

PROJECT REPORT

DeepLearning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

1.INTRODUCTION :

1.1 Project Overview :

The problem statement of this project is a disease that is caused by Diabetics. 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. Diabetic Retinopathy 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. The evaluation of diabetic retinopathy is associated with peoples having diabetics. The evaluation will be based on the fundus or retinal images of the diabetic patients eye. In project will be best for the diabetic patients for the earlier detection of diabetic retinopathy. 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 main purpose of this project is to help the diabetic patients for the early detection of diabetic retinopathy. The root cause of the diabetic retinopathy is because of high sugar level in the blood due to the diabetics. One of the main cause of diabetic retinopathy is people fail to notice the illness and that cause the adverse reaction. This project will help them to detect diabetic retinopathy at the earlier stage and it can be treated easily.

As diabetic retinopathy progresses it blocks the tiny blood vessels that nourish the retina and cut off its blood supply. This project will help to detect

diabetic retinopathy at the early stage by analysing Fundus images. This will provide the result with better accuracy and saves the time and cost of the patient. This will help the patient to recover from the diabetic retinopathy in a better way.

Diabetic patients are not aware of the complications of the diabetes so they fail to notice these serious diseases. Diabetic retinopathy doesn't have any specific symptoms other than blurred vision so many people will fail to notice the illness and the adverse reaction of the diabetic retinopathy. This project will help them for the early detection of Diabetic Retinopathy.

2. LITERATURE SURVEY

2.1 Existing problem:

Diabetic Retinopathy (DR) is a complication of diabetes that influences the eyes. Damage to blood vessels in the tissue of the retina, the back layer of the eye, typically causes blurriness, floaters, dark or empty areas in the vision, and difficulty recognizing color blindness are some of the early symptoms. It necessitates constant monitoring, and in the event of complications, it may shorten life expectancy. If it is not diagnosed and treated, it can blind you. The medication cannot be cured at this time. Diabetic retinopathy can be stopped or slowed down with treatment. Diabetes management may be used carefully to treat mild cases.

The diabetes on a fundus image is identified by the proposed method, which makes use of an Alex net Convolutional Neural Network (CNN). The dataset that was used came from the MESSIDOR database. It has 1200 images of the fundus and was divided into 580 images of normal and exudates for the project. The dataset has been divided into two parts for the CNN process: the training dataset and the testing dataset. On 50% of the training dataset, this method achieves accuracy greater than 90%, and the remaining 50% of the dataset is used for testing. The tests give an accuracy of about 85%. Even though the images received a good accuracy, only 580 were utilized for both training and testing, despite the fact that the dataset was insufficient to train the neural network. Additionally, it had trouble identifying the image's smaller exudates.

In order to categorize diabetic retinopathy in the fundus imagery into five categories—No DR, Mild DR, Moderate DR, Severe DR, and Proliferative DR—the proposed system developed a CNN architecture. They have examined previous efforts to detect DR using CNN, and they have altered the networks in CNN to improve its accuracy and efficiency. They have achieved a 75% accuracy on the dataset of 80000 images. Classification of DR into mild, moderate, and severe forms presents some challenges.

To analyze the fundus image and predict the stage, they used a Deep Convolutional Neural Network (DCNN), which includes No DR, Moderate DR (a combination of mild and moderate Non-Proliferative DR), and Severe DR (severe NPDR and Proliferative DR). Over a period of time, they have almost used 3468 fundus images from various Kaggle clinics. They have achieved an accuracy rate of over 80%. When a model is trained with a small dataset and fails when applied to a new dataset, an overfitting problem occurs.

The architecture used in the proposed model is DenseNet121. This is unique in that each feature map output from a convolution layer is concatenated with the subsequent layers of the same block. Based on the severity of the disease, it divides DR into five categories: PDR, No DR, Slight DR, Medium DR, and Severe DR. Cross-testing two datasets—Messidor and APTOS—has been used in the proposed method to enable the model to acquire complex features. They used a cross-testing strategy with unbalanced data, so their accuracy is lower than that of current methods. Additionally, the model had trouble categorizing the Slight NDPR class.

2.2 References:

1] Johari, Mohamad; Hassan, Hiron; Yassin, Ahmad; Tahir, Noorita; Azlee Zabidi; Rizman, Zairi; Baharom, R.; and Wahab, N. Utilizing a deep learning neural network for the early detection of diabetic retinopathy. United Arab Emirates International Journal of Engineering and Technology 7.198 10.14419/ijet.v7i4.11.20804

[2] Convolutional Neural Networks for Diabetic Retinopathy, by Harry Pratta, Frans Coenenb, Deborah M Broadbent, Simon P Hardinga, and Yalin Zhenga (2016).

<https://doi.org/10.1016/j.procs.2016.07.014>.

[3] M. Shaban, Z. Ogur, A. Mahmoud, A. Switala, A. Shalaby, and H. Abu Khalifeh, among others(2020) A convolutional neural network for diabetic retinopathy screening and staging.

[4] PLoS ONE 15:e0233514.<https://doi.org/10.1371/journal.pone.0233514>. [4] Ayala, A.; Ortiz Figueroa;B. Fernandes;Deep Learning Improved Diabetic Retinopathy Detection, Cruz, F.Appl.Sci;.2021, 11, 11970.Doi :<https://doi.org/10.3390/app112411970>.

2.3 Problem Statement Definition:

PROBLEM STATEMENT 1: The Physician will examine the medical condition of the eye and try to predict diabetic retinopathy which is manually sternous.

PROBLEM STATEMENT 2: The medical practitioner will determine the diabetic retinopathy and to inspect the medical condition of the patient to measure the extent of diabetic retinopathy.

PROBLEM STATEMENT 3: The Oculist have to suggest the treatment and to measure the level of diabetic retinopathy and provide treatment based on the extent of diabetic retinopathy.

PROBLEM STATEMENT 4: In a serious level the opthamalogist will find the reason for the blurry vision and provide treatment for diabetic retinopathy.

