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Convolutional Neural Networks for Automatic Classification of Diabetic Retinopathy

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Abstract - : *Diabetic Retinopathy (DR) is the main source of visual deficiency in diabetic patients. To tackle the problem of late diagnosis of diabetic retinopathy in affected people leading to permanent blindness, we are using convolutional neural networks for automated, quick and precise identification of the disease. The convolutional neural networks are trained by a labelled training dataset of fundoscopic images where they automatically learn the features of a diseased and normal retina and further use these features to detect the disease in the test fundoscopic images. Tensorflow's Inception Model and its functions are used to construct the convolutional neural network and to train and test the neural network. This method of deep learning/machine learning to diagnose a DR is less timing consuming, almost accurate and can handle hundreds of test fundoscopic images at once, thereby helping a large number of people receive treatment in the earliest possible stages of the disease.*

Key Words: **Convolutional Neural Networks, Diabetic Retinopathy, Supervised Learning, TensorFlow**

1. INTRODUCTION

Diabetic retinopathy (DR) is a medical condition in which damage occurs to the retina due to diabetes mellitus and is a leading cause of blindness, both partial and permanent. Diabetic retinopathy may cause no symptoms or only mellow vision issues. In long run, it can cause blindness. Without proper and timely detection, the disease may advance and lead to permanent blindness. Diabetic Retinopathy is characterized by the presence of hemorrhages on the retina and degree of severity is decided by the extent to which damage has been caused to the veins in the retina. Generally, Fundoscopic shots of the retina are screened by ophthalmologists to detect the disease. The idea is to use Machine Learning to detect and diagnose DR in a subject to accelerate the process in order to tackle the problem of doctor to diabetic patient ratios in India. A standout amongst the most widely recognized approaches to distinguish diabetic eye sickness is to have a pro look at photos of the back of the eye and decide if there are indications of the ailment, and assuming this is the case, how extreme it is. While yearly screening is prescribed for all patients with diabetes, numerous individuals live in regions without simple access to master mind. That implies a large number of individuals aren't getting the care they have to avoid loss of vision. We're energized by the outcomes, yet there's significantly more to do before a calculation like this can be utilized broadly. For instance, understanding of a 2D retinal photo is just a single step during the time spent diagnosing diabetic eye infection — now and again, specialists utilize a 3D imaging innovation to analyze different layers of a retina in detail. We are taking a shot at applying machine learning to that strategy. [1] Later on, these two integral strategies may be utilized together to help specialists in the analysis of a wide range of eye illnesses. To implement this idea, we are using an open source library for machine learning called Tensorflow. With the help of tensorflow, we can use the necessary functions required to construct a Convolutional Neural Network for image classification.

2. RELATED WORKS

2.1 Supervised Learning

Supervised learning is the machine learning assignment of deducing a function from supervised training data. [2] The training data consists of a set of examples. In this, each example is a pair consisting of an input object and a desired output. A supervised learning algorithm analyzes the training data and results a function, which is referred as a classifier or a regression function. The function should predict the precise output value for any valid input data. This requires the taking in calculation to sum up from the preparation information to concealed circumstances sensibly.

The parallel task in human and animal psychology is often referred to as concept learning. In supervised learning, the training data set should be well prepared to ensure the model works properly with accurate results.

2.2 Convolutional Neural Networks

Convolutional Neural Networks are fundamentally the same as standard Neural Networks from the past: they are comprised of neurons that have learnable weights and predispositions. Every neuron gets a few sources of info, plays out a speck item and alternatively tails it with a non-linearity. The entire system still communicates a solitary differentiable score work: from the crude picture pixels toward one side to class scores at the other.[3] Despite everything they have a misfortune work (e.g. SVM/Softmax) on the last (completely associated) layer and every one of the tips/traps we produced for learning customary Neural

Networks still apply. The architecture of a CNN is intended to exploit the 2D structure of an information picture (or other 2D information, for example, a discourse flag). This is accomplished with nearby associations and tied weights took after by some type of pooling which brings about interpretation invariant highlights. Another advantage of CNNs is that they are less demanding to prepare and have numerous less parameters than completely associated systems with a similar number of concealed units.

