Artificial Intelligence Based Radiology Image Classification

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ABSTRACT:

Artificial intelligence (AI) algorithms, particularly deep learning, have demonstrated remarkable progress in image-recognition tasks. Methods ranging from convolutional neural networks (CNN) to variation auto encoders have found myriad applications in the medical image analysis field, propelling it forward at a rapid pace.

The objective of this article is to present a view on the potential impact of Artificial Intelligence (AI) on processing medical images, in particular in relation to diagnostic. d. For accurate segmentation, a novel completely automatic and reliable segmentation based on CNN is proposed. The main aim of this paper is to distinguish between normal and abnormal pixels, based on texture based and statistical based features.

INTRODUCTION:

Artificial intelligence (AI) and machine learning (ML) have influenced medicine in myriad ways, and medical imaging is at the forefront of technological transformation. Recent advances in AI/ML fields have made an impact on imaging and image analysis across the board, from microscopy to radiology.

Radiology involves a complex interplay of physics, engineering, and medicine and provides a rich playground for AI. Re - searchers have employed AI algorithms to solve problems ranging from image reconstruction to image analysis and computeraided diagnosis.

An important role is played by Medical imaging in current medical research and clinical practice. Tumor detection mainly involves MRI, Computed tomography (CT) and ultrasound images [1]. Precise extraction of tumor is necessary and advantageous. When we have huge number of sequence of images, the manual observation of tumors is time-consuming, and frequently, the depiction quality depends on the operators. So, for clinical analysis, medical image
segmentation has gained much attention and different segmentation methods have been proposed. Imaging techniques allow medical practitioners and researchers, even before performing invasive surgery, to assess activities and disorders in the human brain.
The technique magnetic resonance imaging (MRI) is of good quality among other techniques as it gives better contrast details about the brain tissues from a variety of image sequences [2]. The neurosurgeons and medical scientists have great opportunity with the increase in brain MR image data. The diagnosis using computer aids and treatment can be administered through the analysis and processing of image data.

It is important for the tumor to be detected early. Tumors are detected through established medical procedures, such as magnetic resonance imaging, and biopsies are taken for tests. What interests us is the images taken by MRI, because we will be feeding our model on them. MRI is the first medical procedure to follow for tumor detection. MRI produces cross-sectional images of the brain, and each image is analyzed separately to determine the location of the tumor and the size of the tumor mass. The tumor is detected from the images by the difference in the contrast of the black and white degrees in the image. The tumor appears as a white block or pattern with a bright white color. But there are also parts of the brain that have the same behavior as tumor cells. Here, misdiagnosis may occur, and the role may come on the medical procedures that depend in their procedures on surgical methods and biopsies.

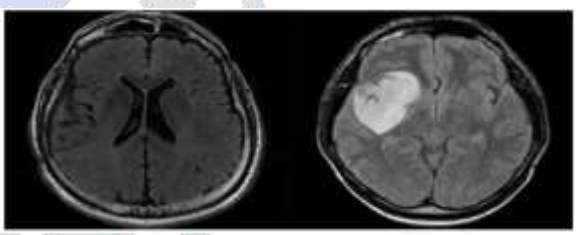


Fig. 1. MRI taken for two different brains. Healthy on the left, tumor on the right.

In this paper, we proposed an efficient and skillful method which helps in the segmentation and detection of the brain tumor without any human assistance based on Convolutional Neural Network.

LITERATURE SURVEY:

Devkota et al. [7] established the whole segmentation process based on Mathematical Morphological Operations and spatial FCM algorithm which improves the computation time, but the proposed solution has not been tested up to the evaluation stage and outcomes as- Detects cancer with 92% and classifier has an accuracy of 86.6%

Yantao et al. [8] resembled Histogram based segmentation technique. Regarding the brain tumor segmentation task as a three-class (tumor including necrosis and tumor, edema and normal. tissue) classification problem regarding two modalities

FLAIR and T1. The abnormal regions were detected by using a region-based active contour model on FLAIR modality. The edema and tumor tissues were distinguished in the abnormal regions based on the contrast enhancement T1 modality by the k-means method and accomplished a Dice coefficient and sensitivity of 73.6% and 90.3% respectively.