3: IDEATION AND PROPOSED SOLUTION:

3.1 Empathy map canvas:

The empathy map demonstrates the different emotions of the diabetic patients like what do they think and feel,what do they say and do,what do they hear, what to they see ,Pain and gain of the diabetic patients.

What do they think and feel?

Feel depressed,Wishing to have a normal eyesight, irritated eyes and want to maintain a healthy food diet.

What do they hear?

They will hear so many comments like have a regular check up,manage the blood level correctly,maintain proper food diet and take sufficient vitamins.

What do they see?

Encouragements from families and friends,research on more successful solutions and consulting specialized doctors and physicians.

What do they see and do ?

Starts planning their life in a right manner,makes more research on the diseases.They will understand the problem and try to persuade .

3.2 IDEATION AND BRAINSTORMING

The brainstorming is a process of sourcing ideas from the team members and collaborating all the ideas and making a perfect idea. Different ideas were given by different members like the different symptoms of the disease, different algorithms that can be used to train the model,the process of getting the fundus images, the preventing measures of the disease and also the best treatment for the accurate level of the disease. These all ideas were combined and the ideation had done in a best way.

3.3 PROPOSED SOLUTION:

Diabetic Retinopathy is one of the emerging diseases which is the reason for blindness. DR mutilates the retinal blood vessels of a patient having diabetes. Diabetic Retinopathy (DR) is an ophthalmic disease that damages retinal blood vessels. DR causes imperfect vision and may cause

blindness if it is not diagnosed in early stages. Early detection of Diabetic Retinopathy includes the identification of microaneurysms and hemorrhages. Because the signs and symptoms of diabetic retinopathy are typically not present during the first stage of the disease, it can often go undiagnosed until damage to vision has occurred. Existing methods are lacking in the earlier detection. Because preprocessing techniques used in those methods are not effective to analyze such smaller features (nearly 10 microns to 100 microns).

We opt to use multi-layer neural networks as deep NN.

Due to the fact that data is Image, the best type of neural network satisfying our goal is Convolutional Neural Networks.

As we have to do for most of the data, normalization plays an important role in our process. Before doing any tasks, preprocessing images (our dataset) is highly recommended. Consequently better accuracy will be achieved by preprocessed data. After preprocessing and normalizing, the prepared dataset could be used as input to our deep convolutional neural network. Then deep NN will be run and fit to our data and the result will be produced by that.

This report will cover step by step how this deep convolutional network be implemented.

One of the major decisions had to be made was choosing the suitable programming language satisfying our goal for extracting knowledge from our data. After some searching the suitable decision has been made by selecting Python as the project programming language. Due to the fact that, a lot of tools and frameworks are available for Python to create powerful Artificial Neural Networks. Also IBM Watson helps to predict future outcomes, automate complex processes and optimize user's time. And also the result accuracy will be increased from 70% which is the accuracy of the test results that the previous developed codes produced.

It Reduction of Diabetic Retinopathy risk. It Provides Digital Assistance. It is Very helpful in making decisions faster. It Can be used 24x7.

This can be implemented as an essential diagnosis method in every hospital. Accurate detection and analysis can encourage the increase in financial benefit. It can collaborate with the government for health awareness camps

Accurate predictions and extensive use. Based on the times of the correct diagnosis. Availability. This project will help us to detect DR more precisely than the existing methodologies.

Also it can produce a result which specifies the stages of Diabetic Retinopathy.

3.4 PROBLEM SOLUTION FIT:

The evaluation of the Diabetic Retinopathy is associated with peoples having Diabetes. The evaluation will be based on the fundus or retinal images of the diabetic patients eye. This project will be best for the diabetic patients for the earlier detection of diabetic retinopathy. Diabetic retinopathy is one of the serious consequence of diabetics, earlier detection of diabetic retinopathy will help the patients to recover from the disease effectively. Advising Diabetic patients not to intake high level of sugars and to maintain a normal blood pressure and cholesterol in order to prevent them from diabetic retinopathy. Diabetics patients are not aware of the complications of the diabetics so they fail to notice these serious diseases. Diabetic retinopathy doesn't have any specific symptoms other than blurred vision so many people will fail to notice the illness and the adverse reaction of the diabetic retinopathy. The treatments are depend on the severity of the disease. The treatments are mostly focus on slowing or stopping the progression of diabetic retinopathy. There are so many solutions available for diabetic retinopathy some of them are Injecting medications on to the eye, Photocoagulation, Panretinal photocoagulation, Vitrectomy. Laser treatment is best at treating the growth of new blood vessels. The root cause of the diabetic retinopathy is because of high sugar level in the blood due to the diabetics. One of the main cause of diabetic

retinopathy is people fail to notice the illness and that cause the adverse reaction .This project will help them to detect diabetic retinopathy at the earlier stage and it can be treated easily.As diabetic retinopathy progresses it blocks the tiny blood vessels that nourish the retina and cut off its blood supply.This project will help to detect diabetic retinopathy at the early stage by analysing Fundus images.This will provide the result with better accuracy and saves the time and cost of the patient. This will help the patient to recover from the diabetic retinopathy in a better way.Our solution is that the diabetic patients should be aware of the consequence of the diabetes and should monitor their health frequently.And the DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY will help To diagnose the diabetic retinopathy at the early Stage and it can be easily treated.This model will give them the better accuracy and saves the patient's time and cost.

4: REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FRNo .	Functional Requirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	Identify and selecting dataset	The appropriate dataset to enhance the model's performance is the necessary to select.
FR-2	Training	It is required to import the libraries needed for the training of the model.
FR-3	Diagnosis	The training should ensure proper diagnosis and make sure to identify the true and false of the medical condition [DiabeticRetinopathy].
FR-4	Analysis	Based on the training the model should analyse the medical condition [DR] in order to predict/detect the disease accurately.

FR-5	Testing	The trained model is tested with different data to ensure that trained well to predict/detect the medical condition[DR].
FR-6	Reporting	The result of the experiment gives the medical report of the disease[DR] so that the patient can understand the level of the disease.
FR-7	Treatment	The testing of the model gives us the level of the medical conditions so that we can go for the required treatment.