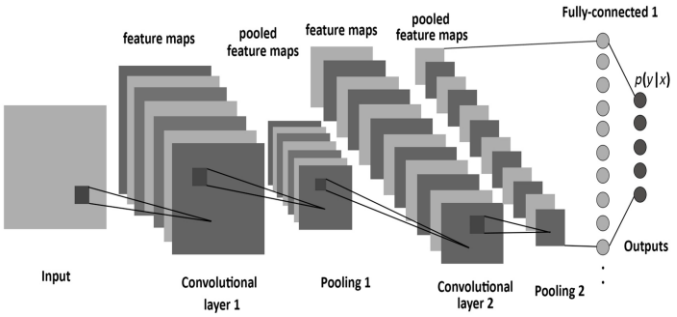

Figure 1: CNN Architecture

2.3 TensorFlow

TensorFlow is an open-source software library for dataflow programming across a range of tasks. It is a math library, is also used in machine learning applications such as neural networks. [5] While the reference usage keeps running on single gadgets, TensorFlow can keep running on numerous CPUs and GPUs (with discretionary CUDA and SYCL augmentations for broadly useful figuring on designs handling units).TensorFlow is accessible on 64-bit Linux, macOS, Windows, and portable processing stages including Android and iOS.[6] TensorFlow calculations are communicated as stateful dataflow diagrams. The name TensorFlow gets from the activities that such neural systems perform on multidimensional information exhibits. These exhibits are alluded to as tensors. [7]

3. PROBLEM STATEMENT

Diabetes Mellitus affects a vast percentage of Indians and so does Diabetic Retinopathy. The number of doctors compared to the number of patients in India is quite low which leads to delayed diagnosis of various diseases. But delayed diagnosis of Diabetic Retinopathy leads to irreversible damage to eyes, further leading to complete permanent blindness. This disease can be treated but the damage is not completely reversible. To avoid this situation, we decided to automate the process of diagnosis by using machine learning. Convolutional Neural Networks, whose architecture imitates the biological system of vision in animals, is the machine learning model we have used. [8] This neural network is trained on a labelled training data set of fundoscopic images. Once the model is trained it generates a graph file that can be used for the purpose of classifying diseased retinas from the normal retinas.

4. EXPERIMENTS

4.1 Experimental setup

We downloaded a training dataset of about 40,000 fundoscopic images from the open-source website, Kaggle.[9] These training images of the retina are divided into five classes and labelled as: No DR, Mild, Moderate, Proliferative and Severe. We are using Python (v 3.5.3) are the main programming language to construct the convolutional neural network. Python as a programming language provides an extensive library for machine learning and deep learning. One such library is TensorFlow, which is open source and provides functions for creating and using machine learning models. With the help of TensorFlow (v 1.2.1), we constructed a convolutional neural network and trained it using the training dataset. Once the model is trained, it generates a graph file (.pb). This graph file takes a test image/test images and performs the classification. Normalized scores are given to each of the classes based on a softmax function. The class with the highest normalized score is the result.

5. Results and Discussions

We can run the neural network with a test image as an input in order to label it with any of the 5 labels. The test image is processed just like the training set of image, where the model weights saved from training of the neural networks are used to identify its label. The graph file returns logits and these logits pass through the softmax function to output the normalized values. The results for a test image that has been identified by the doctor as severe DR are given below.

Table-1: Results for a test image (Figure 2) classified as Severe DR

Results				
No DR	Mild	Moderate	Proliferative	Severe
0.0116	0.0175	0.1068	0.1505	0.7134

Fig - 2: Fundoscopic Shot for Severe Diabetic Retinopathy

6. Future Scope

The scope for this project in the future is to increase the accuracy by training the model on machines with better processing power. By using GPU, possibly multiple, the processing power needed to train a convolutional neural network can be achieved. Better trained CNN, means better accuracy. At the same time accuracy can be tremendously increased by using multiple databases of training images.

CONCLUSION

With our research we aim to provide quick and accessible diagnosis to people from all walks of life, to prevent this disease from further deteriorating to a point where it becomes untreatable. We aim at using state of the art neural networks to automate the process of diagnosing and classifying diabetic retinopathy in order to prevent the progression of the disease and avoid blindness in the people suffering from it.

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