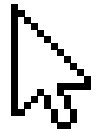
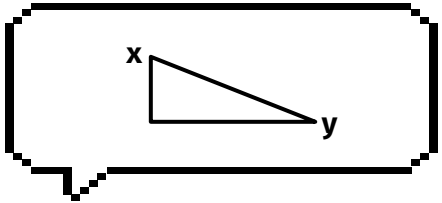
Image Classification using **K-Nearest Neighbor** Learning

MNIST Database



NCSSM CS4320 Machine Learning

Srihas Surapaneni



01

Image Classification

Problem Description

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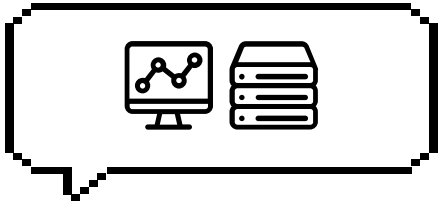
I used a dataset of various images of handwritten numbers from 0 through 9 and used K-Nearest Neighbors to classify different images as integers.

I plan on showing a simple version of how computers and commonly used artificial intelligence chatbots recognize text in images, and how can we accurately classify images as a digit using machine learning.

This technology, optical character recognition (OCR), is incredibly useful for data processing, accessibility, and automation.



02

MNIST

Modified National Institute of Standards and Technology

MNIST CSV Dataset

MNIST is a widely used dataset of 70,000 handwritten digits from 0 to 9, found on Kaggle.

MNIST CSV reformats each image as a row of data.

- 60,000 Train + 10,000 Test
- Each Row is 785 Columns
  - Label + 784 Values
  - 28×28 Grid of Values
- Each Value is Between 0-255
  - 0 - White
  - 255 - Black

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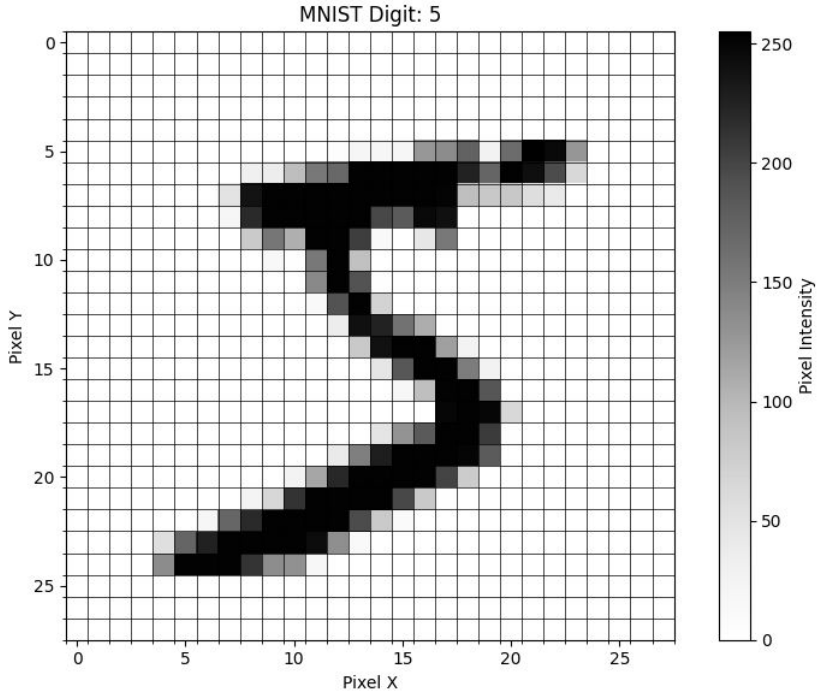

