RSNA-MICCAI Brain Tumor Radiogenomic Classification

Problem Statements

What does this topics cover?

For keeping human body healthy cells in body grow and divide to forms new cells. Throw this procedure some cells may lose their control on growing properly. These abnormal cells will create form of mass which called tumors. Not all forms of tumors are going to get hostile and become dangerous. This abnormal growth will lead to multiply problem in body. With this problem in the brains most of human activities like: movements, speech, taste and... will get interrupted [1]. Use of Artificial Intelligence (AI) model will help to detect these tumors in early stages and make treatments easier.

Why is it important?

In the last decades due to the consumption of none organics foods and lazy life style, number of peoples involved in cancerous tumors increased rapidly. Based on published information on Both the National Brain Tumor Foundation (NBTF) and the American Brain Tumor Associations (ABTA) this growth makes brain tumor the primary reason for death in all age groups with tumor issues [2]. Unfortunately expected life of patients with brain tumor cancer is most case are less than 10 years. Brain and other nervous system cancer are the 10th leading cause of death for men and women. It is estimated that 18,600 adults (10,500 men and 8,100 women) will die from primary cancerous brain and CNS tumors this year [3]. People with nervous system cancer in total have an expected life of 10 years with 31% chance. The 5 years survival rate for these patients is 36% [3]. One key factor for survival rate for People with nervous system cancer is age. For example, 5 years survival rate for age groups of 15 to 39 years is 72%.

Applications

What are applications of this topics?

Early diagnosis of cancerous tumor will make treatment easier. Machine learning and deep learning model had used advantages of era of fast computational power and more data availability. With use of positron Emission Tomography (PET), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), functional Magnetic Resonance Imaging (fMRI) a wide range of data is available to the researchers all around the world. Use of this information in form of pictures or video have been center of attention in recent years. Use of conventional and sophisticated deep learning model has proven to be worthy for tumor detection. Early-stage detection of these tumors is another application of deep learning. Application of AI techniques for tumor detection can help patients and medicines to improve life style of the people with cancers very much and make treatment more easy and cheaper.

What is the societal significance of this research?

Effects of using machine learning are in social life of peoples with cancers are very high. Application of machine learning in detection and classification of different tumors like breast and

brain have been proved already throe different research. The main significant of this research is to prevent tumors to become maligned and treat them better.

Area of interest in this topic.

Brain tumors can be seen as a deadly disease. Expected life on the patients with this disease is varies between 5 to 10 years. One pf the main problem with this disease can be seen on lately detection of the disease. Our main interest in this work will be early detection of tumors growth in the brain. If these tumors can get detected in their Benign condition expected life time of patients will grow rapidly and treatments will become easier. Also, rapid tumors detection in the brain will make health care system to prevent excessive payment for medical treatments of patients.

Literature Review

In the last decade with rapid usage of the graphical processor unit (GPU) use of deep learning model had been increased very much. In a work by Abd-Ellah et.al [4]. They tried to work with Convolutional Neural Network (CNN) for brain tumor detection. They used MRI as their input data. Their work consisted of two phases. In the phase 1 they tried to classify pictures into normal and abnormal cases. Then in second phase they tried to locate the location of tumors. They used Supported Vector Machine (SVM) first phase classification and CNN for object detection. The result of their work indicated an accuracy of 99.55% for classification part. For detection part they reached DICE score of 0.87.

In another work they tried to work with SVM for detection of the tumors in the brain [5]. SVM is a machine learning algorithm that can be used for classification task but on the 2d vector features. Based on the nature of 3-dimension of the pictures, it cannot be used directly for classification. In this work they tried to first denoise the picture first and use a segmentation techniques like mean shift clustering. Then they deployed feature extraction techniques for gathering relevant information form segmented pictures. They indicated that with use of SVM on the extracted feature tumor detection task can be done effectively.

In another work they tried to detect the tumors in the brain with an autoencoder algorithms. The had used convolutional layer at the encoder and decoder part of this mode. They used autoencoder with wavelet transformation and created a wavelet autoencoder. The result of their work indicated an accuracy of 93% and specificity of 92%. They also had compared their works with other researchers which they shown that their work is superior that others with 3% margins for accuracy.

In other works, they had tried to use AI algorithms and create a conventional app for brain tumor detection [6]. They indicated that with use of machine learning algorithms reaching to a good denoising and detector accuracy is reachable. They also had compared the accuracy of tumors detection with AI and assessment of tumors detection by medicines. The result of this work has shown in Figure1.

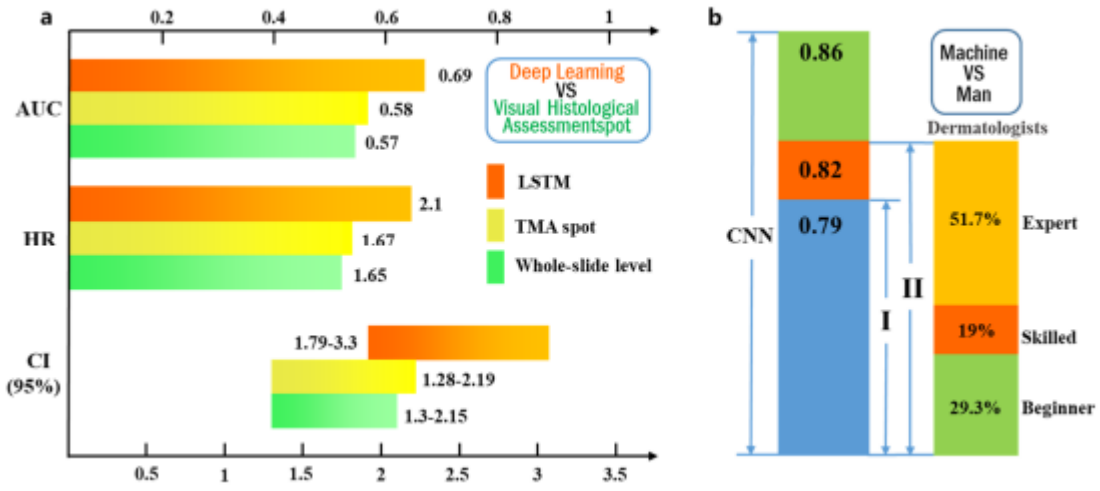

Figure 1. Detecting different tumors in the body with human skills verses AI [7].

