DEEP LEARNING FUNDUS IMAGE ANALYSIS FOR EARLY DETECTION OF DIABETIC RETINOPATHY

PROJECT REPORT

Submitted by

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IN

ELECTRONICS AND COMMUNICATION ENGINEERING

VELAMMAL INSTITUTE OF TECHNOLOGY

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PROJECT REPORT

Team ID	PNT2022TMID24431
Project Name	Deep Learning Fundus Image Analysis for Early Detection of Diabetic retinopathy.
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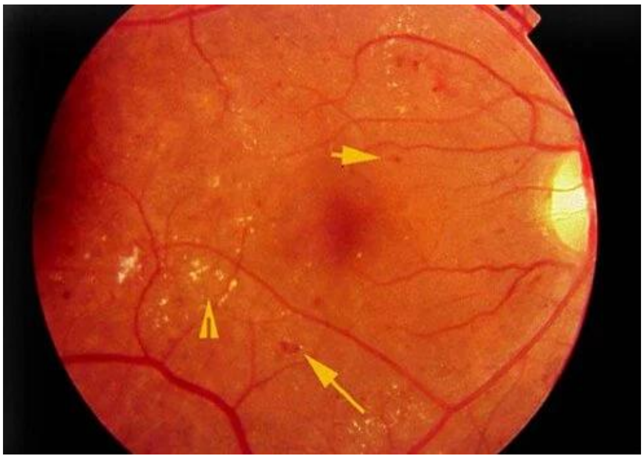


ABSTRACT:

Diabetic Retinopathy is a retina disease caused by diabetes mellitus and it is the leading cause of blindness globally. Early detection and treatment are necessary in order to delay or avoid vision deterioration and vision loss. To that end, many artificial-intelligence-powered methods have been proposed by the research community for the detection and classification of diabetic retinopathy on fundus retina images. This review article provides a thorough analysis of the use of deep learning methods at the various steps of the diabetic retinopathy detection pipeline based on fundus images. We discuss several aspects of that pipeline, ranging from the datasets that are widely used by the research community, the preprocessing techniques employed and how these accelerate and improve the models' performance, to the development of such deep learning models for the diagnosis and grading of the disease as well as the localization of the disease's lesions. We also discuss certain models that have been applied in real clinical settings. Finally, we conclude with some important insights and provide future research directions.

INDEX

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. The manual diagnosis process of DR retina fundus images by ophthalmologists is time, effort and cost-consuming and prone to misdiagnosis unlike computer-aided diagnosis systems. The longer you have diabetes and the less controlled your blood sugaris, the more likely you are to develop this eye complication.

Deep-learning systems have the potential to enhance and automate aspects of screening for diabetic retinopathy, and studies have examined their clinical applicability. Several retrospective and prospective studies sought to validate the use of deep-learning systems in diabetic retinopathy screening.

LITERATURE SURVEY:

Approximately four hundred and twenty million people worldwide have been diagnosed with diabetes mellitus. The prevalence of this disease has doubled in the past 30 years and is only expected to increase, particularly in Asia. Of those with diabetes approximately one-third are expected to be diagnosed with diabetic retinopathy (DR), a chronic eye disease that can progress to irreversible vision loss. Early detection which is critical for good prognosis, release on skilled readers and is both labour and time-intensive. Automated techniques for diabetic retinopathy diagnoses are essential to solving these problems.

References:

- https://pubmed.ncbi.nlm.nih.gov/27898976
- https://arxiv.org/abs/1905.07203
- https://www.scitepress.org/Papers/2020/89708/89708
- https://www.researchgate.net/publication/353056389 Explainable Diabetic Retinopathy Detection and Retinal Image Generation

PROBLEM STATEMENT:

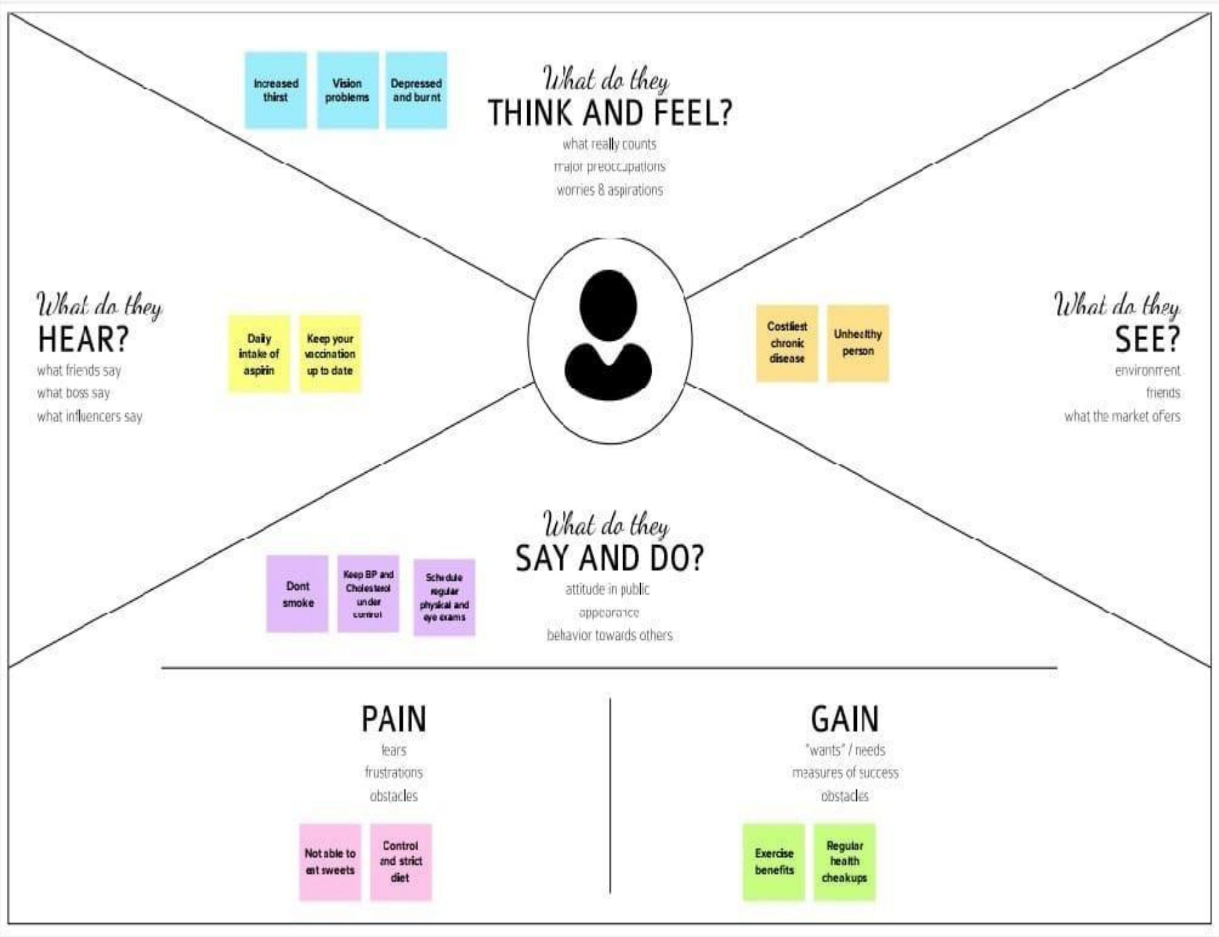
Who does the problem affect?	Persons who have Diabetes mellitus
What are the boundaries of the problem?	The longer you have diabetes and the less controlled your blood sugaris, the more likely you are to develop this eye complication.
What is the issue?	• Spots or dark strings floating in your vision (floaters) • Blurred vision • Fluctuating vision • Dark or empty areasin your vision • Vision loss
When does the issue occur?	Developing diabetes when pregnant (gestational diabetes) orhaving diabetes before becoming pregnant can increase risk of diabetic retinopathy.
Where does the issue occur?	The manual diagnosis process of DR retina fundus images by ophthalmologists is time, effort and cost-consuming and prone to misdiagnosis unlike computer-aideddiagnosis systems.
Why is it important that we fix the Problem?	If it is not detected early, it can leadto blindness. Unfortunately, diabetic retinopathy is not a reversible process, and treatment only sustains vision.

What solution to solve this issue?	DR early detection and treatment can significantly reduce the risk ofvision loss
What methodology used to solve the issue?	Deep learning techniques are used for early detection of diabetic retinopathy that can prevent blindness and other eye relateddiseases.

IDEATION AND PROPOSED SOLUTION:

EMPATHY MAP CANVAS:

Diabetes is a globally prevalent disease that can cause visible microvascular complications such as diabetic retinopathy and macular edema in the human eye retina, the images of which are today used for manualdisease screening and diagnosis. This labor-intensive task could greatly benefit from automatic detection using deep learning technique. Here we present a deep learning system that identifies referable diabetic retinopathy comparably or better than presented in the previous studies, although we use only a small fraction of images (<1/4) in training but are aided with higher image resolutions. We also provide novel results for five different screening and clinical grading systems for diabetic retinopathy and macular edema classification, including state-of-the-art results for accurately classifying imagesaccording to clinical five-grade diabetic retinopathy and for the first time for the four-grade diabetic macular edema scales. These results suggest, that a deep learning system could increase the cost-effectiveness of screening and diagnosis, while attaining higher than recommended performance, and that the system could be applied in clinical examinations requiring finer grading.



