ISSN 2063-5346

CLUSTERING AND PREDICTION STRATAGEM FOR HANDWRITTEN DIGIT RECOGNITION WITH MINST TEST DATA USING CNN

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Article History: Received: 10.05.2023 Revised: 29.05.2023 Accepted: 09.06.2023

Abstract

The example order community has been debating the issue of transcribed digit acknowledgment for a time. Numerous studies have demonstrated how effective neural networks are at organising information. The main objective of this study is to examine many existing model configurations in order to give trustworthy and effective ways for detecting transcribed numerical data. The implementation of the Convolutional Neural Network (CCN) is discussed in this essay. The results demonstrate that the CNN classifier beat the Neural Network while maintaining execution quality and greatly improving computational effectiveness. Handwritten digits can be recognised using the Convolutional neural network in machine learning. The CNN compilation and the MNIST (Modified National Institute of Standards and Technologies) database provided the basic basis for the construction of my research. Therefore, a number of libraries, including NumPy, "Pandas," TensorFlow, and Keras, are all that are required to execute the model. These act as the cornerstone of my main project. The MNIST data contains about 70,000 images of handwritten numerals from 0 to 9. So, a class 10 model is used to classify objects. The two halves of this dataset are the training and test datasets. Each cell of a 28*28 matrix used to represent an image contains a grayscale pixel value.

Keywords—Handwriting recognition, Machine learning algorithms, Personal digital devices, Organizations, Machine learning, Convolutional neural networks, Security.

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DOI:10.48047/ecb/2023.12.9.82

I. INTRODUCTION

The issue of manually written numerals acknowledgment has been broadly concentrated lately and the huge amount of pre-processing strategies and arrangement calculations have been created. Notwithstanding, transcribed numerals acknowledgment is as yet a test for us. The primary trouble of transcribed numerals acknowledgment is the genuine change in size, interpretation, stroke thickness, pivot and twisting of the numeral picture as a result of written by hand digits are composed by various clients and their composing style is not quite the same as one client to another. A few considered have utilized various approaches to manually written digit with various AI procedures Khotanzad et at (1998) who have applied the ideas of Machine Learning and Neural Networks to perceive and decide the transcribed digits from its picture. This investigation has indicated that digit acknowledgment is an amazing model issue for finding out about neural organizations and it gives an extraordinary method to grow further developed strategies like profound learning. Transcribed acknowledgment (HWR) is the capacity of a PC to get and comprehend understandable manually written contribution from sources, for example, paper archives, client input contact screens and different gadgets.[1] The picture of the composed content might be detected from a bit of paper by optical filtering (optical character acknowledgment) or canny word acknowledgment or by client input. Then again, the developments of the pen tip might be detected "on line", for instance by a pen-based PC screen surface, a for the most part simpler undertaking as there are more hints accessible This paper presents perceiving the manually written digits (0 to 9) from the renowned MNIST dataset utilizing TensorFlow framework (library) and python as language and its libraries as client enters the particular digit the machine would perceive and show the outcomes with exactness rate.

II. RESEARCH BACKGROUND

Aim of the project

The exhibition of Convolutional Neural Network (CCN). Results demonstrate that CNN classifier beat over Neural Network with critical improved computational effectiveness without relinquishing execution. Handwritten digit recognition can be performed using the Convolutional neural network from Machine Learning. Using the MNIST (Modified National Institute of Standards and Technologies) database and compiling with the CNN gives the basic structure of my project development.

Scope of the project

In this work, with the point of improving the exhibition of transcribed digit acknowledgment, we assessed variations of a convolutional neural organization to keep away from complex pre-preparing, exorbitant component extraction and a perplexing troupe (classifier blend) approach of a conventional acknowledgment framework. Through broad assessment utilizing a MNIST dataset, the current work recommends the job of different hyper-boundaries. We additionally confirmed that tweaking of hyper-boundaries is fundamental in improving the presentation of CNN engineering. We accomplished acknowledgment with the Adam analyzer for the MNIST information base, which is superior to all recently revealed outcomes.

The impact of expanding the quantity of convolutional layers in CNN design on the presentation of transcribed digit acknowledgment is unmistakably introduced through the tests. The oddity of the current work is that it altogether explores all the boundaries of CNN engineering that convey best acknowledgment precision for a MNIST dataset. Companion scientists couldn't coordinate this precision utilizing an unadulterated CNN model. A few analysts utilized gathering CNN network models for the equivalent dataset to improve

their acknowledgment precision at the expense of expanded computational expense and high testing multifaceted nature yet with practically identical exactness as accomplished in the present work.

