Brain Tumor Segmentation and Area Calculation using Convolutional Neural Networks

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1 Background

According to World Health Organisation (WHO), cancer is a leading cause of death worldwide at the moment. Early cancer recognition can prevent fatalities, but this is not always possible. Unlike cancer, the tumour can be benign, pre-carcinoma, or malignant. Benign tumors vary from malignancies in that benign tumors usually do not spread to other organs and tissues and can be surgically removed. The brain, the most important component of the body which has the most complex structure as well. The existence of the skull around the brain hinders the examination of its functions and also raises the difficulty of the diagnosis of diseases. The brain is not vulnerable to any single illness, like the other parts of the body, but can be caused by irregular cell growth in which the behavior and structure of the brain change. This abnormality is normally demonstrated by the brain known as a tumor. Magnetic resonance imaging (MRI) is used to identify certain tumors with technological advances, the segmentation of brain tumors and tissues has become an active field of study.

In different applications, machine learning and deep learning have enjoyed promising phenomena and obtained exciting results in image classification. Neural networks have become a strong and useful framework with their ability to be research abundant, non-linear parametric mappings on large-scale data sets, which have been applied to difficult issues that were previously difficult to handle using conventional techniques. Machine learning is the field of computer science that enables computers to learn without being explicitly programmed building on top of computational statistics and data mining. The subcategory of machine learning, where computers train with the assistance of layered neural networks is deep learning. However, there is no strict line between machine and deep learning, generally, the cleanliness of data and the difficulty of the problem decide which one is more appropriate. A deep neural network is when the output of one neural network is inserted further into the input of another, chaining it together as layers. Beyond that, convolutional neural networks (CNN) are common for the recognition of images, video, and audio data due to their ability to work with dense data. Here, we are introducing a new CNN architecture for the brain tumor classification of various kinds of tumors.

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2 Literature Review

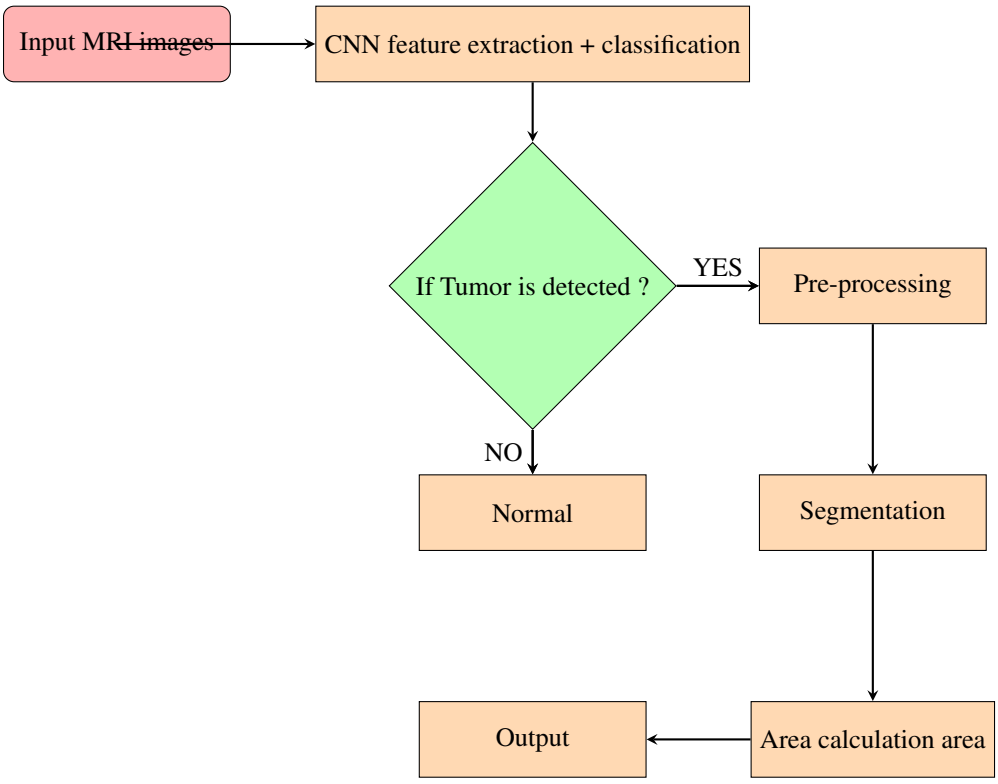
Recently, Machine Learning and Deep Learning methods have been widely used for the identification and grading of brain tumors using various imaging methods, especially those obtained using MRI. Bower, J.M and Beeman, D propose [1] a system that combines with CNN for brain tumor classification. The proposed model attained an overall classification accuracy of 95.82%. Hasan[2] proposed a system for MRI brain scan classification using deep and handcrafted image features. Here Automatic feature extraction was done by CNN and Support Vector Machine (SVM) classification with a 10 fold cross-validations have shown 99.30 % accuracy on 600 axial MRI scans. The Naive Bayes-based brain tumor detection method [3] uses maximum entropy segmentation based on the threshold. The proposed approach has the advantage of being able to locate a tumor in all possible areas in the brain, including the temporal lobe. Seetha. J and S.S. Raja [4] suggested a deep CNN method for automatic brain tumor identification and grading. The system is based on Fuzzy C-Means (FCM) for brain segmentation and The results showed that the method achieved a rate of 97.5 percent accuracy.

