PROJECT DOCUMENTATION

Deep Learning Fundus Image Analysis for Early Detection of Diabetic Retinopathy

Team Id: PNT2022TMID38219

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1.INTRODUCTION :

Diabetes is a serious condition that affects approximately 2.6 million Malaysians over 18 years of age in 2012 according to the National Diabetic Registry (NDR). It is a condition that needs constant monitoring and, if problems arise, can shorten life expectancy. In addition, there is currently no cure for diabetes. Therefore, it is very important to have some knowledge of the condition, the effect on the body and how to manage it effectively. According to the article, the diagnosis of diabetes is made using the image of the fundus and the deep neural learning network. Fundus image is a photo taken using a 3CCD color video camera on Topcon TRC NW6 non-mydriatic retinography with a 45-degree view field. In short, fundus is the inner image of the human eye.

Therefore, this project introduces a way to diagnose diabetes in a person using fundus images of their eyes. Accordingly, diabetes can have many effects on the eyes such as blurred vision, blurred vision and / or blurred vision, eye pain, cataracts, slow recovery after eye damage and blindness. In addition, many of the most frightening things affecting the eye of a diabetic patient are blindness. Basically, diabetic retinopathy was something that damaged the retina in the eyes. Basically, the retina was lying behind the eyes and sensitive to light. Therefore, if injured, it can cause a person to become blind.

According to, there are two types of diabetes, type 1 and type 2 diabetes. However, to date, the most common type of diabetes is type 90% to 95% diabetes.

1.1. DIABETES:

Type 1 diabetes is called insulin-dependent diabetes mellitus. It usually starts in childhood and from infancy has been called juvenile-onset diabetes. Type 1 diabetes is an autoimmune disease and is caused by the body's immune system. In addition, if a person has type 1 diabetes, their pancreas will be damaged and will not produce any insulin. Basically, this type of diabetes can be caused by genetics from their parents.

It can also be the result of abnormal beta cells in the pancreas that normally produce insulin. Therefore, treatment for type 1 diabetes involves taking insulin, which needs to be injected into the skin and into the fatty tissue below. Then, in type 2 diabetes it is called diabetes that starts in adults, which are overweight and obese children. According to him, adolescents nowadays have this type of diabetes.

Scientifically speaking, type 2 diabetes is called insulin-dependent diabetes mellitus and is higher than type 1 diabetes. In addition, it can cause certain organs to become less active, especially the tiny blood vessels in the body that work to support the kidneys and eyes. Thereafter, it can interfere with the pancreas where it normally produces insulin and cause the amount of insulin produced to be insufficient for the body's needs, or the body's cells to refuse to receive insulin. Generally, obese boys are 20% lower than their ideal body because they are able to withstand insulin in their bodies. However, type 2 diabetes can be prevented by exercise, diet and weight control. Unfortunately, type 2 diabetes often develops and medications for diabetes are often needed.

Basically, the operating system for the eyes to see the object, the light must pass in front of the pupil's eye, and then the iris and others. Finally, the latter will reach the retina which converts the light signal into an electrical signal and the signal will be translated by the brain and produce an image. This disease is usually caused by high blood sugar for a long time. As patients continue to have high blood sugar, it will damage the blood vessels inside their eyes. After its damage, vessels will begin to leak and will sometimes create new vessels in the eye to replace damaged vessels. Unfortunately, these new ships could jeopardize the idea.

1.2 DIABETIC RETINOPATHY:

According to, there are two types of diabetes retinopathy namely non-proliferative diabetesic retinopathy (NPDR) and proliferative diabetesic retinopathy (PDR). NPDR is a hallmark of the early stages of diabetic retinopathy and is divided into 3 types namely Mild NPDR, Medium NPDR and Intensive NPDR. To show a mild NPDR, it has a small balloon-like area that swells within the small retinal blood vessels called scientifically called micro-aneurysms. These micro-aneurysms are harmful and may leak some fluid into the retina. After that, there was usually macula inside our eyes, but in patients with diabetes it was called Diabetic Macular Edema (DME).

