder="Phoneno"
name="phoneno" required><br><br>
                                        <input type="password" class="inputs" placeholder="Password"
name="pwd"  required><br><br>
                                        <select name="loginas" class="inputs btn" style="border:2px
solid";>
                                          <option value="admin">Admin</option>
                                          <option value="user">User</option>
                                        </select><br><br>
                                        <a href="fp" style="color:blue;margin-left:150px;">  Forgot
password?</a><br><br>
                                        <button type="submit" class="inputs btn si" >Login</button>
                                        <br><br>
                                                New user?<a href="register" style="color:blue;">
Register</a>
                        </form>
                </div>



        </body>
</html>
```

logout.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
```

```css
height:100%;
font-family:Roboto;
display: flex;
flex-direction: column;
}
.header{
position: fixed;
top: 0px;
width:100%;
height:100px;
background-color:dimgrey;
display: flex;
flex-direction: row;
align-items: center;
justify-content: space-between;

}
.log
{
color:black;
font-size:50px;
}
#heading{
padding:10px;
color:white;
font-size:25px;
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.content{
margin:auto;
}
```

```
                .frm{
                margin-top: 100px;
                border:2px solid black;
                padding:30px;
                border-radius:5px;
                }
                .inputs{
                padding:10px;
                border-radius:5px;
                outline:0;
                width:250px;
                }
                .btn{
                cursor: pointer;
                width:50%;

                }
                .si:hover{
                        color:white;
                        background-color:dimgrey;
                }
                img{
                height:60px;
                width:60px;
                border-radius:50%;
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">Diabetic retinopathy</p>
                        <div class="options">
                                <p id="option1"><a href="index">Home</a></p>
                                <p id="option1"><a href="login">Login </a></p>
                        </div>
                </div>
                <div class="content">
                <p class="log">Successfully logout</p>
                <p>  Login for more information</p><br>
                </div>



        </body>
</html>
```

modify.html

```
<!DOCTYPE
html>
            <html>
                    <head>
```

```
                <title>Deep learning fundus image analysis for early detection of Diabetic
Retinopathy</title>
                <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
        </head>
        <style>
                html,body{
                margin:0;
                width:100%;
                height:100%;
                font-family:Roboto;
                display: flex;
                flex-direction: column;
                }
                .header{
                position: fixed;
                top: 0px;
                width:100%;
                height:100px;
                background-color:dimgrey;
                display: flex;
                flex-direction: row;
                align-items: center;
                justify-content: space-between;
                }
                #heading{
                padding:10px;
                color:white;
                font-size:25px;
                font-style: italic
                }
                #option1{
                margin-right:2px;
                padding:10px;
                color:white;
                font-size:20px;
                }
                .options{
                display: flex;
                }
                a{
                text-decoration:none;
                color:white;
                }
                #option1:hover{
                border:1px solid white;
                border-radius:10px;
                background-color:black;
                }
                .content{
```

```
              margin:auto;
              }
              .frm{
              margin-top: 100px;
              border:2px solid black;
              padding:30px;
              border-radius:5px;
              }
              .inputs{
              padding:10px;
              border-radius:5px;
              outline:0;
              width:250px;
              }
              .btn{
              cursor: pointer;
              width:-webkit-fill-available;
              }
              .si:hover{
                     color:white;
                     background-color:dimgrey;
              }
              img{
              height:60px;
              width:60px;
              border-radius:50%;
              }
              </style>
       <body>
              <div class="header">
                     <p id="heading">Location change</p>
                     <div class="options">
                            <p id="option1"><a href="index">Home</a></p>
                            <p id="option1"><a href="prediction">Back</a></p>
                            <p id ="option1"><a href="logout">Logout</a></p>
                     </div>
              </div>

              <div class="content">
              <center><p style="color: blue;width:250px;">{{predict}}</p></center><br>
                     <form class="frm" action="http://127.0.0.1:5000/aftermodify" method="POST">


                                   <input type="password" class="inputs" placeholder="password"
name="pwd" required><br><br>
                                   <input type="text" class="inputs" placeholder="Enter new location"
name="location"  required><br><br>


                                   <button type="submit" class="inputs btn si" >Modify</button>
```

```
                                        <br><br>

                            </form>
                    </div>



            </body>
    </html>
```

