DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

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A PROJECT REPORT

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CHAPTER - 1

INTRODUCTION

1.1 PROJECT OVERVIEW

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

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

1.2 PURPOSE

The Proposed work intends to automate the detection and classification of diabetic retinopathy from retinal fundus image which is very important in ophthalmology. Most of the existing methods use handcrafted features and those are fed to the classifier for detection and classification purpose. Recently convolutional neural network (CNN) is used for this classification problem but the architecture of CNN is manually designed. In this work, a genetic algorithm based technique is proposed to automatically determine the parameters of CNN and then the network is used for classification of diabetic retinopathy. The proposed CNN model consists of a series of convolution and pooling layer used for feature extraction. Finally support vector machine (SVM) is used for classification.

Hyper-parameters like number of convolution and pooling layer, number of kernel and kernel size of convolution layer are determined by using the genetic algorithm. The proposed methodology is tested on publicly available Messidor dataset.

CHAPTER - 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

Diabetic Retinopathy (DR) is a degenerative disease that impacts the eyes and is a consequence of Diabetes mellitus, where high blood glucose levels induce lesions on the eye retina. Diabetic Retinopathy is regarded as the leading cause of blindness for diabetic patients, especially the working-age population in developing nations. Treatment involves sustaining the patient's current grade of vision since the disease is irreversible. Early detection of Diabetic Retinopathy is crucial in order to sustain the patient's vision effectively. The main issue involved with DR detection is that the manual diagnosis process is very time, money, and effort consuming and involves an ophthalmologist's examination of eye retinal fundus images. The latter also proves to be more difficult, particularly in the early stages of the disease when disease features are less prominent in the images.

Machine learning-based medical image analysis has proven competency in assessing retinal fundus images, and the utilization of deep learning algorithms has aided the early diagnosis of Diabetic Retinopathy (DR). This paper reviews and analyzes state-of-the-art deep learning methods in supervised, self-supervised, and Vision Transformer setups, proposing retinal fundus image classification and detection. For instance, referable, nonreferable, and proliferative classifications of Diabetic Retinopathy are reviewed and summarized. Moreover, the paper discusses the available retinal fundus datasets for Diabetic Retinopathy that are used for tasks such as detection, classification, and segmentation. The paper also assesses research gaps in the area of DR detection/classification and addresses various challenges that need further study and investigation

2.2 REFERENCES

1. **Deep Learning Fundus Image Analysis for Diabetic Retinopathy and Macular Edema Grading** by Jakko Shalsten , Joel Jaskari

   https://www.nature.com/articles/s41598-019-47181-w

2. **Early Detection of Diabetic Retinopathy by Using Deep Learning Neural Network** by

Mohamad hazim Johari and Hiron Hassan

https://www.researchgate.net/publication/328272991_Early_Detection_of_Diabetic_Retinopathy_by_Using_Deep_Learning_Neural_Network

3.Diabetic Retinopathy Fundus Image Classification and Lesions Localization System Using Deep Learning by Wajdan L.Alyoubi and Maysoon F.Abdulkhair

https://www.mdpi.com/1424-8220/21/11/3704

4. Deep Learning based Early Detection and Grading of Diabetic Retinopathy Using Retinal Fundus Images by Sheik Muhammad Saiful Islam and Md Mahedi Hasan

https://arxiv.org/abs/1812.10595

2.3 PROBLEM STATEMENT DEFINITION

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

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

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

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

WHERE ? Blurred vision, Distorted vision will occur. WHO? It is common among the Diabetic patients.

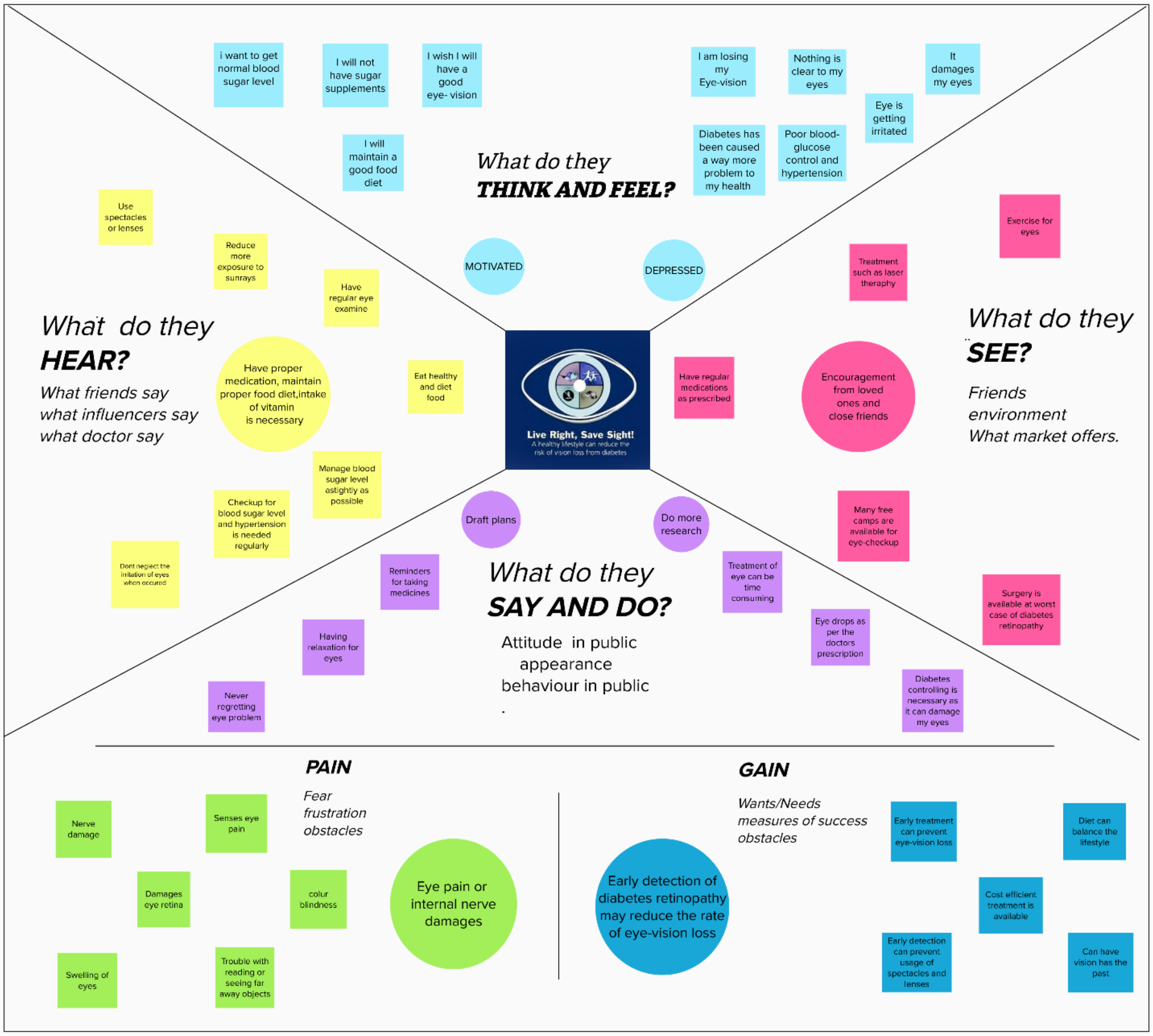
HOW ? The manual early detection of this DR is a challenging task

CHAPTER - 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool that helps teams to better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



What do they
THINK AND FEEL?
i want to get normal blood sugar level
I will not have sugar supplements
I wish I will have a good eye- vision
I will maintain a good food diet
I am losing my Eye-vision
Nothing is clear to my eyes
It damages my eyes
Eye is getting irritated
Diabetes has been caused a way more problem to my health
Poor blood-glucose control and hypertension
MOTIVATED
DEPRESSED
What do they
HEAR?
What friends say
what influencers say
what doctor say
Use spectacles or lenses
Reduce more exposure to sunrays
Have regular eye examine
Have proper medication, maintain proper food diet,intake of vitamin is necessary
Eat healthy and diet food
Manage blood sugar level astightly as possible
Checkup for blood sugar level and hypertension is needed regularly
Dont neglect the irritation of eyes when occured
Live Right, Save Sight!
A healthy lifestyle can reduce the risk of vision loss from diabetes
What do they
SEE?
Friends
environment
What market offers.
Exercise for eyes
Treatment such as laser theraphy
Have regular medications as prescribed
Encouragement from loved ones and close friends
Many free camps are available for eye-checkup
Surgery is available at worst case of diabetes retinopathy
What do they
SAY AND DO?
Attitude in public
appearance
behaviour in public
Draft plans
Do more research
Reminders for taking medicines
Having relaxation for eyes
Never regretting eye problem
Treatment of eye can be time consuming
Eye drops as per the doctors prescription
Diabetes controlling is necessary as it can damage my eyes
PAIN
Fear
frustration
obstacles
Nerve damage
Senses eye pain
Damages eye retina
colur blindness
Swelling of eyes
Trouble with reading or seeing far away objects
Eye pain or internal nerve damages
GAIN
Wants/Needs
measures of success
obstacles
Early detection of diabetes retinopathy may reduce the rate of eye-vision loss
Early treatment can prevent eye-vision loss
Diet can balance the lifestyle
Cost efficient treatment is available
Early detection can prevent usage of spectacles and lenses
Can have vision has the past

Link :

https://app.mural.co/t/ibmempathymap3103/m/ibmempathymap3103/1663059795871/7e6bce5d8486b3eaaec35e86d2c6a417100380e1?invited=true&sender=ub6077de14f9dbbb03f077158

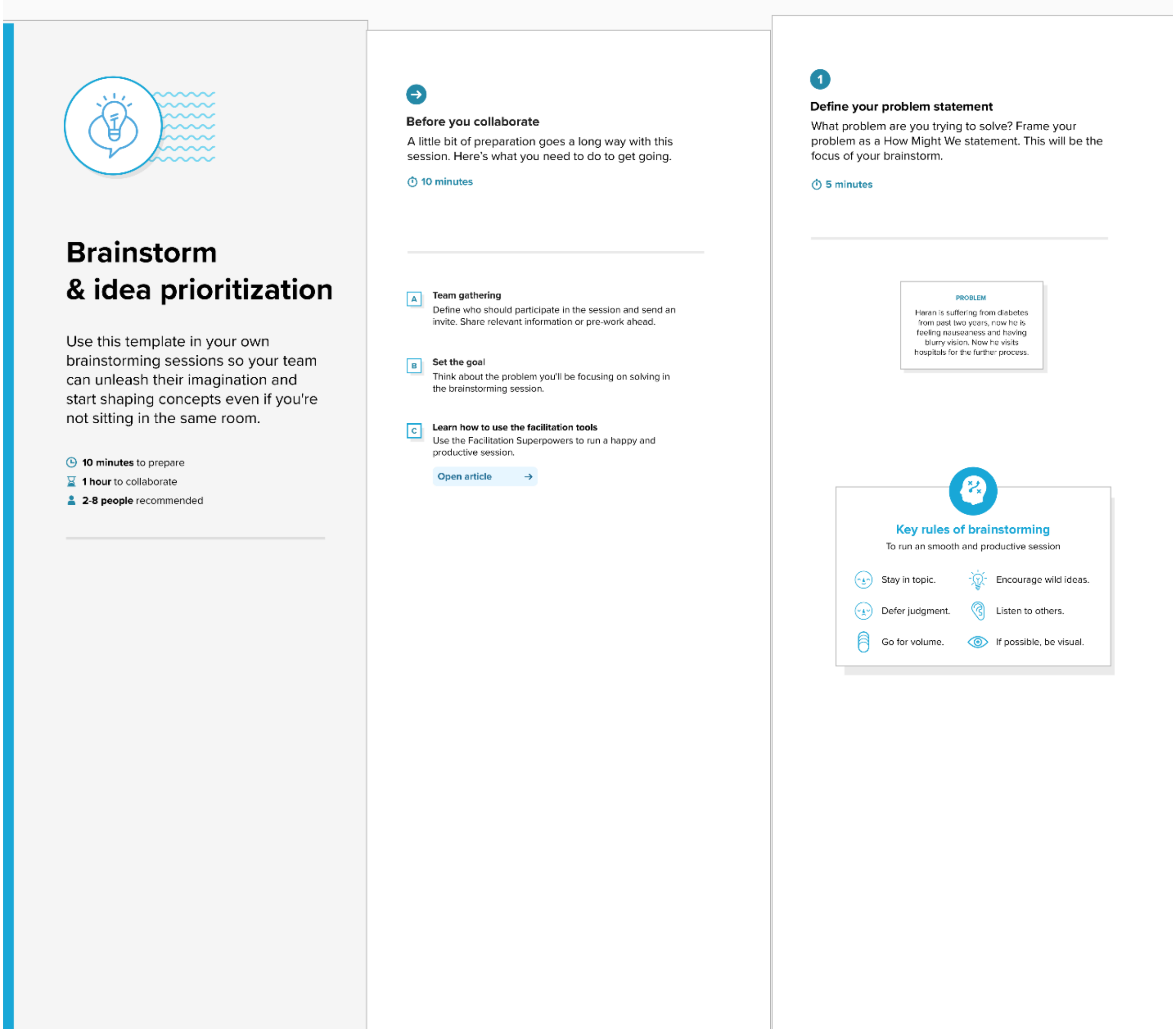
3.2 IDEATION & BRAINSTORMING

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving.

