Brain Tumor Detection Using Convolutional Neural Networks and Data Augmentation

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***Abstract*—This project report discusses image classification using a Convolutional Neural Network. The data provided is a few images of Brain MRI. In order to get better results the given data is augmented 10 times and 20 times. After augmenting the given data, Convolutional Neural Network is applied to both the 10 times and 20 times augmented data to calculate their respective f1-score and compare them. This report provides an insight on how to perform data augmentation on a small dataset and apply Convolutional Neural Network to classify images.**

Keywords—Data Augmentation, Machine Learning, Convolutional Neural Network, f1-score, Image Classification

I. Introduction

Brain Tumor is one of the most terminal diseases. A brain tumor is basically a growth of abnormal cells. CNN (Convolutional Neural Network) can be used for image classification. Different images of Brain MRI are given as input and CNN can be used to classify those images into images of brain MRI with tumor and without tumor.

To obtain more accurate results, data augmentation is applied to the given data which helps us to increase the size of the dataset significantly and we can obtain better results with more accuracy

II. Data Augmentation

A. What is Data Augmentation?

Data Augmentation is a technique that enables us to increase the size of our dataset without collecting any new data. It significantly increases the diversity of the data for training and testing.

B. Why use Data Augmentation?

It is common knowledge that the more data an ML algorithm has access to, the more effective it can be. Even when the data is of lower quality, algorithms can actually perform better, as long as useful data can be extracted by the model from the original data set[1]. Image data augmentation can be used to create modified version of the images which can be used to expand the training dataset.

C. How does it work?

In image data augmentation new images are generated from already existing ones. This can be done through various methods like rotating the image, flipping the image, changing the colour scheme of the image etc. All these methods will generate a different image which can be used to train our model.

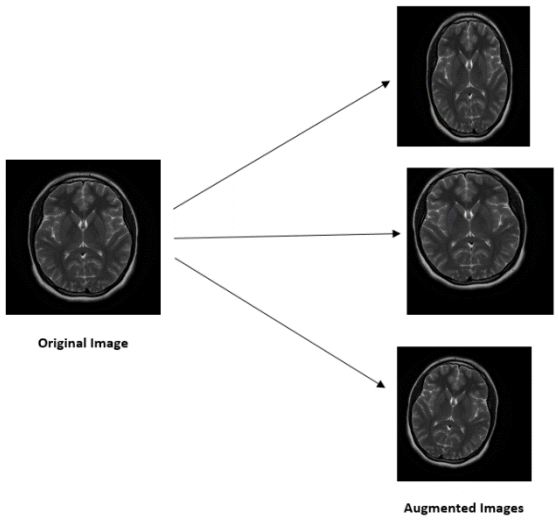

Fig. 1. Example of Image Data Augmentation

III. Convolutional Neural Network

A. What is Convolutional Neural Network?

A neural network is a network of interconnected neurons or nodes which is inspired by biological neurons. A neural network can be used to perform tasks without being explicitly programmed. A Convolutional Neural Network is a neural network which is especially used for image classification and object recognition. Convolutional neural networks can help identify patterns and classify images.

B. How does it work?

There are three main components of a CNN namely convolutional layers, pooling layers and fully connected layers.
The convolutional layer is the core part of any CNN. Convolutional layer consist of filters. These filters help the CNN to distinguish different features of an image. These features are learnt by the CNN and are known as feature map. These

features then convolve (i.e. combine). This operation results in a matrix called activation map. The pooling layer reduces the size of an input representation to make assumptions about the features and reduce the computational cost. Fully connected layers are the ones in which every node in first layer is connected to every node in second layer. Fully connected layers are responsible for producing different patterns based on the features extracted from the previous layers.

