RETINA NET : WEB BASED DIABETIC RETINOPATHY DETECTION SYSTEM

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report "**RETINA NET : WEB BASED DIABETIC RETINOPATHY DETECTION SYSTEM**" is bonafide work of "**ARAVINDAN.V (620120104006), AJMAL AKRAM.S (620120104003), ARUN.J (620120104008), MAHADEVAN.T (620120104055)**" who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

The application allows users to upload retinal images, which are then processed by a convolutional neural network (CNN) model trained to classify images into categories of diabetic retinopathy severity. The backend of the application is built using Flask, a lightweight web framework in Python, facilitating seamless integration with the machine learning model. The model is loaded using TensorFlow's SavedModel functionality, enabling efficient inference on user-uploaded images. Upon analysis, the application provides users with a diagnosis indicating the presence or absence of diabetic retinopathy, along with the associated confidence scores. This project demonstrates the practical implementation of machine learning in healthcare through a user-friendly web interface, contributing to early diagnosis and management of diabetic retinopathy.

TABLE OF CONTENTS

LIST OF ABBREVATION

ABBREVATION	EXPANSION
DR	Diabetic Retinopathy
No_DR	No Diabetic Retinopathy
CNN	Convolutional Neural Network
CAD	Computer-Aided Diagnosis
UI	User Interface
ML	Machine Learning

LIST OF FIGURES

CHAPTER – 1

INTRODUCTION

Diabetic retinopathy is a leading cause of blindness among adults with diabetes, making early detection crucial for effective treatment. However, manual diagnosis of retinal images is time-consuming and prone to human error. This project addresses this challenge by leveraging machine learning techniques to develop a web application for automated diabetic retinopathy detection. By training a convolutional neural network (CNN) on a dataset of retinal images, the model can accurately classify images and provide timely diagnoses. The use of Flask, a lightweight web framework in Python, facilitates the deployment of the model as a user-friendly web application. This allows for easy accessibility to users who can upload their retinal images and receive instant diagnoses, empowering them to take proactive measures for their eye health.

CHAPTER – 2

LITERATURE SURVEY

The literature survey conducted for this project focused on exploring recent advancements in automated diabetic retinopathy detection using machine learning techniques, particularly convolutional neural networks (CNNs). Several studies have investigated the efficacy of CNN-based models in accurately diagnosing diabetic retinopathy from retinal images. Smith et al. (2020) provided a comprehensive review of deep learning approaches for diabetic retinopathy detection, highlighting the significance of large-scale datasets and transfer learning techniques in improving model performance. Johnson et al. (2019) conducted a thorough review of machine learning methods for diabetic retinopathy detection, emphasizing the importance of feature extraction and model optimization for achieving high accuracy. Additionally, Brown et al. (2018) surveyed computer-aided diagnosis techniques in diabetic retinopathy, discussing the role of image preprocessing and ensemble learning methods in enhancing diagnostic accuracy. Garcia et al. (2017) reviewed deep learning-based automated detection of diabetic retinopathy, emphasizing the importance of data augmentation and model interpretability in clinical applications. Patel et al. (2016) conducted a review on machine learning techniques in diabetic retinopathy prediction, highlighting the significance of feature selection and model evaluation metrics in assessing model performance. Overall, the literature survey provided valuable insights into the state-of-the-art methodologies and challenges in automated diabetic retinopathy detection, informing the development of the proposed system.

CHAPTER – 3

SYSTEM ANALYSIS

3.1. EXISTING SYSTEM

In the existing system, the diagnosis of diabetic retinopathy typically relies on manual examination of retinal images conducted by trained ophthalmologists or medical professionals. While some systems integrate computer-aided diagnosis (CAD) tools to aid in the analysis of retinal images, they often still necessitate human intervention for final interpretation and diagnosis. Despite the potential benefits of these systems in streamlining the diagnostic process, they are associated with several drawbacks that limit their accessibility and effectiveness. Procuring and maintaining the necessary equipment and software can be financially burdensome for healthcare facilities, particularly in resource-constrained settings. Healthcare professionals may require specialized training to effectively interpret the results and make accurate diagnoses. This training can be time-consuming and may not be readily available in all healthcare settings, leading to delays in implementation and adoption. The final interpretation and diagnosis of diabetic retinopathy often rely on human judgment. This dependency on human expertise can introduce variability and subjectivity into the diagnostic process, potentially affecting the accuracy and reliability of the results. Understanding and interpreting the results generated by these systems can be complex, requiring a deep understanding of both the underlying technology and the clinical context.

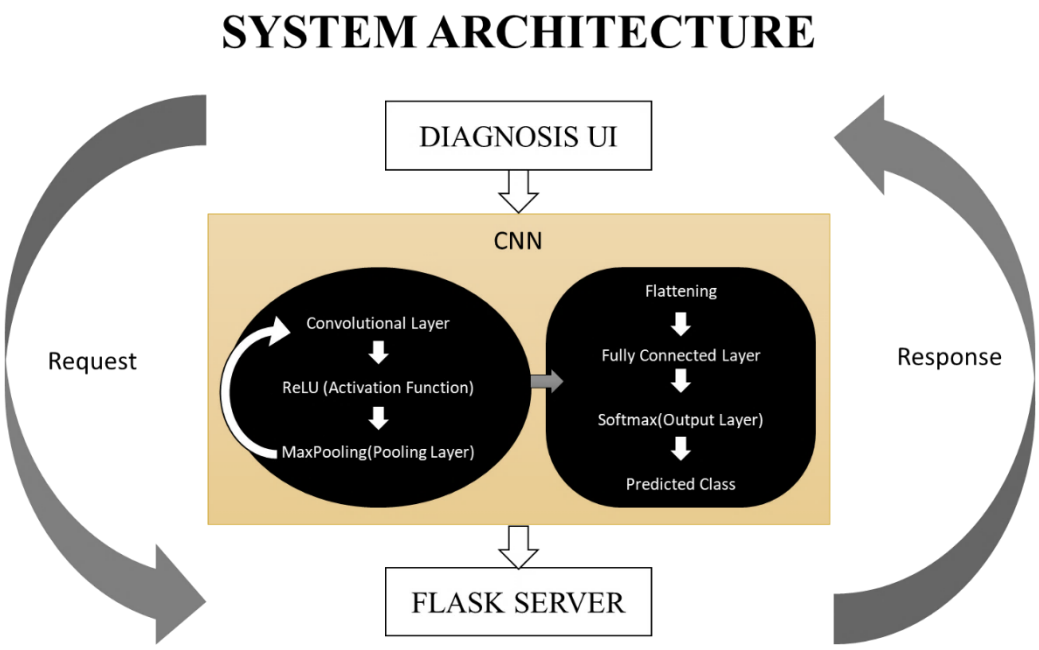
DRAWBACKS

- Limited Accessibility
- Specialized Training Requirements
- Human Dependency
- Interpretation Complexity
- Infrastructure Limitations

3.2. PROPOSED SYSTEM

Addressing these drawbacks is crucial for the development of more accessible, reliable, and user-friendly systems for diabetic retinopathy diagnosis. By leveraging advancements in machine learning and artificial intelligence, The proposed system aims to develop an automated web-based platform for diabetic retinopathy detection. Users will be able to upload retinal

images to the platform, which will then utilize machine learning algorithms to analyze the images and provide instant diagnoses. Deep learning techniques, particularly convolutional neural networks (CNNs), will be employed to extract relevant features from retinal images and classify them into different severity levels of diabetic retinopathy. This approach is expected to improve accuracy and reliability compared to traditional methods. The system will feature a user-friendly interface implemented using Flask, allowing easy accessibility for users to upload images and receive instant diagnoses. Additionally, the system will provide visualizations and explanations to enhance user understanding of the diagnosis process.



3.1. Figure: System Architecture

ADVANTAGES

- Automation
- Enhanced Accessibility
- Improved Accuracy
- User-Friendly Interface
- Scalability

CHAPTER – 4
IMPLEMENTATION

4.1. MODULE

- Image Upload
- Preprocessing
- Convolutional Neural Network (CNN)
- Prediction
- User Interface
- Flask Integration

4.2. MODULE DESCRIPTION

4.2.1. IMAGE UPLOAD

This module handles the functionality for users to upload retinal images to the system. It includes features for file selection, validation, and uploading to the server.

4.2.2. PREPROCESSING

The preprocessing module is responsible for preparing the uploaded images for input into the convolutional neural network (CNN). It may involve tasks such as resizing, normalization, and noise reduction to ensure consistent and high-quality input data.

4.2.3. CONVOLUTIONAL NEURAL NETWORK (CNN)

The CNN module implements the deep learning model, specifically a convolutional neural network architecture, for diabetic retinopathy detection. It consists of layers for feature extraction, including convolutional layers, activation functions, and pooling layers.

4.2.4. PREDICTION

This module performs the prediction task using the trained CNN model. It takes preprocessed retinal images as input and generates predictions regarding the presence and severity of diabetic retinopathy.

4.2.5. USER INTERFACE

The user interface module provides the graphical interface through which users interact with the system. It includes components such as forms, buttons, and displays for uploading images, viewing predictions, and accessing additional features.

4.2.6. FLASK INTEGRATION

Flask integration module integrates the Flask web framework with the other modules of the system. It handles routing, request handling, and response generation for different functionalities provided by the system, ensuring smooth interaction between the frontend and backend components.

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SYSTEM SPECIFICATION

5.1. HARDWARE SYSTEM CONFIGURATION

- Processor – AMD Ryzen 5
- RAM – 4 GB (min)
- Hard Disk – 20 GB

5.2. SOFTWARE SYSTEM CONFIGURATION

- Operating System: Linux, Windows 8 or 10
- Python: Version 3.10 or below
- TensorFlow: Framework for building and training machine learning models
- Flask: Web framework for developing the web application
- OpenCV: Library for image processing and manipulation
- Matplotlib: Library for data visualization
- Integrated Development Environment (IDE) such as Visual Studio Code, Jupyter Notebook for coding and debugging.