4.2 Non-functional Requirements:

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

FRNo.	Non-Functional Requirement	Description
NFR-1	Usability	User with basic understanding of the medical condition and computer knowledge can operate the system. User friendly interface that can be accessed with ease by users.
NFR-2	Reliability	There is a chance of hardware failure or false positives when the testing data is more of different than the training dataset. Permission granted only by the administrator of the system
NFR-3	Performance	If the system update fails or bugs in the code even though the system can roll back to its initial state. The performance of the model is meant to give speedy results for the patients.
NFR-4	Availability	The treatments should be available at low costs so that everyone with DR can find it beneficial.

NFR-5	Scalability	By processing more datasets for the reference of DR detection.
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5. PROJECT DESIGN

5.1: SolutionArchitecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goal is to:

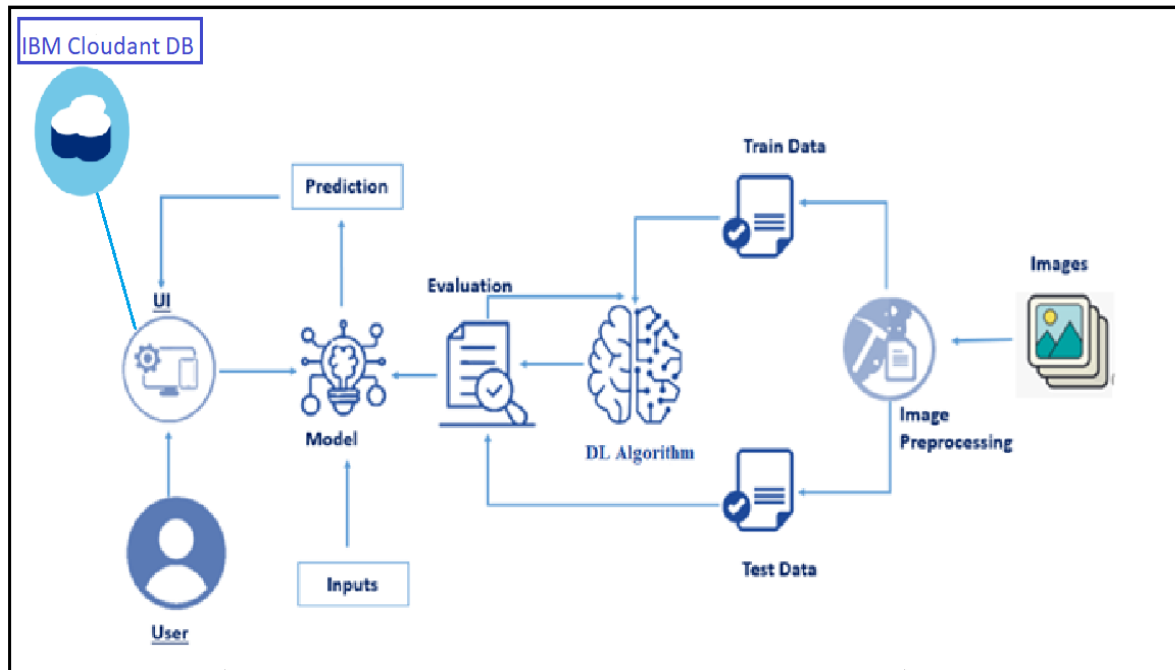
- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Technologies needed for Minimum Viable Product deployment

Software technologies required for the systematic development and deployment of the project are:

- HTML/CSS/JavaScript/bootstrap-FrontEndDevelopment
- Python
- TensorFlow
- ImageprocessingBasics
- Flask-BackendDevelopment
- Git&GitHub-projectManagement
- IBMCloud-Hosting

IBM Watson-Training the Deep Learning Model



6. PROJECT PLANNING & SCHEDULING:

6.1: Sprint Planning & Estimation

To build a DL model we have to split training and testing data into two separate folders. But In the project dataset folder training and testing folders are presented. So, in this case we just have to assign a variable and pass the folder path to it.

Four different transfer learning models are used in our project and the best model (Xception) is selected.

The image input size of xception model is 299, 299.

Data Pre-Processing

import the necessary libraries

```
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('/content/preprocessed dataset/preprocessed dataset/training',
                                                target_size = (299, 299),
                                                batch_size = 32,
                                                class_mode = 'categorical')

test_set = test_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/testing',
                                           target_size = (299, 299),
                                           batch_size = 32,
                                           class_mode = 'categorical')

Found 3662 images belonging to 5 classes.
Found 734 images belonging to 5 classes.
```

Model Building

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

Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/xception_kernels_notop.h5
83689472/83683744 [=====] - 1s 0us/step
83697664/83683744 [=====] - 1s 0us/step

# don't train existing weights
for layer in xception.layers:
    layer.trainable = False

# our layers - you can add more if you want
x = Flatten()(xception.output)
```

```
# view the structure of the model
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 ation)	(None, 149, 149, 32)	128	['block1_conv1[0][0]']
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 ation)	(None, 147, 147, 64)	256	['block1_conv2[0][0]']
block1_conv2_act (Activation)	(None, 147, 147, 64)	0	['block1_conv2_bn[0][0]']
block2_sepconv1 (SeparableConv 2D)	(None, 147, 147, 12)	8768	['block1_conv2_act[0][0]']

batch_normalization_3 (Batch Normalization)	(None, 10, 10, 1024)	4096	['conv2d_3[0][0]']
add_11 (Add)	(None, 10, 10, 1024)	0	['block13_pool[0][0]', 'batch_normalization_3[0][0]']
block14_sepconv1 (SeparableConv2D)	(None, 10, 10, 1536)	1582080	['add_11[0][0]']
block14_sepconv1_bn (Batch Normalization)	(None, 10, 10, 1536)	6144	['block14_sepconv1[0][0]']
block14_sepconv1_act (Activation)	(None, 10, 10, 1536)	0	['block14_sepconv1_bn[0][0]']
block14_sepconv2 (SeparableConv2D)	(None, 10, 10, 2048)	3159552	['block14_sepconv1_act[0][0]']
block14_sepconv2_bn (Batch Normalization)	(None, 10, 10, 2048)	8192	['block14_sepconv2[0][0]']
block14_sepconv2_act (Activation)	(None, 10, 10, 2048)	0	['block14_sepconv2_bn[0][0]']
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

```

# fit the model
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
)

