Journal of Applied Bioinformatics & Computational Biology

Research Article A SCITECHNOL JOURNAL

Hemorrhage Detection Using Transfer Learning

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Received: 31 March, 2021, Manuscript No. JABCB-21-28848;

Editor assigned: 05 April, 2021, PreQC No. JABCB-21-28848 (PQ);

Reviewed: 19 April, 2021, QC No. JABCB-21-28848 (R);

Revised: 03 August, 2022, QI No. JABCB-21-28848 Manuscript No. R-28848;

Published: 31 August, 2022, DOI: 10.4172/2329-9533.11.7.1000250

Abstract

Bleeding, likewise named hemorrhage, is the name used to depict blood loss. It refers to blood clots inside the body or outside the body, which are called internal or external bleeding. Blood clots can take place anywhere in the body. Internal bleeding usually appears when there is a blood leak seen through a damaged blood vessel or an organ. When bleeding is seen to be taking place inside the skull it is known as Intracranial Hemorrhage. This leads to various causes like head trauma, bleeding tumours, high blood pressure, blood clotting disorders, and others. Neurosurgeons use a Computed Tomography (CT) to detect hemorrhage which appears to be intense (white) and try to identify its subtypes by extracting some essential features depending upon the shape, location, and vicinity. Deep Learning can change the future of health care. Using Deep Learning Algorithms, we can try analyzing the data from electronic documents like CT Scans or X-Rays. The aim is to classify the hemorrhage images; the results states it will detect the hemorrhage from the images. In this, we are using deep learning methods like transfer learning where we are training with predefined networks like alexnet, googlenet, resnet, etc. For this, we used Densenet as our pretrained network which was trained and tested with 200 brain CT images. The resultant accuracy on the training dataset is 99.38% and the test is 94.44%.

Keywords: Hemorrhage; Deep learning; Convolutional neural networks; Transfer learning; Densenet

Introduction

A hemorrhage is a fatal environment leading to death or a primary cause of brain stroke [1]. This is a situation wherein leakage is caused inside of the head by a ruptured blood vessel [2]. The two leading factors are hypertension and wounds which lead to hemorrhage stroke [3]. Taking blood-thinning medicines can also increase the risk of an individual [4]. This is a medical emergency where it requires immediate action of treatment [5]. The skull encompasses the mind, and any spilling blood from a drain can make pressure and harm the cerebrum tissues [6].

Among various age groups, the symptoms of a brain hemorrhage differ [7]. For older people, brain hemorrhages are often more probable to appear [8]. Many of the unexpectedly occurring intracerebral hemorrhages in kids are due to blood vessel problems [9]. Blood cancers, neurological disorders, septicemia, or the use of alcohol and other drugs are some other possible reasons. A brain hemorrhage may happen in children due to a childhood accident or blunt trauma injury to the abdomen of a woman while she is pregnant. In infants and adults, the effects along with some of the treatment options are rather similar. Care in children depends on both the hemorrhage site and the seriousness of the event. According to the CDC (Centers for Disease Control and Prevention) stroke is the fifth largest reason for death within the US ("FastStats-Leading Causes of Death," 2021). As children's brains continuously develop, children usually recover from brain hemorrhages with greater results than adults.

The issues related to a hemorrhage in the brain depend on the particular area of the brain affected. Unless the leakage is correlated to sight in the portion of the brain, problems focusing could be present. Issues with equilibrium and coordination, shortcoming on one side, deadness, or unexpected seizure may happen. For several people, the voice centre is situated on the left hemisphere, and inflammation in this region may cause mainly disruptions invoice. A patient can become unconscious and go into a coma if the leakage is in the lower brain (brain stem), in which most of the automated body systems are controlled. A variety of different indications can cause a brain hemorrhage. Such signs can include sudden tingly feeling, fatigue, numbness, or face, arm, or leg paralysis. This is most likely to take place on only one part of the body. Other symptoms like severe headache, vision problem, difficulty in comprehension, etc. The tests which find the exact location of the bleeding of the brain are CT (Computed Tomography) and MRI (Magnetic Resonance Imaging). After the test, the treatment happens according to the level of severity. The highest level needs surgery where surgeons operate to relieve the pressure on the brain. For the middle and low levels, the treatment options are using drugs and medications. The detection is very important where this is the main idea of this project where we are using the deep learning algorithms in which we are detecting and classify hemorrhage using CT scans. Neural networks have proved to be very efficient in image classification. With the help of deep learning methods like transfer learning, we could detect the hemorrhage inside the brain where it helps doctors incorrectly detecting abnormality in the brain.