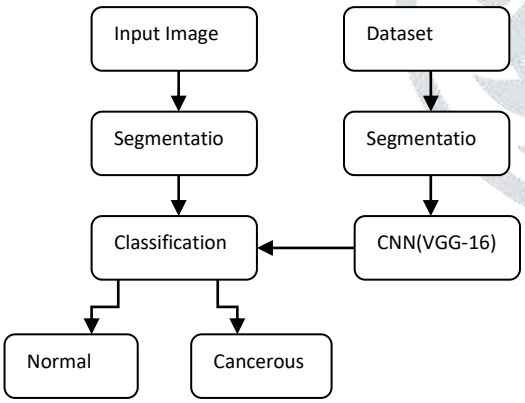
Based on edge detection approaches, Badran et al. [9] adopted the canny edge detection model accumulated with Adaptive thresholding to extract the ROI. The dataset contained 102 images. Images were first preprocessed, then for two sets of a neural network, for the first set canny edge detection was applied, and for the second set, adaptive thresholding was applied. The segmented image is then represented by a level number and characteristics features are extracted by the Harris method. Then two neural network is employed, first for the detection of healthy or tumor containing the brain and the second one is for detecting tumor type. Depicting the outcomes and comparing these two models, the canny edge detection method showed better results in terms of accuracy.

PROPOSED METHOD:

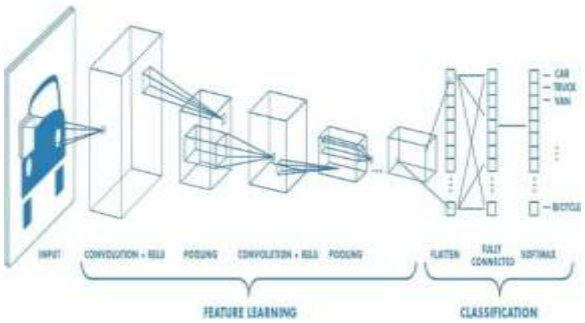
In this paper we have proposed a method for brain tumor detestation using convolution neural network. Here we have used VGG-16 model of CNN.

Input brain MRI image will be segmented using skimge toolbox then feed to CNN model for perdition of input image is normal or cancerous.

Block Diagram:



1) Convolutional Neural Network:



A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNets have the ability to learn these filters/characteristics.

Convolutional Neural Networks, like neural networks, are made up of neurons with learnable weights and biases. Each neuron receives several inputs, takes a weighted sum over them, pass it through an activation function and responds with an output.

The whole network has a loss function and all the tips and tricks that we developed for neural networks still apply on Convolutional Neural Networks.

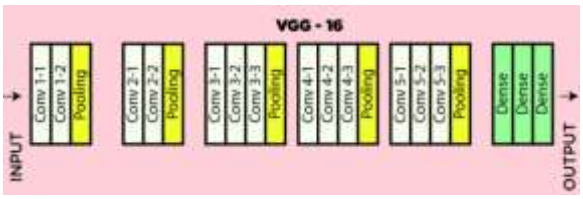
There are four layered concepts we should understand in Convolutional Neural Networks:

- Convolution,
- ReLu,
- Pooling and
- Full Connectedness (Fully Connected Layer).

VGG-16 | CNN model:

Architecture:

The input to the network is image of dimensions *(224, 224, 3)*. The first two layers have *64* channels of *3*3* filter size and same padding. Then after a max pool layer of stride *(2, 2)*, two layers which have convolution layers of 256 filter size and filter size *(3, 3)*. This followed by a max pooling layer of stride *(2, 2)* which is same as previous layer. Then there are *2* convolution layers of filter size *(3, 3)* and *256* filter. After that there are *2* sets of *3* convolution layer and a max pool layer. Each have *512* filters of *(3, 3)* size with same padding.This image is then passed to the stack of two convolution layers. In these convolution and max pooling layers, the filters we use is of the size *3*3* instead of *11*11* in AlexNet and *7*7* in ZF-Net. In some of the layers, it also uses *1*1* pixel which is used to manipulate the number of input channels. There is a padding of *1-pixel* (same padding) done after each convolution layer to prevent the spatial feature of the image.

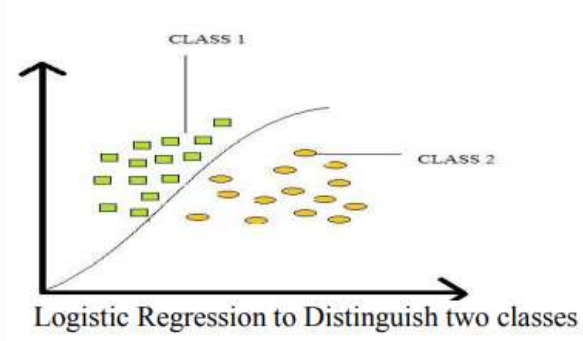


After the stack of convolution and max-pooling layer, we got a *(7, 7, 512)* feature map. We flatten this output to make it a *(1, 25088)* feature vector.After this there are *3 fully* connected

layer, the first layer takes input from the last feature vector and outputs a *(1, 4096)* vector, second layer also outputs a vector of size *(1, 4096)* but the third layer output a *1000* channels for *1000* classes of ILSVRC challenge, then after the output of 3rd fully connected layer is passed to softmax layer in order to normalize the classification vector. After the output of classification vector top-5 categories for evaluation. All the hidden layers use ReLU as its activation function. ReLU is more computationally efficient because it results in faster learning and it also decreases the likelihood of vanishing gradient problem.

