Various Augmentation Techniques for Semantic Segmentation of Brain Tumors on MRI

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Problem Statement

Over the last years deep learning has been playing a major role in the field of computer vision. One of its major applications in the healthcare industry is the reduction of human judgment in the diagnosis of diseases. Particularly, brain tumor diagnosis requires high accuracy, where slight errors in judgment may lead to disaster. For this reason, brain tumor segmentation is an important challenge for medical diagnosis. Currently several deep learning algorithms exist for tumor segmentation but they all lack high accuracy as these algorithms requires a lot of data.

Here, I studied various augmentation techniques that enables researchers to significantly increase the diversity of data available for training models, without actually collecting new data. Further, this techniques will be applied before modelling, to several promising neural network architectures and then the results will be compared.

Introduction

A brain tumor is an abnormal growth of tissue in the brain. They can lead to death if they are not detected early and accurately. Brain tumors can be cancerous (malignant) or noncancerous (benign).

There are 2 main types of brain tumors:

- Primary tumor.
- Secondary (metastatic) tumor.

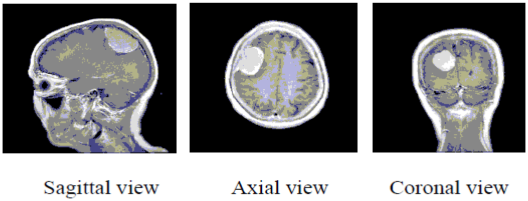


Figure 1: Brain MRI slices captured from different directions.

The most common types of Primary Brain Tumors are Meningioma, Glioma, and Pituitary tumors. One of the tests to diagnose brain tumor is Magnetic Resonance Imaging (MRI). MRI scan is used because it is less harmful and more accurate than CT brain scan.The MR images are taken from three different directions. These views are called sagittal, axial and coronal. These three types of brain MR images are shown in fig1.

Introduction (cont.,)

Different MRI sequences are employed for the diagnosis and delineation of tumor compartments. These sequence images include T1-weighted MRI (T1w), T1-weighted MRI with contrast enhancement (T1wc), T2-weighted MRI (T2w) and FLuid-Attenuated Inversion Recovery (FLAIR), etc.

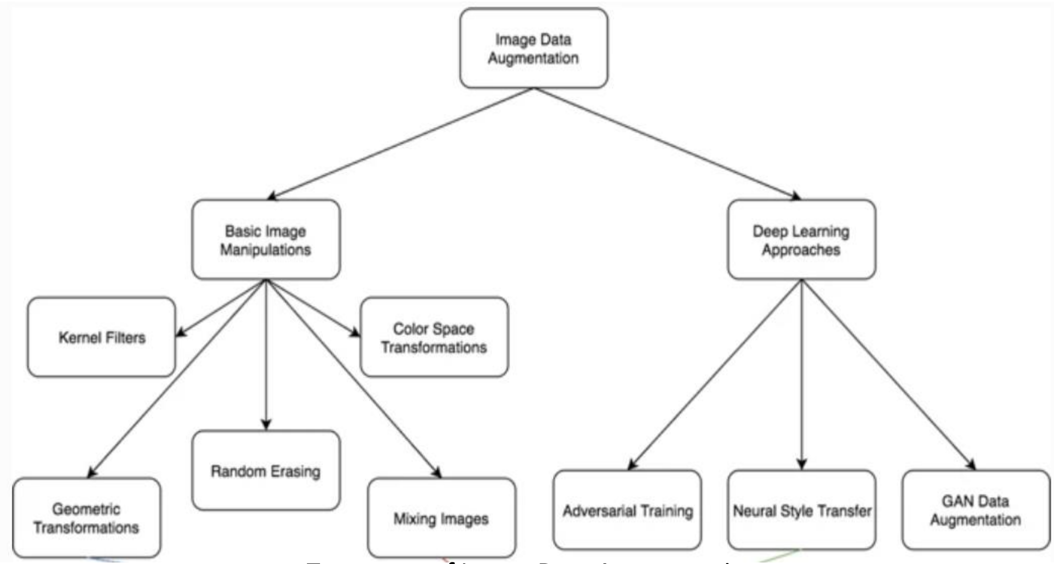
Due to the large amount of brain tumor images that are currently being generated in the clinics, it is not possible for clinicians to manually annotate and segment these images in a reasonable time. Hence, the automatic segmentation has become inevitable. Brain tumor segmentation is to segment abnormal tissues such as active cells, necrotic core, and edema from normal brain tissues. This segmentation can be achieved using deep learning algorithms.