Step 1 : Team Gathering,Collaboration and selection the Problem Statement

In this step team members gather and provide their ideas and collaborate those

ideas and select their problem statement.The ideas should be relevant to their problem statement.



Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

- **10 minutes** to prepare
- **1 hour** to collaborate
- **2-8 people** recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

1 **Define your problem statement**

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

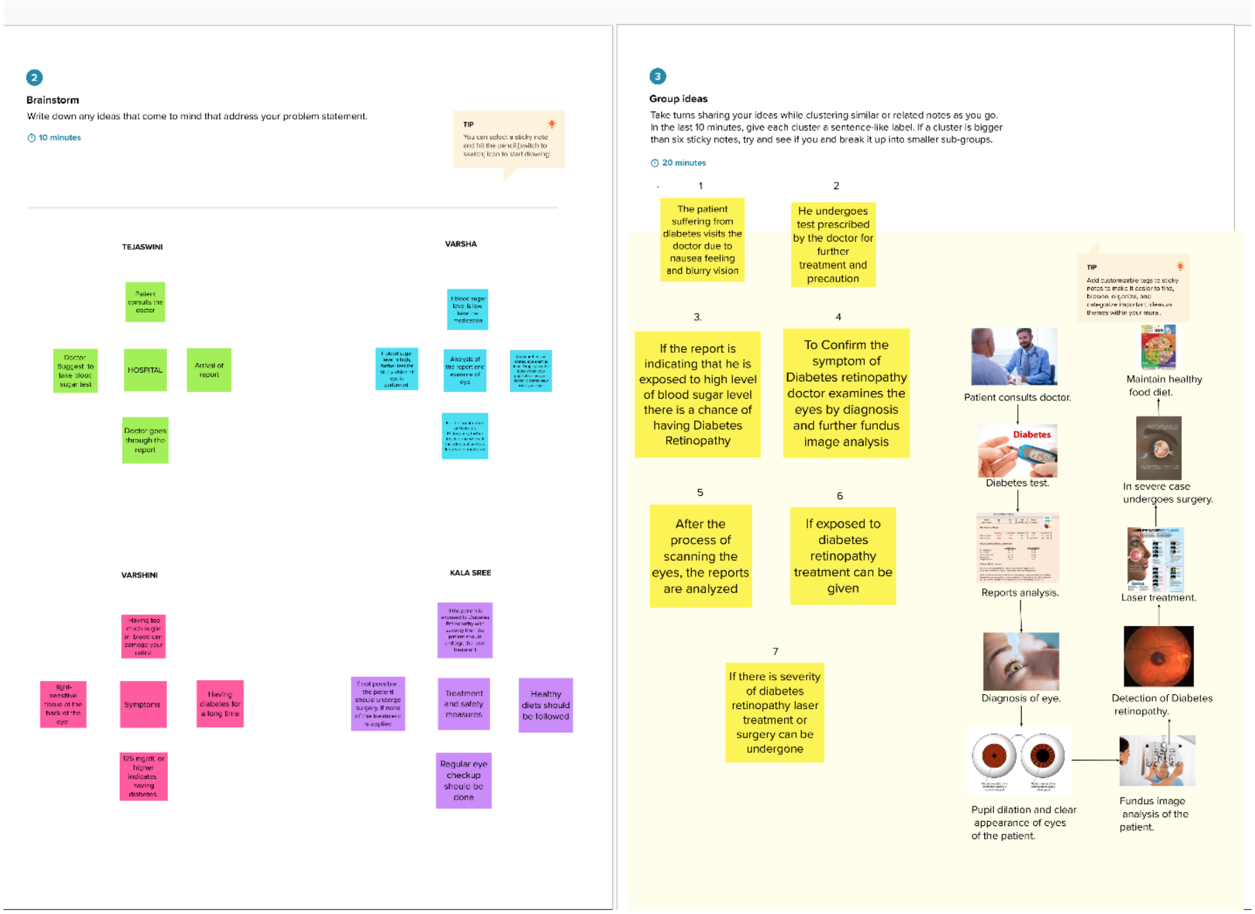
Haran is suffering from diabetes from past two years, now he is feeling nauseaness and having blurry vision. Now he visits hospitals for the further process.

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Step 2 : Brainstorm,Idea Listing and Grouping



2

Brainstorm

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

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

TEJASWINI

Patient consults the doctor

Doctor Suggest to take blood sugar test

HOSPITAL

Arrival of report

Doctor goes through the report

VARSHA

If blood sugar level is low, take the medication

If blood sugar level is high, further test for blurry vision of eye is performed

Analysis of the report and examine of eye

[illegible]

[illegible]

VARSHINI

Having too much sugar in blood can damage your retina

light-sensitive tissue at the back of the eye

Symptoms

Having diabetes for a long time

125 mg/dL or higher indicates having diabetes.

KALA SREE

If the patient is exposed to Diabetes Retinopathy with severity then the patient should undergo the laser treatment

If not possible , the patient should undergo surgery. If none of the treatment is applied

Treatment and safety measures

Healthy diets should be followed

Regular eye checkup should be done

3

Group ideas

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

20 minutes

1

The patient suffering from diabetes visits the doctor due to nausea feeling and blurry vision

2

He undergoes test prescribed by the doctor for further treatment and precaution

3.

If the report is indicating that he is exposed to high level of blood sugar level there is a chance of having Diabetes Retinopathy

4

To Confirm the symptom of Diabetes retinopathy doctor examines the eyes by diagnosis and further fundus image analysis

5

After the process of scanning the eyes, the reports are analyzed

6

If exposed to diabetes retinopathy treatment can be given

7

If there is severity of diabetes retinopathy laser treatment or surgery can be undergone

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Patient consults doctor.

Diabetes test.

Reports analysis.

Diagnosis of eye.

Pupil dilation and clear appearance of eyes of the patient.

Fundus image analysis of the patient.

Detection of Diabetes retinopathy.

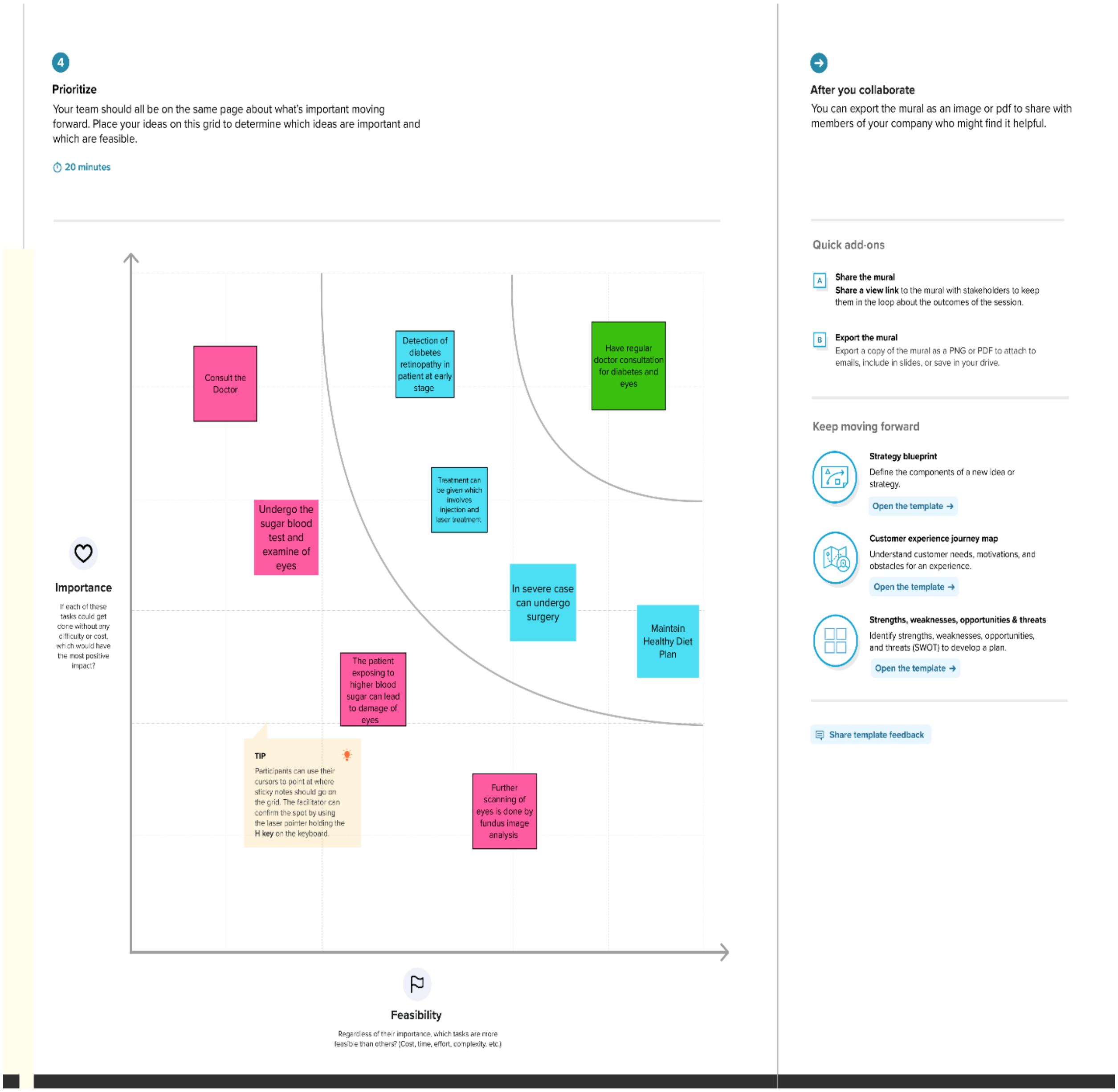
Laser treatment.

In severe case undergoes surgery.

Maintain healthy food diet.

Step 3 : Idea Prioritization

As mentioned, idea prioritization is just a part of the idea management process. Having a structured idea management process and a systematic way of gathering, evaluating and prioritizing new ideas takes time. To make it work, the entire idea management process should be integrated into everyday ways of working



4 Prioritize

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

20 minutes

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A **Share the mural**
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B **Export the mural**
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

Consult the Doctor
Detection of diabetes retinopathy in patient at early stage
Have regular doctor consultation for diabetes and eyes
Treatment can be given which involves injection and laser treatment
Undergo the sugar blood test and examine of eyes
In severe case can undergo surgery
Maintain Healthy Diet Plan
The patient exposing to higher blood sugar can lead to damage of eyes
Further scanning of eyes is done by fundus image analysis

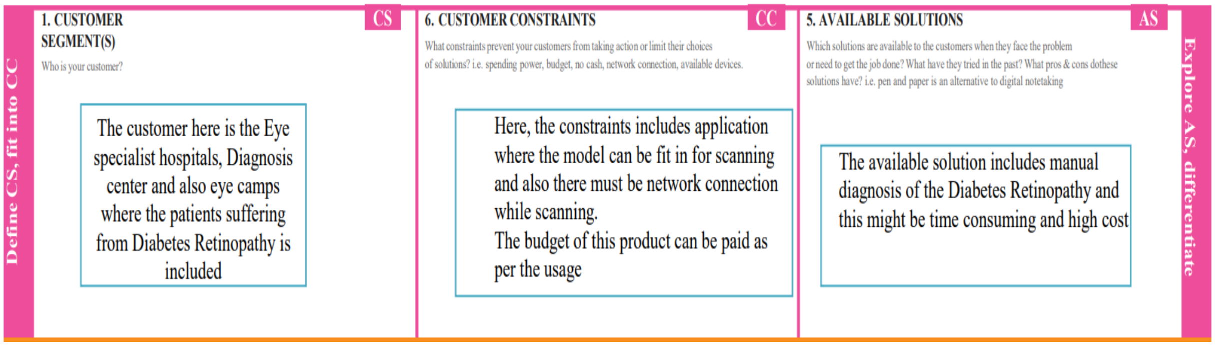
3.3 PROPOSED SOLUTION

- **Problem Statement :** A Diagnosis center of eye care has come upwithaproblem where the patients suffering fromDiabetes are in large scale. To detect the DiabetesRetinopathy is a time consuming process andthetools used for detecting the eye is costly andevenafter the detection is done due to the long process, the patient could obtain the severityif he/she is suffering from Diabetes Retinopathy.
- **Idea / Solution description :** To avoid the situation of long termdetectionanapplication can be build with the data collectionof fundus images where this could be an early detection

process of Diabetes Retinopathy. Themodel will be trained to detect the Diabetes Retinopathy at earlier stage and give the precautions to be followed by the patient .

- **Novelty / Uniqueness :** The existing solution includes the training of thedataset whereas the proposed solution is TransferLearning technique, here the data is pre trainedand the prediction can be made on past output orexperience.
- **Social Impact / Customer Satisfaction :** The product can be easier to use where theapplication developed will be user-friendly andalso cost efficient.
- **Business Model (Revenue Model) :** The Business Model is defined as the usageof theproduct by the client or customer . Here thebusiness model can be paid as per the usageof theapplication .
- **Scalability of the Solution :** The solution includes training of the model withTransfer Learning techniques which includes Inception V3,Resnet50,Xception V3 that aremorewidely used in medical image analysis andtheyarehighly effective. Here the Data can be trainednot only for the particular output but also for similar output of the previous or experienced data.

