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Detecting Brain Tumor using VGG16 and ResNet50 and comparing the two Models

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Abstract: With the recent boost in the technology in the 21st century, a tremendous amount of data is flushing into the market, AI and Big Data have proved to be prolific for any industry adopting these methods. The use of this data has helped enterprises analyze the trends, recommend various changes in the current approaches, and introduce new techniques for the prosperity of that industry. The ongoing research in the Healthcare sector has been a hub of attraction for various Data Scientists and doctors around the globe. With the available amount of data, it is believed that soon all the medical procedures will be performed by machines. The only way for it to be possible is to make the machine work like a human brain. With the introduction of deep learning, there have been various artificial neural networks such as ResNet50, VGG16, XceptionNet, InceptionNet, etc. The main aim of these deep learning architectures is to achieve the accuracy with which the human brain functions. The human brain is known to be the most complex organ because it performs various functions such as controlling thoughts, performing actions, etc. and making a machine perform all these functions with similar accuracy as the human brain has been a challenging task. This paper aims at predicting whether a person has a brain tumor or not from the dataset containing MRI images of the brain using ResNet50 and VGG16 and comparing their performance.

Index Terms— About four key words or phrases in alphabetical order, separated by commas.

INTRODUCTION

The brain is the most complex and crucial organ of the human body because it takes care of the functional unit of the human body. The human brain and the spinal cord together form the central nervous system of the human body. The brain consists of 3 major segments:- Cerebrum, Cerebellum, and Brain stem. The cerebrum is the most significant part of the brain. It contains two cerebral hemispheres on either side of the brain that each controls the opposite side of the body. It is divided into four lobes were following specific functions such as emotions, problem-solving, speech, senses, hearing, etc. occur. The second one is the cerebellum, which is located at the back end of the brain below the cerebrum, which is vital for coordination and balance. It also regulates the functions which are performed on the same side of the body. Last is the brain stem, which is the portion of the brain that connects the spinal cord and the cerebellum. It controls many involuntary functions that are fundamental for life, like maintaining heartbeat and breathing. Messages for the functions to perform by the body, which is regulated by the cerebrum and cerebellum, travel through the brain stem throughout the body.

Brain Tumor, also known as gliomas, is the most common type of brain tumor. Studies are still going on to find the exact origin of gliomas, but it is believed that it grows on the glial cells or glial precursor cells. Astrocytoma is one of the most popular forms of glioma. Astrocytoma cells look similar to glial cells called astrocytes that are found in the cerebrum or cerebellum. There are four grades of astrocytoma.

-Grade I known as pilocytic astrocytoma is a slow-growing tumor that is most often benign and rarely spreads into nearby tissue. Astrocytoma more common in children than adults.

- Grade II, known as low-grade diffuse astrocytoma, is also a slow-growing tumor, but it can often spread into nearby tissue and can convert to a higher degree.

- Grade III known as anaplastic astrocytoma is a cancerous tumor that can multiply and spread to adjacent tissues

- Grade IV, known as glioblastoma, is the most threatening mode of astrocytoma.

Oligodendroglioma is a tumor whose cells look similar to glial cells known as oligodendrocytes. These cells are liable for making myelin. Myelin envelopes the nerves and is rich in protein and fatty substances called lipids. They are subclassified as either the low-grade oligodendroglioma or anaplastic oligodendroglioma. Ependymoma commonly initiates in the passageways in the brain where CSF is made and stored. In adults, they occur more often in the spine and can also be of the myxopapillary subtype.

A brain stem glioma begins in the glial cells in the brain

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stem. Learn about brain stem glioma in children.
Deep Learning is the extended branch of machine learning, whose main aim is to replicate the functionality of the brain. There have been many successful developments recently in the field of deep learning, which has led to the increased possibility in the aim to achieve Computer-Aided Diagnosis.[1] Convolution Neural Networks commonly knows as CNN, brought a radical revolution in this field. They tend to work in a similar way as the human brain works. CNN is formed when all the neurons in a layer are connected to all the neurons in the next layer.[2] There are many different types of Convolution Neural Networks, such as VGG16, ResNet50, XceptionNet, InceptionNet, etc.[3] This paper will compare the performance of VGG16 and ResNet50 on the given dataset to predict whether the subject has a Brain tumor or not.

DATA

The dataset consists of 253 subjects out of which 155 subjects have brain tumor while the rest 98 subjects don't have brain tumor. Figure1(a) shows a subject having tumor while figure1(b) shows a subject without tumor.

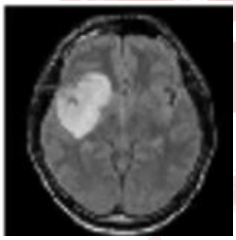

Figure 1(a)

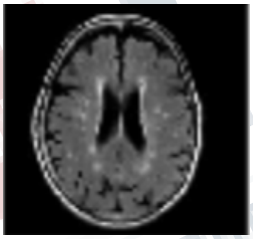

Figure 1(b)

The dataset is further divided into three major categories
-Train Set(It is the data used to train our model in the initial phase):- The training set consists of 119 images indicating a person is having cancer while 76 images show no tumor presence of a tumor.
-Validation Set (used for validating the model trained):- The validation set consists of 31 images indicating a person is having cancer while 19 images show no tumor presence of a tumor.
-Test Set(Used to check if the model is trained correctly): The testing set consists of 10 images, five images of each.