Prediction.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
                            height:100%;
                            font-family:Roboto;
                            display: flex;
                            flex-direction: column;
                            }
                            .header{
                            position: fixed;
                            top: 0px;
                            width:100%;
                            height:100px;
                            background-color:dimgrey;
                            display: flex;
                            flex-direction: row;
                            align-items: center;
                            justify-content: space-between;
                            }
                            #heading{
                            padding:10px;
                            color:white;
                            font-size:25px;
                            font-style: italic
                            }
                            #option1{
                            margin-right:2px;
                            padding:10px;
                            color:white;
```

```
    font-size:20px;
    }
    .options{
    display: flex;
    }
    a{
    text-decoration:none;
    color:white;
    }
    #option1:hover{
    border:1px solid white;
    border-radius:10px;
    background-color:black;
    }
    .container{
    margin-top: 100px;
    display: flex;
    flex-direction: row;
    align-items: center;
    justify-content: center;
    border:2px solid black;
    }
    .retinaimg{
    margin-top:25px;
    height:100px;
    width: 100px;
    border-radius:50%;
    padding:20px;
    }
    .stages{
    height:500px;
    width:600px
    }
    hr {
    width:100%;
    border:1px solid black;
    background:black;
    }
    </style>
<body>
    <div class="header">
        <p id="heading">Prediction</p>
        <div class="options">
            <p id="option1"><a href="index">Home</a></p>
            <p id="option1"><a href="locsugges">Hospitals</a></p>
            <p id="option1"><a href="modify">Modify</a></p>
            <p id="option1"><a href="logout">Logout</a></p>
        </div>
    </div>
```

```
                <div class="container">
                        <img class="retinaimg", src="{{image}}",alt="RetinaImage">
                        <form class="frm" action="/afterpred" method="POST"  enctype="multipart/form-
data">
                                <input type="file" name="pfile" placeholder="Choose file"
accept="image/*" required>
                                <button type="submit" name="submit" value="submit" >Submit</button>
                        </form>
                </div>
                <br><br>
                        <center><p>Diabetic Retinopathy Classification is: {{prediction}}</p></center>
                        <hr>
                        <center><img class="stages" src="{{image2}}",alt="StagesImage"></center>