3.4 PROBLEM SOLUTION FIT



Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

The customer here is the Eye specialist hospitals, Diagnosis center and also eye camps where the patients suffering from Diabetes Retinopathy is included

6. CUSTOMER CONSTRAINTS CC

What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.

Here, the constraints includes application where the model can be fit in for scanning and also there must be network connection while scanning.

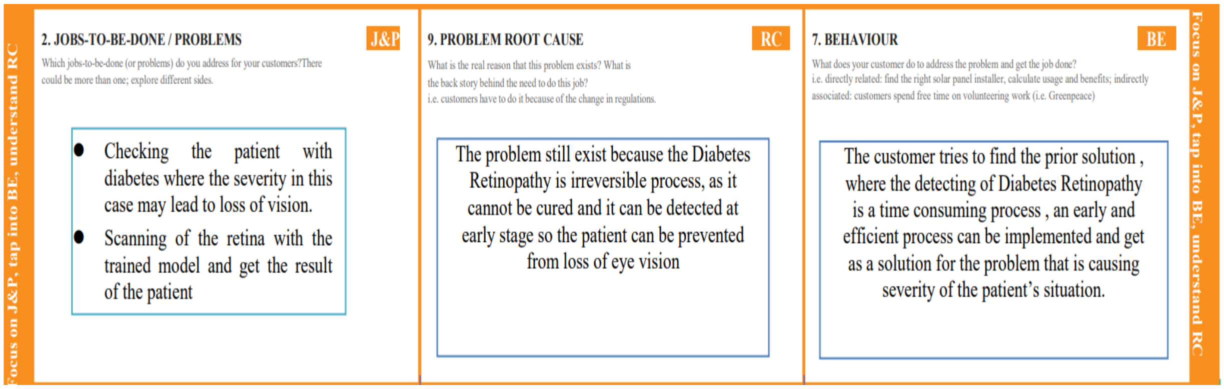
The budget of this product can be paid as per the usage

5. AVAILABLE SOLUTIONS AS

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons dothese solutions have? i.e. pen and paper is an alternative to digital notetaking

The available solution includes manual diagnosis of the Diabetes Retinopathy and this might be time consuming and high cost

Explore AS, differentiate



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

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

Which jobs-to-be-done (or problems) do you address for your customers?There could be more than one; explore different sides.

- Checking the patient with diabetes where the severity in this case may lead to loss of vision.
- Scanning of the retina with the trained model and get the result of the patient

9. PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

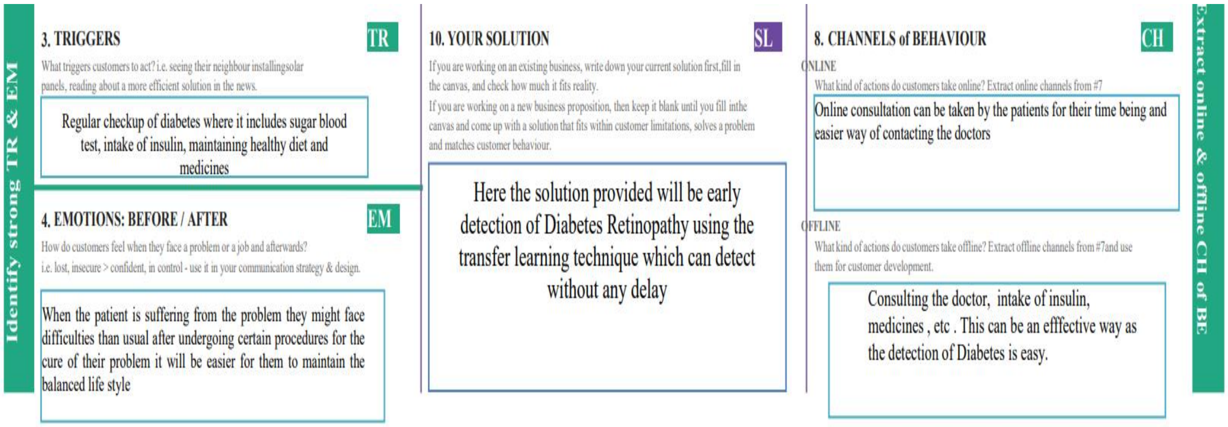
The problem still exist because the Diabetes Retinopathy is irreversible process, as it cannot be cured and it can be detected at early stage so the patient can be prevented from loss of eye vision

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?
i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

The customer tries to find the prior solution , where the detecting of Diabetes Retinopathy is a time consuming process , an early and efficient process can be implemented and get as a solution for the problem that is causing severity of the patient’s situation.

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



Identify strong TR & EM

3. TRIGGERS

TR

What triggers customers to act? i.e. seeing their neighbour installingsolar panels, reading about a more efficient solution in the news.

Regular checkup of diabetes where it includes sugar blood test, intake of insulin, maintaining healthy diet and medicines

4. EMOTIONS: BEFORE / AFTER

EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

When the patient is suffering from the problem they might face difficulties than usual after undergoing certain procedures for the cure of their problem it will be easier for them to maintain the balanced life style

10. YOUR SOLUTION

SL

If you are working on an existing business, write down your current solution first,fill in the canvas, and check how much it fits reality.

If you are working on a new business proposition, then keep it blank until you fill inthe canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

Here the solution provided will be early detection of Diabetes Retinopathy using the transfer learning technique which can detect without any delay

8. CHANNELS of BEHAVIOUR

CH

ONLINE

What kind of actions do customers take online? Extract online channels from #7

Online consultation can be taken by the patients for their time being and easier way of contacting the doctors

OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7and use them for customer development.

Consulting the doctor, intake of insulin, medicines , etc . This can be an efffective way as the detection of Diabetes is easy.

Extract online & offline CH of BE

CHAPTER - 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

- **FR-1**

  Functional Requirement (Epic) : User Registration

  Sub Requirement (Story / Sub-Task) : Registration through Application

- **FR-2**

  Functional Requirement (Epic) : Patient Registration

  Sub Requirement (Story / Sub-Task) : Confirmation via any of their ID proof and the information provided in the hospital

- **FR-3**

  Functional Requirement (Epic) : Collecting the data of the patient-1

  Sub Requirement (Story / Sub-Task) : The data of the patient can be entered in the application to stored it in the database for futurereference

- **FR-4**

  Functional Requirement (Epic) : Collecting the data of the patient-2

  Sub Requirement (Story / Sub-Task) : The user data which is considered to be scanning or detecting the diabetes retinopathy can be collectedandanalysed by the model that is being trained .

4.2 NON – FUNCTIONAL REQUIREMENTS

- **NFR-1**

  Non-Functional Requirement : Usability

  Description : It is easier for the user to operate the product withtheavailable information by the user.

- **NFR-2**

  Non-Functional Requirement : Security

  Description : It is used only by the authenticated user where thelogincredentials are given to access and use the product, herethesensitive information can be accessed only by theauthorizeduser.

- **NFR-3**

  Non-Functional Requirement : Reliability

Description : The product will be maintained and tested for thefaultsanderrors that is being occurred , so the performanceof theproduct can be increased with higher efficiency

- **NFR-4**

  Non-Functional Requirement : Performance

Description : It will be easier and efficient to use the product withlightavailability knowledge by the user and the performanceisstated with accurate measurement.

- **NFR-5**

  Non-Functional Requirement : Availability

  Description : The availability of the product can be in the places of medicalavailability and assistance for the patient sufferingfromDiabetes retinopathy

- **NFR-6**

  Non-Functional Requirement : Scalability

  Description : The usage of the product can be available to useat amaximum inputs at same time where the patients samplescanbe collected at different phases which is from different patient

CHAPTER - 5

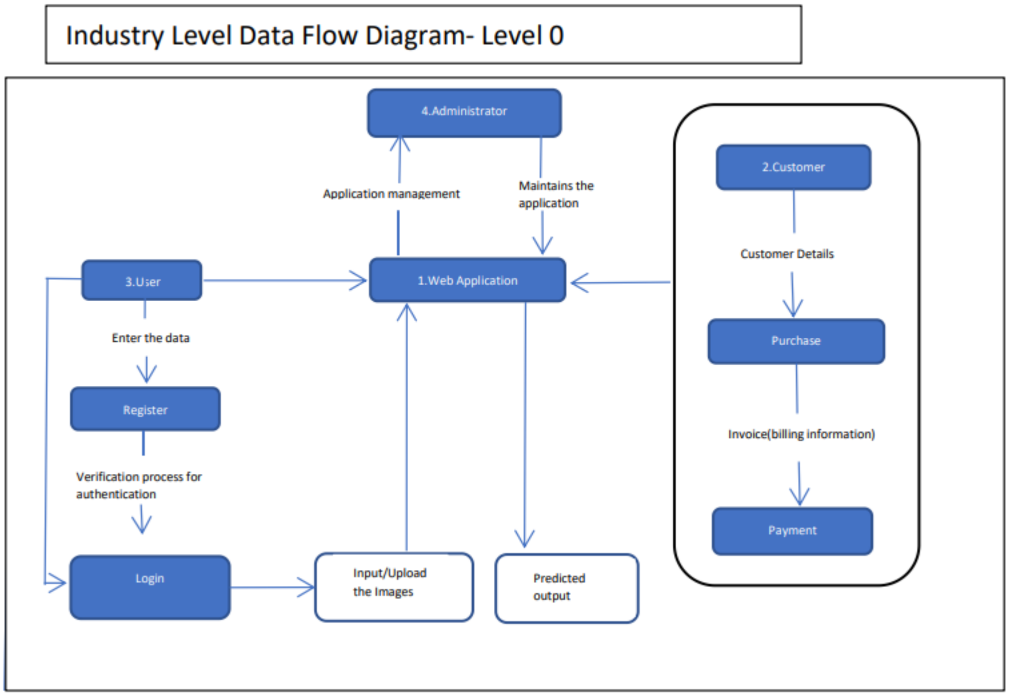
PROJECT DESIGN

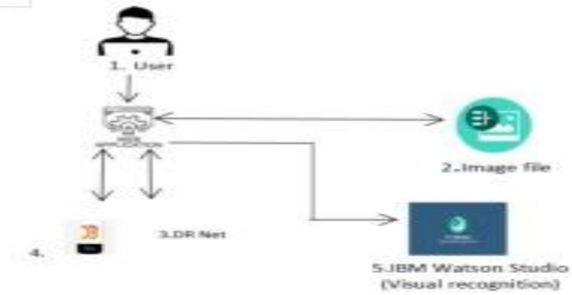
5.1 DATA FLOW DIAGRAMS

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.

A data flow diagram shows the way information flows through a process or system. It includes data inputs and outputs, data stores, and the various sub processes the data moves through. DFDs are built using standardized symbols and notation to describe various entities and their relationships.

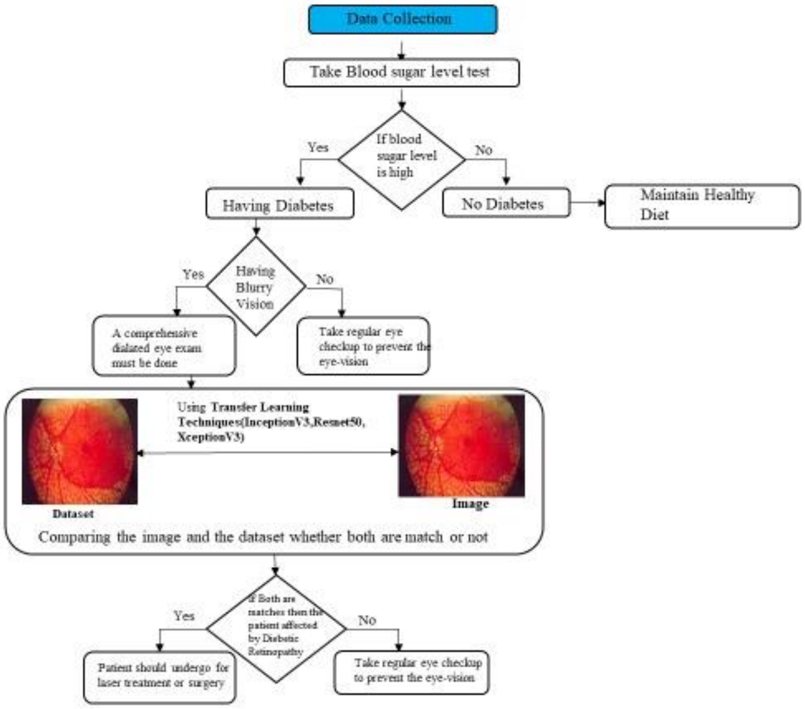
A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and the routes between each destination. Data flowcharts can range from simple, even hand-drawn process overviews, to in-depth, multi-level DFDs that dig progressively deeper into how the data is handled. They can be used to analyze an existing system or model a new one. Like all the best diagrams and charts, a DFD can often visually “say” things that would be hard to explain in words, and they work for both technical and nontechnical audiences, from developer to CEO. That’s why DFDs remain so popular after all these years.



