# PROJECT DOCUMENTATION

# Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

**Team Id:-PNT2022TMID48260**

***Submitted By:-***

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# DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

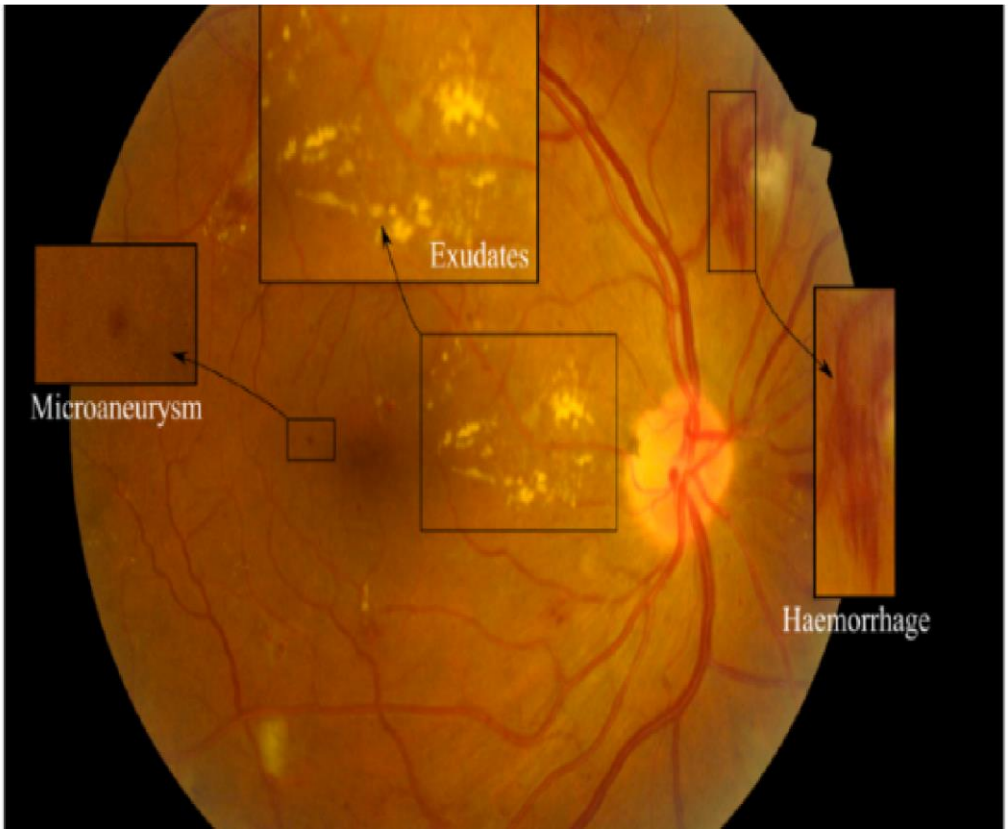
## Table of Contents:-

**DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY**

# 1. INTRODUCTION :-

During the early stages of diabetic retinopathy microaneurysms can be observed on the retina, and are caused by degeneration and loss of pericytes, leading to capillary wall dilatation When the wall of a capillary or microaneurysm is ruptured, intraretinal hemorrhages occur. Other lesions of non-proliferative diabetic retinopathy include soft and hard exudates, intraretinal microvascular abnormalities (IRMA), venous beading and venous loops or reduplication. According to Stitt et al., IRMAs appear as large caliber tortuous vessels in areas of ischemia and may represent attempted vascular remodeling. Finally, the distinction between non-proliferative and proliferative diabetic retinopathy is based on the presence of neovascularization, which essentially refers to the growth of new retina vessels due to ischemia to pre existing ones. Below figure presents some lesions on an indicative fundus image of a retina.

At any stage of diabetic retinopathy, diabetic macular edema (DME) can occur, an endpoint which constitutes the most common cause of blindness . The presence of edema is accompanied by abnormalities such as exudates within one disc diameter of the center of the fovea, exudates within the macula, retinal thickening within one disc diameter of the center of the fovea and microaneurysms or hemorrhages within one disc diameter of the center of the fovea. Regarding the clinical grading protocols of DR, although the gold standard is the Early Treatment Diabetic Retinopathy Study (ETDRS) grading scheme, its use in everyday clinical practice has not proven to be easy or practical. Several alternative scales have been proposed in an effort to improve the screening of patients and communication among caregivers. The development of such simplified diabetic retinopathy severity scales in several countries, had not led to a single international severity scale so far. To that end, the Global Diabetic Retinopathy Project Group has proposed the International Clinical Diabetic Retinopathy Disease Severity Scale, which classifies DR in 5 severity scales.




**DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION 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 retinopathy from retinal fundus image which is very important in ophthalmology. Most of the existing methods use handcrafted features and those are fed to the classifier for detection and classification purposes. Recently convolutional neural networks (CNN) are used for this classification problem but the architecture of CNN is manually designed. In this work, a genetic algorithm based technique is proposed to automatically determine the parameters of CNN and then the network is used for classification of diabetic retinopathy. The proposed CNN model consists of a series of convolution and pooling layers used for feature extraction. Finally, the support vector machine (SVM) is used for classification. Hyper-parameters like number of convolution and pooling layer, number of kernels 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 results show 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

### 2.1.Existing problem:

Diabetic Retinopathy is a retina disease caused by diabetes mellitus and it is the

leading cause of blindness globally. Early detection and treatment are necessary in order to delay or avoid vision deterioration and vision loss. To that end, many artificial-intelligence-powered methods have been proposed by the research community for the detection and classification of diabetic retinopathy in fundus retina images. This review article provides a thorough analysis of the use of deep learning methods at the various steps of the diabetic retinopathy detection pipeline based on fundus images. We discuss several aspects of that pipeline, ranging from the datasets that are widely used by the research community, the

preprocessing techniques employed and how these accelerate and improve the models' performance, to the development of such deep learning models for the diagnosis and grading of the disease as well as the localization of the disease's lesions. We also discuss certain models that have been applied in real clinical settings. Finally, we conclude with some important insights and provide future research directions.



## 2.2 REFERENCES:-

[1] International Diabetes Federation. International diabetes federation diabetes atlas, ninthed.https://www.diabetesatlas.org/en/.