```



```
Epoch 1/30
3/3 [=====] - 32s 6s/step - loss: 9.6582 - accuracy: 0.4479
Epoch 2/30
3/3 [=====] - 15s 5s/step - loss: 9.3711 - accuracy: 0.5417
Epoch 3/30
3/3 [=====] - 15s 5s/step - loss: 7.4651 - accuracy: 0.5208
Epoch 4/30
3/3 [=====] - 16s 5s/step - loss: 4.8766 - accuracy: 0.5938
Epoch 5/30
3/3 [=====] - 15s 5s/step - loss: 6.3676 - accuracy: 0.6458
Epoch 6/30
3/3 [=====] - 14s 5s/step - loss: 5.2558 - accuracy: 0.6667
Epoch 7/30
3/3 [=====] - 16s 5s/step - loss: 5.4306 - accuracy: 0.6458
Epoch 8/30
3/3 [=====] - 13s 4s/step - loss: 4.8280 - accuracy: 0.6562
Epoch 9/30
3/3 [=====] - 14s 5s/step - loss: 3.9236 - accuracy: 0.6458
Epoch 10/30
3/3 [=====] - 13s 4s/step - loss: 3.2804 - accuracy: 0.6562
Epoch 11/30
3/3 [=====] - 15s 5s/step - loss: 2.1550 - accuracy: 0.6875
Epoch 12/30
3/3 [=====] - 15s 5s/step - loss: 3.0436 - accuracy: 0.6979
Epoch 13/30
3/3 [=====] - 14s 5s/step - loss: 3.4109 - accuracy: 0.7500
Epoch 14/30
3/3 [=====] - 15s 5s/step - loss: 2.8810 - accuracy: 0.7396
Epoch 15/30
3/3 [=====] - 15s 5s/step - loss: 3.4979 - accuracy: 0.6667
Epoch 16/30
3/3 [=====] - 14s 5s/step - loss: 3.1029 - accuracy: 0.6562
Epoch 17/30
3/3 [=====] - 14s 5s/step - loss: 2.8477 - accuracy: 0.6979
Epoch 18/30
3/3 [=====] - 14s 4s/step - loss: 2.6290 - accuracy: 0.6979
Epoch 19/30
3/3 [=====] - 16s 5s/step - loss: 4.5827 - accuracy: 0.5938
```

```

Epoch 20/30
3/3 [=====] - 13s 4s/step - loss: 1.7713 - accuracy: 0.7604
Epoch 21/30
3/3 [=====] - 14s 5s/step - loss: 4.1266 - accuracy: 0.6042
Epoch 22/30
3/3 [=====] - 15s 5s/step - loss: 2.2045 - accuracy: 0.7188
Epoch 23/30
3/3 [=====] - 15s 5s/step - loss: 2.7497 - accuracy: 0.7500
Epoch 24/30
3/3 [=====] - 16s 5s/step - loss: 3.3502 - accuracy: 0.7083
Epoch 25/30
3/3 [=====] - 15s 5s/step - loss: 3.1592 - accuracy: 0.7188
Epoch 26/30
3/3 [=====] - 14s 5s/step - loss: 3.2060 - accuracy: 0.6354
Epoch 27/30
3/3 [=====] - 16s 5s/step - loss: 3.4886 - accuracy: 0.6250
Epoch 28/30
3/3 [=====] - 15s 5s/step - loss: 3.0558 - accuracy: 0.6979
Epoch 29/30
3/3 [=====] - 14s 5s/step - loss: 4.7360 - accuracy: 0.6250
Epoch 30/30
3/3 [=====] - 14s 5s/step - loss: 2.0049 - accuracy: 0.7708

```

```

model.save('Updated-xception-diabetic-retinopathy.h5')

```

7. CODING & SOLUTIONING:

Import the necessary libraries.

ImageDataGenerator class is instantiated and the configuration for the types of data augmentation

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

- Image shifts via the `width_shift_range` and `height_shift_range` arguments.
- The image flips via the `horizontal_flip` and `vertical_flip` arguments.
- Image rotations via the `rotation_range` argument
- Image brightness via the `brightness_range` argument.

- Image zoom via the `zoom_range` argument.
- For Training set using `flow_from_directory` function.

This function will return batches of images from the subdirectories

Arguments:

- `directory`: Directory where the data is located. If labels are "inferred", it should contain subdirectories, each containing images for a class. Otherwise, the directory structure is ignored.
- `batch_size`: Size of the batches of data which is 64.
- `target_size`: Size to resize images after they are read from disk.
- `class_mode`:
 - 'int': means that the labels are encoded as integers (e.g. for `sparse_categorical_crossentropy` loss).
 - 'categorical' means that the labels are encoded as a categorical vector (e.g. for `categorical_crossentropy` loss).
 - 'binary' means that the labels (there can be only 2) are encoded as float32 scalars with values 0 or 1 (e.g. for `binary_crossentropy`).
 - None (no labels)

For one of the models, we will use it as a simple feature extractor by freezing all the five convolution blocks to make sure their weights don't get updated after each epoch as we train our own model.

Here, we have considered images of dimension (229,229,3).

Also, we have assigned `include_top = False` because we are using convolution layer for features extraction and wants to train fully connected layer for our images classification(since it is not the part of Imagenet dataset)

Flatten layer flattens the input. Does not affect the batch size.

A dense layer is a deeply connected neural network layer. It is the most common and frequently used layer.

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

Optimization is an important process that optimizes the input weights by comparing the prediction and the loss function. Here we are using adam optimizer.

