Brain Tumor Detection Using Convolutional Neural Network

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***Abstract*—This Project report is about Image Classification with use of Convolutional Neural Network. The Data used for the project report is images of brain MRI scans. The dataset has lesser number of images and hence data is augmented. The augmented data is passed on to Convolutional Neural Network and the corresponding accuracy & f1 score is calculated and compared.**

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

I. INTRODUCTION

Brain Tumour is considered to be one of the deadliest diseases. It results from abnormal growth of cells in brain. Convolutional Neural Network can be applied so as to detect if a particular MRI scanned images has a tumour or not. Images are divided into two categories with tumour and without tumour. CNN is popular for Image classification, with the help of convolutional neural network the images with or without tumour can be detected and easily classified.

Further Data Augmentation is done so that the number of images on which we train our model increases which results in better and more accurate predictions.

II. CONVOLUTUIONAL NEURAL NETWORK

A. What is Convolutional Neural Network?

Convolutional Neural Network is a type of deep learning algorithm which is used mainly for image classification purpose. It takes the image as an input reads it pixel by pixel, understands the important features present in the image and tries to predict which category does the image belongs to based on the training done by the model.

B. How does it work?

Any image is basically a matrix of 0's and 1's.
Broadly CNN can be divided into two main components as per the functionality. First part is the hidden layers and then feature extraction which focuses on the input side functions and the second part is the full connection of the model to generate the output.

From the given input image firstly convolution layers are formed and then the features of image are extracted.
This step is of utmost importance so that the size of image can be reduced and important features are taken into account for further exploration and then max pooling is applied so that maximum information is obtained from the given set of pixels. Max pooling is a technique where size of convolution layer is reduced but still important features are kept for processing. The layers are then flattened and full connection is formed by adding hidden layers which help in improving the information quality.

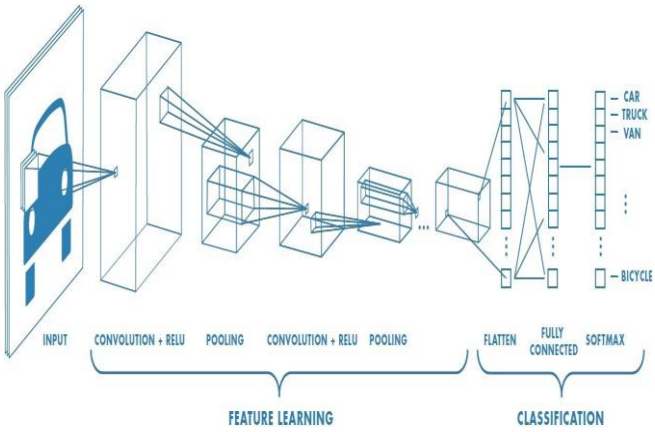

Fig 1: Working of CNN

III. DATA AUGMENTATION

A. What is Data Augmentation?

Data Augmentation is the process of Increasing the number of images in our data so that there would be more images to train our model which would result in diversified data set which results in return increases the accuracy.

B. Why Data Augmentation is necessary?

Data Augmentation is highly important step in increasing the quality of Convolutional Neural Network model when the images for training purpose are very less. Convolutional Neural Network works best when the number of images for training is in the range of around ten thousand.

In our case of the brain tumour dataset the number of images overall is 253 which is very less for training a Convolutional Neural Network hence augmentation of data becomes a necessary step which results in greater number of images for training and validation purpose.

C. How does Data Augmentation work?

Initially an image is taken from the available images. Transformations such as zooming, shearing, horizontal flipping etc are applied on them which results in greater number of images.

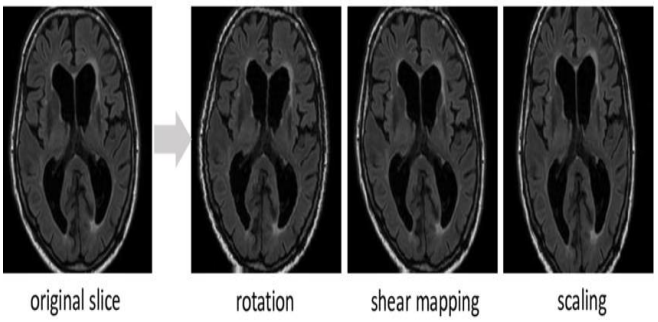

Fig 2: Data Augmentation

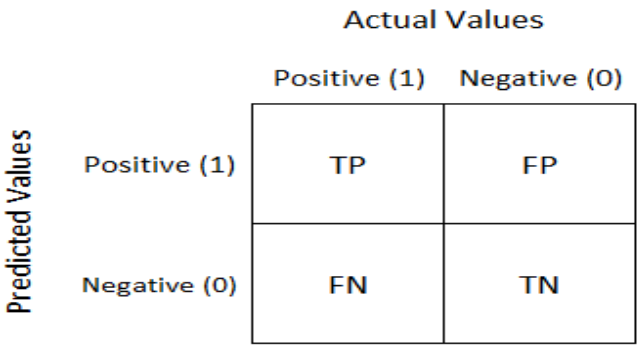

Fig 3: Confusion Matrix

IV. PROBLEM SOLVING APPROACH

This section is about how the solution for problem faced due to lesser number of images was approached so that the accuracy of the model would increase.

The steps involved in the process are:

A. Data Acquisition

The dataset used for the project is taken from Kaggle [1] It has 253 images partitioned into two classes 'yes' and 'no'. Which is "with and without tumor". The dataset was further divided into two folders for easy identification into training and testing data. 209 images for training and 43 images for testing which were later augmented.

B. Convolutional Neural Network

The classifier used in the project is the sequential classifier which helps in creating model layer by layer. Initial Convolution is added and then max pooling is applied to the layer to take maximum features into the account for further processing. The Matrices are further flattened and the hidden layers are connected to form fully connected layer

C. Data Augmentation

The Data Augmentation process in this project is done by using Image Data Generator class from Keras pre processing library. The parameters used for augmentation are shear, zoom, horizontal flipping and rescaling. vertical flipping is not done since that would result in lesser accuracy as image would be completely inverted.

D. Calculation of Accuracy and f1-score metrics

The parameters used for testing the completeness of model are accuracy and f1 score. Accuracy is the ratio of number of instances correctly predicted to that of total number of cases whereas f1 score depends on the precision and recall and can be calculated based on confusion matrix. Confusion matrix describes the performance of classifier. The F1 score is the weighted harmonic mean of precision and recall. F1 score provides more accurate and realistic view of the dataset by using both precision and recall

TP = True Positive (Actual Positive which have been predicted as positive)

TN = True Negative (Actual Negative which have been predicted as Negative)

FP = False Positive (Actual Negative which have been predicted as positive)

FN = False Negative (Actual Positive which have been predicted as negative)

Recall is the ratio of Correctly predicted positive values to that of total number of positive values present in data. Mathematically:

Recall = TP / (TP + FN)

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

F1 score is the weighted average of Precision and Recall Mathematically:

F1 Score =(2*Precision*Recall) / (Precision + Recall)

Accuracy without Augmentation of Data = 54.05%
F1 score: 0.7041

Accuracy of Model with Augmented Data = 81.82%

F1 score: 0.8319

V. CONCLUSION

This report has information regarding working and architecture of Convolutional Neural Network and importance of Augmentation of data. More the Augmentation of images in right direction better the accuracy and F1 score

VI. REFERENCES

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

[2] Jason Wang and Luis Perez, “The Effectiveness of Data Augmentation in Image Classification using Deep Learning”

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