

## CS 334: Machine Learning

Emory University

Fall 2023

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# Project Proposal: Converting Handwritten Math to $\text{\LaTeX}$ , 2023 Edition

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## Introduction

Using machine learning to parse an image to text is an extremely common problem. For example, the MNIST dataset is a common introduction to neural networks. [2] The dataset was released to parse the numerical values written on checks. Google's use of reCAPTCHA also demonstrates how optical character recognition worth pursuing. [1] For mathematical academics, it would be extremely useful to convert handwriting for mathematical equations, as much of math is still done by hand to this day.

## Dataset

In our project, we aim to address the open problem of optical character recognition. More specifically, we want to address the open problem of converting handwritten mathematical expressions into  $\text{\LaTeX}$ . To do so, we use ICDAR's 2023 Competition on Recognition of Handwritten Mathematical Expressions (CHROME) dataset. This dataset is partitioned into three tasks: online recognition, offline recognition, and bimodal recognition. Online recognition attempts to determine the characters as they are being written. For this purpose, the partitioned dataset for this task includes inkml files, a file format that stores the vectorized data of each expression written by hand, from previous iterations of CHROME. In our case, we will likely use the data set aside for task two, offline recognition. This partition of the dataset includes rendered inkml files and scanned images. It is meant for models that give the  $\text{\LaTeX}$  expression for a written expression based on the entire expression rather than individual strokes. From the above explanation, it should be obvious bimodal deals with both. Also, it should be clear we are choosing offline recognition given the apparent complexity of online recognition.

While the general problem seems simple, it has several components. A given model has to identify the strokes of a given character, the positioning of the character, and the relationship between the characters to be able to find a suitable  $\text{\LaTeX}$  expression. Based on the work of Sakshi and Kukreja, there

are five main areas of challenges with current approaches: Preprocessing, Input/Output formats and representations, Recognition model challenges, Comparative analysis and performance evaluation, and Hardware challenges. Based on the content of the class, we can ignore challenges pertaining to hardware, and Input/ Output formats and representation. Between the final three areas, we are narrowing down the exact question we would like to answer. Currently, we believe answering questions relating to the Comparative analysis such as developing guidelines for metric standardization and "forgiveness" symbols based on similarity. Alternatively, we could deal with recognition model challenges by comparing different neural network structures or determining and comparing optimal hyperparameters between models. Finally, we could consider the effect of multiple preprocessing techniques such as illumination, curve and blur, low resolution, noise, and occlusion on model accuracy.

## Model

## References

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- [3] Sakshi and Vinay Kukreja. “A dive in white and grey shades of ML and non-ML literature: a multivocal analysis of mathematical expressions”. In: *Artificial Intelligence Review* 56.7 (July 2023), pp. 7047–7135. ISSN: 1573-7462. DOI: 10.1007/s10462-022-10330-1. URL: <https://doi.org/10.1007/s10462-022-10330-1>.
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- [5] Yejing Xie et al. *ICDAR 2023 CROHME: Competition on Recognition of Handwritten Mathematical Expressions*. 2023. URL: <https://crohme2023.ltu-ai.dev>.