III. SYSTEM ANALYSIS

Data Analysis

Dataset: Modified National Institute of Standards and Technology (MNIST) is a database which is freely available for handwritten digits and is standard for machine learning algorithms. It is similar to TIDigit which is a database of speech created by Texas Instruments, which tasks in speech recognition [9]. For our project, MNIST dataset is used. In this dataset, the images of digits were taken from a variety of scanned documents in which each image is Greyscaled and of 28*28 pixels. It uses 60,000 images to train the network and 10,000 images to evaluate hoe accurately the network learned to classify the images. Some of the sample images of the MNIST dataset are shown below.

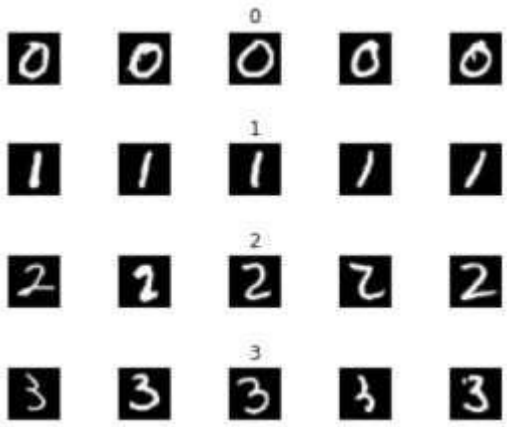


Fig 2: Sample images of MNIST dataset

To use the MNIST dataset in Keras, an API is provided to download and extract images, labels automatically. The task is to classify a given input image of a handwritten digit into one of the 10 classes representing the integer values from 0 to 9 inclusively. The distribution of training data in MNIST is shown below.

Fig 3: Bar diagram showing the distribution of training dataset

Proposed System

In this project, we emphasize over evaluation process on prediction performance using Handwritten Digit Recognition using Deep learning methods has been implemented. The most widely used Machine learning algorithms, KNN, SVM, RFC and CNN have been trained and tested on the same data in order acquire the comparison between the classifiers. Utilizing these deep learning techniques, a high amount of accuracy can be obtained. Compared to other research methods, this method focuses on which classifier works better by improving the accuracy of classification models by more than 99%. Using Keras as backend and Tensorflow as the software, a CNN model is able to give accuracy of about 98.72%. In this initial experiment, CNN gives an accuracy of 98.72%, while KNN gives an accuracy of 96.67%, while RFC and SVM are not that outstanding.

Advantages:

- High accuracy
- Can be extended to real time environments.

IV. ALGORITHMIC PROCESS

Formulation of the Project

The data which is already collected can be used for extracting the features of each digit. The availability of

more powerful machine learning algorithms introduces an efficient and better approach to solve this problem. The project is divided two modules as shown below.

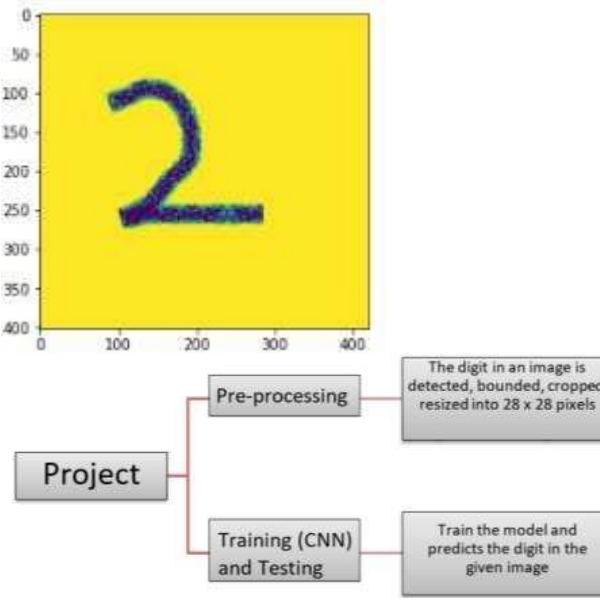
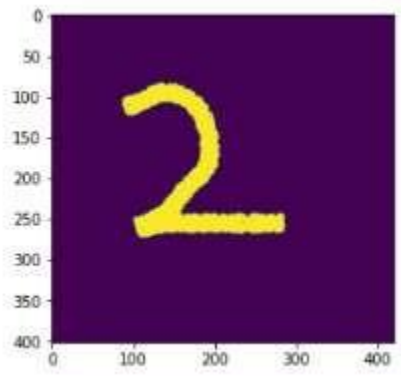


Fig 7: Modules of HDR



- **Pre-processing module:**

1. **Read the image**

OpenCV is a Machine Learning library that is used to read and manipulate images. The image is read and then stored in multiple copies for performing different operations. After reading the image is plotted in its shape to make sure it is read perfectly.

