Recognition of Mathematical Symbols using a Combination of Convolutional neural net with Restricted Boltzmann Machines

Dhanush Dharmaretnam
Department of Computer Science, University of Victoria, Canada.
Email: dhanushd @uvic.ca

Abstract—Recognition of mathematical expression is a widely discussed area of research. The ability to recognize and evaluate mathematical expressions in both offline (Hand Written) and online (Digital media) will be an extremely useful tool in the field of science. For example, software suits like 'maple' relies on accurate identification of mathematical symbols to perform various computations online.

In this paper, we propose to build a combined neural network of CNN-RBM to classify the Mathematical Handwritten symbols as compared to earlier models. Recent research has shown a great improvement in classification accuracies on the classic MNIST dataset for handwritten numbers by combining convolutional layers with Restricted Boltzmann machines. We plan to understand how these combined network could be used to improve the accuracies of classification of handwritten mathematical symbols.

I. INTRODUCTION

The task of classifying mathematical symbols has been an area of immense interest over the last decade. In fact, some of the works in this area were published in the international conference on frontiers in handwriting recognition(ICFHR). The results of identifying and evaluating mathematical expressions at the Competition on Recognition of Online Handwritten Mathematical Expressions (CROHME) were generally poor with the top team achieving 60% Accuracy. Such low accuracies can be attributes to the fact that there are so many mathematical handwritten symbols and it's a daunting task to classify and label them all correctly. Significantly less research has been undertaken in this area and therefore we strongly believe that improving the accuracies of classifying mathematics symbols will strongly help us in creating a drastic improvement in identifying and evaluation of mathematical expressions. Recent researches on combinational neural nets has prompted us to try a CNN-RBM approach towards classifying mathematical symbols.

II. Related Works

There were many papers and research done over the last four years in the area of recognition of mathematical symbols and expression especially after CHROME. Xinyan et and al[1] used a combination of Genetic algorithm and neural network to classify the mathematical symbols and got accuracies close to 90.6%. Another work in this area was done by Lu et and al [2] who used a convolutional Neural network to classify the symbols. They got accuracies close to 83% and used HMM models to evaluate the classified expression. Sometimes the symbols need to be preprocessed and features needs to selected before a classifier can be trained. Nicholas et and al[3] showed that PHOG(Pyramid of Oriented Gradients) features used in conjunction with a linear SVM classified could achieve higher accuracies. They were able to attain accuracies close to 96% for online content while the accuracies for online handwritten symbols dropped to 92%.

There are many other methods suggested for extraction of features for this task and these are discussed in detail in the ICFHR papers. Notable features include loops, intersection, point density, Height-Width ration etc as discussed by watt and Xie[4] where they used a preprocessing step with elastic matching technique to extract the features.

III. Dataset Description

The CHROME dataset [5] is the standard dataset for the mathematical symbol recognition. The CHROME dataset which contains 85 symbols were parsed and added to kaggle Recently . We are proposing to use this dataset for our experiments as it can be used as a benchmarking to evaluate our models against other existing successful models. Dataset consists of (45x45) .jpg images. Dataset consists of (45x45) .jpg images. DISCLAIMER: dataset does not contain Hebrew alphabet at all. It includes basic Greek alphabet symbols like: alpha, beta, gamma, mu, sigma, phi and theta. English alphanumeric symbols are included. All math operators, set operators. Basic pre-defined math functions like: log, lim, cos, sin, tan. Math symbols like: int, sum, sqrt, delta etc.

IV. Proposed Work

The dataset needs to be analyzed to see if it needs any preprocessing. There are many methods proposed for the last few years which could be experimented with for feature extraction. We initially propose to train a simple Convolutional model and then build the combination network. Based on the availability of the time, we could even venture into Generative Adversarial networks which could be modified to act as a classifier.

REFERENCES

[1]. Cao Xinyan1,2, Yu Hongli,Wang Xin "Handwritten Mathematical Symbol Recognition Based on Niche Genetic Algorithm"

[2] Catherine Lu, K Mohan " Recognition of Online Handwritten Mathematical Expressions Using Convolutional Neural Networks"

[3] Nicolas D. Jimenez,Lan Nguyen "Recognition of Handwritten Mathematical Symbols with PHOG Features"

[4] Stephen M. Watt and Xiaofang Xie "RECOGNITION FOR LARGE SETS OF HANDWRITTEN MATHEMATICAL SYMBOLS"

[5] CHROME Original: http://tc11.cvc.uab.es/datasets/CROHME-2014_2/task_2_1