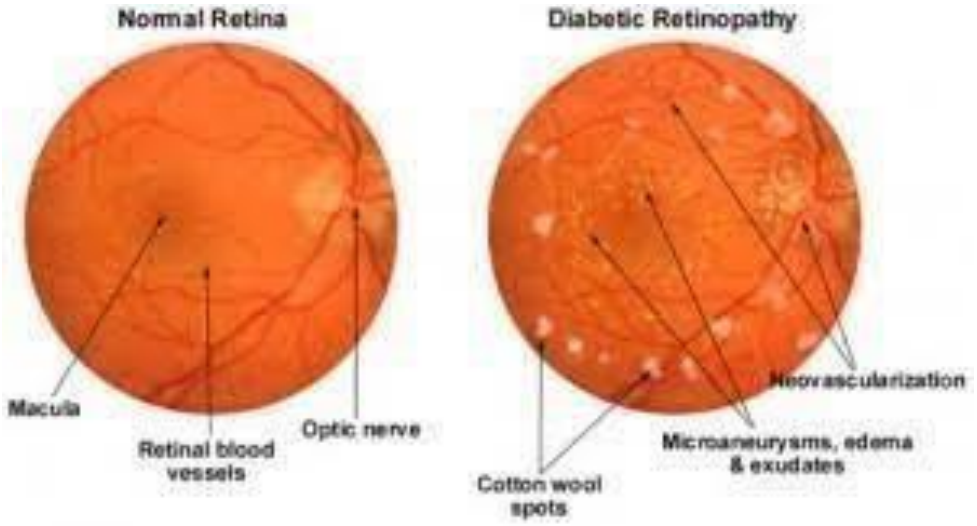
Basically, macula is important for sharpening and sharpening and is often used for reading, facial expressions, and driving. According to, about half of all people with diabetes retinopathy will develop this DME. Typically, DME occurs when diabetic retinopathy becomes more severe. However, these DMEs can occur at any stage of the disease. Next, in the NPDR Central, it is a disease that progresses when the arteries that feed the retina become swollen and twisted. From there, the efficiency of blood flow will decrease.

In NPDR Medium and NPDR Medium, both conditions cause certain changes in the appearance of the retina element and may help the eye to have DME. Another type of NPDR is the Severe NPDR, which occurs when too many blood vessels are blocked and reduces blood supply to the retina. Thereafter, PDR refers to the later stages of the disease. At this point, the retina receives a limited amount of oxygen as the circulatory system becomes less efficient. This is the stage when new blood vessels begin to grow and blur their vision. If left untreated, it can lead to retinal

detachment and eventually blindness. Therefore, it will cause the retina to swell, which will lead to blurred or clouded vision. Usually, the leak will affect both eyes.

1.3 FUNDUS IMAGE:

Fundus image is an image of the eyes which is the interior. These fundus images were attached to the retina, optic disc, macula, fovea, and posterior pole. According to [6], the fundus can be tested using ophthalmoscopy or fundus photography. It can filmed using a fundus camera on fundus images or period of ophthalmoscopy. Photography of fundus, there is many machines need to be considered. The first is the fundus camera, where it is a special microscope of low power and optical dethe mark is based on an indirect ophthalmoscope.



Based on figure above, on the left side of the figure shows a normal retina and the rightside is a diabetic retinopathy. At the diabetic retinopathy, it shows the neovascularization point, which is nearly to the optic nerve and the optic nerve is the brightest region of fundus images. It is appeared because of the retina blood vessels are leaked and then its growth some random abnormal blood vessels.

Next on the exudates, it is divided into two types which is hard exudates and soft exudates. For the soft exudates, it can be defined as a cotton-wool spots which is a nerve fibre layer infarction from occlusion of precapillary arterioles. These cottonwool
spots are often blocked by the micro aneurysms and vascular hyperpermeability. Basically, this cotton wool appears as fluffy white patches on the retina. For the hard exudates, it is a distinct yellow-white intra-retinal deposit which can fluctuate from small specks to larger patches and

can evolve into rings known as circinate. Most of the hard exudates is contains of serum proteins, lipids, and protein which has been created by the breakdown of the bloodretina barrier.

Nevertheless, the micro aneurysms are the earliest changes of diabetic retinopathy and usually looks saccular and localised capillary dilatations. Normally, they appear as small red dots in slight retinal layers and were existing to rupture the deeper layers of the retina, such as inner nuclear and outer plexiform layers. However, its relieve since this red dot did not affect the vision and it is one.
After that, in state that by using the fundus images, human eyes can detect the intraregional haemorrhages which is shaped as dot-blot (arrowhead), flame (arrow) and boat-shaped (asterisk) depending upon their depth within the retina.

However, between the dot haemorrhages and micro aneurysms, it is hard to differentiate by using human eyes since both are changes of background retinopathy. Typically, every shape of haemorrhages is correlate to the others shape on the eyes. For dot-blot haemorrhage, it corresponds to blood in the middle layers which is can be specified as inner nuclear and outer plexiform layers of the retina. Next, the flame-shaped haemorrhage corresponds to blood in the nerve fiber layers, and the boatshaped haemorrhage corresponds to sub hyaloid blood.
Basically, on the early stage of this disease, it is difficult to detect from the outlook view of a person. Therefore, a check-up with the doctor is needed. Typically, in Malaysia to detect this disease, a blood sugar test and urine test will be used to determine whether a person has a diabetes or not. In addition, these two methods take a lot of process and takes a long time to complete. Besides that, the methods that been applied in Malaysia is outdated. Malaysia need some improvement of their technology on medical sectors as its quite important for Malaysia to achieve well developed countries title in 2020.