        </body>
</html>
```

query1.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                            <script>
                                    function calc()
                                    {
                                    var d = new Date();
                                    var n = d.getTime();
                                    document.getElementById('timstmp').value=n;
                                    }
                            </script>
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
                            height:100%;
                            font-family:Roboto;
                            display: flex;
                            flex-direction: column;
                            }
                            .header{
                            position: fixed;
                            top: 0px;
                            width:100%;
                            height:100px;
                            background-color:dimgrey;
display: flex;
flex-direction: row;
align-items: center;
justify-content: space-between;
}
#heading{
padding:10px;
color:white;
font-size:25px;
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.container{
display:flex;
justify-content:center;
align-items: center
flex-direction:row;
}
#imgs{
margin-top:100px;
height: 300px;
width: 60vw;
}
.frm{
position: fixed;
left: 0;
bottom: 0;
width: 100%;
border:2px solid black;
padding:30px;
border-radius:5px;
}
```

```
    .inputs{
    padding:10px;
    border-radius:5px;
    outline:0;
    width:300px;
    }
    .btn{
    cursor: pointer;
    width:300px;
    }
    .si:hover{
        color:white;
        background-color:dimgrey;
    }
    #subhead{
    font-size: 30px;
    color: coral;
    text-align: center;
    text-decoration-line: underline;
    }
    th, td {
    width:40vw;
    padding: 15px;
    }
    th{
    color:darkgreen;
    text-decoration-line: underline;
    }
    td{
    color:brown;
    text-align:justify;
    }
    .disp{
    height:62vh;
    }
    </style>
<body>
    <div class="header">
        <p id="heading">Queries and Responses</p>
        <div class="options">
            <p id="option1"><a href="index">Home</a></p>
        </div>
    </div>
    <div class="container">
    <center><p style="color: blue;margin-top: 100px;">{{predict}}</p></center><br>
    </div>
    <div class="disp" style="margin-top:-7px; overflow-y:scroll;">
        {% set i=0 %}
        {% for i in range(data|length)%}
```

```
                        {% if data[i]=="user" :%}
                        <p>User:{{data[i+1] }}</p>
                        <p>Query:{{data[i+2] }}</p>
                        {% set i=i+1 %}
                        <hr>
                        {% endif %}
                        {% if data[i]=="admin": %}
                        <p style="text-align:right; margin-
right:10px;color:deeppink;">User:{{data[i+1]}}</p>
                        <p style="text-align:right;margin-
right:10px;color:deeppink;">Response:{{data[i+2]}}</p>
                        {% set i=i+1 %}
                        <hr>
                        {% endif %}
                        {% endfor %}
                </div>
                <div>
                        <form class="frm" action="http://127.0.0.1:5000/afterquery" method="POST"
onsubmit="calc()">
                                        <input type="hidden" id="timstmp" name="timestamp" value="0">
                                        <input type="hidden" name="who" value="user">
                                        <input type="text" class="inputs" placeholder="Phone number"
name="phoneno" required>
                                        <input type="text" class="inputs" placeholder="Query" name="query"
required>
                                        <button type="submit" class="inputs btn si" >Submit</button>
                                        <br><br>
                        </form>
                </div>




        </body>
</html>
```

register.html

```
<!DOCTYPE
html>
            <html>
                    <head>
                            <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                    </head>
                    <style>
                            html,body{
                            margin:0;
                            width:100%;
                            height:100%;
```

```css
font-family:Roboto;
display: flex;
flex-direction: column;
}
.header{
position: fixed;
top: 0px;
width:100%;
height:100px;
background-color:dimgrey;
display: flex;
flex-direction: row;
align-items: center;
justify-content: space-between;
}
#heading{
padding:10px;
color:white;
font-size:25px;
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.content{
margin:auto;
}
.frm{
margin-top: 100px;
border:2px solid black;
padding:30px;
border-radius:5px;
}
.inputs{
```

```
                padding:10px;
                border-radius:5px;
                outline:0;
                width:250px;
                }
                .btn{
                cursor: pointer;
                width:100%;
                }
                .si:hover{
                        color:white;
                        background-color:dimgrey;
                }
                img{
                height:60px;
                width:60px;
                border-radius:50%;
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">Registration</p>
                        <div class="options">
                                <p id="option1"><a href="index">Home</a></p>
                        </div>
                </div>
                <div class="content">
                        <form class="frm" action="http://127.0.0.1:5000/afterreg" method="POST">
                                <h3><center><img src="{{image}}",alt="registerimg"></center></h3>
                                        <input type="text" class="inputs" placeholder="Name" name="name"
required>
                                        <input type="text" class="inputs" placeholder="Email id"
name="email" required><br><br>
                                        <input type="text" class="inputs" placeholder="Phone Number"
name="phoneno" required>
                                        <input type="text" class="inputs" placeholder="Location of
Residence" name="location" required><br><br>
                                        <input type="password" class="inputs" placeholder="Password"
name="pwd" required>
                                        <input type="text" class="inputs" placeholder="Your favourite
Pet(Security Question)" name="secques" required><br><br>
                                        <select name="loginas" class="inputs btn" style="border:2px
solid";>

                                          <option value="user">User</option>
                                        </select><br><br>
                                        <button type="submit" class="inputs btn si" name="submit"
value="submit" >Register</button>
                                        <br><br>
                                        Already a user?<a href="login" style="color:blue;">  Login</a>
                </form>
            </div>
            <br>
            <center><p style="color: blue;">{{pred}}</p></center>

        </body>
    </html>
```