What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations

Increased thirst

Vision problems

Depressed and burnt

What do they
HEAR?
what friends say
what boss say
what influencers say

Daily intake of aspirin

Keep your vaccination up to date

What do they
SEE?
environment
friends
what the market ofers

Costliest chronic disease

Unhealthy person

What do they
SAY AND DO?
attitude in public
appearance
behavior towards others

Dont smoke

Keep BP and Cholesteol under control

Schedule regular physical and eye exams

PAIN
fears
frustrations
obstacles

Not able to eat sweets

Control and strict diet

GAIN
"wants" / needs
measures of success
obstacles

Exercise benefits

Regular health cheakups

IDEATION & BRAINSTROMING:

Team Lead Anusheya

Close examination of diabetic patients

Analyzing pattern of symptoms among the patients

Create a detailed report for the patitent

Getting the medical detail of the patient

Team member Pavithra

Examine the images for linearity

working with images from any format

Recommending for regular health checkup

Suggest the optimal blood sugar level

Team member Helan Joice

Analysis of the fundus images

Eye checkups at regular intervals

Use Machine learning algorithms for detection

Showing the results at the time of prediction

Team member Kavitha

Conscious about food habits

Keep diabetics and BP under control

Avoid high carbs food

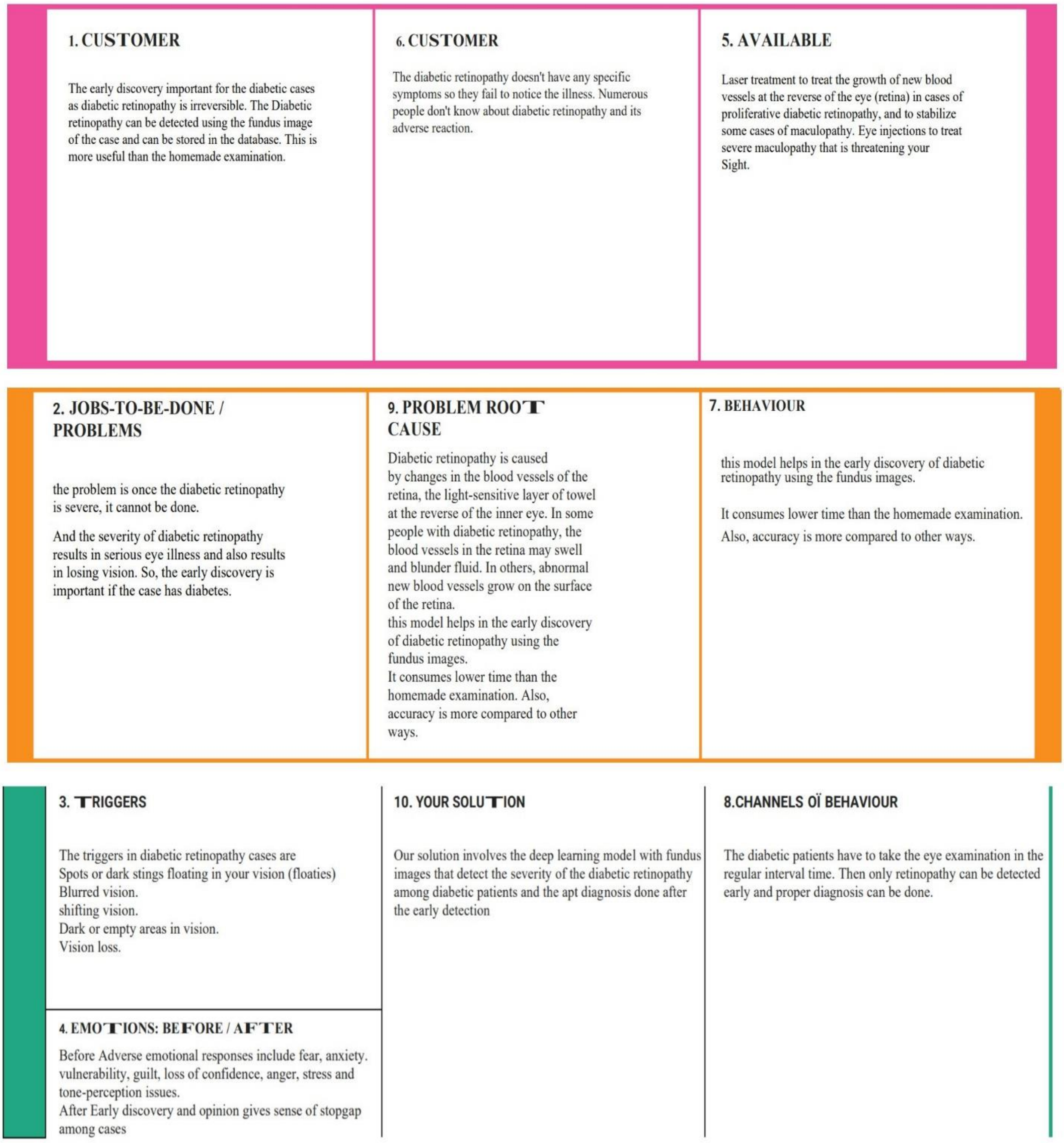
Python model to train the datasets

PROPOSED SOLUTION:

S.No:	Parameter	Description
1.	Problem Statement (Problem to besolved)	Diabetic retinopathy is a diabetes complicationthat affects eyes. It is caused by damage to the blood vessels of the light-sensitive tissue at theback of the eye (retina). At first, diabetic retinopathy might cause no symptoms or only mild vision problems. But itcan lead to blindness. The condition can develop in anyone who has type 1 or type 2 diabetes. The longer you have diabetes and the less controlled your blood sugar is, the more likely you are to develop thiseye complication.
2.	Idea / Solution description	Diabetic retinopathy is not a reversible process,and treatment only sustains vision. DR early detection and treatment can significantly reduce the risk of vision loss. The manual diagnosis process of DR retina fundus images byophthalmologists is time, effort, and cost- consuming and prone to misdiagnosis unlike computer-aided diagnosis systems. So, deep learning techniques can be used for early detection of diabetic retinopathy that can prevent blindness and other eye relateddiseases.
3.	Novelty / Uniqueness	This model provides the patient with the resultwhether they have serious condition or normal condition. The prediction comes with different levels of illness helps to diagnose properly.

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

PROBLEM SOLUTION FIT:



1. CUSTOMER

The early discovery important for the diabetic cases as diabetic retinopathy is irreversible. The Diabetic retinopathy can be detected using the fundus image of the case and can be stored in the database. This is more useful than the homemade examination.

6. CUSTOMER

The diabetic retinopathy doesn't have any specific symptoms so they fail to notice the illness. Numerous people don't know about diabetic retinopathy and its adverse reaction.

5. AVAILABLE

Laser treatment to treat the growth of new blood vessels at the reverse of the eye (retina) in cases of proliferative diabetic retinopathy, and to stabilize some cases of maculopathy. Eye injections to treat severe maculopathy that is threatening your Sight.

2. JOBS-TO-BE-DONE / PROBLEMS

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

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

9. PROBLEM ROOT CAUSE

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

this model helps in the early discovery of diabetic retinopathy using the fundus images.

It consumes lower time than the homemade examination. Also, accuracy is more compared to other ways.

7. BEHAVIOUR

this model helps in the early discovery of diabetic retinopathy using the fundus images.

It consumes lower time than the homemade examination.

Also, accuracy is more compared to other ways.

3. TRIGGERS

The triggers in diabetic retinopathy cases are
Spots or dark stings floating in your vision (floaties)
Blurred vision.
shifting vision.
Dark or empty areas in vision.
Vision loss.

4. EMOTIONS: BEFORE / AFTER

Before Adverse emotional responses include fear, anxiety. vulnerability, guilt, loss of confidence, anger, stress and tone-perception issues.
After Early discovery and opinion gives sense of stopgap among cases

10. YOUR SOLUTION

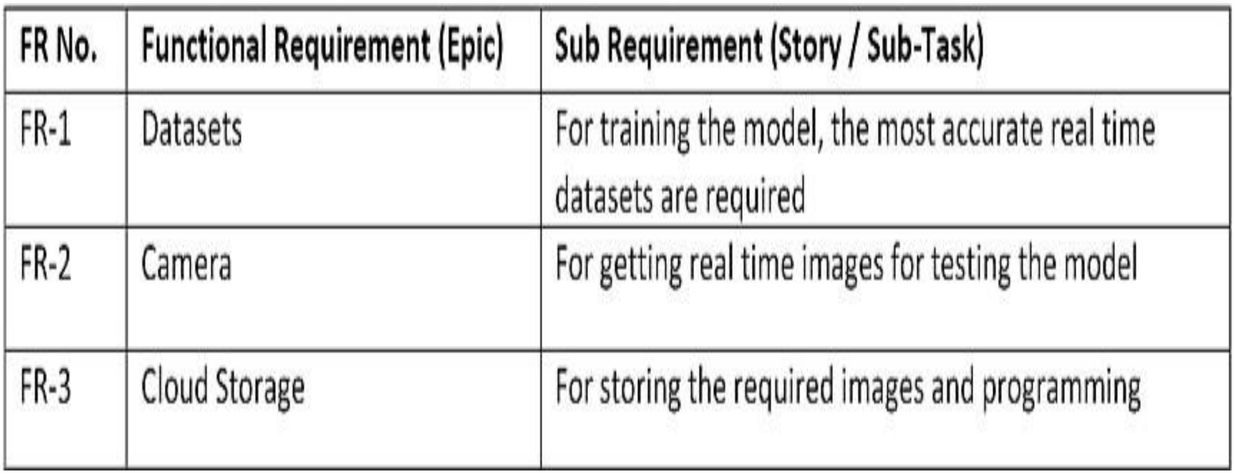
Our solution involves the deep learning model with fundus images that detect the severity of the diabetic retinopathy among diabetic patients and the apt diagnosis done after the early detection