Next, there are a lot of existing project that detecting a diabetes by using fundus. But, most of them were complicated where it is used some filter on the image such as colour of the image, size of the image. The aim of this project is to detect an early signs of diabetes disease by using fundus images, classified by using CNN. Therefore, by using deep learning CNN, the detection is much easier and faster.

2. LITERATURE REVIEW:

2.1 & 2.2: EXISTING PROBLEM & PROPOSED SOLUTION:

We have downloaded our datasaet from the kaggle which is a dataset provider. These datsets are helpful for making small projects. It's a subsidiary of Google LLC, is an online community of data scientists and machine learning practitioners.

Kaggle allows users to find and publish data sets, explore and build models in a web-based data-science environment, work with other data scientists and machine learning engineers, and enter competitions to solve data science challenges.

We have multiple other dataset providers such as

- Numer.ai
- DrivenData
- Open Data Science(ods.ai)
- TianChi
- AICrowd
- Data Castle
- Kesci
- Bien Data
- Data Fountain
- Open ML
- ML Collective
- Signate
- CrowdANALYTIX
- Zindi
- Grand Challenge

- DataSource.ai

Few platforms are domain-specific like finance, medical, social sciences, etc.

Kaggle is best than others because it have data that they feel needs to be analyzed. The most significant benefit of Kaggle is that these companies can easily find someone who knows how to work with their data, which makes solving the problem much easier than if they were trying to figure out what was wrong with their system themselves.

In the next part,

we have used google collaboratory environment for training the model. Colaboratory, or "Colab" for short, is a product from Google Research. Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education. More technically, Colab is a hosted Jupyter notebook service that requires no setup to use, while providing access free of charge to computing resources including GPUs.
These are the alternatives available out there for Google colab.

1. Azure Notebooks:

Azure notebooks by Microsoft is very similar to Colab in terms of functionality. Both platforms have a cloud sharing functionality available for free. Azure Notebooks wins in terms of speed and is much better than Colab in this regard. It has a memory of 4 gigabytes. Azure Notebooks creates a collection of related notebooks called Libraries. These libraries are the size of each data file as less than 100 megabytes. Azure Notebooks supports programming languages of Python, R and F#. It has a native Jupyter UI. Azure Notebooks is more suitable for simple applications.

2. Amazon Sagemaker:

Amazon SageMaker notebook runs on the Jupyter Notebook App. It is responsible to create and manage Jupyter notebooks that can further be used to process data and further train and deploy ML models. For the training and deployment of the models, it provides APIs. Amazon SageMaker provides a console that lets the user use the console UI to start model training or deploy a model. It allows for easy integration of ML models in applications.

3. IBM DataPlatform Notebooks:

IBM introduced Watson Data Platform and Data Science Experience (DSX) back in 2016 with support for open-source options. These options included Apache Spark, R, Python, Scala and Jupyter notebooks. It eventually started its platform for multi-cloud freedom of choice for data science work. This was done with the help of containerization of the product by way of Kubernetes. As a result, it can be deployed in Docker or CloudFoundry containers wherever the data resides. IBM DataPlatform Notebooks, unlike Google Colab, have containerization for multi-cloud deployment or a hybrid deployment. Colab needs data science to be fone on its own public cloud.

IBM supports containerization because it encourages customers to be able to analyze data and build, deploy and run models anywhere, including rival public clouds. DSX is both a part of and, optionally, independent from Watson Data Platform as DSX Local. It provides permission-controlled, collaborative access to projects, data, data science tools, services, and community space. DataPlatform Notebooks supports languages of R, Python and Scala and supports Jupyter and Apache Zeppelin notebooks. DSX users can use open source libraries including Spark MLlib, TensorFlow, Caffe, Keras and MXNet.

4. Jupyter Notebook:

Jupyter Notebook is an open source web application whose purpose is to create and share documents that contain live code, equations, visualizations and text. Jupyter Notebook is maintained by the people at Project Jupyter. They are an incidental project which originated from the IPython project. It supports languages of Python, R and Julia. Their main use is in computational physics and data analysis. It provides a variety of visualisations which is rendered directly in the notebook. There are two modes that it has called insert and escape. Just like Colab, Jupyter notebooks are more focused on making work reproducible and easier to understand.

We have picked colab because "Google Colab" is an excellent tool for deep learning tasks. It is a hosted Jupyter notebook that requires no setup and has an excellent free version, which gives free access to Google computing resources such as GPUs and TPUs.

DATA PREPROCESSING:

In this part of the project, we need to import libraries for proper implementation of the project. So we need to import these libraries

- Keras
- Numpy
- Flask
- Google Colab
- TensorFlow.

After importing these libraries, we need to configure the ImageDataGenerator class. Then after configuration we need to apply them to Training and Testing set.

