DESIGN OF AUTOMATIC GLAUCOMA CLASSIFICATION USING GRAY-LEVEL CO-OCCURRENCE MATRIX AND NEURAL NETWORK ON MATLAB GUI AND PYTHON KERAS

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Contents

Abstract

Glaucoma according to the W.H.O is one of the major causes of blindness worldwide. Due to its complexity and silent nature early detection of this disease makes it hard to detect. There have been several technique over the years for classification which have shown significant improvement over the past decade or two. Some of the many classification models are SVM (support vector machine), KNN (K- Nearest Neighbors), Decision tree, Logistic Regression and ANN (Artificial Neural Network) back propagation. For this paper I would consider different procedure and method of early detection of the disease using the matlab neural network and also compared with the python *tensorflow keras* neural network framework. ANN have been a popular method and highly sort after mean of model classification in our today's society. The ANN basically works like the human brain with input, neurons, hidden layers and output. For this project *Fundus image* of both healthy image and glaucoma image are collected with good lighting condition so that all hidden features can be identify. The Fundus image are then passed through different image processing method such as *Grayscale, B&W, Complement, Robert, Resize and power Transform*. The fundus is then passed through a texture feature extraction algorithm know as *Gray Level Co-occurrence Matrix (GLCM) and Local Binary Pattern (LBP).* The features gotten are *Contrast,*

Correlation, energy, Homogeneity, Entropy, Mean, Standard deviation, Variance, skewness and Kurtosis.

Note: the LBP uses a process called *wavelet transform.*

After the feature extraction the data are arrangement on a spreadsheet which serves as a means of record. Lastly, a neural network is written with one hidden layer, 16 input neuron and 2 output either healthy or not. The data are split into train and test dataset with 70% for training 15% validation and 15% for testing. Accuracy is found to vary between 85-92% depending on the number of iteration or epochs.

NOTE: A GUI WAS DESIGN ON MATLAB FOR BOTH THE FEATURE EXTRACTION AND IMAGE PROCESSING OF THE FUNDUS IMAGE.

1. INTRODUCTION

Statistic according to the World Health Organization shows that over 286 million people are affected with one form of eyes disease or the other. While 39 million are totally blind and 246 partially. Glaucoma being a major cause of blindness in the world today damages the optic nerves causing partial or total blindness depending on its stage. The eye disease is caused by increasing intraocular pressure (IOP). Also other causes can be traced to heredity, ethnic background and having

high myopia. It is also caused by poor blood flow which is meant to regulate the optic nerve. This diseases are usually detected late due to the fact that it's usually painless until it gets to critical state. So, the ever growing need for quick and automated detection is needed in most societies today.

In this project we are going to introduce a system with a GUI that takes in images. Extracts features of the image passed into it and perform different image processing techniques. This project would certainly be helpful in early Glaucoma detection and would cost less for such test to be perform on patients of all kinds. With this project health care inflation would slow down, elimination of waste and increase in efficiency thereby reducing production cost would be experience in most hospitals.

Figure 2 Glaucoma Fungus Image

Figure 1 Healthy Fungus image

.The figure 1 and 2 are the fundus image of both and healthy and glaucoma image which would be later passed through the GLCM algorithm to get necessary features.

The goal of the project is to help design a system that is much faster and efficient in making accurate prediction. NOTE: this system is not aimed at replacing scientists in this filed.

DISCLAIMER

The dataset used for this project was gotten from a cousin of mine who is a master student in the Federal University of Petroleum Warri, Delta state Nigeria.

2. LITERATURE REVIEW

Great effort have been made by researchers all over the world and numerous studies have been presented over a period of years. The fundus image are usually presented in RGB form, which are then converted to grayscale to make easy processing of the image. This is done become RGB are usually 3x the size of Grayscale image. Then different image processing technique are performed on the image to help understand the image better. The GLCM feature extraction technique is then performed to get some feature after that passed to a neural network back propagation.

Optic disk are very important in RGB of fundus image. As the optic disk extract features from ROI (region of interest). Also, Glaucoma is detected by the appearance of hemorrhages on optic disk.

Other faster ways of detection is applying convolutional neural network technique. This method works the same way the optical human eyes function. Image is first converted into pixels, this process is called *convolution*, after that it is passed to the hidden layer where *max-pooling* and *fully-connected layer* are form. The amount of hidden layers depend on the data and how strong your computing power can process as much data as possible.