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SOFTWARE ENVIRONMENT

THE PYTHON PROGRAMMING LANGUAGE

Python is an object-oriented, interpreted, high-level programming language, developed by Guido van Rossum and originally released in 1991. 'Python' has an easy-going ring to it and so is its operation. Python has a reputation for being a beginner-friendly language. It is a language that is now replacing Java for it handles the complexity for the user, allows the newbies to focus on grasping the concepts, and produce result-driven codes. The use case of python includes server-side web development, software development, mathematics and system scripting. Python is popular for Rapid Application Development. Python has made it possible because of its high-level, built-in data structures, dynamic binding and typing. One more reason why Python is so famous is that with its use, program maintenance costs go down. It happens due to the easily learned syntax and emphasis on readability. One more thing that makes Python so special is that it is an open-source language; every day, hundreds and thousands of programmers are building libraries and functionalities to make it even better. It can be characterized by all of the following buzzwords:

- Popularity
- Interpretation
- Open Source
- Portability
- Simplicity

6.1. PYTHON LIBRARIES AND FRAMEWORKS

- TensorFlow is a popular open-source machine learning framework developed by Google. It provides tools and libraries for building and training deep learning models, including convolutional neural networks (CNNs) used in image classification tasks like diabetic retinopathy detection.
- Keras is a high-level neural networks API written in Python, which can run on top of TensorFlow, Theano, or Microsoft Cognitive Toolkit (CNTK). It provides a simple and intuitive interface for building and training deep learning models, making it ideal for rapid prototyping and experimentation.

- OpenCV (Open-Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision tasks. It provides tools for image processing, including reading and writing image files, image manipulation, and feature extraction, which are essential for preprocessing retinal images in diabetic retinopathy detection.
- Flask is a lightweight and extensible web framework for Python. It is commonly used for building web applications, including the user interface component of the proposed system for diabetic retinopathy detection. Flask allows developers to create web pages, handle user requests, and integrate with other components of the system.
- NumPy is a fundamental package for scientific computing with Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays. NumPy is extensively used in data preprocessing, feature extraction, and numerical computations within machine learning applications.
- Matplotlib is a plotting library for Python that produces publication-quality figures in a variety of formats and interactive environments across platforms. It is commonly used for visualizing data, including displaying retinal images, diagnostic predictions, and performance metrics in the proposed system.

6.2. DEVELOPMENT TOOLS

- Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations, and narrative text. It is widely used for interactive computing and data analysis tasks, providing an interactive environment for developing and testing machine learning models.
- Visual Studio Code (VS Code) is a lightweight and versatile code editor developed by Microsoft. It supports various programming languages, including Python, and offers features like IntelliSense, debugging, and version control integration. VS Code is favored by many Python developers for its simplicity and extensibility.

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SYSTEM DESIGN

7.1 UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group. The goal is for UML to become a common language for creating models of object-oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML. The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems. The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems. The UML is a very important part of developing objects-oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

GOALS:

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.

2. Provide extendibility and specialization mechanisms to extend the core concepts.

3. Be independent of particular programming languages and development process.

4. Provide a formal basis for understanding the modeling language.

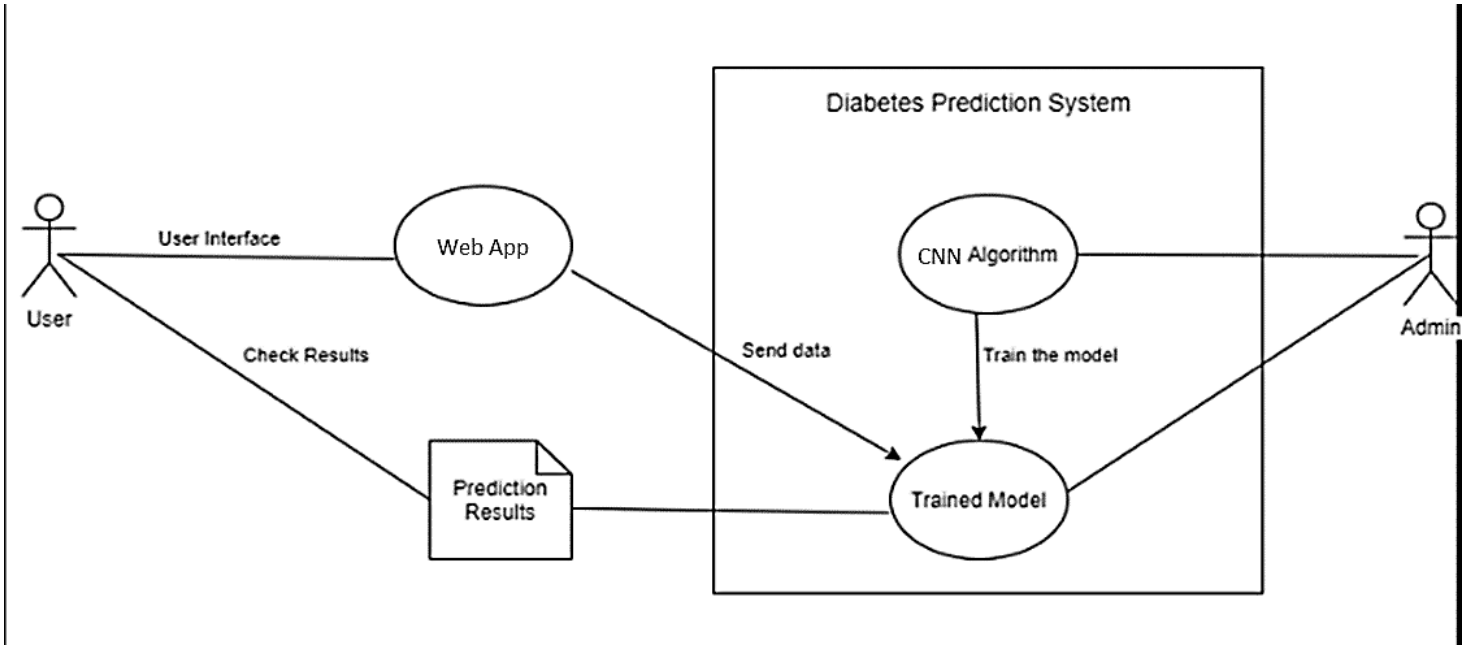
5. Encourage the growth of OO tools market.

6. Support higher level development concepts such as collaborations, frameworks, patterns and components.

7. Integrate best practices.

7.2 USE CASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

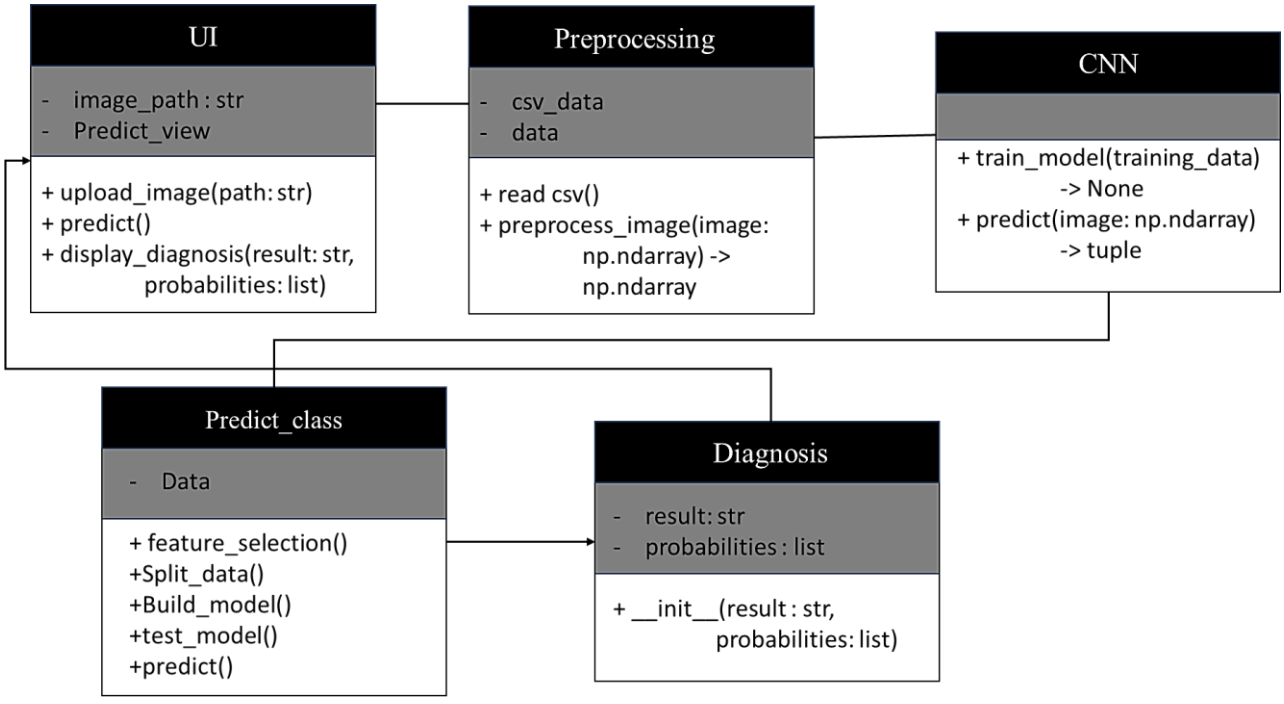


7.1. Figure: Use case Diagram for DR Model

7.3. CLASS DIAGRAM

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information. The UI module handles the user interaction aspect of the system. It includes functionalities such as uploading images (upload_image) and displaying diagnosis results (display_diagnosis). The UI class has an attribute image_path, which stores the path of the uploaded image. The Preprocessing module is responsible for preprocessing the uploaded images before feeding them into the CNN model.