[2] Alicia J. Jenkins, Mugdha V. Joglekar, Anandwardhan A. Hardikar, Anthony C. Keech,David N. O'Neal, S. Andrzej, Januszewski, Biomarkers in diabetic retinopathy, Rev. Diabet. Stud.: Reg. Dev. Stud. 12 (1–2) (2015) 159.

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Global prevalence and major risk factors of diabetic retinopathy, Diabetes Care 35 (3) (2012) 556–564.

[5] Jonathan E. Shaw, Richard A. Sicree, Paul Z. Zimmet, Global estimates of the prevalenceof diabetes for 2010 and 2030, Diabetes Res. Clin. Pract. 87 (1) (2010) 4–14.

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[9] H Bresnick George, Dana B. Mukamel, John C. Dickinson, David R. Cole, A screening approach to the surveillance of patients with diabetes for the presence of vision-threatening retinopathy, Ophthalmology 107 (1) (2000) 19–24.

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## 2.3.PROBLEM STATEMENT DEFINITION:-

Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which will cause lesions on the retina that affects vision. If it is not detected early, it can lead to blindness. Unfortunately, DR is not reversible, and the given treatment will only give us a sustained vision. DR early detection and treatment can significantly reduce the risk of vision loss.

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

**WHY ?** Diabetes-related retinopathy is brought on by high blood sugar levels harming the eye's iris. This could result in a permanent loss of vision.

**WHEN ?** Early on, the DR has no symptoms, but later on, the vessels may start to leak a tiny amount of blood into your retina..

**WHERE ?** Blurred vision, Distorted vision will occur.

**WHO?** It is common among the Diabetic patients.

**HOW ?** The manual early detection of this DR is a challenging task.

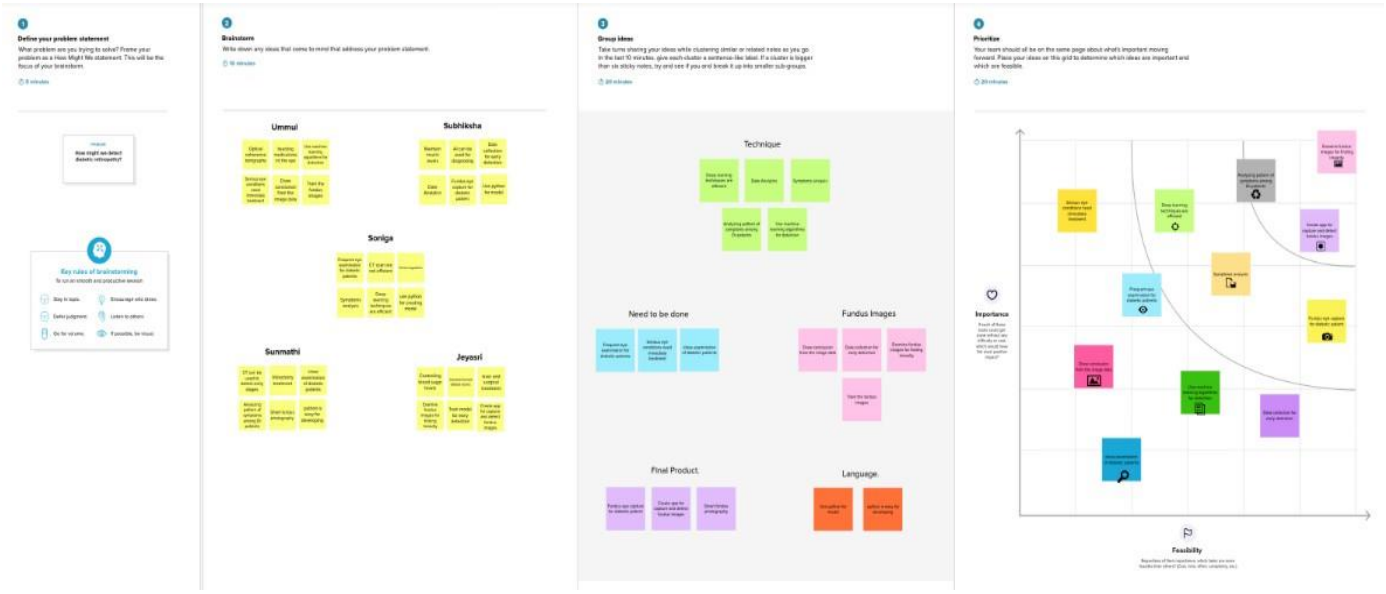
**OBJECTIVES** :

The primary goal is to identify diabetic retinopathy by processing retinal images. Transfer learning has arisen 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 medical image analysis and have been extremely effective, including such Inception V3, Resnet50, and Xception V3.

# 3.IDEATION PHASE & PROPOSED SOLUTION

## 3.1 Empathy Map Canvas :

# 3.2 IDEATION AND BRAINSTORMING:-



| S. No. | Parameter | Description |
| --- | --- | --- |

| | | |
|---|---|---|
| 1. | Problem Statement (Problem to be solved) | Diabetic retinopathy is a diabetes complication that affects eyes. It's caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina).At first, diabetic retinopathy 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 2 diabetes. The longer you have diabetes and the less controlled your blood sugar is, the more likely you are to develop this eye complication |
| 2. | Idea / Solution description | Diabetic retinopathy 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. So, deep learning techniques can be used for early detection of diabetic retinopathy that can prevent blindness and other eye related diseases. |
| 3. | Novelty / Uniqueness | This model provides the patient with the result whether they have a serious condition or normal condition. The prediction comes with different levels of illness and helps to diagnose properly. |

## 3.3 PROPOSED SOLUTION:-

| | | |
|---|---|---|
| 4. | Social Impact / Customer Satisfaction | Since, Diabetic retinopathy is irreversible, early detection helps many people from losing eyesight and other complicated diseases. The manual screening costs more than this model hence it is more feasible for customers that they can take this screening without any hardships |
| 5. | Business Model (Revenue Model) | We can collaborate with the health care centers and diabetic diagnosis centers for regular screening of diabetic retinopathy whenever the diabetic patient comes to check their diabetic level. We can create awareness among people because many people have no idea about the effects diabetic retinopathy, it may result in many screening tests in future. |
| 6. | Scalability of the Solution | The solution with the transfer learning model offers a better solution for diabetic retinopathy and can be detected at an early stage. The model developed using deep learning technology can be implemented on many clinical examinations. This system is versatile as it can learn from any datasets. It gives higher performance than manual examination. |

# 3.4 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:** PNT2022TMID48260

Define CS, fit into CC

**1. CUSTOMER SEGMENT(S)** CS

The early detection important for the diabetic patients as diabetic retinopathy is irreversible. The Diabetic retinopathy can be detected using the fundus image of the patient and can be stored in the database.This is more useful than the manual examination

**6. CUSTOMER CONSTRAINTS** CC

The diabetic retinopathy does not nave any specific symptoms so they fail to notice the illness. Many people do not know about diabetic retinopathy and its adverse reaction.

