PROJECT DOCUMENTATION

Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

Team Id:-PNT2022TMID35900

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DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

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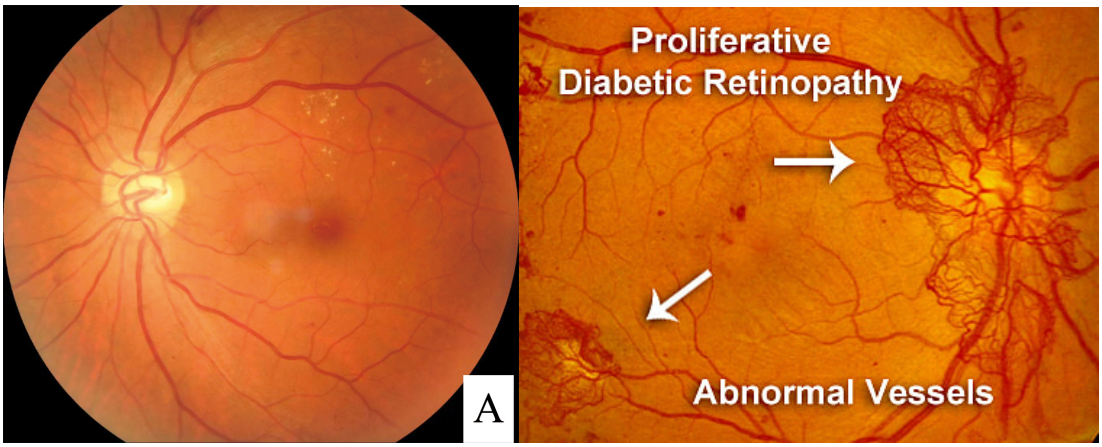
1.INTRODUCTION

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/ordot hemorrhages, vascularhyper 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 suddenvision 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. This project presents a method to detect diabetic retinopathy on the fundus images by using deep learning neural network. Alexnet Convolution Neural Network (CNN) has been used in the project to ease the process of neural learning.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.we propose the multistage approach to transfer learning, which makes use of similar datasets with different labeling.

1.2 PURPOSE

DR early detection and treatment can significantly reduce the risk of vision loss. AI can save the manual effort and cost and also potentially have more accuracy than human experts, thus improving value of service. The purpose of our study is to investigate the effectiveness of UWF fundus image in DR detection.

2.LITERATURE SURVEY

2.1 EXISTING PROBLEM

Diabetes is a globally prevalent disease that can cause visible microvascular complications such as diabetic retinopathy and macular edema in the human eye retina, the images of which are today used for manual disease screening and diagnosis.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.
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.

2.2 REFERENCES

1. Y. S. Kanungo, B. Srinivasan and S. Choudhary, "Detecting diabetic retinopathy using deep learning," *2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, 2017, pp. 801-804, doi: 10.1109/RTEICT.2017.8256708.

2. N. Chakrabarty, "A Deep Learning Method for the detection of Diabetic Retinopathy," *2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, 2018, pp. 1-5, doi: 10.1109/UPCON.2018.8596839.

3. S. Qummar *et al*., "A Deep Learning Ensemble Approach for Diabetic Retinopathy Detection," in *IEEE Access*, vol. 7, pp. 150530-150539, 2019, doi: 10.1109/ACCESS.2019.2947484.

4. A. Elzennary, M. Soliman and M. Ibrahim, "Early Deep Detection for Diabetic Retinopathy," *2020 International Symposium on Advanced Electrical and Communication Technologies (ISAECT)*, 2020, pp. 1-5, doi: 10.1109/ISAECT50560.2020.9523650.

5. Y. Miao, S. Tang, P. Du and Z. Li, "Research on Deep Learning in the Detection and Classification of Diabetic Retinopathy," *2021 IEEE International Conference on Computer Science, Electronic Information Engineering and Intelligent Control Technology (CEI)*,

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2021, pp. 107-113, doi: 10.1109/CEI52496.2021.9574509.

2.3 PROBLEM STATEMENT DEFINITION

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.If it is not detected early, it can lead to blindness.This labour-intensive task could greatly benefit from automatic detection using deep learning technique. 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.Weused 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.

WHAT ? In contrastto computer-aided diagnosis systems, the manual/ human-based diagnosisprocess of DR retina fundus images by doctors (ophthalmologists) is time-consuming, labor-intensive, expensive, and prone to error.

WHY ? Diabetes-related retinopathy is broughton by high blood sugarlevels harming theeye's iris. which could result in a permanent loss of vision.

WHEN ? Early on, theDR has no symptoms, but later on, the vessels may start to leak atinyamount of blood into your retina..

WHERE ? Blurred vision,Distorted vision will occur.

WHO? It is common among the Diabeticpatients.

HOW ? The manualearly detection of this DR is a challenging task.

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OBJECTIVES :