The model is trained for 30 epochs and after every epoch, the current model state is saved if the model has the least loss encountered till that time. We can see that the training loss decreases in almost every epoch till 10 epochs and probably there is further scope to improve the model.

fit_generator functions used to train a deep learning neural network

Arguments:

- steps_per_epoch: it specifies the total number of steps taken from the generator as soon as one epoch is finished and the next epoch has started. We can calculate the value of steps_per_epoch as the total number of samples in your dataset divided by the batch size.
- Epochs: an integer and number of epochs we want to train our model for.
- validation_data can be either:
 - an inputs and targets list
 - a generator

- an inputs, targets, and sample_weights list which can be used to evaluate

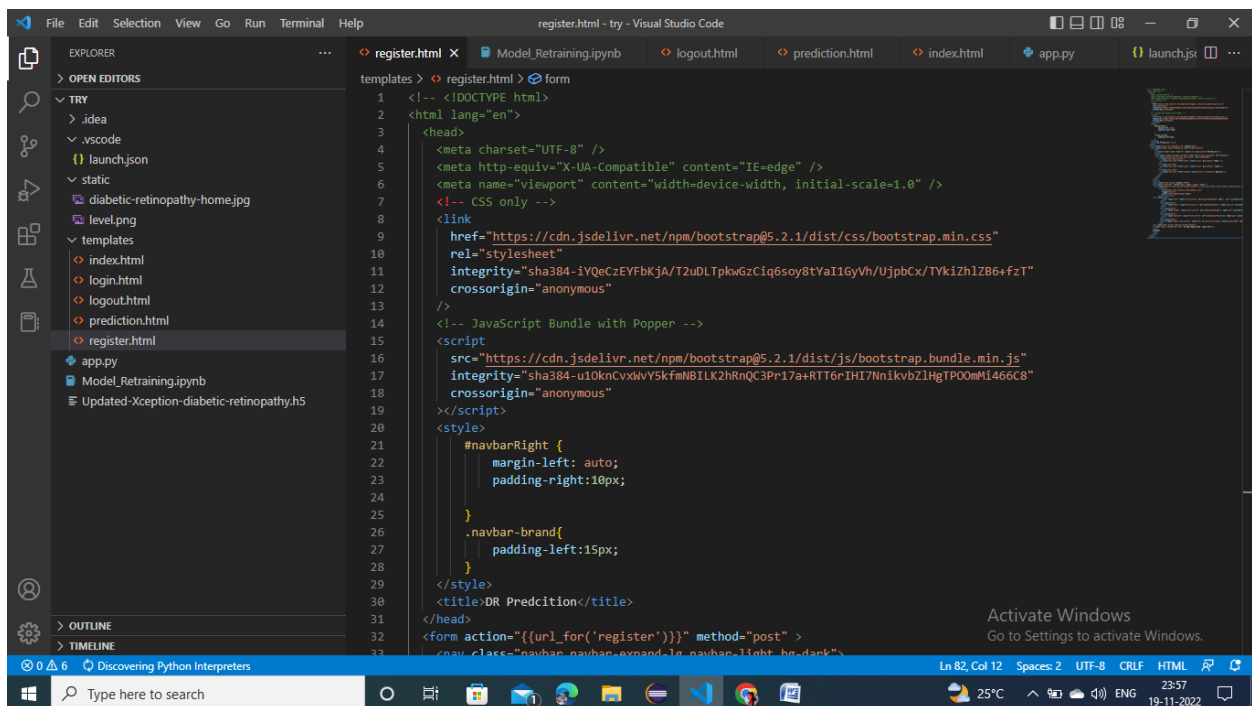
the loss and metrics for any model after any epoch has ended.

