International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-10, August 2019

A Deep Learning Neural Network for Detecting the Diabetic Retinopathy

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Abstract: ***Diabetic Retinopathy (DR) is the leading cause of disease to blindness of people globally. The retinal screening examinations of diabetic patients is needed to prevent the disease. There are many untreated and undiagnosed cases present in especially in India. DR requires smart technique to detect it. In this paper, we proposed a deep learning based architecture for detecting the DR. The experiments are done on the DR Dataset available in UCI machine Learning Repository. The results obtained from the experiments are satisfactory.***

Keywords : Diabetic Retinopathy, Deep Learning, Neural Network, UCI

I. INTRODUCTION

There are approximately 415 million of people have Diabetes worldwide, that means 1 in every 12 adults. The fine eye vessels are affected by DR [1]. Out of the Diabetic patients, 40-45% may have DR at some point of time in their life [1]. The diabetic eye and Normal eye are shown in the Figure 1. Less than 50% of patients are aware of DR. In the last stage of DR, it's highly challenging for the ophthalmologists and DR causes to permanent blindness. Although DR is preventable as of today, its early detection is much more needed because prevention is always better than

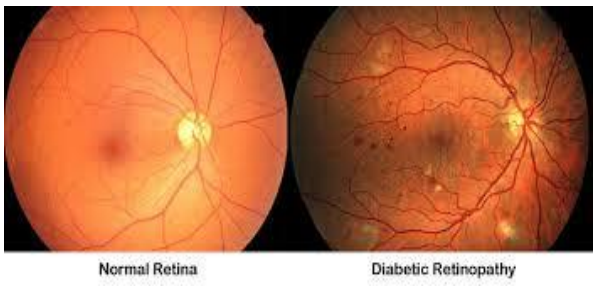

Figure 1: Example of a Normal Eye and Diabetic Eye (Source:https://bwprimarycare.com/services/retinal-eye-exam)

cure. The DR is detected and diagnosed by direct examination of the opthamologists using the visual assessments. The process of manual examinations is risky and time consuming and there is a chance of manual error occurred in the process. Hence DR problem requires some technique which can assist the opthamologists so that the quality of detecting and diagnosing DR improves considerably. The trained specialists are less in this field of study [2]. Furthur most of the DR patients live in non developed and developing countries where the specialists and hardware to detect DR are not available or seldomely available. Hence millions from the worldwide experienceing visual impairement problems. We propose a deep learning neural network architecture that can classify the DR from non DR patients which can assist the opthamologists. The rest of the paper is organized as follows. Section II presents the Literature Survey. The proposed architecture is presented in the Secion III. Dataset used for the experiements is discussed in the Section IV. The experimental results are presented in Section V. The conclusion and future directions are presented in Section VI.

II. LITERATURE SURVEY

Ting, Daniel Shu Wei, et al. proposed a deep learning system method to detect DR and vision threatening [3]. Roychowdhury, Sohini, Dara D. Koozekanani, and Keshab K. Parhi presented a computer aided screening system, DREAM which analyses fundus DR images with varying illuminations [4]. They used the adaboos algorithm for feature ranking and reduced the number of features used for classification [4]. A two step hierarchical classification process is followed where the nonleison are eliminated in the first step and classification process is done in the second step.

Sinthanayothin, Chanjira, et al proposed three we sequence of steps in their automatic detection of DR [5], the preprocessing of color images, identifying main retina components and recognizing DR as the final step. Niemeijer, Meindert, et al proposed a system that detects the cotton wool spots and exudates from the digital photos for early diagnosis of DR [6]. They developed a machine learning algorithm to separate among cotton wool spots, drusen and cotton wool spots. Krause, Jonathan, et al. finds that the adjudicated DR grades improve performance substantially in detecting DR [7]. Yang, Yehui, et al. developed an algorithm based on two-stage deep convolution neural networks [8]. The algorithm finds the lesion and severity grades in DR in the first stage. In the second stage the algorithm uses imbalanced weight map to detect the patches of lesion for DR detection.