8.CHANNELS OÏ BEHAVIOUR

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

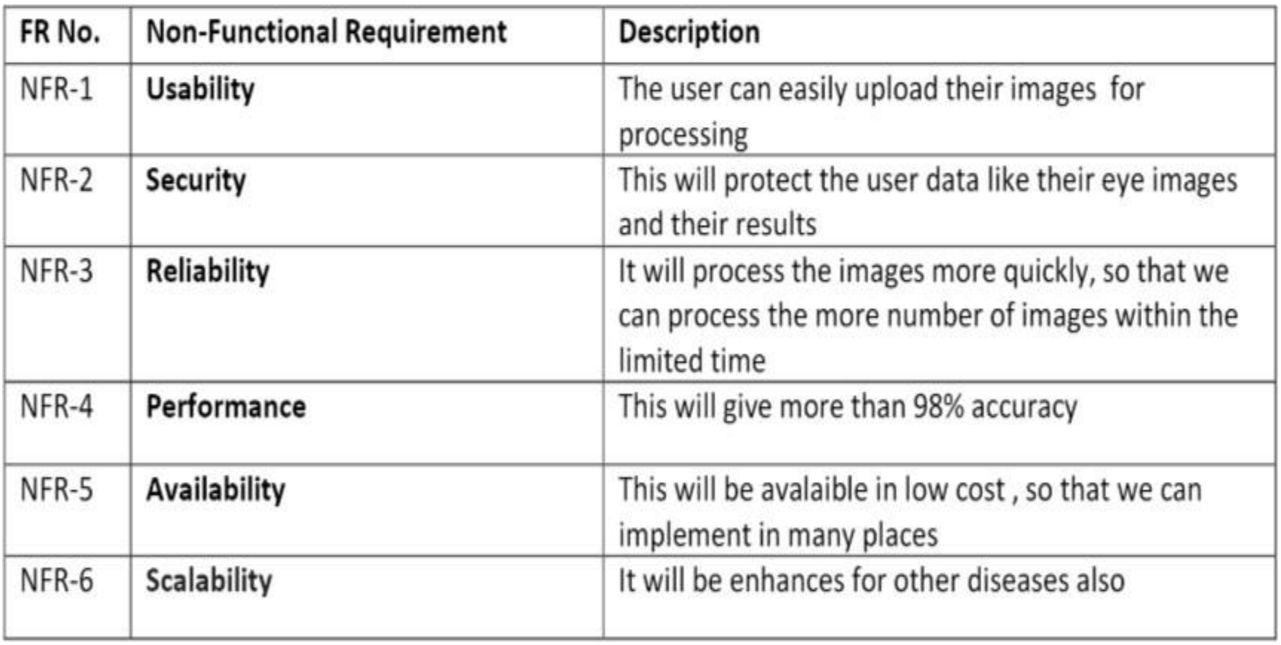
REQUIREMENT ANALYSIS:

FUNCTIONAL REQUIREMENT:



FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Datasets	For training the model, the most accurate real time datasets are required
FR-2	Camera	For getting real time images for testing the model
FR-3	Cloud Storage	For storing the required images and programming

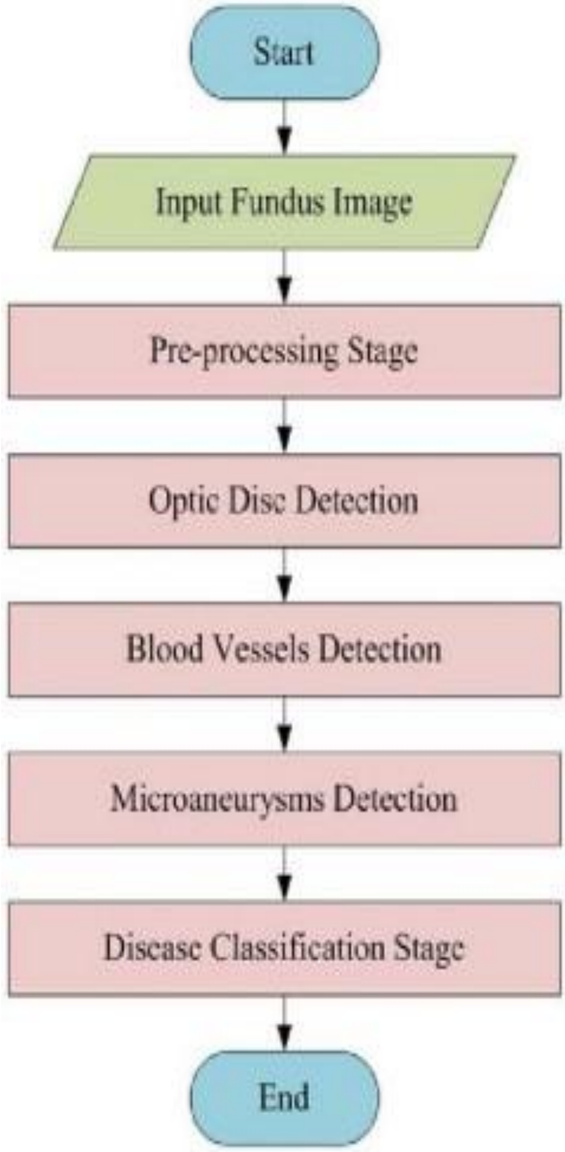
NON-FUNCTIONAL REQUIREMENT:



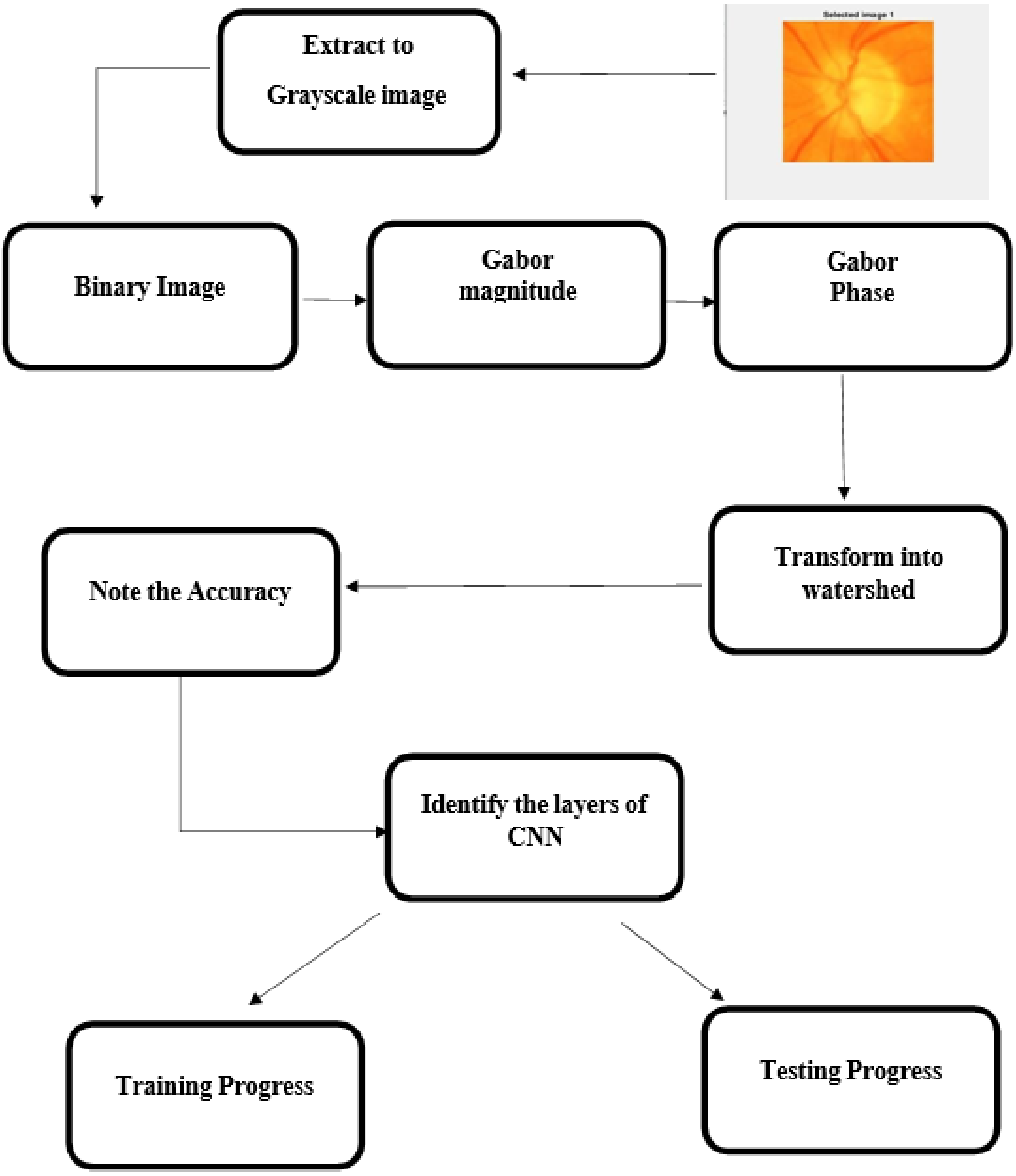
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The user can easily upload their images for processing
NFR-2	**Security**	This will protect the user data like their eye images and their results
NFR-3	**Reliability**	It will process the images more quickly, so that we can process the more number of images within the limited time
NFR-4	**Performance**	This will give more than 98% accuracy
NFR-5	**Availability**	This will be avalaible in low cost , so that we can implement in many places
NFR-6	**Scalability**	It will be enhances for other diseases also

