

# Deep Learning Approach in Brain Tumor Classification

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**Abstract:** *Various Computer-Aided Diagnosis (CAD) systems have been recently used in medical imaging to assist radiologist about their patients. Generally, various image technique such as Computer Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound image are used to evaluate the tumor in a brain, lung, liver, breast, prostate etc., Especially, in this work MRI images are used to diagnose tumor in the brain. For full assistance of radiologists and better analysis of Magnetic Resonance Imaging, classification of brain tumor is essential procedure. The automatic classification scheme is essential to prevent the death rate of human. Deep learning is the newest and the current trend of machine learning field that paid a lot of the researchers' attention in the recent few years. As a proven powerful machine learning tool, deep learning was widely used in several applications for solving various complex problems that require extremely high accuracy and sensitivity, particularly in the medical field. Tumor regions from an MR images are segmented using a deep learning technique. The automatic brain tumor classification is very challenging task in large spatial and structural variability of surrounding region of brain tumor. In this work, automatic brain tumor detection using Convolutional Neural Networks (CNN) classification. In general, brain tumor is one of the most common and aggressive malignant tumor diseases which is leading to very short expected life if it is diagnosed at higher grade. The deeper architecture design is performed by using small kernels. Other performance measures used in this study are the accuracy, sensitivity and specificity.*

**Keywords:** Brain tumor, Convolutional Neural Network, MRI, Deep learning.

## I. INTRODUCTION

Brain tumor can be defined as unnatural and uncontrolled Growth in brain cells. Numerous imaging techniques can be used to detect and classify brain tumors. Many different types of brain tumors exist. Some brain tumors are non-cancerous (Benign), and some brain tumors are cancerous (malignant). Brain tumors can begin in your brain (primary brain tumors), or cancer can begin in other parts of the body and spread to your brain (secondary or metastatic brain tumor).

How quickly a brain tumor grows can vary greatly. The growth rate as well as location of a brain tumor determines how it will affect the function of our nervous system. Brain tumor treatment options depend on the type of brain tumor we have, as well as its size and location. MRI is one of the most common non-invasive technique.

In this work, three types of brain tumors are classified. They are Glioma, Meningioma and Pituitary tumor. Gliomas are the most prevalent type of brain tumors that originate in the glial cells of the brain. Gliomas include 30% of all brain tumors and CNS, and 80% of all malignant brain tumors. Gliomas are classified into four grades according to the WHO starting from type 1 to 4. Grade I tumors are benign and have a much similar texture of the normal glial cells, Grade II is a slightly different in texture, Grade III tumors are malignant with abnormal tissue appearance while Grade IV is the most severe stage of Gliomas and tissue abnormalities that can be visualized by naked eye. Meningioma is a tumor that forms on the membrane that covers the brain and spinal cord inside the human skull and grows placidly. Most of the meningioma tumor are benign. However, pituitary tumor starts from the pituitary glands that control the hormones and regulate functions in the brain. It can be benign, that expands to bones, and malignant. Complications of

pituitary tumors may cause permanent hormone deficiency and vision loss. Machine Learning (ML) is an application of artificial intelligence (AI) that provides system the ability to automatically learn and improve from experience without being explicitly programmed. The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Machine Learning algorithms are often categorized as supervised or unsupervised. Supervised Machine Learning algorithm can apply what has been learned in the past to new data using labeled examples to predict future events. In contrast, Unsupervised Machine Learning are used when the information used to train is neither classified nor labeled. Semi supervised machine learning algorithms fall somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training – typically a small amount of labeled data and a large amount of unlabeled data.

Reinforcement Machine Learning Algorithm is a learning method that interact with its environment by producing action and discovers error or rewards. Machine Learning enables analysis of massive quantities of data. While it generally delivers faster, more accurate results in order to identify profitable opportunities or dangerous risks , it may also require additional time and resource to train it properly. Brain tumor classification has been performed using many machine learning techniques and imaging modalities over the years. In 2009, Zacharakiet al. proposed a system to classify different grades of glioma besides a binary classification for high and low grade using SVMs and KNN. Accuracy of 85% is obtained for multi- classification and 88% for binary classification. El-Dahshan et al. Introduced a method to classify 80 brain tumor normal and abnormal images using Discrete Wavelet Transform (DWT) to extract features, Principal Component Analysis (PCA) to reduce features, and then ANN and KNN to classify images with overall accuracy of 97% and 98% respectively. In 2015, Cheng et al. Proposed a method to enhance the brain tumor classification performance by augmenting the tumor region via image dilation and then by splitting into sub-regions. They used three approaches to extract features; intensity histogram, Gray Level Co-occurrence Matrix (GLCM) and Bag of Words (BOW) and finally achieved best accuracy of 91.28% by using ring form partition in addition to tumor region augmentation.