NOTE it is said to get a higher accuracy the amount of hidden layers and neurons have to be increased. ***Dropout*** are usually added to prevent *over-fitting* of the model. The CNN network would be shown in further updates.

Researcher had a breakthrough a couple of years ago with the Concept of Transfer learning which otherwise known as pre-trained model. In this type of architecture neural network does not need to be built from stretch but rather an already built network is used with only the output removed. This technique was achieved during a competition organized yearly by **imagenet,** with each competitor coming up with different models and architecture to see who have the best model with close to 100's of hidden layers.

It should be noted that the transfer learning technique does not require much data as the pre-trained data contains millions of data with thousands of categories. Only the output sigmoid layer is removed and changed to your preferred output.

3. METHODOLOGY

The Glaucoma detection is based on extracting features using the GLCM on a fundus image. The different steps carried out would be shown on a flowchart, which gives a better understanding on steps carried out.

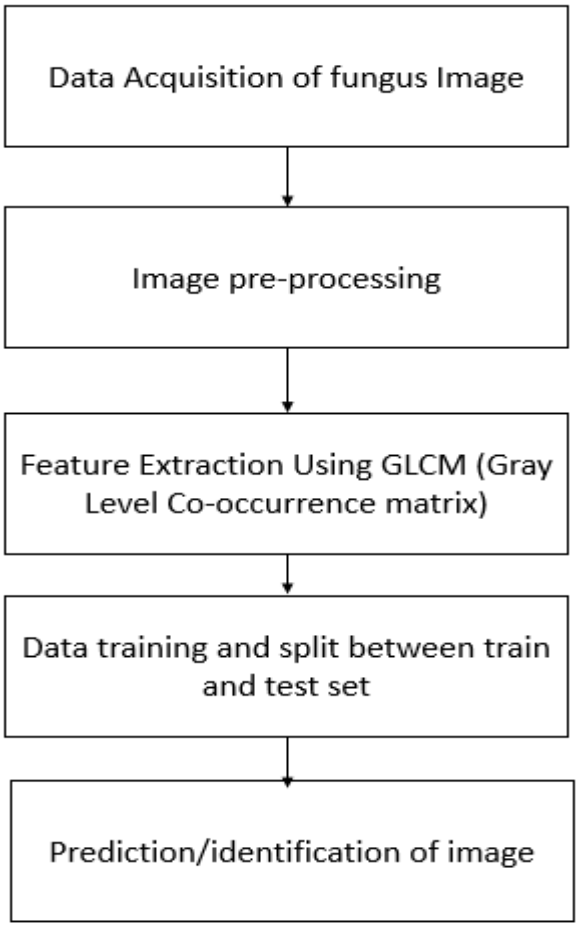


Figure 3 Methodology of the different step carried out

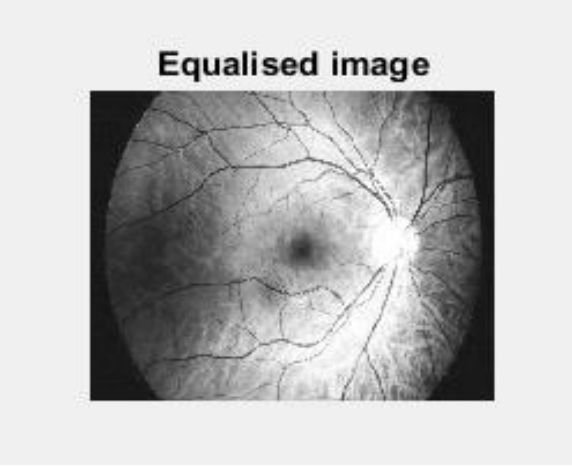
3.1 Data Acquisition

Data acquisition deals with the process and form at which data are usually collected. Data can either be in form of jpg or MPEG. But for this research the fungus image are in jpg form and are two folders both for the healthy and Glaucoma image.

3.2 Image Pre-processing

Image processing basically deals with pixels adjustment. Adjusting the pixels of an image to a desired form. Data pre-processing are usually done to reduce contrast, unwanted noise of image, luminous of the image. For the pre-processing aspect the image are converted to grayscale, Black and White, Histogram Equalization and Thresholding.

NOTE: More image pre-processing technique were carried out on the image using a Developed GUI on the matlab software.