**5. AVAILABLE SOLUTIONS** AS

Laser treatment to treat the growth of new blood vessels at the back of the eye (retina) in cases of proliferative diabetic retinopathy, and to stabilize some cases of maculopathy. eye injections - to treat severe maculopathy that's threatening your sight.

Explore AS, differentiate

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

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

The problem is once the diabetic retinopathy is severe, it cannot be done.

And the severity of diabetic retinopathy results in serious eye illness and also results in losing vision. So, the early detection is important if the patient has diabetes.

**9. PROBLEM ROOT CAUSE** RC

Diabetic retinopathy is caused by changes in the blood vessels of the retina, the light-sensitive layer of tissue at the back of the inner eye. In some people with diabetic retinopathy, the blood vessels in the retina may swell and leak fluid. In others, abnormal new blood vessels grow on the surface of the retina.

**7. BEHAVIOUR** BE

This model helps in the early detection of diabetic retinopathy using the fundus images.
It consumes less time than the manual examination.
Also, accuracy is more compared to other techniques.

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

Identify strong TR & EM

**3. TRIGGERS** TR

The triggers in diabetic retinopathy patients are
- Spots or dark strings floating in your vision (floaters)
- Blurred vision.
- Fluctuating vision.
- Dark or empty areas in vision.
- Vision loss.

**4. EMOTIONS: BEFORE / AFTER** EM

Before: Adverse emotional responses include fear, anxiety, vulnerability, guilt, loss of confidence, anger, stress and self-perception issues.
After: Early detection and diagnosis gives sense of hope among patients

**10. YOUR SOLUTION** SL

Our solution involves the deep learning model with fundus images that detect the severity of the diabetic retinopathy among diabetic patients and the apt diagnosis done after the early detection.

**8.CHANNELS OF BEHAVIOUR** CH

The diabetic patients have to take the eye examination in the regular interval time. Then only retinopathy can be detected early and proper diagnosis can be done.

# 4.REQUIREMENT ANALYSIS:-

## 4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story/ Sub-Task) |
|---|---|---|
| FR-1 | User registration | Registration through phone number<br>Registration through Gmail |
| FR-2 | User Confirmation | Confirmation via OTP Confirmation<br>via Mail |
| FR-3 | Describe what the product does | Our project can detect early changes in your retina before you notice any difference in your eyesight |
| FR-4 | Focus on user requirements | Reduce the risk of visual loss and blindness in patients with retinal complications of diabetes. |
| FR-5 | Usually defined by user | Fundus image obtained from patients. |
| FR-6 | Define product features | To an advanced eye screening technology by which eye related diseases can be detected at an early stage. |

## Non-functional Requirements:

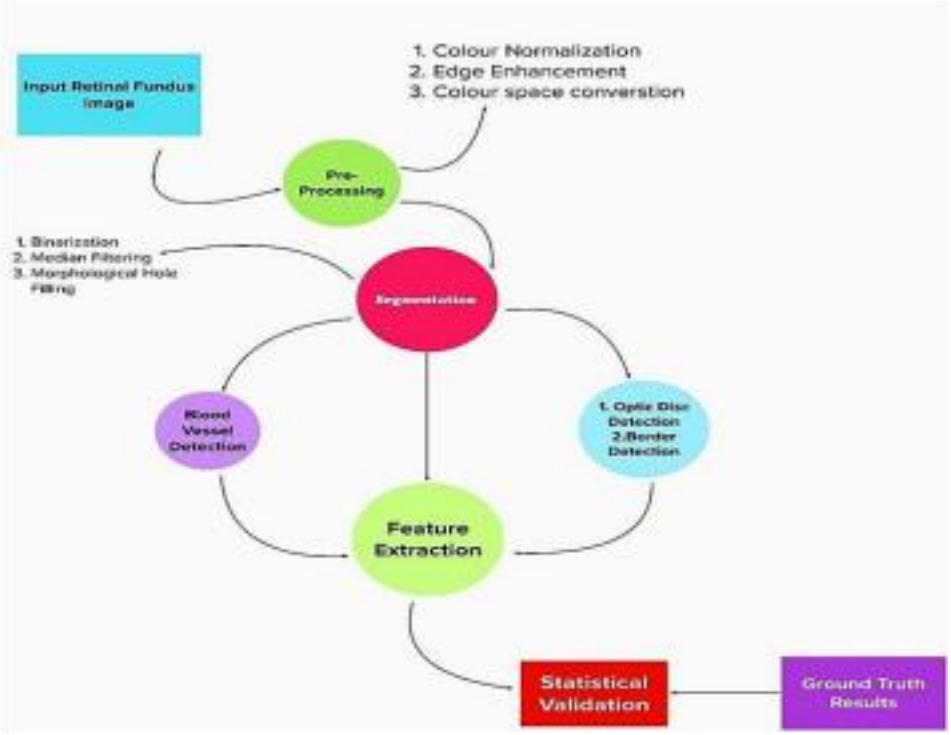
Following are the non-functional requirements of the proposed solution.

| FR NO: | Non-Functional Requirement | Description |
|---|---|---|
| NFR-1 | **Usability** | Assuring that a software can effectively perform one or more defined functions. |
| NFR-2 | **Security** | Permission granted only by the administrator of the system. |

| | | |
|---|---|---|
| NFR-3 | **Reliability** | If the system update fails or bugs in the code even though the system can roll back to its initial state. |
| NFR-5 | **Availability** | Health care affordability, quality and accessibility is made easier using the device. |
| NFR-6 | **Scalability** | The product must hold stable even when multiple users are using it at the same times. |

# 5.PROJECT DESIGN:5.1
# DATA FLOW DIAGRAM:-

**Data Flow Diagrams:**




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, what modifies the data, and where information is kept.