PROJECT DESIGN:

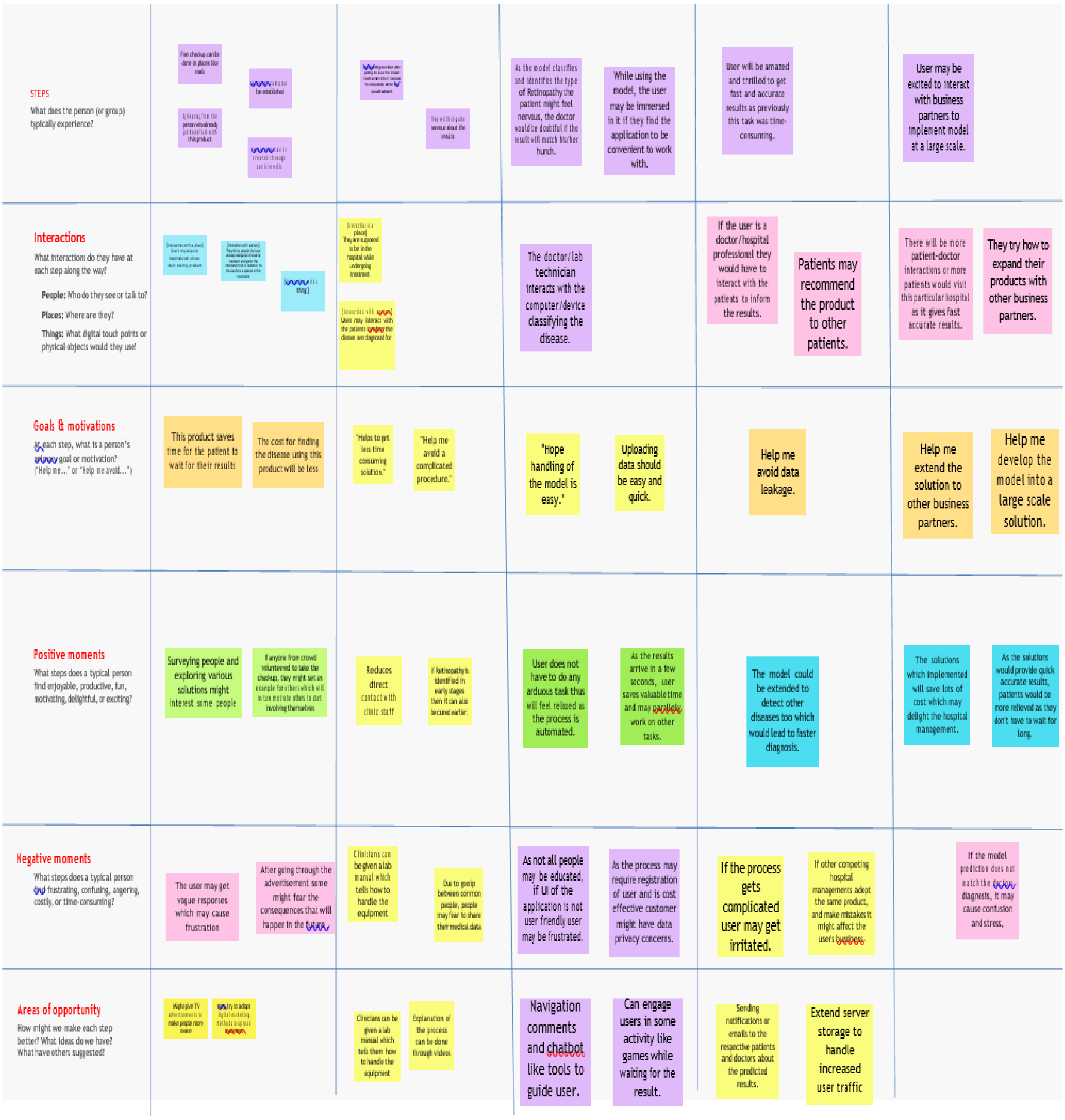
DATA FLOW DIAGRAM:



SOLUTION ARCHITECTURE:



USER STORIES:



STEPS What does the person (or group) typically experience?	Free checkup can be done in places like malls [illegible] can be established [illegible] from the person who already got [illegible] with this product [illegible] can be created through social media	[illegible] They will feel quite nervous about the results	As the model classifies and identifies the type of Retinopathy the patient might feel nervous, the doctor would be doubtful if the result will match his/her hunch. While using the model, the user may be immersed in it if they find the application to be convenient to work with.	User will be amazed and thrilled to get fast and accurate results as previously this task was time-consuming.	User may be excited to interact with business partners to implement model at a large scale.
Interactions What interactions do they have at each step along the way? **People:** Who do they see or talk to? **Places:** Where are they? **Things:** What digital touch points or physical objects would they use?	[Interaction with a place] Users may enquire hospitals and clinics about existing products [Interaction with a person] [illegible] [illegible] the thing]	[Interaction in a place] They are supposed to be in the hospital while undergoing treatment [Interaction with [illegible]] Users may interact with the patients [illegible] the disease are diagnosed for	The doctor/lab technician interacts with the computer/device classifying the disease.	If the user is a doctor/hospital professional they would have to interact with the patients to inform the results. Patients may recommend the product to other patients.	There will be more patient-doctor interactions or more patients would visit this particular hospital as it gives fast accurate results. They try how to expand their products with other business partners.
Goals & motivations At each step, what is a person's primary goal or motivation? ("Help me..." or "Help me avoid...")	This product saves time for the patient to wait for their results The cost for finding the disease using this product will be less	"Helps to get less time consuming solution." "Help me avoid a complicated procedure."	"Hope handling of the model is easy." Uploading data should be easy and quick.	Help me avoid data leakage.	Help me extend the solution to other business partners. Help me develop the model into a large scale solution.
Positive moments What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?	Surveying people and exploring various solutions might interest some people If anyone from crowd volunteered to take the checkup, they might set an example for others which will in turn motivate others to start involving themselves	Reduces direct contact with clinic staff If Retinopathy is identified in early stages then it can also be cured earlier.	User does not have to do any arduous task thus will feel relaxed as the process is automated. As the results arrive in a few seconds, user saves valuable time and may parallely work on other tasks.	The model could be extended to detect other diseases too which would lead to faster diagnosis.	The solutions which implemented will save lots of cost which may delight the hospital management. As the solutions would provide quick accurate results, patients would be more relieved as they don't have to wait for long.
Negative moments What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?	The user may get vague responses which may cause frustration After going through the advertisement some might fear the consequences that will happen in the future	Clinicians can be given a lab manual which tells how to handle the equipment Due to gossip between common people, people may fear to share their medical data	As not all people may be educated, if UI of the application is not user friendly user may be frustrated. As the process may require registration of user and is cost effective customer might have data privacy concerns.	If the process gets complicated user may get irritated. If other competing hospital managements adopt the same product, and make mistakes it might affect the user's business.	If the model prediction does not match the doctors diagnosis, it may cause confusion and stress.
Areas of opportunity How might we make each step better? What ideas do we have? What have others suggested?	Might give TV advertisements to make people more aware [illegible] try to adopt digital marketing methods to spread [illegible]	Clinicians can be given a lab manual which tells them how to handle the equipment Explanation of the process can be done through videos	Navigation comments and chatbot like tools to guide user. Can engage users in some activity like games while waiting for the result.	Sending notifications or emails to the respective patients and doctors about the predicted results. Extend server storage to handle increased user traffic	