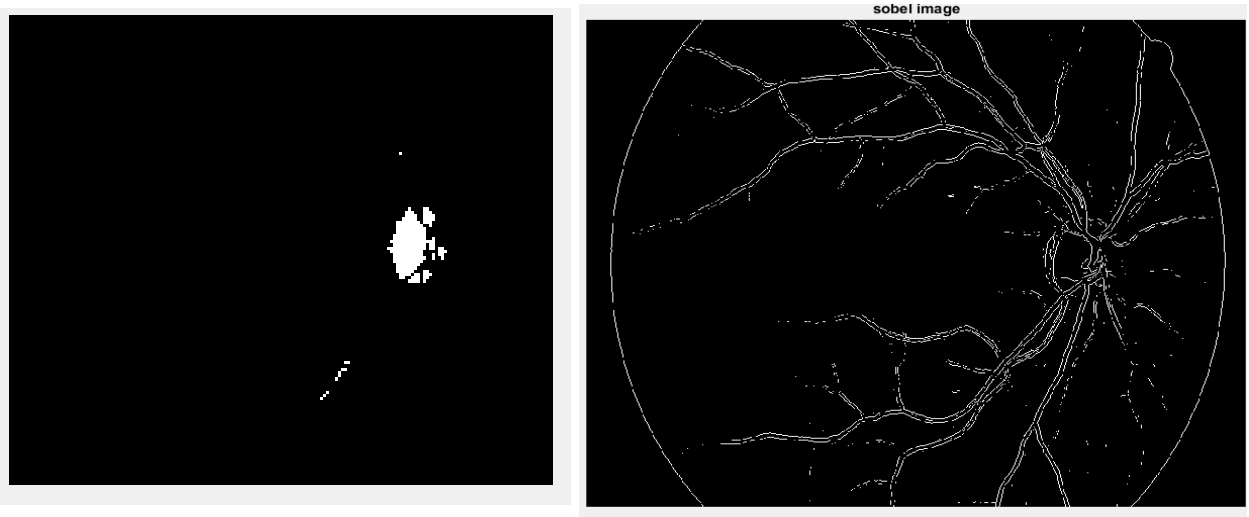


Figure 4 thresholding

3.3 Feature Extraction

Feature extraction is an important process in machine Learning. This process involves extracting important features from the image dataset. This features includes: *Contrast, Correlation, Energy, Homogeneity and Entropy.* The GLCM is a technique that evaluates texture of image by taking into attention the spatial relationship of pixels.

In this research feature extraction is important to easy identify between the Glaucoma and healthy eyes. The matrices distance are usually in degree of various form which are starting from 0, 45, 90, and 135.

NOTE: To get a better accuracy we can increased the amount of features gotten to be more.

	A	B	C	D	E	F
1	CONTRAS	CORRELAT	ENERGY	Homogen	ENTROPY	OUTPUT
2	0.0944	0.9671	0.2584	0.9546	1.6474	1
3	0.0817	0.9636	0.2808	0.9593	1.6774	1
4	0.0755	0.9685	0.2499	0.9628	1.688	1
5	0.0811	0.9684	0.2312	0.9598	1.7332	1
6	0.052	0.9772	0.286	0.9744	1.4939	1
7	0.0687	0.97	0.2936	0.9661	1.4788	1
8	0.0609	0.974	0.2934	0.9706	1.4974	1
9	0.0656	0.9744	0.3106	0.9682	1.479	1
10	0.0739	0.9717	0.3348	0.9648	1.458	1
11	0.0515	0.9789	0.3349	0.9751	1.3912	1
12	0.0732	0.9656	0.2614	0.9638	1.5694	1
13	0.0625	0.9488	0.3821	0.9691	1.3299	1
14	0.0601	0.9538	0.3897	0.9711	1.2321	1
15	0.0748	0.9453	0.3513	0.9634	1.3265	1
16	0.0447	0.9729	0.3974	0.9797	1.2382	1
17	0.0382	0.9776	0.4027	0.9815	1.2102	1
18	0.0489	0.9676	0.3476	0.9759	1.3598	1
19	0.0555	0.9664	0.3128	0.9726	1.4373	1
20	0.0574	0.9636	0.3828	0.9726	1.2583	1
21	0.0685	0.969	0.2878	0.9666	1.5525	1
22	0.0686	0.9656	0.2977	0.9662	1.5542	1
23	0.0661	0.9608	0.3333	0.9674	1.419	1