- Diabetic retinopathy disease is frequently detected and examined using retinal fundus.Preprocessing of raw retinal fundus images is performed using extraction of the green channel, histogram equalization, image enhancement,and resizing techniques.

- One of the main tasks in retinal image processing is the segmentation of the retinalvasculature from images of the eye fundus.
- By omitting the optic disc (OD) region of the retina, the computer-assisted automatic recognitionand segmentation of blood vessels.
- Mathematical Binary morphological techniques are used to identify the retinal blood vessels.
- The term "feature extraction from the fundus images for the diagnosis of DiabeticRetinopathy" refers to a sophisticated eye screening technique that allows for the early detection of eye-related disorders.

# 5.2 TECHNOLOGY ARCHITECTURE:-

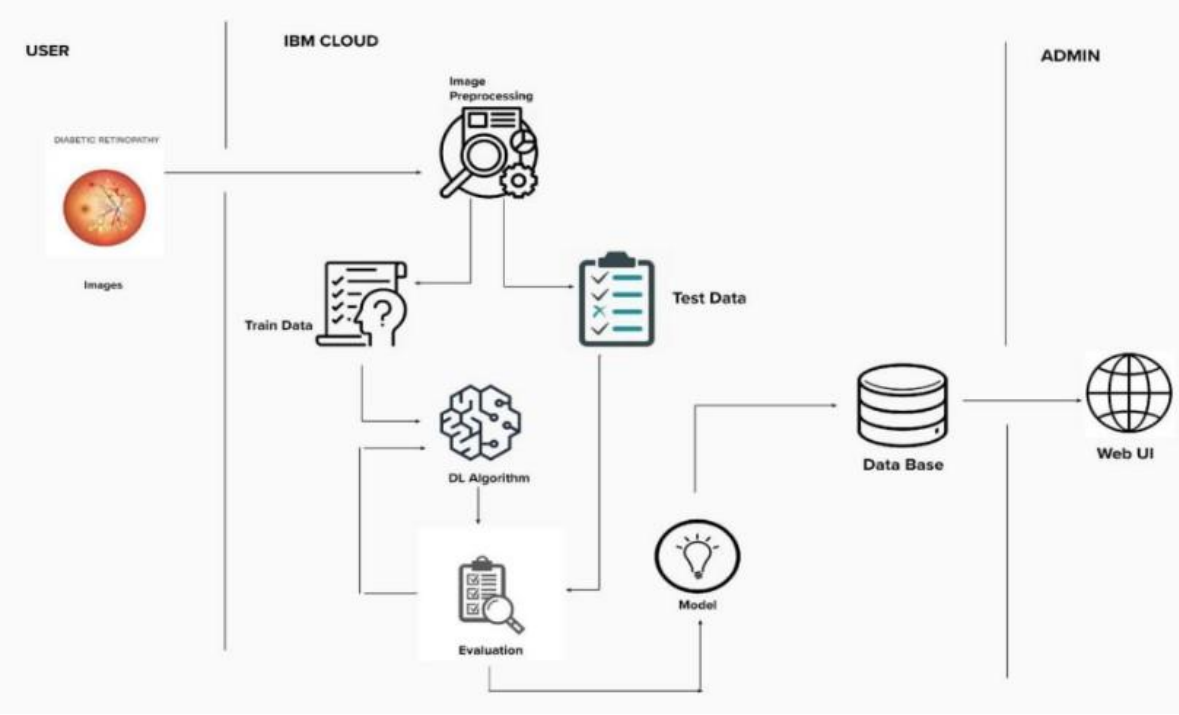



**Table-1:Components & Technologies:**

| | | | |
|---|---|---|---|
| 1 | User Interface | Web UI | HTML, CSS, JavaScript, Python |
| 2 | Application logic-1 | Image Preprocessing | Keras,Tensorflow,Numpy |
| 3 | Application logic-2 | CNN Model | Keras,Tensorflow,Numpy |
| 4 | Application logic-3 | Web UI Application | Flask |

| | | | |
|---|---|---|---|
| 5 | Database | DR Images (Jpeg,Png,Jpg,Etc.,) | Uploads Folder |
| 6 | File storage | File Storage Requirements (Only If Necessary) | IBM Block Storage, GoogleDrive |
| 7 | External Api | Keras | Image Processing API |
| 8 | Deep Learning Model | Inception V3 Architecture | Pre-Trained Convolution NeuralNetwork Model |
| 9 | Infrastructure (Server) | Application Deployment on Webserver | Flask-A PythonWSGI HTTP Server. |

**Table-2:Application characteristics:**

**Product Backlog, Sprint Schedule, and Estimation (4 Marks)**

Use the below template to create product backlog and sprint schedule

| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| Sprint-3 | Registration | USN-1 | As a user, I can register through website either by email id or phone number with password. | 5 | High | Ummul Raihan.M Sunmathi. M. M |
| Sprint-3 | Login | USN-2 | As a user, I can login to the site by the given Login credentials. | 5 | High | Subhiksha. M Sunmathi. M. M |
| Sprint-3 | Upload image | USN-3 | As a user,I can upload my data in the form of pdf, doc etc. | 2 | Medium | Subhiksha. M Jeya Sri . A |
| Sprint-3 | Admin login | USN-4 | As an admin I can login to the site and analyze the user data. | 2 | High | Soniga. M. P Jeya Sri . A |

| S.No | Characteristics | Description | Technology |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. | Open-Source Frameworks | Flask | Flask Frameworks |
| 2. | Security Implementations | CSRF Protection,Secure Flag For Cookies | Flask-WTF, Session Cookie Secure |
| 3. | Scalable Architecture | Micro-Services | Micro Web Application FrameworkBy Flask |

