CATARACT DETECTION

A PROJECT REPORT

Submitted by

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Department of Computer Science & Engineering
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DECLARATION BY THE STUDENT

We hereby declare that the work reported in the B.Tech. project entitled as "**CATARACT DETECTION**", in partial fulfillment for the award of degree of B.Tech. (CSE) submitted at Jaypee University of Engineering and Technology, Guna, as per best of my knowledge and belief there is no infringement of intellectual property right and copyright. In case of any violation, we will solely be responsible.

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CERTIFICATE

This is to certify that the work entitled **"CATARACT DETECTION"**, submitted by **ABHIMANYU PONIA(191B008), ABHISHEK DIXIT(191B011), HARSH GUPTA (191B114)** in partial fulfillment for the award of degree of Bachelor of Technology of Jaypee University of Engineering and Technology, Guna has carried out under my supervision. As per best of my knowledge and belief there is no infringement of intellectual property right and copyright. Also, this work has not been submitted partially or wholly to any other Institute or University for the award of this or any other degree or diploma. In case of any violation concern student will solely be responsible.

DR. RAHUL PACHAURI

Dept. of CSE

Date: 16th MAY, 2023

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EXECUTIVE SUMMARY

Cataract is one of the most common eye disorders that causes vision distortion. The creation of a cloud on the lens of our eyes is known as a cataract. Blurred vision, faded colors, and difficulty seeing in strong light are the main symptoms of this condition. As a result, preliminary cataract detection and prevention may help to minimize the rate of blindness.

We aim towards analyzing and recognizing various eye images from a database. Database consists of various images with 300 images of normal eye and 300 eyes with cataract, with each image clicked in different conditions. With such a divergent data set, we are able to train our system to good levels and thus obtain good results.

Following the early promising results of AI systems in various eye diseases, there have also been several AI algorithms developed for automated detection and grading of cataract, based on either machine learning or deep learning approaches.

This project is aimed at classifying cataract disease using Artificial Neural Networks based on a publicly available image dataset. In this observation, we used Machine Learning Models such as Support Vector Machine (SVM), Random Forest Classifier, Logistic Regression, K-Nearest Neighbors (KNN), Naïve Based Algorithms and Deep Learning Model of Artificial Neural Network with input layer, hidden layer and output layer. This model predicts cataract disease with a training loss of 15.4574%, a training accuracy of 84.5243%. In addition, the model greatly minimizes training loss while boosting accuracy

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CHAPTER 1

INTRODUCTION

Cataract is a lenticular opacity clouding the transparent lens in human eyes. Typically, the lens converges the light to the retina. The presence of the cataract causes this light to be blocked and not reach the lens that results in poor visual acuity. It is a worldwide leading eye disease that develops gradually and does not affect sight early. However, after a while, it can interfere with vision and even cause vision loss in people over age 40. Cataract detection in earlier stages may avoid painful and costly surgeries and prevent blindness depending on its severity.

The world health organization (WHO) reported that about 285 million people in the world have a visual impairment. Among them, 39 million people have limited vision, and the remaining ones have impaired vision. Cataract was responsible for 33% of visual impairment, and 51% of blindness. In 2020, Flaxman *et al.* predicted that the number of people suffering from moderate to severe vision impairment (MSVI) and blindness would be 237.1 and 38.5 million, respectively. Of them, 57.1 million (24%) and 13.4 million (35%) people would be affected by cataract. The worldwide blindness will exceed 40 million by 2025. Comparing the results of these reports prove that there was only a slight improvement in the eye care system and controlling the vision loss during the last decade.

Among the leading causes of blindness such as glaucoma, corneal opacity, trachoma, and diabetic retinopathy, cataract accounts for the most significant proportion. It is considered as one of the leading causes of blindness. Cataract can be categorized into three main groups based on the location and area where it develops: Nuclear Cataract, Cortical Cataract, and Posterior Sub Capsular (PSC) Cataract.

These three types of cataracts occur due to several common factors such as aging, diabetes, and smoking. Early detection of cataracts plays a vital role in the treatment and can significantly reduce the risk of blindness. The state-of-the-art automatic cataract detection systems consist three steps: pre-processing, feature extraction, and classification. These methods are categorized into two groups based on the algorithms used in either feature extraction or classification stages: Machine Learning (ML)-based and Deep Learning (DL)- based methods.

CHAPTER 2

THEORETICAL BACKGROUND

This section introduces the theoretical backgrounds of the various aspects that are part of the thesis in detail. The topics include Machine Learning Algorithms and Deep Learning Algorithms

1. Machine Learning

Machine learning is a form of AI that enables a system to learn from data rather than through explicit programming. However, machine learning is not a simple process. As the algorithms ingest training data, it is then possible to produce more precise models based on that data. A machine-learning model is the output generated when you train your machine-learning algorithm with data. After training, when you provide a model with an input, you will be given an output. For example, a predictive algorithm will create a predictive model. Then, when you provide the predictive model with data, you will receive a prediction based on the data that trained the model.

Machine learning enables models to train on data sets before being deployed. Some machine- learning models are online and continuous. This iterative process of online models leads to an improvement in the types of associations made between data elements. Due to their complexity and size, these patterns and associations could have easily been overlooked by human observation. After a model has been trained, it can be used in real time to learn from data. The improvements in accuracy are a result of the training process and automation that are part of machine learning.

Machine-learning techniques are required to improve the accuracy of predictive models. Depending on the nature of the business problem being addressed, there are different approaches based on the type and volume of the data. In this section, we disc uss the categories of machine learning.

1. Supervised learning

Supervised learning typically begins with an established set of data and a certain understanding of how that data is classified. Supervised learning is intended to find patterns in data that can be applied to an analytics process. This data has labeled features that define

the meaning of data. For example, you can create a machine-learning application that distinguishes between millions of animals, based on images and written descriptions.

2. Unsupervised learning

Unsupervised learning is used when the problem requires a massive amount of unlabeled data. For example, social media applications, such as Twitter, Instagram and Snapchat, all have large amounts of unlabeled data. Understanding the meaning behind this data requires algorithms that classify the data based on the patterns or clusters it finds. Unsupervised learning conducts an iterative process, analyzing data without human intervention. It is used with email spam-detecting technology. There are far too many variables in legitimate and spam emails for an analyst to tag unsolicited bulk email. Instead, machine-learning classifiers, based on clustering and association, are applied to identify unwanted email.

3. Reinforcement learning

Reinforcement learning is a behavioral learning model. The algorithm receives feedback from the data analysis, guiding the user to the best outcome. Reinforcement learning differs from other types of supervised learning, because the system isn't trained with the sample data set. Rather, the system learns through trial and error. Therefore, a sequence of successful decisions will result in the process being reinforced, because it best solves the problem at hand.

2.2 Deep Learning

Deep learning is based on the branch of machine learning, which is a subset of artificial intelligence. Since neural networks imitate the human brain and so deep learning will do. In deep learning, nothing is programmed explicitly. Basically, it is a machine learning class that makes use of numerous nonlinear processing units so as to perform feature extraction as well as transformation. The output from each preceding layer is taken as input by each one of the successive layers.