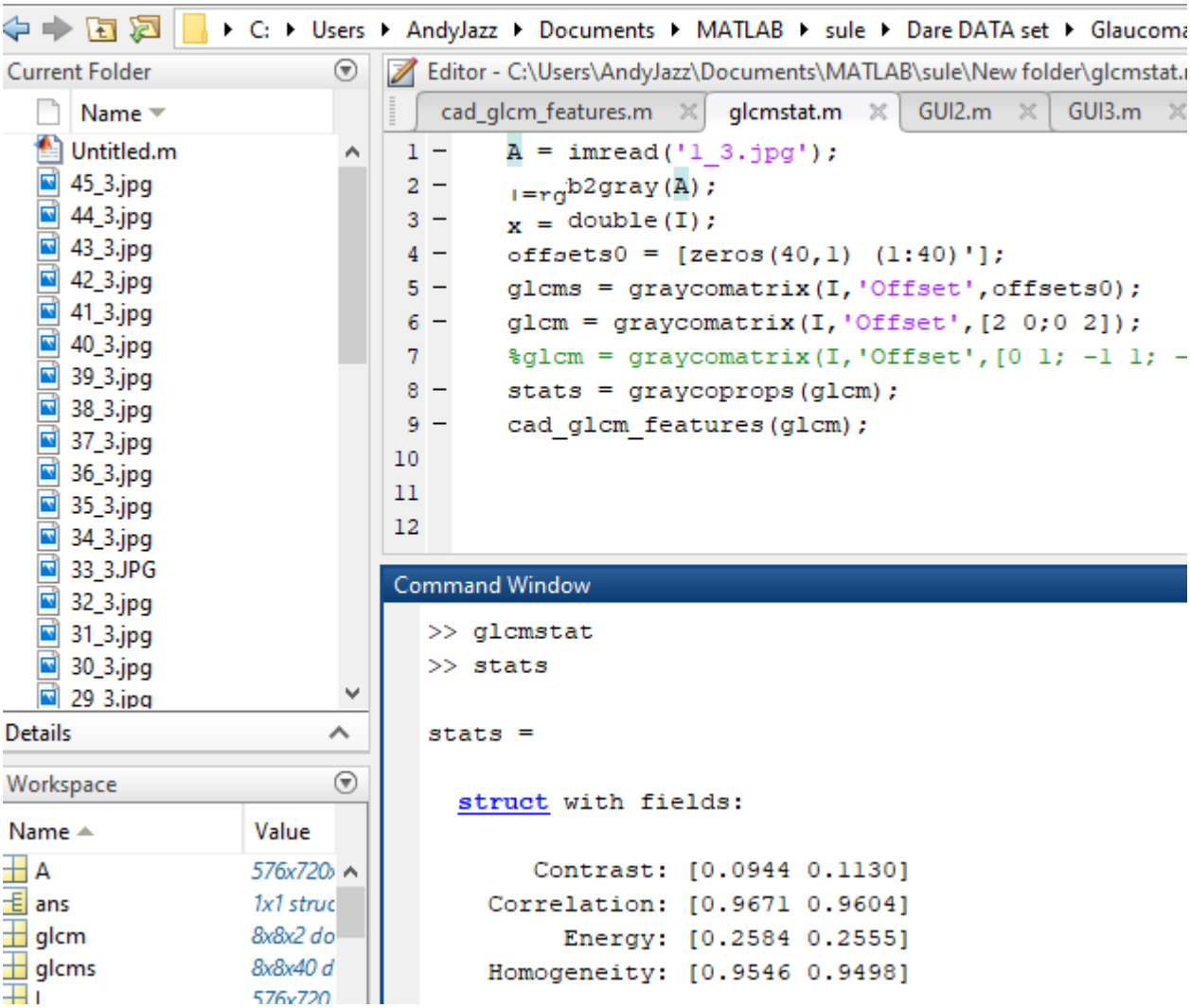


Figure 5 Feature extraction using GLCM text

3.4 Data Training and testing

The Dataset gotten was split into three parts 70% training, 15% testing and 15% Validation.

An artificial neural network back propagation was created using the matlab ***nntool.*** With a total of 1000 epochs each was set. The number of accuracy can also be increased if we retrain the neural network repeatedly.

The input data are set at 5 different input. With a single hidden layer, a total of 16 neuron are set in the hidden layer with 2 outputs.

