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Department Of Electronics and Communication Engineering

Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

A Project Report

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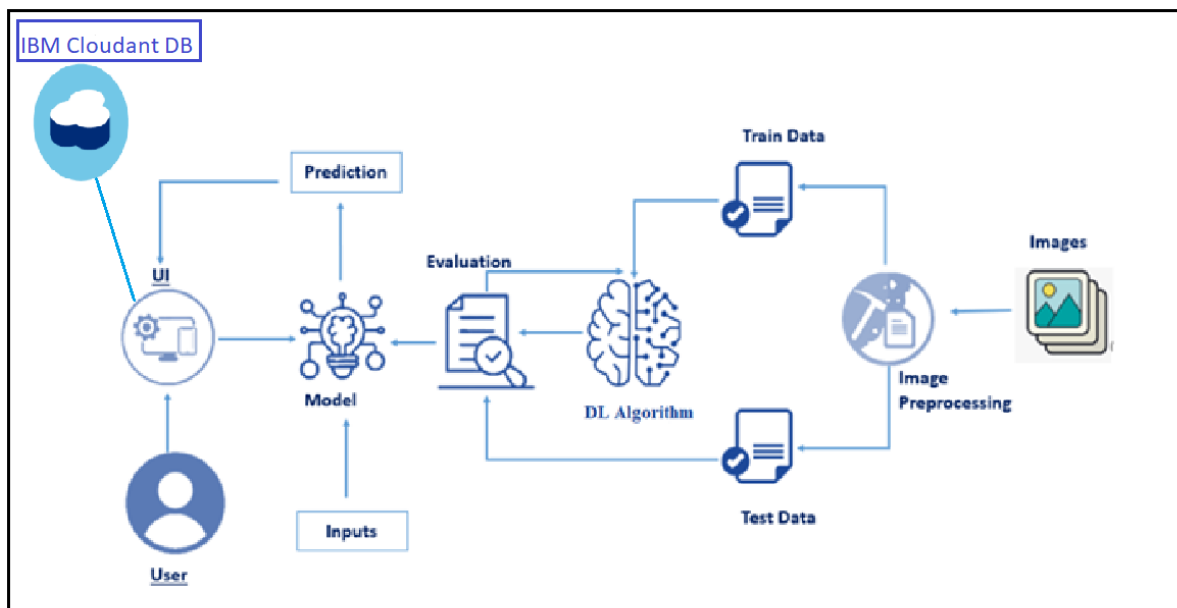
Source Code

GitHub & Project Demo Link

INTRODUCTION:

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

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



1.1) Project Overview :

- The user interacts with the UI (User Interface) to choose the image.
- The chosen image analyzed by the model which is integrated with flask application.
- The Xception Model analyzes the image, then the prediction is showcased on the Flask UI.

To accomplish this, we have to complete all the activities and tasks listed below

- Data Collection.
 - ☆ Create a Train and Test path.
- Data Pre-processing.
- Import the required library
- Configure ImageDataGenerator class
- Apply ImageDataGenerator functionality to Trainset and Testset
- Model Building
 - ☆ Pre-trained CNN model as a Feature Extractor
 - ☆ Adding Dense Layer
 - ☆ Configure the Learning Process
 - ☆ Train the model
 - ☆ Save the Model
 - ☆ Test the model
- Cloudbant DB
 - ☆ Register & Login to IBM Cloud
 - ☆ Create Service Instance
 - ☆ Creating Service Credentials
 - ☆ Launch Cloudbant DB
 - ☆ Create Database
- Application Building
 - ☆ Create an HTML file
 - ☆ Build Python Code

1.2) Purpose :

- Know fundamental concepts and techniques of transfer learning like Xception.
- Gain a broad understanding of image data.
- Know how to pre-process/clean the data using different data pre-processing techniques.
- Know how to build a web application using the Flask framework.

2.LITERATURE SURVEY

Three basic elements:

An introduction or background information section; the body of the review containing the discussion of sources; and, finally, a conclusion and/or recommendations section to end the paper

2.2)References

- Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs. JAMA. 316(22), 2402-2410 (2016).
- Ting, D. S. W. et al. Development and Validation of a Deep Learning System for Diabetic Retinopathy and Related Eye Diseases Using Retinal Images From Multiethnic Populations With Diabetes. JAMA. 318(22), 2211-2223 (2017).
- Wilkinson, C. P. et al. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmology. 110(9), 1677-1682 (2003).
- Summanen, P. et al. Update on Current Care Guideline: Diabetic retinopathy. Duodecim. 131(9), 893-894 (2015)
- Krause, J. et al. Grader Variability and the Importance of Reference Standards for Evaluating Machine Learning Models for Diabetic Retinopathy. Ophthalmology. 125(8), 1264–1272 (2018).
- Guan, M. Y., Gulshan, V., Dai, A. M. & Hinton, G. E. Who Said What: Modeling Individual Labelers Improves Classification. arXiv e-prints., <https://ui.adsabs.harvard.edu/#abs/2017arXiv170308774G>. (Accessed March 01, 2017).
- Wang, F., Casalino, L. P. & Khullar, D. Deep Learning in Medicine-Promise, Defice Progress, and Challenges. JAMA Intern Med.