MODEL BUILDING:

In this phase of model building, we already mentioned we have used the google collab. we have created a new API token from the Kaggle. Then we configured it and processed our images in the created model. It takes to process all the images since the dataset is about 10GB.

After processing all the images, as it is mentioned eaarlier we use our pre-trained model as a feature extractor. We will be adding dense layers to the project the maintain the accuracy and all different features of the images that are being provided in the dataset. Throughout this process, we will be configuring learning process and training the model.

In this process, if the model meets the accuracy needed we will be moving forward in making a cloudant DB. If it's not then we should try changing the number of epochs along with the number of steps.

CREATING DATABASE IN CLOUDANT DB:

We need to create an account in the IBM Cloud, then we need to make a new credentials for service instances which are required for our project. We need to keep our API Key and Username with us and should not be shared with anyone else. We do this entire thing to deploy our webpage and to store the images provided by the customers.

We receive these images to process and show them the results. So by this, we need to create a databse in the cloudant DB. All we did here is for creating service instances and credentials.

BUILDING THE APPLICATION:

In creating the application, we have used the HTML language and flask. The HyperText Markup Language or HTML is the standard markup language for documents designed to be displayed in a web browser. It can be assisted by technologies such as Cascading Style Sheets (CSS) and scripting languages such as JavaScript.

Web browsers receive HTML documents from a web server or from local storage and render the documents into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document.

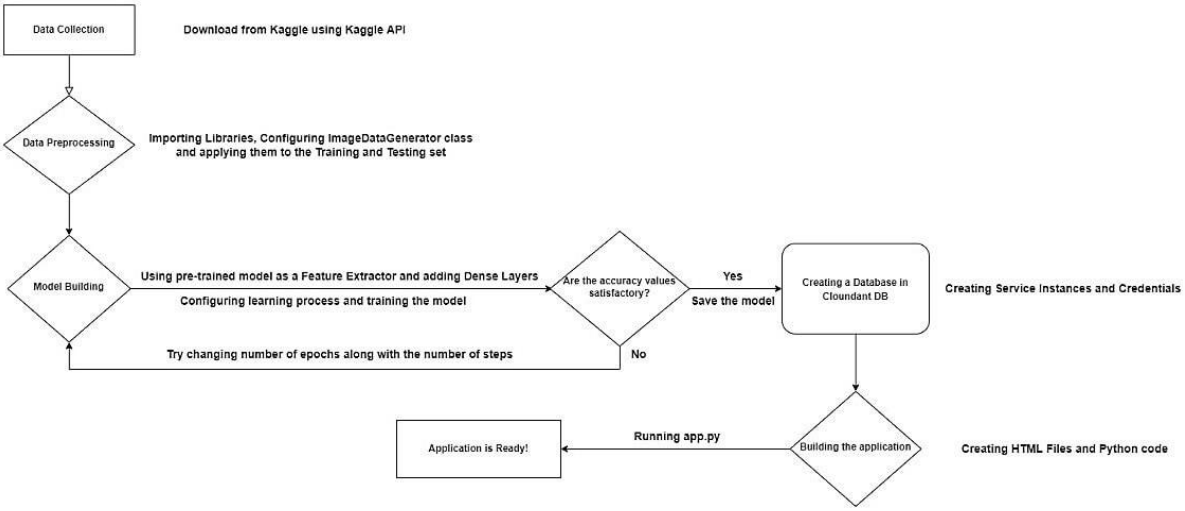
HTML elements are the building blocks of HTML pages. With HTML constructs, images and other objects such as interactive forms may be embedded into the rendered page. HTML provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, quotes and other items. HTML elements are delineated by tags, written using angle brackets. Since it is the easiest and efficient way we have selected HTML in improving our web page.

So after deployment of all the modules and the programs we just need to run the "app.py" file to run the webpage. Make sure you have entered all the cells with the appropriate code so that errors wouldn't occur.

3. BLOCK DIAGRAM:

3.1. Block Diagram:

This is the diagramattic overview of the project



3.2. Hardware/Software Designing:

These are the Hardware and Software requirements of the project

Hardware requirements: There are no specific hardware requirements needed in the project. We just need a personal computer or any laptop which should have good specifications. We also need a stable internet connection in running the libraries we have installed.