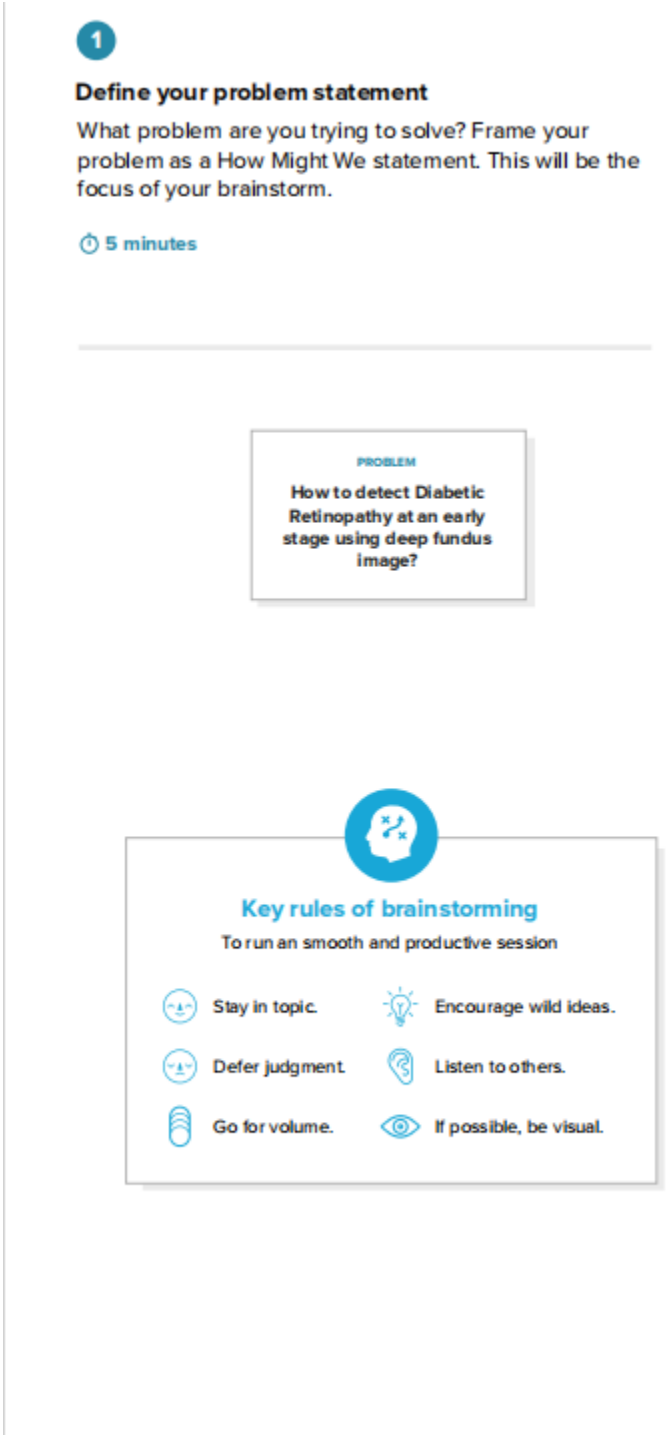
The primary goal is to identify diabetic retinopathy by processing retinal images. Transfer learning has arose as one of the most popular techniques that has enhanced performance in many areas, notably in the analysis and classification of medical images. We used transfer learning techniques that are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

3. IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

3.2 IDEATION AND BRAIN STROMING



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2

Brainstorm

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

10 minutes

Priyadharsini B

Nandhini R

Khamila Banu

Diviya N

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3

Group ideas

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

20 minutes

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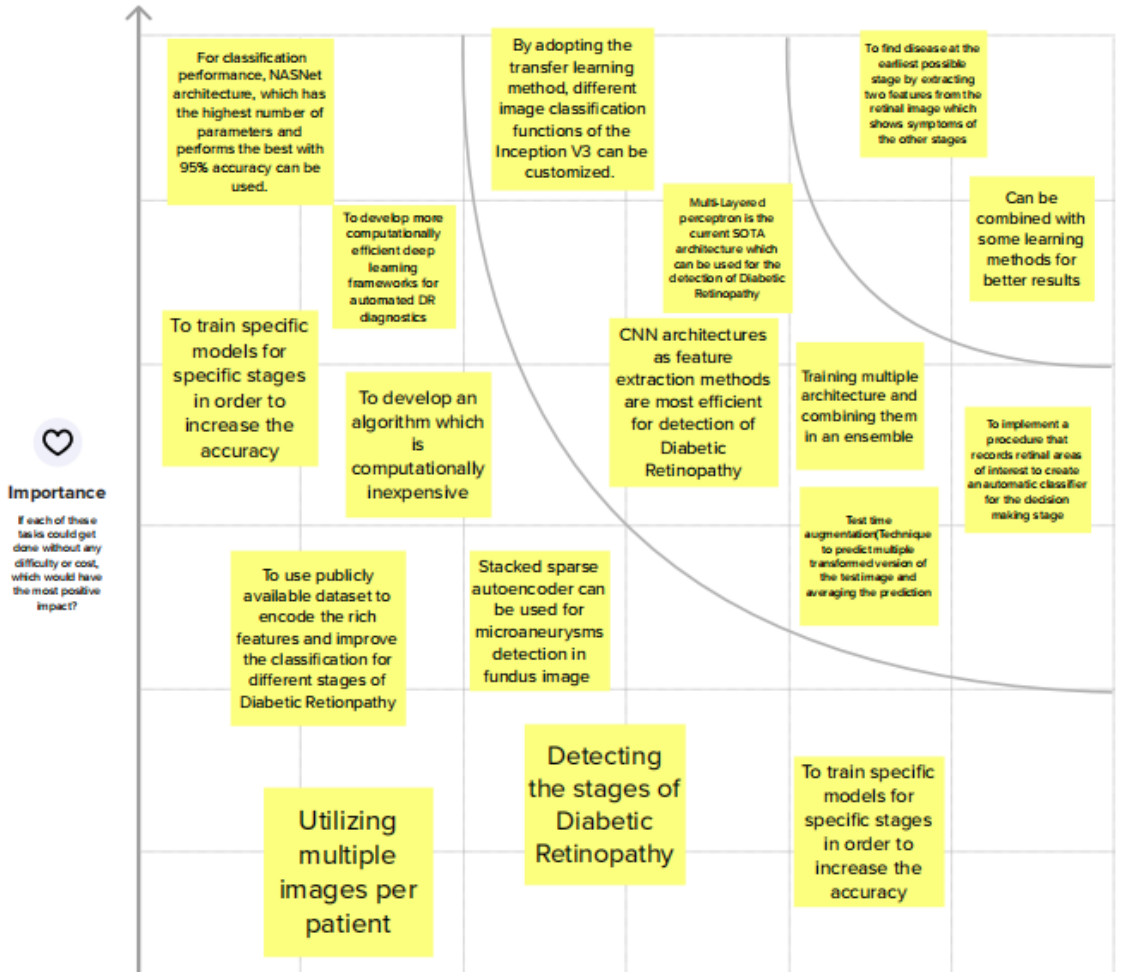
4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes



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3.3 PROPOSED SOLUTION

S.NO	Parameter	Description
1	Problem Statement (Problem to be solved)	Diabetic retinopathy is a leading cause of blindness.it becomes needof the hour to build safe and reliable system that will work on early detection of this disease and willprovide genuine result.
2.	Idea / Solution description	Patient's retinal images are captured via smart phone camera and uploaded to a cloud based web application for patient dataentry, image capture and uploading , integration with the AI model
3.	Novelty/Uniqueness	User can detect their disease in early stage.
4.	Social impact /customer satisfaction	Helps in preventing theloss of visibility to the needed through CSR activities or through healthcare camps.
5.	Business Model (Revenue	1. Can collaborate with

	Model)	diagnosis centers andhospitals. Can collaborate with government for health awareness camps.
6.	Scalability of The Solution	Laser treatment- is used to treat new blood vessels at the back of the eyes in the advanced stages of diabetic retinopathy .

3.3 PROBLEM SOLUTION FIT

PATIENTS SEGMENTS This method can potentially be utilized to monitor and regulate patients. An ophthalmologist generally determines the seriousness of the retinopathy of the eye by directly examining color photos and evaluating them by visually inspecting the fundus.
PROBLEM/PAINS There are 4 stages namely mild NPDR, moderate NPDR, and proliferative diabetic retinopathy. No treatment is usually done at this stage though there is evidence that anti-vascular endothelial growth factor (VEGF) injections may help decrease the severity of retinopathy and lower the risk of vision complications.
TRIGGERS TO ACT Diabetic Retinopathy is best diagnosed with a comprehensive dilated eye exam. For this exam, drops placed in patients' eyes widen(dilate) their pupils to know a better view inside the patient's eyes.

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EMOTIONS

Diabetic retinopathy (DR) is the most common cause of blindness in the working population of the United States and of the European Union. Early detection ('screening') and timely treatment have been shown to prevent visual loss and blindness in patients with retinal complications of diabetes.

AVAILABLE SOLUTIONS

Non-efficient image processing algorithms were used in earlier systems. This traditional
approach gives lower accuracy and is time-consuming. This drawback of the existing system propelled us towards the idea of developing a system that could ease this effort.

PATENTS LIMITATIONS

Diabetes-affected patients need to keep track of their dilated exams at least once a year.

BEHAVIOR

In our project, we identify the patient's diseases using fundus images. Then it recommends the treatment to be used. Our project's accuracy is more because we are using Artificial Intelligence.

8.CHANNELS OF BEHAVIOR

Early detection and treatment can usually prevent severe vision loss. Diabetic Retinopathy includes- Effective diabetes management and Regular eye examinations. This will help the patients to delay the development of retinopathy.

PROBLEM ROOT CAUSE

Diabetic retinopathy is caused by high blood sugar due to diabetes. Over time, having too much sugar in your blood can damage your retina — the part of your eye that detects light and sends signals to your brain through a nerve in the back of your eye (optic nerve).

YOUR SOLUTION

Patients reduce your risk of developing diabetic retinopathy or help stop it from getting worse, by keeping your blood sugar levels, blood pressure, and cholesterol levels under control. This can often be done by making healthy lifestyle choices, although some people will also need to take medication.

4. REQUIREMENT ANALYSIS

4.1Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Identification of population eligible for screening	Determine the group to be screened based on best evidence and use registers to make sure people's detailsare collected and up to date

FR-2	Invitation and information	Invite the full cohort for screening, supplying information tailored appropriately for different groupsto enable informed choice to participate
FR-3	Testing	Screening test(s) are conducted using agreed/recommended methods
FR-4	Referral of screen positives andreporting of screen-negative results	Making sure screen negatives are reported to individuals and they stay in the screening program byreferring to all screen-positive results to appropriate services
FR-5	Diagnosis	Differentiate true cases from false positive diagnoses.
FR-6	Intervention/treatment/follow up	In some conditions, surveillance or follow up will also berequired to Intervene/treat cases appropriately
FR-7	Reporting of outcomes	To identify false negatives and improve effectiveness andcost-effectiveness of screening program report on outcomes is collected and analyzed