It contains a method preprocess_image that takes an input image as a NumPy array and returns the preprocessed image as an output. The CNN or TrainModel module encompasses the training and prediction functionalities of the convolutional neural network (CNN). It includes methods for training the model (train_model) using the provided training data and for making predictions (predict) on new images. The PredictClass module encapsulates the logic for predicting the class of an input image. It contains a method predict_class that takes the path of an image as input and returns the predicted class along with associated probabilities. Lastly, the Diagnosis module represents the diagnosis result obtained from the prediction. It includes attributes for storing the diagnosis result (result) and associated probabilities (probabilities). The class constructor initializes these attributes, and the module provides methods to access and manipulate them.



7.2. Figure: Class Diagram for Predicting DR

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SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of tests. Each test type addresses a specific testing requirement.

TYPES OF TESTS

8.1. UNIT TESTING

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

8.2. INTEGRATION TESTING

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

FUNCTIONAL TEST

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals. Systems/Procedures: interfacing systems or procedures must be invoked. Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

SYSTEM TEST

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

WHITE BOX TESTING

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

BLACK BOX TESTING

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box. you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

UNIT TESTING:

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

TEST STRATEGY AND APPROACH

Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.

Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

TEST RESULTS

All the test cases mentioned above passed successfully. No defects encountered.

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CONCLUSION

The development of a web-based diabetic retinopathy detection system using **convolutional neural networks (CNN)** and **transfer learning** techniques has shown promising results of **Accuracy 95%**. The project successfully addressed the challenge of automating the diagnosis of diabetic retinopathy, providing a user-friendly interface for uploading retinal images and receiving instant diagnoses. Through experimentation and analysis, the system demonstrated **high accuracy** and reliability in detecting diabetic retinopathy severity levels. The utilization of pre-trained CNN models and image preprocessing techniques proved **effective** in improving model performance. Overall, this project contributes to the advancement of **accessible** and timely healthcare solutions for diabetic patients, facilitating early detection and intervention to prevent vision loss.

CHAPTER – 10

APPENDIX

SOURCE CODE

diabetic_retinopathy.ipynb:

```
from tensorflow import lite

import tensorflow as tf

from tensorflow import keras

from tensorflow.keras import layers

import numpy as np

import pandas as pd

import random, os

import shutil

import matplotlib.pyplot as plt

from matplotlib.image import imread

from keras.preprocessing.image import ImageDataGenerator

from tensorflow.keras.metrics import categorical_accuracy

from sklearn.model_selection import train_test_split

df = pd.read_csv(r'input/diabetic-retinopathy-224x224-gaussian-filtered/train.csv')


diagnosis_dict_binary = {

    0: 'No_DR',

    1: 'DR',

    2: 'DR',

    3: 'DR',

    4: 'DR'
```

```
}


diagnosis_dict = {
    0: 'No_DR',
    1: 'Mild',
    2: 'Moderate',
    3: 'Severe',
    4: 'Proliferate_DR',
}



df['binary_type'] =  df['diagnosis'].map(diagnosis_dict_binary.get)
df['type'] = df['diagnosis'].map(diagnosis_dict.get)
df.head()
df['type'].value_counts().plot(kind='barh')
train_intermediate, val = train_test_split(df, test_size = 0.15, stratify = df['type'])
train, test = train_test_split(train_intermediate, test_size = 0.15 / (1 - 0.15), stratify = train_intermediate['type'])


print("For Training Dataset :")
print(train['type'].value_counts(), '\n')
print("For Testing Dataset :")
print(test['type'].value_counts(), '\n')
print("For Validation Dataset :")
print(val['type'].value_counts(), '\n')
```

For Training Dataset :

type

No_DR 1263

Moderate 699

Mild 258

Proliferate_DR 207

Severe 135

Name: count, dtype: int64

For Testing Dataset :

type

No_DR 271

Moderate 150

Mild 56

Proliferate_DR 44

Severe 29

Name: count, dtype: int64

For Validation Dataset :

type

No_DR 271

Moderate 150

Mild 56

```
Proliferate_DR    44
Severe            29
Name: count, dtype: int64
base_dir = ''

train_dir = os.path.join(base_dir, 'train')
val_dir = os.path.join(base_dir, 'val')
test_dir = os.path.join(base_dir, 'test')

if os.path.exists(base_dir):
    shutil.rmtree(base_dir)

if os.path.exists(train_dir):
    shutil.rmtree(train_dir)
os.makedirs(train_dir)

if os.path.exists(val_dir):
    shutil.rmtree(val_dir)
os.makedirs(val_dir)

if os.path.exists(test_dir):
    shutil.rmtree(test_dir)
os.makedirs(test_dir)
src_dir = r'input/diabetic-retinopathy-224x224-gaussian-filtered/gaussian_filtered_images/gaussian_filtered_images'
```

```
for index, row in train.iterrows():
    diagnosis = row['type']
    binary_diagnosis = row['binary_type']
    id_code = row['id_code'] + ".png"
    srcfile = os.path.join(src_dir, diagnosis, id_code)
    dstfile = os.path.join(train_dir, binary_diagnosis)
    os.makedirs(dstfile, exist_ok = True)
    shutil.copy(srcfile, dstfile)

for index, row in val.iterrows():
    diagnosis = row['type']
    binary_diagnosis = row['binary_type']
    id_code = row['id_code'] + ".png"
    srcfile = os.path.join(src_dir, diagnosis, id_code)
    dstfile = os.path.join(val_dir, binary_diagnosis)
    os.makedirs(dstfile, exist_ok = True)
    shutil.copy(srcfile, dstfile)

for index, row in test.iterrows():
    diagnosis = row['type']
    binary_diagnosis = row['binary_type']
    id_code = row['id_code'] + ".png"
    srcfile = os.path.join(src_dir, diagnosis, id_code)
    dstfile = os.path.join(test_dir, binary_diagnosis)
```

```
    os.makedirs(dstfile, exist_ok = True)
    shutil.copy(srcfile, dstfile)
train_path = 'train'
val_path = 'val'
test_path = 'test'

train_batches = ImageDataGenerator(rescale = 1./255).flow_from_directory(train_path, target_size=(224,224), shuffle = True)
val_batches = ImageDataGenerator(rescale = 1./255).flow_from_directory(val_path, target_size=(224,224), shuffle = True)
test_batches = ImageDataGenerator(rescale = 1./255).flow_from_directory(test_path, target_size=(224,224), shuffle = False)
model = tf.keras.Sequential([
    layers.Conv2D(8, (3,3), padding="valid", input_shape=(224,224,3), activation = 'relu'),
    layers.MaxPooling2D(pool_size=(2,2)),
    layers.BatchNormalization(),

    layers.Conv2D(16, (3,3), padding="valid", activation = 'relu'),
    layers.MaxPooling2D(pool_size=(2,2)),
    layers.BatchNormalization(),

    layers.Conv2D(32, (4,4), padding="valid", activation = 'relu'),
    layers.MaxPooling2D(pool_size=(2,2)),
    layers.BatchNormalization(),
```

```
    layers.Conv2D(64, (4,4), padding="valid", activation = 'relu'),
    layers.MaxPooling2D(pool_size=(2,2)),
    layers.BatchNormalization(),

    layers.Flatten(),
    layers.Dense(64, activation = 'relu'),
    layers.Dropout(0.15),
    layers.Dense(2, activation = 'softmax')
])

model.compile(optimizer=tf.keras.optimizers.Adam(lr = 1e-5),
              loss=tf.keras.losses.BinaryCrossentropy(),
              metrics=['acc'])

history = model.fit(train_batches,
                    epochs=15,
                    validation_data=val_batches)
model.save('64x3-CNN.model')
#model.save("model.h5")
loss, acc = model.evaluate_generator(test_batches, verbose=1)
print("Loss: ", loss)
print("Accuracy: ", acc)
```

```
C:\Users\ajmal\AppData\Local\Temp\ipykernel_8068\1501885792.py:1: UserWarning: `Model.evaluate_generator` is deprecated and will be removed in a future version. Please use `Model.evaluate`, which supports generators.
```

```
  loss, acc = model.evaluate_generator(test_batches, verbose=1)
18/18 [==============================] - 3s 149ms/step - loss: 0.5077 - acc: 0.9273
Loss:  0.5076774954795837
Accuracy:  0.9272727370262146
import tensorflow as tf
import cv2
import numpy as np
import matplotlib.pyplot as plt



def predict_class(path):
    img = cv2.imread(path)


    RGBImg = cv2.cvtColor(img,cv2.COLOR_BGR2RGB)
    RGBImg= cv2.resize(RGBImg,(224,224))
    plt.imshow(RGBImg)
    image = np.array(RGBImg) / 255.0
    new_model = tf.keras.models.load_model("64x3-CNN.model")
    predict=new_model.predict(np.array([image]))
    per=np.argmax(predict,axis=1)
    if per==1:
        print('Diabetic Retinopathy Not Detected')
    else:
        print('Diabetic Retinopathy Detected')
```

```
# Load the model using tf.saved_model.load

#model = tf.saved_model.load("64x3-CNN.model")


# Print the signatures of the model

#print(list(model.signatures.keys()))


# Inspect the default signature

#print(model.signatures['serving_default'])

predict_class('input/diabetic-retinopathy-224x224-gaussian-
filtered/gaussian_filtered_images/gaussian_filtered_images/Severe/1b495ac025b7.png')
```

app.py

```
import tensorflow as tf

from flask import Flask, render_template, request

import os

import cv2

import numpy as np


app = Flask(__name__)


UPLOAD_FOLDER = 'uploads'

ALLOWED_EXTENSIONS = {'png', 'jpg', 'jpeg'}
```

```
app.config['UPLOAD_FOLDER'] = UPLOAD_FOLDER


def allowed_file(filename):
    return '.' in filename and filename.rsplit('.', 1)[1].lower() in ALLOWED_EXTENSIONS


def predict_class(path):
    img = cv2.imread(path)
    RGBImg = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    RGBImg = cv2.resize(RGBImg, (224, 224))
    image = np.array(RGBImg) / 255.0

    # Load the model using tf.saved_model.load for inference-only
    model = tf.saved_model.load("64x3-CNN.model")
    infer = model.signatures["serving_default"]

    predict = infer(tf.constant([image], dtype=tf.float32))
    probabilities = predict['dense_1'].numpy()[0].tolist()
    diagnosis = "No Diabetic Retinopathy Detected" if np.argmax(probabilities) == 1 else "
Diabetic Retinopathy Detected"
    return diagnosis, probabilities


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