2.3) Problem Statement Definition:

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.

I am	Describe customer with 3-4 key characteristics - <i>who are they?</i>	Describe the customer and their attributes here
I'm trying to	List their outcome or "job" the care about - <i>what are they trying to achieve?</i>	List the thing they are trying to achieve here
but	Describe what problems or barriers stand in the way – <i>what bothers them most?</i>	Describe the problems or barriers that get in the way here
because	Enter the "root cause" of why the problem or barrier exists – <i>what needs to be solved?</i>	Describe the reason the problems or barriers exist
which makes me feel	Describe the emotions from the customer's point of view – <i>how does it impact them emotionally?</i>	Describe the emotions the result from experiencing the problems or barriers

3.IDEATION & PROPOSED SOLUTION:

3.1) Empathy Map Canvas:

3.2) Ideation & Brainstorming:

3.3)Proposed Solution :

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	<p>Diabetic Retinopathy (DR) is a common complication of diabetes mellitus, which causes lesions on the retina that affect vision. It can lead to blindness if it is not detected early. Unfortunately, DR is not a reversible process. DR early detection and treatment can significantly reduce the risk of vision loss.</p>
2.	Idea / Solution description	<p>In this project, we intend to build a Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy using a convolutional neural network (CNN).We plan on creating a web application where the user interacts with the UI (User Interface) to choose the image.</p> <p>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.</p>
3.	Novelty / Uniqueness	<p>The manual diagnosis process by ophthalmologists is cost and time consuming.our model gives the patient with the outcome whether they have serious condition or normal condition. many models are already there.but we are mainly focusing on the higher accuracy which avoid false results.</p>

4.	Social Impact / Customer Satisfaction	This model provides speed results with higher accuracy. It provides useful and precise information and guidance for diabetic retinopathy prediction, clinical diagnosis and medical services.
5.	Business Model (Revenue Model)	Mainly our intention is to make our project a non profitable one. However we can monetizing the website using google adsense to make money by showing advertisements.
6.	Scalability of the Solution	First we are going to test this model with certain amount of people. Then we can increase the number of users. And also we can further train our model using their inputs as well.

3.4) Problem Solution fit:

4. REQUIREMENT ANALYSIS :

4.1) Functional requirement:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Identifying and selecting dataset	The appropriate dataset to enhance the model's performance is necessary to select.
FR-2	Invitation and information	Invite the full cohort for screening, supplying information tailored appropriately for different groups To enable informed choice to participate.
FR-3	Training	It is required to import the libraries needed for training the model.
FR-4	Diagnosis	Diagnose true cases and identify the false positives.
FR-5	Testing	Conduct screening tests with different data to test if the model is trained well to predict the medical condition.
FR-6	Reporting	Report the outcomes to identify false negatives and improve effectiveness of the screening program.
FR-7	Intervention/Treatment/Followup	The testing of the model helps us to identify the appropriate treatment.

4.2) Non Functional requirement:

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

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Users with basic understanding of the medical condition and computer knowledge can operate the system. User friendly interface that can be

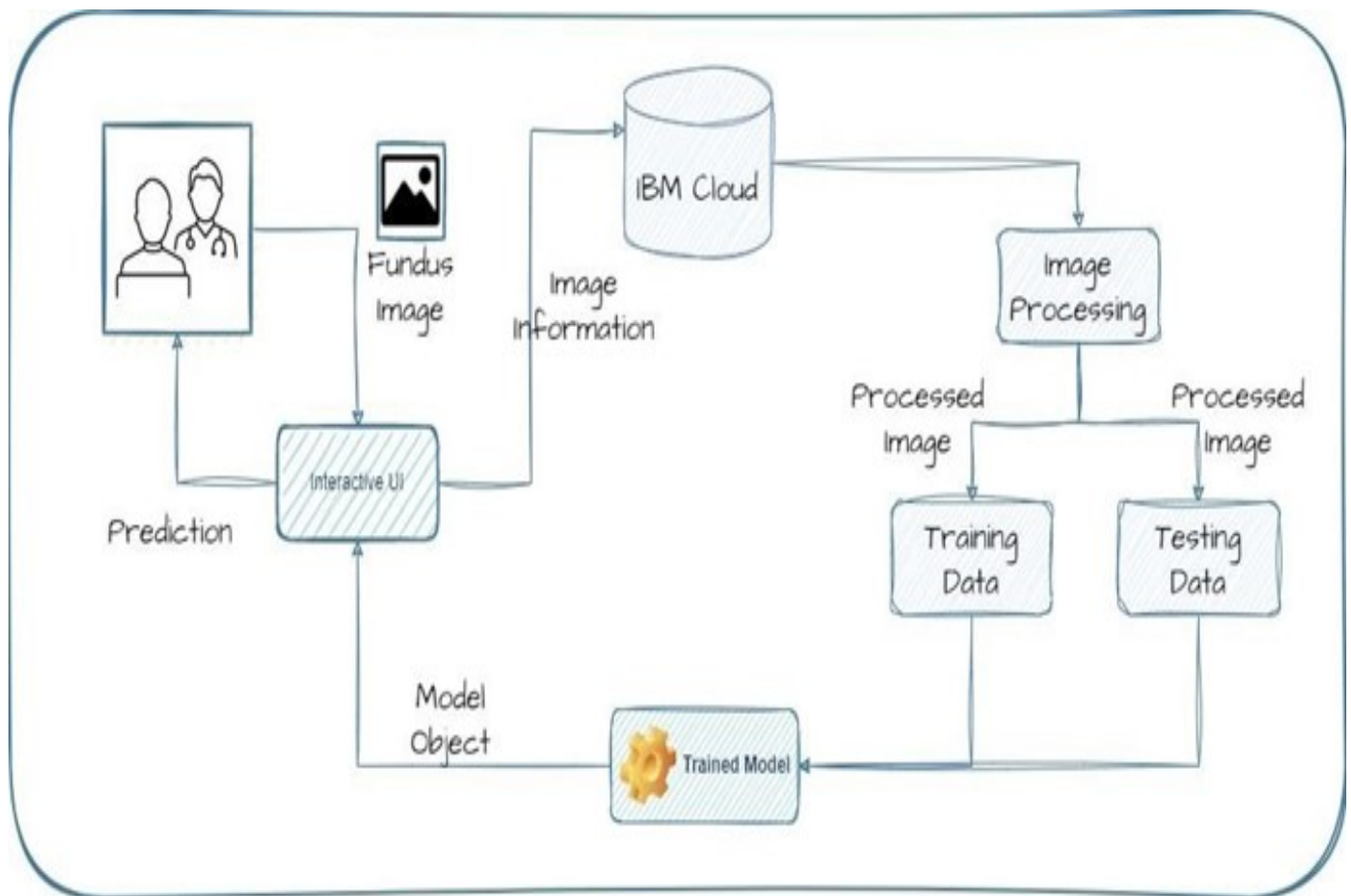
		accessed with ease by users.
NFR-2	Security	Deep learning AI can be more precise around sensitive organs and tissues, reduce blood loss, risk of infection, and pain during detection.
NFR-3	Reliability	There is a chance of hardware failure or false positives when the testing data is more different