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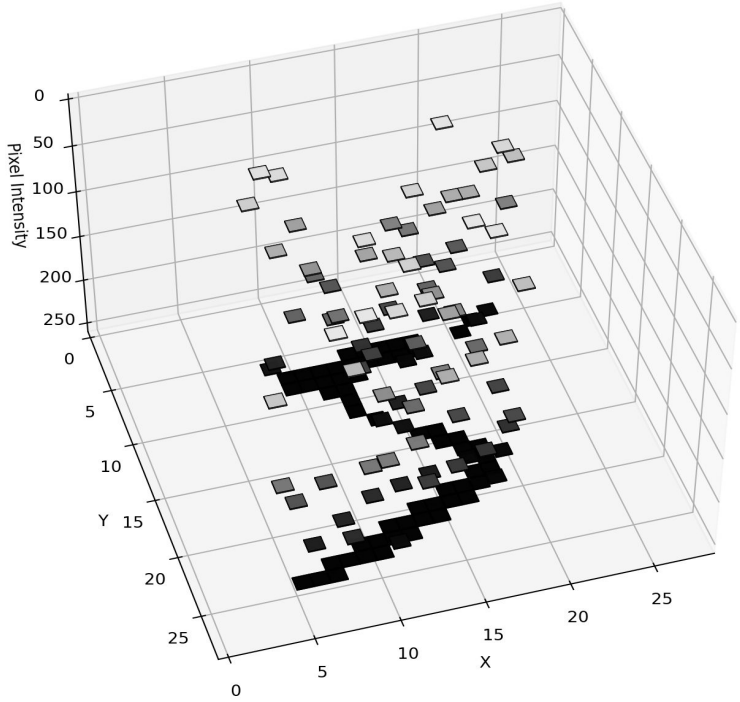
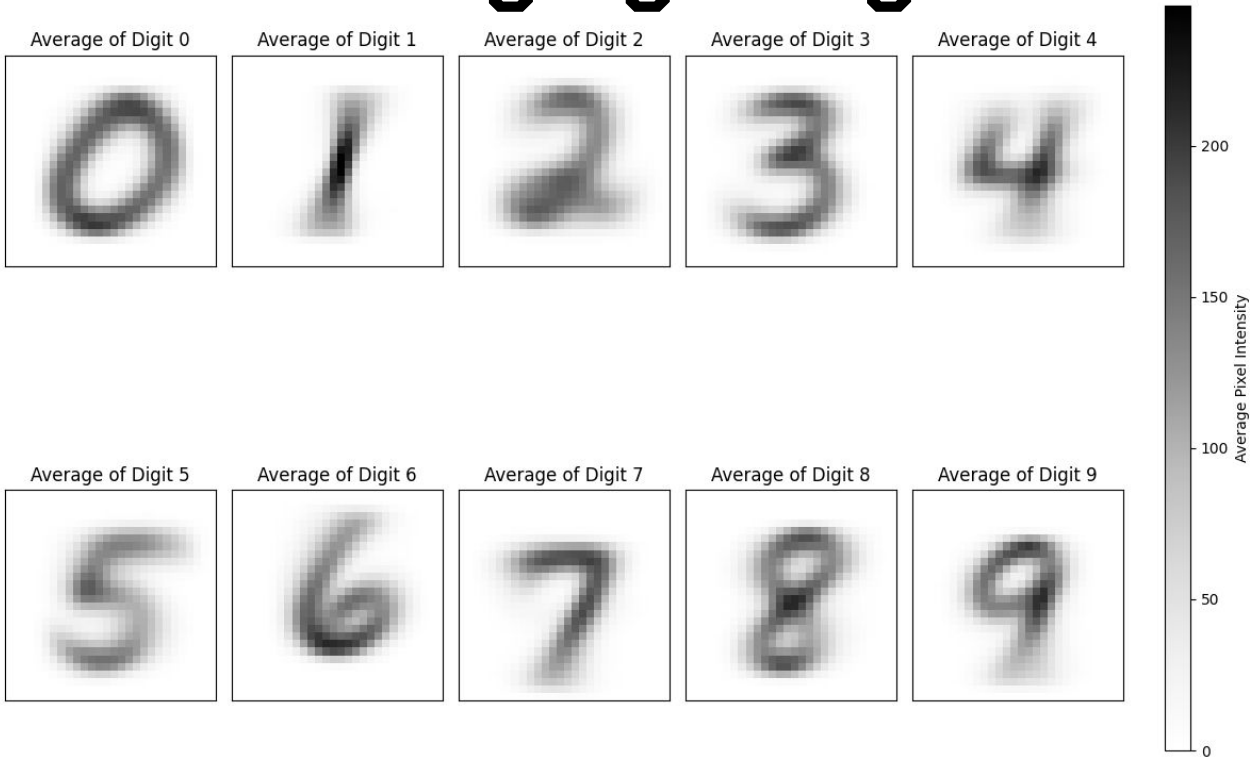
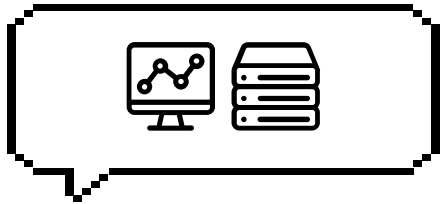


Averaging Images



We can visualize an approximate of what KNN is testing against by averaging the intensity of every pixel for every digit, and produce the "average image" of each digit.



03

K-Nearest Neighbors

Distance Based Classification Algorithm

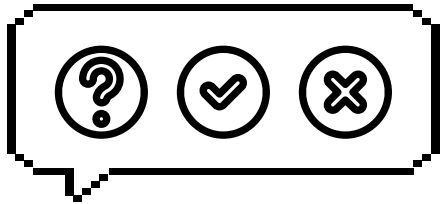
Why KNN

What is KNN?