Methodology

In this work, I present various augmentation techniques to increase the size of training sets, which results in improving the network performance. The various augmentation techniques are:

- Flipping
- Rotation
- Shift
- Shear
- Zoom
- Brightness
- Elastic Distortion
- GAN Data Augmentation
- Adversarial Training etc.,

Methodology (cont.,)



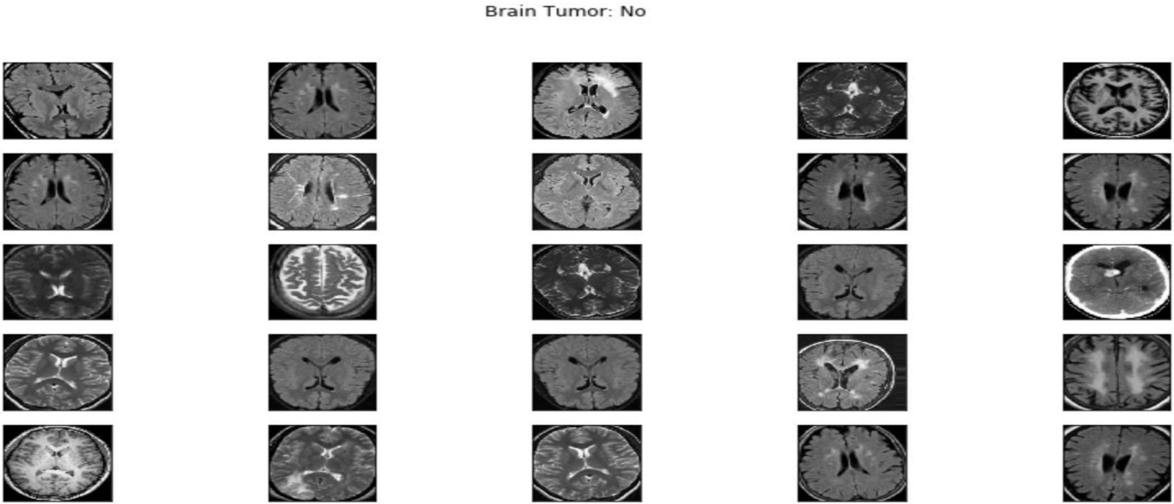
Taxonomy of Image Data Augmentations

Methodology (cont.,)

I tried some of the augmentation techniques on the brain MRI images dataset which can be found on Kaggle. The dataset contains 2 folders: yes and no which contains 253 Brain MRI Images. The folder yes contains 155 Brain MRI Images that are tumorous (malignant) and the folder no contains 98 Brain MRI Images that are non-tumorous (benign).

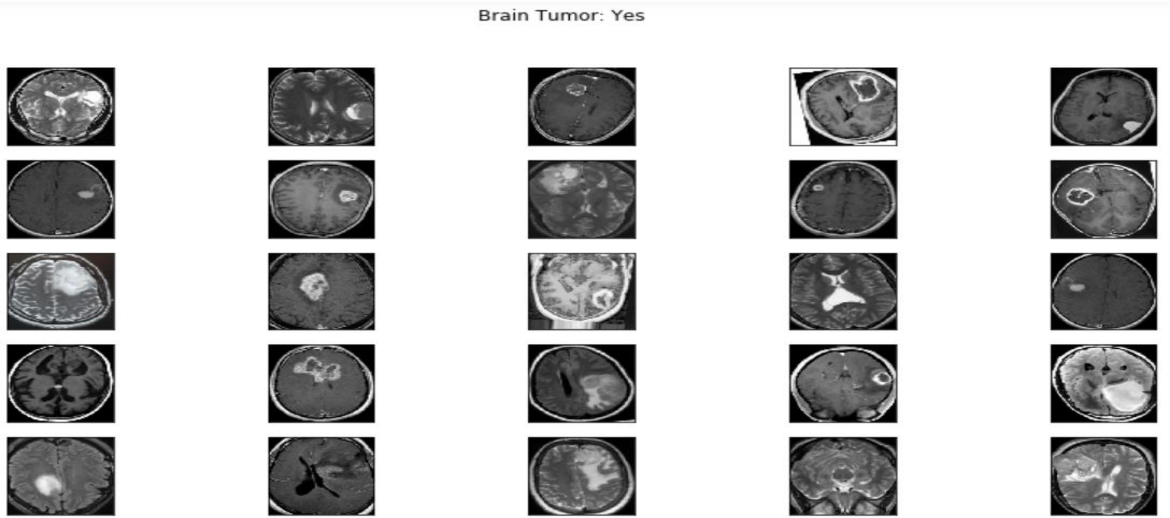
Since this is a very small dataset, there wasn’t enough examples to train a neural network. And, data augmentation was useful in solving the data imbalance issue. So after data augmentation, now the dataset consists of 1085 images that are malignant and 1078 images that are benign. Soon after augmentation, several preprocessing steps applied such as Cropping, Resize and Normalization etc.,

Results



Newly generated Benign Tumor MRI Images after Augmentation

Results (cont.,)



Newly generated Malignant Tumor MRI Images after Augmentation

Conclusion

In this research, I have showed various augmentation techniques which I have studied from different research papers and have applied some of the techniques to brain MRI Images dataset. Also I have given an overview of Brain Tumor and Medical Imaging Techniques (MRI).

In near future, I will apply some other augmentation methods to various MRI Images and compare the results for to choose the best techniques on brain tumor segmentation. This way we can achieve higher accuracy which can help in diagnosis of diseases.

References

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Thank you!