		than the training dataset. Permission granted only by the administrator of the system.
NFR-4	Performance	If the system update fails or bugs in the code even though the system can rollback to its initial state. The performance of the model is meant to give speedy results for the patients.
NFR-5	Availability	The treatment should be available at low cost so that everyone with DR can find it beneficial.
NFR-6	Scalability	By processing more datasets for the reference of DR detection.

5. PROJECT DESIGN:

5.1) Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2) Solution & Technical Architecture:

Table-1 :

Components&Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript
2.	Application Logic-1(Back-end)	Logic for a process in the application and the UI	Python, Flask
3.	Application Logic-2	Logic for a process in the application and cloud	IBM Watson STT service
4.	Cloud Database	Database Service on Cloud	IBM Cloudant.
5.	File Storage	File storage requirements	IBM Block Storage
6.	Machine Learning Model	Purpose of Machine Learning Model	Deep Learning, Convolutional Neural Network.
7.	Infrastructure (Server / Cloud)	Application Deployment on Cloud	IBM Cloud.

Table-2:
Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Front end apps
2.	Security Implementations	Email constraint and database	Mail notifications, IBM free trial cloud instant service.
3.	Scalable Architecture	Scalability of architecture (3 – tier, Micro-services) is extensible as it is web-oriented with database application	Cloudant DB, Front end apps
4.	Availability	Availability of application (e.g. use of load balancers, distributed servers etc.)	Open source platforms provide great service.
5.	Performance	Session management & Model Accuracy	User sessions from automatic controller provided by python.

5.3)User Stories:

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register and access the dashboard with Gmail Login	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-6	As a user, I can navigate through various sections of the application.	I can navigate the sections of the application	High	Sprint-2
Customer (Web user)	Registration	USN-1	As a user, I can register for the application by entering, password, and confirming my password	I can access my account/ dashboard	High	Sprint-1
Customer Care Executive		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can review confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register and access the dashboard with Gmail Login	Medium	Sprint-1

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
	Login	USN-5	As a user, I can log onto the application by entering email & password	I can login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-6	As a user, I can navigate through sections of the applications	I can navigate the sections of the applications	High	Sprint-2
Administrator	Login	USN-1	As a administrator, I can log into the application by entering email and password	I can Login the application by email and access the dashboard	High	Sprint-1
	Dashboard	USN-2	As an administrator, I can navigate through various sections of the application	I can navigate the sections of the application	High	Sprint-2
		USN-3	As an administrator, I can update data in database	I can update all data in the database.	High	Sprint-3
		USN-4	As an administrator, I can view all stages of the product	I can view and review all stages of the product	High	Sprint-3
		USN-5	As an administrator, I can add or remove user	I can add or remove an user from the application	Medium	Sprint-3

6) PROJECT PLANNING & SCHEDULING**6.1) Sprint Planning & Estimation:**

Project Planning Phase	Sprints	19 Oct 2022 - 22 Oct 2022
Project Development Phase	Sprint-1	24 Oct 2022 - 28 Oct 2022
	Sprint-2	30 Oct 2022 - 04 Nov 2022
	Sprint-3	06 Nov 2022- 11 Nov 2022
	Sprint-4	13 Nov 2022 - 18 Nov 2022