3.5 Prediction

After the neural network have been created, the gotten feature that are extracted from the image are then passed into the network for easy classification between healthy or glaucoma. Note that we had to represent the string data in numerical form

Glaucoma (positive) = 1

Healthy (negative) = 0

4. RESULT AND DISCUSSION

The result gotten from the neural network was first split into train, test and validation data set. All this was done to prevent over-fitting of the neural network.

The *nntool* of matlab was used to create the neural network.

From figure 5 below it can be seen that only one hidden layer was created from the neural network formula

Y = XW + b

Y = output

X = input

W = weight b= bias

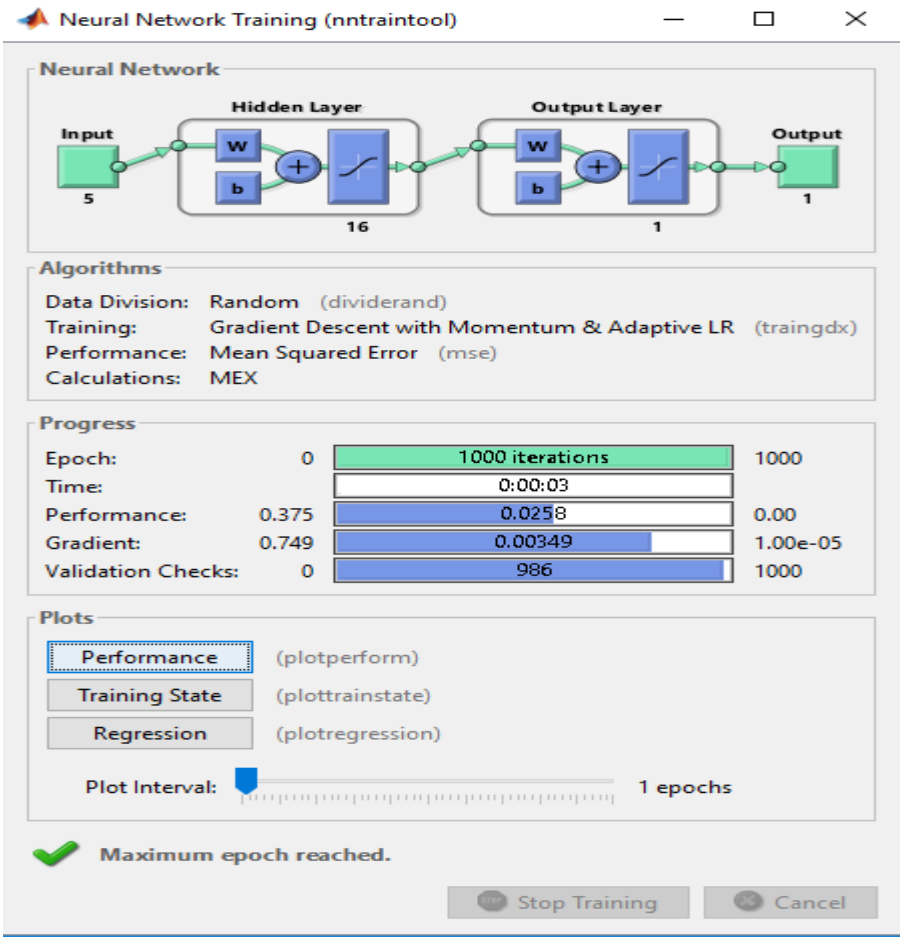


Figure 6 nntraintool on matlab

The validation check was set at 1000 epoch and gradient at 1.00-e05.

4.1 Performance Measurement

The confusion matrix is a mathematical formula that helps show how accurate an algorithm or model can be. It is usually in 4 feature output