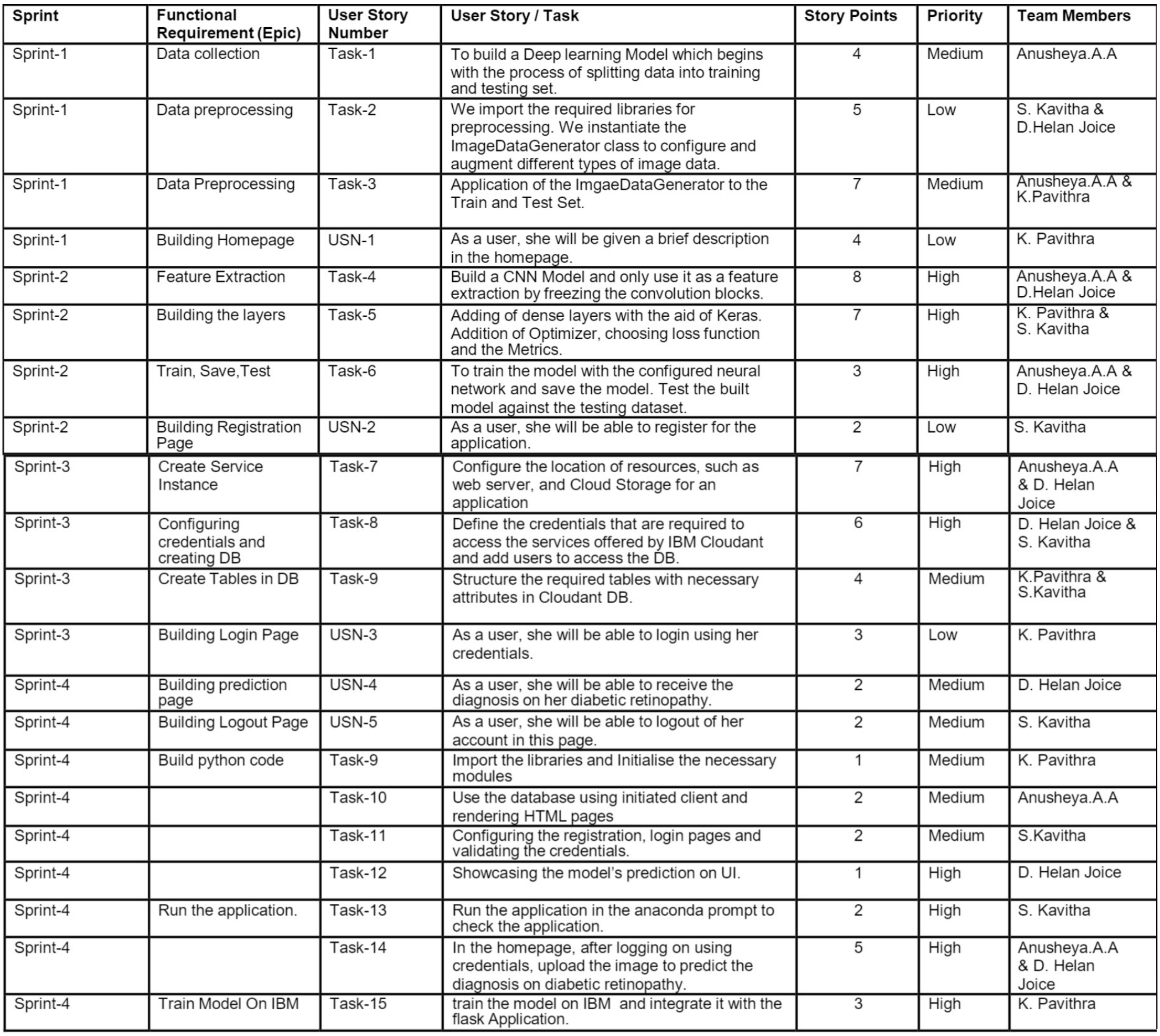
PROJECT PLANNING AND SCHEDULING:

SPRINT PLANNING AND ESTIMATION:

S.NO	ACTIVITY TITLE	DESCRIPTION	DURATION
1	Understanding the project and its requirement	Assign the team members and create repository in the GitHub, Assign the task to each team member and teach how to use the GitHub and IBM career education.	1 week
2	Start the project	Advice students to attend classes of IBM portal create and develop an rough diagram based on project description and gather information on AI and IBM project and team leader assign task to each member of the project.	1 week

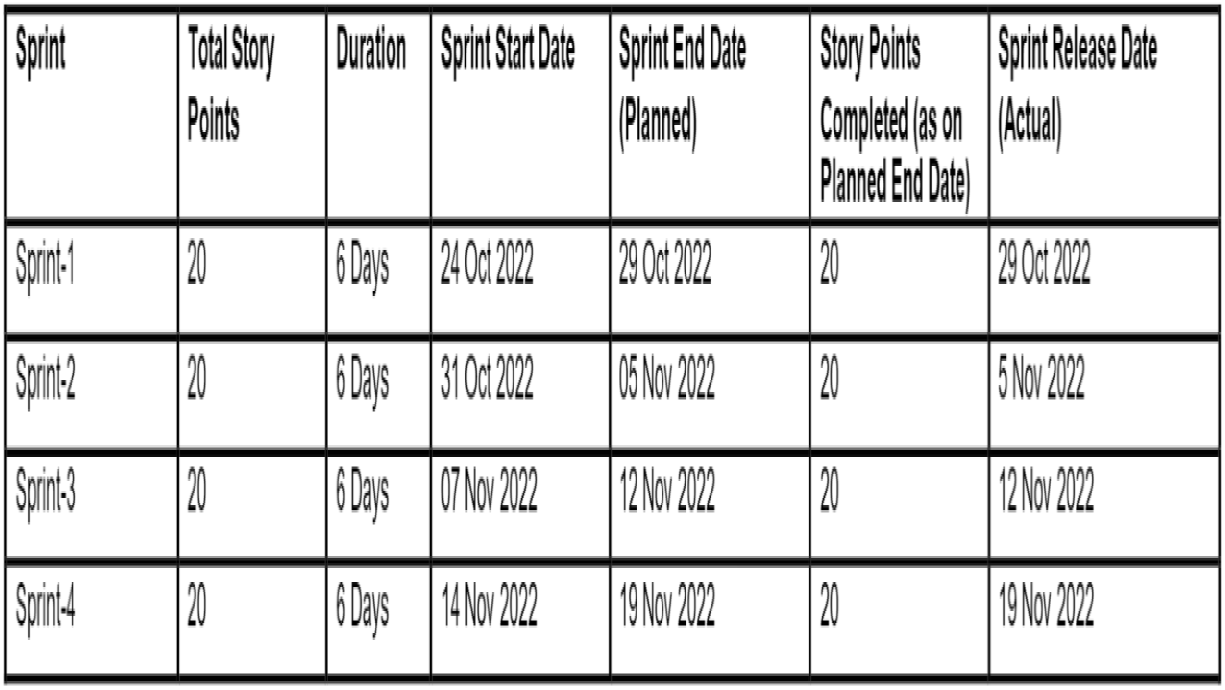
3	Attend class	Team members and team lead must attend the classes and learn from classes provided by IBM and NALAYA THIRAN and must gain access ofMIT license for theproject.	4 weeks
4	Budget and scope of project	Reduce cost efficiency and analysis the use of AI in the project.	Progress

SPRINT DELIVERY SCHEDULE:



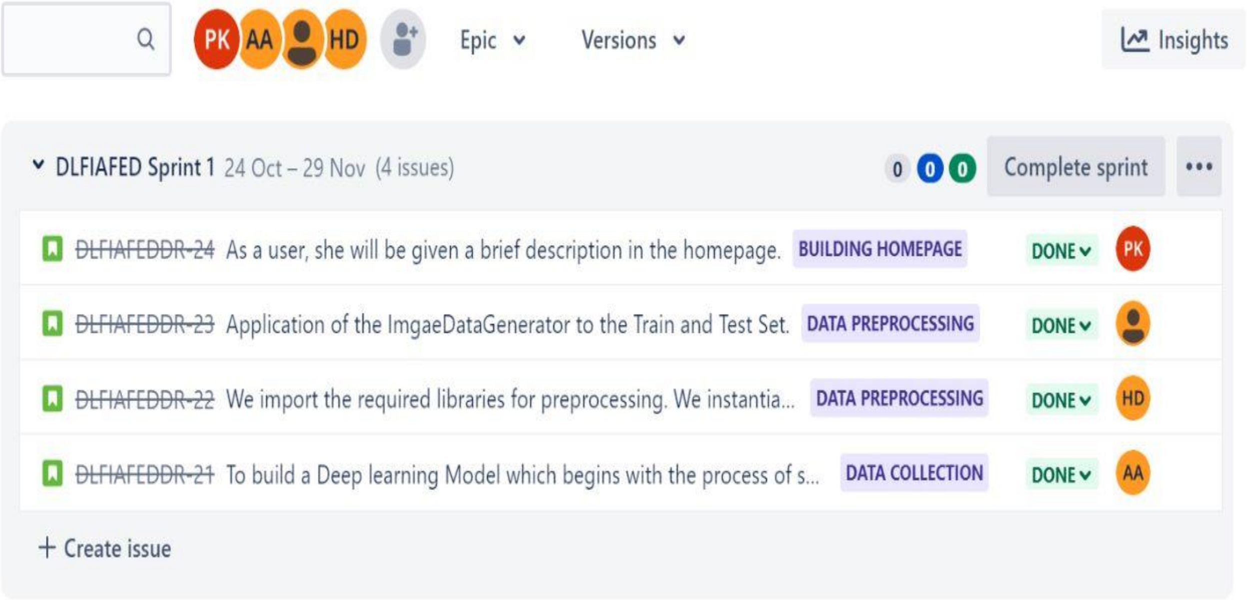
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data collection	Task-1	To build a Deep learning Model which begins with the process of splitting data into training and testing set.	4	Medium	Anusheya.A.A
Sprint-1	Data preprocessing	Task-2	We import the required libraries for preprocessing. We instantiate the ImageDataGenerator class to configure and augment different types of image data.	5	Low	S. Kavitha & D.Helan Joice
Sprint-1	Data Preprocessing	Task-3	Application of the ImgaeDataGenerator to the Train and Test Set.	7	Medium	Anusheya.A.A & K.Pavithra
Sprint-1	Building Homepage	USN-1	As a user, she will be given a brief description in the homepage.	4	Low	K. Pavithra
Sprint-2	Feature Extraction	Task-4	Build a CNN Model and only use it as a feature extraction by freezing the convolution blocks.	8	High	Anusheya.A.A & D.Helan Joice
Sprint-2	Building the layers	Task-5	Adding of dense layers with the aid of Keras. Addition of Optimizer, choosing loss function and the Metrics.	7	High	K. Pavithra & S. Kavitha
Sprint-2	Train, Save,Test	Task-6	To train the model with the configured neural network and save the model. Test the built model against the testing dataset.	3	High	Anusheya.A.A & D. Helan Joice
Sprint-2	Building Registration Page	USN-2	As a user, she will be able to register for the application.	2	Low	S. Kavitha
Sprint-3	Create Service Instance	Task-7	Configure the location of resources, such as web server, and Cloud Storage for an application	7	High	Anusheya.A.A & D. Helan Joice
Sprint-3	Configuring credentials and creating DB	Task-8	Define the credentials that are required to access the services offered by IBM Cloudant and add users to access the DB.	6	High	D. Helan Joice & S. Kavitha
Sprint-3	Create Tables in DB	Task-9	Structure the required tables with necessary attributes in Cloudant DB.	4	Medium	K.Pavithra & S.Kavitha
Sprint-3	Building Login Page	USN-3	As a user, she will be able to login using her credentials.	3	Low	K. Pavithra
Sprint-4	Building prediction page	USN-4	As a user, she will be able to receive the diagnosis on her diabetic retinopathy.	2	Medium	D. Helan Joice
Sprint-4	Building Logout Page	USN-5	As a user, she will be able to logout of her account in this page.	2	Medium	S. Kavitha
Sprint-4	Build python code	Task-9	Import the libraries and Initialise the necessary modules	1	Medium	K. Pavithra
Sprint-4		Task-10	Use the database using initiated client and rendering HTML pages	2	Medium	Anusheya.A.A
Sprint-4		Task-11	Configuring the registration, login pages and validating the credentials.	2	Medium	S.Kavitha
Sprint-4		Task-12	Showcasing the model's prediction on UI.	1	High	D. Helan Joice
Sprint-4	Run the application.	Task-13	Run the application in the anaconda prompt to check the application.	2	High	S. Kavitha
Sprint-4		Task-14	In the homepage, after logging on using credentials, upload the image to predict the diagnosis on diabetic retinopathy.	5	High	Anusheya.A.A & D. Helan Joice
Sprint-4	Train Model On IBM	Task-15	train the model on IBM and integrate it with the flask Application.	3	High	K. Pavithra