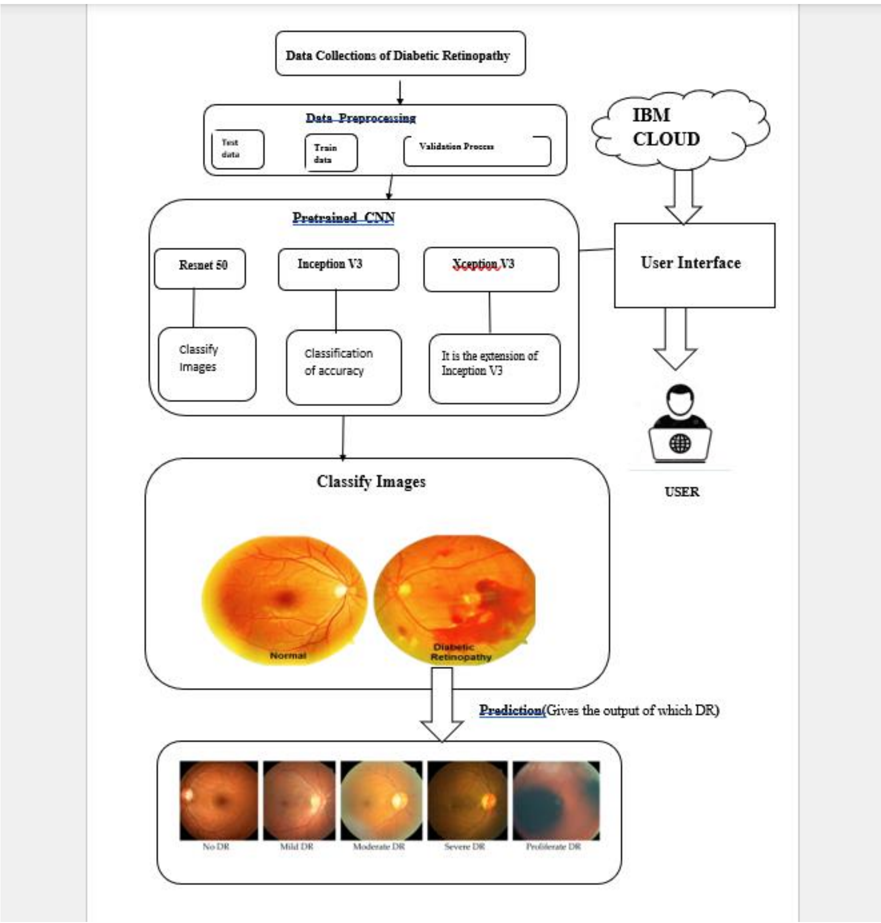


5.2 SOLUTION AND TECHNICAL ARCHITECTURE

SOLUTION ARCHITECTURE


Data Collection
Take Blood sugar level test
If blood sugar level is high
Yes
No
Having Diabetes
No Diabetes
Maintain Healthy Diet
Having Blurry Vision
Yes
No
A comprehensive dialated eye exam must be done
Take regular eye checkup to prevent the eye-vision
Using Transfer Learning Techniques(InceptionV3,Resnet50, XceptionV3)
Dataset
Image
Comparing the image and the dataset whether both are match or not
If Both are matches then the patient affected by Diabetic Retinopathy
Yes
No
Patient should undergo for laser treatment or surgery
Take regular eye checkup to prevent the eye-vision

TECHNICAL ARCHITECTURE



COMPONENTS AND TECHNOLOGIES

1. **Component :** User Interface
   Description : The user interacts with the web UI

   Technology : HTML, CSS, JavaScript ,Flask,Python

2. **Component :** Application Logic-Registration

   Description : The user registers the details in the web UI

   Technology : Flask,IBM Cloudant DB

3. **Component :** Application Logic-Authentication

   Description : The user confirms the registration ,whether he/she is authorized user by confirmation of the mail

   Technology : E-mail,Flask ,IBM Cloudant

4. **Component :** Application Logic-Login

Description : The user log in the application to verify the registered credentials are available in the database

Technology : Flask, IBM Cloudant DB

5. **Component :** Application Logic-User gives the image as input

   Description : The user gives the input of the Diabetes Retinopathy image as input and uploads the image as file

   Technology : Flask, IBM Cloudant DB

6. **Component :** Application Logic- Image Pre processing

   Description : The given input from the user is pre processed

   Technology : Flask, IBM Cloudant DB

7. **Component :** Application Logic- Image Classification with the dataset

   Description : The Pre-processed image is analysed with the dataset and image classification is done whether the given image is predicted as Diabetes Retinopathy or normal image

   Technology : Flask, IBM Cloudant DB

8. **Component :** Application Logic-Display the output

   Description : The result is displayed

   Technology : Flask, IBM Cloudant DB

9. . **Component :** Application Logic- Save the data

Description : The analysed and predicted output is saved in the database

Technology : IBM Cloudant DB

10. . **Component :** Machine Learning Model

Description : The Image classification and analysis is being done and predicts the result of the given input image

Technology : CNN-Xception V3,Resnet 50,InceptionV3

11. **Component :**Database

    Description : The database is used to store the data of all the given inputs

    Technology : IBM Cloudant DB

12. **Component :** File Storage

Description : The files and data are stored for future reference

Technology : IBM Block storage

13. **Component :** Deployment

Description : Application Deployment on Cloud

Technology : Cloud foundry

APPLICATION CHARACTERISTICS

1. **Characteristics :** Open-Source Frameworks

Description : Google Colab is used as a open source framework

Technology : Google Colaboratory

2. **Characteristics :** Security Implementations

Description : Some encryption methods can be used to protect the application

Technology : SHA-256, Encryptions, IAMControls

3. **Characteristics :** Scalable Architecture

Description : Justify the scalability of architecture (3 – tier, Micro-services)

Technology : IBM Cloud pak

4. **Characteristics :** Availability

Description : The availability of requested data in the application can in the form of Load Balancer where the queuing of data is available.

Technology : Application Load Balancer

5. **Characteristics :** Performance

Description : The request of the cache and other data can be given for a particular range of times as the application can get the CDNs from the server

Technology : Proxy server

5.3 USER STORIES

Sprint-01 :

USN-1-01 - As a user, I can register for the application by using government certified IDs.

USN-1-02 - As a user, I will authenticate using ID credentials.

USN-1-03 - With the credentials the user can login easily.

Sprint-02 :

USN-1-04 - Model is trained with all different images of diabetic retinopathy and in different dimensions.

USN-1-05 - The model is implemented to check its working and accuracy.

Sprint-03 :

USN-1-06 - Classify the images into Normal images and DR images

USN-1-07 - Predict the output of which DR level will be the output

Sprint-04 :

USN-1-08 - On accurate detection of diabetic retinopathy in early time will be save the eye-vision

USN-1-09 - The customer needs are checked and satisfied.

Handle any sort of emergency and get it fixed.

USN-1-10 - All the past datas are collected and stored for future reference.

CHAPTER - 6

PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint-01 :

USN-1-01 - As a user, I can register for the application by using government certified IDs.

Team Members :

- **Tejaswini**

USN-1-02 - As a user, I will authenticate using ID credentials.

Team Members :

- **Tejaswini**
- **Varsha**

USN-1-03 - With the credentials the user can login easily.

Team Members :

- **Varshini**

Sprint-02 :

USN-1-04 - Model is trained with all different images of diabetic retinopathy and in different dimensions.

Team Members :

- **Kala Sree**
- **Tejaswini**

USN-1-05 - The model is implemented to check its working and accuracy.

Team Members :

- **Varsha**
- **Varshini**

Sprint-03 :

USN-1-06 - Classify the images into Normal images and DR images

Team Members :

- **Tejaswini**

- **Varshini**

USN-1-07 - Predict the output of which DR level will be the output

Team Members :

- **Kala Sree**
- **Varshini**

Sprint-04 :

USN-1-08 - On accurate detection of diabetic retinopathy in early time will be save the eye-vision

Team Members :

- **Varsha**
- **Kala Sree**

USN-1-09 - The customer needs are checked and satisfied.

Team Members :

- **Varsha**

Handle any sort of emergency and get it fixed.

USN-1-10 - All the past datas are collected and stored for future reference.

Team Members :

- **Kala Sree**

6.2 SPRINT DELIVERY SCHEDULE

Sprint-1

- **Total Story Points –** 20
- **Duration** – 7 Days
- **Sprint Start Date –** 24 Oct , 2022
- **Sprint End Date(Planned)** – 29 Oct , 2022
- **Story Points Completed(as on Planned End Date) -**20
- **Sprint Release Date(Actual) –** 30 Oct , 2022

Sprint-2

- **Total Story Points –** 20
- **Duration** – 7 Days
- **Sprint Start Date –** 31 Oct , 2022
- **Sprint End Date(Planned)** – 05 Nov , 2022
- **Story Points Completed(as on Planned End Date) -**20
- **Sprint Release Date(Actual) –** 06 Nov , 2022

Sprint-3

- **Total Story Points –** 20
- **Duration** – 7 Days
- **Sprint Start Date –** 07 Nov , 2022
- **Sprint End Date(Planned)** – 12 Nov, 2022
- **Story Points Completed(as on Planned End Date) -**20
- **Sprint Release Date(Actual) –** 13 Nov, 2022

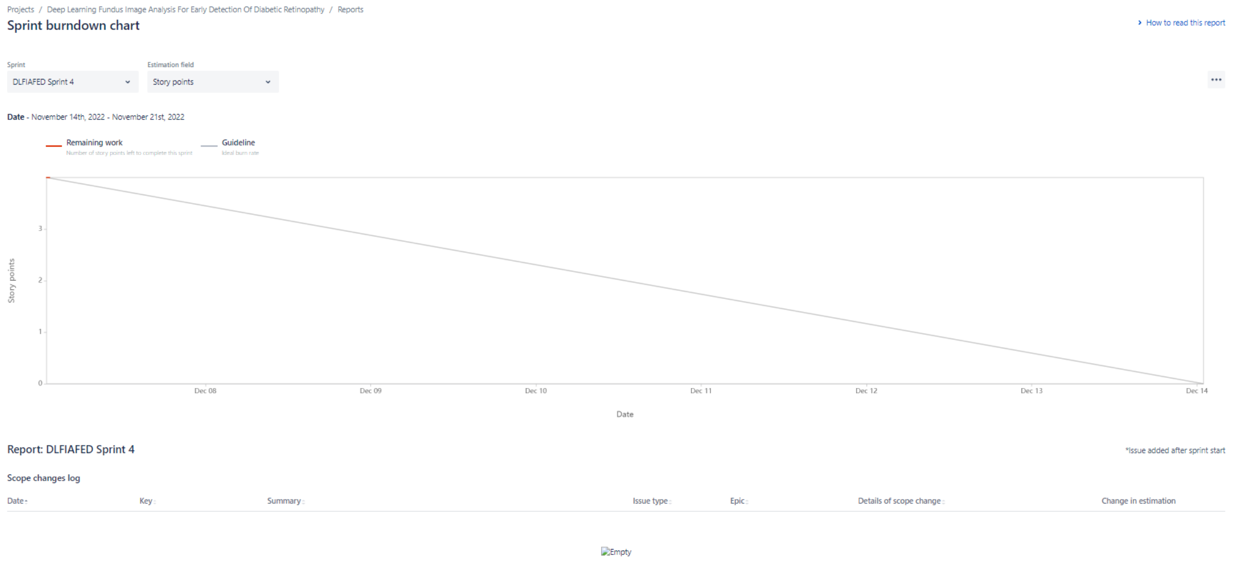
Sprint-4

- **Total Story Points –** 20
- **Duration** – 7 Days
- **Sprint Start Date –** 14 Nov , 2022
- **Sprint End Date(Planned)** – 19 Nov , 2022
- **Story Points Completed(as on Planned End Date) -**20
- **Sprint Release Date(Actual) –** 20 Nov , 2022

6.3 REPORTS FROM JIRA

Burndown Chart Report :

A burndown chart is a graphical representation of work left to do versus time and completed work.It is often used in agile software development methodologies such as scrum, jira. However burndown charts can be applied to any project containing measurable time.