2) Logistic Regression

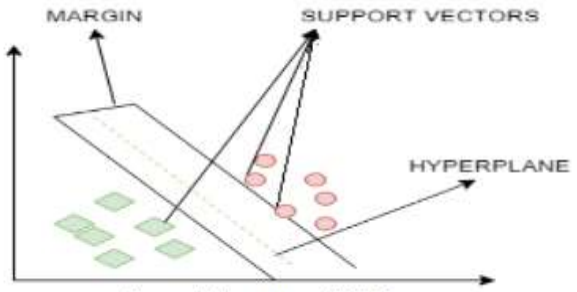
Logistic regression is a classification algorithm used to assign observations to a discrete set of classes. Unlike linear regression which outputs continuous number values, logistic regression transforms its output using the logistic sigmoid function to return a probability value which can then be mapped to two or more discrete classes.



Logistic Regression to Distinguish two classes

3) Support-vector machine

In machine learning, support-vector machines are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible.



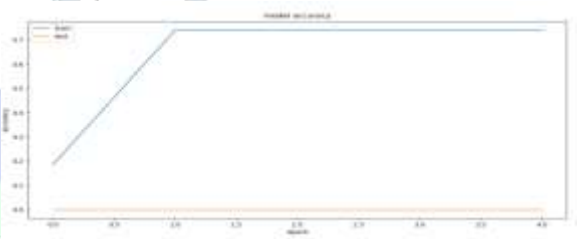
General Structure of SVM

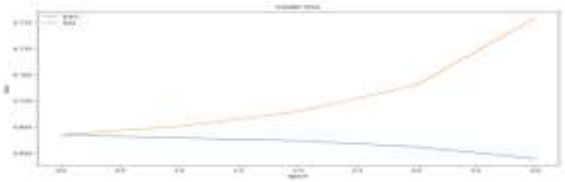
4) Random forest

Random forests or random decision forests are an ensemble learning method for classification, regression and other tasks that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.[1][2] Random decision forests correct for decision trees' habit of over fitting to their training set.

Based on the given data to the algorithm it forms various decision trees and checks for how many trees give the same prediction. It is based on the votes it will count and which trees give the same output after that the output given by the maximum trees it will show as output

RESULTS:


CNN Training Accuracy


CNN loss validation

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Cross validation:
[Logistic Regression]
Accuracy: 0.742 F1 Weighted: 0.632
[Decision Tree]
Accuracy: 0.742 F1 Weighted: 0.632
[Linear SVM]
Accuracy: 0.742 F1 Weighted: 0.632
[Random Forest]
Accuracy: 0.742 F1 Weighted: 0.632
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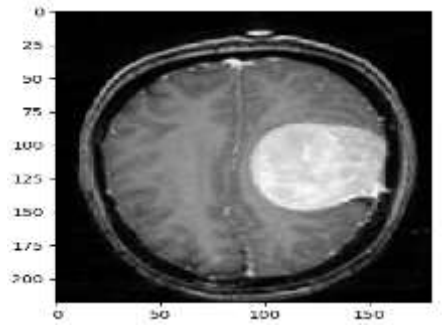
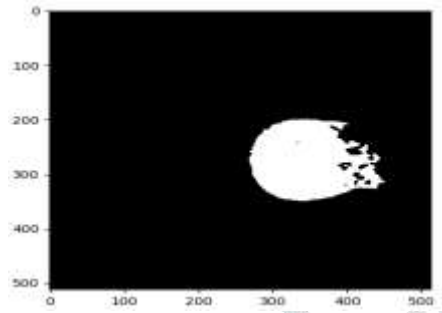
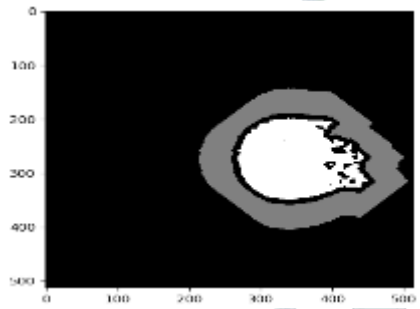
Different type of machine learning accuracy



Input Image



Segmented Image



Bounded detected Tumor region

CONCLUSION:

This study aimed to design automatic algorithm to detect the tumor from radiology image by Artificial neural networks. An algorithm has been successfully designed, implemented and tested with available radiology MRI images. This paper proposed a brain MRI image segmentation and classification using CNN VGG-16 model which gives a satisfactory result.

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