- Uses reference values to calculate numerical distances between test and training data
- Uses the “k” points in the training data to classify a test point.

Why KNN is perfect for this problem:

- Data is already standardized from 0-255.
- Non-binary classification so referencing training data increases accuracy.

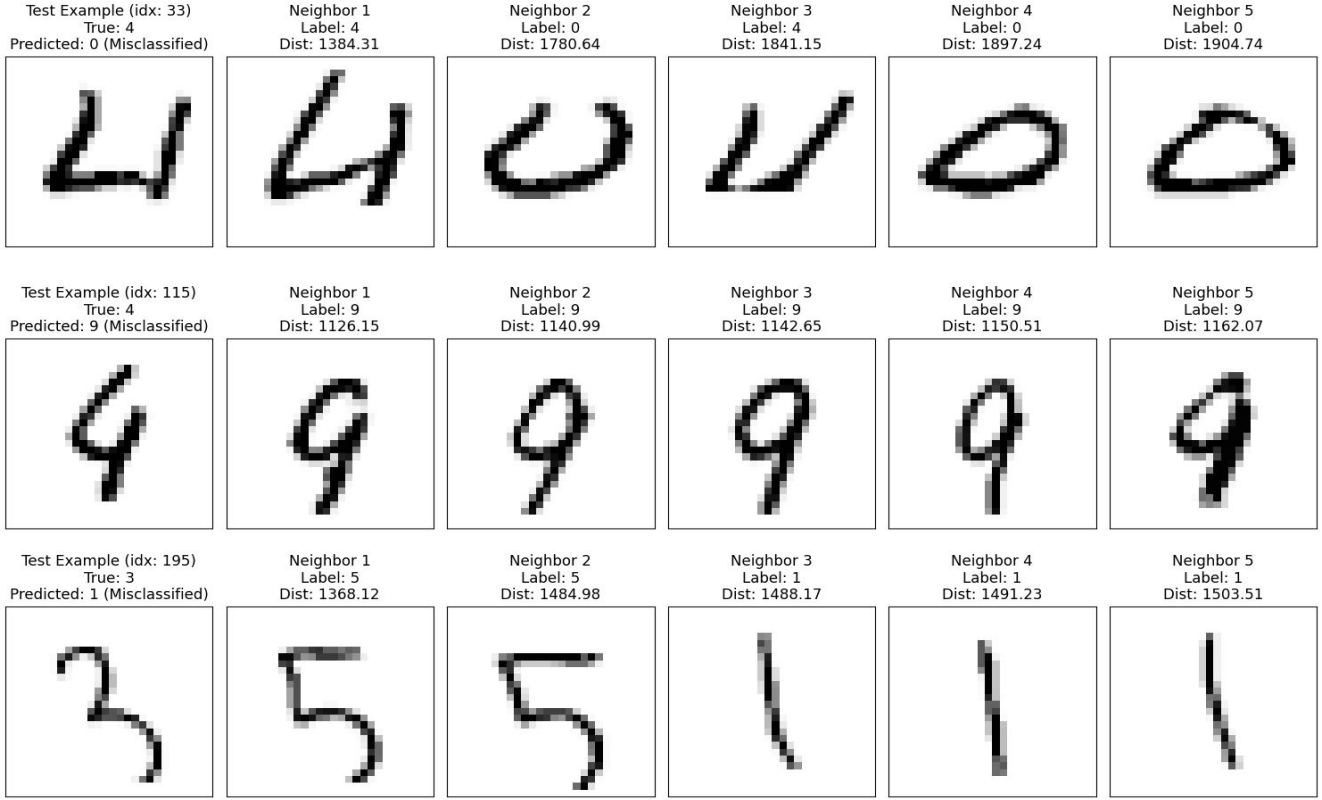


04

Model Validation

Training, Validation, and Testing Methods

Misclassification



Choosing k

k vs. # of Misclassifications

k	1	3	5	7	9	11	13	15
FP + FN	309	295	318	306	341	332	347	367

k = 3, as it resulted in the least number of misclassifications.

k = 5

MNIST is pre-split into 60,000 Lines of Training and 10,000 Testing.