Deep learning models are capable enough to focus on the accurate features themselves by requiring a little guidance from the programmer and are very helpf ul in solving out the problem of dimensionality. Deep learning algorithms are used, especially when we have a huge no of inputs and outputs.

Since deep learning has been evolved by the machine learning, which itself is a subset of artificial intelligence and as the idea behind the artificial intelligence is to mimic the human behavior, so same is "the idea of deep learning to build such algorithm that can mimic the brain".

2.2.1 Artificial Neural Network

At earlier times, the conventional computers incorporated algorithmic approach that is the computer used to follow a set of instructions to solve a problem unless those specific steps need that the computer need to follow are known the computer cannot solve a problem. So, obviously, a person is needed in order to solve the problems or someone who can provide instructions to the computer so as to how to solve that particular problem. It actually restricted the problem-solving capacity of conventional computers to problems that we already understand and know how to solve.

But what about those problems whose answers are not clear, so that is where our traditional approach face failure and so Neural Networks came into existence. Neural Networks processes information in a similar way the human brain does, and these networks actually learn from examples, you cannot program them to perform a specific task. They will learn only from past experiences as well as examples, which is why you don't need to provide all the information regarding any specific task. So, that was the main reason why neural networks came into existence.

Neural networks are modeled in accordance with the human brain so as to imitate their functionality. The human brain can be defined as a neural network that is made up of several neurons, so is the Artificial Neural Network is made of numerous perceptron.

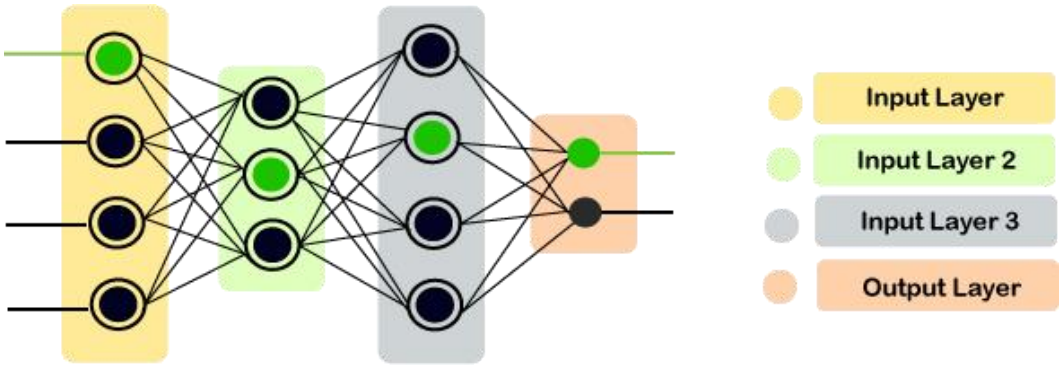

Fig 1: Neural Network

A neural network comprises of three main layers, which are as follows:

- Input layer: The input layer accepts all the inputs that are provided by the programmer.
- Hidden layer: In between the input and output layer, there is a set of hidden layers on which computations are performed that further results in the output.
- Output layer: After the input layer undergoes a series of transformations while passing through the hidden layer, it results in output that is delivered by the output layer.

Basically, the neural network is based on the neurons, which are nothing but the brain cells. A biological neuron receives input from other sources, combines them in so me way, followed by performing a nonlinear operation on the result, and the output is the final result.

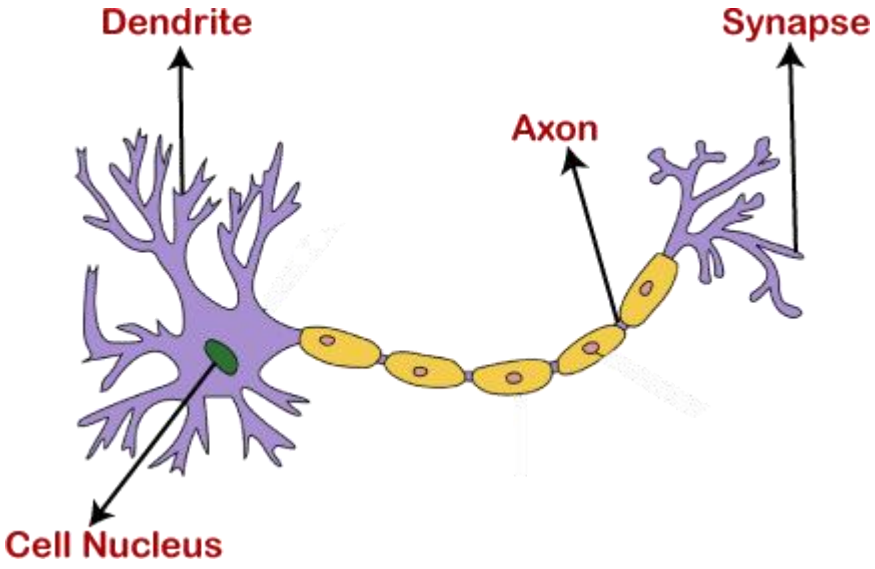

Fig 2: Human Neuron

The dendrites will act as a receiver that receives signals from other neurons, which are then passed on to the cell body. The cell body will perform some operations that can be a summation, multiplication, etc. After the operations are performed on the set of input, then they are transferred to the next neuron via axion, which is the transmitter of the signal for the neuron.

Instead of directly getting into the working of Artificial Neural Networks, lets breakdown and try to understand Neural Network's basic unit, which is called a Perceptron.

So, a perceptron can be defined as a neural network with a single layer that classifies the linear data. It further constitutes four major components, which are as follows;

- **Inputs**
- **Weights and Bias**
- **Summation Functions**
- **Activation or transformation function**

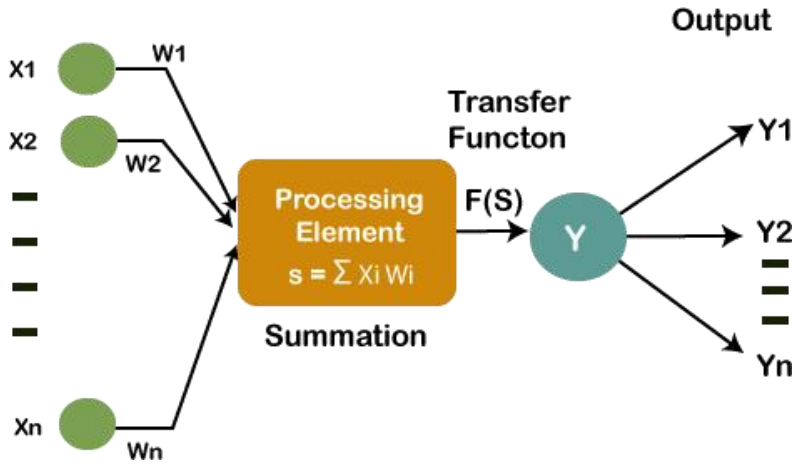

Fig 3: ANN Weight Calculation Function

The main logic behind the concept of Perceptron is as follows:

1. Inputs

The inputs (x) are fed into the input layer, which undergoes multiplication with the allotted weights (w) followed by experiencing addition in order to form weighted sums. Then these inputs weighted sums with their corresponding weights are executed on the pertinent activation function.