respond.html

```
<!DOCTYPE
html>
    <html>
        <head>
            <title>Deep learning fundus image analysis for early detection of Diabetic
    Retinopathy</title>
            <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
            <script>
                function calc()
                {
                var d = new Date();
                var n = d.getTime();
                document.getElementById('timstmp').value=n;
                }
            </script>
        </head>
        <style>
            html,body{
            margin:0;
            width:100%;
            height:100%;
            font-family:Roboto;
            display: flex;
            flex-direction: column;
            }
            .header{
            position: fixed;
            top: 0px;
            width:100%;
            height:100px;
            background-color:dimgrey;
            display: flex;
            flex-direction: row;
            align-items: center;
            justify-content: space-between;
            }
            #heading{
            padding:10px;
            color:white;
            font-size:25px;
```

```
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.container{
display:flex;
justify-content:center;
align-items: center
flex-direction:row;
}
#imgs{
margin-top:100px;
height: 300px;
width: 60vw;
}
.frm{
position: fixed;
left: 0;
bottom: 0;
width: 100%;
border:2px solid black;
padding:30px;
border-radius:5px;
}
.inputs{
padding:10px;
border-radius:5px;
outline:0;
width:300px;
}
.btn{
cursor: pointer;
width:300px;
```

```
        }
        .si:hover{
                color:white;
                background-color:dimgrey;
        }
        #subhead{
        font-size: 30px;
        color: coral;
        text-align: center;
        text-decoration-line: underline;
        }
        th, td {
        width:40vw;
        padding: 15px;
        }
        th{
        color:darkgreen;
        text-decoration-line: underline;
        }
        td{
        color:brown;
        text-align:justify;
        }
        .disp{
        height:62vh;
        }
        </style>
<body>
        <div class="header">
                <p id="heading">Queries and Responses</p>
                <div class="options">
                        <p id="option1"><a href="admin">Back</a></p>
                        <p id="option1"><a href="logout">Logout</a></p>
                </div>
        </div>
        <div class="container">
        <center><p style="color: blue;margin-top: 100px;">{{predict}}</p></center><br>
        </div>
        <div class="disp" style="margin-top:-7px; overflow-y:scroll;">
                {% set i=0 %}
                {% for i in range(data|length)%}
                {% if data[i]=="user" :%}
                <p>User:{{data[i+1] }}</p>
                <p>Query:{{data[i+2] }}</p>
                {% set i=i+1 %}
                <hr>
                {% endif %}
                {% if data[i]=="admin": %}
                <p style="text-align:right; margin-
```

```
right:10px;color:deeppink;">User:{{data[i+1]}}</p>
            <p style="text-align:right;margin-
right:10px;color:deeppink;">Response:{{data[i+2]}}</p>
            {% set i=i+1 %}
            <hr>
            {% endif %}
            {% endfor %}
        </div>
        <div>
            <form class="frm" action="http://127.0.0.1:5000/afterrespond" method="POST"
onsubmit="calc()">
                    <input type="hidden" id="timstmp" name="timestamp" value="0">
                    <input type="hidden" name="who" value="admin">
                    <input type="text" class="inputs" placeholder="Requestof"
name="phoneno" required>
                    <input type="text" class="inputs" placeholder="Response"
name="query"  required>
                    <button type="submit" class="inputs btn si" >Post</button>
                    <br><br>
            </form>
        </div>




    </body>
</html>
```