## 5.3 PROJECT PLANNING:

| | | | | | | |
|---|---|---|---|---|---|---|
| Sprint-1 | Data collection | USN-5 | As an admin, I can collect the dataset related to the DR from source. | 5 | Low | Soniga. M. P Ummul Raihan.M |
| Sprint-1 | Create model | USN-6 | As an admin,I can create the model for prediction. | 5 | High | Subhiksha. M Jeya Sri. A |
| Sprint-2 | Test the model | USN-7 | As an admin, I can test the model for prediction. | 6 | High | Jeya Sri . A Sunmathi. M. M |

| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| Sprint-2 | Diagnosis | USN-8 | As a user I can get the diagnosis result on the application and follow up with treatments. | 6 | High | Soniga. M. P Sunmathi. M. M |
| Sprint-4 | Train the model | USN-9 | As an admin, I can train the model for prediction. | 10 | High | Subhiksha. M jeyasri.A |

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

| Sprint | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date (Actual) |
|---|---|---|---|---|---|---|
| Sprint-1 | 10 | 6 Days | 24 Oct 2022 | 29 Oct 2022 | 10 | 29 Oct 2022 |
| Sprint-2 | 12 | 6 Days | 31 Oct 2022 | 05 Nov 2022 | 12 | 05 Nov 2022 |
| Sprint-3 | 14 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 14 | 12 Nov 2022 |
| Sprint-4 | 10 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 10 | 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) per iteration unit (story points per day)

AV1=Sprint duration/velocity=10/6=1.66

AV2=Sprint duration/velocity=12/6=2

AV3=Sprint duration/velocity=14/6=2.3

AV4=Sprint duration/velocity=10/6=1.66

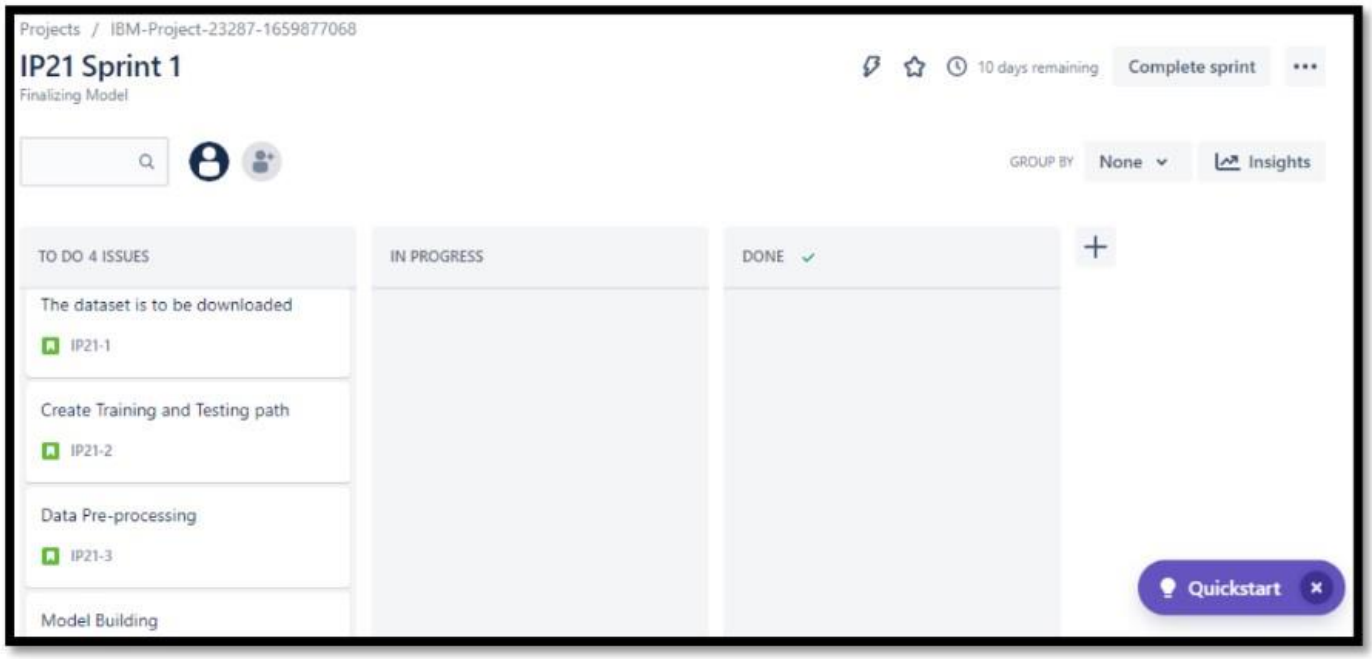
Burndown chart:

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

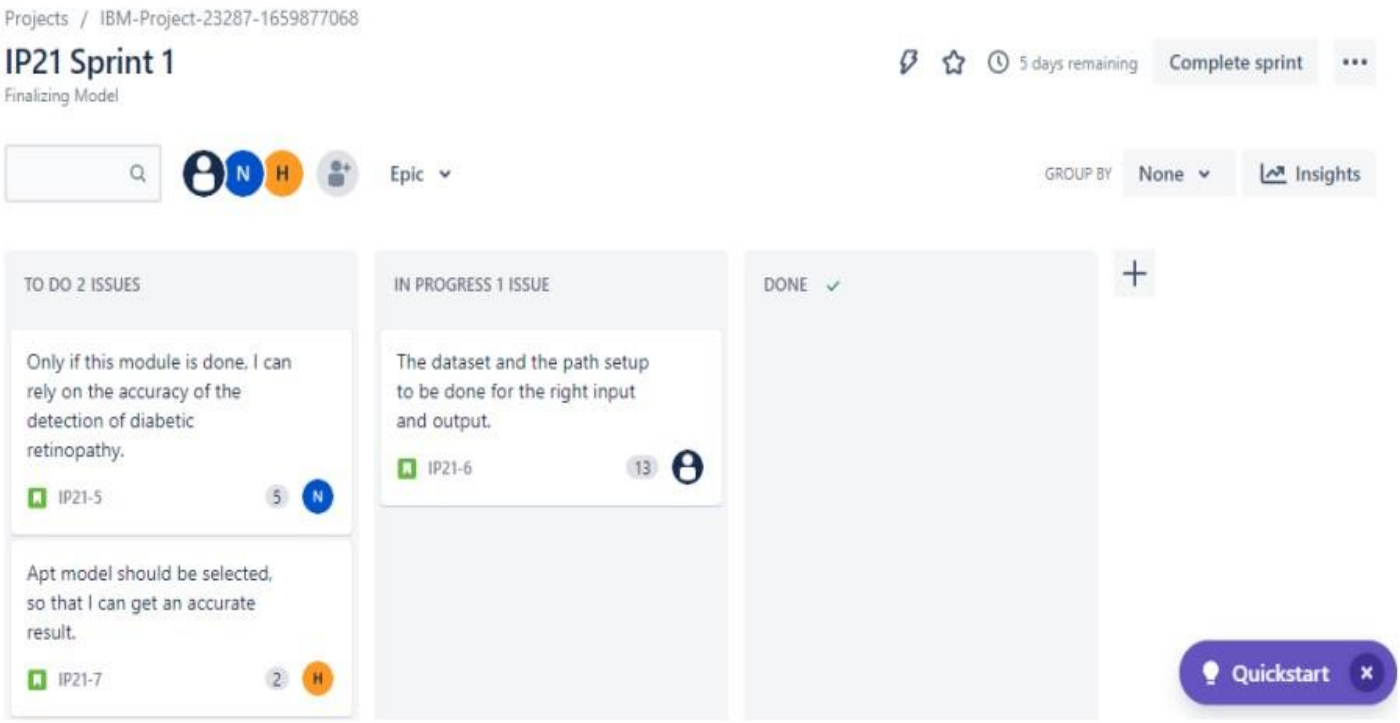



## JIRA SCREENSHOTS:

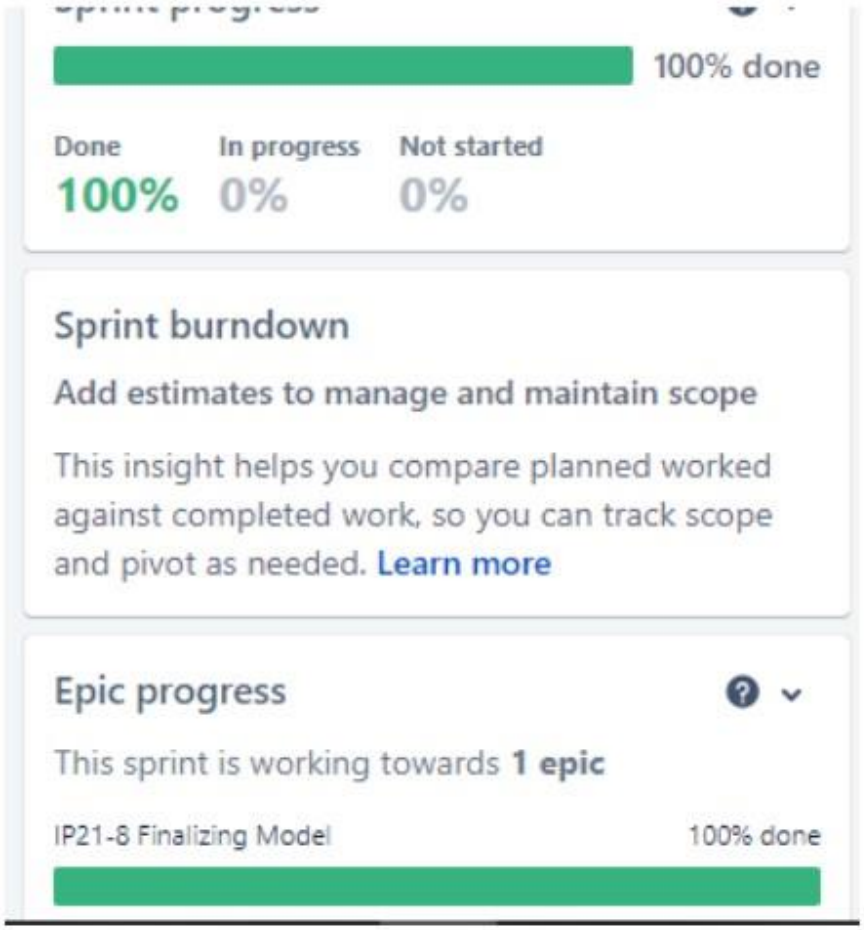
Sprint 1 Creation:



# Board Details:




# Insights:



## 7.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.

## 8.TESTING:8.1

## TEST CASES:-

## 8.2 USER ACCEPTANCE TESTING:-

### 1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

### 2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

| Resolution | Severity 1 | Severity 2 | Severity 3 | Severity 4 | Subtotal |
|---|---|---|---|---|---|
| By Design | 4 | 1 | 0 | 0 | 5 |
| Duplicate | 4 | 1 | 3 | 2 | 10 |
| External | 1 | 3 | 2 | 0 | 6 |
| Fixed | 2 | 4 | 4 | 2 | 12 |
| Not Reproduced | 0 | 0 | 0 | 1 | 1 |
| Skipped | 0 | 0 | 0 | 0 | 0 |
| Won't Fix | 0 | 0 | 0 | 0 | 0 |
| Totals | 11 | 9 | 9 | 5 | 34 |

## 3. Test Case Analysis

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

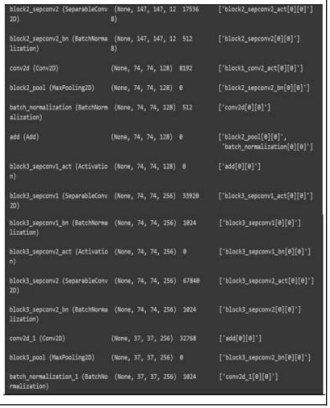
| Section | Total Cases | Not Tested | Fail | Pass |
|---|---|---|---|---|
| Print Engine | 6 | 0 | 0 | 6 |
| Client Application | 12 | 1 | 0 | 11 |
| Security | 2 | 0 | 0 | 2 |
| Outsource Shipping | 3 | 0 | 0 | 3 |
| Exception Reporting | 6 | 0 | 0 | 6 |
| Final Report Output | 4 | 0 | 0 | 4 |
| Version Control | 2 | 0 | 0 | 2 |