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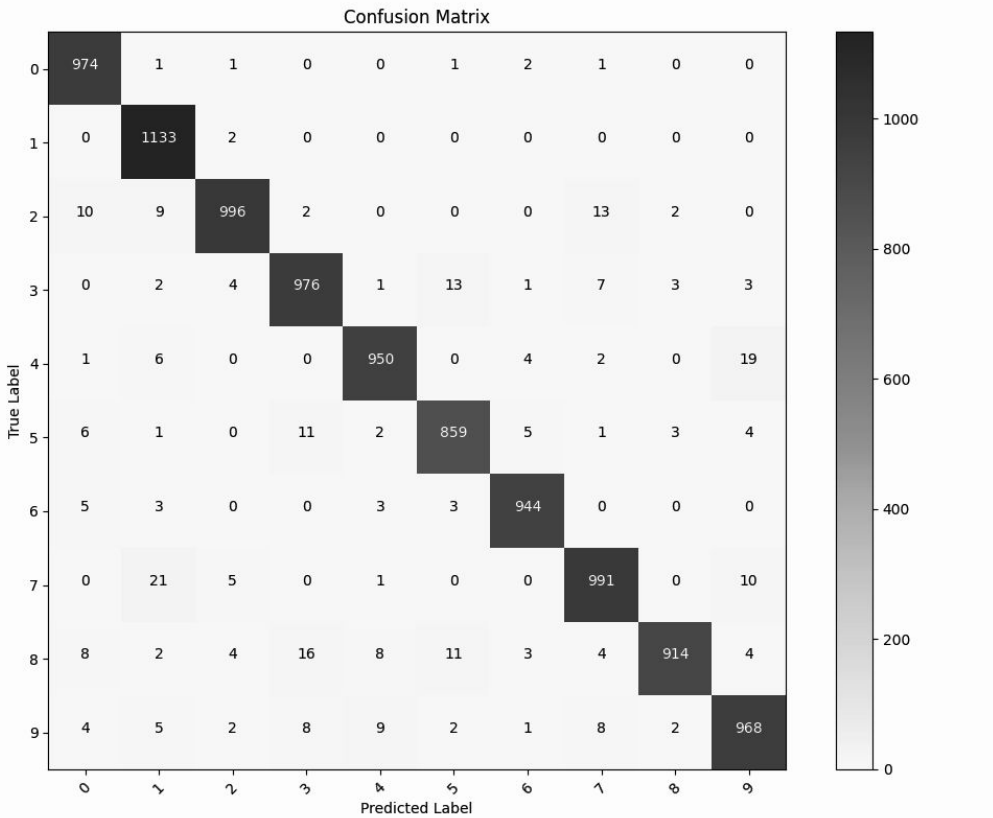
Validation Metrics



Macro-averaging metrics is a method of getting validation metrics for non-binary classification by taking the mean of the metrics for every individual class.

Macro-Average Metrics:

- Precision: 0.9709
- F1: 0.9701
- Recall: 0.9704
- Accuracy: 0.9941

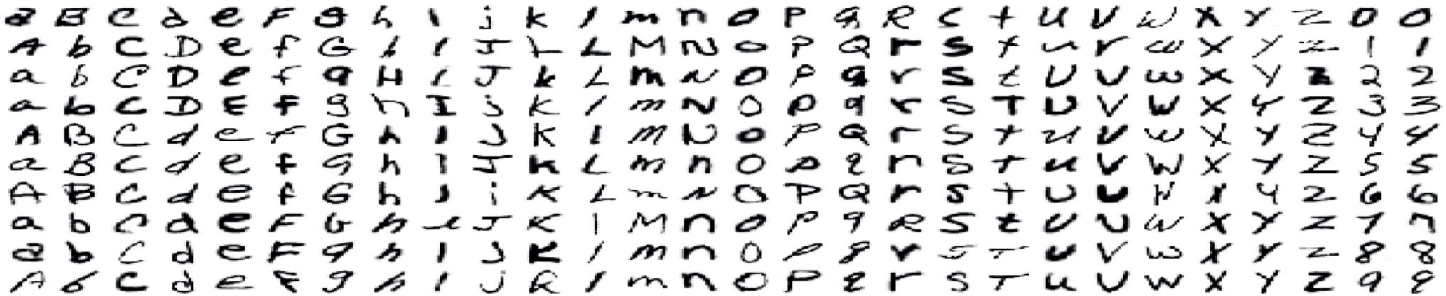
05

Results

Evaluating Results

Results

- KNN can transform images into text at 99.41% accuracy.
- Can be scaled through increasing size of training data with more variations.
  - Can also be expanded to interpret letters or special characters.



What I Learned?

KNN proves effective for image-to-text conversion, offering a foundation for developing more sophisticated OCR systems.

Each k-value test took 20-30 minutes to process 10,000 test images, varying based on whether the program ran in the foreground or background of my system.

Real World Applications:

- Document Processing
- Data Entry Automation
- Accessibility Tools

Limitations of KNN for OCR:

- Computationally Expensive: O(nd)
- Scaling: Slower with Larger Datasets
- Memory Requirements: Stores Training Data

Though KNN is effective for OCR it is nowhere near as practical as the more widely used alternative, Convolutional Neural Networks.

Thank You

Any Questions?

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