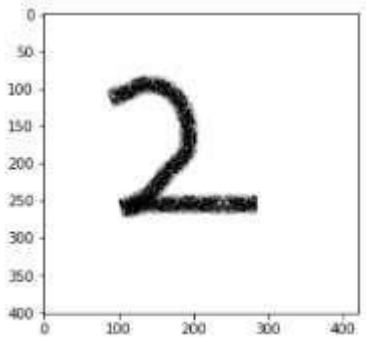


Fig 8: Handwritten image

2. **Converting an RGB image to a Greyscale image**

An RGB image that is three-dimensional is converted to a Greyscale image that is one-dimensional. A BGR image is a three-dimensional image (w, h, c)

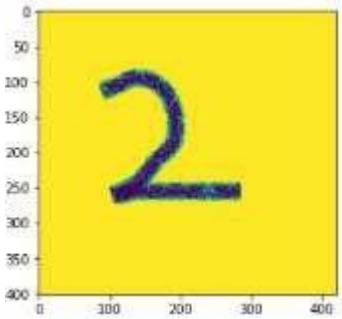


Fig 9: Greyscale image

3. **Remove noise**

Gaussian blur is applied to the greyscale image to remove noise in the image.

Fig 10: Image after applying Gaussian blur

4. **Object Detection**

The standard step for object detection is Otsu thresholding.

Fig 11: Image after applying Otsu thresholding

5. **Finding and drawing contours**

The findContours() and drawContours methods() are used for finding and drawing boundaries of the detected object in an image.

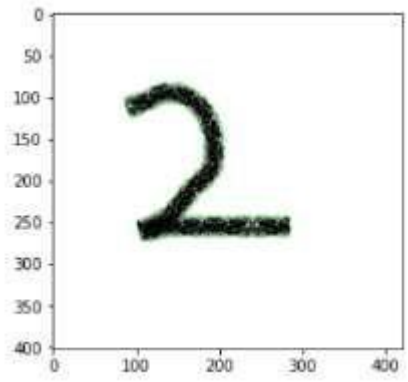


Fig 12: Image with Contours

- **Training & Testing module:**

Any model learns by using past data and Machine Learning algorithms. It learns from the past data by feature extractions. For training the model, a sequence of hidden layers is created with some nodes in each layer.

Then, we compile the model by 'categorical_crossentropy'as loss function, 'adam' as an optimizer , and 'accuracy' as metrics.

Then, the model is trained using CNN and tested by giving new handwritten digit images that are not present in the dataset.

Architecture

Fig 5: Architecture

The proposed model contains four stages to classify and detect the digits:

A. Pre-Processing:

Pre-processing is a part of HDR. If there are some rules like a box for each digit then, it will be much easier to detect the boundaries. The fundamental motivation behind pre-processing is to take off noise filtering, smoothing, and standardization. Binarization converts a Greyscaled image into a binary image.

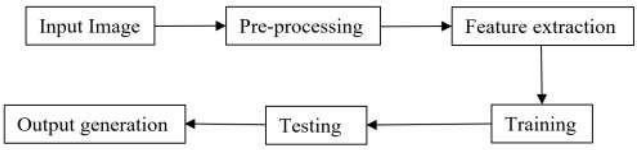
B. Feature Extraction:

Different type of algorithms used for feature extraction have different types of error rate. The errors made by each separate algorithm does not overlap, so combining all these methods lead to a perfect recognition rate and also helps to reject the ambiguous digits recognition and improve the recognition rate of misclassified digits that can be recognized by humans.