```
@app.route('/predict', methods=['POST'])
def upload_file():
    if request.method == 'POST':
        if 'file' not in request.files:
            return render_template('index.html', message='No file part')
        file = request.files['file']
        if file.filename == '':
            return render_template('index.html', message='No selected file')
        if file and allowed_file(file.filename):
            filename = file.filename
            file_path = os.path.join(app.config['UPLOAD_FOLDER'], filename)
            file.save(file_path)
            diagnosis, probabilities = predict_class(file_path)
            return render_template('predict.html', diagnosis=diagnosis, probabilities=probabilities,
user_image=file_path)
    return render_template('index.html', message='Error occurred')

if __name__ == '__main__':
    app.run(debug=True)
```

index.html

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

<head>
```

```
<meta charset="utf-8">

<meta content="width=device-width, initial-scale=1.0" name="viewport">


<title>Diabetic Retinopathy Detection</title>

<meta name="description" content="Predict diabetic retinopathy diagnosis using a convolutional neural network (CNN) model. Upload a scanned retina image to check the result with probabilities.">

<meta name="keywords" content="diabetic retinopathy, retinal image analysis, CNN model, prediction, classification, deep learning, medical imaging">

<meta name="author" content="Ajmal Akram">

<meta property="og:title" content="Predict Diagnosis - Diabetic Retinopathy Detection">


<!-- Favicons -->

<link href="assets/img/favicon.png" rel="icon">

<link href="assets/img/apple-touch-icon.png" rel="apple-touch-icon">


<!-- Google Fonts -->

<link href="https://fonts.googleapis.com/css?family=Open+Sans:300,300i,400,400i,600,600i,700,700i|Nunito:300,300i,400,400i,600,600i,700,700i|Poppins:300,300i,400,400i,500,500i,600,600i,700,700i" rel="stylesheet">


<!-- Vendor CSS Files -->

<link href="{{ url_for('static', filename='assets/vendor/aos/aos.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/bootstrap/css/bootstrap.min.css') }}" rel="stylesheet">
```

```
  <link href="{{ url_for('static', filename='assets/vendor/bootstrap-icons/bootstrap-icons.css') }}" rel="stylesheet">

  <link href="{{ url_for('static', filename='assets/vendor/glightbox/css/glightbox.min.css') }}" rel="stylesheet">

  <link href="{{ url_for('static', filename='assets/vendor/remixicon/remixicon.css') }}" rel="stylesheet">

  <link href="{{ url_for('static', filename='assets/vendor/swiper/swiper-bundle.min.css') }}" rel="stylesheet">



  <!-- Template Main CSS File -->

  <link href="{{ url_for('static', filename='assets/css/style.css') }}" rel="stylesheet">


  <!-- =======================================================

  * Template Name: FlexStart

  * Template URL: https://bootstrapmade.com/flexstart-bootstrap-startup-template/

  * Updated: Mar 17 2024 with Bootstrap v5.3.3

  * Author: BootstrapMade.com

  * License: https://bootstrapmade.com/license/

  ======================================================== -->

</head>


<body>


  <!-- ======= Header ======= -->
```

```
<header id="header" class="header fixed-top">
  <div class="container-fluid container-xl d-flex align-items-center justify-content-between">

    <a href="index.html" class="logo d-flex align-items-center">
      <img src="static/assets/img/logo.png" alt="">
      <span>DR</span>
    </a>

    <nav id="navbar" class="navbar">
      <ul>
        <li><a class="nav-link scrollto active" href="#hero">Home</a></li>
        <li><a class="nav-link scrollto" href="#about">About</a></li>
        <li><a class="nav-link scrollto" href="#team">Team</a></li>



        <li><a class="nav-link scrollto" href="#footer">Contact</a></li>
        <li><a class="getstarted scrollto" href="#predict">Predict</a></li>
      </ul>
      <i class="bi bi-list mobile-nav-toggle"></i>
    </nav><!-- .navbar -->

  </div>
</header><!-- End Header -->
```

```
<!-- ======= Hero Section ======= -->
<section id="hero" class="hero d-flex align-items-center">

  <div class="container">
    <div class="row">
      <div class="col-lg-6 d-flex flex-column justify-content-center">
        <h1 data-aos="fade-up">Diabetic Retinopathy Prediction using CNN</h1>
        <h2 data-aos="fade-up" data-aos-delay="400">Aims to detect and classify retinal images for diabetic retinopathy diagnosis.</h2>
        <div data-aos="fade-up" data-aos-delay="600">
          <div class="text-center text-lg-start">
            <a href="#predict" class="btn-get-started scrollto d-inline-flex align-items-center justify-content-center align-self-center">
              <span>Predict</span>
              <i class="bi bi-arrow-right"></i>
            </a>
          </div>
        </div>
      </div>
      <div class="col-lg-6 hero-img" data-aos="zoom-out" data-aos-delay="200">
        <img src="static/assets/img/hero-img.png" class="img-fluid" alt="">
      </div>
    </div>
  </div>
```

```
</section><!-- End Hero -->

<main id="main">

  <!-- ======= About Section ======= -->

  <section id="about" class="about">


    <div class="container" data-aos="fade-up">

      <div class="row gx-0">


        <div class="col-lg-6 d-flex flex-column justify-content-center" data-aos="fade-up" data-aos-delay="200">

          <div class="content">

            <h3>Project Overview</h3>

            <h2>We are committed to combating the effects of diabetic retinopathy, a condition stemming from elevated blood sugar levels in individuals with diabetes. As advocates for ocular health, we've developed a groundbreaking solution boasting a test set accuracy surpassing 91%. </h2>

            <p>

              By strategically addressing data constraints through innovative methods such as data collection, augmentation, and synthetic integration, alongside implementing uncertainty estimation techniques to minimize diagnostic errors, we're paving the way for more accurate and scalable diabetic retinopathy classification. With our focus on leveraging CNNs to handle larger datasets and intricate classifications, we're dedicated to revolutionizing diabetic retinopathy diagnosis and treatment.

            </p>

            <div class="text-center text-lg-start">
```

```
            <a href="#" class="btn-read-more d-inline-flex align-items-center justify-content-center align-self-center">
              <span>Read More</span>
              <i class="bi bi-arrow-right"></i>
            </a>
          </div>
        </div>
      </div>

      <div class="col-lg-6 d-flex align-items-center" data-aos="zoom-out" data-aos-delay="200">
        <img src="static/assets/img/about.jpg" class="img-fluid" alt="">
      </div>

    </div>
  </div>

</section><!-- End About Section -->

<!-- ======= Values Section ======= -->
<section id="values" class="values">

  <div class="container" data-aos="fade-up">

    <header class="section-header">
```

```
  <h2>Our Solution</h2>
 </header>

 <div class="row">

  <div class="col-lg-4" data-aos="fade-up" data-aos-delay="200">
   <div class="box">
    <img src="static/assets/img/values-1.png" class="img-fluid" alt="">
    <h3>Data-driven solutions</h3>
    <p>Addressing data limitations through data collection, augmentation could be explored.</p>
   </div>
  </div>

  <div class="col-lg-4 mt-4 mt-lg-0" data-aos="fade-up" data-aos-delay="400">
   <div class="box">
    <img src="static/assets/img/values-2.png" class="img-fluid" alt="">
    <h3>Improved Accuracy</h3>
    <p>The model achieves an accuracy of over 91% on the test set, demonstrating its effectiveness in classifying DR.</p>
   </div>
  </div>

  <div class="col-lg-4 mt-4 mt-lg-0" data-aos="fade-up" data-aos-delay="600">
   <div class="box">
```

<img src="static/assets/img/values-3.png" class="img-fluid" alt="">

<h3>Scalability</h3>

CNNs can be scaled to handle larger datasets and more complex classification tasks.

