MAIS 202: Project Deliverable 1

Description: The main idea is a program that is able to recognize online handwritten mathematical characters (possibly expressions) using computer vision and eventually convert the latter to digital (LaTeX).

1. **Dataset Choice** (https://www.kaggle.com/rtatman/handwritten-mathematical-expressions) (dataset compiled by Harold Mouchère of the University of Nantes)

   Big advances in the recognition of handwritten mathematical symbols and expressions were achieved thanks to the CROHME competition. The Kaggle dataset I chose is a compilation of datasets used in that competition over several years, themselves created by academic institutions in the likes of the University of Waterloo. I hence chose it due to its reliability and thoroughness.

2. **Methodology**

   i. **Data Preprocessing**
   The Data is made up of thousands InkML files (digital writing) representing a total of 75 different symbols or mathematical functions (log, sin, etc.). This format includes the strokes done with the pen in order to get the desired symbol: the number of strokes can thus be used as an additional feature.
   To extract the information from the data, we will convert the InkML files into normalized images represented as pixel arrays[1].

   ii. **Machine Learning Model**
   The project will be limited to the classification of characters one at a time. If feasible, I'll try to implement expression recognition by separating the symbols. Either way, the model will be a convolutional neural network.
   A quick internet search was enough to see that CNN's are the most popular option for image classification problems. CNN's outperform conventional neural networks as they're capable of feature learning.

   iii. **Final Conceptualization**
   Being more interested in research, I decided to prepare a poster presentation to display my project. However, I can't seem to find any average baseline results to beat yet, seeing as all the results I'm finding are from CROHME contestants (very experienced, thus having a very high accuracy).
   In the eventuality that I can't find any baseline, I'll integrate the model in a simple web-app where the user can draw a mathematical symbol with his/her cursor and see it match.

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1. Recognition of Online Handwritten Mathematical Expressions Using Convolutional neural Networks. *Lu, Catherine & Mohan, Karanveer.* http://cs231n.stanford.edu/reports/2015/pdfs/mohan_lu_cs231n-project-final.pdf