C. Classification and Recognition:

In the classification and recognition step, the extracted feature vectors are given as single input values to each classifier. CNN Convolution layer and the subsampling layer can have various different layers . The down sampling layer is also known as pooling layer. The image is divided into small segments of small areas, and a value is calculated for each area. Then the calculated values are rearranged in sequence to form a new image . This process is similar to fuzzy filter, which can increase the robustness of image feature withdrawal. Extracted features are combined and are defined using the following four classifiers:

- **K-nearest neighbor**
- **Random forest classifier**
- **Support vector machine:**
- **Convolutional neural networks:**



V. PROJECT IMPLIMENTATION

A. Proposed Modular Implementation

Below is the proposed modular implementation of the project. It consists of module:

Admin Module:

1. Login
2. Upload MNIST dataset

3. Feeding the dataset to multiple classification algorithms
    a. Random Forest
    b. Support Vector Machine
    c. K-Nearest Neighbour
    d. CNN
4. Creation of model using CNN algorithm

1. Upload the hand-written digit image
2. Predict the hand-written digit

B. SYSTEM DESIGN

1. Data Flow Diagram: Admin

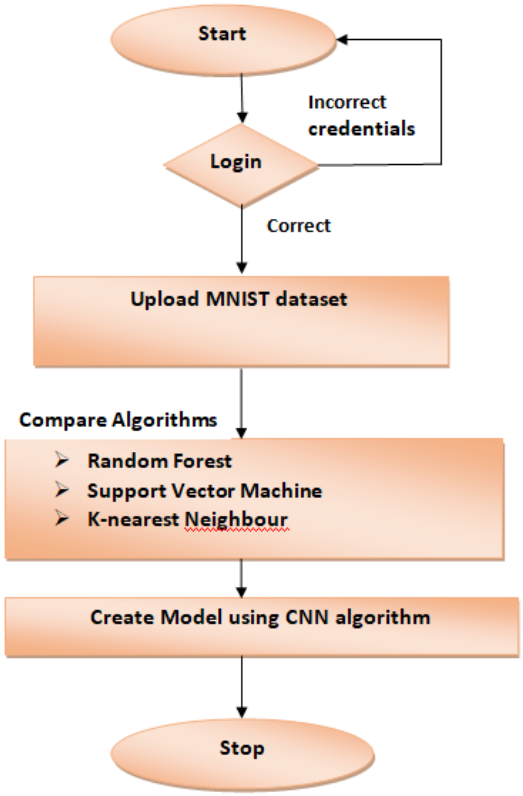
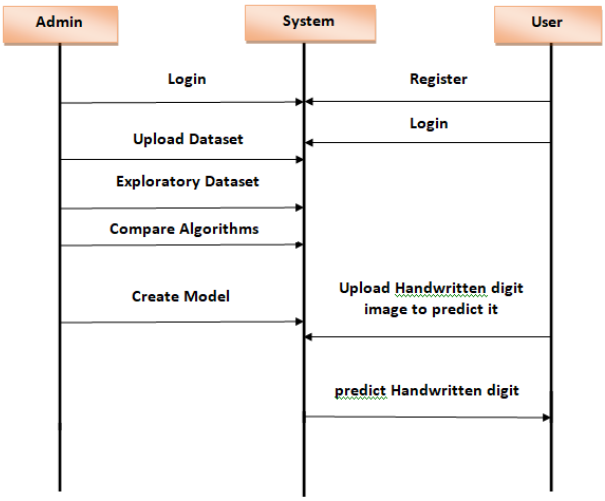


Figure 1: A Data Flow Diagram for Admin

Sequence Diagrams:



VI. IMPLEMENTATION AND RESULT ANALYSIS

Admin Login:

This is the login page for the admin module. The admin need to login into the system with his credentials in order to perform operations like uploading the dataset, Training the dataset, Exploratory data Analysis of the dataset, Feeding the dataset to different Machine learning Algorithms to find the Algorithm that can meet the best accuracy and Create a model that can be hosted on the Flask Application to be used by the users.

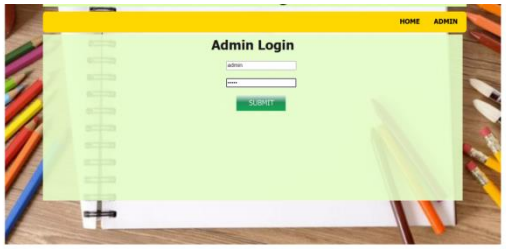


Fig: Admin Login

Upload Dataset:

On this page, the administrator of the system can upload datasets that are used for training the machine learning models. The admin has to select the file by clicking on the Choose file button and click on the upload button to upload the file to the

server. Once the upload is complete, a success message would be displayed that the file is successfully uploaded. For this project we are using train.csv as a dataset.