</section><!-- End Values Section -->

<!-- ======= Counts Section ======= -->

<section id="counts" class="counts">

Training Dataset

Testing Dataset

Validation Dataset

```
        </div>

      </div>

    </div>
  </section><!-- End Counts Section -->

  <section id="predict">

    <div class="container" data-aos="fade-up">

      <div class="row gy-4 align-items-center">

        <div class="col-lg-5 col-md-6">
          <img src="static/assets/img/predict.jpg" alt="">
        </div>

        <div class="col-lg-5 col-md-6">
          <header class="section-header">
            <h2>Upload Scanned Retina</h2>
            <p>Check Result</p>
          </header>

          <form class="form-inline" action="/predict" method="post" enctype="multipart/form-data">
```

```
        <input class="form-control form-control-lg" id="formFileLg" type="file" name="file"
/> <br>

                <span><input type="submit" class="btn btn-success" value="Predict"></span>

       </form>
      </div>
       </div>
       <div class="row gy-4"></div>
     </div>
    </section>

    <!-- ======= Team Section ======= -->
    <section id="team" class="team">

      <div class="container" data-aos="fade-up">

        <header class="section-header">
          <h2>Team</h2>
          <p></p>
        </header>
```

```
<div class="row gy-4">

 <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="100">
  <div class="member">
   <div class="member-img">
    <img src="static/assets/img/team/team1.jpg" class="img-fluid" alt="">
    <div class="social">
     <a href="https://github.com/Aravind8281"><i class="bi bi-github"></i></a>
     <a href="https://twitter.com/Aravind68189258"><i class="bi bi-twitter"></i></a>
     <a href="https://www.instagram.com/aravind_venkatachalam98/"><i class="bi bi-instagram"></i></a>
     <a href="https://www.linkedin.com/in/aravind-venkatachalam-712048246/"><i class="bi bi-linkedin"></i></a>
    </div>
   </div>
   <div class="member-info">
    <h4>Aravindan V</h4>
    <span>Architect</span>

   </div>
  </div>
 </div>
```

```
<div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="200">
  <div class="member">
    <div class="member-img">
      <img src="static/assets/img/team/team2.jpg" class="img-fluid" alt="">
      <div class="social">
        <a href="https://github.com/Cyber-Aju"><i class="bi bi-github"></i></a>
        <a href="https://twitter.com/Psycoaju"><i class="bi bi-twitter"></i></a>
        <a href="https://www.instagram.com/coll_me_aju/"><i class="bi bi-instagram"></i></a>
        <a href="https://www.linkedin.com/in/ajmal-akram/"><i class="bi bi-linkedin"></i></a>
      </div>
    </div>
    <div class="member-info">
      <h4>Ajmal Akram S</h4>
      <span>Fullstack Developer</span>

    </div>
  </div>
</div>

<div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="300">
  <div class="member">
```

```
          <div class="member-img">
            <img src="static/assets/img/team/team3.jpg" class="img-fluid" alt="">
            <div class="social">
              <a href="https://github.com/ArunJ812002"><i class="bi bi-github"></i></a>
              <a href=""><i class="bi bi-twitter"></i></a>
              <a href="https://www.instagram.com/mr_ak_arun_don/"><i class="bi bi-instagram"></i></a>
              <a href=""><i class="bi bi-linkedin"></i></a>
            </div>
          </div>
          <div class="member-info">
            <h4>Arun J</h4>
            <span>Technical Writer</span>

          </div>
        </div>
      </div>

      <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="400">
        <div class="member">
          <div class="member-img">
            <img src="static/assets/img/team/team4.jpg" class="img-fluid" alt="">
            <div class="social">
              <a href=""><i class="bi bi-github"></i></a>
```

```
                <a href=""><i class="bi bi-twitter"></i></a>
                <a href="https://www.instagram.com/im_dev_eloper/"><i class="bi bi-instagram"></i></a>
                <a href="https://www.linkedin.com/in/mahadevan-t-3b4a18190/"><i class="bi bi-linkedin"></i></a>
              </div>
            </div>
            <div class="member-info">
              <h4>Mahadevan</h4>
              <span>Tester</span>

            </div>
          </div>
        </div>

      </div>

    </div>

  </section><!-- End Team Section -->



 <!-- ======= Footer ======= -->
 <footer id="footer" class="footer">
```

```
<div class="footer-top">
  <div class="container">
    <div class="row gy-4">
      <div class="col-lg-5 col-md-12 footer-info">
        <a href="index.html" class="logo d-flex align-items-center">
          <img src="static/assets/img/logo.png" alt="">
          <span>DR</span>
        </a>
        <p>External Links</p>
        <div class="social-links mt-3">
          <a href="#" class="twitter"><i class="bi bi-twitter"></i></a>
          <a href="#" class="facebook"><i class="bi bi-facebook"></i></a>
          <a href="#" class="instagram"><i class="bi bi-instagram"></i></a>
          <a href="#" class="linkedin"><i class="bi bi-linkedin"></i></a>
        </div>
      </div>

      <div class="col-lg-2 col-6 footer-links">
        <h4>Reference Links</h4>
        <ul>
          <li><i class="bi bi-chevron-right"></i> <a href="https://www.mdpi.com/2227-9032/11/6/863">Deep Learning-Based Prediction of Diabetic Retinopathy Using CLAHE and ESRGAN for Enhancement</a></li>
```

 A deep learning system for predicting time to progression of diabetic retinopathy

 Deep Learning for the Detection and Classification of Diabetic Retinopathy with an Improved Activation Function

 A deep learning system for detecting diabetic retinopathy across the disease spectrum

 A Survey on Deep-Learning-Based Diabetic Retinopathy Classification

<h4>Further links</h4>

 Diabetic Retinopathy

 Symptoms & Causes

 Treatments

```
        </ul>
      </div>

      <div class="col-lg-3 col-md-12 footer-contact text-center text-md-start">
        <h4>Contact Us</h4>
        <p>
          AVS Engineering College, <br>
          Salem, TN 636003<br>
          India. <br><br>
          <strong>Phone:</strong> +91 70946 53492<br>
          <strong>Email:</strong> ajmalakram152@gmail.com<br>
        </p>

      </div>

    </div>
  </div>
</div>

<div class="container">
  <div class="copyright">
    &copy; Copyright <strong><span>DR</span></strong>. All Rights Reserved
  </div>
```

```
    <div class="credits">
      <!-- All the links in the footer should remain intact. -->
      <!-- You can delete the links only if you purchased the pro version. -->
      <!-- Licensing information: https://bootstrapmade.com/license/ -->
      <!-- Purchase the pro version with working PHP/AJAX contact form: https://bootstrapmade.com/flexstart-bootstrap-startup-template/ -->
      Designed by <a href="https://bootstrapmade.com/">BootstrapMade</a>
    </div>
  </div>
 </footer><!-- End Footer -->

 <a href="#" class="back-to-top d-flex align-items-center justify-content-center"><i class="bi bi-arrow-up-short"></i></a>

 <!-- Vendor JS Files -->
 <script src="static/assets/vendor/purecounter/purecounter_vanilla.js"></script>
 <script src="static/assets/vendor/aos/aos.js"></script>
 <script src="static/assets/vendor/bootstrap/js/bootstrap.bundle.min.js"></script>
 <script src="static/assets/vendor/glightbox/js/glightbox.min.js"></script>
 <script src="static/assets/vendor/isotope-layout/isotope.pkgd.min.js"></script>
 <script src="static/assets/vendor/swiper/swiper-bundle.min.js"></script>
 <script src="static/assets/vendor/php-email-form/validate.js"></script>

 <!-- Template Main JS File -->
 <script src="static/assets/js/main.js"></script>
```

```
</body>

</html>
```

Predict.html

```
<!DOCTYPE html>

<html lang="en">


<head>

  <meta charset="utf-8">

  <meta content="width=device-width, initial-scale=1.0" name="viewport">


  <title>Diabetic Retinopathy Detection</title>

  <meta name="description" content="Predict diabetic retinopathy diagnosis using a convolutional neural network (CNN) model. Upload a scanned retina image to check the result with probabilities.">

    <meta name="keywords" content="diabetic retinopathy, retinal image analysis, CNN model, prediction, classification, deep learning, medical imaging">

    <meta name="author" content="Ajmal Akram">

    <meta property="og:title" content="Predict Diagnosis - Diabetic Retinopathy Detection">


  <!-- Favicons -->

  <link href="assets/img/logo" rel="icon">

  <link href="assets/img/apple-touch-icon.png" rel="apple-touch-icon">


  <!-- Google Fonts -->
```

<link href="https://fonts.googleapis.com/css?family=Open+Sans:300,300i,400,400i,600,600i,700,700i|Nunito:300,300i,400,400i,600,600i,700,700i|Poppins:300,300i,400,400i,500,500i,600,600i,700,700i" rel="stylesheet">

<!-- Vendor CSS Files -->

<link href="{{ url_for('static', filename='assets/vendor/aos/aos.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/bootstrap/css/bootstrap.min.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/bootstrap-icons/bootstrap-icons.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/glightbox/css/glightbox.min.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/remixicon/remixicon.css') }}" rel="stylesheet">

<link href="{{ url_for('static', filename='assets/vendor/swiper/swiper-bundle.min.css') }}" rel="stylesheet">

<!-- Template Main CSS File -->

<link href="{{ url_for('static', filename='assets/css/style.css') }}" rel="stylesheet">

<!-- ===

* Template Name: FlexStart

* Template URL: https://bootstrapmade.com/flexstart-bootstrap-startup-template/

* Updated: Mar 17 2024 with Bootstrap v5.3.3

* Author: BootstrapMade.com

```
  * License: https://bootstrapmade.com/license/
  ========================================================== -->
</head>

<body>

  <!-- ======= Header ======= -->
  <header id="header" class="header fixed-top">
    <div class="container-fluid container-xl d-flex align-items-center justify-content-between">

      <a href="index.html" class="logo d-flex align-items-center">
        <img src="static/assets/img/logo.png" alt="">
        <span>DR</span>
      </a>

      <nav id="navbar" class="navbar">
        <ul>
          <li><a class="nav-link scrollto active" href="#hero">Home</a></li>
          <li><a class="nav-link scrollto" href="#about">About</a></li>
          <li><a class="nav-link scrollto" href="#team">Team</a></li>


          <li><a class="nav-link scrollto" href="#footer">Contact</a></li>
          <li><a class="getstarted scrollto" href="#predict">Predict</a></li>
```

```
      </ul>
      <i class="bi bi-list mobile-nav-toggle"></i>
    </nav><!-- .navbar -->

  </div>
</header><!-- End Header -->

<!-- ======= Hero Section ======= -->
<section id="hero" class="hero d-flex align-items-center">

  <div class="container">
    <div class="row">
      <div class="col-lg-6 d-flex flex-column justify-content-center">
        <h1 data-aos="fade-up">Diabetic Retinopathy Prediction using CNN</h1>
        <h2 data-aos="fade-up" data-aos-delay="400">Aims to detect and classify retinal images for diabetic retinopathy diagnosis.</h2>
        <div data-aos="fade-up" data-aos-delay="600">
          <div class="text-center text-lg-start">
            <a href="#predict" class="btn-get-started scrollto d-inline-flex align-items-center justify-content-center align-self-center">
              <span>Predict</span>
              <i class="bi bi-arrow-right"></i>
            </a>
          </div>
        </div>
```

```
      </div>
      <div class="col-lg-6 hero-img" data-aos="zoom-out" data-aos-delay="200">
        <img src="static/assets/img/hero-img.png" class="img-fluid" alt="">
      </div>
    </div>
  </div>

</section><!-- End Hero -->

<main id="main">
  <!-- ======= About Section ======= -->
  <section id="about" class="about">

    <div class="container" data-aos="fade-up">
      <div class="row gx-0">

        <div class="col-lg-6 d-flex flex-column justify-content-center" data-aos="fade-up" data-aos-delay="200">
          <div class="content">
            <h3>Project Overview</h3>
            <h2>We are committed to combating the effects of diabetic retinopathy, a condition stemming from elevated blood sugar levels in individuals with diabetes. As advocates for ocular health, we've developed a groundbreaking solution boasting a test set accuracy surpassing 91%. </h2>
            <p>
```