SPRINT DELIVERY SCHEDULE:



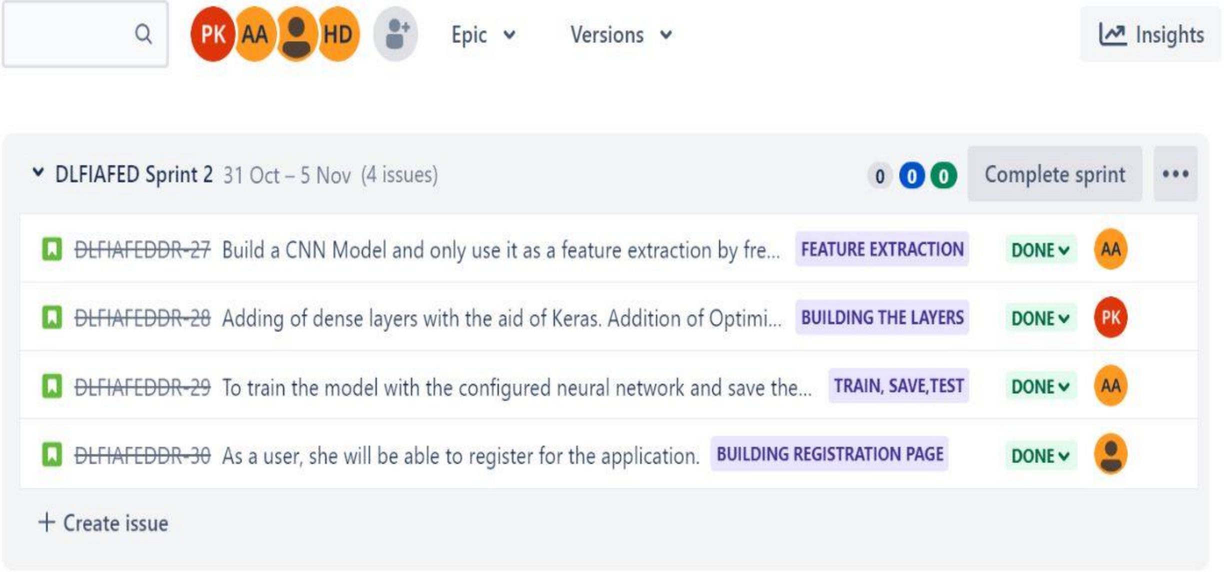
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	5 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

REPORTS FROM JIRA:



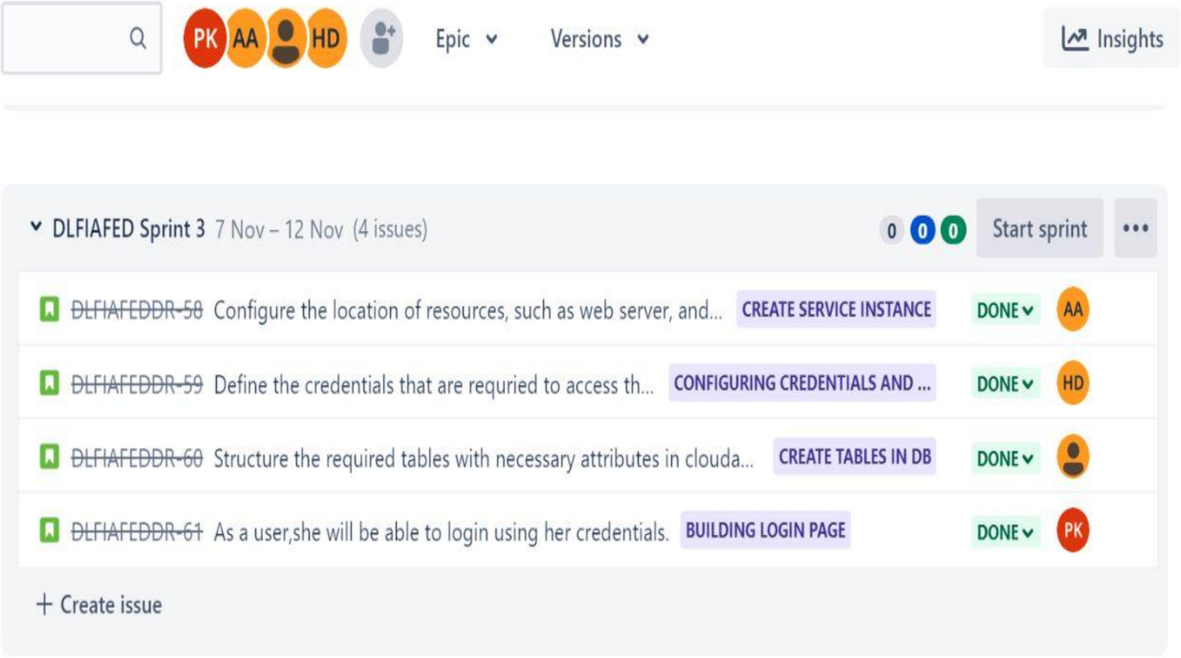
DLFIAFED Sprint 1 24 Oct – 29 Nov (4 issues)

~~DLFIAFEDDR-24~~ As a user, she will be given a brief description in the homepage.	BUILDING HOMEPAGE	DONE	PK
~~DLFIAFEDDR-23~~ Application of the ImgaeDataGenerator to the Train and Test Set.	DATA PREPROCESSING	DONE	
~~DLFIAFEDDR-22~~ We import the required libraries for preprocessing. We instantia...	DATA PREPROCESSING	DONE	HD
~~DLFIAFEDDR-21~~ To build a Deep learning Model which begins with the process of s...	DATA COLLECTION	DONE	AA



DLFIAFED Sprint 2 31 Oct – 5 Nov (4 issues)

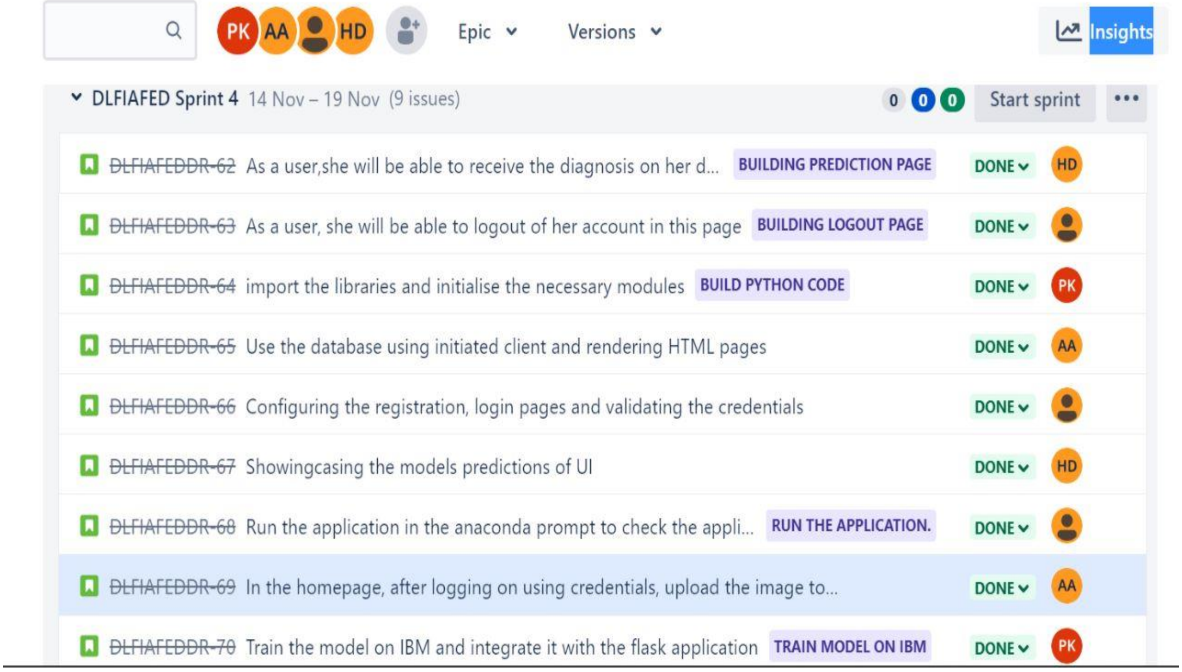
~~DLFIAFEDDR-27~~ Build a CNN Model and only use it as a feature extraction by fre...	FEATURE EXTRACTION	DONE	AA
~~DLFIAFEDDR-28~~ Adding of dense layers with the aid of Keras. Addition of Optimi...	BUILDING THE LAYERS	DONE	PK
~~DLFIAFEDDR-29~~ To train the model with the configured neural network and save the...	TRAIN, SAVE,TEST	DONE	AA
~~DLFIAFEDDR-30~~ As a user, she will be able to register for the application.	BUILDING REGISTRATION PAGE	DONE	