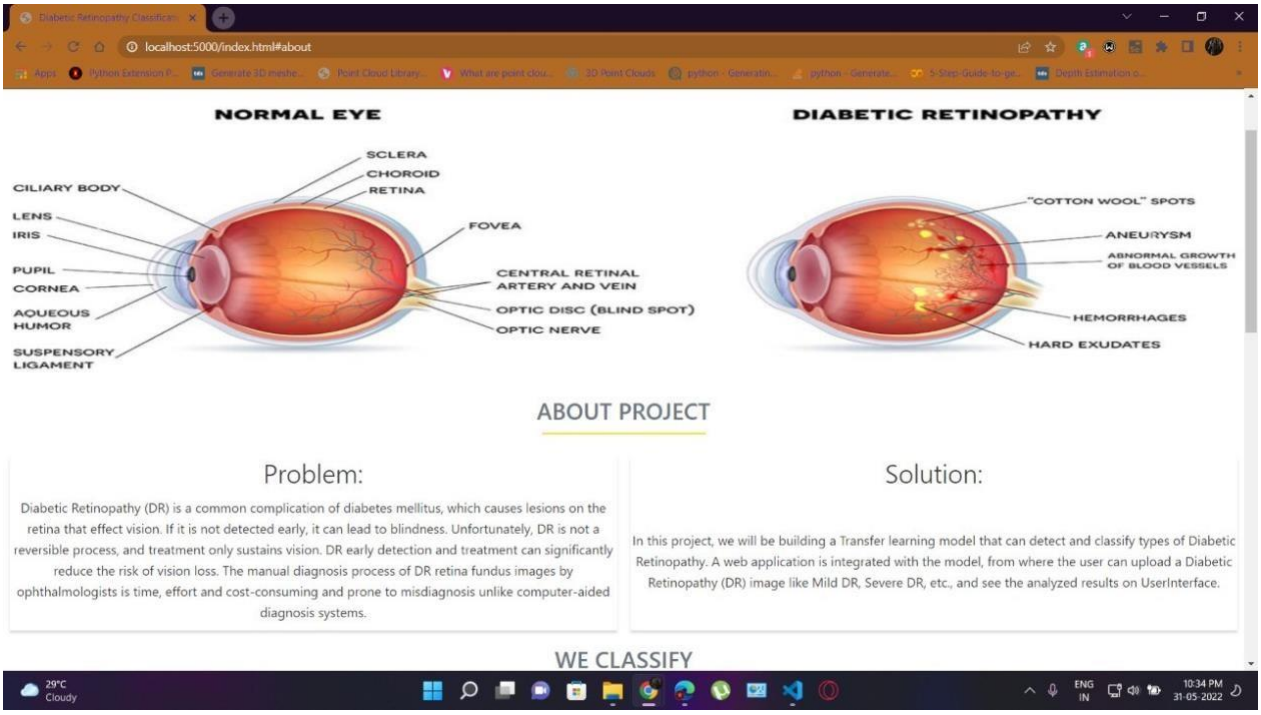
Coming to software requirements, we must import certain libraries such as

- Keras
- Numpy
- Flask
- Google Colab ● TensorFlow.

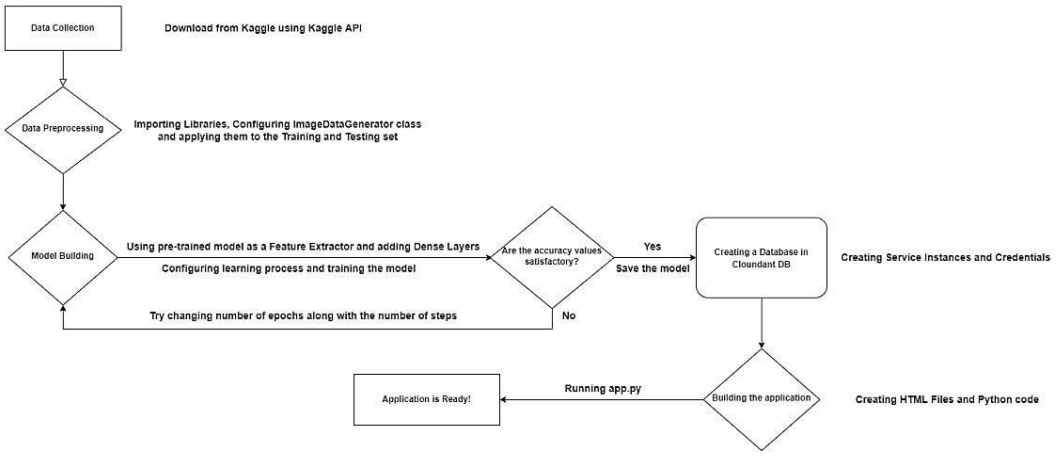
4. EXPERIMENTAL INVESTIGATIONS:

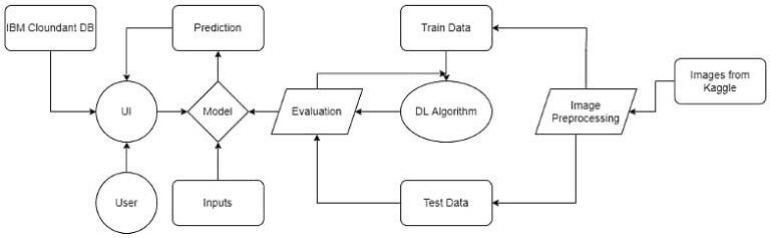
We have investigated that the model is processing at a rate of 85 % rate which is not really a bad implementation part.
We made another few investigations in creating and running the apllication in the local web host. Those are that the total project is running smoothly without any errors and providing us the results from the images which we provided.