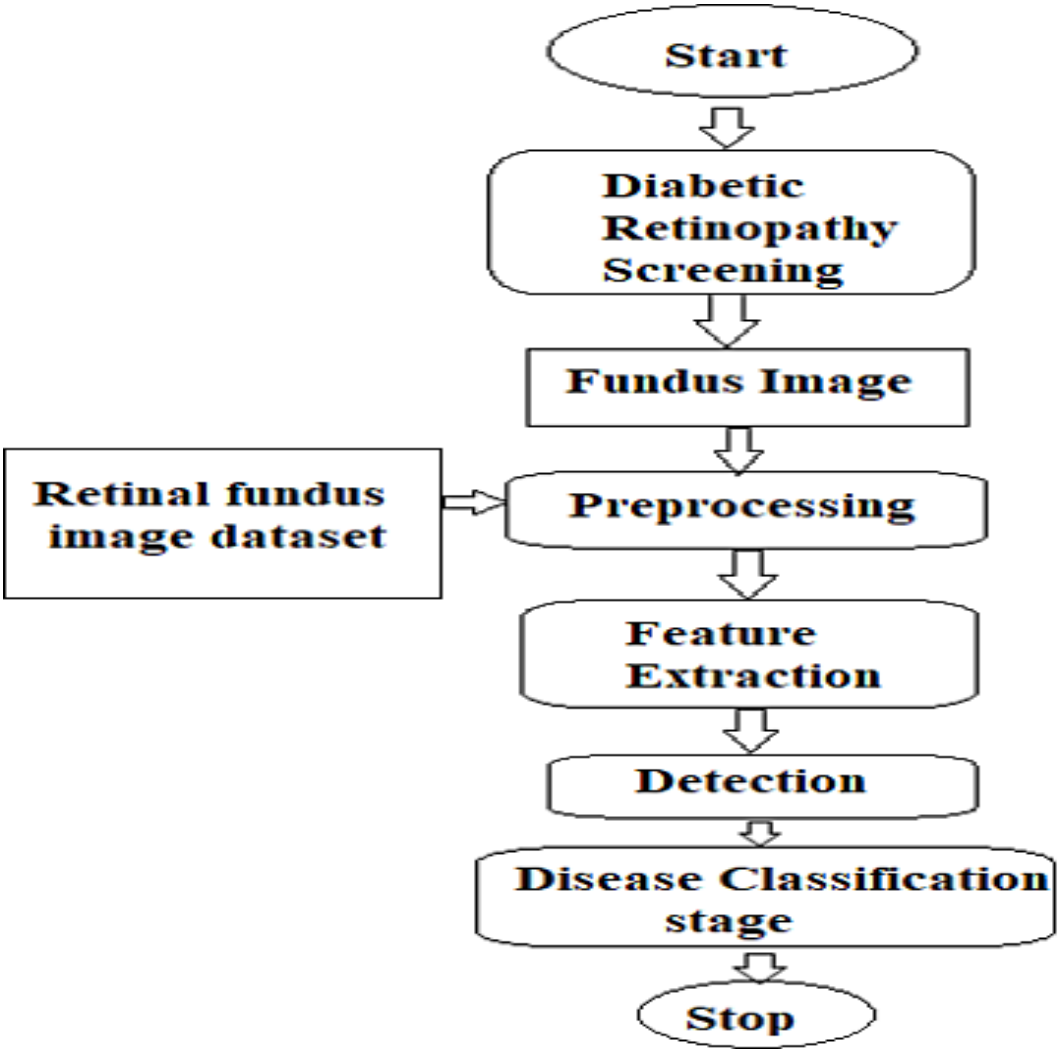
4.2 Non-Functional Requirements:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	For accurately classifying images according to clinical five-grade diabetic retinopathy it provides novel results for five different screening and clinicalgrading systems for diabetic retinopathyincluding state-of-the-art results.
NFR-2	**Security**	Aroundsensitive organs and tissues deep Learning using AI can be more precise, reduce blood loss, riskof infection, and pain during detection/screening.
NFR-3	**Reliability**	The ability of Deep Learning is to perform pattern recognition by creating complex relationships based

		on input data and then comparing it withperformance standards.
NFR-4	**Performance**	AI in simple words means to accomplish a task mainly by a computer or a robot, with minimal involvement of human beings. Standard templatesfor drawing findings of the retina may improve accuracy of recording of results.
NFR-5	**Availability**	Healthcare affordability, quality, and accessibilitycan be amplified using this technology.
NFR-6	**Scalability**	It is possible to build on existing systems and take a stepwise approach to improving the effectiveness ofcurrent approaches so that high-quality systematic diabetic retinopathy screening becomes a universal offer to all people with diabetes.

5. REQUIREMENT ANALYSIS

5.1 DATA FLOW DIAGRAM



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5.2 SOLUTION & TECHNICAL ARCHITECTURE

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5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptan cecriteria	Priority	Release
Common User	Dashboard	USN-1	As a user, I can I must be able to upload image of my eyes	I can upload or take image	High	Sprint-1
		USN-2	As a user, I will receive thediagnosis as to whether I have retinopathy or not	I can receive the diagnosis	High	Sprint-1
		USN-3	As a user, I receive the severity of the retinopathy	I can receive the severity of the retinopathy	Medium	Sprint-2
		USN-4	As a user, I can receive thesuggested remedy	I can receive the suggested remedy	Medium	Sprint-2

6 PROJECT PLANNING AND SCHEDULING:-

6.1 -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, and confirming my password.	10	High	Priyadharshini.B
Sprint-1	E-mail confirmation	USN-2	As a user, I will receive a confirmation emailonce I have registered for the application	10	Medium	Nandhini.R
Sprint-2	Login	USN-3	As a user, I can log into the application byentering my email & password	5	High	Priyadharshini.B Khamila Banu
Sprint-2	Upload Images	USN-4	As a user,I should be able to upload the imageof ECG.	10	High	Khamila Banu
Sprint-2	Dashboard	USN-5	As a user, based on my requirement I cannavigate through the dashboard.	5	Medium	Nandhini.R Diviya.N

6.2 -SPRINT DELIVERY SCHEDULE

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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:

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 (AV) periteration unit (story points per day)