**II. PROPOSED METHOD**

The proposed Deep neural network-based brain tumor image classification is proposed can be used.

**2.1 Dataset**

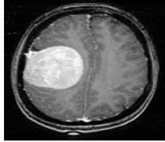
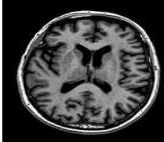
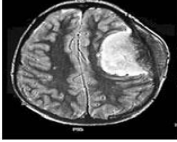
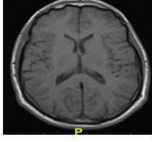
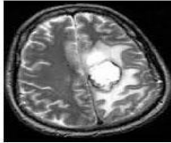
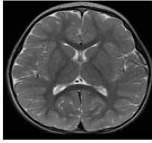
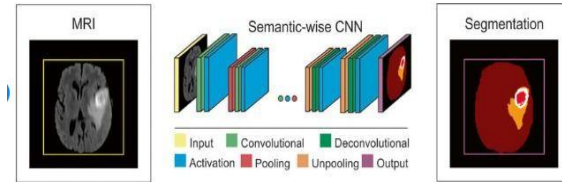
Brain Tumor Image	Brain Non Tumor Image
	
	
	

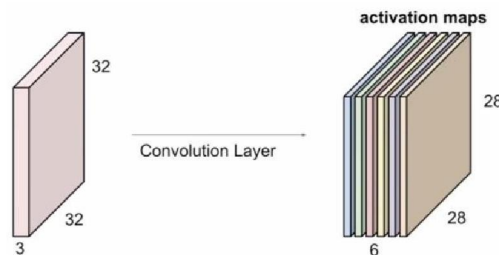
Figure 2: CNN based classified results

The application of DCNN for Computer Tomography (CT) brain image classification is explored. This proposed system we can detect and identify the thickness of brain tumor and we segregate classes of brain tumor stages.



### 2.2 Convolutional Layer

Computers read images as pixels and it is expressed as a matrix (N×N×3) — (height by width by depth). Images make use of three channels (RGB), so that is why we have a depth of 3. The Convolutional Layer makes use of a set of learnable filters. A filter is used to detect the presence of specific features or patterns present in the original image (input). It is usually expressed as a matrix (M×M×3), with a smaller dimension but the same depth as the input file. This filter is convolved (slide) across the width and height of the input file, and a dot product is computed to give an activation map. Different filters which detect different features are convolved on the input file and a set of activation maps is outputted which is passed to the next layer in the CNN.



$$(N + 2P - F) / S + 1;$$

where N = Dimension of image (input) file.

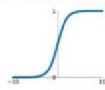
### 2.3 Activation Function

The activation function is a node that is put at the end of or in between Neural Networks. They help to decide if the neuron would fire or not.

#### Activation Functions

##### Sigmoid

$$\sigma(x) = \frac{1}{1+e^{-x}}$$



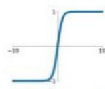
##### Leaky ReLU

$$\max(0.1x, x)$$



##### tanh

$$\tanh(x)$$



##### Maxout

$$\max(w_1^T x + b_1, w_2^T x + b_2)$$

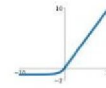
##### ReLU

$$\max(0, x)$$



##### ELU

$$\begin{cases} x & x \geq 0 \\ \alpha(e^x - 1) & x < 0 \end{cases}$$



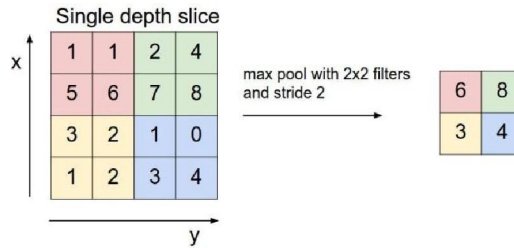
### 2.4 Pooling Layer

The Pooling layer can be seen between Convolution layers in a CNN architecture. This layer basically reduces the number of parameters and computation in the network, controlling over fitting by progressively reducing the spatial size of the network. There are two operations in this layer; Average pooling and Maximum pooling. Only Max-pooling will be discussed in this post.

**Max-pooling**, like the name states; will take out only the maximum from a pool. This is actually done with the use of filters sliding through the input; and at every stride, the maximum parameter is taken out and the rest is dropped. This actually down-samples the network. Unlike the convolution layer, the pooling layer does not alter the depth of the network, the depth dimension remains unchanged.

