



Handwritten Recognition in Banking : MNIST Implementation

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Handwritten Filled Deposit Slip

NAME Jane Doe

DATE 01/01/2025

ADDRESS 123 Main St., USA

ACCOUNT NUMBER 123456789

Jane Doe

Signature

CASH 100 00

CHECK 150 50

75 00

SUBTOTAL 325 50

LESS CASH 40 00

NET DEPOSIT 285 50

Source: supermoney

Problem

Handwritten Deposit Slip

Manual check and deposit slip processing is slow and error-prone.

Document verification is inefficient.

MNIST Dataset Overview

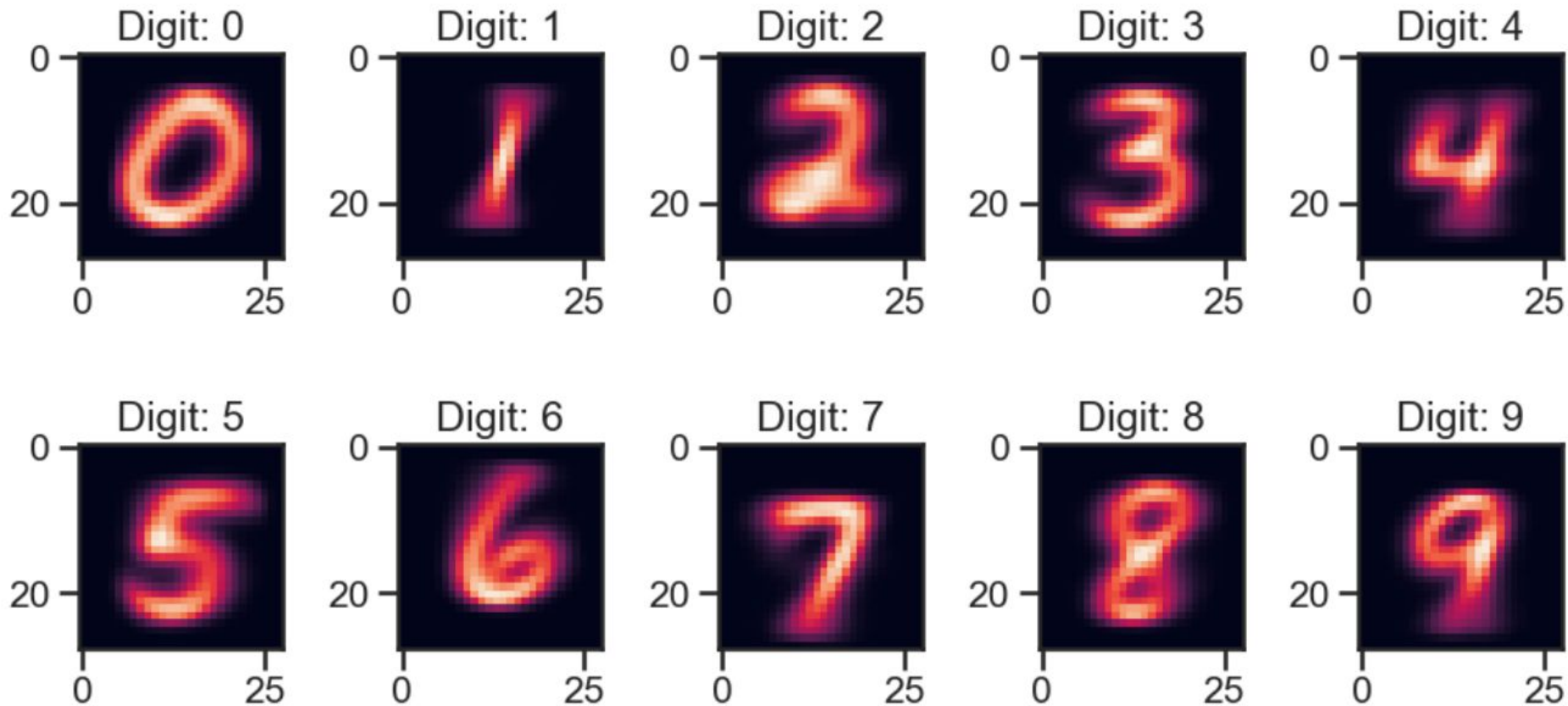
- Number of Instances & Attributes: 70,000 images & 784 (28x28 pixels)
- Target: Column represents the digit (0-9) corresponding to the handwritten image