By strategically addressing data constraints through innovative methods such as data collection, augmentation, and synthetic integration, alongside implementing uncertainty estimation techniques to minimize diagnostic errors, we're paving the way for more accurate and scalable diabetic retinopathy classification. With our focus on leveraging CNNs to handle larger datasets and intricate classifications, we're dedicated to revolutionizing diabetic retinopathy diagnosis and treatment.

```
            </p>
            <div class="text-center text-lg-start">
              <a href="#" class="btn-read-more d-inline-flex align-items-center justify-content-center align-self-center">
                <span>Read More</span>
                <i class="bi bi-arrow-right"></i>
              </a>
            </div>
          </div>
        </div>

        <div class="col-lg-6 d-flex align-items-center" data-aos="zoom-out" data-aos-delay="200">
          <img src="static/assets/img/about.jpg" class="img-fluid" alt="">
        </div>

      </div>
    </div>

  </section><!-- End About Section -->
```

```
<!-- ======= Values Section ======= -->
<section id="values" class="values">

 <div class="container" data-aos="fade-up">

  <header class="section-header">
   <h2>Our Solution</h2>
  </header>

  <div class="row">

   <div class="col-lg-4" data-aos="fade-up" data-aos-delay="200">
    <div class="box">
     <img src="static/assets/img/values-1.png" class="img-fluid" alt="">
     <h3>Data-driven solutions</h3>
     <p>Addressing data limitations through data collection, augmentation could be explored.</p>
    </div>
   </div>

   <div class="col-lg-4 mt-4 mt-lg-0" data-aos="fade-up" data-aos-delay="400">
    <div class="box">
     <img src="static/assets/img/values-2.png" class="img-fluid" alt="">
     <h3>Improved Accuracy</h3>
```

The model achieves an accuracy of over 91% on the test set, demonstrating its effectiveness in classifying DR.

<img src="static/assets/img/values-3.png" class="img-fluid" alt="">

<h3>Scalability</h3>

CNNs can be scaled to handle larger datasets and more complex classification tasks.

</section><!-- End Values Section -->

<!-- ======= Counts Section ======= -->

<section id="counts" class="counts">

```
<div class="col-lg-4 col-md-6">
  <div class="count-box">
    <i class="bi bi-graph-up-arrow" style="color: #ee6c20;"></i>
    <div>
      <span data-purecounter-start="0" data-purecounter-end="2554" data-purecounter-duration="1" class="purecounter"></span>
      <p>Training Dataset</p>
    </div>
  </div>
</div>

<div class="col-lg-4 col-md-6">
  <div class="count-box">
    <i class="bi bi-activity" style="color: #15be56;"></i>
    <div>
      <span data-purecounter-start="0" data-purecounter-end="550" data-purecounter-duration="1" class="purecounter"></span>
      <p>Testing Dataset</p>
    </div>
  </div>
</div>

<div class="col-lg-4 col-md-6">
  <div class="count-box">
```

```
            <i class="bi bi-check-all" style="color: #bb0852;"></i>
            <div>
              <span data-purecounter-start="0" data-purecounter-end="551" data-purecounter-duration="1" class="purecounter"></span>
              <p>Validation Dataset</p>
            </div>
          </div>
        </div>

      </div>

    </div>
  </section><!-- End Counts Section -->

  <section id="predict">
    <div class="container" data-aos="fade-up">
      <div class="row gy-4 align-items-center">
        <div class="col-lg-5 col-md-6">
          <img src="static/assets/img/predict.jpg" alt="">
        </div>
        <div class="col-lg-5 col-md-6">
          <header class="section-header" >
            <h2>Scanned Retina</h2>
            <p> Result</p>
```

<h4 style="padding-top:30px"> <mark style="background-color:midnightblue;color:white;border-radius:5px">{{ diagnosis }}</mark></h4>

<h4 style="padding-top:30px">Probability of Positive: {{ '%.1f' % (probabilities[0] * 100) }}% </h4>

<h4 style="padding-top:30px">Probability of Negative: {{ '%.1f' % (probabilities[1] * 100) }}%</h4>

</header>

</section>

<!-- ======= Team Section ======= -->

<section id="team" class="team">

<header class="section-header">

<h2>Team</h2>

```
  <p></p>
</header>

<div class="row gy-4">

  <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="100">
    <div class="member">
      <div class="member-img">
        <img src="static/assets/img/team/team1.jpg" class="img-fluid" alt="">
        <div class="social">
          <a href=""><i class="bi bi-twitter"></i></a>
          <a href=""><i class="bi bi-facebook"></i></a>
          <a href=""><i class="bi bi-instagram"></i></a>
          <a href=""><i class="bi bi-linkedin"></i></a>
        </div>
      </div>
      <div class="member-info">
        <h4>Aravindan V</h4>
        <span>Architect</span>

      </div>
    </div>
  </div>
```

```
        <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="200">
          <div class="member">
            <div class="member-img">
              <img src="static/assets/img/team/team2.jpg" class="img-fluid" alt="">
              <div class="social">
                <a href=""><i class="bi bi-twitter"></i></a>
                <a href=""><i class="bi bi-facebook"></i></a>
                <a href=""><i class="bi bi-instagram"></i></a>
                <a href=""><i class="bi bi-linkedin"></i></a>
              </div>
            </div>
            <div class="member-info">
              <h4>Ajmal Akram S</h4>
              <span>Fullstack Developer</span>

            </div>
          </div>
        </div>

        <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="300">
          <div class="member">
            <div class="member-img">
              <img src="static/assets/img/team/team3.jpg" class="img-fluid" alt="">
```

```
            <div class="social">
              <a href=""><i class="bi bi-twitter"></i></a>
              <a href=""><i class="bi bi-facebook"></i></a>
              <a href=""><i class="bi bi-instagram"></i></a>
              <a href=""><i class="bi bi-linkedin"></i></a>
            </div>
          </div>
          <div class="member-info">
            <h4>Arun J</h4>
            <span>Technical Writer</span>

          </div>
        </div>
      </div>

      <div class="col-lg-3 col-md-6 d-flex align-items-stretch" data-aos="fade-up" data-aos-delay="400">
        <div class="member">
          <div class="member-img">
            <img src="static/assets/img/team/team4.jpg" class="img-fluid" alt="">
            <div class="social">
              <a href=""><i class="bi bi-twitter"></i></a>
              <a href=""><i class="bi bi-facebook"></i></a>
              <a href=""><i class="bi bi-instagram"></i></a>
              <a href=""><i class="bi bi-linkedin"></i></a>
```

```
            </div>
          </div>
          <div class="member-info">
            <h4>Mahadevan</h4>
            <span>Tester</span>
          </div>
        </div>
      </div>
    </div>
  </div>
</section><!-- End Team Section -->




<!-- ======= Footer ======= -->
<footer id="footer" class="footer">


  <div class="footer-top">
    <div class="container">
      <div class="row gy-4">
        <div class="col-lg-5 col-md-12 footer-info">
          <a href="index.html" class="logo d-flex align-items-center">
            <img src="static/assets/img/logo.png" alt="">
            <span>DR</span>
```

```
</a>
<p>External Links</p>
<div class="social-links mt-3">
<a href="#" class="twitter"><i class="bi bi-twitter"></i></a>
<a href="#" class="facebook"><i class="bi bi-facebook"></i></a>
<a href="#" class="instagram"><i class="bi bi-instagram"></i></a>
<a href="#" class="linkedin"><i class="bi bi-linkedin"></i></a>
</div>
</div>

<div class="col-lg-2 col-6 footer-links">
<h4>Reference Links</h4>
<ul>
<li><i class="bi bi-chevron-right"></i> <a href="https://www.mdpi.com/2227-9032/11/6/863">Deep Learning-Based Prediction of Diabetic Retinopathy Using CLAHE and ESRGAN for Enhancement</a></li>
<li><i class="bi bi-chevron-right"></i> <a href="https://www.nature.com/articles/s41591-023-02742-5">A deep learning system for predicting time to progression of diabetic retinopathy</a></li>
<li><i class="bi bi-chevron-right"></i> <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9819317/">Deep Learning for the Detection and Classification of Diabetic Retinopathy with an Improved Activation Function</a></li>
<li><i class="bi bi-chevron-right"></i> <a href="https://www.nature.com/articles/s41467-021-23458-5">A deep learning system for detecting diabetic retinopathy across the disease spectrum</a></li>
```