2. Weights and Bias

As and when the input variable is fed into the network, a random value is given as a weight of that particular input, such that each individual weight represents the importance of that

input in order to make correct predictions of the result. However, bias helps in the adjustment of the curve of activation function so as to accomplish a precise output.

3. Summation Function

After the weights are assigned to the input, it then computes the product of each input and weights. Then the weighted sum is calculated by the summation function in which all of the products are added.

4. Activation Function

The main objective of the activation function is to perform a mapping of a weighted sum upon the output. The transformation function comprises of activation functionssuch as tanh, ReLU, sigmoid, etc.

The activation function is categorized into two main parts:

- **Sigmoid or Logistic Activation Function**

It provides a smooth gradient by preventing sudden jumps in the output values. It has an output value range between 0 and 1 that helps in the normalization of each neuron's output. For X, if it has a value above 2 or below -2, then the values of y will be much steeper. In simple language, it means that even a small change in the X can bring a lot of change in Y.

It's value ranges between 0 and 1 due to which it is highly preferred by binary classification whose result is either 0 or 1.

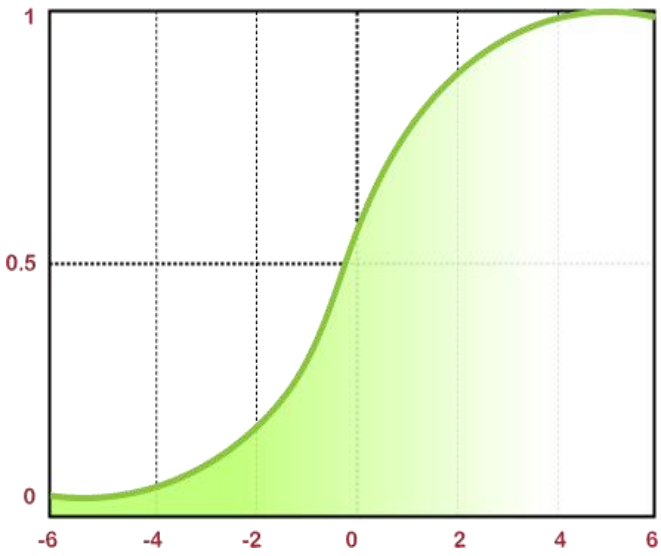

Fig 4: Sigmoid Function

- **ReLU(Rectified Linear Unit) Activation Function**

ReLU is one of the most widely used activation function by the hidden layer in the neural network. Its value ranges from 0 to infinity. It clearly helps in solving out the problem of backpropagation. It tends out to be more expensive than the sigmoid, as well as the tanh activation function. It allows only a few neurons to get activated at a particular instance that leads to effectual as well as easier computations.

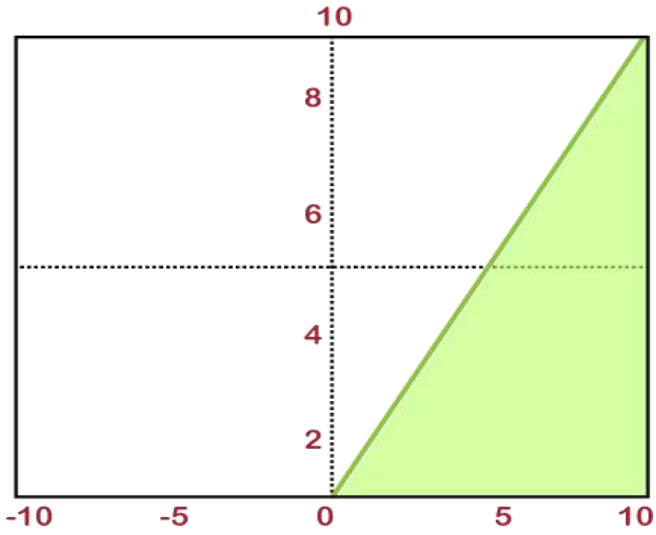

Fig 5: reLu Activation Function

- **SoftMax Function**

It is one of a kind of sigmoid function whereby solving the problems of classifications. It is mainly used to handle multiple classes for which it squeezes the output of each class between 0 and 1, followed by dividing it by the sum of outputs. This kind of function is specially used by the classifier in the output layer.

2.2.1.5 Gradient Descent Algorithm

Gradient descent is an optimization algorithm that is utilized to minimize the cost function used in various machine learning algorithms so as to update the parameters of the learning model. In linear regression, these parameters are coefficients, whereas, in the neural network, they are weights.

Procedure:

It all starts with the coefficient's initial value or function's coefficient that may be either 0.0 or any small arbitrary value. For estimating the cost of the coefficients, they are plugged into the function that helps in evaluating.

2.2.3 Convolutional Neural Network

Convolutional Neural Networks are a special kind of neural network mainly used for image classification, clustering of images and object recognition. DNNs enable unsupervised construction of hierarchical image representations. To achieve the best accuracy, deep convolutional neural networks are preferred more than any other neural network.

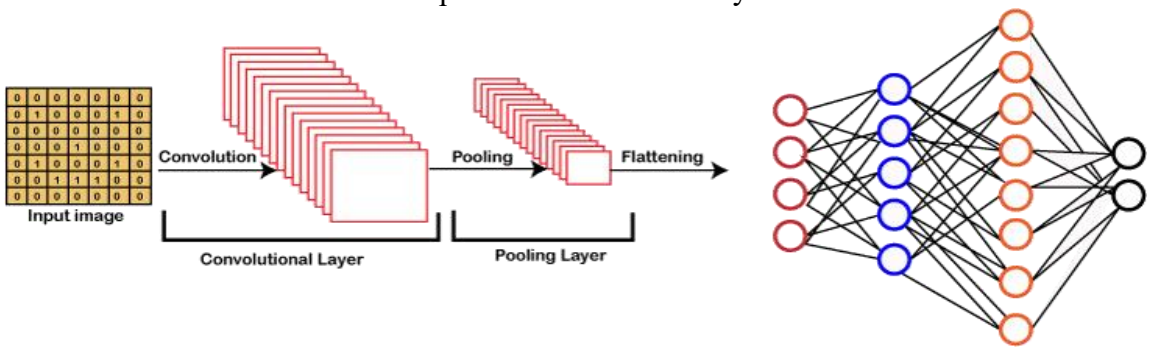

Fig 6: Convolutional Neural Network

2.2.4 Recurrent Neural Network

Recurrent neural networks are yet another variation of feed-forward networks. Here each of the neurons present in the hidden layers receives an input with a specific delay in time. The Recurrent neural network mainly accesses the preceding info of existing iterations. For example, to guess the succeeding word in any sentence, one must have knowledge about the words that were previously used. It not only processes the inputs but also shares the length as well as weights crossways time. It does not let the size of the model to increase with the increase in the input size. However, the only problem with this recurrent neural network is that it has slow computational speed as well as it does not contemplate any future input for the current state.