The dataset is divided into two main subsets:

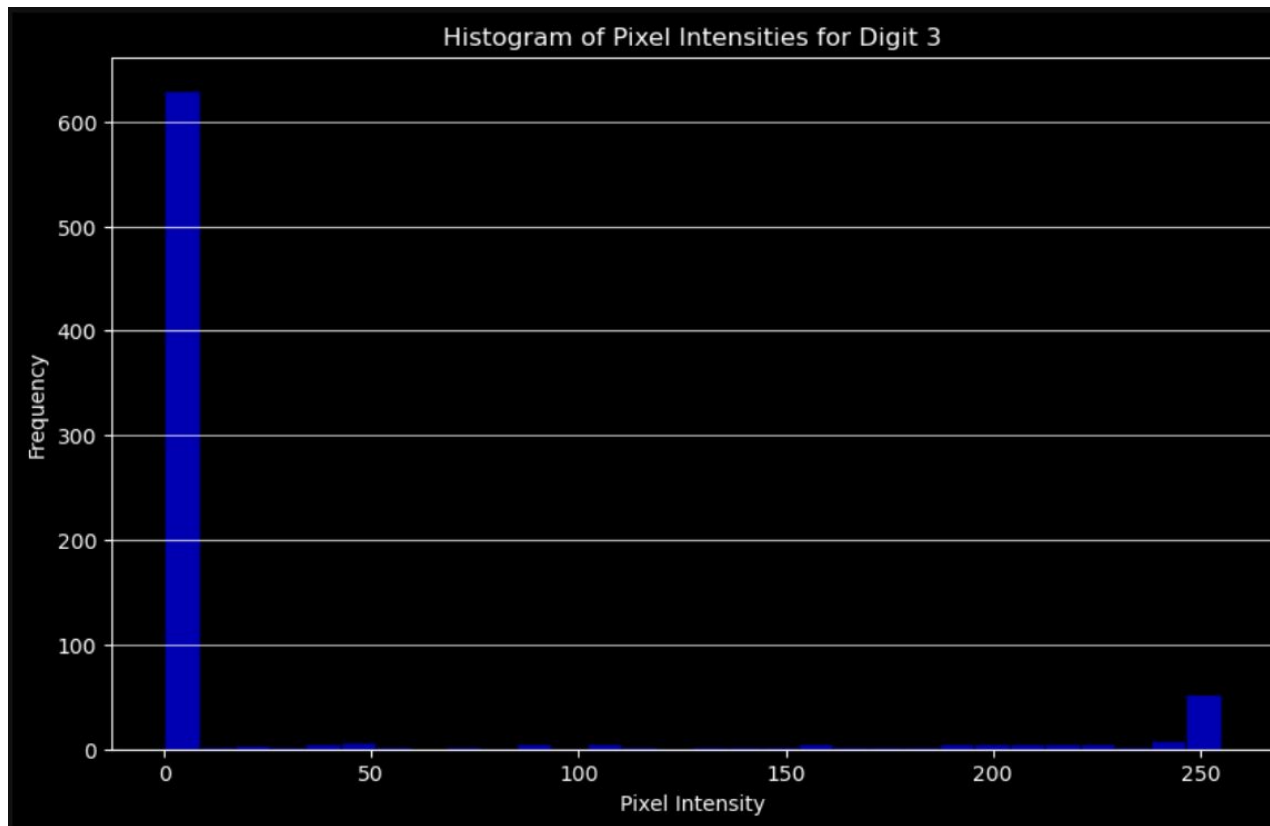
- Training Set: Consists of 60,000 images along with their labels.
- Test Set: Contains 10,000 images with their corresponding labels.