 A Survey on Deep-Learning-Based Diabetic Retinopathy Classification

<h4>Further links</h4>

 Diabetic Retinopathy

 Symptoms & Causes

 Treatments

<h4>Contact Us</h4>

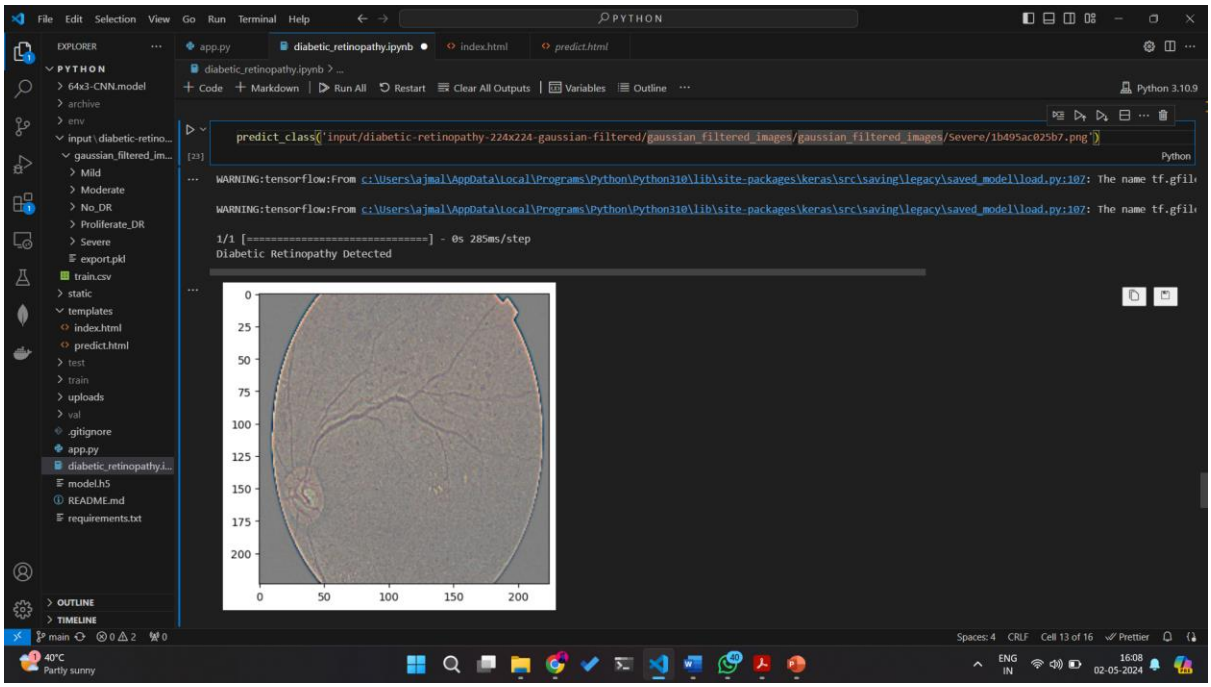
<p>

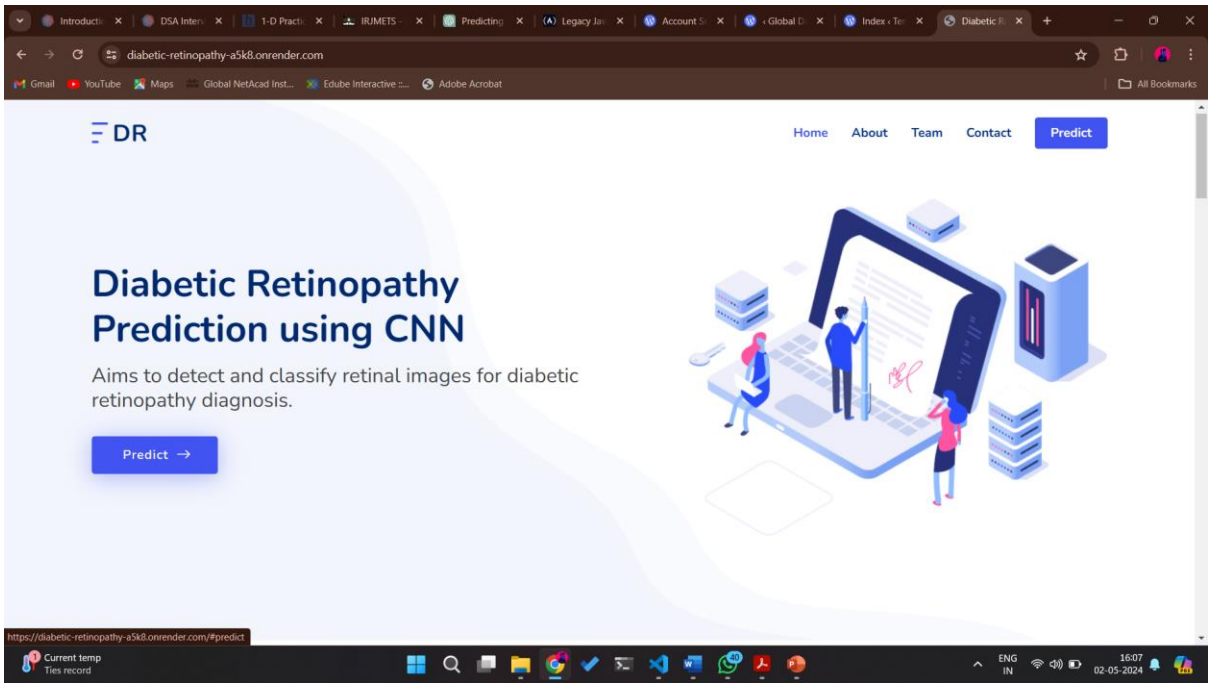
AVS Engineering College,

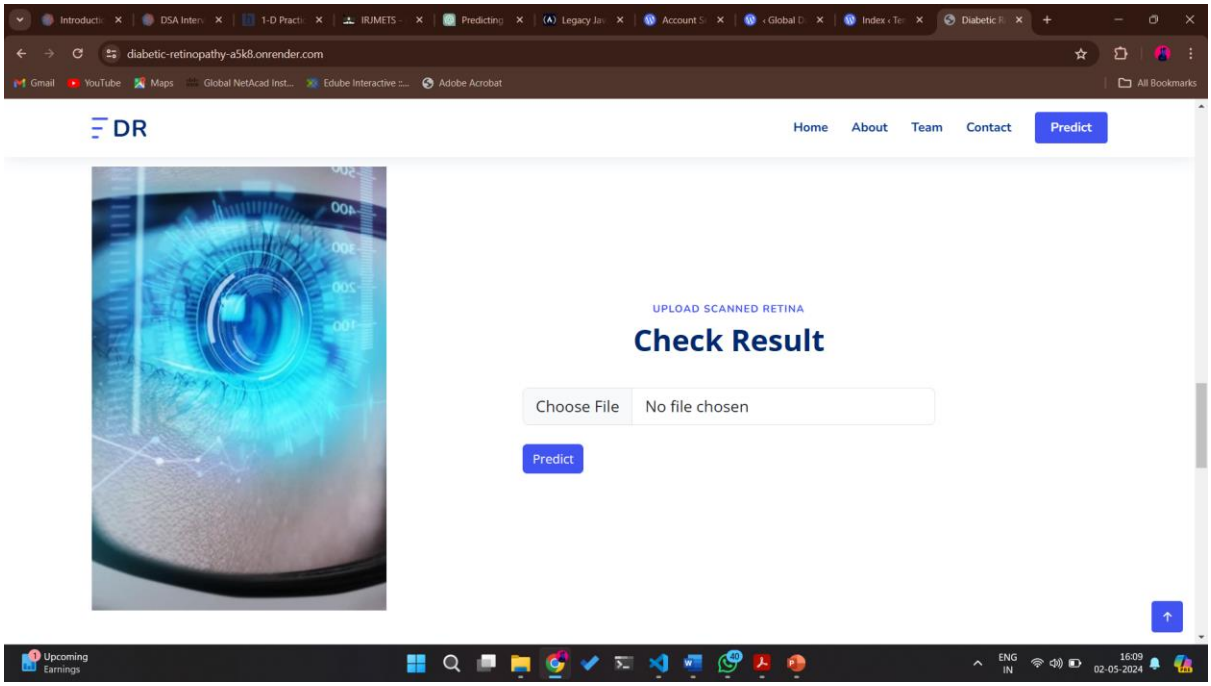
```
            Salem, TN 636003<br>
            India. <br><br>
            <strong>Phone:</strong> +91 70946 53492<br>
            <strong>Email:</strong> ajmalakram152@gmail.com<br>
          </p>

        </div>

      </div>
    </div>
  </div>

  <div class="container">
    <div class="copyright">
      &copy; Copyright <strong><span>DR</span></strong>. All Rights Reserved
    </div>
    <div class="credits">
      <!-- All the links in the footer should remain intact. -->
      <!-- You can delete the links only if you purchased the pro version. -->
      <!-- Licensing information: https://bootstrapmade.com/license/ -->
      <!-- Purchase the pro version with working PHP/AJAX contact form: https://bootstrapmade.com/flexstart-bootstrap-startup-template/ -->
      Designed by <a href="https://bootstrapmade.com/">BootstrapMade</a>
    </div>
  </div>
```

