Using a Convolutional Neural Network to Classify Brain Tumors

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Abstract

With 85,000 diagnosed each year and 16,500 deaths annually, brain cancer is a prominent and dangerous disease. Discovering brain cancer as early as possible is essential for increasing the five year survival rate of thirty-six percent. Knowing that brain cancer is a deadly disease, our project focuses on training a model with Python to aid with the classification of brain tumors. Artificial Intelligence (AI) provides the capability to detect and identify brain cancer at its early stages. By using MRI scans with AI, a neural network model was trained to classify the tumor in the brain MRI scan. The classification provided by the model aids with the differentiation between benign and malignant tumors. By determining whether a tumor is benign or malignant, appropriate measures can be taken early on to counter this deadly disease.

Keywords: tumors, brain cancer, AI, CNN

1 Introduction

Brain tumors can be divided into multiple categories with several being cancerous. Oftentimes, benign brain tumors only fuel aggression, however, malignant tumors will also rapidly spread to different parts of the body. Since the brain is a restricted and vulnerable place, any damage can give rise to long-term difficulties. Tumors of brain cancer are difficult to identify and detect what stage the tumor may be in without having a professional neurosurgeon. Developing countries or those that lack the access to advanced medical professionals are hindered from detecting brain cancer in its early stages. MRI scans are the first step for identifying the brain tumor. The four main categories determined to be used for classification were healthy brains, brains with pituitary tumors, brains with meningiomas, and brains with gliomas. By training a convolutional neural network (CNN) through python and using a dataset with brain scans, each MRI scan could be classified accordingly. As a neural network is given images from a training set, it is able to identify key similarities between images of the same classification and differences between images of different classifications. At the end of the training process, the newly fitted neural network model can classify new data points.

Github link: https://github.com/adelly13/BrainTumorClassification

2 Methods

In order to train the convolutional neural network to classify brain tumors, the following libraries were mainly used: Matplotlib, Numpy, PIL, Tensorflow, Sci-kit Learn, Pandas, and Seaborn. Importing the brain tumor dataset was the first step. Since we needed to access the dataset from Kaggle, an API token was used. Next, we worked with our dataset to better visualize and determine the shape of the given images using Numpy and PIL. After determining the shape of each image, we split our dataset for training and testing, before noting the four different classes the tumors could be classified into: Glioma, Meningioma, No Tumor, and Pituitary. To check whether our training and testing datasets were relatively balanced, we used matplotlib to show the distributions of the training and testing datasets' images across the four classes in two pie charts. Finally, we moved from preprocessing our data to training our model. A sequential model neural network with ten layers was created using Tensorflow. The model was compiled and fit to the training dataset after being run with ten epochs. After fitting the model, we measured the accuracy of our model by testing it on our training set. To determine more specifically which classes our model was weaker at identifying, we created a confusion dataframe using Pandas and Sci-kit Learn. The confusion dataframe was then visualized as a confusion matrix with Seaborn.

3 Results

In our project, we successfully created a model which is able to classify brain tumors with a 73% accuracy. After viewing our confusion matrix, it was determined that our model was able to classify No Tumor images accurately 100% of the time. This was followed by Meningioma images which only had five images of the 115 images classified incorrectly. In other words, our model classified Meningioma images with 95% accuracy. Next, our model was able to classify Pituitary brain tumor images with a 72% accuracy. However, our model was inaccurate when it came to classifying Glioma tumor images; it was only able to classify 18 out of the 100 images accurately. Instead, it classified 61 of the images as no tumors, meaning that there were 61 false negatives. This is not a desired result; we would like to seek out another model that will be able to reduce the number of false negatives and improve the accuracy for identifying Glioma tumors.

4 Discussion

In the future, we would like to improve the accuracy of classifying Glioma tumors as our current model resulted in many false negatives for that class; we could try to use a different model or number of layers. Furthermore, we noticed the dataset had a slight imbalance with the images, specifically with the no tumors in the training set and with the pituitary tumor in the testing images. This may have affected the accuracy of our model, so we would like to work on training our model on a balanced dataset. Neural networks like these can be trained to classify other types of tumors as well, not just brain tumors. As a result, we would like to work on training a neural network that pertains to all tumors, including not only identifying whether a tumor is present in an image but also the type of tumor.

5 Conclusion

The ability to combine MRI scans with cancer classification brings in the vast possibilities in classifying brain cancer through training the CNN and experimenting with Tensorflow. Furthermore, the model allows for the early detection of brain cancer and provides those that do not have direct access to neurosurgeons an equal opportunity with this process.

References

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