In this medical imaging field lots of research happening to solve these types of problems. In our research, many researchers did a lot of effort and gave their insightful knowledge. In this paper, describes the process of using deep learning and utilizing different transfer learning techniques like described the detection of hemorrhage using machine learning. Discussed in one of its book chapters about transfer learning and its methodologies. With these people's inspiration new methodologies, using new trained networks, and trying to improve the accuracy were started.

Materials and Methods

Materials

This informational collection contains 100 ordinary cerebrum and 100 hemorrhagic CT pictures. It comprises 200 examples. A picture illustration of informational collection classes; Normal CT picture,

hemorrhagic CT picture. There is no differentiation between the kinds of bleeding. The picture in the dataset speaks to an alternate individual. Hence, the pictures were gathered from 200 unique patients. The record expansion of the pictures is PNG format (Figure 1).

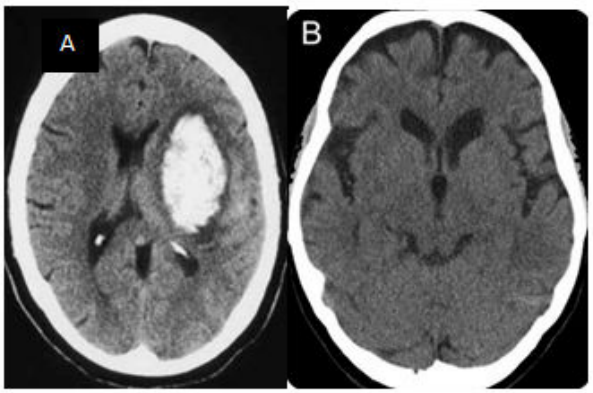

Figure 1: A) normal CT scan; B) hemorrhagic CT scan.

Methods

In this, we used two different types of techniques in deep learning one is CNN and Transfer learning.

Convolutional neural networks

In deep learning image processing CNN is one of the best algorithms which works more accurately while using images. There are two layers input and output in between there are many concealed layers. The concealed layers consist of a convolutional layer, pooling layer and fully connected layers the last layer is the output layer and there are activation functions where these functions are used to decide the neuron should be active or not by estimation of the weighted factor and add bias to it. The convolution layer and pooling layer is used for feature extraction and the last layer is used for the output like classification.

Convolution is a special linear classifier process used for extracting features, in which a limited set of numbers, named a kernel, is added throughout the input, called a tensor, which is a sequence of numbers. The convolution layer creates new pictures called feature maps. The feature maps emphasize the novel highlights of the first picture. The convolution layer works in a different manner contrasted with the other neural network layers. This layer doesn't utilize association loads and a weighted sum. All things being equal, it contains channels that convert pictures. We will call these channels convolution channels. The cycle of contributing the picture through the convolution channels yields the feature map.

The pooling layer reduces the size of the picture, as it consolidates neighbouring pixels of a specific region of the picture into solitary delegate esteem. Consider the 4 × 4 pixel size input image, which is expressed in the form of the matrix. Now we will combine with a 2 × 2 matrix without any confusion in element formation. There are types in pooling layer:

Max pooling: It is the popular pooling technique that selects the max value from each block and removes all the other values in the block.

Average pooling: It calculates the average value using all values in the block and get the output value. The final layer is a fully connected layer where it gets the flattened 1 D vector from the pooling layer and sends it to other connected layers known as dense layers. After the extraction of the features and flatten the pixel values, the subset of the fully connected layer gives the probabilities of each class as output in a classification task. The activation function used for the final layer was softmax which standardizes yield genuine qualities from the last completely associated layer to target class probabilities, where each worth reaches somewhere in the range of 0 and 1 and all qualities aggregate. In this way, CNN works, with this vision new methodology was created called Transfer Learning.