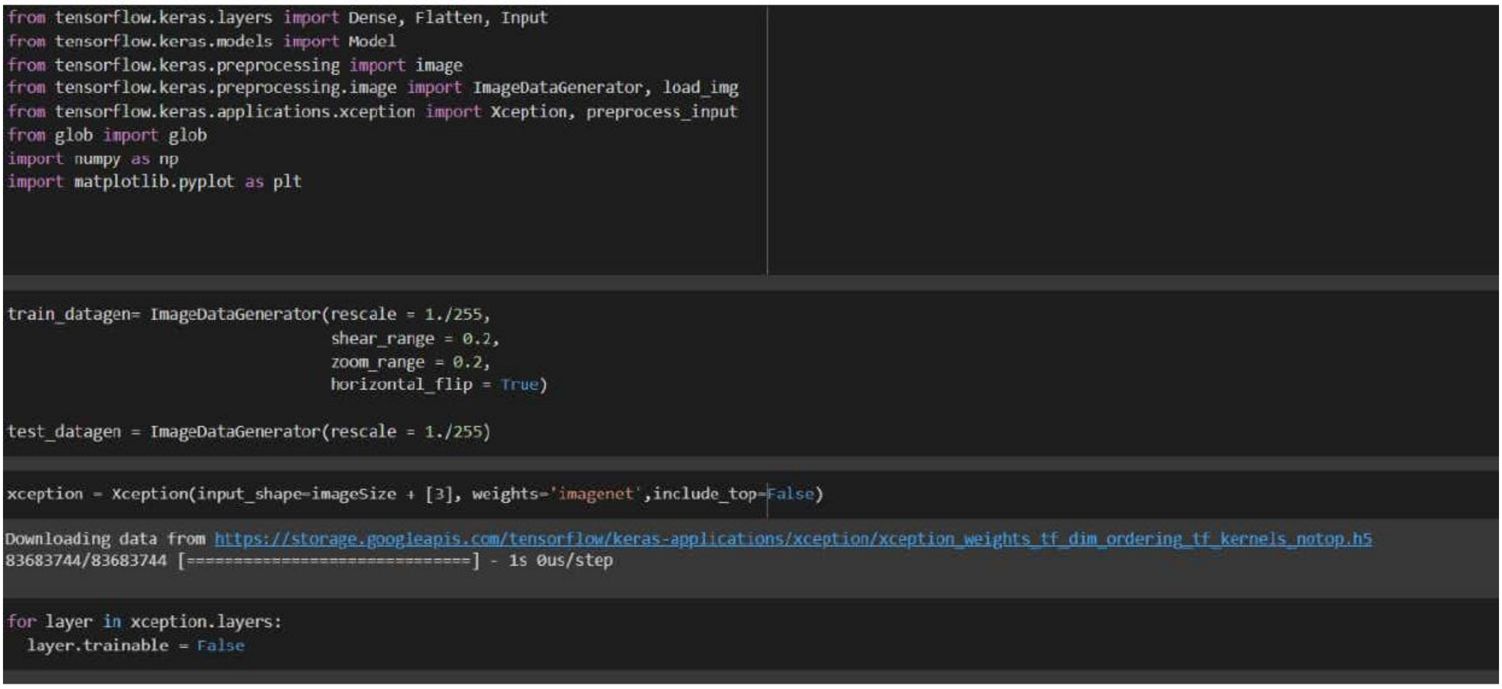
uploc.html

```
<!DOCTYPE
html>
            <html>
                <head>
                    <title>Deep learning fundus image analysis for early detection of Diabetic
            Retinopathy</title>
                    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Roboto">
                </head>
                <style>
                    html,body{
                    margin:0;
                    width:100%;
                    height:100%;
                    font-family:Roboto;
                    display: flex;
                    flex-direction: column;
                    }
                    .header{
                    position: fixed;
                    top: 0px;
```

```
width:100%;
height:100px;
background-color:dimgrey;
display: flex;
flex-direction: row;
align-items: center;
justify-content: space-between;
}
#heading{
padding:10px;
color:white;
font-size:25px;
font-style: italic
}
#option1{
margin-right:2px;
padding:10px;
color:white;
font-size:20px;
}
.options{
display: flex;
}
a{
text-decoration:none;
color:white;
}
#option1:hover{
border:1px solid white;
border-radius:10px;
background-color:black;
}
.content{
margin:auto;
}
.frm{
margin-top: 100px;
border:2px solid black;
padding:30px;
border-radius:5px;
}
.inputs{
padding:10px;
border-radius:5px;
outline:0;
width:250px;
}
.btn{
cursor: pointer;
```

```
                width:-webkit-fill-available;
                }
                .si:hover{
                        color:white;
                        background-color:dimgrey;
                }
                img{
                height:60px;
                width:60px;
                border-radius:50%;
                }
                </style>
        <body>
                <div class="header">
                        <p id="heading">Admin update</p>
                        <div class="options">
                                <p id="option1"><a href="index">Home</a></p>
                                <p id="option1"><a href="admin">Back</a><p>

                        </div>
                </div>

                <div class="content">
                <center><p style="color: blue;width:250px;">{{predict}}</p></center><br>
                        <form class="frm" action="http://127.0.0.1:5000/afteruploc" method="POST">

                                        <input type="text" class="inputs" placeholder="Enter the location
of hospital" name="loch"  required><br><br>
                                        <input type="text" class="inputs" placeholder="Enter the  hospital
name" name="hname"  required><br><br>
                                        <input type="text" class="inputs" placeholder="location"
name="lname"  required><br><br>
                                        <input type="text" class="inputs" placeholder="phone no"
name="contact"  required><br><br>
                                        <button type="submit" class="inputs btn si" >UPDATE</button>
                                        <br><br>

                        </form>
                </div>



        </body>
</html>
```