Projects / Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy / Reports

Sprint burndown chart

Sprint: DLFIAFED Sprint 4

Estimation field: Story points

Date - November 14th, 2022 - November 21st, 2022

Report: DLFIAFED Sprint 4

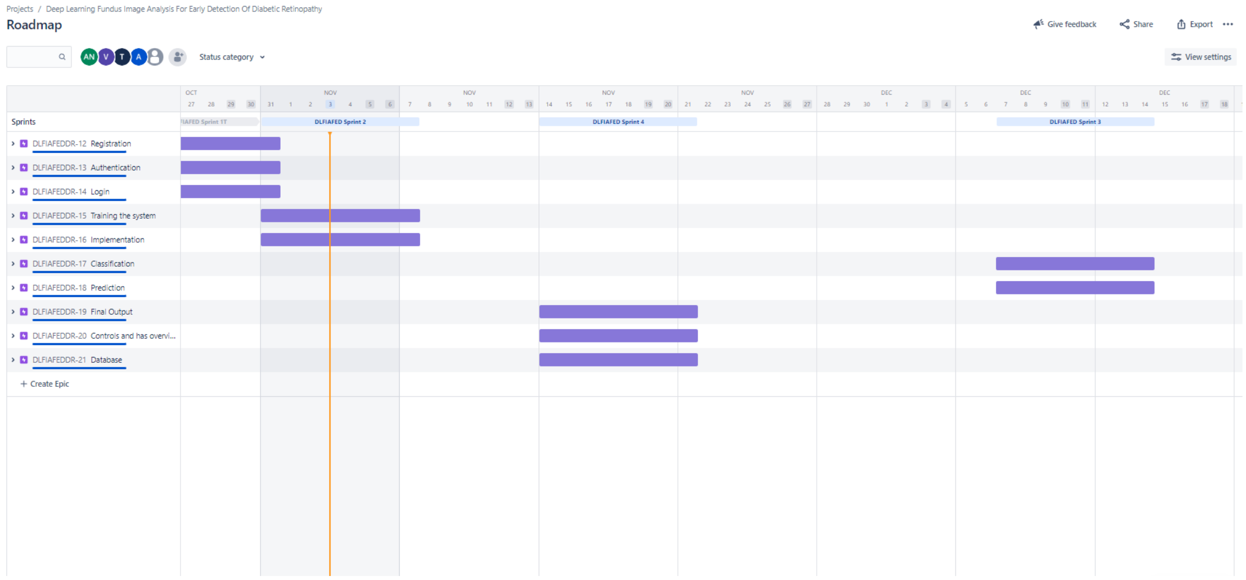
*Issue added after sprint start

Scope changes log

Date	Key	Summary	Issue type	Epic	Details of scope change	Change in estimation

Empty

Road Map



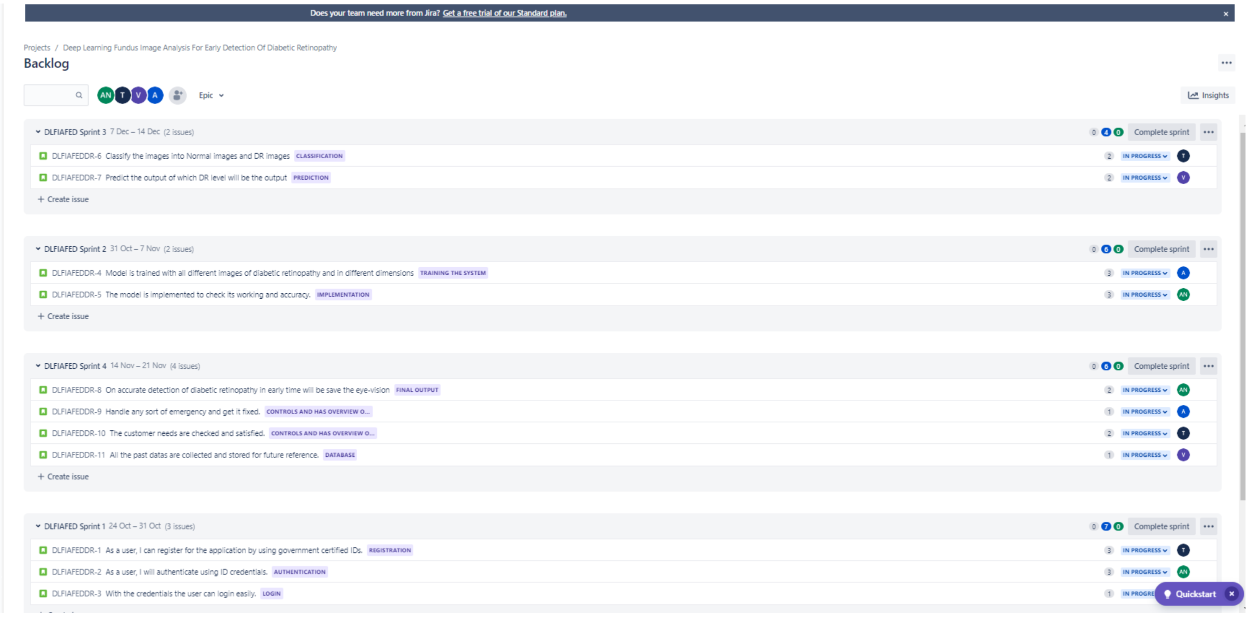
Projects / Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy

Roadmap

Sprints: DLFIAFED Sprint 1T, DLFIAFED Sprint 2, DLFIAFED Sprint 4, DLFIAFED Sprint 3

- DLFIAFEDDR-12 Registration
- DLFIAFEDDR-13 Authentication
- DLFIAFEDDR-14 Login
- DLFIAFEDDR-15 Training the system
- DLFIAFEDDR-16 Implementation
- DLFIAFEDDR-17 Classification
- DLFIAFEDDR-18 Prediction
- DLFIAFEDDR-19 Final Output
- DLFIAFEDDR-20 Controls and has overvi...
- DLFIAFEDDR-21 Database

Backlog



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Projects / Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy

Backlog

AN T V A Epic Insights

DLFIAFED Sprint 3 7 Dec – 14 Dec (2 issues) 0 4 0 Complete sprint

- DLFIAFEDDR-6 Classify the images into Normal images and DR images CLASSIFICATION 2 IN PROGRESS T
- DLFIAFEDDR-7 Predict the output of which DR level will be the output PREDICTION 2 IN PROGRESS V

+ Create issue

DLFIAFED Sprint 2 31 Oct – 7 Nov (2 issues) 0 6 0 Complete sprint

- DLFIAFEDDR-4 Model is trained with all different images of diabetic retinopathy and in different dimensions TRAINING THE SYSTEM 3 IN PROGRESS A
- DLFIAFEDDR-5 The model is implemented to check its working and accuracy. IMPLEMENTATION 3 IN PROGRESS AN

+ Create issue

DLFIAFED Sprint 4 14 Nov – 21 Nov (4 issues) 0 6 0 Complete sprint

- DLFIAFEDDR-8 On accurate detection of diabetic retinopathy in early time will be save the eye-vision FINAL OUTPUT 2 IN PROGRESS AN
- DLFIAFEDDR-9 Handle any sort of emergency and get it fixed. CONTROLS AND HAS OVERVIEW O... 1 IN PROGRESS A
- DLFIAFEDDR-10 The customer needs are checked and satisfied. CONTROLS AND HAS OVERVIEW O... 2 IN PROGRESS T
- DLFIAFEDDR-11 All the past datas are collected and stored for future reference. DATABASE 1 IN PROGRESS V

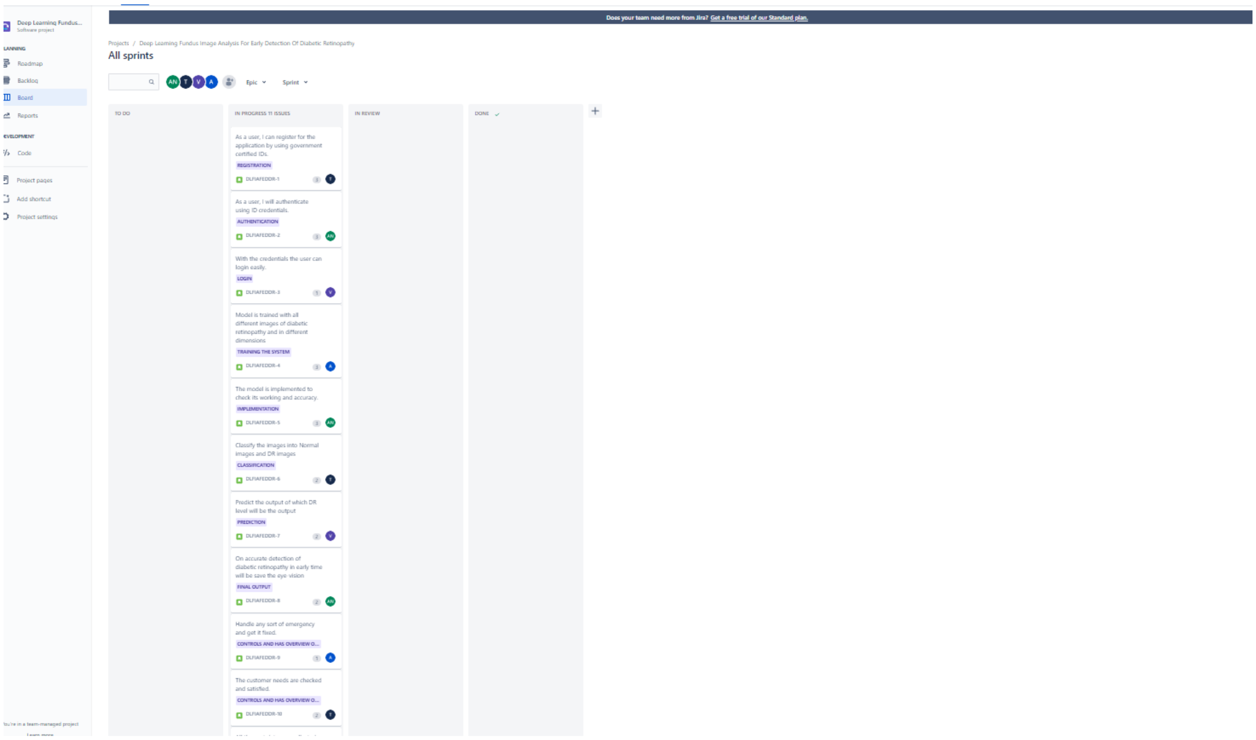
+ Create issue

DLFIAFED Sprint 1 24 Oct – 31 Oct (3 issues) 0 7 0 Complete sprint

- DLFIAFEDDR-1 As a user, I can register for the application by using government certified IDs. REGISTRATION 3 IN PROGRESS T
- DLFIAFEDDR-2 As a user, I will authenticate using ID credentials. AUTHENTICATION 3 IN PROGRESS AN
- DLFIAFEDDR-3 With the credentials the user can login easily. LOGIN 1 IN PROGRE

Quickstart

Board



Deep Learning Fundus... Software project

LANNING Roadmap Backlog Board Reports

EVELOPMENT Code

Project pages Add shortcut Project settings

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Projects / Deep Learning Fundus Image Analysis For Early Detection Of Diabetic Retinopathy

All sprints

AN T V A Epic Sprint

TO DO | IN PROGRESS 11 ISSUES | IN REVIEW | DONE ✓

IN PROGRESS 11 ISSUES:

- As a user, I can register for the application by using government certified IDs. REGISTRATION DLFIAFEDDR-1 3 T
- As a user, I will authenticate using ID credentials. AUTHENTICATION DLFIAFEDDR-2 3 AN
- With the credentials the user can login easily. LOGIN DLFIAFEDDR-3 1 V
- Model is trained with all different images of diabetic retinopathy and in different dimensions TRAINING THE SYSTEM DLFIAFEDDR-4 3 A
- The model is implemented to check its working and accuracy. IMPLEMENTATION DLFIAFEDDR-5 3 AN
- Classify the images into Normal images and DR images CLASSIFICATION DLFIAFEDDR-6 2 T
- Predict the output of which DR level will be the output PREDICTION DLFIAFEDDR-7 2 V
- On accurate detection of diabetic retinopathy in early time will be save the eye-vision FINAL OUTPUT DLFIAFEDDR-8 2 AN
- Handle any sort of emergency and get it fixed. CONTROLS AND HAS OVERVIEW O... DLFIAFEDDR-9 1 A
- The customer needs are checked and satisfied. CONTROLS AND HAS OVERVIEW O... DLFIAFEDDR-10 2 T

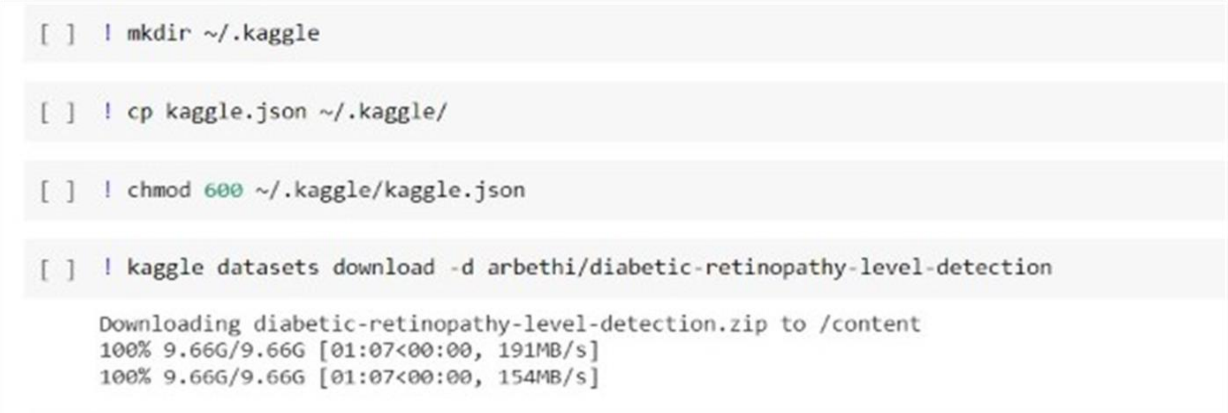
CHAPTER - 7

CODING & SOLUTIONING

7.1 FEATURES

DATA COLLECTION:

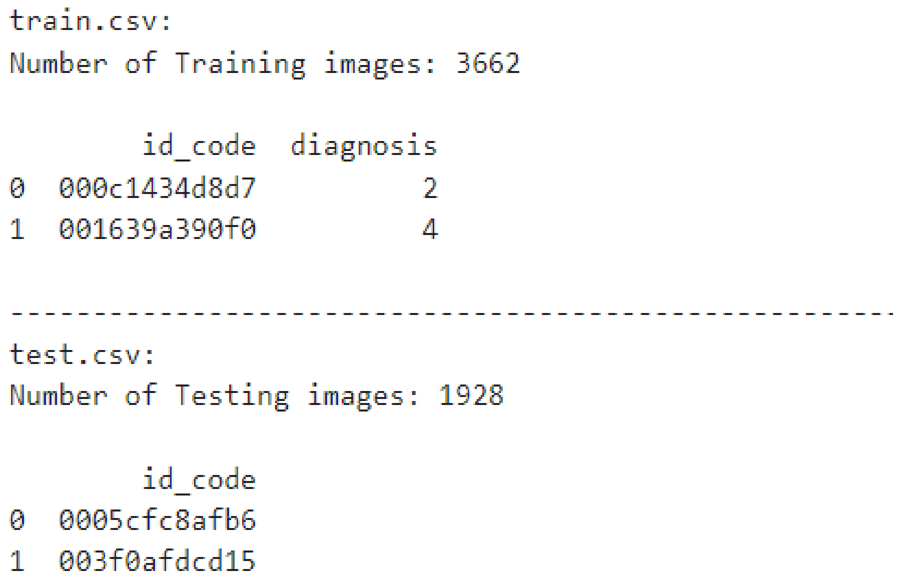
- DL depends heavily on data, it is the most crucial aspect that makes algorithm training possible.
- The dataset is obtained from kaggle as json file which includes the necessary dataset that are needed to be downloaded
- Dataset that is used is diabetic retinopathy level detection.
- It is downladed as zip file and the unzipped for the early detection of diabetes retinopathy



```
[ ]  ! mkdir ~/.kaggle

[ ]  ! cp kaggle.json ~/.kaggle/

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

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

     Downloading diabetic-retinopathy-level-detection.zip to /content
     100% 9.66G/9.66G [01:07<00:00, 191MB/s]
     100% 9.66G/9.66G [01:07<00:00, 154MB/s]
```

TRAIN AND TEST DATASET:

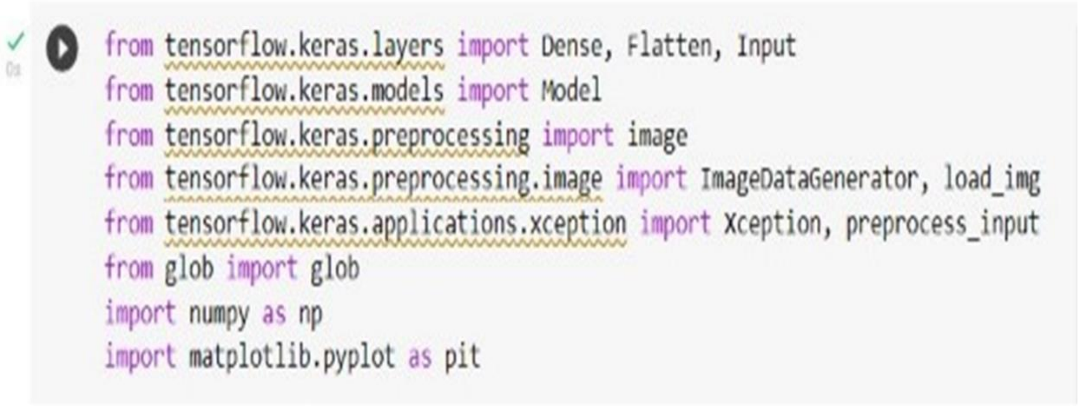
- To build a DL module we have to split training and testing data in to two separate folders. In this, we just have to assign a variable and pass the folder path to it.
- Training data is the subset of original dataset which is fed into the machine learning model.
- Testing data is for computing an unbiased, or increasingly biased in the context of the validation dataset.



```
train.csv:
Number of Training images: 3662

       id_code  diagnosis
0  000c1434d8d7          2
1  001639a390f0          4

-----------------------------------------------------
test.csv:
Number of Testing images: 1928

       id_code
0  0005cfc8afb6
1  003f0afdcd15
```

IMPORT LIBRARY:

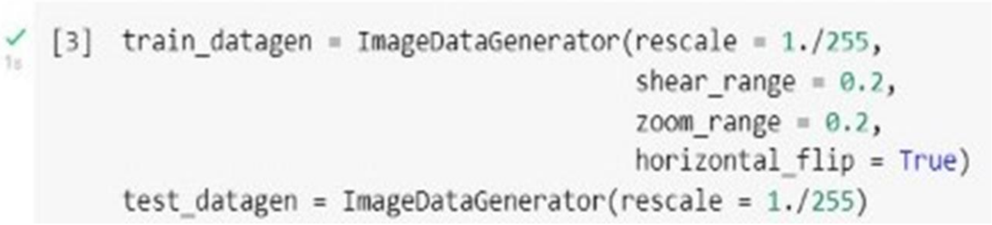
- Import the necessary libraries that are numpy, matplotlib. pyplot,glob, Dense,Flatten.
- Matplotlib is used for creating static, animated and visualization
- Keras is used as interface for the tensorflow library
- Tensorflow is used to process and load data.
- Preprocessing is used to identify and handle the missing values in the dataset.



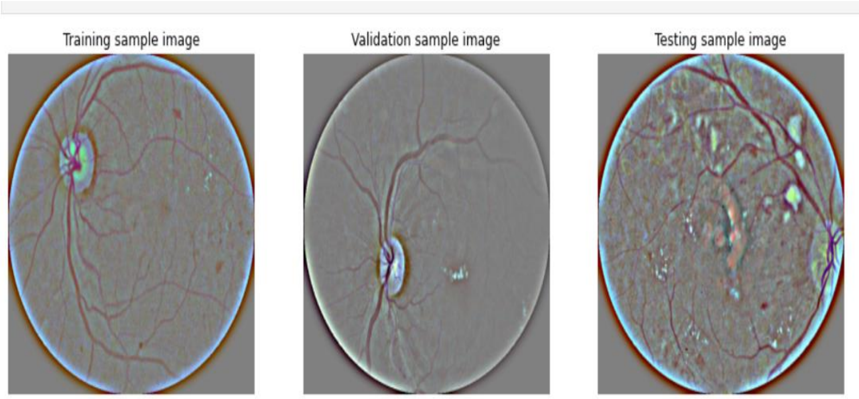
```
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as pit
```

IMAGE DATA GENERATOR:

- ImageDataGenerator class is instantiated and the configuration for data augmentation.
- An instance of the ImageDataGenerator class can be consctucted for train and test.

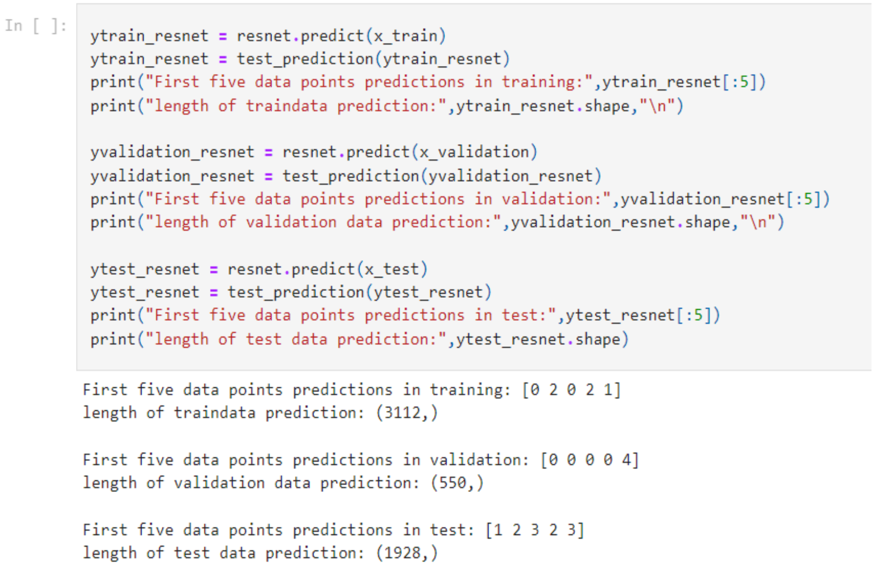


```
train_datagen = ImageDataGenerator(rescale = 1./255,
                                   shear_range = 0.2,
                                   zoom_range = 0.2,
                                   horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
```



PRETRAINED CNN MODEL AS A FEATURE EXTRACTOR:

- The prerained CNN which contains RESNET-50 is used as a image net database to load the images.
- Resnet-50 is for classification of images in the dataset.
- It is used for obtaining the computational accuracy and validation of the input images.
- Inception v3 has smaller weights but the computational cost is high.
- Xception is an extension of Inception v3 which is used for depthwise saparable convoltion.

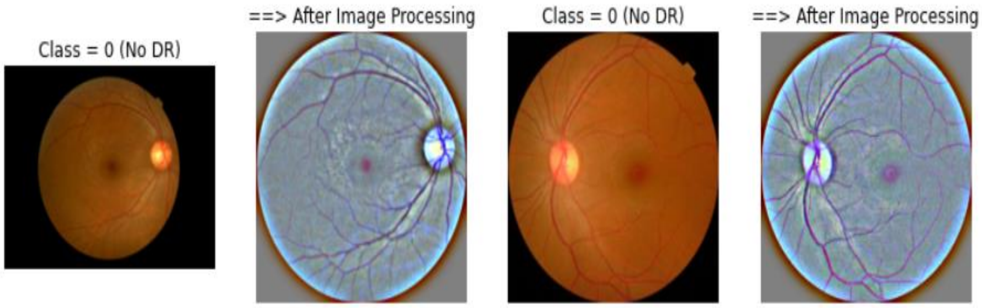


```
In [ ]:
ytrain_resnet = resnet.predict(x_train)
ytrain_resnet = test_prediction(ytrain_resnet)
print("First five data points predictions in training:",ytrain_resnet[:5])
print("length of traindata prediction:",ytrain_resnet.shape,"\n")

yvalidation_resnet = resnet.predict(x_validation)
yvalidation_resnet = test_prediction(yvalidation_resnet)
print("First five data points predictions in validation:",yvalidation_resnet[:5])
print("length of validation data prediction:",yvalidation_resnet.shape,"\n")

ytest_resnet = resnet.predict(x_test)
ytest_resnet = test_prediction(ytest_resnet)
print("First five data points predictions in test:",ytest_resnet[:5])
print("length of test data prediction:",ytest_resnet.shape)
```

```
First five data points predictions in training: [0 2 0 2 1]
length of traindata prediction: (3112,)

First five data points predictions in validation: [0 0 0 0 4]
length of validation data prediction: (550,)

First five data points predictions in test: [1 2 3 2 3]
length of test data prediction: (1928,)
```

VISUALIZATION OF IMAGE:

- After preprocessing is done the image are being split into test and train set where the visualization of the image is shown by separating the classes of the image.



7.2 FEATURES

app.py

```
import numpy as np

import os

# from tensorflow.keras.models import load_model

# from tensorflow.keras.preprocessing import image

# from tensorflow.keras.applications.inception_v3 import preprocess_input

from flask import Flask, request,flash, render_template, redirect,url_for

from cloudant.client import Cloudant

from twilio.rest import Client


# model = load_model(r"C:\Users\nvars\flask_test\Xception-diabetic-retinopathy (1).h5")

app = Flask(__name__)

app.secret_key="abc"

app.config['UPLOAD_FOLDER'] = "User_Images"

# Authenticate using an IAM API key

client = Cloudant.iam('5e183e68-6288-4c71-84fb-5ce6fe11e2a7-bluemix','rn2GnKgXfP0v_qWogmV-MqgMlqkxeWHD9MTbjWdPWCJ1',connect=True)

# Create a database using an initialized client

my_database = client.create_database('my_database')
```

```
if my_database.exists():
    print("Database '{0}' successfully created.".format('my_db'))
# default home page or route

user = ""

@app.route('/', methods=['GET', 'POST'])
def index():
    if request.method == 'POST':
        model.save()
        # Failure to return a redirect or render_template
    else:
        return render_template('index.html')

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


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

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



@ app.route('/login', methods=['GET','POST'])
def login():
    if request.method == "GET":
        user = request.args.get('mail')
        passw = request.args.get('pass')
        print(user, passw)
        query = {'mail': {'$eq': user}}
        docs = my_database.get_query_result(query)
        print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            return render_template('login.html', pred="")
        else:
            if ((user == docs[0][0]['mail'] and passw == docs[0][0]['psw'])):
                flash("Logged in as " + str(user))
                return render_template('index.html', pred="Logged in as "+str(user), vis
="hidden", vis2="visible")

            else:

                return render_template('login.html', pred="The password is wrong.")

    else:

        return render_template('login.html')




@ app.route('/logout')

def logout():

    return render_template('logout.html')


@app.route("/predict",methods=["GET", "POST"])

def predict():

    if request.method == "POST":

        f = request.files['file']

        # getting the current path 1.e where app.py is present

        basepath = os.path.dirname(__file__)

        #print ( " current path " , basepath )

        # from anywhere in the system we can give image but we want that

        filepath = os.path.join(str(basepath), 'User_Images', str(f.filename))

        #print ( " upload folder is " , filepath )
        f.save(filepath)

        img = image.load_img(filepath, target_size=(299, 299))

        x = image.img_to_array(img)  # ing to array

        x = np.expand_dims(x, axis=0)  # used for adding one more dimension

        #print ( x )

        img_data = preprocess_input(x)

        prediction = np.argmax(model.predict(img_data), axis=1)

        index = [' No Diabetic Retinopathy ', ' Mild NPDR ',

                 ' Moderate NPDR ', ' Severe NPDR ', ' Proliferative DR ']

        result = str(index[prediction[0]])

        print(result)

        return render_template('prediction.html', prediction=result, fname = filepath)

    else:

        return render_template("prediction.html")



@app.route('/result')

def result():

     return render_template("result.html")

if __name__ == "__main__":

    app.run(debug=True ,port=8080,use_reloader=False)
```

index.html

```
<!DOCTYPE html>

<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-
iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT
"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script

src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-
u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi4
66C8"
      crossorigin="anonymous"
    ></script>
    <style>
      #navbarRight {
        margin-left: auto;
        padding-right:10px;
      }
      .navbar-brand{
        padding-left:15px;
      }
    </style>
    <title>DR Predcition</title>
  </head>
  <body>
    <nav class="navbar navbar-expand-lg navbar-light bg-dark">
      <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
      </div>
      <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>
        <li class="nav-item">
         <a class="nav-link" href="predict"style="color: aliceblue;">Prediction</a>
        </li>
       </ul>
      </div>
      </nav>
      <div class="d-flex justify-content-center">
      <img style="width:70vw;" src="static/diabetic-retinopathy-home.jpg">
      </div>
  </body>
</html>
```

login.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
        #navbarRight {
            margin-left: auto;
            padding-right:10px;
      }
      .navbar-brand{
          padding-left:15px;
      }
  </style>
  <title>DR Predcition</title>
</head>
<form action="",method='POST'>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
      <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">DR Register</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">