This is a result page for the image we uploaded:



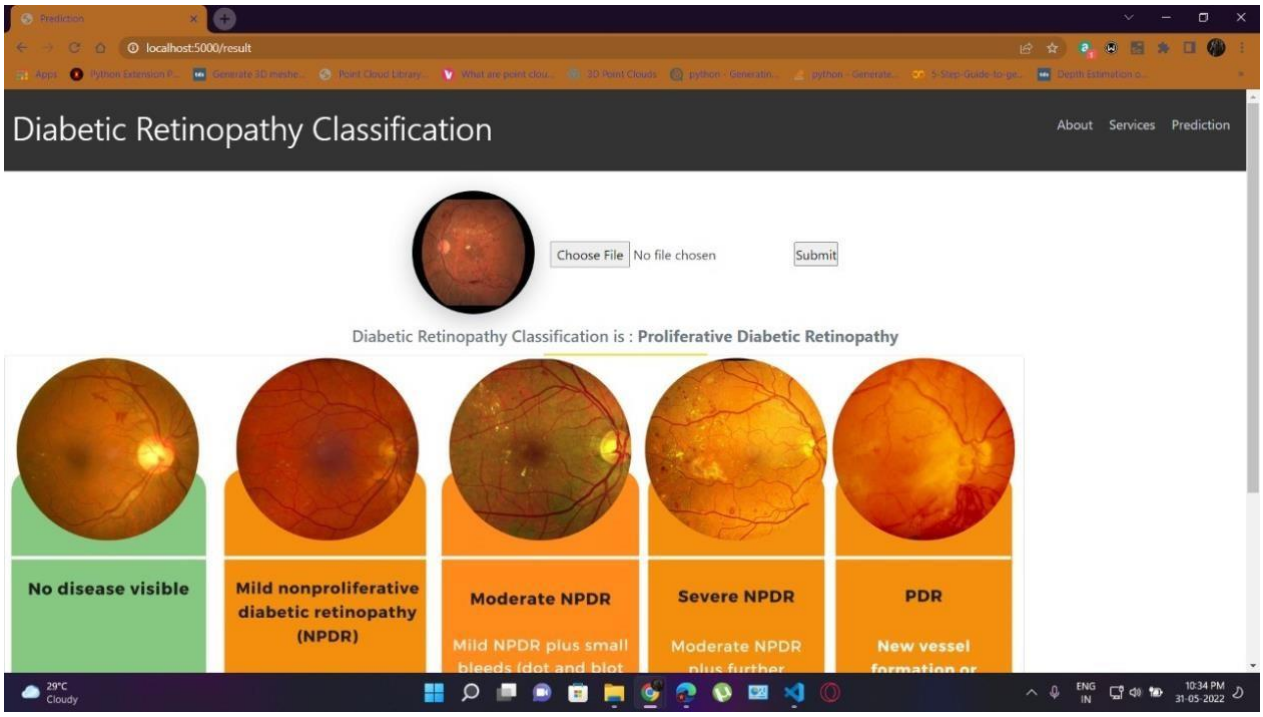
5. FLOWCHART:



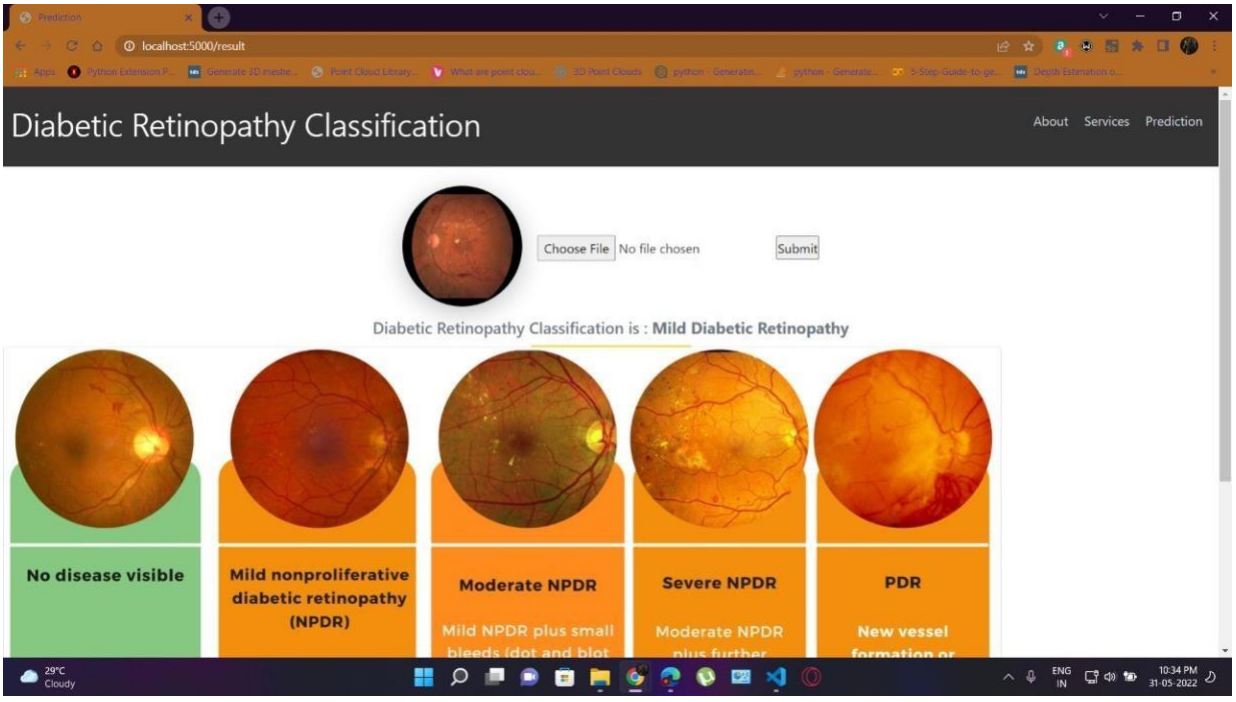


6. RESULT:

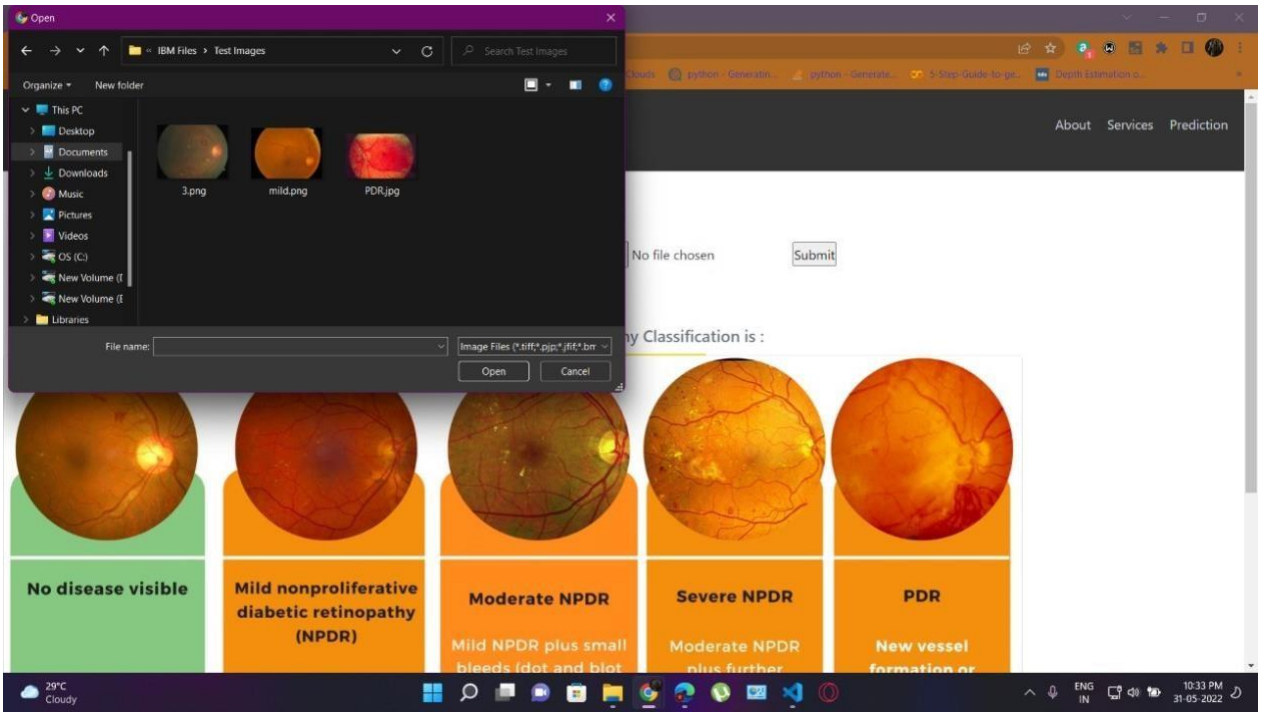
This is the early phase where we can visit a webpage which gives detailed introduction about the retinopathy classification.