Jupyter Notebook screenshots:-



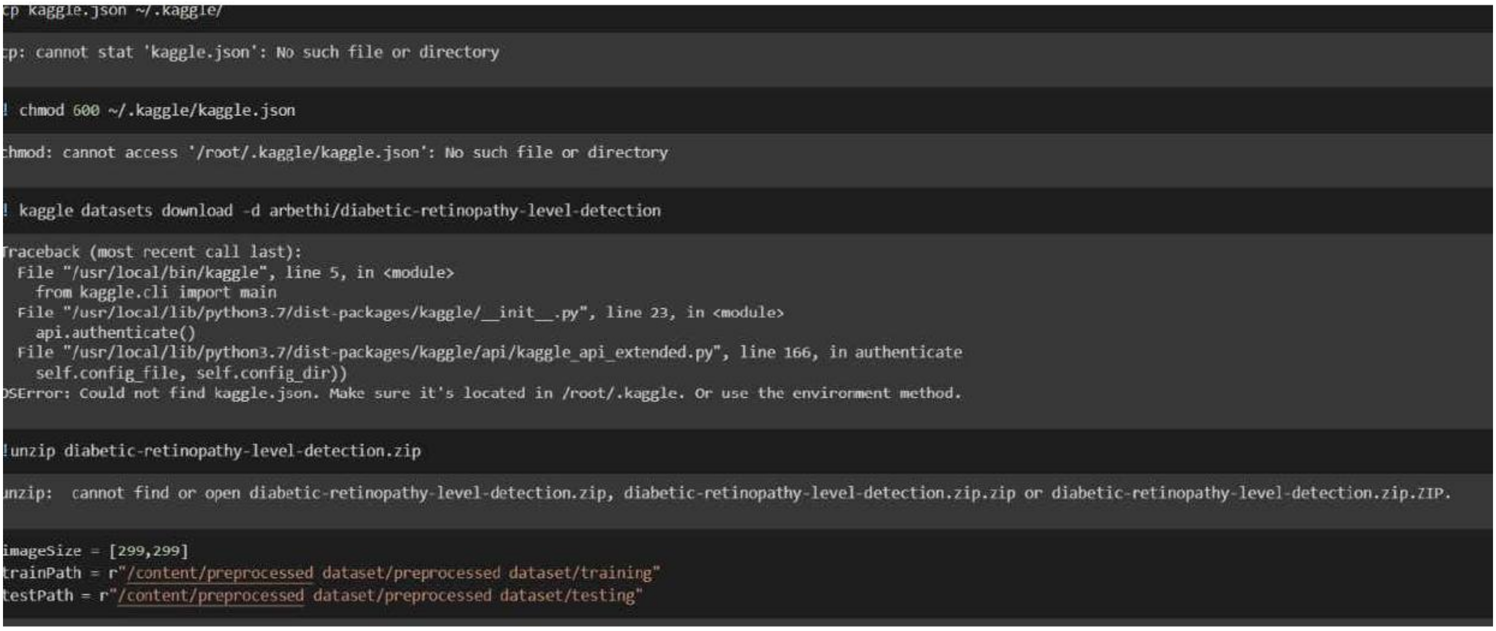
```
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
```