TP = True Positive

TN = True Negative

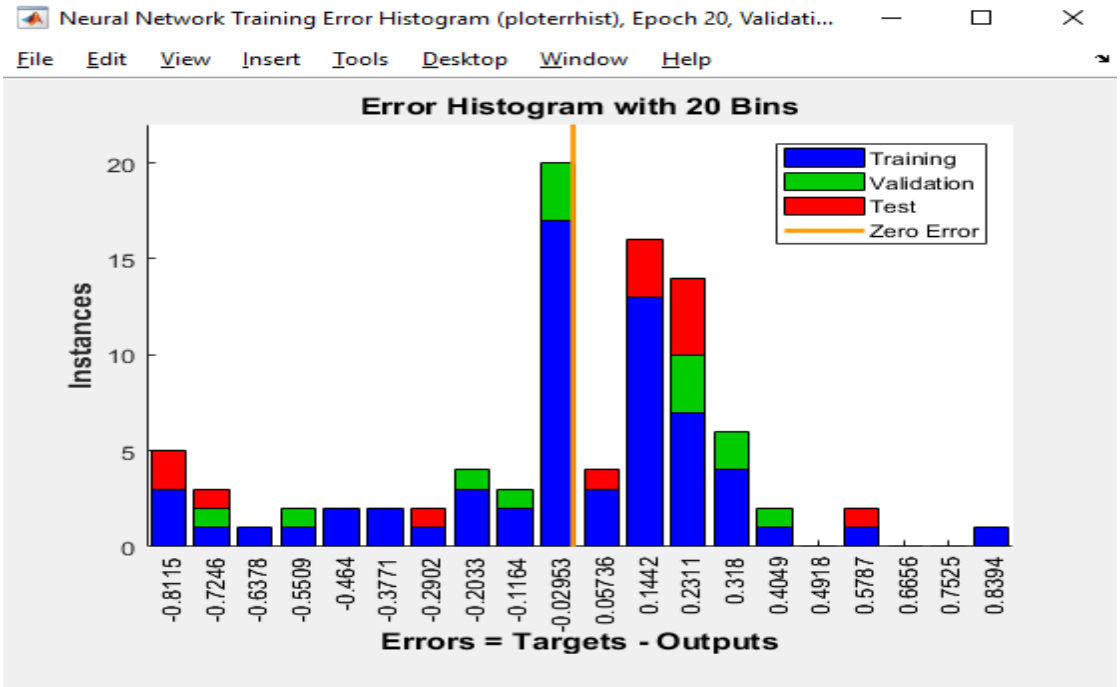
FP = False positive

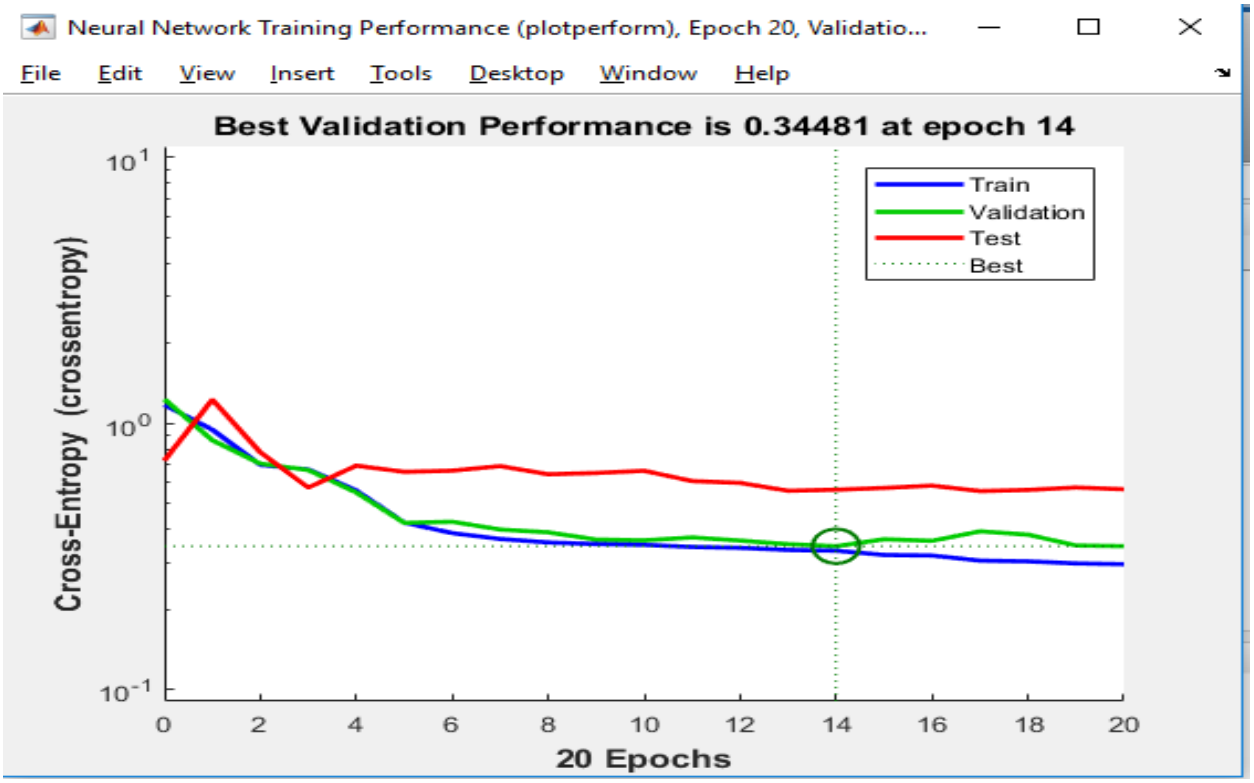
FN = False Negative

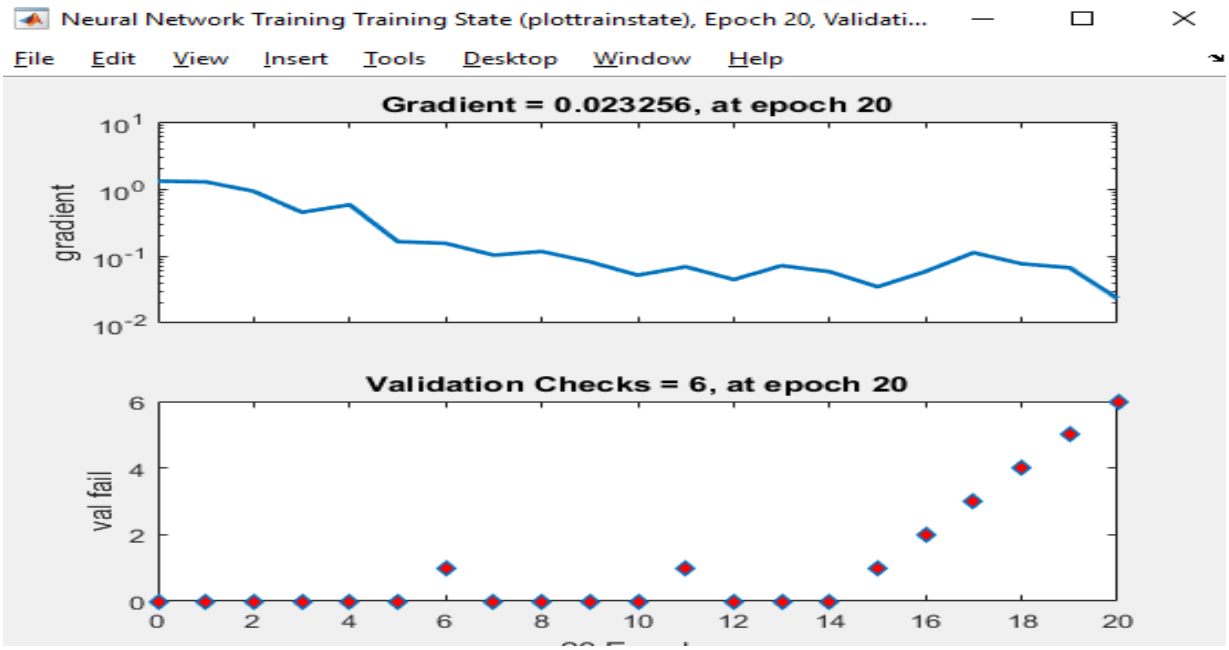
All this statement are useful in getting the ***Sensitivity, Precision, specificity and Accuracy*** of the model created

4.2 Error Histogram

The histogram error are usually used in terms of determining outliers in a model. Outliers are usually odd or weird features found in a dataset.