The result of Figure1 clearly indicate that difference between machine learning algorithms and human expert is more than 12%. This graph reveals the superiority of AI model specially CNN algorithms for detection of tumor in the body.

Other approaches had tried to deal with this problem with segmentation process. This process will help researchers to segment the important part for detection of the tumors. In this process most of work tries to segment MRI and CT pictures. In a work by Sumana et al [8]. they tried to work with enhanced T1 weighted magnetic resonance (MR) images. They used SVM model for classification of tumors in benign and maligned condition.

In other work they had tried to work with fully connected CNN for classification of MRI picture into normal and abnormal class. The result of their work indicates an 88% accuracy with segmentation and result of classification.

Open-source research

There are a lot of data which are related to the tumor and cancer in brain in total. RNSA-intracranial-hemorrhage-detection is one of them [9]. This dataset contains information about 460 GB of DICOM format. BraTS 2020 is another data set which had been used for tumor classification [10]. BraTS 2020 utilizes multi-institutional pre-operative MRI scans and primarily focuses on the segmentation of intrinsically heterogeneous (in appearance, shape, and histology) brain tumors, namely gliomas. Furthermore, to pinpoint the clinical relevance of this segmentation task, BraTS'20 also focuses on the prediction of patient overall survival, and the distinction between pseudo progression and true tumor recurrence, via integrative analyses of radiomic features and machine learning algorithms. Finally, BraTS'20 intends to evaluate the algorithmic uncertainty in tumor segmentation. Br37H is another tumor detection data set which will be used for tumor detection and classification task too [11]. This data set contain 501 samples of MRI for

training stage, 202 pictures for validation and 101 for testing. All of these mentioned data had been used for classification and detections. Many of the researcher's work can be seen in the [9,10,11].

Duplication of the result.

There are many researchers whom dedicated their time for solving problem of tumor detection. One of these researchers had worked on MRI pictures with 2 class of brain tumor present ad none tumor present [12].

They had worked on efficient net version 3 for detection task. This model is one branch of CNN with efficient structure for detection. They had worked on BraTS'20 as their data set and they reached to 0.69 loos in tumor detection task. In other work by other researcher, they tried to use deeper CNN model with segmentation structure [13].

The result of their work indicated a 0.67 loss with 62% accuracy in total for detection of tumors in human brain.

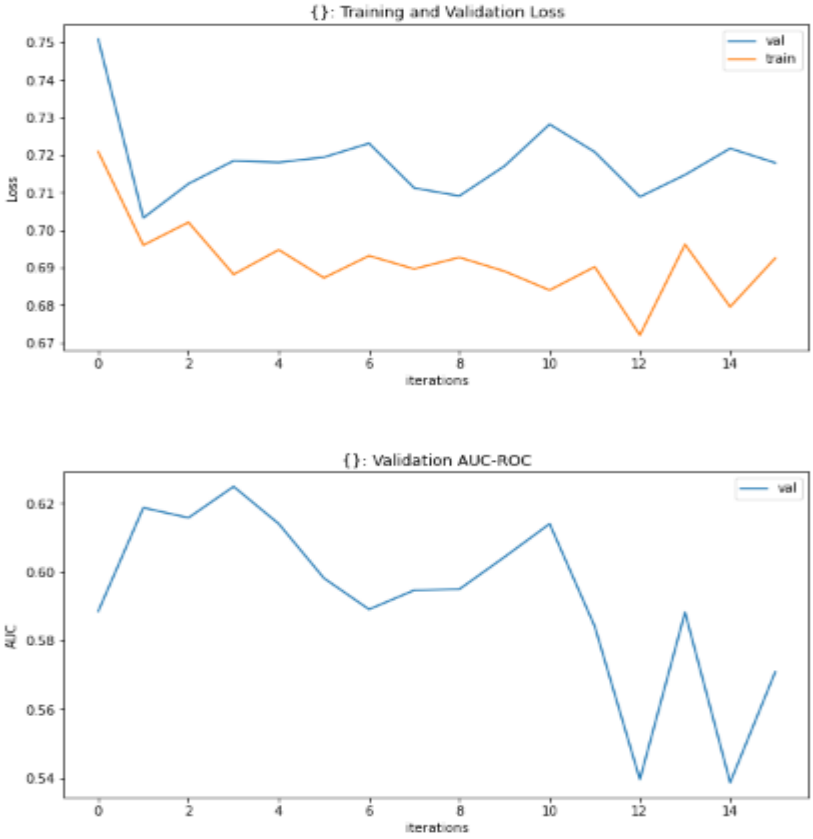

Figure 2. Result on using CNN on MRI brats tumor detection [13].

Comparison between [12] and [13] shows with CNN structure tumor detection task can be done with good result.

Reference

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