     <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%;">Login</button>

         </div>

     </div>

    </form>
```

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

register.html

```
<!-- <!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
      src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
      integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
      crossorigin="anonymous"
    ></script>
    <style>
```

```
      #navbarRight {
          margin-left: auto;
          padding-right:10px;

      }
      .navbar-brand{
          padding-left:15px;
      }
  </style>
  <title>DR Predcition</title>
</head>
<form action="{{url_for('register')}}" method="post" >
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
      <div>
      <a class="navbar-brand" href="#" style="color:aliceblue">DR Register</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> -->
```

Prediction.html

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

<head>
  <meta charset="UTF-8" />
  <meta http-equiv="X-UA-Compatible" content="IE=edge" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <!-- CSS only -->
  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css" rel="stylesheet"
    integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT" crossorigin="anonymous" />
  <!-- JavaScript Bundle with Popper -->
  <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
    integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
    crossorigin="anonymous"></script>
  <style>
    #navbarRight {
      margin-left: auto;
      padding-right: 10px;
    }

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

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

```
<body>
 <nav class="navbar navbar-expand-lg navbar-light bg-dark">
  <div>
   <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy Classification</a>
  </div>
  <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
   <ul class="navbar-nav mr-auto text-center" id="navbarRight">
    <li class="nav-item active">
     <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
    </li>
    <li class="nav-item">
     <a class="nav-link" href="logout" style="color: aliceblue;">Logout</a>
    </li>
   </ul>
  </div>
 </nav>
 <br><br>
 <div class="container justify-content-center" style="width:400px">
  <form>
  <label for="formFileLg" class="form-label">Upload Image</label>
  <input class="form-control form-control-lg" id="formFileLg" type="file" />
  <br>
  <a href="result" class="btn btn-dark">Predict</a>
  </form>
 </div>
```

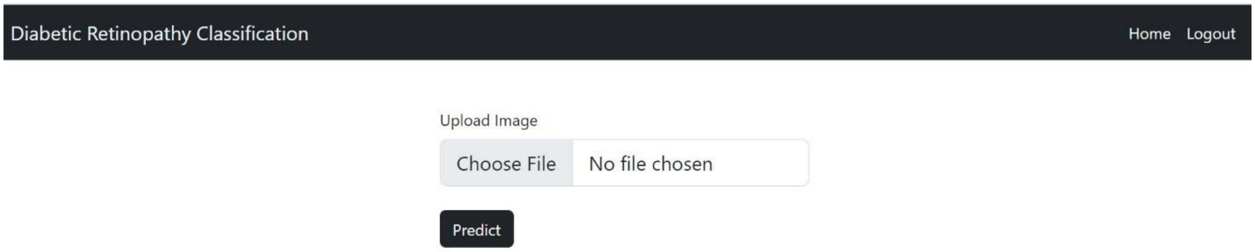
```
  <br><br><br>
  <div>
      {{prediction}}
      <img src="static/level.png" style="width: 90%">
  </div>
</body>
</html>
```

logout.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <!-- CSS only -->
    <link
      href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/css/bootstrap.min.css"
      rel="stylesheet"
      integrity="sha384-iYQeCzEYFbKjA/T2uDLTpkwGzCiq6soy8tYaI1GyVh/UjpbCx/TYkiZhlZB6+fzT"
      crossorigin="anonymous"
    />
    <!-- JavaScript Bundle with Popper -->
    <script
```

```
   src="https://cdn.jsdelivr.net/npm/bootstrap@5.2.1/dist/js/bootstrap.bundle.min.js"
   integrity="sha384-u1OknCvxWvY5kfmNBILK2hRnQC3Pr17a+RTT6rIHI7NnikvbZlHgTPOOmMi466C8"
   crossorigin="anonymous"
  ></script>
  <style>
    #navbarRight {
      margin-left: auto;
      padding-right:10px;
    }
    .navbar-brand{
      padding-left:15px;
    }
  </style>
  <title>DR Predcition</title>
 </head>
 <body>
  <nav class="navbar navbar-expand-lg navbar-light bg-dark">
    <div>
    <a class="navbar-brand" href="#" style="color:aliceblue">Diabetic Retinopathy</a>
    </div>
    <div class="navbar-collapse collapse w-100 order-3 dual-collapse2" id="navbarNav">
     <ul class="navbar-nav mr-auto text-center" id="navbarRight">
      <li class="nav-item active">
       <a class="nav-link" href="index" style="color: aliceblue;">Home </a>
      </li>
```

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

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

        </li>

        <li class="nav-item">

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

        </li>

      </ul>

    </div>

  </nav>

  <br><br>

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

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

        Successfully Logged Out!

        <br><br>

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

          </div>

      </div>

</body></html>
```



CHAPTER - 8

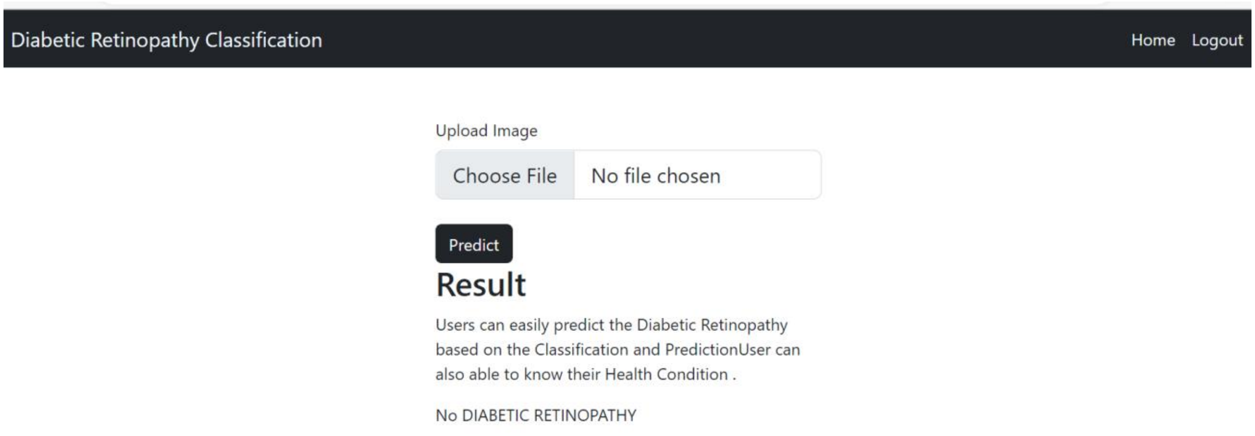
TESTING

8.1 TEST CASES

- We need to check whether the person especially diabetic person is affected by Diabetic Retinopathy or not based on the Classification and Prediction process.
- If the images are matched then the result will be displayed as a person is affected by Diabetic Retinopathy in DR Prediction Page.
- If the images are not matched then the result will be displayed as a person is not affected by Diabetic Retinopathy in DR Prediction Page.

8.2 USER ACCEPTANCE TESTING

If a person not affected by Diabetic Retinopathy



Result

Users can easily predict the Diabetic Retinopathy based on the Classification and PredictionUser can also able to know their Health Condition .

No DIABETIC RETINOPATHY

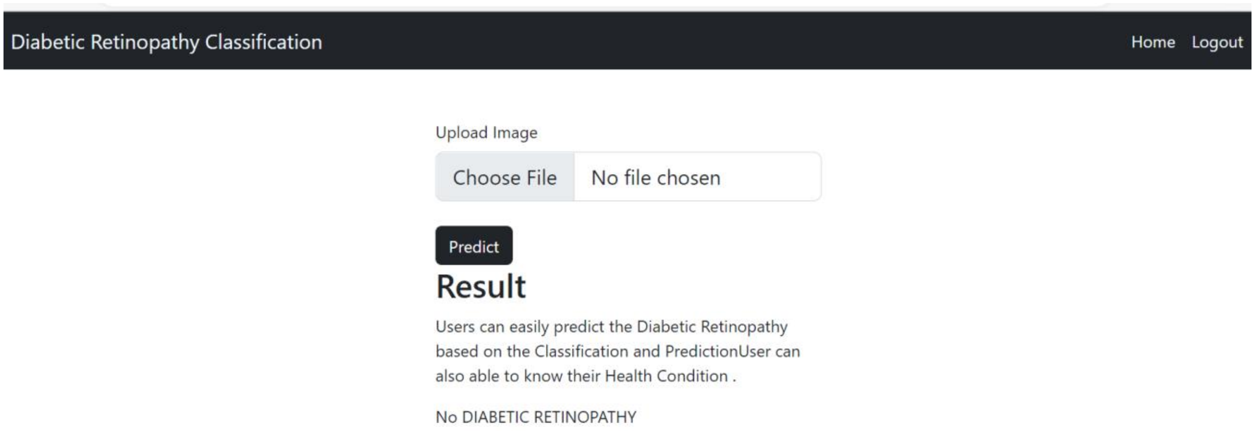
CHAPTER – 9

RESULTS

9.1 PERFORMANCE METRICS

With this user interface users can easily predict the Diabetic Retinopathy based on the Classification and PredictionUser can also able to know their Health Condition .

Some sample images of the output are provided below:



Result

Users can easily predict the Diabetic Retinopathy based on the Classification and PredictionUser can also able to know their Health Condition .

No DIABETIC RETINOPATHY

CHAPTER - 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

- There are several advantages of using deep learning for fundus image analysis for early detection of diabetic retinopathy. First, deep learning is well-suited for image analysis tasks.
- This is because deep learning algorithms can automatically learn features from images, which is essential for accurate image analysis.
- Second, deep learning is efficient at handling large amounts of data.
- This is important for medical image analysis, as medical images are often very large.
- Third, deep learning is scalable. This means that it can be used to train models on very large datasets, which is important for medical image analysis tasks where data is often limited.
- Fourth, deep learning is able to learn from data with little supervision. This is important for medical image analysis, as often there is limited labeled data available.
- Finally, deep learning is robust. This means that it is less likely to overfit to the data, which is important for medical image analysis where data is often limited
- Here we are using **Transfer Learning Techniques** (Resnet 50, Xception V3 and Inception V3).
- **Resnet 50 and Xception V3** are used to pretrained version of thr network trained on more than million images from the image net database.
- **Inception V3** is a pretrained CNN model. It is used for analysis and recognition of image model with an accuracy of above 75%.

DISADVANTAGES :

- There are several disadvantages of deep learning for early detection of diabetic retinopathy.
- One disadvantage is that deep learning requires a large amount of data to train the models.
- This can be a challenge for researchers who do not have access to a large dataset.
- Another challenge is that deep learning models can be very complex, which can make them difficult to interpret.
- Finally, deep learning models can be computationally intensive, which can make them difficult to deploy in resource-limited settings.

CHAPTER - 11
CONCLUSION

Early detection of diabetes Retinopathy may reduce the rate of eye-vision loss.For diabetes retinopathy, cost efficient treatment is available.Can get information within less time and can cure the diabetes retinopathy at less time.

A deep-learning enhanced algorithm for the automated detection of DR, achieves significantly better performance than a previously reported, otherwise essentially identical, algorithm that does not employ deep learning.Deep learning enhanced algorithms have the potential to improve the efficiency of DR screening, and thereby to prevent visual loss and blindness from this devastating disease

CHAPTER - 12

FUTURE SCOPE

- There is a great potential for deep learning in fundus image analysis for early detection of diabetic retinopathy.
- However, there are a few challenges that need to be addressed.
- First, the current data sets are small and lack diversity.
- Second, the images are often low quality and need to be pre-processed before they can be used for deep learning.
- Third, the ground truth labels for the images are often not available.
- Finally, the current deep learning models are not able to generalize well to real-world data.

CHAPTER - 13

APPENDIX

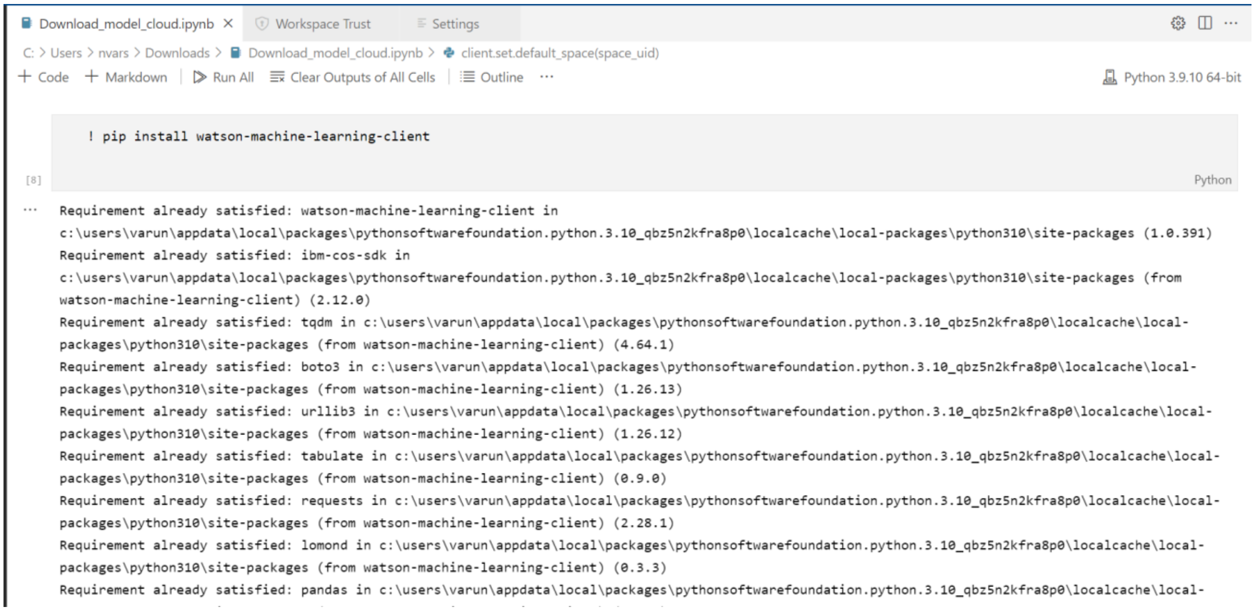
SOURCE CODE

Source code for Flask Integration

app.py

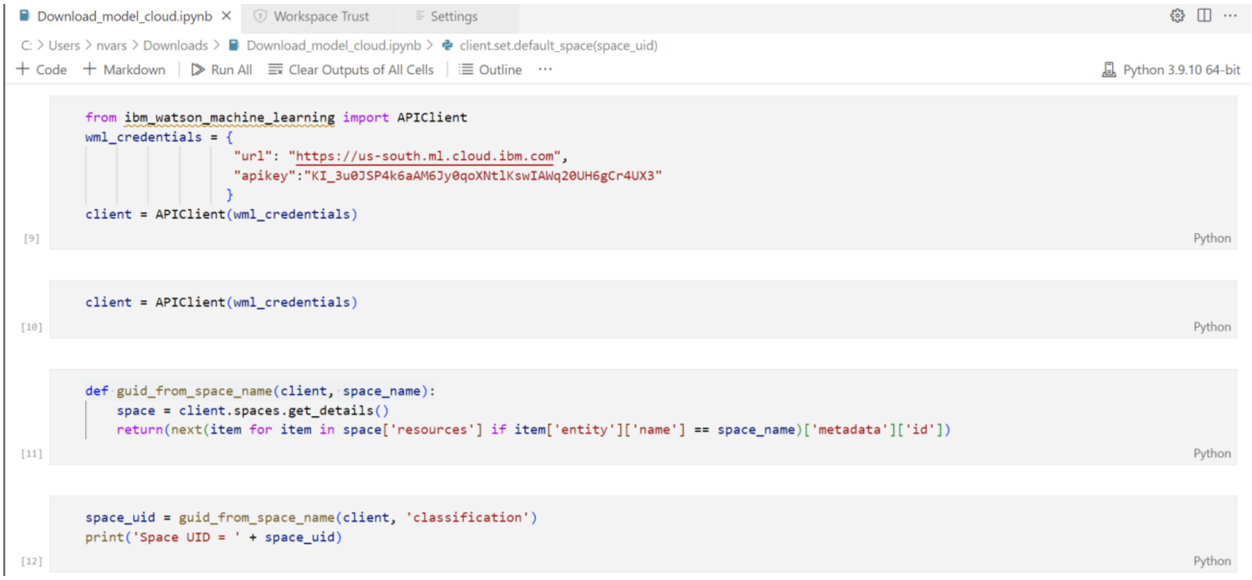
```
import numpy as np
import os
from tensorflow import keras