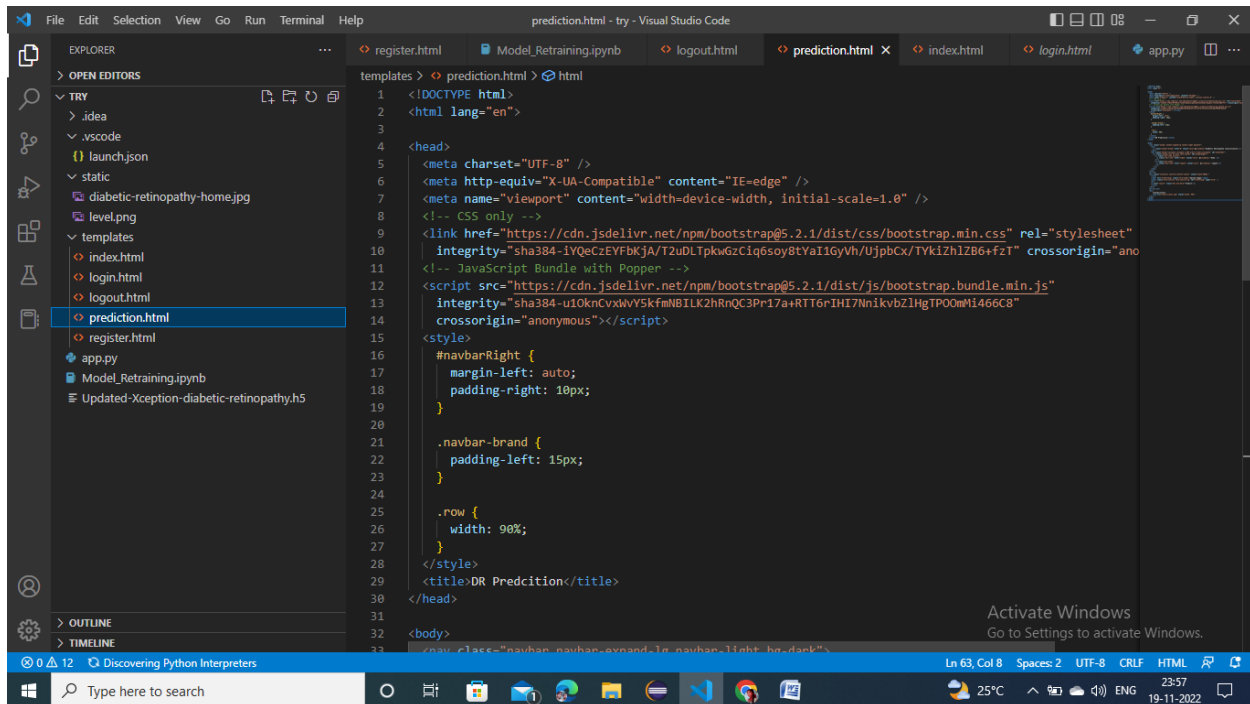
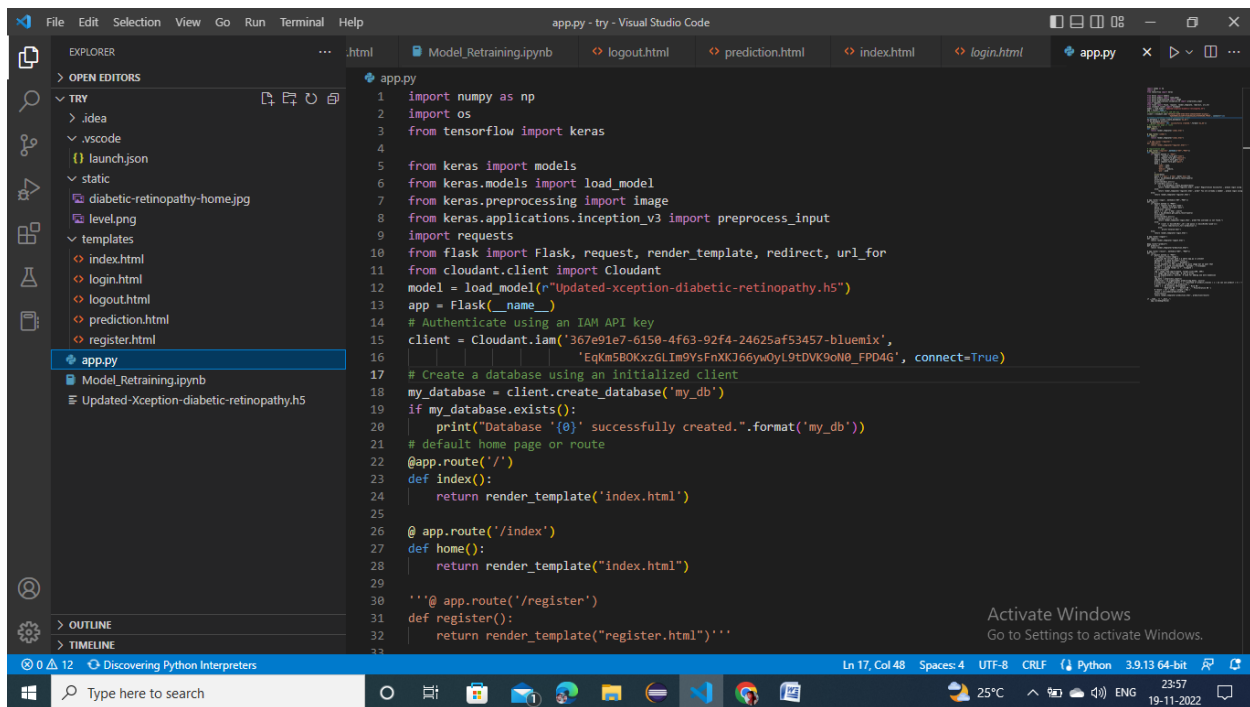
- validation_steps: only if the validation_data is a generator then only this argument

can be used. It specifies the total number of steps taken from the generator before it is

stopped at every epoch and its value is calculated as the total number of validation data points

in your dataset divided by the validation batch size.