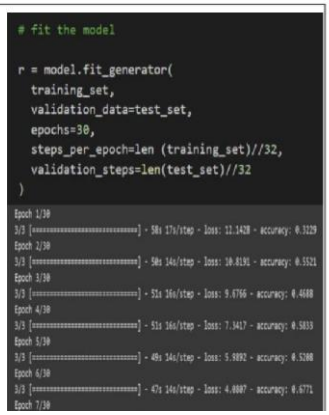
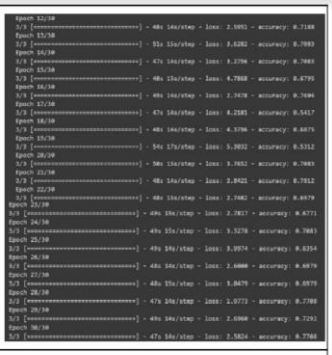
# 9.RESULTS:-

## 9.1 Performance Metrics:Model

## Performance Testing:

Model performance testing:

| s.no | Parameter | values | screenshot |
|---|---|---|---|
| 1. | Model summary | |  |
| | | - |  |

| | | | |
|---|---|---|---|
| 2. | Accuracy | Training Accuracy -<br><br>Validation Accuracy - |  |
| | | |  |
| 3. | Confidence Score(Only Yolo Projects) | Class Detected -<br><br>Confidence Score - | NA |

# 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.

First, 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.

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

Third, 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.

Fourth, 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.

**DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY**

# 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.py:**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 flask import Flask, request,flash,
render_template, redirect,url_for from cloudant.client import Cloudant
from twilio.rest import Client model = load_model(r"Updated-xception-
diabetic-retinopathy.h5")
app = Flask(__name__) app.secret_key="abc"
app.config['UPLOAD_FOLDER'] =
"User_Images"
# Authenticate using an IAM API key

client = Cloudant.iam('08bcbaf0-260b-48e0-abdb-08db348afcf2-bluemix',
'yhZfUubpS3vS1vEKZSS37teD6IAUi8oLynOCQLIwnQsa', 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'))
# default home 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(query)
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
already a member , please login using your details ")  else: return render_template('register.html')


@ app.route('/login',
methods=['GET','POST']) 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(query)
print(docs) print(len(docs.all())) if
(len(docs.all()) == 0):
return render_template('login.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",methods=["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 to array 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 Diabetic Retinopathy ', ' Mild NPDR ', ' Moderate
NPDR ', ' Severe NPDR ', ' Proliferative DR '] result =
str(index[prediction[0]]) print(result) account_sid =
'AC8e0f2f5263d71c8f630a6486779cf08b' auth_token =
'30b489873afb3c47340070eabd6bfb15' client =
Client(account_sid, auth_token)

''' Change the value of 'from' with the number received
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()
```

DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

**cloud.ipynb:-**

```
from cloudant.client import Cloudant
client=Cloudant.iam('655489f8-18d0-4a44-a701-
5de60570a973bluemix','Jc4eF6CXk72w0wGCsM_KUuXKVjsCcT4a54UKBXckK5Bv',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/TYkiZhlZB6+fzT"
crossorigin="anonymous"
/>
<!-- JavaScript Bundle with 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;
}
</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 collapse w-100 order-3 dual-collapse2" id="navbarNav">
<ul class="navbar-nav mr-auto text-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 diabetes complication that affects eyes. It's caused by damage to the blood vessels of the light-sensitive tissue at the back of the eye (retina).
 At first, diabetic retinopathy 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 2 diabetes. The longer you have diabetes and the less  controlled 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/TYkiZhlZB6+fzT"
crossorigin="anonymous"
/> <!-- JavaScript Bundle with 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;
}
</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 collapse w-100 order-3 dual-collapse2" id="navbarNav">
<ul class="navbar-nav mr-auto text-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.lordicon.com/elkhjhci.json"
 trigger="hover"
 style="width:200px;height: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="Enter
Password">
</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/TYkiZhlZB6+fzT"
crossorigin="anonymous"
/>
<!-- JavaScript Bundle with 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;
}
</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 collapse w-100 order-3 dual-collapse2" id="navbarNav">
<ul class="navbar-nav mr-auto text-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:**

```
<!DOC
TYPE 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/TYkiZhlZB6+fzT"
crossorigin="anonymous" />
<!-- JavaScript Bundle with 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 collapse w-100 order-3 dual-collapse2" id="navbarNav">
<ul class="navbar-nav mr-auto text-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>
```

## DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION

## OF DIABETIC RETINOPATHY

# DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION

# OF DIABETIC RETINOPATHY

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

**register.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/TYkiZhlZB6+fzT"
crossorigin="anonymous"
/>
<!-- JavaScript Bundle with 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;
}
</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 collapse w-100 order-3 dual-collapse2" id="navbarNav">
<ul class="navbar-nav mr-auto text-center" id="navbarRight">
<li class="nav-item active">
<a class="nav-link" href="index" style="color: aliceblue;">Home </a>
</li>
```

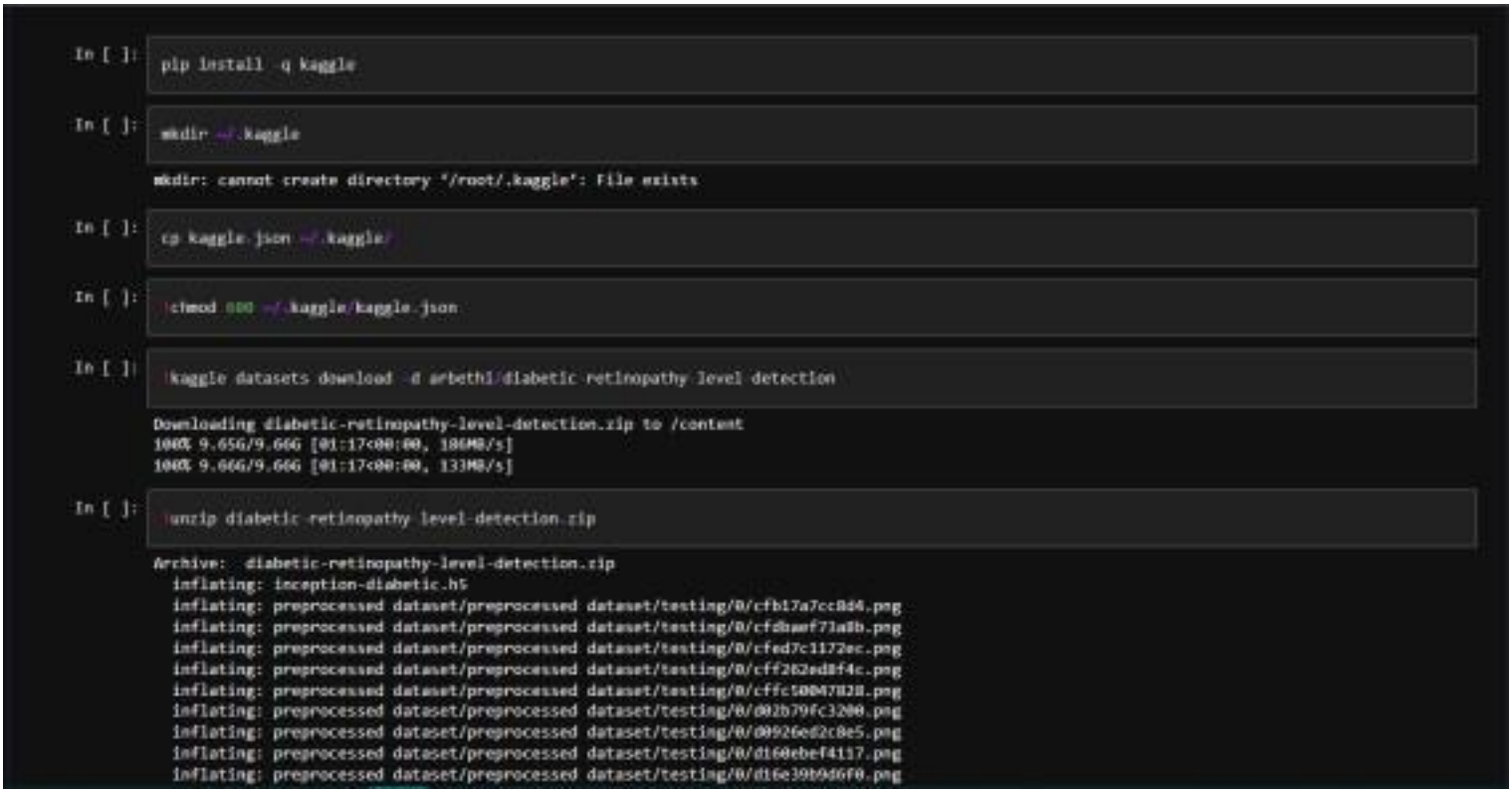


```
<li class="nav-item">
```

```
<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-flex justify-content-center"><script src="https://cdn.lordicon.com/xdjxvujz.js"></script>
<lord-icon
 src="https://cdn.lordicon.com/elkhjhci.json"
 trigger="hover"
 style="width:200px;height: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="Enter
Password">
</div>
<div class="mb-3">
<button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;">Register</button>
</div>
                                <div class="mb-3 d-flex justify-content-center">
                                <a href="login" class="nav-link"> Already Registered: Login Here</a>
</div>
{{pred}}
</div>
</form>
 </body>
</html> -->
```

## DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

# Python Notebook screenshots:-



```
In [ ]: pip install -q kaggle

In [ ]: mkdir ~/.kaggle

mkdir: cannot create directory '/root/.kaggle': File exists

In [ ]: cp kaggle.json ~/.kaggle/

In [ ]: !chmod 600 ~/.kaggle/kaggle.json

In [ ]: !kaggle datasets download -d arbethi/diabetic-retinopathy-level-detection

Downloading diabetic-retinopathy-level-detection.zip to /content
100% 9.65G/9.66G [01:17<00:00, 186MB/s]
100% 9.66G/9.66G [01:17<00:00, 133MB/s]

In [ ]: !unzip diabetic-retinopathy-level-detection.zip

Archive:  diabetic-retinopathy-level-detection.zip
  inflating: inception-diabetic.h5
  inflating: preprocessed dataset/preprocessed dataset/testing/0/cfb17a7cc8d4.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/cfd8aaef71a8b.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/cfed7c1172ec.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/cff282ed8f4c.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/cffc500478J8.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/d02b79fc3200.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/d0926ed2c8e5.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/d160ebef4117.png
  inflating: preprocessed dataset/preprocessed dataset/testing/0/d16e39b9d6f0.png
```

```
inflating: preprocessed dataset/preprocessed dataset/training/4/ed246ae1e088.png
inflating: preprocessed dataset/preprocessed dataset/training/4/ed3a0fc5b546.png
inflating: preprocessed dataset/preprocessed dataset/training/4/ee1ec90b080f.png
inflating: preprocessed dataset/preprocessed dataset/training/4/ef26625121b3.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f0098e9d4aee.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f025f33b2c9b.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f03d3c4ce7fb.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f0f89314e868.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f1dc26c4bfa3.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f2d2a0c92034.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f549294e12e1.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f58d37d48e42.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f5e6226bd2e0.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f69835dc7c50.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f6f3ea0d2693.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f72adcac5638.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f850cb51fdba.png
inflating: preprocessed dataset/preprocessed dataset/training/4/f8cf7ed8ef00.png
inflating: preprocessed dataset/preprocessed dataset/training/4/fa59221cf464.png
inflating: preprocessed dataset/preprocessed dataset/training/4/fb696a8e055a.png
inflating: preprocessed dataset/preprocessed dataset/training/4/fce93caa4758.png
inflating: preprocessed dataset/preprocessed dataset/training/4/fdd534271f3d.png
inflating: preprocessed dataset/preprocessed dataset/training/4/ff8a0b45c789.png
```

In [ ]:
```
from tensorflow.keras.layers import Dense,Flatten,Input
```

In [ ]:
```
from tensorflow.keras.models import Model
```

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

In [ ]:
```
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img
```

In [ ]:
```
from glob import glob
```

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

In [ ]:
```
import matplotlib.pyplot as plt
```

In [ ]:
```
imageSize=[299,299]
```

In [ ]:
```
trainPath=r"/content/preprocessed dataset/preprocessed dataset/training"
```

In [ ]:
```
testPath=r"/content/preprocessed dataset/preprocessed dataset/testing"
```

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

In [ ]:
```
test_datagen=ImageDataGenerator(rescale=1./255)
```

In [ ]:
```
training_set=train_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/training',target_size=(299,299),batch_size=
```

```
Found 3662 images belonging to 5 classes.
```

In [ ]:
```
test_set=test_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/testing',target_size=(299,299),batch_size=32,cla
```