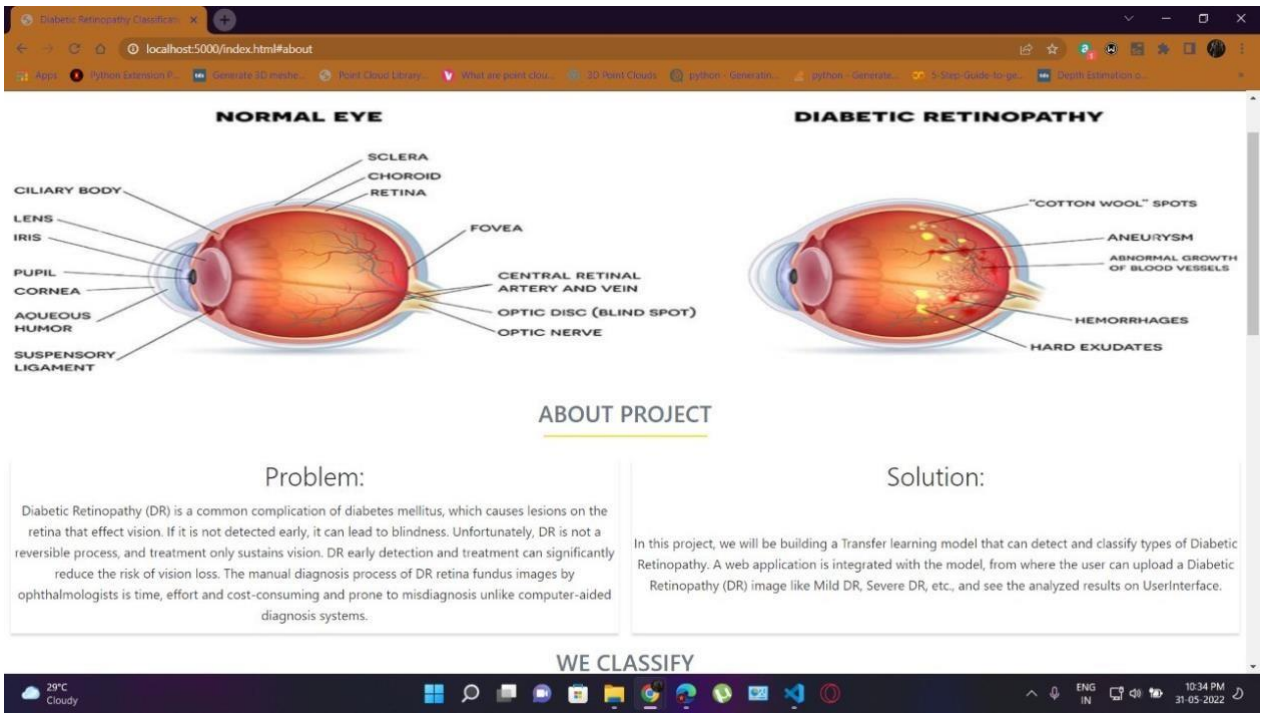
Then the webpage asks for a file to check the image we have with us. As it says, tap on "Choose File".



Then it pops up a window of file explorer, in which shows your local images. Select the eye image in your local storage.



Then it shows the problem and solution for the given image provided.



The screenshots provided are for the refrence purposes.

7. ADVANTAGES AND DISADVANTAGES :

By this project, we can observe if any person is going through starting phase of diabetes through fundus images which will be present in the database.

The main advantage by doing this project is that it successfully detects the diabetes by using deep learning on a fundus images and it can be used as one of method to detect the diabetes on the future. Nevertheless, it need some improvement to make the accuracy of the project nearest to 100%.

The current disadvantage of this project is that it requires vast amount of data which usually gets stored in the dataset. Even though we train the model and draw the conclusions the accuracy of the model will be below 85 %. So we can't assure the rest 15 % to be perfectly analyzed. So we shoud need perfect knowledge and requirements to improve the accuracy of the model.

8. APPLICATIONS :

This can be applied in the medical industry. If a person goes through starting phase of diabetes our project can be applied to check whether it is sure or not.

9. CONCLUSION :

This project successfully diagnoses diabetes by utilising deep learning on fundus photos, and it can be utilised as one of the future methods to identify diabetes. Nonetheless, certain improvements are required to bring the project's accuracy closer to 100 percent. Next, Alexnet layers are the most ideal layer for deep learning neural networks today.

10. FUTURE SCOPE:

Diabetic Retinopathy causes lesions on the retina that effect vision. If it is not detected early, it can lead to blindness. Early detection and treatment of DR 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.

If this project is being handled with less errors and perfect dataset and images then it gets accuracy and provides good result for the image we provided, then we can test our diabetic stage just by uploading the fundus image we received.

It will be very useful, if all the enhancements are reached perfectly. So a perfect medical advisor such as endocrinologist will be in our own hands. Instead going to hospital, waitiing in queue, paying fee etc., we can have our own report in our hands within minutes.

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