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

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

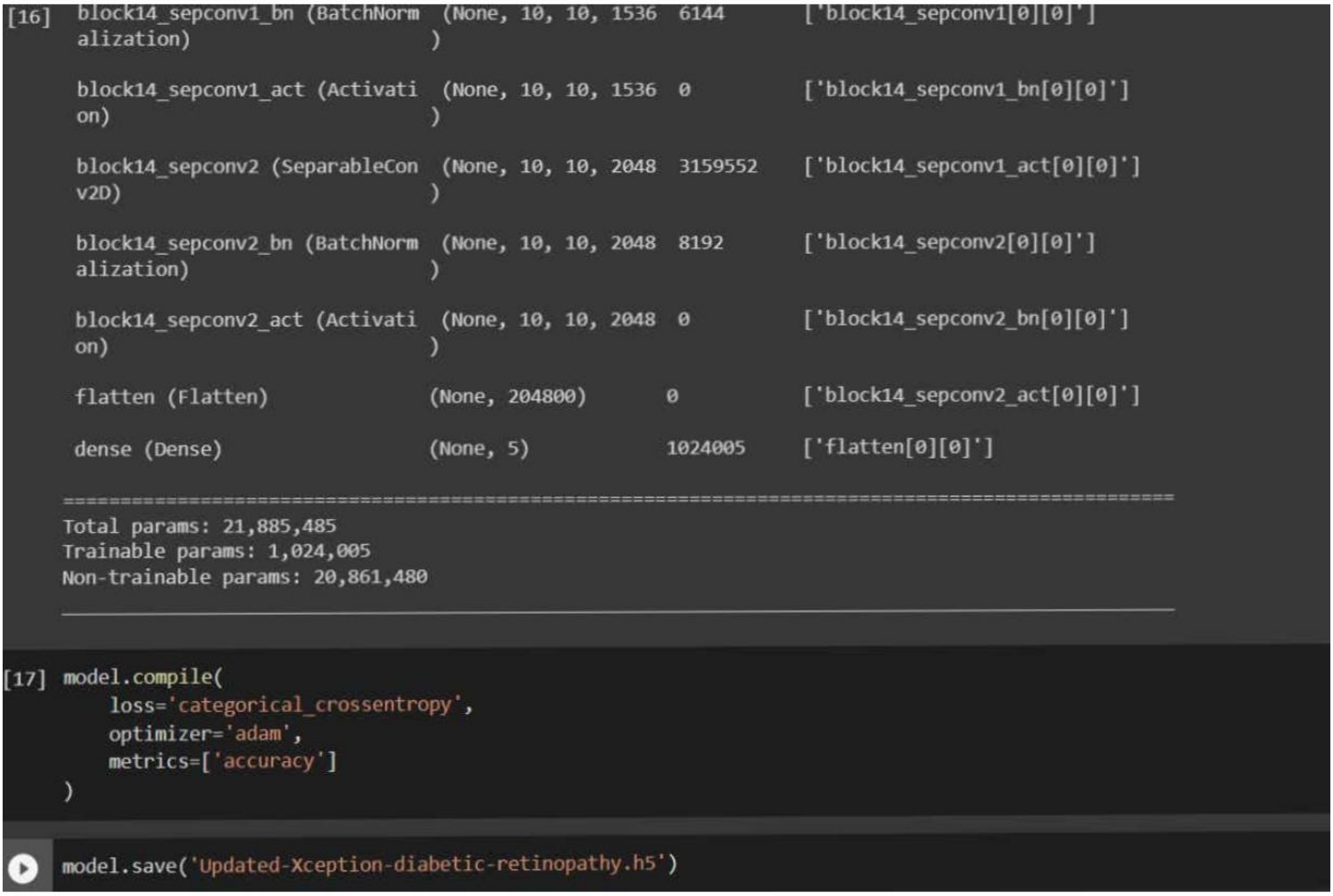
```
xception = Xception(input_shape=imageSize + [3], weights='imagenet',include_top=False)
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/xception/xception_weights_tf_dim_ordering_tf_kernels_notop.h5
83683744/83683744 [==============================] - 1s 0us/step
```

```
for layer in xception.layers:
  layer.trainable = False
```



```
cp kaggle.json ~/.kaggle/

cp: cannot stat 'kaggle.json': No such file or directory

! chmod 600 ~/.kaggle/kaggle.json

chmod: cannot access '/root/.kaggle/kaggle.json': No such file or directory

! kaggle datasets download -d arbethi/diabetic-retinopathy-level-detection

Traceback (most recent call last):
  File "/usr/local/bin/kaggle", line 5, in <module>
    from kaggle.cli import main
  File "/usr/local/lib/python3.7/dist-packages/kaggle/__init__.py", line 23, in <module>
    api.authenticate()
  File "/usr/local/lib/python3.7/dist-packages/kaggle/api/kaggle_api_extended.py", line 166, in authenticate
    self.config_file, self.config_dir))
OSError: Could not find kaggle.json. Make sure it's located in /root/.kaggle. Or use the environment method.

!unzip diabetic-retinopathy-level-detection.zip

unzip:  cannot find or open diabetic-retinopathy-level-detection.zip, diabetic-retinopathy-level-detection.zip.zip or diabetic-retinopathy-level-detection.zip.ZIP.

imageSize = [299,299]
trainPath = r"/content/preprocessed dataset/preprocessed dataset/training"