6.2)Sprint Delivery Schedule:

Sprint-1	<ol style="list-style-type: none"> 1. Download The Dataset 2. Import ImageDataGenerator 3. Library 4. Configure 5. ImageDataGenerator class 6. Import Libraries 7. Initialize the Model 	24 Oct 2022 – 30 Oct 2022
Sprint – 2	<ol style="list-style-type: none"> 1. Register IBM Cloud 2. ApplyImageDataGenerator functionality to Trainset and Dataset 3. Test the model 	31 Oct 2022 – 06 Nov 2022
Sprint – 3	<ol style="list-style-type: none"> 1. Train the model on IBM 2. Create Html files 3. Test the model 	07 Nov 2022 – 13 Nov 2022
Sprint - 4	<ol style="list-style-type: none"> 1. Configure the Learning Process 2. Build python code 3. Adding dense layer 4. Adding CNN layer 	14 Nov 2022 – 20 Nov 2022

6.3) Reports from JIRA:

The screenshot displays the Jira Software interface for a project named 'ibm-diabetic-retinopathy'. The left sidebar shows navigation options under 'PLANNING' (Roadmap, Backlog, Board) and 'DEVELOPMENT' (Code, Project pages, Add shortcut, Project settings). The main area shows a Kanban board for 'Sprint-1'. The board has three columns: 'TO DO', 'IN PROGRESS', and 'DONE 3 ISSUES'. The 'DONE' column contains three issues: IDR-11, IDR-12, and IDR-13, each with a description and a green checkmark. The top navigation bar includes 'Jira Software', 'Your work', 'Projects', 'Filters', 'Dashboards', 'People', 'Apps', and a 'Create' button. A search bar is located in the top right corner.

The screenshot displays the Jira Software interface for the same project, 'ibm-diabetic-retinopathy', but for 'Sprint-2'. The left sidebar is identical to the previous screenshot. The main area shows a Kanban board for 'Sprint-2'. The board has three columns: 'TO DO', 'IN PROGRESS', and 'DONE 3 OF 6 ISSUES'. The 'DONE' column contains three issues: IDR-15, IDR-14, and IDR-16, each with a description and a green checkmark. The top navigation bar is identical to the previous screenshot. A 'Download' button is visible in the top right corner.

Jira Software Your work ▾ Projects ▾ Filters ▾ Dashboards ▾ People ▾ Apps ▾ Create

Search

ibm-diabetic-retinopat...
Software project

PLANNING

- Roadmap
- Backlog
- Board**

DEVELOPMENT

- Code

Project pages

Add shortcut

Project settings

Projects / ibm-diabetic-retinopathy

Sprint-3

0 days remaining

Search SK Epic ▾ Sprint 1 ▾ Clear filters

GROUP BY None

TO DO

IN PROGRESS 1 OF 1 ISSUE

Doctor uses this report for seeing patient's activity
IDR-18

DONE 1 OF 7 ISSUE ✓

Connecting to database
IDR-17 ✓

Jira Software Your work ▾ Projects ▾ Filters ▾ Dashboards ▾ People ▾ Apps ▾ Create

Search

ibm-diabetic-retinopat...
Software project

PLANNING

- Roadmap
- Backlog
- Board**

DEVELOPMENT

- Code

Project pages

Add shortcut

Project settings

Projects / ibm-diabetic-retinopathy

Sprint-4

2 days remaining

Search SK Epic ▾ Sprint 1 ▾ Clear filters

GROUP BY None

TO DO

IN PROGRESS

DONE 2 OF 9 ISSUES ✓

User can see their dashboard
IDR-19 ✓

Logout from the current user
IDR-20 ✓

7.CODING & SOLUTIONING

7.1)Feature 1: Login Page

```
<!DOCTYPE html>

<html lang="en">

  <head>

    <meta charset="UTF-8" />

    <meta http-equiv="X-UA-Compatible" content="IE=edge" />

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

    <!-- CSS only -->

    <link

      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"

      rel="stylesheet"

      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"

      crossorigin="anonymous"

    />

    <!-- JavaScript Bundle with Popper -->

    <script

      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"

      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIH7NnikvbZlHgTPOOmMi466C8"

      crossorigin="anonymous"

    ></script>

    <style>

      #navbarRight {

        margin-left: auto;
```

```
padding-right:10px;

}

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

</style>

<title>DR Predcition</title>

</head>

<form action="",method='POST'>

<nav class="navbar navbar-expand-lg navbar-light bg-dark">

  <div>

    <a class="navbar-brand" href="#" style="color:aliceblue">User Login</a>

  </div>

  <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

    <ul class="navbar-nav mr-auto text-center" id="navbarRight">

      <li class="nav-item active">

        <a class="nav-link" href="index" style="color: aliceblue;">Home </a>

      </li>

      <li class="nav-item">

        <a class="nav-link" href="login" style="color: aliceblue;">Login</a>

      </li>

      <li class="nav-item">

        <a class="nav-link" href="register" style="color: aliceblue;">Register</a>

      </li>

    </ul>

  </div>

</nav>

</form>
```

```

    </ul>

</div>

</nav>

<br><br>

<form class="form-inline" action="/login" method="GET">

<div class="container" style="width: 600px; height: 600px;">

    <div class="mb-3 d-flex justify-content-center"><script
src="https://cdn.lordicon.com/xdjxvujz.js"></script>

        <lord-icon

            src="https://cdn.lordicon.com/elkhjhci.json"

            trigger="hover"

            style="width:200px;height:200px">

        </lord-icon></div>

        <div class="mb-3">

            <input type="email" class="form-control" id="exampleInputEmail1" name="mail" aria-
describedby="emailHelp" placeholder="Enter Registered Mail ID">

        </div>

        <div class="mb-3">

            <input type="password" class="form-control" id="exampleInputPassword1" name="pass"
placeholder="Enter Password">

        </div>

        <div class="mb-3">

            <button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;"
type="submit">Login</button>

        </div>

        {{pred}}

</div>