from keras import models
from keras.models import load_model
from keras.preprocessing import image
from keras.applications.inception_v3 import preprocess_input
import requests
from flask import Flask, request, render_template, redirect, url_for
from cloudant.client import Cloudant
model = load_model(r"C:\Users\nvars\Downloads\Xception-diabetic-retinopathy.h5")
app = Flask(__name__)
# Authenticate using an IAM API key
client = Cloudant.iam('367e91e7-6150-4f63-92f4-24625af53457-bluemix',
                      'EqKm5BOKxzGLIm9YsFnXKJ66ywOyL9tDVK9oN0_FPD4G', connect=True)
# Create a database using an initialized client
my_database = client.create_database('my_db')
if my_database.exists():
    print("Database '{0}' successfully created.".format('my_db'))
# default home page or route
@app.route('/')
def index():
    return render_template('index.html')
@ app.route('/index')
def home():
    return render_template("index.html")
'''@ app.route('/register')
def register():
    return render_template("register.html")'''
# registration page
@ app.route('/register',methods=["GET","POST"])
def register():
    if request.method == "POST":
        name =  request.form.get("name")
        mail = request.form.get("emailid")
        mobile = request.form.get("num")
        pswd = request.form.get("pass")
        data = {
            'name': name,
            'mail': mail,
            'mobile': mobile,
            'psw': pswd
        }
        print(data)
        query = {'mail': {'$eq': data['mail']}}
        docs = my_database.get_query_result(query)
        print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            url = my_database.create_document(data)
            return render_template("register.html", pred=" Registration Successful , please login using your
details ")
        else:
            return render_template('register.html', pred=" You are already a member , please login using your details ")
    else:
        return render_template('register.html')
    @ app.route('/login', methods=['GET','POST'])
def login():
    if request.method == "POST":
        user = request.form.get('name')
        passw = request.form.get('pass')
        print(user, passw)
        query = {'_id': {'$eq': user}}
        docs = my_database.get_query_result(query)
        print(docs)
        print(len(docs.all()))
        if (len(docs.all()) == 0):
            return render_template('login.html', pred="The username is not found.")
        else:
            if ((user == docs[0][0]['_id'] and passw == docs[0][0]['pswd'])):
                return redirect(url_for('prediction'))
            else:
                print('Invalid User')
    else:
        return render_template('login.html')
@ app.route('/logout')
def logout():
    return render_template('logout.html')
@app.route("/predict")
def predict():
    return render_template("prediction.html")
@ app.route('/result', methods=["GET", "POST"])
def res():
    if request.method == "POST":
        f = request.files['image']
        # getting the current path 1.e where app.py is present
        basepath = os.path.dirname(__file__)
        #print ( " current path " , basepath )
        # from anywhere in the system we can give image but we want that
        filepath = os.path.join(basepath, 'uploads', f.filename)
        #print ( " upload folder is " , filepath )
        f.save(filepath)
        img = image.load_img(filepath, target_size=(299, 299))
        x = image.img_to_array(img)  # ing to array
        x = np.expand_dims(x, axis=0)  # used for adding one more dimension
        #print ( x )
        img_data = preprocess_input(x)
        prediction = np.argmax(model.predict(img_data), axis=1)
        # prediction = model.predict ( x ) #instead of predict_classes ( x ) we can use predict ( X ) ---- >
predict_classes ( x ) gave error
        # print ( " prediction is prediction )
        index = [' No Diabetic Retinopathy ', ' Mild DR ',
                 ' Moderate DR ', ' Severe DR ', ' Proliferative DR ']
        # result = str ( index [ output [ 011 )
        result = str(index[prediction[0]])
        print(result)
        return render_template('prediction.html', prediction=result)


if __name__ == "__main__":
    app.run(debug=False)
```

Cloud Deployment Model


Download_model_cloud.ipynb
Workspace Trust
Settings
C: > Users > nvars > Downloads > Download_model_cloud.ipynb > client.set.default_space(space_uid)
+ Code
+ Markdown
Run All
Clear Outputs of All Cells
Outline
Python 3.9.10 64-bit
[8]
Python

```
! pip install watson-machine-learning-client
```

```
Requirement already satisfied: watson-machine-learning-client in
c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-packages\python310\site-packages (1.0.391)
Requirement already satisfied: ibm-cos-sdk in
c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-packages\python310\site-packages (from
watson-machine-learning-client) (2.12.0)
Requirement already satisfied: tqdm in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (4.64.1)
Requirement already satisfied: boto3 in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (1.26.13)
Requirement already satisfied: urllib3 in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (1.26.12)
Requirement already satisfied: tabulate in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (0.9.0)
Requirement already satisfied: requests in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (2.28.1)
Requirement already satisfied: lomond in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
packages\python310\site-packages (from watson-machine-learning-client) (0.3.3)
Requirement already satisfied: pandas in c:\users\varun\appdata\local\packages\pythonsoftwarefoundation.python.3.10_qbz5n2kfra8p0\localcache\local-
```

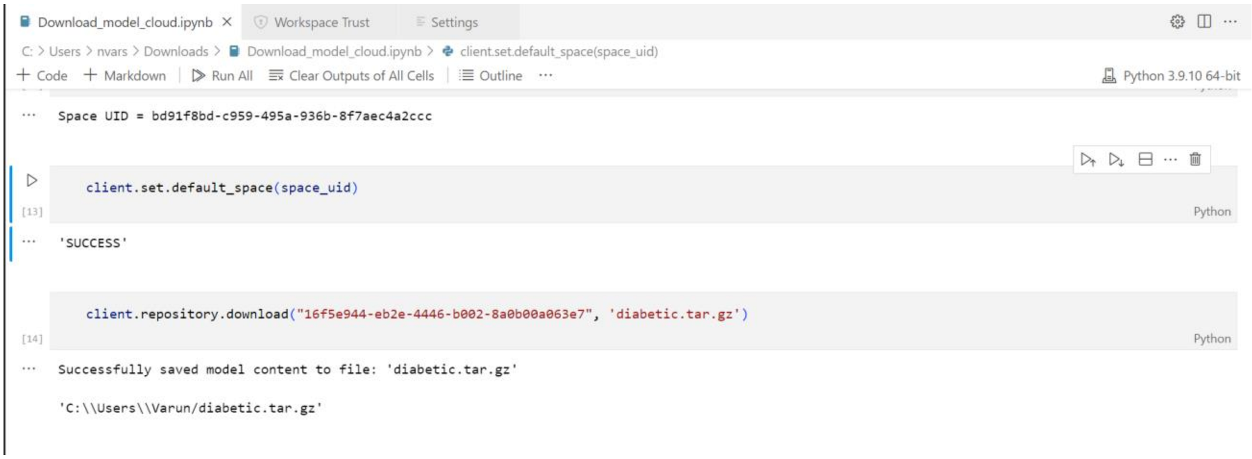

Download_model_cloud.ipynb
Workspace Trust
Settings
C: > Users > nvars > Downloads > Download_model_cloud.ipynb > client.set.default_space(space_uid)
+ Code
+ Markdown
Run All
Clear Outputs of All Cells
Outline
Python 3.9.10 64-bit
[9]
Python
[10]
Python
[11]
Python
[12]
Python

```
from ibm_watson_machine_learning import APIClient
wml_credentials = {
                   "url": "https://us-south.ml.cloud.ibm.com",
                   "apikey":"KI_3u0JSP4k6aAM6Jy0qoXNtlKswIAWq20UH6gCr4UX3"
                  }
client = APIClient(wml_credentials)
```

```
client = APIClient(wml_credentials)
```

```
def guid_from_space_name(client, space_name):
    space = client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']['name'] == space_name)['metadata']['id'])
```

```
space_uid = guid_from_space_name(client, 'classification')
print('Space UID = ' + space_uid)
```


Download_model_cloud.ipynb
Workspace Trust
Settings
C: > Users > nvars > Downloads > Download_model_cloud.ipynb > client.set.default_space(space_uid)
+ Code
+ Markdown
Run All
Clear Outputs of All Cells
Outline
Python 3.9.10 64-bit
Python
Python

```
Space UID = bd91f8bd-c959-495a-936b-8f7aec4a2ccc
```

```
[13]
client.set.default_space(space_uid)
```

```
'SUCCESS'
```

```
[14]
client.repository.download("16f5e944-eb2e-4446-b002-8a0b00a063e7", 'diabetic.tar.gz')
```

```
Successfully saved model content to file: 'diabetic.tar.gz'

'C:\\Users\\Varun/diabetic.tar.gz'
```

GITHUB LINK : https://github.com/IBM-EPBL/IBM-Project-12708-1659458906

DEMO LINK : https://youtu.be/UdY9KpzVezY