3 Objectives

Early detection of brain tumors can play an indispensable role in improving care choices, and a higher probability of survival can be achieved. And yet manual segmentation of tumors or abnormalities is a time-consuming, demanding, and onerous task as large number of MRI images are produced in the medical routine. Brain tumor segmentation from MRI plays the most crucial task in medical image processing. Therefore, it is a very expansive process to achieve precise segmentation of tumors from the human brain. The main objective behind this project is to provide a new CNN architecture for classifying brain tumors using brain MRI images.

4 Methodology

We propose an architecture of the brain tumor segmentation. There are two phases of operation that are called pre-processing and Segmentation. Furthermore the projected methodology for classifying the brain tumors in brain tomography is as follows.



First we consider, the MRI brain image is used as input for the convolution neural network system. System will classify the existence of tumors based on the input image. If the tumor is present, it goes to the segmentation portion. Thereafter the output segmented image will be obtained from the convolutional neural network. Finally the area is computed in order to get a clear understanding of how the area and tumor existence will be related. If the tumour is not present, it would directly show the normal brain as well.

As we know Convolution Neural Networks contains neurons with some weights and biases. These neurons are given some inputs from the anterior layer. It measures the point product between the input and the weights and optionally follows it with non-linearity as well. Convolution layer contains more than one convolution layer with ReLU activation feature and a pooling phase. At the end of the final layer, the layers will be linked to the fully connected layer as shown below in a typical neural network architecture. Below you can see Figure 1 of CNN neural network architecture.

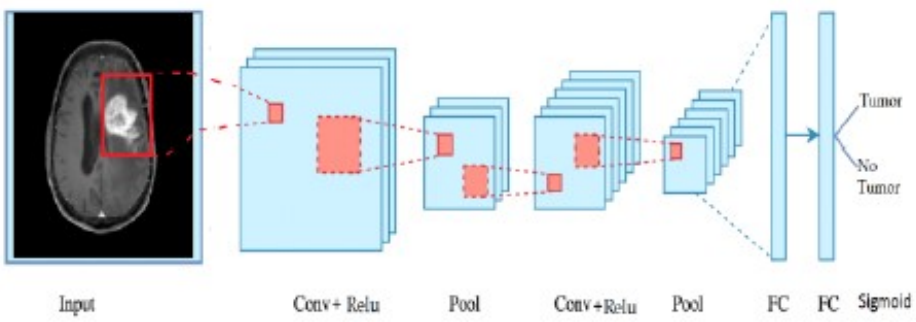
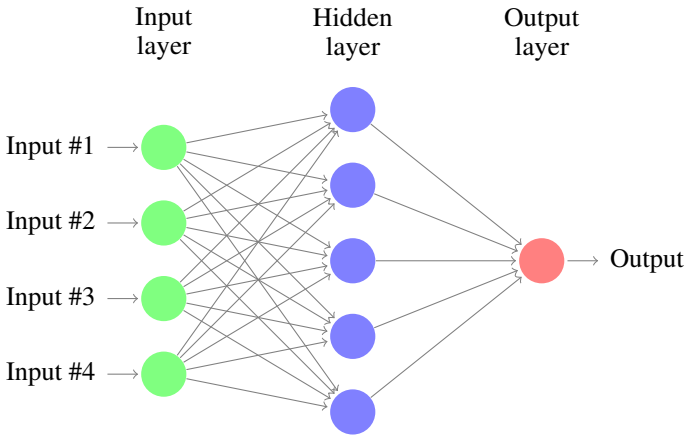