```



```

</form>

</body>

</html>

```

7.2)Feature 2 Image Analysis :

```

{
  "nbformat": 4,
  "nbformat_minor": 0,
  "metadata": {
    "colab": {
      "provenance": [],
      "collapsed_sections": []
    },
    "kernelspec": {
      "name": "python3",
      "display_name": "Python 3"
    },
    "language_info": {
      "name": "python"
    }
  },
  "cells": [
    {
      "cell_type": "code",
      "execution_count": 1,
      "metadata": {

```

```

"colab": {
  "base_uri": "https://localhost:8080/"
},
"id": "Q7zNU4HI0OR3",
"outputId": "5385827c-6890-4b17-dcb2-5225ac83b4f8"
},
"outputs": [
  {
    "output_type": "stream",
    "name": "stdout",
    "text": [
      "Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-
wheels/public/simple/\n",
      "Collecting cloudant\n",
      "  Downloading cloudant-2.15.0-py3-none-any.whl (80 kB)\n",
      "    \u001b[K | 80 kB 6.3 MB/s \n",
      "    \u001b[?25hRequirement already satisfied: requests<3.0.0,>=2.7.0 in
/usr/local/lib/python3.7/dist-packages (from cloudant) (2.23.0)\n",
      "Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-
packages (from requests<3.0.0,>=2.7.0->cloudant) (2022.9.24)\n",
      "Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packages
(from requests<3.0.0,>=2.7.0->cloudant) (2.10)\n",
      "Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-
packages (from requests<3.0.0,>=2.7.0->cloudant) (3.0.4)\n",
      "Requirement already satisfied: urllib3!=1.25.0,!<1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from requests<3.0.0,>=2.7.0->cloudant) (1.24.3)\n",
      "Installing collected packages: cloudant\n",

```

```

        "Successfully installed cloudant-2.15.0\n"
    ]
}
],
"source": [
    "pip install cloudant"
]
},
{
    "cell_type": "code",
    "source": [
        "from cloudant.client import Cloudant\n"
    ],
    "metadata": {
        "id": "0d5jBjO7OfET"
    },
    "execution_count": 2,
    "outputs": []
},
{
    "cell_type": "code",
    "source": [
        "client=Cloudant.iam('0f5ab837-7e5c-486c-a220-5256e075616c-
bluemix','0UGpqPnFUGkN6XC93fLwLujtajQ7wWmOVf7HGB2z2gqX',connect=True)"
    ],

```

```

    "metadata": {
      "id": "JTLaKJBKOpYb"
    },
    "execution_count": 6,
    "outputs": []
  },
  {
    "cell_type": "code",
    "source": [
      "my_database=client.create_database('my_database')"
    ],
    "metadata": {
      "id": "Oo9UsVKIQYFs"
    },
    "execution_count": 7,
    "outputs": []
  }
]
}

```

9 TESTING

Test Cases:

User Acceptance Testing:

1. Purpose of Document:-

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

2. Defect Analysis:-

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

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	1	0	0	0	1
Duplicate	4	1	3	0	8
External	1	3	0	0	4
Fixed	2	4	4	2	12
Not Reproduced	0	0	0	1	1
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	8	8	4	2	22

3. Test-Case Analysis

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

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	5	0	0	5
Client Application	10	0	0	10
Security	2	0	0	2
Out-source Shipping	0	0	0	0
Exception Reporting	2	0	0	2
Final Report Output	4	0	0	4
Version Control	2	0	0	2

Result:**Performance Metric:**

In the binary classification tasks, i.e. NRDR/RDR and NRDME/RDME, our algorithm achieved the best results using the largest 2095×2095 pixels input image size. In the NRDR/RDR classification on our primary validation set having 7118 images, our algorithm achieved the sensitivity of 0.896 (with 95% CI: 0.885–0.907) and specificity 0.974 (with 95% CI: 0.969–979) and AUC of 0.987 (with 95% CI: 0.984–0.989). Our model performance was evaluated at the operating point where the tuning set achieved 0.900 sensitivity, in a similar manner to Ting et al.5, while Gulshan et al.4 had two operating points namely at a high specificity (0.980) point and at a high sensitivity (0.975) point. In Table 2 we present the AUC values of our model, along with the AUC values reported by Gulshan et al.4 and Ting et al.5. The Table 2 also illustrates our results and the results reported by Ting et al.4 at 0.900 sensitivity operating point and results reported by Gulshan et al.4, closest to the 0.900 sensitivity operating point. Two other recent studies, Krause et al.8 and Guan et al.9, also explored the NRDR/RDR classification, but as they do not report results close to the 0.900 sensitivity point, we make a separate comparison with these studies.