Digits from the MNIST dataset

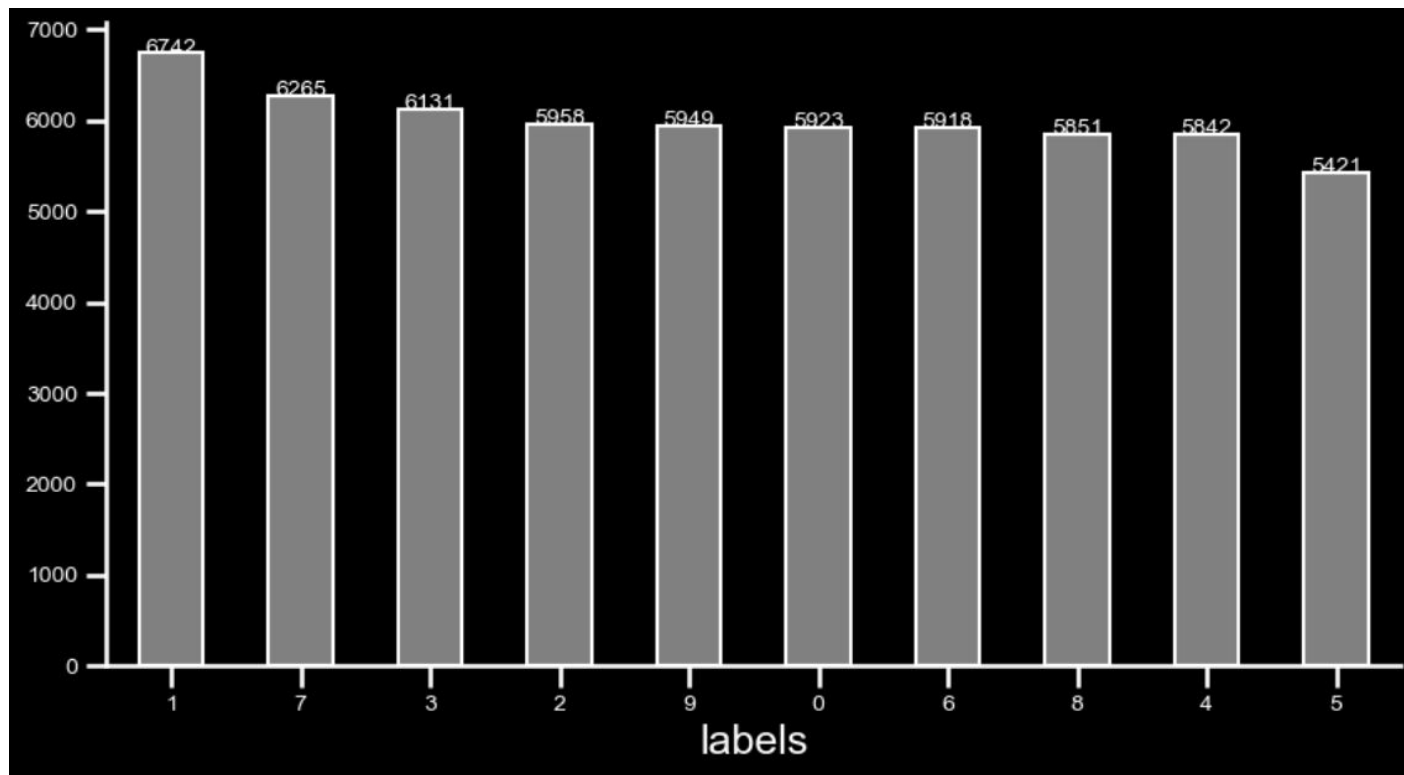


Visualization of Mean Pixel Intensity Across MNIST Dataset:
This image represents the average pixel intensity for each digit (0-9)



Histogram of Pixel Intensities for Digit 3

Checking Target Imbalance



Solutions

Machine Learning Approaches

Gaussian Naïve Bayes (GNB)

Non-Naïve Bayes (Multivariate Gaussian)

K-Nearest Neighbors (KNN)

Gaussian Naïve Bayes (GNB)

Used Scaling to Improve Accuracy

Accuracy	Before Scaling	After Scaling - $X/255$
Train Dataset	0.593	0.768
Test Dataset	0.587	0.774

Non-Naïve Bayes (Multivariate Gaussian)

