

## CS 334: Machine Learning

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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 have optical character recognition 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. While the problem seems simple, it has several components. 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.

First, the data must be processed into the desired format. For our purposes, the data set aside for task two (offline recognition), which includes rendered inkml files, scanned images, and images from the Offline Recognition and Spotting of Handwritten Mathematical Expressions (OFFRaSHME dataset), will suffice because the problem of realtime recognition (online recognition) seems unsuitable for the content learned in the course. Second, the features must be extracted. This is especially pertinent in approaches that want to convert expressions within a larger text CITE FIRST TAB (A DL BASED SYSTEM FOR MATHEMATICAL EXPRESSION....). But, based on the dataset we have

chosen, we will not address this problem since it only contains the mathematical expressions in isolation. Third,

## Model

## References

- [1] Luis von Ahn et al. “reCAPTCHA: Human-Based Character Recognition via Web Security Measures”. In: *Science* 321.5895 (2008), pp. 1465–1468. DOI: 10.1126/science.1160379. eprint: <https://www.science.org/doi/pdf/10.1126/science.1160379>. URL: <https://www.science.org/doi/abs/10.1126/science.1160379>.
- [2] Yann LeCun, Corinna Cortes, and CJ Burges. “MNIST handwritten digit database”. In: *ATT Labs [Online]*. Available: <http://yann.lecun.com/exdb/mnist> 2 (2010).
- [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>.
- [4] Amit Schechter, Norah Borus, and William Bakst. *Converting Handwritten Mathematical Expressions into LATEX*. 2017. URL: <https://cs229.stanford.edu/proj2017/final-reports/5241761.pdf>.
- [5] Yejing Xie et al. *ICDAR 2023 CROHME: Competition on Recognition of Handwritten Mathematical Expressions*. 2023. URL: <https://crohme2023.ltu-ai.dev>.