Model Performance Testing:

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

S.No	Parameter	Values	Screenshot
1.	Model Summary	-	
2.	Accuracy	Training Accuracy – 76.92 Validation Accuracy -71.83	
3.	Confidence Score (Only Yolo Projects)	Class Detected Confidence Score -	

ADVANTAGES	DISADVANTAGES
Retains computational simplicity of the enhancement thresholding type of edge operators.	It incorporates the advantages of using model based edge detectors due to large size of the convolutional kernel.
This method reduces the false positive rate by a factor of 15 times	This approach not captured in evaluation is the property connectedness of

CONCLUSION:

This project successfully detects the diabetes by using deep learn-ing on a fundus images and it can be used as one of method to detect the diabetes on the future. Nevertheless, it need some im-provement to make the accuracy of the project nearest to 100%. Next, Alexnet layers is the most perfect layer for deep learning neural network these day.

Automated screening systems significantly reduce the time required to determine diagnoses, saving effort and costs for ophthalmologists and result in the timely treatment of patients. Automated systems for DR detection play an important role in detecting DR at an early stage. The DR stages are based on the type of lesions that appear on the retina. This article has reviewed the most recent automated systems of diabetic retinopathy detection and classification that used deep learning techniques. The common fundus DR datasets that are publicly available have been described, and deep-learning techniques have been briefly explained. Most researchers have used the CNN for the classification and the detection of the DR images due to its efficiency. This review has also discussed the useful techniques that can be utilized to detect and to classify DR using DL.

FUTURE SCOPE:

With the recent advancement of the high-resolution UWF imaging, up to 82% of the retinal surface can be captured in a single image³³. Several study groups obtained a high level of agreement from a comparison between the UWF photography and the ETDRS 7SF photography for DR evaluation^{33,34,35,36}. Furthermore, Silva et al. demonstrated that peripheral lesions identified on UWF imaging are associated with the increased risk of DR progression³⁷. Those pioneering studies^{33,34,35,36,37} regarding the UWF imaging for DR severity evaluation utilized capturing devices from Optos. The wide-field scanning laser ophthalmoscopy (SLO) by Optos provides a single image covering nearly 200° of the retina¹⁸. During transforming the wide-field image of the spherical eye into the 2-D image, small lesions may be inconspicuous due to distortion¹⁸. Furthermore, eyelashes and eyelids cover the superior and inferior periphery of the retina in some cases³². Aiello et al.³³ demonstrated that the ETDRS 7SF photography and corresponding fields in the UWF photography have moderate to substantial agreements for DR severity evaluation.

In this study, we configured a deep learning system for DR detection using the ETDRS 7SF image extracted from the UWF fundus image. Although the UWF imaging provides a wide captured area, the far periphery of the retina in UWF images may contain eyelids and eyelashes. Furthermore, to our knowledge, most of the existing deep learning systems for DR detection and evaluation adopt conventional single-field fundus photography. Hence, we extracted and utilized the ETDRS 7SF from UWF images for the DR detection task. By segmenting the ETDRS 7SF from UWF photography, we can save the time and effort for capturing the ETDRS 7SF photography using a single-field fundus camera. To demonstrate the effectiveness of the automated DR detection system based on the ETDRS 7SF images segmented from the UWF photography, we compared the DR detection performance of our system with a system based on the ETDRS F1–F2 images.

APPENDIX:**Source Code (Login Page):**

```
<!DOCTYPE html>

<html lang="en">

<head>

  <meta charset="UTF-8" />

  <meta http-equiv="X-UA-Compatible" content="IE=edge" />

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

  <!-- CSS only -->

  <link

    href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"

    rel="stylesheet"

    integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"

    crossorigin="anonymous"

  />

  <!-- JavaScript Bundle with Popper -->

  <script

    src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"

    integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIH7NnikvZlHgTPOOmMi466C8"

    crossorigin="anonymous"

  ></script>

  <style>

    #navbarRight {

      margin-left: auto;

      padding-right: 10px;
```

```
}

.navbar-brand{

    padding-left:15px;

}

</style>

<title>DR Predcition</title>

</head>

<form action="",method='POST'>

<nav class="navbar navbar-expand-lg navbar-light bg-dark">

    <div>

        <a class="navbar-brand" href="#" style="color:aliceblue">User Login</a>

    </div>

    <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

        <ul class="navbar-nav mr-auto text-center" id="navbarRight">

            <li class="nav-item active">

                <a class="nav-link" href="index" style="color: aliceblue;">Home </a>

            </li>

            <li class="nav-item">

                <a class="nav-link" href="login" style="color: aliceblue;">Login</a>

            </li>

            <li class="nav-item">

                <a class="nav-link" href="register" style="color: aliceblue;">Register</a>

            </li>

        </ul>

    </div>

</nav>
```

```

</div>

</nav>

<br><br>

<form class="form-inline" action="/login" method="GET">

  <div class="container" style="width: 600px; height: 600px;">

    <div class="mb-3 d-flex justify-content-center"><script
src="https://cdn.lordicon.com/xdjxvujz.js"></script>

      <lord-icon

        src="https://cdn.lordicon.com/elkhjhci.json"

        trigger="hover"

        style="width:200px;height:200px">

      </lord-icon></div>

      <div class="mb-3">

        <input type="email" class="form-control" id="exampleInputEmail1" name="mail" aria-
describedby="emailHelp" placeholder="Enter Registered Mail ID">

      </div>

      <div class="mb-3">

        <input type="password" class="form-control" id="exampleInputPassword1" name="pass"
placeholder="Enter Password">

      </div>

      <div class="mb-3">

        <button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;"
type="submit">Login</button>

      </div>

      {{pred}}

    </div>

  </form>

