Applied Deep Learning.

Identification of Cerebral Micro-Bleeds(CMB) using CNN

Pranshu Prakash Vaish

Aman Oswal

Priyanshu Kumar

Rupendra Singh Saran

Nallani Venkata Harsha

Naman Kaushik

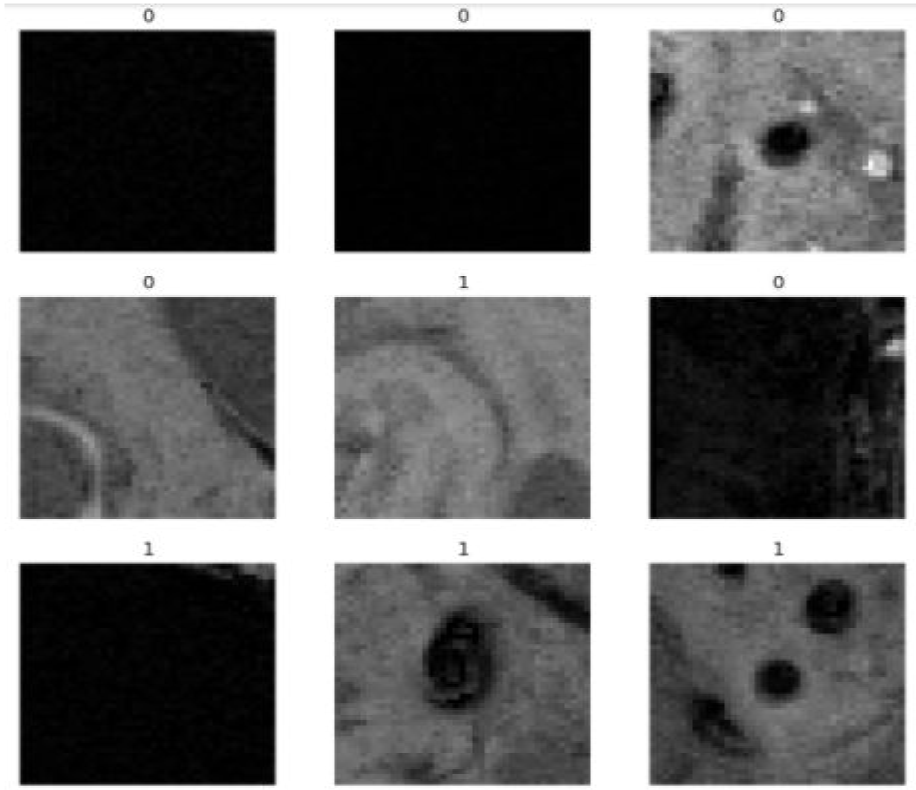
Introduction

Cerebral microbleeds (CMBs) are a chronic accumulation of small blood products in the brain tissue. When brain magnetic resonance imaging (MRI) began to apply a high magnetic susceptibility technique in the mid-1990s, CMBs became well known. With further development of MRI techniques, the detection rate of CMBs increased significantly, and it has become of great interest and importance to certain conditions, such as dementia and stroke, as well as normal aging.

CMBs have been considered to be asymptomatic lesions that may be found incidentally on the brain MRI. Recently, CMBs were associated with an increased risk of cognitive decline, dementia, intracerebral hemorrhage (ICH), cerebral infarction, recurrence of transient ischemic attack, and mortality rate.
It is very essential that CMBs get detected at the early stage of life, and since traditional methods. of CMB detection involve too much human dependence, and is expectedly very error-prone, an automatic method has to devised which is robust, has high precision, and is indifferent to the varying qualities like morphology and size. Our product is a step towards the same direction which uses Convolutional Neural Networks and transfer learning to classify CMBs. The demonstration is done using a labeled dataset of MR images and their augmented forms. The results are satisfyingly precise and have equally good recall.