Adjust epsilon to Improve Accuracy

Accuracy	Before Adjust Parameter	After Adjust Parameter
Train Dataset	0.783	0.9549
Test Dataset	0.751	0.9542

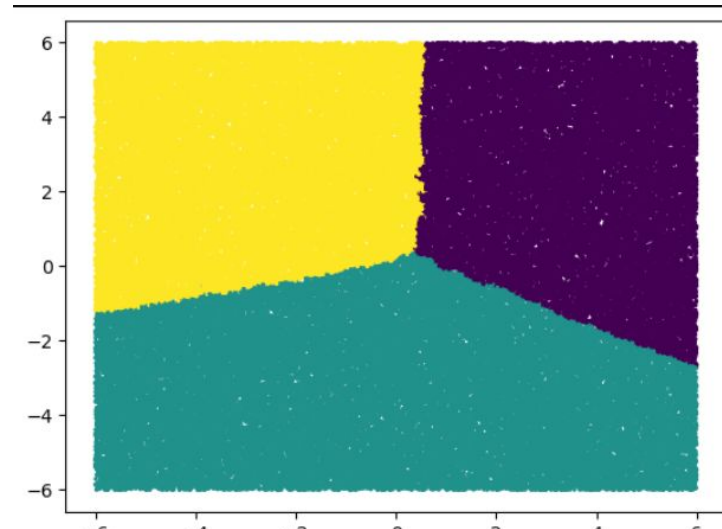
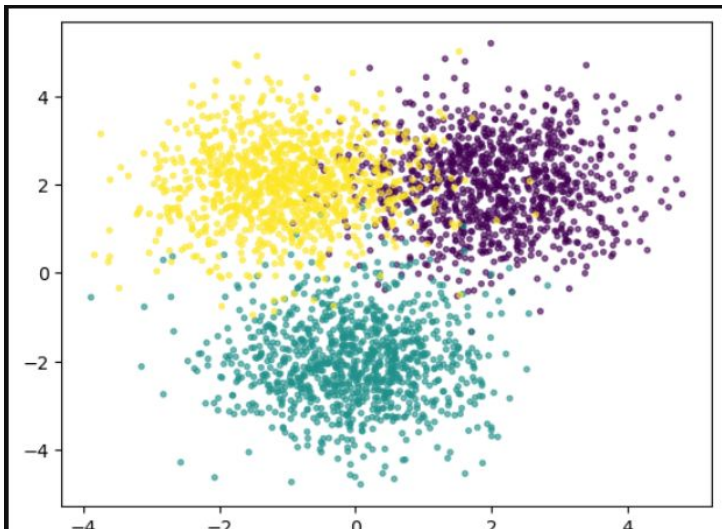
K-Nearest Neighbors (KNN)