DLFIAFED Sprint 3 7 Nov – 12 Nov (4 issues) 0 0 0 Start sprint •••

~~DLFIAFEDDR-58~~	Configure the location of resources, such as web server, and...	CREATE SERVICE INSTANCE	DONE	AA
~~DLFIAFEDDR-59~~	Define the credentials that are requried to access th...	CONFIGURING CREDENTIALS AND ...	DONE	HD
~~DLFIAFEDDR-60~~	Structure the required tables with necessary attributes in clouda...	CREATE TABLES IN DB	DONE	
~~DLFIAFEDDR-61~~	As a user,she will be able to login using her credentials.	BUILDING LOGIN PAGE	DONE	PK

+ Create issue



DLFIAFED Sprint 4 14 Nov – 19 Nov (9 issues) 0 0 0 Start sprint •••

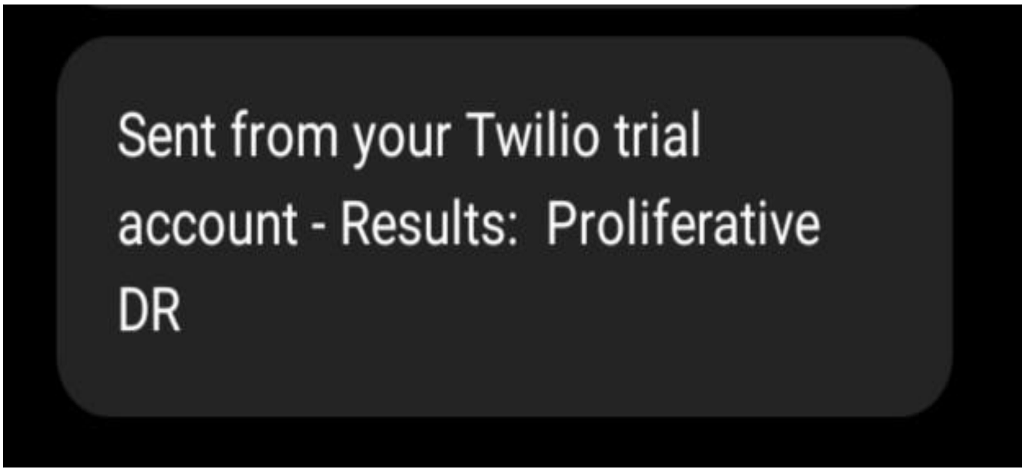
~~DLFIAFEDDR-62~~	As a user,she will be able to receive the diagnosis on her d...	BUILDING PREDICTION PAGE	DONE	HD
~~DLFIAFEDDR-63~~	As a user, she will be able to logout of her account in this page	BUILDING LOGOUT PAGE	DONE	
~~DLFIAFEDDR-64~~	import the libraries and initialise the necessary modules	BUILD PYTHON CODE	DONE	PK
~~DLFIAFEDDR-65~~	Use the database using initiated client and rendering HTML pages		DONE	AA
~~DLFIAFEDDR-66~~	Configuring the registration, login pages and validating the credentials		DONE	
~~DLFIAFEDDR-67~~	Showingcasing the models predictions of UI		DONE	HD
~~DLFIAFEDDR-68~~	Run the application in the anaconda prompt to check the appli...	RUN THE APPLICATION.	DONE	
~~DLFIAFEDDR-69~~	In the homepage, after logging on using credentials, upload the image to...		DONE	AA
~~DLFIAFEDDR-70~~	Train the model on IBM and integrate it with the flask application	TRAIN MODEL ON IBM	DONE	PK

CODING:

```
imageSize = [299,299]
trainPath = r"/content/preprocessed dataset/preprocessed dataset/training"
testPath = r"/content/preprocessed dataset/preprocessed dataset/testing"
from tensorflow.keras.layers import Dense, Flatten, Input
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
train_datagen = ImageDataGenerator (rescale = 1./255,
                                   shear_range = 0.2,
                                   zoom_range = 0.2,
                                   horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set = train_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/training',
                                                 target_size = (299, 299),
                                                 batch_size = 32,
                                                 class_mode = 'categorical')
test_set = test_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/testing',
                                            target_size = (299, 299),
                                            batch_size = 32,
                                            class_mode = 'categorical')
xception = Xception(input_shape=imageSize + [3], weights='imagenet', include_top=False)
# don't train existing weights for layer in xception.layers:
for layer in xception.layers:
  layer.trainable = False
# our Layers (- you can add more if you want x = Flatten(/(xception.output)
x = Flatten()(xception.output)
prediction = Dense(5, activation='softmax')(x)
model = Model(inputs=xception.input, outputs=prediction)
```

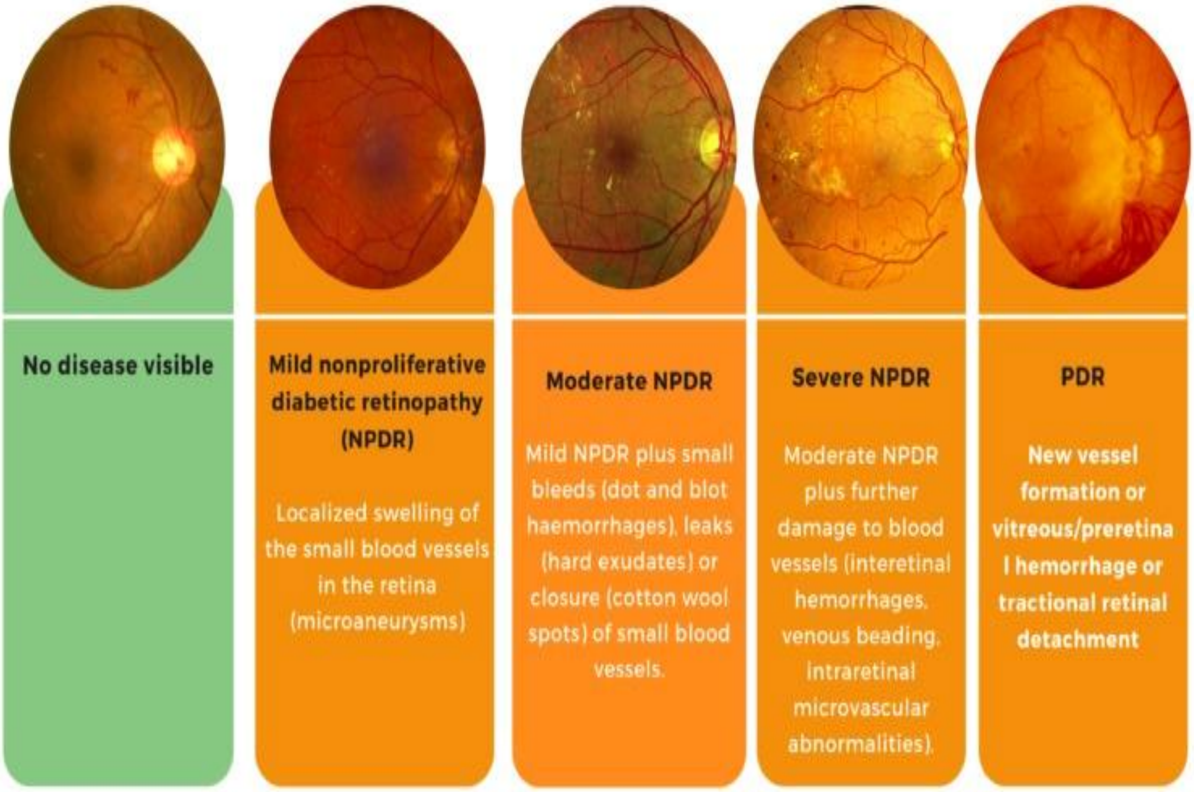
```
model.summary()
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
r=model.fit_generator(training_set,validation_data=test_set,epochs=30,steps_per_epoch=len(training_set)//32,validation_steps=len(test_set)//32)
model.save('Updated-Xception-diabetic-retinopathy.h5')
```

SOLUTION:



Sent from your Twilio trial account - Results: Proliferative DR

TESTING:



No disease visible

Mild nonproliferative diabetic retinopathy (NPDR)

Localized swelling of the small blood vessels in the retina (microaneurysms)

Moderate NPDR

Mild NPDR plus small bleeds (dot and blot haemorrhages), leaks (hard exudates) or closure (cotton wool spots) of small blood vessels.