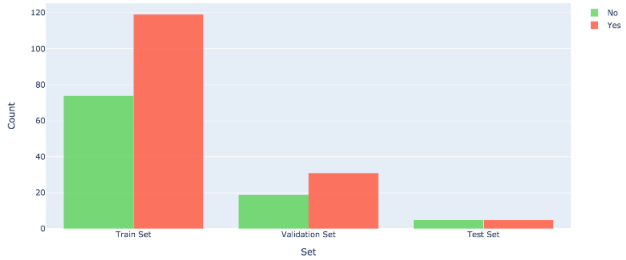

Figure 2: Distribution of dataset

RESNET50

ResNet 50 which was first introduced by He et al in 2015. It was found that it can be trained to very huge networks from 50-200 layers. In the imagenet challenge 2015 it was found that it has the least top-5 error rate even when it was trained to a very deeper network of 152 layers . As we can see from the figure below that with the emerging development in Neural Networks the no of layers started to increase while the error late decreased. The Resnet architecture takes the initial input of multiples of 32 and 3 as the channel width. In this paper the input was considered to be 224 x 224 x 3. The architecture ResNet50 has 50 Convolution Layers followed by an average pooling layer and a Fully connected layer. The initial architecture first performs a 7x7 convolution followed by 3x3 max pool and only then the image is passed into the deeper layers of the network.[4]

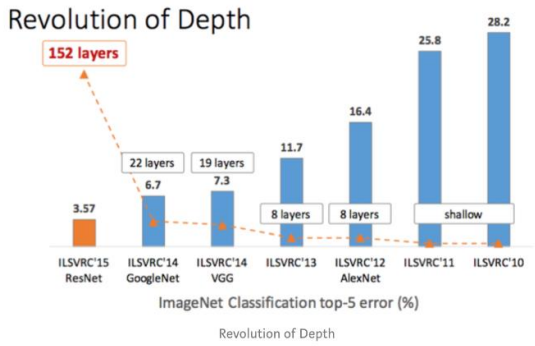

Figure 3: Comparison of error rate of various CNN nets

VGG-16

As the name suggests, it has 16 weigthed layers whoich turned out to be a drastic improvement fron the Alexnet in

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2010. The layers in the architecture include Convolution, Max Pooling, Activation Layers and Fully connected Layers. The first set of conv layers has 64 filters, the second conv having 128 while the third conv has 256 and conv four and five having 512 Filters each. Before the image is fed to the different conv, it goes through max pooling for the feature map produced from the preceding conv layers [5]

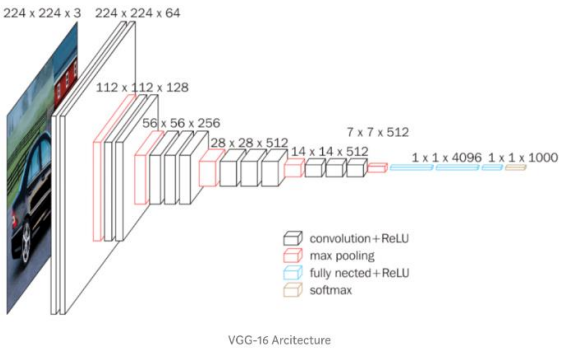
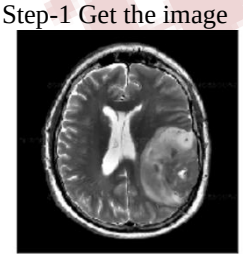


Figure 4: VGG16 Architecture

METHODOLOGY

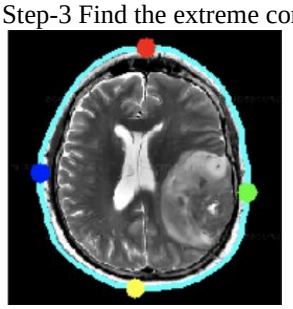
Data Preprocessing
Data preprocessing is a method to make the data in a more presentable form so that the data when sent into the model produces a better quality output. In this paper data pre-processing was applied in the following manner

Step-1 Get the image

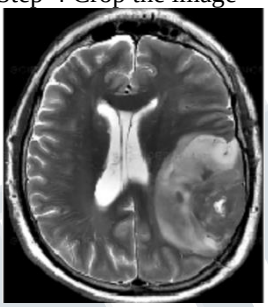


Step-2 Find the biggest Contour

Step-3 Find the extreme corners



Step-4 Crop the image



B. Models used
In order to test the accuracy of the above stated networks, we used keras pretrained models of VGG16, ResNet50. The difference that was found between RenNet50 and vgg16 was not only the number of layer but the number of parameters that were in the model.

The 2 models can be compared by

Model	Total Parameters	Trainable parameters	Non-trainable Parameters
VGG16	14,739,777	25,089	14,714,688
ResNet50	23,688,065	100,353	23,587,712

Table1: Comparison of VGG16 and ResNet50

As we see from the data there is a difference of 75,264 parameters and since the number of parameters is huge because of a deeper network, the ResNet model is expected to give a better accuracy. Both the models were trained upto 10 epochs.

RESULTS

After successful implementation of both the models it was found that ResNet50 gave a better accuracy because of more number of parameters due to deeper layers. The results can be obtained with a higher accuracy when the

networks are trained with more parameters and more epochs
Results obtained

Model	Accuracy (percentage)	Loss
VGG16	86.12	1.0593
ResNet50	95.69	0.4424

Table 2: Results comparison

CONCLUSION

Since Brain tumor is one of the most common cancer around the world, there is a need to determine it at an early stage. The comparison above states that the deeper the network, more the number of parameters, better the accuracy. It is believed that studies about many deeper networks are going on and we can aim at achieving better accuracies and more precised results and thereby increasing the usage of Computer-Aided-Diagnostics.

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