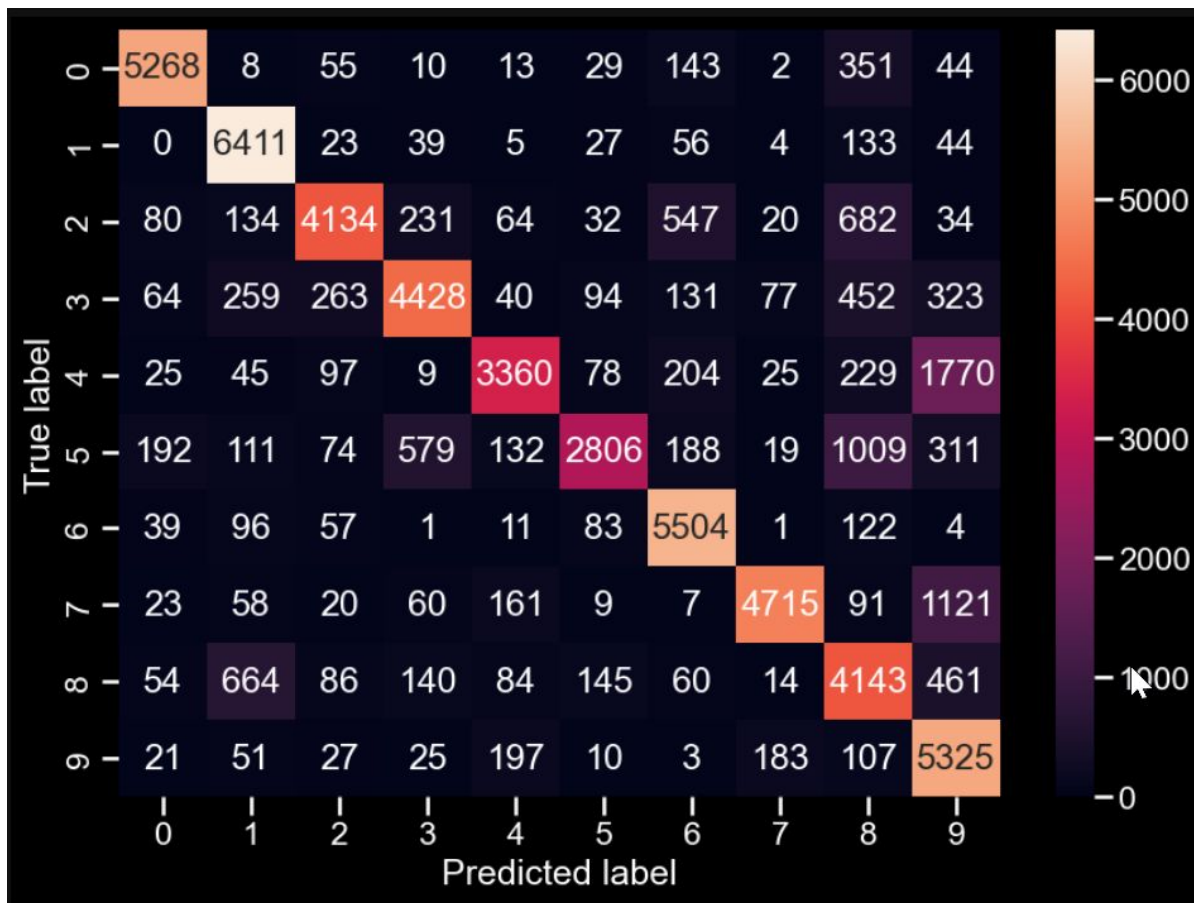
Finds closest k points using distance. $K = 20 / 200$

Extracts a subset of the training dataset

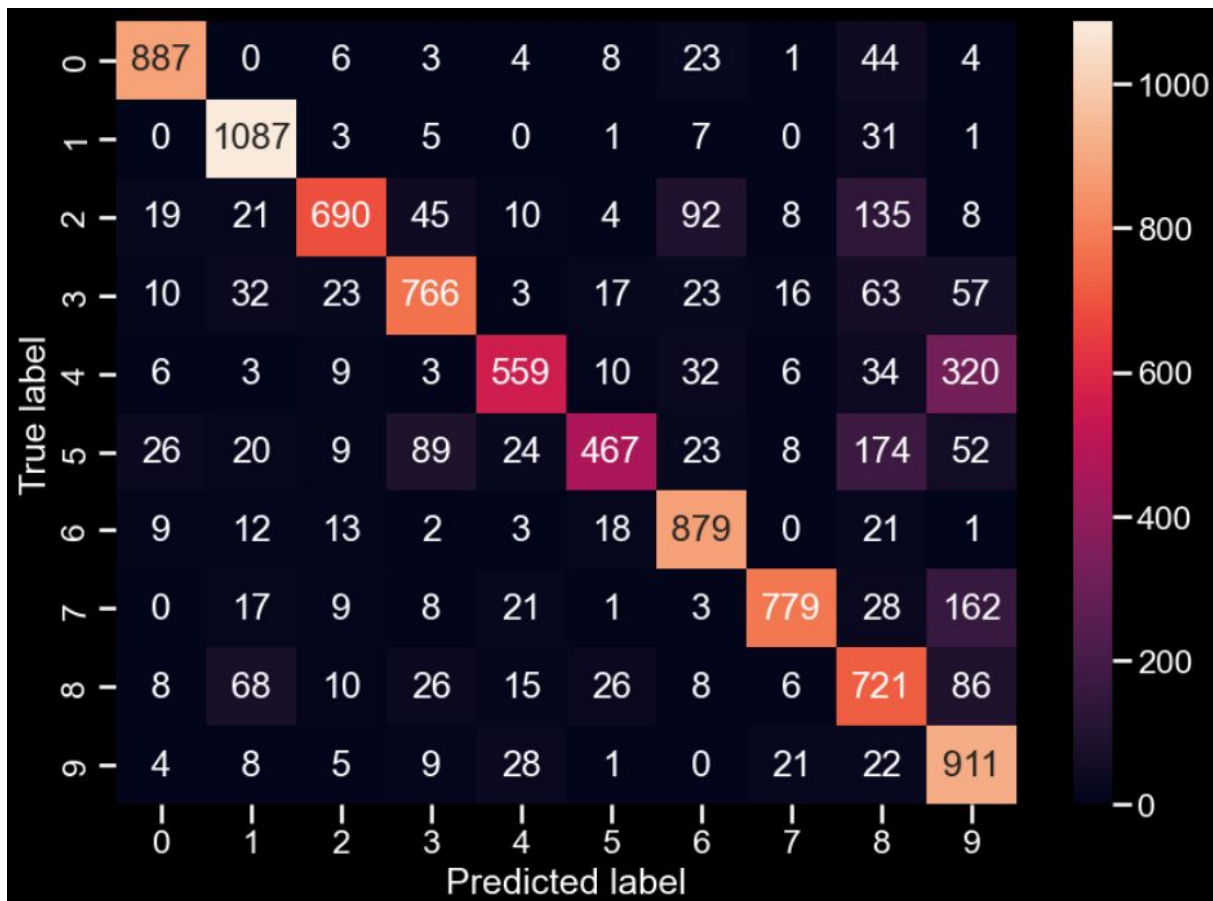
Accuracy of train dataset - 0.902 test dataset - 0.91

