CAPSTONE THREE

PROJECT PROPOSAL

Recognition of Handwritten Math Symbols

(Image Processing)

1. INTRODUCTION

Many researchers have worked on the recognition of handwritten mathematical symbols and expressions [1] [2] [3] [4]. Character and digit recognition are very well-studied problems; the MNIST dataset is often used as a dataset to try out new machine learning models because it is so widely used [4]. Most academicians and researchers use pen and paper while solving a complex mathematical equation and later transform into digital manuscripts for publications. However, many tools are available to insert equations in softwares that creates documents like Microsoft Word, it is always better if a solution is available that directly converts the scanned handwritten mathematical equations to digital format for publications and presentations. Microsoft word has introduced a new feature of ink equation which lets a user write the equations digitally, however most academicians solve the long mathematical problems on pen and paper only. This project approaches towards the first step of identifying the mathematical expressions i.e. recognition of mathematical symbols from scanned images.

2. PROPOSED METHODOLOGY

This project will be mainly focussing on the recognition of hand written mathematical symbols using image processing and deep learning algorithms. The dataset for scanned images of mathematical symbols have been acquired from Kaggle [5]. The data set available [5] contains over 100,000 images of mathematical symbols of different classes. The next section discusses in detail about the features of the dataset and probable algorithms that can be used for solving the problem.

2.1. Handwritten Math Symbols Dataset

The dataset available on Kaggle [5] contains 375,974 images of handwritten math symbols classified into 82 labels like +, -, cos, Δ, $\rightarrow$ etc. Each image is a 45x45 pixel

grayscale image and hence not much pre-processing is required for this dataset. However, while going through some of the discussions on Kaggle, it has been found that various images are exact matches on pixel-to-pixel level. The same user has also given a python script to delete the repeated images so that the sample space can be unique and false accuracies can be avoided. Hence, the pre-processing step will require running the script on available dataset to make the sample space unique.

After deleting the repeated images, the total available images are 83,501 consisting of 82 classes. Many of these classes like Delta contains 35 images, exists contains 4 images, for all symbol contains 4 images etc. Therefore, due to less training examples such classes will be omitted from the classification algorithms.

2.2. Deep Learning Algorithms

The algorithms that will be used for classification of the math symbols will be Convolutional Neural Network (CNN), that is the most popular algorithm for image classification problems. Hyper parameters such as learning rate and optimizers will be tuned to achieve the best possible accuracy and dropout or batch normalization will be applied to prevent overfitting of the model.

2.3. Transfer Learning

There are various architectures like VGGnet, Resnet, CUImage, Senet which has already been published as “State of art” algorithms for image classification. This project will try to use one of the algorithm in our dataset to classify the images.

3. MODEL PERFORMANCE

The model will be evaluated based on the accuracy achieved on the hold out data i.e test data. For this type of classification problem accuracy is the best metrics for the evaluation of the model performance.

4. REFERENCES

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2. Matsakis Nicholas E. (1999). Recognition of Handwritten Mathematical Expressions. Submitted to the Department of Electrical Engineering and Computer Science on May 21, 1999, in partial fulfillment of the requirements for the degrees of Bachelor of Science in Electrical Engineering and Computer Science and Master of Engineering in Electrical Engineering and Computer Science.
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4. Lu Catherine and Mohan Karanveer, Recognition of Online Handwritten Mathematical Expressions Using Convolutional Neural Networks (http://cs231n.stanford.edu/reports/2015/pdfs/mohan_lu_cs231n-project-final.pdf)
5. Handwritten math symbols dataset (Kaggle) (https://www.kaggle.com/xainano/handwrittenmathsymbols?select=data.rar)