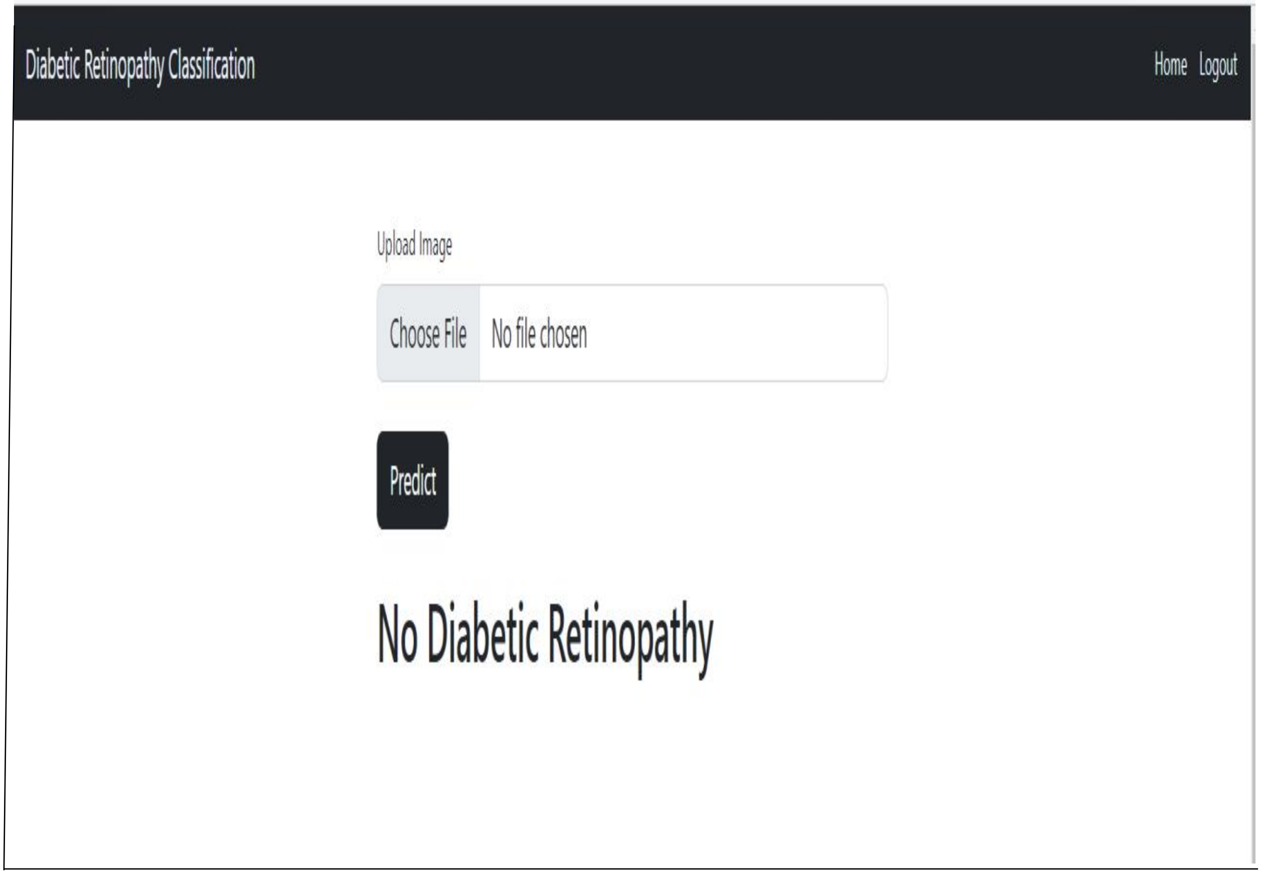
Severe NPDR

Moderate NPDR plus further damage to blood vessels (interetinal hemorrhages, venous beading, intraretinal microvascular abnormalities).

PDR

New vessel formation or vitreous/preretina l hemorrhage or tractional retinal detachment

RESULT:



No Diabetic Retinopathy

ADVANTAGES:

- Earlier detection reduces the risk of Vision loss.
- The amount of time for detecting the DR is less.
- Cost of detecting is less.

DISADVANTAGES:

- If the images are not uploaded correctly then detection may be difficult.

CONCLUSION:

Diabetic retinopathy is a serious complication of diabetes mellitus, leading to progressive damage and even blindness of the retina. Its early detection and treatment is important in order to prevent its deterioration and the retina’s damage. The interest in applying deep learning in detecting diabetic retinopathy has increased during the past years and as several DL systems evolve and become integrated into the clinical practice, they will enable the clinicians to treat the patients in need more effectively and efficiently. This article presents the current state of research regarding the application of deep learning in diagnosing diabetic retinopathy. Although deep learning has paved the way for more accurate diagnosis and treatment, further improvements are still necessary regarding performance, interpretability, and trustworthiness from ophthalmologists.

FUTURE SCOPE:

Use of AI in medical diagnostics, especially in ophthalmology heralds a new era. If proven to be sensitive and specific enough this technology can totally change the way we look at screening programs and community-based ophthalmology programs. Most of the present systems use conventional of 30–50° fundus images. Perhaps applications based on wide field imaging and OCT angiography based vascular analysis might yield even more consistent results. However, the high cost of wide field imaging and OCT angiography may be a limiting factor for this at present. A lot of work is also being done on identifying serum biomarkers for early detection and monitoring of diseases like diabetic retinopathy. Thus, a comprehensive analysis of ocular imaging, systemic parameter profile and other serum biomarkers using AI might provide better insights, perhaps even better conclusions than what human intelligence is capable of deriving.

APPENDIX:

SOURCE CODE:

```
imageSize = [299,299]

trainPath = r"/content/preprocessed dataset/preprocessed dataset/training"

testPath = r"/content/preprocessed dataset/preprocessed dataset/testing"

from tensorflow.keras.layers import Dense, Flatten, Input

from tensorflow.keras.models import Model

from tensorflow.keras.preprocessing import image

from tensorflow.keras.preprocessing.image import ImageDataGenerator, load_img
from tensorflow.keras.applications.xception import Xception, preprocess_input
from glob import glob
import numpy as np
import matplotlib.pyplot as plt
train_datagen = ImageDataGenerator (rescale = 1./255,
                                    shear_range = 0.2,
                                    zoom_range = 0.2,
                                    horizontal_flip = True)
test_datagen = ImageDataGenerator(rescale = 1./255)
training_set = train_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/training',
                                                 target_size = (299, 299),
                                                 batch_size = 32,
                                                 class_mode = 'categorical')
test_set = test_datagen.flow_from_directory('/content/preprocessed dataset/preprocessed dataset/testing',
                                            target_size = (299, 299),
                                            batch_size = 32,
                                            class_mode = 'categorical')
xception = Xception(input_shape=imageSize + [3], weights='imagenet', include_top=False)
# don't train existing weights for layer in xception.layers:
for layer in xception.layers:
  layer.trainable = False
# our Layers (- you can add more if you want x = Flatten(/(xception.output)
x = Flatten()(xception.output)

prediction = Dense(5, activation='softmax')(x)

model = Model(inputs=xception.input, outputs=prediction)

model.summary()

model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])

r=model.fit_generator(training_set,validation_data=test_set,epochs=30,steps_per_epoch=len(training_set)//32,validation_steps=len(test_set)//32)

model.save('Updated-Xception-diabetic-retinopathy.h5')
```

ii) CODE:

```
import numpy as np
import os
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.inception_v3 import preprocess_input
from flask import Flask, request,flash, render_template, redirect,url_for
from cloudant.client import Cloudant
from twilio.rest import Client
model = load_model(r"Updated-xception-diabetic-retinopathy.h5")
app = Flask(__name__)
app.secret_key="abc"
app.config['UPLOAD_FOLDER'] = "User_Images"
# Authenticate using an IAM API key
client = Cloudant.iam('83b0a1d5-ddf6-4b51-87ee-42b95f148756-bluemix','FXu-GpAbsfg-VuOr76a5bFw9lUh9UMFwAq9mK_4pJ46N',connect=True)
# Create a database using an initialized client
my_database = client.create_database('my_database')
```

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


user = ""


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


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




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



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



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


@app.route("/predict",methods=["GET", "POST"])
def predict():
    if request.method == "POST":
        f = request.files['file']
        # getting the current path 1.e where app.py is present
        basepath = os.path.dirname(__file__)
        #print ( " current path " , basepath )
        # from anywhere in the system we can give image but we want that
        filepath = os.path.join(str(basepath), 'User_Images', str(f.filename))
        #print ( " upload folder is " , filepath )
        f.save(filepath)
        img = image.load_img(filepath, target_size=(299, 299))
        x = image.img_to_array(img)  # ing to array
        x = np.expand_dims(x, axis=0)  # used for adding one more dimension
        #print ( x )
        img_data = preprocess_input(x)
        prediction = np.argmax(model.predict(img_data), axis=1)
        index = [' No Diabetic Retinopathy ', ' Mild NPDR ',
                 ' Moderate NPDR ', ' Severe NPDR ', ' Proliferative DR ']
        result = str(index[prediction[0]])
        print(result)
        return render_template('prediction.html', prediction=result, fname = filepath)
    else:
        return render_template("prediction.html")


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

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-53556-1661417947

DEMO VIDEO LINK:

https://drive.google.com/file/d/1XxGhsQDI6m58cQ5lWW-aJqjHFgAjfPZh/view?usp=share_link