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

AV=20/6=3.33points per day

6.3 REPORTS FROM JIRA

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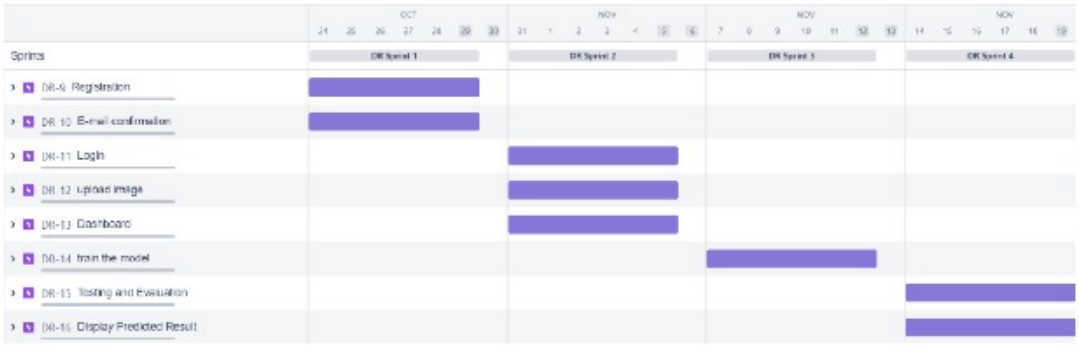
SPRINT ROAD MAP:



7.CODING & TESTING:

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 xception model 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.

DATA BASE SCHEMA

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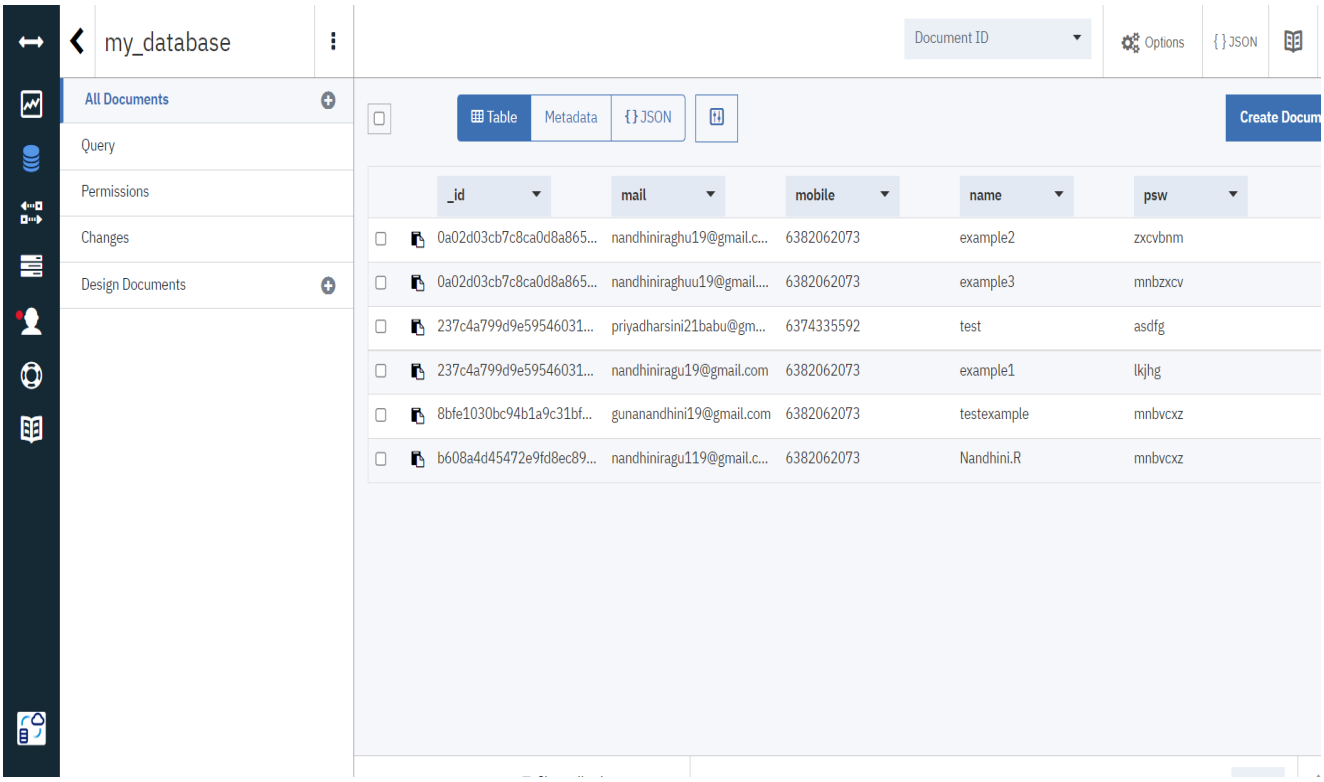


8.TESTING:-

8.1 TEST CASES

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	Severity 4	Subtotal
By Design	4	5	3	3	15
Duplicate	1	0	2	0	3
External	1	3	0	1	5
Fixed	9	2	4	13	28
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	15	15	13	19	62

3. Test-Case Analysis

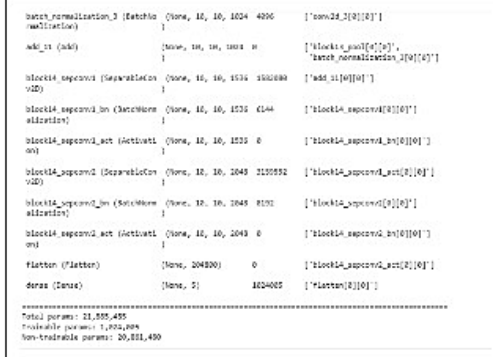
This report shows the number of test cases that have passed, failed, and untested.

