CS 577 Project Proposal: Brain Tumor Detection

Gabe Johnson, Jake Norbie

September 29, 2023

1 Description of Problem

Image Detection is a widely vast and prolific subset of the field of machine learning applications. A subset of image problems, image detection focuses on detecting and notating something within an image, whether it be a person, a car, a word/phrase, or a "target". The key is that it does not attempt to classify each image, but detect the presence of a sought after target, whether it exists within the image, or exists within the image in a single or multiple instances.

In this project, we will tackle the problem of image detection of brain tumors within a Kaggle dataset [4]. To provide an application, we will first experiment and compare various cutting edge convolution neural network models (CNN). We will then use hyperparameter tuning to further discover what hyperparameters influence the results. Lastly, we will also attempt to create our own models using what we have learned, and see what comparative results can be yielded.

2 Summary of Previous Experimentation

Prior experimentation on our problem of Brain Tumor detection stems from the basis of image detection. Image detection is something that has grown in more recent years, with more emphasis on the start of Convolution Neural Networks (CNN). Convolution Neural Networks were conceptualized by Yann LeCun which developed the first ConvNet. This was initially created soley to be used for handwritten numbers identification. This data set would later go on to become the famous MNIST data set which is now used as a practicum for introducing Convolution Neural Networks. The NN architecture was straightforward and simple, with five layers of 5x5 convolutional layers and 2x2 max-pooling. It was named LeNet, after Yann LeCun himself. [1].

After years of LeNet being the most popular CNN, in 2012 a new Convolution neural network called AlexNet was born, which greatly out-preformed all prior deep networks and shallow networks that were currently being used for image detection. "Alexnet has revolutionized the field of machine learning. AlexNet is constituted of 5 convolutional layers and 3 fully connected layers. That's the reason it was better than Lenet, as it contains more filters per layer and stacked convolutional layers. Each such filter is further connected with the activation function." [3]. From here, CNN's have advanced in leaps and bounds as research has exponentially increased in machine learning. Developed in 2014, GoogleLeNet was another network which built upon the CNN topic. The key differentiating factor is that it added an inception model, while also removing the need for Fully Connected Neural Networks. An inception model to put simply, allows us to use multiple types of filter sizes, instead of being restricted to a single filter size, in a single image block, which we then concatenate and pass onto the next layer. During this process, Image Recognition and Classification is something that has been being done since the start of CNN's, starting with the LeNet-5.

"Residual connections are a popular element in convolutional neural network architectures. Using residual connections improves gradient flow through the network and enables training of deeper networks. For many applications, using a network that consists of a simple sequence of layers is sufficient." [2] A residual network (ResNet) is a type of network that has residual (or shortcut) connections that bypass the main network layers. Residual connections enable the parameter gradients to propagate more easily from the output layer to the earlier layers of the network, which makes it possible to train deeper networks. This increased network depth can result in higher accuracy's on more difficult tasks. These have started to be used with connections of CNN's to make them more effective for image processing and classification.

With these new innovations in networks capable of handling images, image processing and classification has grown in usage in the medical field lately, with an insurgence of using them to detect and determine what diseases are affecting a patient based on MRI imaging or other images. This also has been applied to normal classification with the usage of patient data to determine their disease they have. For instance, if they have a cough and sinus issues, the classification model might list the patient with a sinus infections. Our model will take MRI images of several different brains, and learn to classify what each different tumors are. This method has also been done in a similar case "how to apply the convolutional neural network (CNN) based algorithm on a chest X-ray dataset to classify pneumonia." [5]

3 Overview of Objectives

Our milestones exist on a sequential timeline as follows:

1. Create application capable of taking in a training and testing dataset, training a model, testing a model based on validation/testing data, and predicting data and outputting labelled data.
2. Inserting various models, perform experiments using a hyperparameter tuning algorithm to determine the best results for the model.
3. Compare metrics of model, graphing and analyzing the results.
4. Create and test researcher-created models, and analyze results.

References

[1] Brajesh Kumar. *Convolutional Neural Networks: A Brief History of their Evolution.* URL: `https://medium.com/appyhigh-technology-blog/convolutional-neural-networks-a-brief-history-of-their-evolution-ee3405568597`. (accessed: 28.09.2023).

[2] MathWorks. *Train Residual Network for Image Classification.* URL: `https://www.mathworks.com/help/deeplearning/ug/train-residual-network-for-image-classification.html`. (accessed: 28.09.2023).

[3] Ajay Ohri. *AlexNet: An Important Architecture In 3 Easy Points.* URL: `https://u-next.com/blogs/data-science/alexnet/#:~:text=Alexnet%20has%20revolutionized%20the%20field,connected%20with%20the%20activation%20function.`. (accessed: 28.09.2023).

[4] Thomas. *Kaggle: Brain tumors 256x256.* URL: `https://www.kaggle.com/datasets/thomasdubail/brain-tumors-256x256`. (accessed: 28.09.2023).

[5] Samir S. Yadav. "Deep convolutional neural network based medical image classification for disease diagnosis". In: *Journal of Big Data volume* 113 (2019).