III. DEEP NEURAL NETWORK

A neural network is the artificial network inspired from the thinking of the human brain cells. The sample neural network architecture is shown in the Figure 2. Neural network consists of an input layer, number of hidden layers and an Output Layer. The fundamental components of layers are nodes which mimic the neuron in

Manuscript published on 30 August 2019.
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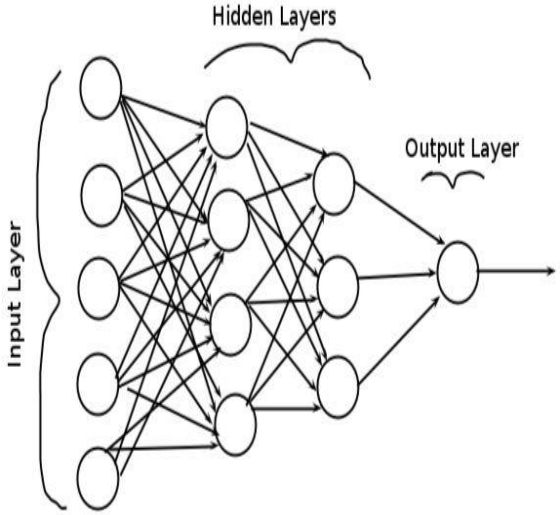

Figure 2: A sample Neural Network Architecture

the brain. The neurons are interconnected with the other neurons using the links and the interconnections forms the synaptic junctions. Like this, billions of neurons are interconnected among themselves and actively works towards the taking decision. In the similar Fashion, the nodes in one layer are connected to the nodes in the other layer. Any neural network has one input layer and zero or more number of hidden layers and one output layer. The nodes receive the input from its previous layer and process the received input and then the output is forwarded to all the nodes connected with this node in its adjacent forward layer. A node may be connected to some or all the nodes in its adjacent layer. If a node connects to all the nodes in the next adjacent layer and this condition is true for every node in the network then that type of network is called fully connected neural network otherwise partially connected neural network. A typical structure of a node is shown in the Figure 3.

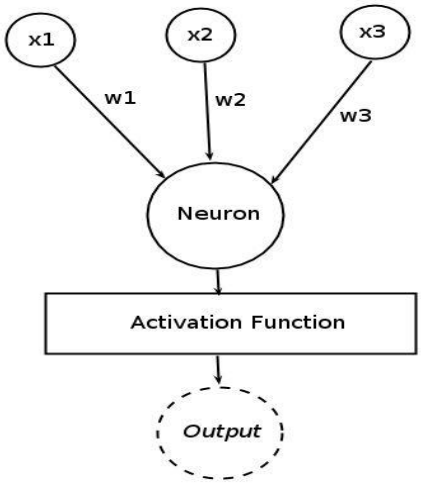

Figure 3: A typical node structure

Let x1, x2 and x3 are the inputs received from the previous layer. w1, w2 and w3 are the corresponding weights respectively. The first operation in the neuron is summation. The inputs are multiplied with the corresponding weights and summed up. This is a linear operation.

$$S = x1w1 + x2w2 + x3w3 \quad (1)$$

The result of summation is applied to Activation Function. Activation Function induces non linearity in the problem as most of the real world problems are nonlinear in nature. The popular activation functions are sigmoid or logistic, tanh, Relu and leaky Relu etc. The input signal is converted to output signal in the activation function. The main purpose of activation functions is to introduce nonlinear properties in the network.

Deep Neural network: A deep neural network is simply a neural network having depth. The depth is related to the number of hidden layers or degree of the network or tuning of different hyper parameters. Deep NN's are capable to process huge and complex data. Generally any NN which has at least one hidden layer is considered a deep neural network. Deep Neural networks are able to perform different complex tasks such as face detection, language translation etc. Multi-Layer Perceptron, Convolution Neural Network, Recurrent Neural Network are the best architectures of Deep Neural Networks. In this paper we used Multi-Layer perceptron model.

IV. DATASET

We used Diabetic Retinopathy Debrecen Dataset obtained from UCI Machine Learning Repository [9]. This dataset contains the features extracted from the Messidor images. The images are used for predicting whether they have signs of Diabetic Retinopathy or not. The total number of instances is 1151. The data are multivariate data. It has no missing values. The dataset contains 20 features. The brief information regarding the attributes is given below.

Feature 0: A binary attribute {0, 1} indicates whether the measurements are having the good quality or bad quality.
Feature 1: A binary attribute {0, 1} where 1 indicates severe retinal abnormality and 0 indicates no lack.
Features 2 – 7: The MA detection results with the confidence levels alpha = 0.5… 1 respectively.
Features 8-15: The MA detection results for exudates.
Feature 16: The Euclidean distance between centers of the optic disc to the center of the macula. This feature is an important feature and normalized with ROI.
Feature 17: The optic disc diameter
Feature 18: The binary attribute {0, 1} represents AM or FM classification.
Feature 19: This feature gives the class label information. There are two class labels are present. The class label 1 represents signs of DR and 0 represents normal eye.