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	9	0	0	9
Client Application	40	0	0	40
Security	2	0	0	2
Out-source Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	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-0.7500 Validation Accuracy-0.8009	`- loss: 0.8009 - accuracy: 0.7500`
3.	Confidence Score-(Only Yolo Projects)	–	–

10. ADVANTAGES AND DISADVANTAGES

10.1 ADVANTAGES:

1. Deep learning is scalable, This means that it can be used to train models on very large datasets.
2. Our model uses pretrained weights from resnet dataset. So, has good context using transfer learning.
3. Earlier detection reduce the risk of Vision loss.
4. Our application is user friendly and easy to use

10.2 DISADVANTAGES:

1. Deep learning models can be very complex, which can make them difficult to interpret.
2. If the images is not uploaded correctly then detection may be difficult.

11. CONCLUSION

We looked at existing solutions and decided to proceed with transfer learning technique. We used Xception V3 as the base model and trained a deep layer on top of it for predictions. Our model had good precision and recall values compared to otheravailable solutions by 5% and 7% respectively. We deployed our model in a simple flask application withauthentication for people to be able to use our inference.

12.FUTURE SCOPE

We can add a extra deep learning layer and fine tuning on top of wrong prediction data again. We can also add more data to the dataset by label from ophthalmologists and other labels.We can also add high quality images that need to be preposed before being used for deep learning.

13. APPENDIX:-

app.py:-

```
import numpy as npimport os
from
tensorflow.keras.mode
ls import load_model
from
tensorflow.keras.prepro
cessing importimage
from tensorflow.keras.applications.inception_v3
importpreprocess_inputfrom flask import Flask,
request,flash, render_template, redirect,url_for
from cloudant.client import Cloudant
from twilio.rest importClient
model = load_model(r"Updated-
xception-diabetic-retinopathy.h5")app =
Flask(_name_)
app.secret_key="abc"
app.config['UPLOAD_F
OLDER'] =
"User_Images"#
Authenticate using an
IAM API key

client = Cloudant.iam('08bcbaf0-260b-48e0-abdb-
                    08db348afcf2-bluemix',
                    'yhZfUubpS3vS1vEKZSS37teD6IAUi8oLynOC
                    QLIwnQsa', connect=True)
# Create a database using
an initialized client
my_database =
client.create_database('my
_database')if
my_database.exists():
    print("Database '{0}' successfully
created.".format('my_db'))#
defaulthome page or route
```

```
user = ""

@app.route('/')def index():
    return render_template('index.html', pred="Login", vis ="visible")

@ app.route('/index')def home():
    return render_template("index.html", pred="Login", vis ="visible")



# registration page
@ app.route('/register',methods=["GET","POST"])




def register():
    if request.method == "POST":
        name = request.form.get("name")mail = request.form.get("emailid")mobile =
        request.form.get("num")pswd = request.form.get("pass") data = {
            'name': name,
            'mail': mail, 'mobile': mobile,'psw': pswd
        }
        print(data)
        query = {'mail':{'$eq': data['mail']}}
        docs =
        my_database.get_
        query_result(quer
        y)print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            url = my_database.create_document(data)
            return render_template("register.html", pred=" Registration Successful , please
        login using your details ")else:
            return render_template('register.html', pred=" You are alreadya member , please login using your
            details ")
    else:
        return render_template('register.html')


@
app.route('/login',
```

```
methods=['GET','P
OST'])def login():
    if request.method  == "GET": user = request.args.get('mail') passw = request.args.get('pass')print(user,
        passw)
        query = {'mail': {'$eq': user}}
        docs =
        my_database.get_
        query_result(quer
        y)print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            return
        render_template('log
        in.html', pred="")
        else:
            if ((user == docs[0][0]['mail'] and passw ==
                docs[0][0]['psw'])):flash("Logged in as " +
                str(user))
                return render_template('index.html', pred="Logged in as "+str(user), vis
            ="hidden", vis2="visible")else:
                return render_template('login.html', pred="The password is wrong.")
    else:
        return render_template('login.html')
```

```
@ app.route('/logout')def logout():
    return render_template('logout.html')

@app.route("/predict",m
ethods=["GET",
"POST"])def predict():
    if request.method == "POST":f = request.files['file']
        # getting the current path
        1.e where app.py is
        present basepath =
        os.path.dirname(__file__)
        #print ( "current path " ,basepath )
```

```
# from anywhere in the system we can
give image but we want that filepath=
os.path.join(str(basepath),
'User_Images', str(f.filename)) #print ( "
upload folder is " , filepath )
f.save(filepath)
img =
image.load_img(filepath,
target_size=(299, 299))x =
image.img_to_array(img)  #
ing toarray
x = np.expand_dims(x, axis=0)# used for
adding one more dimension#print ( x )
img_data = preprocess_input(x)
prediction =
np.argmax(model.predict(img
_data), axis=1)index = [' No
DiabeticRetinopathy ', ' Mild
NPDR ',
        ' Moderate NPDR ', ' Severe
NPDR ', ' Proliferative DR ']result =
str(index[prediction[0]])
print(result)
account_sid =
'AC8e0f2f5263d71c8f630a64
86779cf08b'auth_token =
'30b489873afb3c47340070ea
bd6bfb15'

client = Client(account_sid, auth_token)

''' Changethe value
of 'from' with the
numberreceived
from Twilio and
the value of 'to'
with the number in which you
want to send message.'''
message =
client.messages.create(
```

```
                        from_='+16075363206',
    body ='Results: '+ result,to ='+919445979800'
                    )
     return render_template('prediction.html',
  prediction=result, fname = filepath)else:
     return render_template("prediction.html")

if__name_== "_main_":app.debug = True app.run()
```

cloud.ipynb:-

```
from cloudant.client import Cloudant
client=Cloudant.iam('655489f8-18d0-
4a44-a701-5de60570a973-
bluemix','Jc4eF6CXk72w0wGCsM_KUuXKVjsCcT4a54UK
BXckK5Bv',connect=True)
my_database=client.create_database('my-database')
```

index.html:-

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/
      dist/css/bootstrap.min.css" rel="stylesheet"
      integrity="sha384-
      iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB
      6+fzT" crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/b
      ootstrap.bundle.min.js"
```