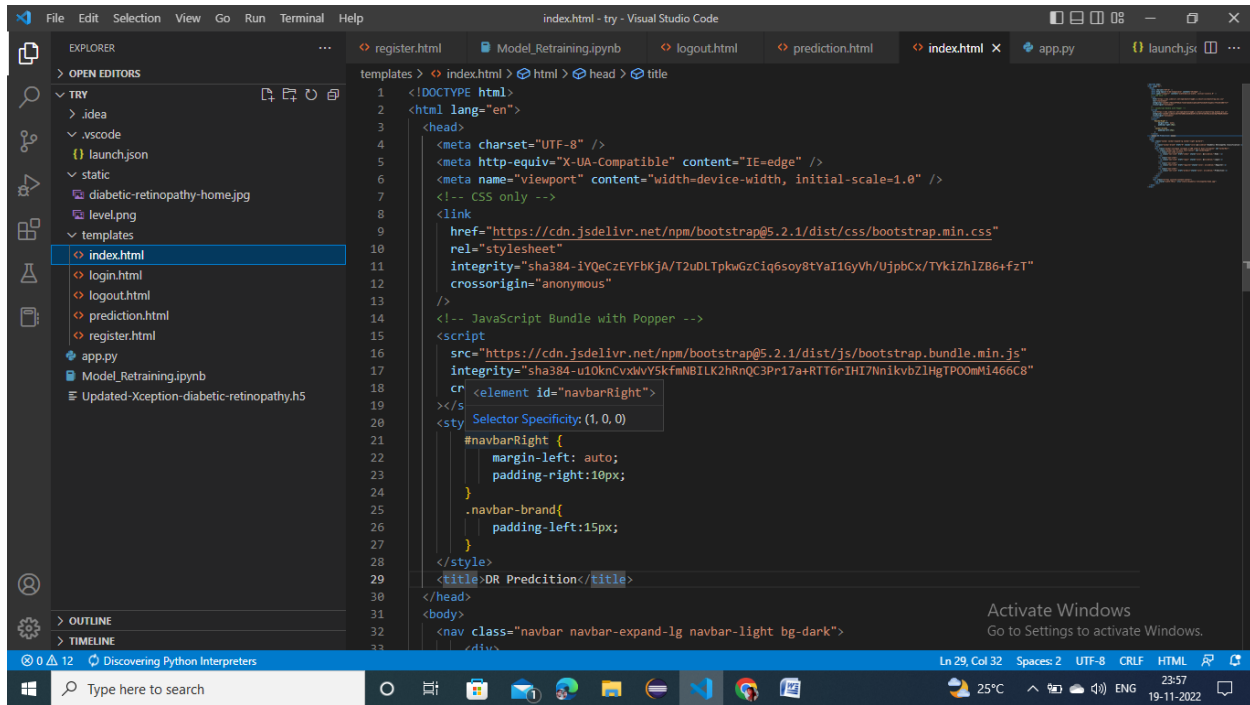


This screenshot shows the Visual Studio Code editor with the file `logouthtml` open. The Explorer sidebar on the left shows a project structure with folders like `idea`, `.vscode`, `static`, and `templates`. The `templates` folder is expanded, showing `index.html`, `login.html`, and `logouthtml`. The main editor area displays the HTML code for `logouthtml`, which includes a Bootstrap 5.2.1 template with a dark theme. The code includes a navigation bar with a right-aligned section. The status bar at the bottom indicates the cursor is at line 59, column 8, with 2 spaces, UTF-8 encoding, and CRLF line endings.

```
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4   <meta charset="UTF-8" />
5   <meta http-equiv="X-UA-Compatible" content="IE=edge" />
6   <meta name="viewport" content="width=device-width, initial-scale=1.0" />
7   <!-- CSS only -->
8   <link
9     href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
10    rel="stylesheet"
11    integrity="sha384-iYQeCzEVfybKjA/T2uDLTPkwGzCiq6soy8tVaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
12    crossorigin="anonymous"
13  />
14   <!-- JavaScript Bundle with Popper -->
15   <script
16     src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
17     integrity="sha384-u10knCvdxWV5kfamNBILK2hRnQC3Pr17a+RTT6rIHI7Nnikyb2lHgTP00mMI466C8"
18     crossorigin="anonymous"
19   ></script>
20   <style>
21     #navbarRight {
22       margin-left: auto;
23       padding-right: 10px;
24     }
25     .navbar-brand {
26       padding-left: 15px;
27     }
28   </style>
29   <title>DR Prediction</title>
30 </head>
31 <body>
32   <nav class="navbar navbar-expand-lg navbar-light bg-dark">
```

This screenshot shows the Visual Studio Code editor with the file `login.html` open. The Explorer sidebar on the left shows the same project structure as the first screenshot. The main editor area displays the HTML code for `login.html`, which is a Bootstrap 5.2.1 template with a dark theme. The code includes a navigation bar with a right-aligned section. The status bar at the bottom indicates the cursor is at line 73, column 8, with 2 spaces, UTF-8 encoding, and CRLF line endings.

```
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4   <meta charset="UTF-8" />
5   <meta http-equiv="X-UA-Compatible" content="IE=edge" />
6   <meta name="viewport" content="width=device-width, initial-scale=1.0" />
7   <!-- CSS only -->
8   <link
9     href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
10    rel="stylesheet"
11    integrity="sha384-iYQeCzEVfybKjA/T2uDLTPkwGzCiq6soy8tVaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
12    crossorigin="anonymous"
13  />
14   <!-- JavaScript Bundle with Popper -->
15   <script
16     src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
17     integrity="sha384-u10knCvdxWV5kfamNBILK2hRnQC3Pr17a+RTT6rIHI7Nnikyb2lHgTP00mMI466C8"
18     crossorigin="anonymous"
19   ></script>
20   <style>
21     #navbarRight {
22       margin-left: auto;
23       padding-right: 10px;
24     }
25     .navbar-brand {
26       padding-left: 15px;
27     }
28   </style>
29   <title>DR Prediction</title>
30 </head>
31 <form action="" method="POST">
32   <div class="navbar navbar-expand-lg navbar-light bg-dark">
```



8. TESTING :

8.1: AcceptanceTesting UAT Execution & Report Submission

- **PurposeofDocument**

The purpose of this document is to briefly explain the test coverage and open issues of the[Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy] project at the time of the release to User Acceptance Testing (UAT).

- **DefectAnalysis**

This report shows the number of resolved or closed bugs a teach severity level,and howthey were resolved

Resolution	Severity1	Severity2	Severity3	Severity4	Subtotal
ByDesign	1	0	0	0	1
Duplicate	4	1	3	0	8
External	1	3	0	0	4
Fixed	2	4	4	2	12
NotReproduced	0	0	0	1	1
Skipped	0	0	0	0	0

Won'tFix	0	0	0	0	0
Totals	8	8	4	2	22

- **TestCaseAnalysis**

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

Section	TotalCases	NotTested	Fail	Pass
PrintEngine	5	0	0	5
ClientApplication	10	0	0	10
Security	2	0	0	2

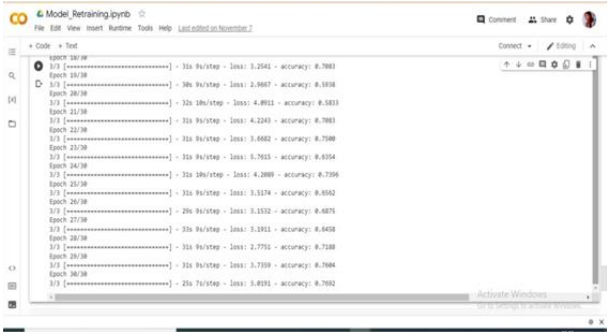
OutsourceShipping	0	0	0	0
ExceptionReporting	2	0	0	2
FinalReportOutput	4	0	0	4
VersionControl	2	0	0	2

9. RESULTS:

9.1: Performance Metrics:

Project team shall fill the following information in model performance testing template.

S.No	Parameter	Values	Screenshot
1.	Model Summary	-	

2.	Accuracy	<p>Training Accuracy - 76.92</p> <p>Validation Accuracy -71.88</p>	
3.	Confidence Score (Only Yolo Projects)	<p>Class Detected -</p> <p>Confidence Score -</p>	

10. CONCLUSION:

The huge population of diabetic patients and the prevalence of Diabetic Retinopathy among them have fostered a great demand in automatic DRdiagnosing systems. So far, a lot of achievements have been made and satisfactoryresults have been achieved in many sub problems like vessel segmentation, lesion detection. However, these results are obtained on datasets relatively small and are steps away from real world applications.