```

```
</body>
```

```
</html>
```

Index Page:

```
<!DOCTYPE html>
```

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

```
<head>
```

```
<meta charset="UTF-8" />
```

```
<meta http-equiv="X-UA-Compatible" content="IE=edge" />
```

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

```
<!-- CSS only -->
```

```
<link
```

```
href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
```

```
rel="stylesheet"
```

```
integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYal1GyVh/UjpbCx/TYkiZhlZB6+fzT"
```

```
crossorigin="anonymous"
```

```
/>
```

```
<!-- JavaScript Bundle with Popper -->
```

```
<script
```

```
src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
```

```
integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIH7NnikvbZlHgTPOOmMi466C8"
```

```
crossorigin="anonymous"
```

```
></script>
```

```
<style>
```

```
#navbarRight {
```

```
margin-left: auto;
```

```
padding-right:10px;

}

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

</style>

<title>DR Predcition</title>

</head>

<form action="",method='POST'>

<nav class="navbar navbar-expand-lg navbar-light bg-dark">

<div>

<a class="navbar-brand" href="#" style="color:aliceblue">User Login</a>

</div>

<div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

<ul class="navbar-nav mr-auto text-center" id="navbarRight">

<li class="nav-item active">

<a class="nav-link" href="index" style="color: aliceblue;">Home </a>

</li>

<li class="nav-item">

<a class="nav-link" href="login" style="color: aliceblue;">Login</a>

</li>

<li class="nav-item">

<a class="nav-link" href="register" style="color: aliceblue;">Register</a>

</li>
```

```

    </ul>

</div>

</nav>

<br><br>

<form class="form-inline" action="/login" method="GET">

<div class="container" style="width: 600px; height: 600px;">

    <div class="mb-3 d-flex justify-content-center"><script
src="https://cdn.lordicon.com/xdjxvujz.js"></script>

    <lord-icon

        src="https://cdn.lordicon.com/elkhjhci.json"

        trigger="hover"

        style="width:200px;height:200px">

    </lord-icon></div>

    <div class="mb-3">

        <input type="email" class="form-control" id="exampleInputEmail1" name="mail" aria-
describedby="emailHelp" placeholder="Enter Registered Mail ID">

    </div>

    <div class="mb-3">

        <input type="password" class="form-control" id="exampleInputPassword1" name="pass"
placeholder="Enter Password">

    </div>

    <div class="mb-3">

        <button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;"
type="submit">Login</button>

    </div>

    {{pred}}

</div>

```



```

</form>

</body>

</html>

```

Logout Page:

```

<!DOCTYPE html>

<html lang="en">

<head>

  <meta charset="UTF-8" />

  <meta http-equiv="X-UA-Compatible" content="IE=edge" />

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

  <!-- CSS only -->

  <link

    href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"

    rel="stylesheet"

    integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"

    crossorigin="anonymous"

  />

  <!-- JavaScript Bundle with Popper -->

  <script

    src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"

    integrity="sha384-u1OknCVxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIH7NnikvbZIHgTPOOmMi466C8"

    crossorigin="anonymous"

  ></script>

  <style>

    #navbarRight {

```

```
margin-left: auto;

padding-right:10px;

}

.navbar-brand{

padding-left:15px;

}

</style>

<title>DR Predcition</title>

</head>

<body>

<nav class="navbar navbar-expand-lg navbar-light bg-dark">

<div>

<a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy</a>

</div>

<div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

<ul class="navbar-nav mr-auto text-center" id="navbarRight">

<li class="nav-item active">

<a class="nav-link" href="index" style="color: aliceblue;">Home </a>

</li>

<li class="nav-item">

<a class="nav-link" href="login" style="color: aliceblue;">Login</a>

</li>

<li class="nav-item">

<a class="nav-link" href="register" style="color: aliceblue;">Register</a>

</li>
```

```

    </ul>

</div>

</nav>

<br><br>

<div class="d-flex justify-content-center">

  <div class="row d-flex display-3 justify-content-center">

    Successfully Logged Out!

    <br><br>

    <a href="login" class="btn btn-lg btn-dark">Login for more Information</a>

  </div>

</div>

</body>

</html>