```
    integrity="sha384-
    u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"
  ></script>
  <style>
     #navbarRight { margin-left: auto; padding-right:10px;
     }
     .navbar-brand{ padding-left:15px;
     }
  </style>
  <title>DR Predcition</title>
</head>
<body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
     <div>
     <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
     </div>
     {{msg}}
     <div class="navbar-collapse collapsew-100 order-3 dual-collapse2" id="navbarNav">
       <ul class="navbar-nav mr-autotext-center" id="navbarRight">




         <li class="nav-item active">
           <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
         </li>
         <li class="nav-item" style="visibility:{{ vis2 }}">
           <a class="nav-link" href="predict" style="color: aliceblue;">Prediction</a>
         </li>
         <li class="nav-item">
           <a class="nav-link" href="login" style="color: aliceblue;">{{pred}}</a>
         </li>
         <li class="nav-item" style="visibility:{{ vis }}">
           <a class="nav-link" href="register" style="color: aliceblue;">Register</a>
         </li>
       </ul>
     </div>
  </nav>
  <br><br>
    <div class="jumbotron container">
      <h1 class="display-4">Diabetic Retinopathy</h1>
      <p class="lead">Diabetic retinopathy is a diabetescomplication that affectseyes. It's
```

```
causedby damage to the bloodvessels of the light-sensitive tissue at the back of the eye (retina).
        At first, diabeticretinopathy might cause no symptoms or only mild vision problems.But it can
        lead to blindness.
        The condition can develop in anyone who has type 1 or type 2diabetes. The longeryou
have diabetesand the lesscontrolled your blood sugar is, the more likely you are to develop this
eye complication.</p>
        <hr class="my-4">
        <div class="d-flex justify-content-center">
          <img style="width:70vw;" src="static/diabetic-retinopathy-home.jpg">
          </div>
       </div>
  </body>
</html>
```

login.html:-

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/
      dist/css/bootstrap.min.css" rel="stylesheet"
      integrity="sha384-
      iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB
      6+fzT" crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->




    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/b
      ootstrap.bundle.min.js"
      integrity="sha384-
      u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
```

```
  ></script>
  <style>
     #navbarRight { margin-left: auto; padding-right:10px;

     }
     .navbar-brand{ padding-left:15px;
     }
  </style>
  <title>DR Predcition</title>
</head>
<form action="",method='POST'>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
     <div>
     <a class="navbar-brand" href="#" style="color:aliceblue">User Login</a>
     </div>
     <div class="navbar-collapse collapsew-100 order-3 dual-collapse2" id="navbarNav">
       <ul class="navbar-nav mr-autotext-center" id="navbarRight">
         <li class="nav-item active">
           <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
         </li>
         <li class="nav-item">
           <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
         </li>
         <li class="nav-item">
           <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
         </li>
       </ul>
     </div>
   </nav>
   <br><br>
   <form class="form-inline" action="/login" method="GET">
   <div class="container" style="width: 600px; height: 600px;">
     <div class="mb-3 d-flex justify-content-center"><script
     src="https://cdn.lordicon.com/xdjxvujz.js"></script>
        <lord-icon
           src="https://cdn.lordico
           n.com/elkhjhci.json"
           trigger="hover"
           style="width:200px;hei
           ght:200px">
        </lord-icon></div>
        <div class="mb-3">
```

```
            <input type="email" class="form-control" id="exampleInputEmail1" name="mail" aria-
describedby="emailHelp"placeholder="Enter Registered Mail ID">
          </div>
          <div class="mb-3">
            <input type="password" class="form-control" id="exampleInputPassword1"
name="pass" placeholder="EnterPassword">
          </div>
          <div class="mb-3">
          <button type="submit form-control" class="btn btn-dark btn-primary"
style="width:100%;"type="submit">Login</button>
        </div>
        {{pred}}
    </div>
  </form>
 </body>
</html>
```

logout.html

```
<!DOCTYPE html>
<html lang="en">
 <head>
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <!-- CSS only -->
  <link
   href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/
   dist/css/bootstrap.min.css" rel="stylesheet"
   integrity="sha384-
   iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB
   6+fzT" crossorigin="anonymous"
  />
  <!-- JavaScript Bundle with Popper -->
  <script
   src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/b
   ootstrap.bundle.min.js"
   integrity="sha384-
   u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
```

```
    crossorigin="anonymous"
  ></script>
  <style>
     #navbarRight { margin-left: auto; padding-right:10px;
     }
     .navbar-brand{ padding-left:15px;
     }
  </style>
  <title>DR Predcition</title>




</head>
<body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
     <div>
     <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy</a>
     </div>
     <div class="navbar-collapse collapsew-100 order-3 dual-collapse2" id="navbarNav">
       <ul class="navbar-nav mr-autotext-center" id="navbarRight">
         <li class="nav-item active">
           <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
         </li>
         <li class="nav-item">
           <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
         </li>
         <li class="nav-item">
           <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
         </li>
       </ul>
     </div>
   </nav>
   <br><br>
   <div class="d-flex justify-content-center">
     <div class="row d-flex
        display-3 justify-content-
        center">Successfully
        Logged Out!
        <br><br>
        <a href="login" class="btn btn-lg btn-dark">Login for more Information</a>
          </div>
     </div>
```