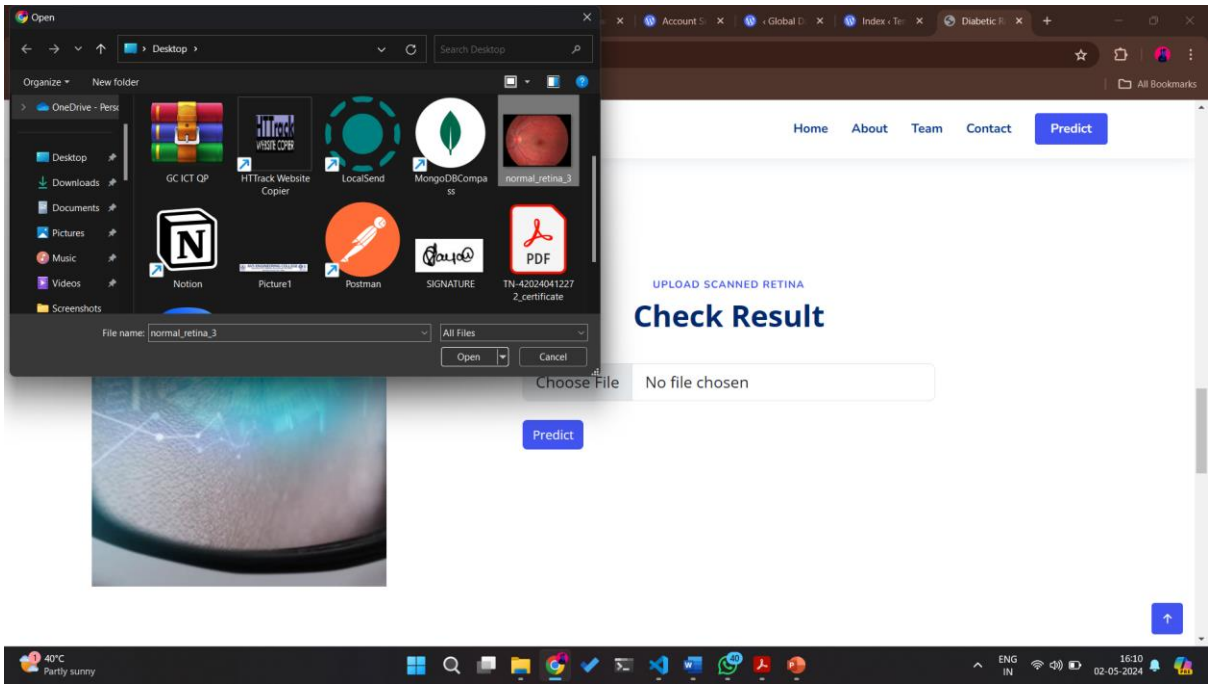
```
  </footer><!-- End Footer -->

  <a href="#" class="back-to-top d-flex align-items-center justify-content-center"><i class="bi bi-arrow-up-short"></i></a>

  <!-- Vendor JS Files -->
  <script src="static/assets/vendor/purecounter/purecounter_vanilla.js"></script>
  <script src="static/assets/vendor/aos/aos.js"></script>
  <script src="static/assets/vendor/bootstrap/js/bootstrap.bundle.min.js"></script>
  <script src="static/assets/vendor/glightbox/js/glightbox.min.js"></script>
  <script src="static/assets/vendor/isotope-layout/isotope.pkgd.min.js"></script>
  <script src="static/assets/vendor/swiper/swiper-bundle.min.js"></script>
  <script src="static/assets/vendor/php-email-form/validate.js"></script>

  <!-- Template Main JS File -->
  <script src="static/assets/js/main.js"></script>
 </body>
 </html>
```

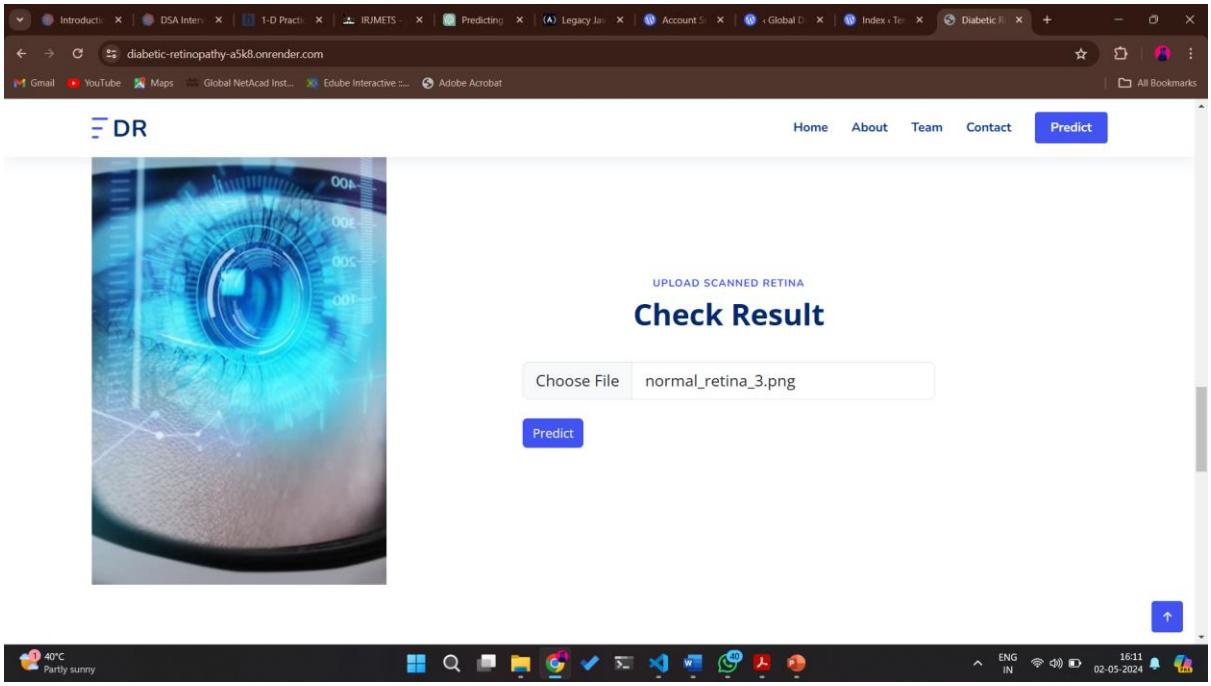
SCREENSHOT AND OUTPUT

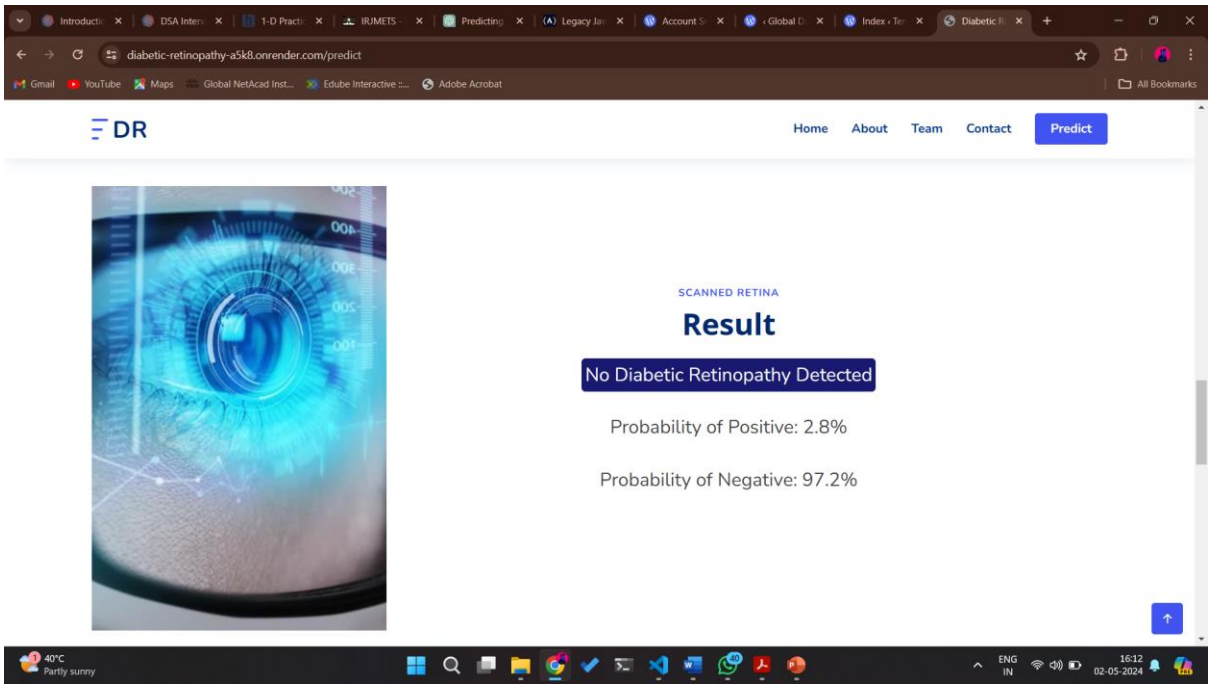





diabetic-retinopathy-a5k8.onrender.com
DR
Home
About
Team
Contact
Predict
UPLOAD SCANNED RETINA
Check Result
Choose File
No file chosen
Predict


Open
Desktop
Search Desktop
Organize
New folder
OneDrive - Perso
Desktop
Downloads
Documents
Pictures
Music
Videos
Screenshots
GC ICT QP
HTTrack Website Copier
LocalSend
MongoDBCompass
normal_retina_3
Notion
Picture1
Postman
SIGNATURE
TN-420240412272_certificate
File name: normal_retina_3
All Files
Open
Cancel
Home
About
Team
Contact
Predict
UPLOAD SCANNED RETINA
Check Result
Choose File
No file chosen
Predict


diabetic-retinopathy-a5k8.onrender.com
DR
Home
About
Team
Contact
Predict
UPLOAD SCANNED RETINA
Check Result
Choose File
normal_retina_3.png
Predict


diabetic-retinopathy-a5k8.onrender.com/predict
DR
Home
About
Team
Contact
Predict
SCANNED RETINA
Result
No Diabetic Retinopathy Detected
Probability of Positive: 2.8%
Probability of Negative: 97.2%

CHAPTER – 11

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