```

Prediction Page:

```

<!DOCTYPE html>

<html lang="en">

<head>

  <meta charset="UTF-8" />

  <meta http-equiv="X-UA-Compatible" content="IE=edge" />

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

  <!-- CSS only -->

  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css" rel="stylesheet"

    integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYal1GyVh/UjpbCx/TYkiZhlZB6+fzT"

    crossorigin="anonymous" />

```

```
<!-- JavaScript Bundle with Popper -->

<script src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
  integrity="sha384-u1OknCVxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHl7NnikvbZlHgTPOOmMi466C8"
  crossorigin="anonymous"></script>

<style>

  #navbarRight {

    margin-left: auto;

    padding-right: 10px;

  }

  .navbar-brand {

    padding-left: 15px;

  }

  .row {

    width: 90%;

  }

</style>

<title>DR Predcition</title>

</head>

<body>

  <nav class="navbar navbar-expand-lg navbar-light bg-dark">

    <div>

      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
```

```

</div>

<div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

  <ul class="navbar-nav mr-auto text-center" id="navbarRight">

    <li class="nav-item active">

      <a class="nav-link" href="index" style="color: aliceblue;">Home </a>

    </li>

    <li class="nav-item">

      <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>

    </li>

  </ul>

</div>

</nav>

<br><br>

<div class="container justify-content-center" style="width:700px">

  <form action = "/predict" method = "POST" enctype="multipart/form-data">

    <label for="formFileLg" class="form-label">Upload Image</label>

    <input class="form-control form-control-lg" name = "file" type="file" />

    <br>

    <button class="btn btn-lg btn-dark" type = "submit">Predict</button>

  </form>

  <br>

  <h1>{{prediction}}</h1>

</div>

<br><br><br>

<div class="d-flex justify-content-center" >

```

```

</div>

</body>

</html>

```

Register Page:

```

<!-- <!DOCTYPE html>

<html lang="en">

<head>

    <meta charset="UTF-8" />

    <meta http-equiv="X-UA-Compatible" content="IE=edge" />

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

    <!-- CSS only -->

    <link

        href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"

        rel="stylesheet"

        integrity="sha384-iYQeCzEYFbKjA/T2uDLTPkwGzCiq6soy8tYal1GyVh/UjpbCx/TYkiZhlZB6+fzT"

        crossorigin="anonymous"

    />

    <!-- JavaScript Bundle with Popper -->

    <script

        src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"

        integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIH7NnikvbZIHgTPOOmMi466C8"

        crossorigin="anonymous"

    ></script>

    <style>

        #navbarRight {

            margin-left: auto;

```

```

padding-right:10px;

}

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

</style>

<title>DR Predcition</title>

</head>

<form action="{{url_for('register')}}" method="post" >

<nav class="navbar navbar-expand-lg navbar-light bg-dark">

<div>

<a class="navbar-brand" href="#" style="color:aliceblue">Registration</a>

</div>

<div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">

<ul class="navbar-nav mr-auto text-center" id="navbarRight">

<li class="nav-item active">

<a class="nav-link" href="index" style="color: aliceblue;">Home </a>

</li>

<li class="nav-item">

<a class="nav-link" href="login" style="color: aliceblue;">Login</a>

</li>

<li class="nav-item">

<a class="nav-link" href="register" style="color: aliceblue;">Register</a>

</li>

</ul>

</div>

```

```

</nav>

<br><br>

<form class="form-inline" method ="POST">

<div class="container" style="width: 600px; height: 600px;">

<div class="mb-3 d-flex justify-content-center"><script src="https://cdn.lordicon.com/xdjxvujz.js"></script>

<lord-icon

    src="https://cdn.lordicon.com/elkhjhci.json"

    trigger="hover"

    style="width:200px;height:200px">

</lord-icon></div>

    <div class="mb-3">

        <input type="text" class="form-control" id="exampleInputName" name = "name" aria-
describedby="nameHelp" placeholder="Enter Name">

    </div>

    <div class="mb-3">

        <input type="email" class="form-control" id="exampleInputEmail1" name="emailid" aria-
describedby="emailHelp" placeholder="Enter Mail ID">

    </div>

    <div class="mb-3">

        <input type="number" class="form-control" id="exampleInputNumber1" name="num" aria-
describedby="numberHelp" placeholder="Enter Mobile number">

    </div>

    <div class="mb-3">

        <input type="password" class="form-control" id="exampleInputPassword1" name="pass"
placeholder="Enter Password">

    </div>

    <div class="mb-3">

        <button type="submit form-control" class="btn btn-dark btn-primary" style="width:100%;">Register</button>

    </div>

```



```
<div class="mb-3 d-flex justify-content-center">  
  
  <a href="login" class="nav-link"> Already Registered: Login Here</a>  
  
</div>  
  
{{pred}}  
  
</div>  
  
</form>  
  
</body>  
  
</html> -->
```

GitHub Link:

<https://github.com/IBM-EPBL/IBM-Project-45581-1664017262>

Project Demo Link:

https://drive.google.com/file/d/1RctdmFYkECYXt696nqNeVYb0_g5IHs2-/view?usp=share_link

Project Demo VIDEO YOUTUBE Link:

<https://www.youtube.com/embed/z8nVJOePej8>