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

prediction.html:-

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

<head>
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <!-- CSS only -->
  <link
    href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.cs
    s" rel="stylesheet" integrity="sha384-
    iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB
    6+fzT"
crossorigin="anonymous" />
  <!-- JavaScript Bundlewith Popper -->
  <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
    integrity="sha384-
    u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"></script>




  <style> #navbarRight { margin-left: auto;
      padding-right: 10px;
    }

    .navbar-brand { padding-left: 15px;
    }

    .row {
      width: 90%;
    }
  </style>
  <title>DR Predcition</title>
</head>

<body>
```

```
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
    </div>
    <div class="navbar-collapse collapsew-100 order-3 dual-collapse2" id="navbarNav">
      <ul class="navbar-nav mr-autotext-center" id="navbarRight">
        <li class="nav-item active">
          <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
        </li>
        <li class="nav-item">
          <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>
        </li>
      </ul>
    </div>
  </nav>
  <br><br>
  <div class="container justify-content-center" style="width:700px">
    <form action = "/predict" method= "POST" enctype="multipart/form-data">
    <label for="formFileLg" class="form-label">Upload Image</label>
    <input class="form-control form-control-lg" name ="file" type="file" />
    <br>
    <button class="btn btn-lg btn-dark" type = "submit">Predict</button>
    </form>
    <br>
    <h1>{{prediction}}</h1>
  </div>
  <br><br><br>
  <div class="d-flex justify-content-center" >
      <img src="static/level.png" style="width: 90%">




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

register.html:-

```
<!-- <!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
```

DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

```
 <meta http-equiv="X-UA-Compatible" content="IE=edge" />
 <meta name="viewport" content="width=device-width, initial-scale=1.0" />
 <!-- CSS only -->
 <link
  href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/
  dist/css/bootstrap.min.css" rel="stylesheet"
  integrity="sha384-
  iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB
  6+fzT" crossorigin="anonymous"
 />
 <!-- JavaScript Bundle with Popper -->
 <script
  src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/b
  ootstrap.bundle.min.js"
  integrity="sha384-
  u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
  crossorigin="anonymous"
 ></script>
 <style>
    #navbarRight { margin-left: auto; padding-right:10px;

    }
    .navbar-brand{ padding-left:15px;
    }
 </style>
 <title>DR Predcition</title>
</head>
<form action="{{url_for('register')}}" method="post" >
 <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
    <a class="navbar-brand" href="#" style="color:aliceblue">Registration</a>
    </div>
    <div class="navbar-collapse collapsew-100 order-3 dual-collapse2" id="navbarNav">
     <ul class="navbar-nav mr-autotext-center" id="navbarRight">
       <li class="nav-item active">
         <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
       </li>



       <li class="nav-item">
```

```
            <a class="nav-link" href="login" style="color: aliceblue;">Login</a>
          </li>
          <li class="nav-item">
            <a class="nav-link" href="register"style="color: aliceblue;">Register</a>
          </li>
        </ul>
      </div>
    </nav>
    <br><br>
    <form class="form-inline" method="POST">
    <div class="container" style="width: 600px; height: 600px;">
      <div class="mb-3 d-flexjustify-content-center"><script
      src="https://cdn.lordicon.com/xdjxvujz.js"></script>
        <lord-icon
          src="https://cdn.lordico
          n.com/elkhjhci.json"
          trigger="hover"
          style="width:200px;hei
          ght:200px">
        </lord-icon></div>
                        <div class="mb-3">
          <input type="text" class="form-control" id="exampleInputName" name = "name"
aria-describedby="nameHelp"placeholder="Enter Name">
          </div>
          <div class="mb-3">
            <input type="email" class="form-control" id="exampleInputEmail1" name="emailid"
aria-describedby="emailHelp"placeholder="Enter Mail ID">
          </div>
          <div class="mb-3">
            <input type="number" class="form-control"
id="exampleInputNumber1" name="num" aria-describedby="numberHelp"
placeholder="Enter Mobile number">
          </div>
          <div class="mb-3">
            <input type="password" class="form-control" id="exampleInputPassword1"
name="pass" placeholder="EnterPassword">
          </div>
          <div class="mb-3">
          <button type="submit form-control" class="btn btn-dark btn-primary"
          style="width:100%;">Register</button>
        </div>
```

```
    </div>
    {{pred}}
    </div>
   </form>
  </body>
</html> -->
```

Source Code:

In [28]:
```
for layer in inception.layers:
  layer.trainable = False
```

In [29]:
```
x = Flatten()(inception.output)
```

In [30]:
```
prediction = Dense(5, activation = 'softmax')(x)
```

In [33]:
```
model = Model(inputs = inception.input, outputs = prediction)
```

In [34]:
```
model.summary()
```

```
Model: "model"
_________________________________________________________________________________________________
 Layer (type)                Output Shape              Param #   Connected to
=================================================================================================
 input_3 (InputLayer)        [(None, 299, 299, 3       0         []
                             )]

 conv2d_188 (Conv2D)         (None, 149, 149, 32       864       ['input_3[0][0]']
                             )

 batch_normalization_188 (Batch  (None, 149, 149, 32   96        ['conv2d_188[0][0]']
 Normalization)              )

 activation_188 (Activation)  (None, 149, 149, 32      0         ['batch_normalization_188[0][0]']
                             )

 conv2d_189 (Conv2D)         (None, 147, 147, 32       9216      ['activation_188[0][0]']
                             )

 batch_normalization_189 (Batch  (None, 147, 147, 32   96        ['conv2d_189[0][0]']
 Normalization)              )
```

DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

Demo video link:
https://drive.google.com/file/d/1pjv98Ht5eETH54LtA1NCS2iZZY5R5dCj/view?usp=share_link

GitHub link:
https://github.com/IBM-EPBL/IBM-Project-493-1658303993