So we separate the data into targets and inputs

Inputs= X

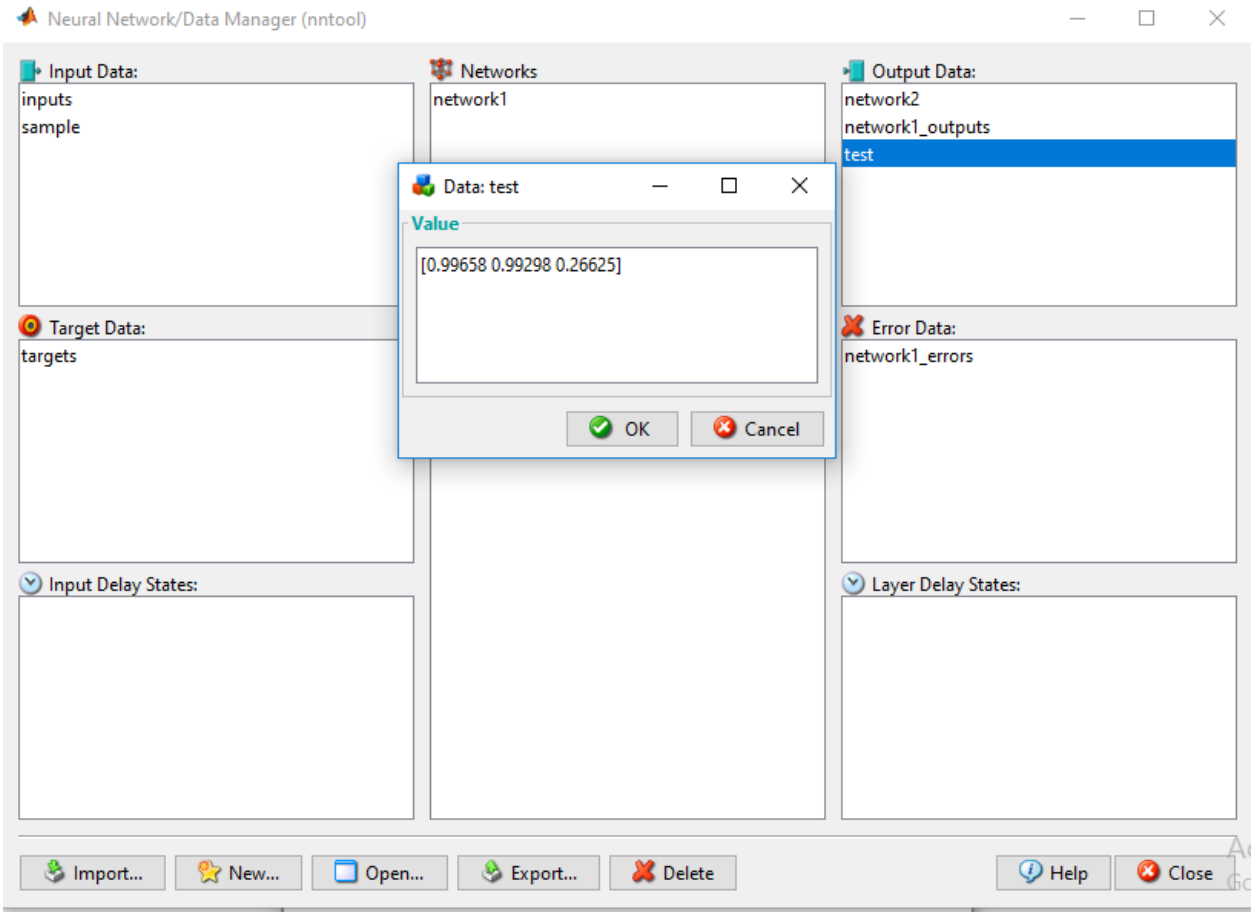
Targets = Y

We add a sample data which we used in testing.

0.0477	0.9379	0.4366	0.9762	1.1256
0.0606	0.9119	0.479	0.9697	1.0866
0.0743	0.9336	0.3522	0.964	1.3376

Random data are copied from the excel dataset we are going to use in testing.

Note the data outputs are 1, 1, 0. We would passed the sample data to the model and see if the model is able to make its prediction accurately.



Expected Result	Model Prediction
1	0.99658
1	0.99298
0	0.26625

From the table able it can be approximated that 0.99658~1 is positive if

approximated to 1 and 0.26625~ 0 negative if approximated.

5. Conclusion and Recommendation

5.1 Conclusion

It can be said that the ANN provides a better and faster computer-based system for classifying between Glaucoma and healthy fungus image of the eyes. Even though the system has not undergone international standard. It still provides an alternative in classification and other purposed work.

5.2 Recommendation

One of the limitation encountered was the unavailability of dataset set. Which lead to the low amount of accuracy.

This research would be useful my scientist all over the world in conducting further research and thesis in future.

ABOUT WRITER:

I am a graduate of Electrical Electronic Engineering of the Federal University of Technology. Over the years my passion have really shifted to Technology and the world innovation ranging from VR, AR, 3D Modelling, Quantum computing, ML and DL. My focus is on CNN and RL in medical field, I believe further studies should be taken to see how well we can explore the use of such architectures.

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