V. EXPERIMENTAL RESULTS

KERAS: Keras is a deep learning open source Framework. Keras is built on the wrap up of Tensorflow and Theano which are the popular deep learning tools. Using Keras We can design the neural network model. The following are the parameters we used for the experiment.
No. of Layers: 1 input layer, 3 hidden layers and 1 output layer
No of nodes in the input layer: 19 since it represent the dimensionality of the problem.
No of nodes in the output layer: 1node. The data set is a binary data set. Hence we used 1 node.
Activation Functions: Relu for the hidden layers and sigmoid function for the output layer.
No of Epochs: Epoch means one complete iteration of the neural network through the entire dataset. The no of epochs used are 50 and 100.

Batch Size: Batch size represents how many input examples are selected at a time for training the neural network. The batch size is 10.

Cross-Validation: We used K-fold cross validation selecting the K value from the set {2, 3, 4, 5, 6, 7, 8, 9, and 10}.

The results obtained are tabulated in the Table 1. The first column represents the k-fold information. The second column represents the accuracy obtained. The third column represents the standard deviation.

Table 1: Accuracy obtained for 50 epochs

k-fold	Accuracy	Std
2	61.66	10.03
3	66.06	9.23
4	64.21	8.70
5	59.52	9.41
6	63.08	11.04
7	59.93	9.26
8	61.76	10.27
9	62.23	11.03
10	66.20	7.90

For improving the accuracy and to soften the standard deviation the number of epochs is increased to 100.

Table 2: Accuracy obtained for 100 epochs

k-fold	Accuracy	Std
2	***72.29***	***0.76***
3	72.20	2.10
4	68.72	7.75
5	60.73	8.78
6	66.36	8.80
7	68.20	9.92
8	57.26	12.54
9	64.20	9.60
10	61.95	10.59

The network shows the best performance for the 2-fold, 100 epochs highlighted in Table 2. The graphical results are shown in the Figure 4.

Figure 4 shows the accuracies versus the k-fold cross validation where k is ranging from 2 to 10. From the Figure 4, it is evident that the network is showing good performance.

VI. CONCLUSION

In this paper we designed a deep learning network for classifying diabetic retinopathy problem. We experimented with DR Dataset from UCI California dataset. The experimental results are satisfactory. The future directions of the word are improving the performance of the model by tuning the hyper parameters and applying the CNN for classifying the DR images.

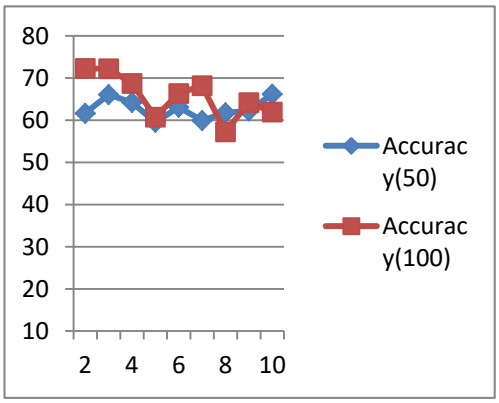

Figure 4: Accuracy obtained for different k-fold validation

REFERENCES

1. Gargeya, R. and Leng, T., 2017. Automated identification of diabetic retinopathy using deep learning. Ophthalmology, 124(7), pp.962-969.
2. Sellahewa L, Simpson C, Maharajan P, et al. Grader agreement, and sensitivity and specificity of digital photography in a community optometry-based diabetic eye screening program. Clin Ophthalmol. 2014;8:1345-1349
3. Ting, Daniel Shu Wei, et al. "Development and validation of a deep learning system for diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes." Jama 318.22 (2017): 2211-2223.
4. Roychowdhury, Sohini, Dara D. Koozekanani, and Keshab K. Parhi. "DREAM: diabetic retinopathy analysis using machine learning." IEEE journal of biomedical and health informatics18.5 (2014): 1717-1728.
5. Sinthanayothin, Chanjira, et al. "Automated detection of diabetic retinopathy on digital fundus images." Diabetic medicine 19.2 (2002): 105-112.
6. Niemeijer, Meindert, et al. "Automated detection and differentiation of drusen, exudates, and cotton-wool spots in digital color fundus photographs for diabetic retinopathy diagnosis." Investigative ophthalmology & visual science 48.5 (2007): 2260-2267.
7. Krause, Jonathan, et al. "Grader variability and the importance of reference standards for evaluating machine learning models for diabetic retinopathy." Ophthalmology 125.8 (2018): 1264-1272.
8. Yang, Yehui, et al. "Lesion detection and grading of diabetic retinopathy via two-stages deep convolutional neural networks." International Conference on Medical Image Computing and Computer-Assisted Intervention. Springer, Cham, 2017.
9. Lichman, Moshe. "UCI machine learning repository." (2013).

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DOI: 10.35940/ijitee.J9746.0881019
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