testPath = r"/content/preprocessed dataset/preprocessed dataset/testing"
```



```
[16]  block14_sepconv1_bn (BatchNorm  (None, 10, 10, 1536  6144       ['block14_sepconv1[0][0]']
      alization)                      )

      block14_sepconv1_act (Activati  (None, 10, 10, 1536  0          ['block14_sepconv1_bn[0][0]']
      on)                             )

      block14_sepconv2 (SeparableCon  (None, 10, 10, 2048  3159552    ['block14_sepconv1_act[0][0]']
      v2D)                            )

      block14_sepconv2_bn (BatchNorm  (None, 10, 10, 2048  8192       ['block14_sepconv2[0][0]']
      alization)                      )

      block14_sepconv2_act (Activati  (None, 10, 10, 2048  0          ['block14_sepconv2_bn[0][0]']
      on)                             )

      flatten (Flatten)              (None, 204800)       0          ['block14_sepconv2_act[0][0]']

      dense (Dense)                  (None, 5)            1024005    ['flatten[0][0]']

     ==================================================================================================
     Total params: 21,885,485
     Trainable params: 1,024,005
     Non-trainable params: 20,861,480
     __________________________________________________________________________________________________
```

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

```
model.save('Updated-Xception-diabetic-retinopathy.h5')
```

GITHUB LINK:- IBM-Project-12198-1659440400Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy (github.com)