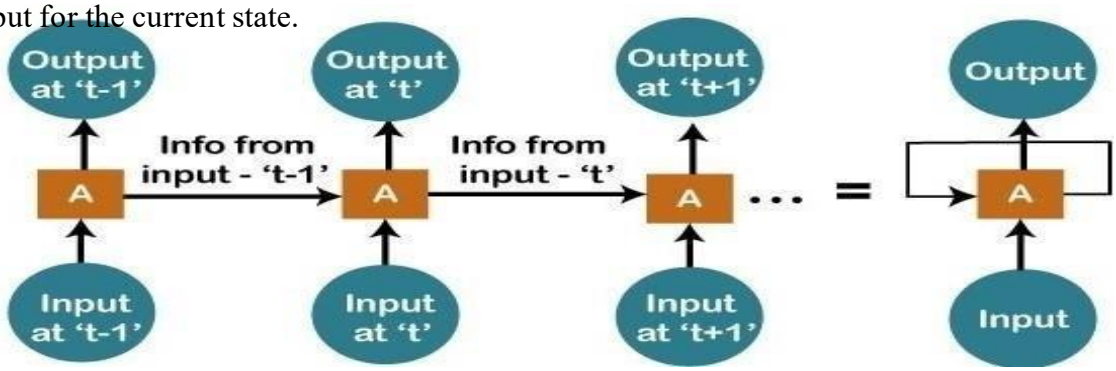

Fig 7: Recurrent Neural Network

CHAPTER 3

TECHNOLOGY

1. Python

Python is an OOPs (Object Oriented Programming) based, high level, interpreted programming language. It is a robust, highly useful language focused on rapid application development (RAD). Python helps in easy writing and execution of codes. Python can implement the same logic with as much as 1/5th code as compared to other OOPs languages. Python provides a huge list of benefits to all. The usage of Python is such that it cannot be limited to only one activity. Its growing popularity has allowed it to enter into some of the most popular and complex processes like Artificial Intelligence (AI), Machine Learning (ML), natural language processing, data science etc. Python has a lot of libraries for every need of this project. For our AV we had used Tkinter Library and PyGame Module Documentation.

Python is reasonably efficient. Efficiency is usually not a problem for small examples. If your Python code is not efficient enough, a general procedure to improve it is to find out what is taking most the time and implement just that part more efficiently in some lower-level language. This will result in much less programming and more efficient code (because you will have more time to optimize) than writing everything in a low-level language.

2. Anaconda Python Distribution

Anaconda is a distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. The distribution includes data-science packages suitable for Windows, Linux, and macOS. It is developed and maintained by Anaconda, Inc., which was founded by Peter Wang and Travis Oliphant in 2012. As an Anaconda, Inc. product, it is also known as Anaconda Distribution or Anaconda Individual Edition, while other products from the company are Anaconda Team Edition and Anaconda Enterprise Edition, both of which are not free.

Package versions in Anaconda are managed by the package management system conda. This package manager was spun out as a separate open-source package as it ended up being useful on its own and for things other than Python.

Python is the most popular programming language or nothing wrong to say that it is the next-generation programming language. In every emerging field in computer science, Python makes its presence actively. Python has vast libraries for various fields such as **Machine Learning (Numpy, Pandas, Matplotlib), Artificial intelligence (Pytorch, TensorFlow).**

3.2.1 Anaconda Installation

- Download the Anaconda installer.
- RECOMMENDED: Verify data integrity with SHA-256. For more information on hashes, see What about cryptographic hash verification?
- Double-click the installer to launch.
- Click Next.
- Read the licensing terms and click I Agree.
- Select an install for Just Me unless you're installing for all users (which requires Windows Administrator privileges) and click Next.
- Select a destination folder to install Anaconda and click the Next button. See FAQ.
- Choose whether to add Anaconda to your PATHenvironment variable. We recommend not adding Anaconda to the PATH environment variable, since this can interfere with other software. Instead, use Anaconda software by opening Anaconda Navigator or the Anaconda Prompt from the Start Menu.
- Choose whether to register Anaconda as your default Python. Unless you plan on installing and running multiple versions of Anaconda or multiple versions of Python, accept the default and leave this box checked.
- Click Install. If you want to watch the packages Anaconda is installing, click Show Details.
- Click Next.
- After a successful installation you will see the "Thanks for installing Anaconda" dialog box.
- Click the Finish button.

3. Python Libraries

While The Python Language Reference describes the exact syntax and semantics of the Python language, this library reference manual describes the standard library that is distributed with Python. It also describes some of the optional components that are commonly included in Python distributions.

Python's standard library is very extensive, offering a wide range of facilities as indicated by the long table of contents listed below. The library contains built-in modules (written in C) that provide access to system functionality such as file I/O that would otherwise be inaccessible to Python programmers, as well as modules written in Python that provide standardized solutions for many problems that occur in everyday programming. Some of these modules are explicitly designed to encourage and enhance the portability of Python programs by abstracting away platform-specifics into platform-neutral APIs

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Hardware and Software Requirements

The software is designed to be light-weighted so that it doesn't be a burden on the machine running it. This system is being build keeping in mind the generally available hardware and software compatibility. Here are the minimum hardware and software requirement for Algorithm Visualizer.

Hardware:

- Intel core i5 7th Gen or above.
- RAM 8GB or more.
- GPU 2GB

Software:

- Windows 7(64-bit) or above.
- Python 3.8.5
- Jupyter Notebook
- Karas
- OpenCV
- Matplot lib
- TensorFlow Library