Using Full Dataset (70,000 samples): ~97% (Referenced)





Confusion Matrix of Train Dataset



Confusion Matrix of Test Dataset

Model Training & Results

Algorithm	Accuracy	Pros	Cons
Gaussian Naïve Bayes	77.4% (after scaling)	Fast, low memory usage, improved accuracy with scaling	Assumes feature independence
Non-Naïve Bayes	95.42% (after adjust parameter)	Captures pixel dependencies	Complex computation
KNN	97% (Referenced)	High accuracy	Slow inference time



Implementation



Mobile Check Deposit using Handwriting Recognition

Banking Apps (Chase, Wells Fargo, PayPal, Google Pay, Apple Pay)



Source: callawaybank

Mobile Check Deposit App

How it Works:

User takes a picture of a check.

Machine learning model detects & extracts handwritten account numbers and amounts.

Verifies authenticity and detects fraud.

Deposits funds into the account automatically.

Benefits:

Reduces fraud & manual verification.

Faster processing & improved user experience.

The screenshot displays the 'Details' screen of the Mobile Check Deposit App. At the top, a red header bar contains the word 'Details' and a progress indicator with three dots, the second of which is filled. Below the header, the screen is divided into two columns: 'Front of Check' and 'Back of Check'. The 'Front of Check' column shows a photo of a check from Bank of America, dated 4/2/12, for \$300.00, payable to John Doe. The 'Back of Check' column shows a photo of the check's back. Below these images, the 'Deposit To' section shows 'Personal Checking - 1346' with an 'Available Balance' of '\$952.13'. The 'Amount \$' is displayed as '\$300.00' with a right-pointing arrow. At the bottom, there is a 'Secure Area' section with a lock icon, followed by copyright information: '© 2012 Bank of America Corporation. All rights reserved. Bank of America, N.A. Member FDIC. Equal Housing Lender'. At the very bottom are two buttons: a blue 'Continue' button and a grey 'Cancel' button.

Source: androidauthority

Conclusion

Handwritten recognition significantly enhances the speed and accuracy of processing checks and receipts.

GNB improved from 59% to 77% accuracy with feature scaling.

Non-Naïve Bayes reached 95% accuracy after parameter adjustments.

KNN achieved the highest accuracy of 97%, making it the best but slowest model.