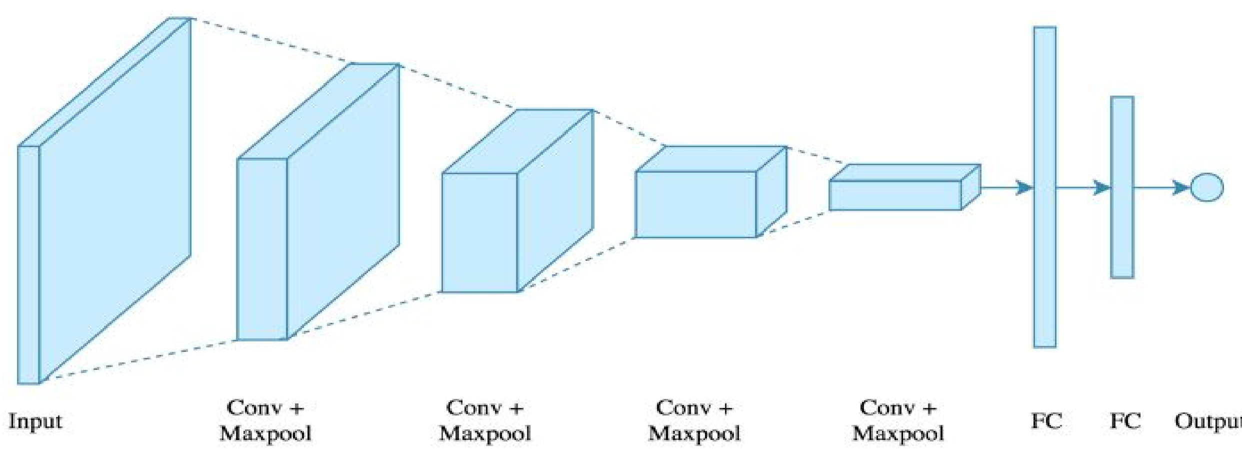
Model and its training.

Since data used to train the model originates from medical testings, they were limited in quantity, consequently, we had to perform data augmentation using the random horizontal flip and random rotation so that the model could have enough data to train itself on. The MR images were used as the input in the convolutional neural network model having consisting of images as the input layer, 5 convolutional blocks, 1 hidden layer, and an output layer.



A look into the dataset.

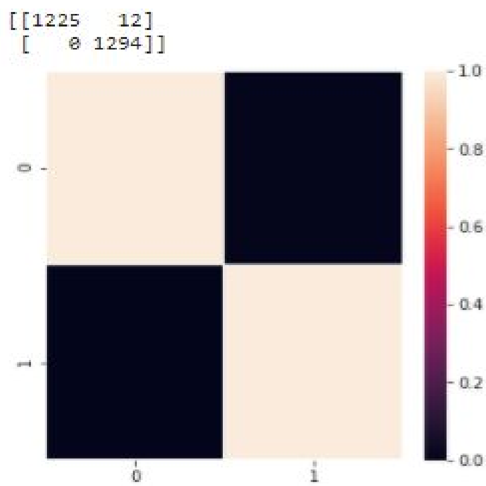
The architecture has five convolutional blocks, each having 2 - 3 feature maps with zero paddings, and stride =1 followed by a pooling layer with stride =2 and batch normalization. The five convolutional blocks are followed by a fully connected dense network and then an output layer.



The general architecture of a CNN classifier.

The model's accuracy vs epoch graph is given below, and the results are excellent and well above 9.8, despite having no significant skewness towards one single label.

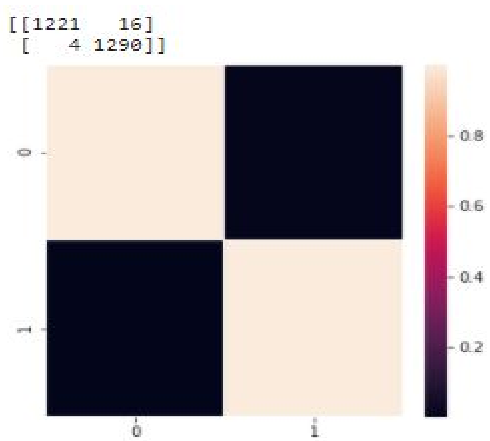
Since the classification has a great medical significance, we must look at its precision and recall. The confusion matrix of the model is given below.



The classifier operates with a precision of more than 99% and the recall also is more than 99, if the average of different test runs is taken.

We later introduced transfer learning into the classifier, where a pre-trained model used in some other classification is used as the starting point for the problem at hand. The accuracy vs epoch graph is a lot volatile for this model.

Although accuracy is high, it is comparatively less than that of the model trained from scratch, even precision and recall values tell the same.



The precision value dropped to 98.7, however, recall still is above 99%

Conclusion.

Like many areas, medical fields too are in dire need to amalgamate its existing science with machine learning and deep learning to create more precise and less error-prone procedures. There are many fields where human biases and limitations prove to be costworthy, introducing these classification techniques after training the model on different datasets a proper classification model indifferent to the unnecessary properties can be developed which can be trusted upon. Our classifier has precision and recall both above 99%, which is sufficient to prove its robustness.