DSGA 1013 Final Project Proposal

Alec Hon, Andrew Yeh

March 1, 2020

1 Introduction

Wavelets, or 'small waves', are a family of zero mean functions that are used mostly in signal processing, with all wavelets being characterized by starting with zero amplitude, followed by an increase in amplitude, and then a final decrease in amplitude back to zero over a small time scale. While Fournier Transforms are powerful in representing a function across the entire time domain by transforming a function into trigonometric polynomials, they struggle with studying functions over a local time space, as many extra coefficients needed to be added into the Fournier Transform of a function to effectively cancel out all the amplitude outside area of study. On the other hand, Wavelet Analysis expands a function into translations and dilations of a mother wavelet function, and thus allow the study of functions at a local time range, making it possible to recreate functions with fewer coefficients at a local space than a Fournier transform. Wavelets have been used in imager processing, with a large amount of study being focused on image compression and denoising.

In this project, we wish to study the use of wavelet decomposition as a pooling technique in Convolutional Neural Networks(CNNs) as a method of improving image classification in CNNs. Conventional CNN pooling techniques include max pooling and mean pooling, with both pooling techniques showing shortcomings, as details in images are either diluted or lost upon using both pooling algorithms. Other pooling methods include mixed pooling, where max pooling or mean pooling is randomly selected at every convolved field. Since wavelets are particularly useful in studying signals at a local level, we can consider the convolved field as a local region in an image in which we can use wavelets to decompose each field and return its approximation or detail coefficient as a pooling technique. It has been shown that wavelet decomposition as a pooling technique on convolved layers in a CNN in image recognition is effective in image classification, particularly with the Haar Wavelet and the Symlet Wavelet, as shown by Chaabane, Mellouli, Hamdani, et. al.. As a result, we want to study the usage of different mother wavelets for decomposition as a pooling technique in image classification first for greyscaled images, and then possibly for color images. Our methodology is described below:

2 Methodology

1.) Our first goal will be to closely recreate the results of Chaabane, Mellouli, Hamdani, et. al in constructing a CNN with wavelet decomposition as a pooling method, utilizing the MNIST dataset as a method to test effective accuracy of wavelet decomposition in image classification. By doing this, we will have shown that we are able to utilize wavelet decomposition effectively in a CNN. We will compare our accuracies of the wavelet decomposition pooling technique with the standard max, mean, and mixed pooling techniques to see whether or not the wavelet decomposition pooling creates CNN with higher accuracy.

2.) Afterwards, we will explore the usage of different wavelet families for the decomposition step in pooling, seeing which wavelet family allows the CNN to classify accurately. Afterwards, time permitting, we will attempt to perform the wavelet decomposition for color images, utilizing the CIFAR-10 dataset for classification. Once again, we will compare our results with standard CNN pooling techniques to see effective performance of our CNN and whether or not it is more accurate than CNNs using conventional pooling.

3 References