Transfer learning

Transfer learning is the process of learning in another errand through the exchange of information from a connected undertaking that has just been educated. Most of the machine learning calculations are intended to address single assignments, the advancement of calculations that encourage move learning is a subject of progressing revenue in the ML community. This is a way where we humans apply the gained knowledge from experience which we use on new tasks. In the same way, we train the neural networks with a huge amount of data. Pre-trained models are valuable to us for some reasons. By utilizing a pre-trained model, you are saving time. Another person has just invested the energy and register assets to become familiar with a ton of highlights and your model will probably profit from it. In this, we are using densenet as our pretrained network.

Evaluation process

In this, we divided the data into train and test where we allotted 80% of data to train and 20% data to test data. In this, we are using Python as our programming language and implemented using Tensorflow and keras framework. In this DenseNet 201 pretrained networks used which is trained with many datasets like ImageNet, CIFAR, etc. We used the sigmoid function as our activation function because it is a binary classification. In the same way the loss in the compiling process we used binary crossentropy. The optimizer places an important role in the training process we used the Adam optimizer as our default optimizer, we gave 100 epochs to train the model. The measured metrics are calculated are accuracy and loss.

Results and Discussion

We performed data augmentation which created new training data using existing data. The images are flipped, rotated, zoomed, etc. The resultant metrics of a model after augmentation. The training accuracy was 99.38% and the testing accuracy was 94.44%. This dataset was also trained on CNN with the same options. The training accuracy of CNN is 65% and the testing accuracy is 52.6%. The pretrained model gave more accuracy than CNN for our dataset (Figures 2 and 3).

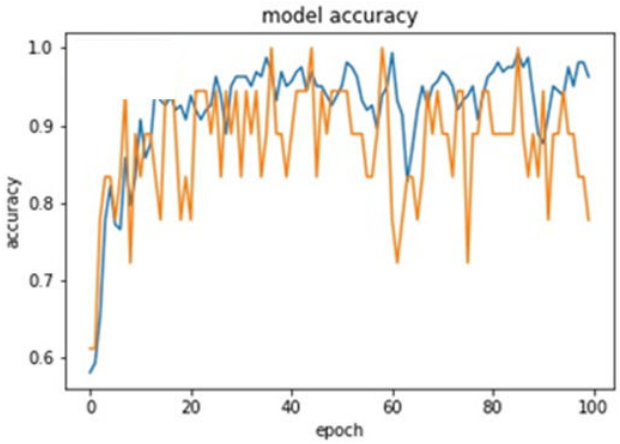

Figure 2: Model accuracy graph. Note: train, valk.

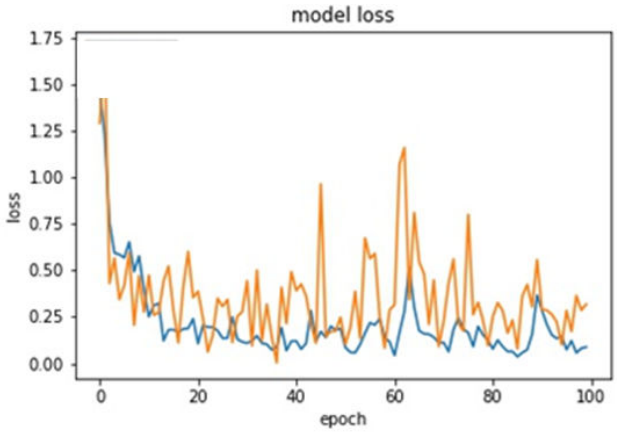

Figure 3: Model loss graph. Note: train, Walk.

Conclusion

This project gave acceptable accuracy on train data and good accuracy on test data which is appropriate. We used a deep learning methodology known as transfer learning which reduces the time of training and increases performance. This is implemented by using the DenseNet 201 pretrained model. With the comparison of CNN, the pretrained model gave a more accurate result and expected to refine and increases the training set. In concluding deep learning is the best way to experiment in the medical imaging area where we have to face many challenging situations, but deep learning methodologies and techniques help us to solve the problems in the medical field.

Future scope

This project detects the hemorrhage from brain CT scans which helps doctors to analyze and implement immediate care. This project could further implement in mobile or web applications. We can add a large amount of data for training and testing purposes. Implementation of different techniques in machine learning to increase accuracy and decrease the loss. Experiment same dataset with different methodologies which works faster and reduces the computation power.

Acknowledgement

We would like to thank Dr Raul Villamarin Rodriguez and Dr Samala Nagaraj for assisting us and we would like to thank the 115 hospitals, Vietnam for providing this imagery data.

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