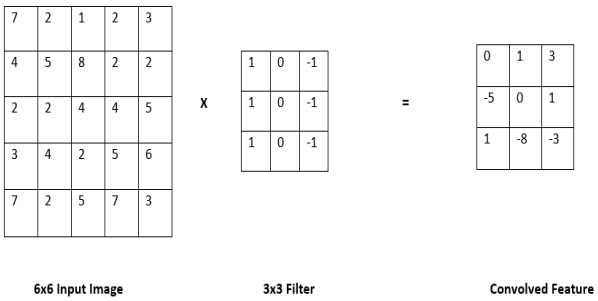

Fig. 2. Working of Convolutional Layer

IV. APPROACH

This section covers in details various steps involved to complete the objective. It discusses in details about the approach taken to complete this project.

A. Data Acquistion

The dataset used in this project was taken from Kaggle [2]. It consists of 253 Brain MRI Images which are divided into two categories 'no' and 'yes'. The images in the 'no' category are the ones which do not have Brain Tumor. The images in the 'yes' category are the ones which have Brain Tumor. Number of images in 'no' category is 98 and the number of images in 'yes' category is 155.

B. Reading and Displaying the data

OpenCV has been used to read images from the directories. Matplotlib has been used to display images from the directories.

C. Augmenting the data

Since the data given to us is very less, we have applied data augmentation technique to increase the size of our dataset. Keras library has been used to augment the data. The data has been augmented 10 times and 20 times respectively.

D. Convolutionl Neural Network

CNN has been used to train the augmented data to obtain predictions, confusion matrix and f1-score.The model used for the CNN is Sequential. Keras library has been used to create this model. The model consist of three convolutional layers (the first one is the input layer) with number of filters=32. There are 3 max pooling layers, 3 fully connected layers and one output layer.

E. Calculating Confusion Matrix and f1 score

A confusion matrix summarizes the performance of a classifier with respect to some test data. It is calculated using the predicted values and the actual values of a test dataset.

TP= True Positive (Actual Observation and predicted Observation both are positive)

TN= True Negative (Actual Observation and predicted Observation both are negative)

FP= False Positive (Actual Observation is negative but predicted Observation is positive)

FN= False Negative (Actual Observation is positive but predicted Observation is negative)

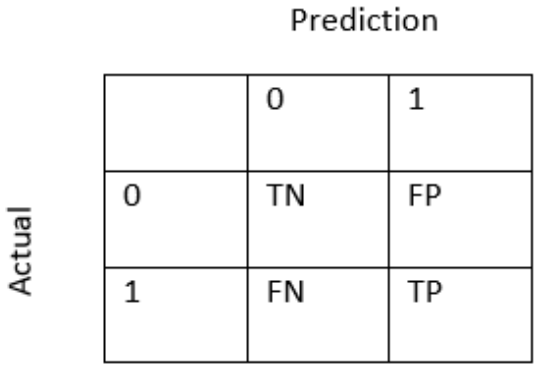

Fig. 3. Confusion Matrix

Recall is the ratio of total number of correctly predicted positive to the total number of positive values

$$\text{Recall} = \frac{\text{TP}}{\text{TP+FN}}$$

Precision is the ratio of total number of correctly predicted positive values to the total number of predicted positive values

$$\text{Precision} = \frac{TP}{TP+FP}$$

F1-score is the weighted measure of Recall and Precision.

$$\text{F1 Score} = \frac{2*Recall*Precision}{Precision+Recall}$$

10X Augmented Data:

F1-Score: 0.849

20x Augmented Data:

F1 Score: 0,893

V. Conclusion

This report covered data augmentation and image classification using CNN in detail. Various aspects of data Augmentation and CNN were discussed in this report. It covered in detail the working of convolutional layers and how convolutional layers are used for feature extraction. The f1-score for 20x augmented data was found to be more than the f1-score of 10x augmented data. This concludes that larger the dataset for training more accurate is the result.

VI. References

[1] Jason Wang and Luis Perez, "The Effectiveness of Data Augmentation in Image Classification using DeepLearning,": http://cs231n.stanford.edu/reports/2017/pdfs/300.pdf"

[2] https://www.kaggle.com/navoneel/brain-mri-images-for-brain-tumor-detection