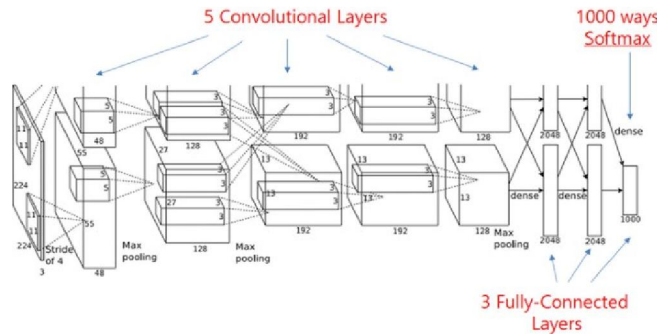
$$(N - F) / S + 1;$$

where N = Dimension of input to pooling



### 2.5 Fully-Connected Layer

In this layer, the neurons have a complete connection to all the activations from the previous layers. Their activations can hence be computed with a matrix multiplication followed by a bias offset. This is the last phase for a CNN network. The Convolutional Neural Network is actually made up of hidden layers and fully-connected layer(s).



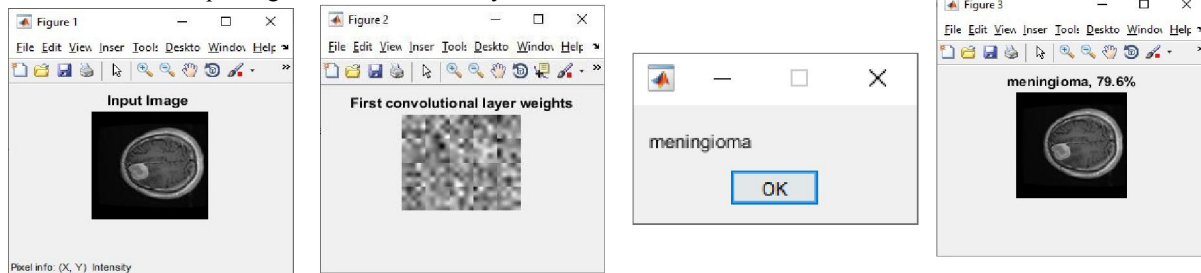
### 2.6 Tools and Time Consumption

MATLAB (matrix laboratory) is a fourth-generation high-level programming language and interactive environment for numerical computation, visualization and programming. MATLAB is developed by Math Works. It allows matrix manipulations; plotting of functions and data; implementation of algorithms; creation of user interfaces; interfacing with programs written in other languages, including C, C++, Java, and Fortran; analyze data; develop algorithms; and create models and applications. It has numerous built-in commands and math functions that help you in mathematical calculations, generating plots and performing numerical methods.

## III. RESULT AND DISCUSSION

Apply convolutional filter in first layer. The sensitivity of filter is reduced by smoothing the convolution filter. The signal transfers from one layer to another layer is controlled by activation layer. Fasten the training period by using rectified linear unit (RELU). The neurons in proceeding layer are connected to every neuron in subsequent layer. During training Loss layer is added at the end to give a feedback to neural network. Our dataset contains tumor and non-tumor MRI images and collected from different online resources. Radiology contains real cases of patients; tumor images were obtained from radiology and Brain Tumor Image Segmentation Benchmark (BRATS) testing dataset. In this work, efficient automatic brain tumor detection is performed by using CNN. Simulation is performed by using MATLAB C language. The training accuracy, validation accuracy and validation loss are calculated to find the

efficiency of proposed brain tumor classification scheme. In the existing technique, the Support Vector Machine (SVM) Based classification is performed for brain tumor detection. It needs feature extraction output. Based on feature value, the classification output is generated and accuracy is calculated.



#### IV. CONCLUSION

The main goal of this research work is to design efficient automatic brain tumor classification with high accuracy, performance and low complexity. In this conventional brain tumor classification is performed by using Fuzzy C Means (FCM) based segmentation, texture and shape feature extraction and SVM and DNN based classification are carried out. The complexity is low. But the computation time is high, meanwhile accuracy is low. Further to improve the accuracy and to reduce the computation time, a convolutional neural network-based classification is introduced in the proposed scheme. Also, the classification results are given as malignant, benign, pituitary or normal brain images. CNN is one of the deep learning methods, which contains sequence of feed forward layers and back propagation layer. This technique does not require preprocessing step. Our proposed method may be implemented as a simple and useful tool for doctors in segmenting of brain tumor in MR images.

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