Figure 1: CNN architecture

The purpose of the convolution layer is to extract the features from the data of the input (images). Using a convolutional layer as a starter layer, the input shape of the MRI images is created, which is 64*64*3 and converts all images into a homogeneous dimension. After processing all the images in the same way, we built a convolutional kernel that is encapsulated with an input layer, administered with 32 convolutional layers of 3*3-size filters each supported by 3-channel tensors. Based on the Brain MRI image may also cost the contamination of the over-fitting and this Max Pooling layer is ideally suited to this perception. After the pooling layer, a pooled feature map is obtained. It would then be fed for processing to the Neural Network. After applying a convolution to the input volume, we need to apply ReLU [Nonlinear Activation Function] to the map feature to get the non-linearity of the method. The figure given below describes the neural network architecture with input layers, hidden layers and output layer (ReLu activation function).



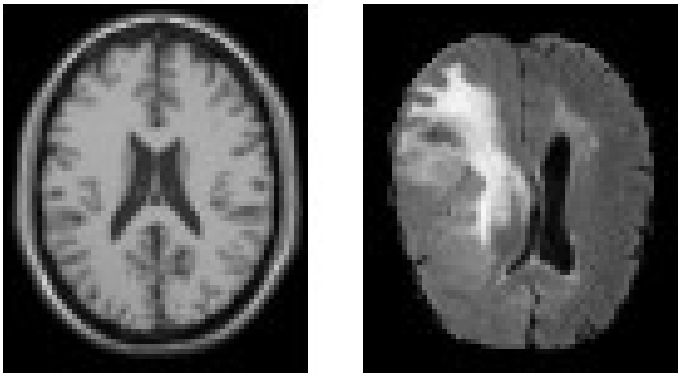


Figure 2: Brain with no tumor and with a tumor

Above Figure 2 images shows the normal and abnormal(tumorous) brain MRI. So in this project we will be segmenting the tumorous region of the abnormal brain MRI image and will calculate the area of the tumor using the segmented result, This will enable early detection and help us to identify critical information that will enable us to cure patients more effectively.

5 Project plan

The following are the milestones.The table shows the time span for each milestone.

5.1 Activity plan

Activity	How To Do It	Expected Outcome
Literature Review	By referring sources regarding CNN	Gaining enough knowledge relative to CNN
Annotated bibliography and Proposal submission	Referring sources and submitted proposal	Submitted proposal
Find a proper architecture	Data mining and go through architectures	Able to find a suit architecture to the data set.
Update with ongoing project	Sketching, Coding by using Python and MATLAB, Plotting	Conclusion of the project with source codes and graphs
Submitted project	Completed with all the methods, codes, graphs analysis, Conclusion	Completed project
Presentation	Get ready with all the presentation	Wonderful presentation

5.2 Time plan

Activity $\backslash Week$	1	2	3	4	5	6	7	8	9	10
Literature Review	X									
Annotated bibliography and Proposal submission	X	X								
Find a proper architecture			X	X						
Update with ongoing project					X	X	X	X		
Submitted project									X	
Presentation										X

References

[1] Bower, J.M. & Beeman, D. (2020) *Automated Categorization of Brain Tumor from MRI Using CNN* Springer-Verlag GmbH Germany, part of Springer Nature 2020.

[2] AM. Hasan, & HA. Jalab & F. Meziane. *Combining Deep and Handcrafted Image Features for MRI Brain Scan Classification* IEEE Access, pp. 79959–79967, 2019.

[3] HT. Zaw, & N. Maneerat, & KY. Win. *Brain tumor detection based on Naïve Bayes classification* International Conference on Engineering, Applied Sciences and Technology,pp.1-4,2019.

[4] Seetha, J., & S.S. Raja. *Brain Tumor Classification Using Convolutional Neural Networks* Biomedical Pharmacology Journal, Vol 11.