

# **Handwriting Calculator Website**

Brighton Mica, Nathan Swedlund

# Introduction

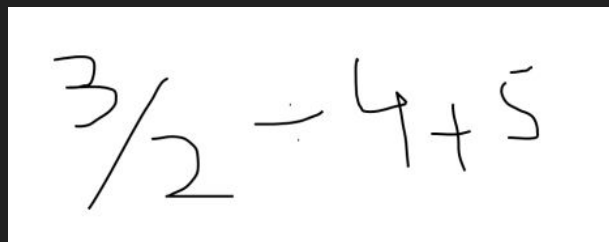
# Problem Statement

## Research Question

What methods and techniques can we use to identify and accurately classify handwritten numerals and mathematical notation while retaining the relationships between them so that we can reduce such input to a numerical calculation?

## What We Are Trying To Do

We are trying to make a classifier for handwritten digits and mathematical notation so that we can reduce handwritten math problems to their numerical answer.

A white rectangular box containing a handwritten mathematical expression in black ink. The expression is  $3/2 - 4 + 5$ . The '3' is written above the '2', and the minus sign is clearly visible between the fraction and the number 4.



$$3/2 - 4 + 5 = 2.5$$

# Techniques/Tools

## Classification

- GuassainNB
- Decision Tree
- K-neighbors
- Neural Network

## Segmentation

- Contour Identification
- Digit Extraction

## Data Manipulation

- Obtaining uniform datasets

# State of Project - Demo

# State of Project - Issues

# Unexpected Issues/Problems

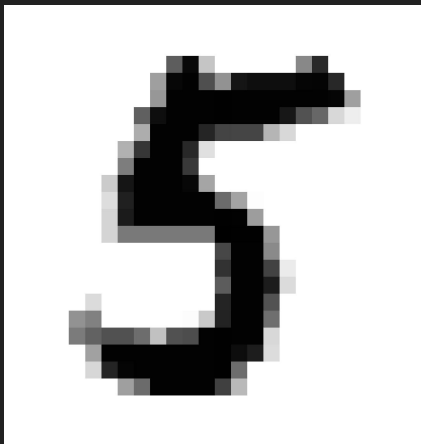
## Differences in Datasets

MNIST - approximately 3px padding around images (fairly uniform)

Math - approximately 0px of padding (not uniform)

(There is also an clear difference in stroke size)

This is a “)” not a “1”



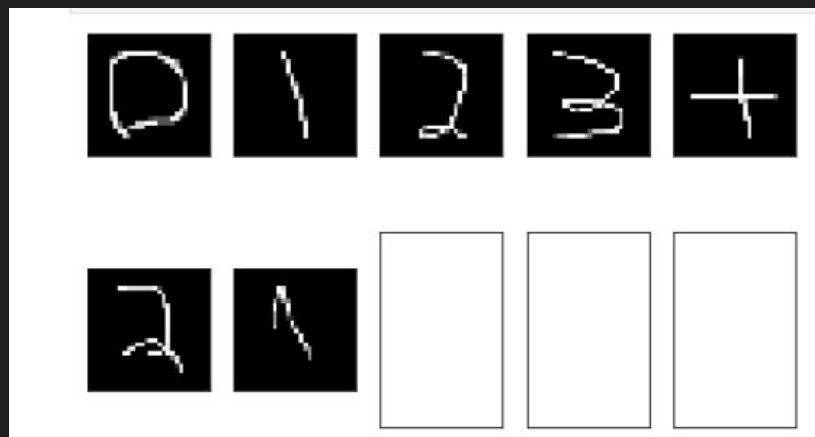
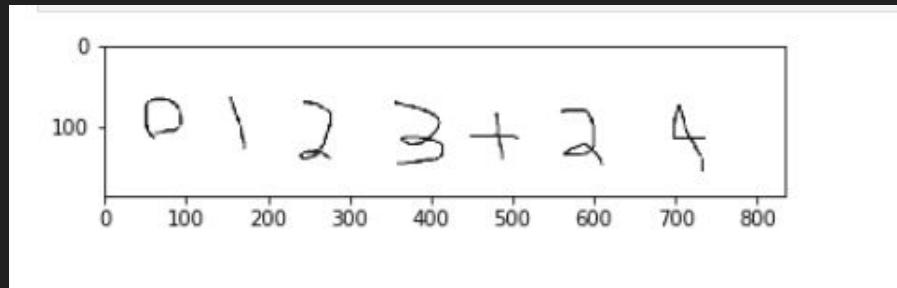
# Unexpected Issues/Problems Cont.

## Loss of Data

Resizing the extracted images to 28x28 comes with heavy data loss.

The bounding box for image extraction rarely has a 1:1 aspect ratio.

It's hard to make an algorithm for extracting characters from an image given the varying character sizes.





# Unexpected Issues/Problems - Going Forward

To avoid data loss we will need to dilate the images in the math dataset before resizing. We will also add a padding to each of the images, so they are more uniform with the MNIST dataset.

Depending on how long these processes take, we may just alter a small subset of the math symbol and train on that. We will do the same to our input images before we classify them. Hopefully doing all this will boost our classifier accuracy to something more acceptable.

There are other factors which could be adjusted that we have coded the functionality for, such as erosion, opening, closing, thresholding, and centering.

State of Project - Progress so Far

# Classification - Results

## Classifier Results on Training Data:

- GuassianNB - 77.6%
- Decision Tree - 92.3%
- K-neighbors - 78.4%
- Neural Network - 94.5%

After testing on the classifiers, we have determined that the neural network is the most accurate. This may change once we make alterations to our datasets.

## Classifier Results on Live Data:

Although we don't have hard number for our classification accuracy, after a few tests it's somewhere 30%.

# Does it seem likely that your project will work?

Our project already “works”. How accurate it will be is another matter. We hope that after we reformat the dataset and alter our input system we will see large improvements.

If this doesn't happen we still have a few ideas that we will try.

- Shrinking the dimensions of the images
- Using different classifiers for different datasets
- Changing the size of the “pen” on the website
- Using a keras convolutional neural network

# Group/Team Management

## Time Spent:

Both group members have spent approximately 20 hours on the project.

## Communication:

Group members meet at least 3 times a week over Discord.

## Individual Progress:

Both group members have accomplished their given tasks.

### Nathan

- Created Server
- Made Preliminary Classifiers
- Made Raw-to-CSV notebook
- Tested Alternate Classification Avenues
- Bug Fixes

### Brighton

- Image Manipulation Functionality
- Segmentation
- Classifier/Segmenter/Website Integration
- Bug Fixes

# Links:

## Datasets:

[https://scikit-learn.org/stable/modules/generated/sklearn.datasets.load\\_digits.html](https://scikit-learn.org/stable/modules/generated/sklearn.datasets.load_digits.html)

[https://scikit-learn.org/stable/modules/generated/sklearn.datasets.load\\_digits.html](https://scikit-learn.org/stable/modules/generated/sklearn.datasets.load_digits.html)

## Github Repository:

<https://github.com/NathanSwedlund/HandwritingCalculator>