CHAPTER 5

IMPLEMENTATION

5.1 Work flow

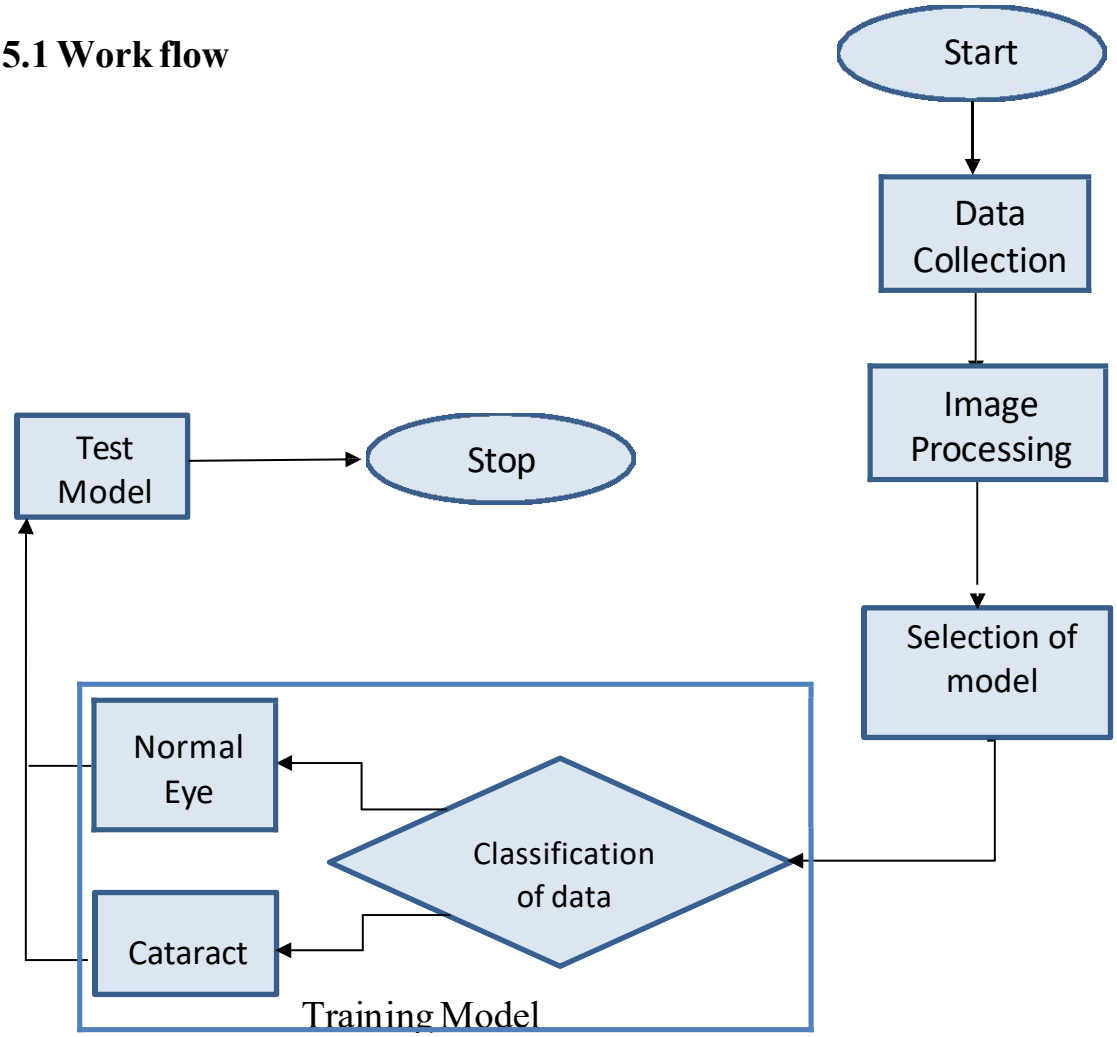

Fig 8 : Flow Chart

The flow chart above in Figure describes the logic of the Model. It begins with the collection of data from open source. The image thus collected is then pre-processed (Cropping, Image Scaling etc.) after which the processed image is used in the model selected. After this the data is classified into either normal eye or cataract eye by the selected model and then we test the model for its accuracy. If the accuracy is less then we repeat this for another model.

5.2 Dataset creation

We collected images from open source

Our Dataset include images:

Two sets of images one set for Normal Eyes and another one is for Cataract Eye

- Each set contains 300 images
- Size of each image is 1600x1600
- Dot per inch (DPI) = 96 dpi
- Total images 300*2 = 600

3. Image Pre-processing

The aim of pre-processing is to improve the quality of the image so that we can analyses it in a better way. By preprocessing we can suppress undesired distortions and enhance some features which are necessary for the particular application we are working for. Those features might vary for different applications**.**

1. RGB to Grey Scale

- **RGB**

The most well-known color model is RGB which stands for Red-Green-Blue. As the name suggests, this model represents colors using individual values for Red, Green, and Blue. The RGB model is used in almost all digital screens throughout the world. Specifically, a color is defined using three integer values from 0 to 255 for red, green, and blue, where a zero value means dark and a value of 255 means bright. Given the values, the final color is defined when we mix these three basic colors weighted by their values.

- **Grey Scale**

Grayscale is the simplest model since it defines colors using only one component that is lightness. The amount of lightness is described using a value ranging from 0 (black) to 255 (white). On the one hand, grayscale images convey less information than RGB. However, they are common in image processing because using a grayscale image requires less available space and is faster, especially when we deal with complex computations.

- **Why is gray scale important?**

Grayscale is an important aspect of images, and it is the only portion that is not removed; otherwise, a pure black image would result no matter what color information there is. A digital image is composed of groups of three pixels with colors of red, green and blue (RGB), also called channels in digital imaging.

- **Function Used to convert RGB to Gray scale image**

We used OpenCV function "cvtColor ()" to convert image into greyscale

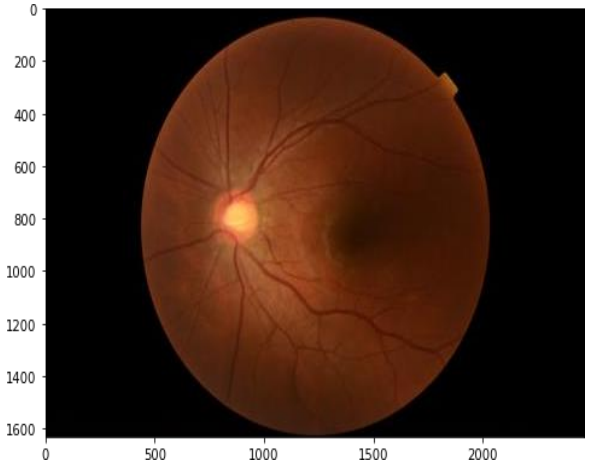

Fig 9 : RGB Image

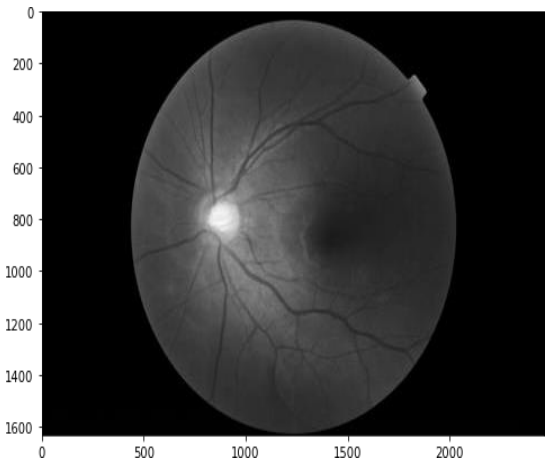

Fig 1 0 : Grey Scale Image

5.3.2 Gray Scale Image Normalization

Image normalization is a typical process in image processing that changes the range of pixel intensity values. Its normal purpose is to convert an input image into a range of pixel values that are more familiar or normal to the senses, hence the term normalization**.**

In this work, we will perform a function that produces a normalization of an input image (Gray Scale). Then, we understand a representation of the range of values of the scale of the image represented between 0 and 255, in this way we get, for example, that very dark images become clearer. The linear normalization of a digital image is performed according to the formula:

$$\text{Output channel} = 255 * (\text{Input channel} - \min) / (\max - \min)$$

If we are using a grayscale image, we only need to normalize using one channel. Otherwise, we have to use 3 channels for RGB Image.