For clinical application, systems that can give DR severity directly are more favourable and practical. However, current results for multi-class severity grading are still not good enough for clinical application. In this work, we investigated the automatic grading of DR using deep neural networks. We proposed a novel dataset that is moderate in size and annotated with a new labeling scheme that is more useful for clinical practice. We proposed a preprocessing pipeline to change fundus images into a uniform format. We used the Inception-V3 network and a proposed modification of it as our diagnostic models and evaluated the performance of them with several mainstream CNN models. The experimental results demonstrate the efficiency of the models in diagnosing DR. Visualization and analysis of the trained models provide insights into how the models make diagnoses using given fundus images and justify the diagnostic ability of the models from a different viewpoint. For clinical applications, the trained models are deployed on a cloud computing platform and provide pilot diagnostic services to several hospitals via the internet. The performance of the system in the clinical

evaluation demonstrate the efficiency of this work. In the future, data from more equipments will be included, and a broader pilot study will be launched. The accumulated data will be further used to improve the accuracy of the models.

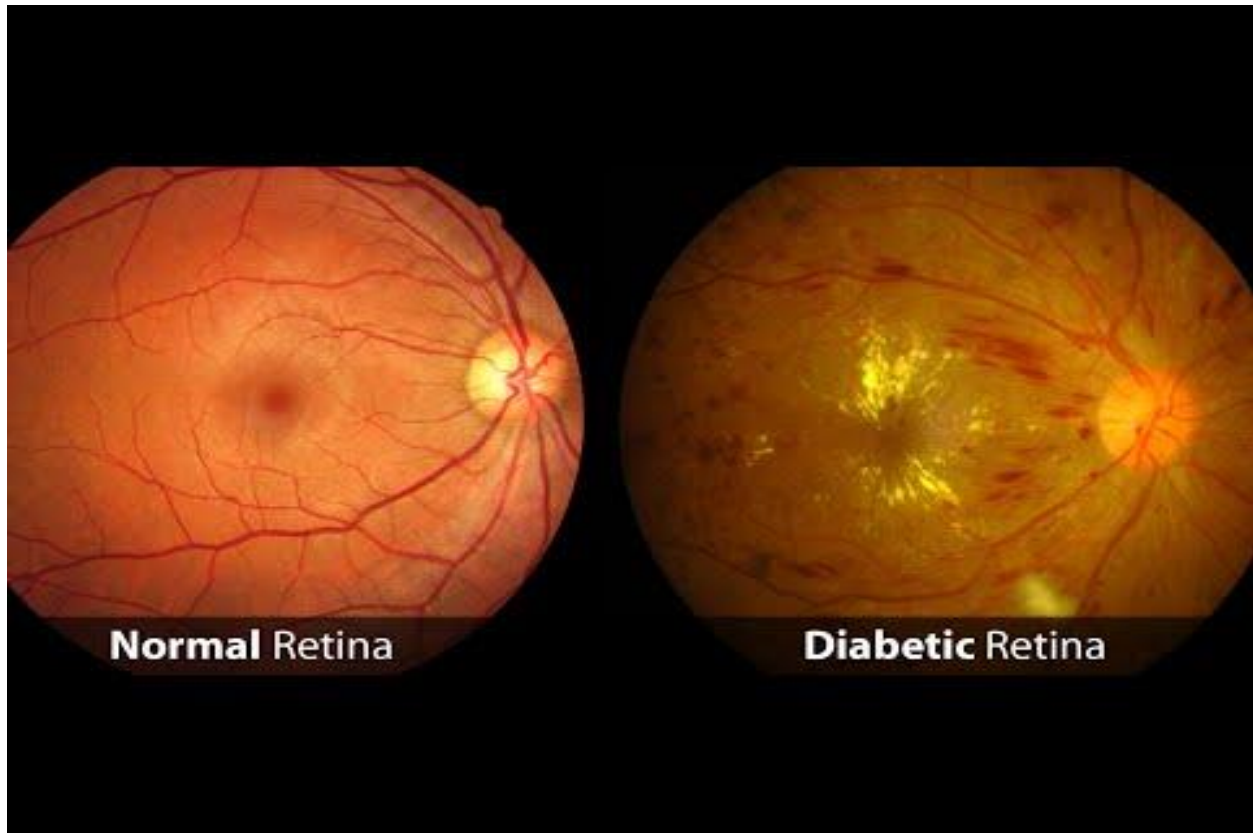
For clinical application, systems that can give DR severity directly are more favourable and practical. However, current results for multi-class severity grading are still not good enough for clinical application. In this work, we investigated the automatic grading of DR using deep neural networks. We proposed a novel dataset that is moderate in size and annotated with a new labeling scheme that is more useful for clinical practice. We proposed a preprocessing pipeline to change fundus images into a uniform format. We used the Inception-V3 network and a proposed modification of it as our diagnostic models and evaluated the performance of them with several mainstream CNN models. The experimental results demonstrate the efficiency of the models in diagnosing DR. Visualization and analysis of the trained models provide insights into how the models make diagnoses using given fundus images and justify the diagnostic ability of the models from a different viewpoint. For clinical applications, the trained models are deployed on a cloud computing platform and provide pilot diagnostic services to several hospitals via the internet. The performance of the system in the clinical evaluation demonstrates the efficiency of this work. In the future, data from more equipments will be included, and a broader pilot study will be launched. The accumulated data will be further used to improve the accuracy of the models.

11. APPENDIX:

Github Link:

<https://github.com/IBM-EPBL/IBM-Project-34389-1660234894>

Demo Link:



Browser tabs: Terv, Spotify - L, IBM-EPBL, IBM-EPBL, IBM-EPBL, Paraphras, WhatsApp, Examinat, DISYS | G, +

Address bar: github.com/IBM-EPBL/IBM-Project-34389-1660234894

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Pre-Development	Delete Demo	11 days ago
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README.md	Update README.md	2 months ago

README.md

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Sprint 2	Delete demo	6 days ago
Sprint 3	Add files via upload	6 days ago
Sprint 4/Train The Model On IBM	Delete demo	6 days ago
User Acceptance Testing	Delete UAT Report Template.docx	yesterday

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Project Design Phase II	Add files via upload	last month
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