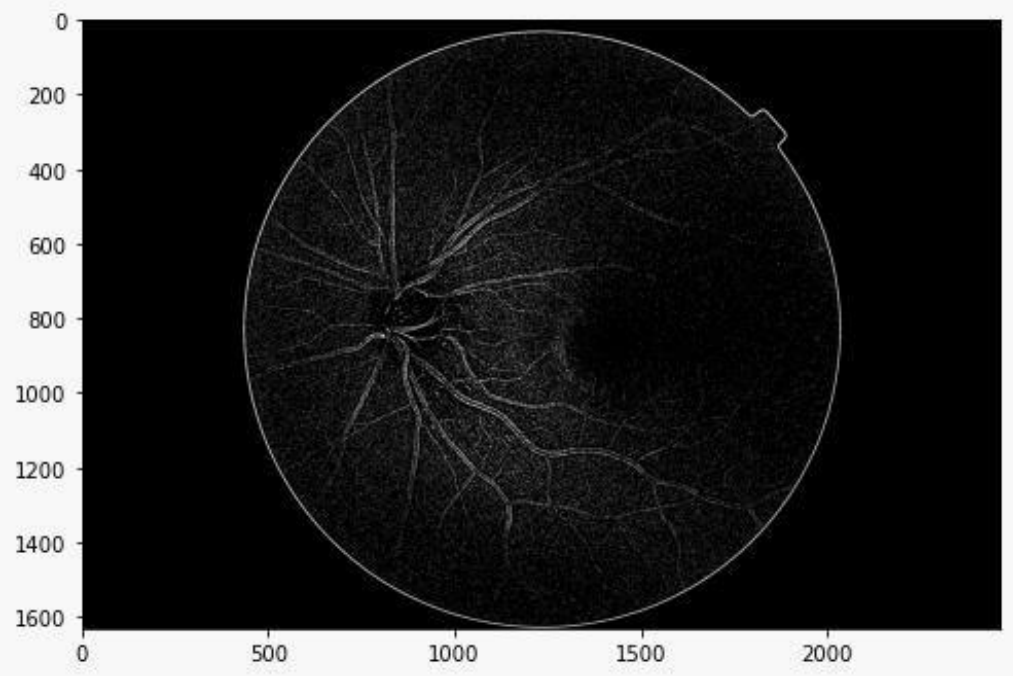

Fig 1 1 : Normalized Image

5.3.3 Image Cropping

Cropping is done to remove all unwanted objects or areas from an image. Or even to highlight a particular feature of an image. There is no specific function for cropping using OpenCV, NumPy array slicing is what does the job. Every image that is read in, gets stored in a 2D array (for each color channel).

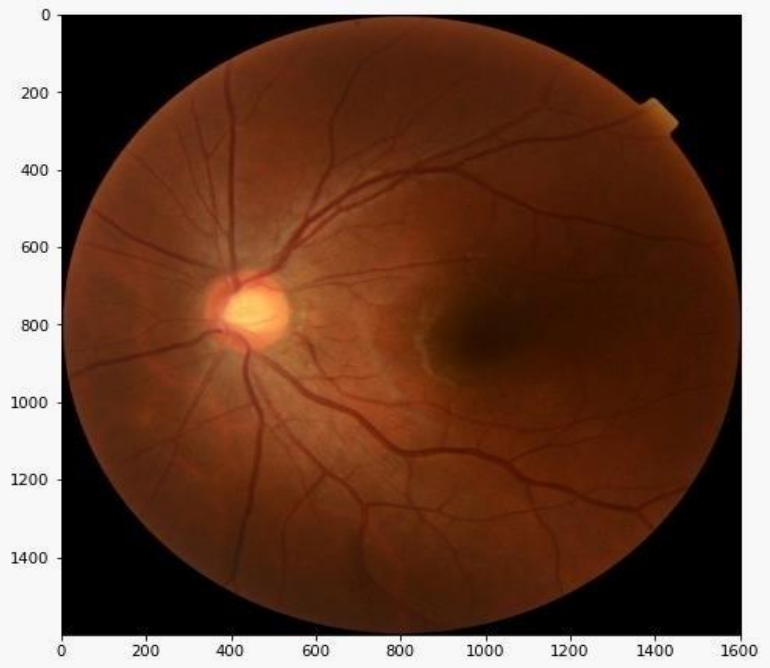

Fig 1 2 : Cropped Image

4. Result of Different Machine Learning Models

1. Support Vector Machine

Classification Report after applying SVM on Cataract Image dataset:

	precision	recall	f1-score	support
0	0.94	0.64	0.76	70
1	0.65	0.94	0.77	50
accuracy			0.77	120
macro avg	0.80	0.79	0.77	120
weighted avg	0.82	0.77	0.77	120

Fig 13: Support Vector machine Classification Report

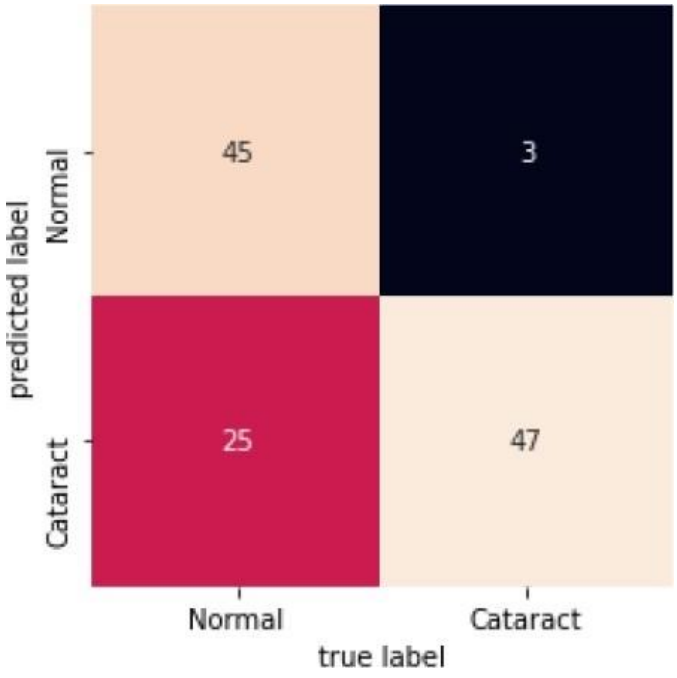

Fig 1 4 : Support Vector machine Heatmap

5.4.2 Random Forest Classifier

Classification Report after applying Random Forest Classifier on Cataract Image dataset:

	precision	recall	f1-score	support
0	1.00	0.84	0.91	70
1	0.82	1.00	0.90	50
accuracy			0.91	120
macro avg	0.91	0.92	0.91	120
weighted avg	0.92	0.91	0.91	120

Fig 15: Random Forest Classifier Classification Report

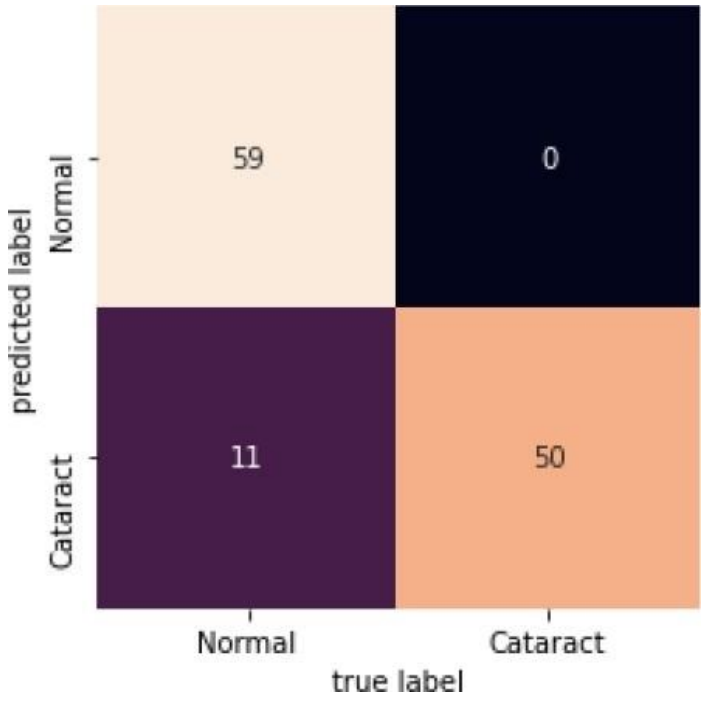

Fig 1 6 : Random Forest Classifier Heatmap

5.4.3 Logistic Regression

Classification Report after applying Logistic Regression on Cataract Image dataset:

	precision	recall	f1-score	support
0	0.91	0.83	0.87	70
1	0.79	0.88	0.83	50
accuracy			0.85	120
macro avg	0.85	0.85	0.85	120
weighted avg	0.86	0.85	0.85	120

Fig 17: Logistic Regression Classification Report

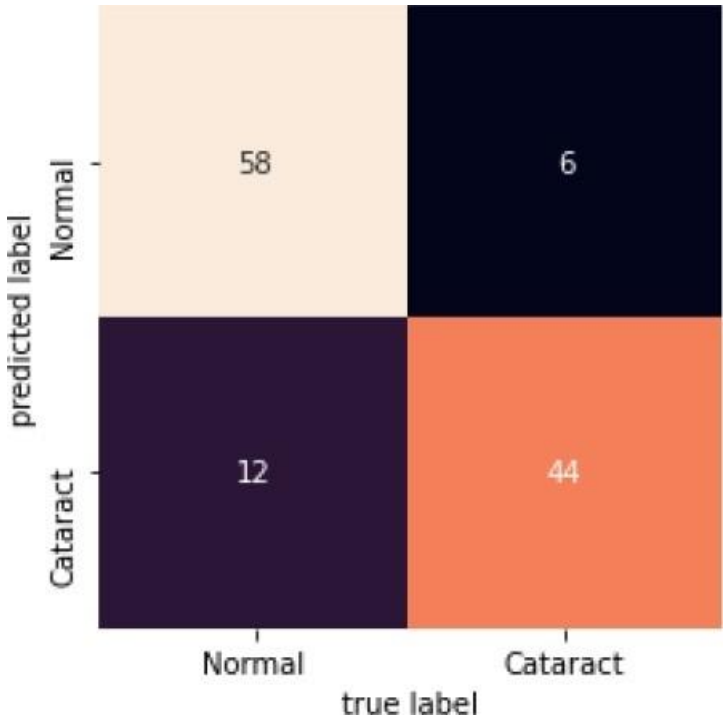

Fig 18: Logistic Regression Heatmap

5.4.4 K-Nearest Neighbors

Classification Report after applying K-Nearest Neighbors on Cataract Image dataset:

	precision	recall	f1-score	support
0	0.83	0.49	0.61	70
1	0.54	0.86	0.67	50
accuracy			0.64	120
macro avg	0.69	0.67	0.64	120
weighted avg	0.71	0.64	0.64	120

Fig 19: K-Nearest Neighbor Classification Report

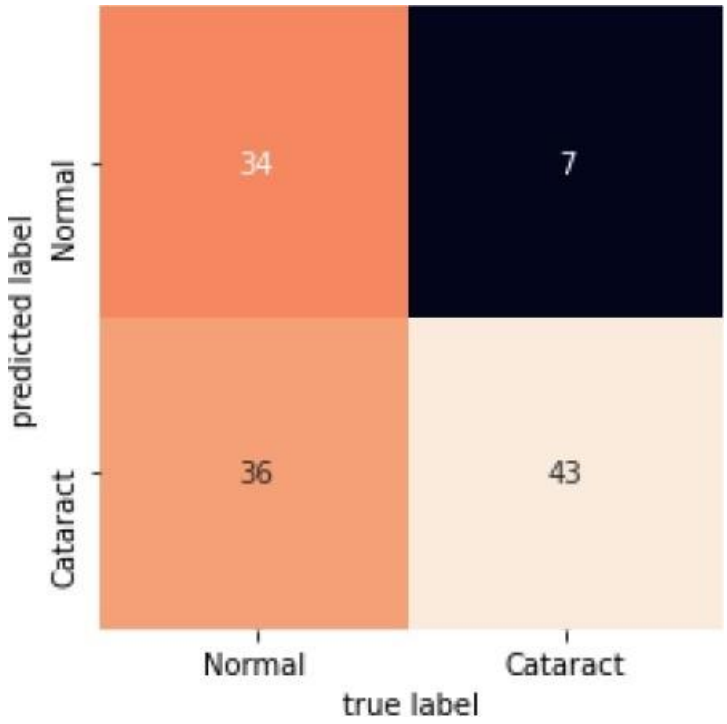

Fig 20: K-Nearest Neighbor Heatmap

5.4.5 Naive Bayes

Classification Report after applying Naïve Bayes on Cataract Image dataset:

	precision	recall	f1-score	support
0	0.91	0.83	0.87	70
1	0.79	0.88	0.83	50
accuracy			0.85	120
macro avg	0.85	0.85	0.85	120
weighted avg	0.86	0.85	0.85	120

Fig 21: Naïve Bayes Classification Report

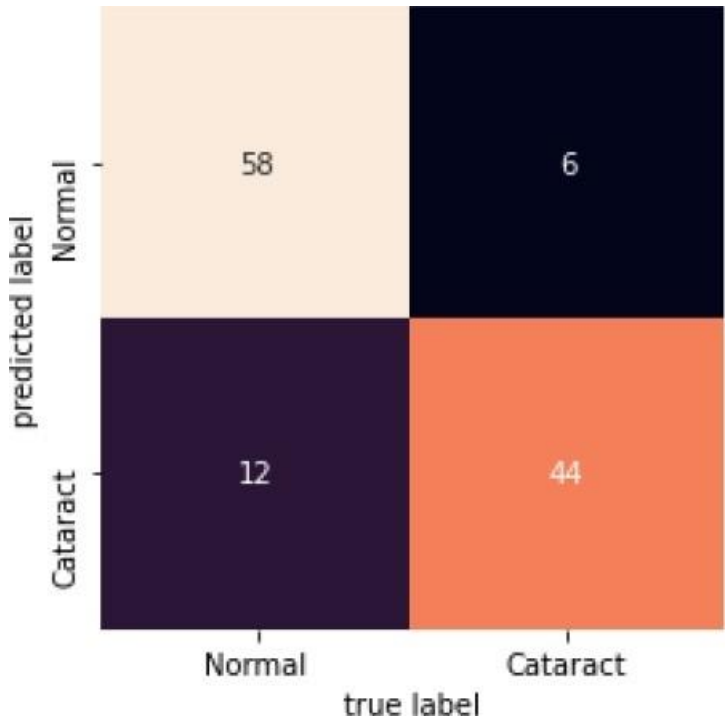

Fig 22: Naïve Bayes Heatmap

5. Result of Deep Learning Models

1. ANN with Input and Output Layer

Artificial Neural Network consist of Neurons Multiple of 100 in Input Layer and output layer consist of 1 Neuron, Activation function used is reLu and Sigmoid with 10 epochs, Number of Neurons were multiple of 100, They starts from 100 to 1000 with 9 possible cases, result of 9 Models with similar conditions are:

Accuracy report of models

Model	1st_Layer	Accuracy
1	100	67.5000011920929
2	200	43.33333373069763
3	300	85.00000238418579
4	400	60.83333492279053
5	500	66.66666865348816
6	600	64.99999761581421
7	700	82.4999988079071
8	800	58.33333134651184
9	900	59.16666388511658

Fig 23: Accuracy of 9 Models with 1 Input Layer

Classifiation Report of 3 Model Because of its maximum Accuracy

	precision	recall	f1-score	support
0	0.83	0.93	0.88	70
1	0.88	0.74	0.80	50
accuracy			0.85	120
macro avg	0.86	0.83	0.84	120
weighted avg	0.85	0.85	0.85	120

Fig 24: Classification report of 3rd Model

5.5.2 ANN with Input Layer, 1 Hidden Layer and Output Layer

Artificial Neural Network consist of Neurons Multiple of 100 in Input Layer and 2 times Neurons in Hidden Layer and output layer consist of 1 Neuron, Activation function used is reLu and Sigmoid with 10 epochs, Number of Neurons were multiple of 100, They starts from 100 to 1000 with 9 possible cases, result of 9 Models with similar conditions are:

Accuracy report of models

Model	1st_Layer	Hidden	Accuracy
1	100	200	68.33333373069763
2	200	400	50.0
3	300	600	72.50000238418579
4	400	800	41.66666567325592
5	500	1000	55.83333373069763
6	600	1200	57.499998807907104
7	700	1400	70.83333134651184
8	800	1600	42.500001192092896
9	900	1800	44.16666626930237

Fig 25: Accuracy of 9 Models with 1 Input Layer and 1 Hidden Layer

Classifiation Report of 3 Model Because of its maximum Accuracy

	precision	recall	f1-score	support
0	0.97	0.54	0.70	70
1	0.60	0.98	0.75	50
accuracy			0.73	120
macro avg	0.79	0.76	0.72	120
weighted avg	0.82	0.72	0.72	120

Fig 26: Classification report of 3rd Model

5.5.3 ANN with Input Layer, 2 Hidden Layer and Output Layer

Artificial Neural Network consist of Neurons Multiple of 100 in Input Layer and 2 times Neurons in 1st Hidden Layer and 3 times Neurons in 2nd Hidden Layer and output layer consist of 1 Neuron, Activation function used is reLu and Sigmoid with 10 epochs, Number of Neurons were multiple of 100, They starts from 100 to 1000 with 9 possible cases, result of 9 Models with similar conditions are:

Accuracy report of models

Model	1st_Layer	Hidden	2nd Hidden	Accuracy
1	100	200	300	41.66666567325592
2	200	400	600	41.66666567325592
3	300	600	900	41.66666567325592
4	400	800	1200	41.66666567325592
5	500	1000	1500	41.66666567325592
6	600	1200	1800	44.16666626930237
7	700	1400	2100	41.66666567325592
8	800	1600	2400	42.500001192092896
9	900	1800	2700	43.33333373069763

Fig 27: Accuracy of 9 Models with 1 Input Layer 2 Hidden Layer

Classifiation Report of 6 Model Because of its maximum Accuracy

	precision	recall	f1-score	support
0	1.00	0.04	0.08	70
1	0.43	1.00	0.60	50
accuracy			0.44	120
macro avg	0.71	0.52	0.34	120
weighted avg	0.76	0.44	0.30	120

Fig 28: Classification report of 6th Model

5.5.4 ANN with Input Layer, 1 Hidden & Output Layer (Half Neurons)

Artificial Neural Network consist of Neurons Multiple of 100 in Input Layer and 1/2 times Neurons in 1st Hidden Layer and output layer consist of 1 Neuron, Activation function used is reLu and Sigmoid with 10 epochs, Number of Neurons were multiple of 100, They starts from 100 to 1000 with 9 possible cases, result of 9 Models with similar conditions are:

Accuracy report of models

Model	1st_Layer	Hidden	Accuracy
1	100	50.0	80.83333373069763
2	200	100.0	64.99999761581421
3	300	150.0	80.0000011920929
4	400	200.0	58.33333134651184
5	500	250.0	80.0000011920929
6	600	300.0	77.49999761581421
7	700	350.0	58.33333134651184
8	800	400.0	72.50000238418579
9	900	450.0	82.4999988079071

Fig 30: Accuracy of 9 Models with 1 Input Layer 1 Hidden Layer with Half Neurons

Classifiation Report of 9 Model Because of its maximum Accuracy

	precision	recall	f1-score	support
0	0.87	0.83	0.85	70
1	0.77	0.82	0.80	50
accuracy			0.82	120
macro avg	0.82	0.82	0.82	120
weighted avg	0.83	0.82	0.83	120

Fig 31: Classification report of 9th Model

CONCLUSION

Our project aims to make work of cataract detection easier by introducing concept of machine learning in Ophthalmology.

An automated cataract diagnostic system would be highly useful in poor countries with insufficient numbers of qualified ophthalmologists to treat patients. Such approaches would make healthcare more accessible, reduce time and screening costs for both the patient and the ophthalmologist, and enable early diagnosis.

Initially, a cataract dataset of fundus images was rearranged, pre-processed, and augmented to improve the dataset to feed the deep network. After that we trained our different models with present dataset and analysed their results. In Machine Learning Model, Random Forest Classifier gave best accuracy with accuracy score of 91% and In Deep Learning Model of ANN with 900 Neurons in Input Layer and 450 Neurons in Hidden Layer and 1 Neuron in Output layer, Activation function used is reLu and Sigmoid with Adam optimizer for 10 Epochs for Cataract Detection gave accuracy of 85.5% . So the best performing model is Random Forest Classifier and will be used for further action.

However, our method cannot discriminate the three types of age-related cataracts (nuclear cataracts, cortical cataracts, and PSCs). Besides, it was only proposed for cataract detection and not for grading or finding its exact location, which can be helpful for ophthalmologists. These issues need further investigation in the future.

In the future, we can focus on improving the accuracy of the model by using a larger and more complex dataset. We can also try to apply various image processing methods so that the model can learn the image pattern more accurately and give better accuracy more efficiently. We can also build a website for easy access by all people worldwide.

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