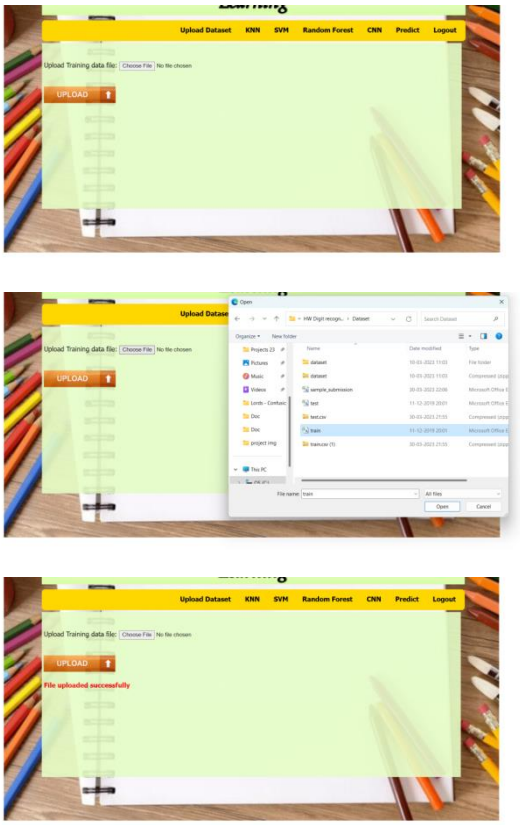


Fig: Upload Dataset & File Uploaded Successfully.

K-Nearest Neighbors Algorithm:

When the dataset is feed to K-Nearest Neighbors algorithm we observe that the Training Accuracy of the Model is 96.68% and Test Accuracy of the Model is 96.86%.

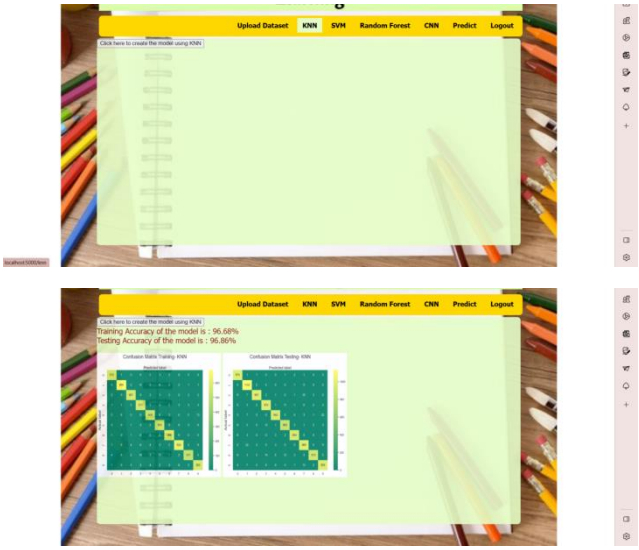


Fig: K-Nearest Neighbors

Support Vector Machine:

When the dataset is feed to Support Vector Machine algorithm we observe that the Training Accuracy of the Model is 97.85% and Test Accuracy of the Model is 97.79%.

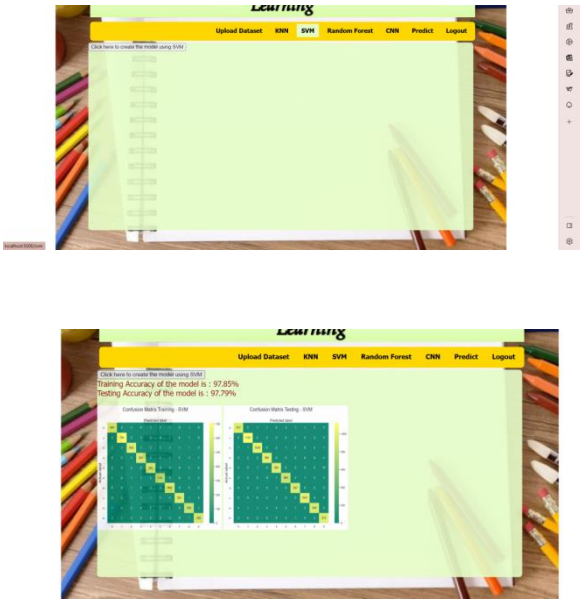


Fig: Support Vector Machine

Random Forest:

When the dataset is feed to Random Forest algorithm we observe that the

Training Accuracy of the Model is 96.85% and Test Accuracy of the Model is 96.93%.

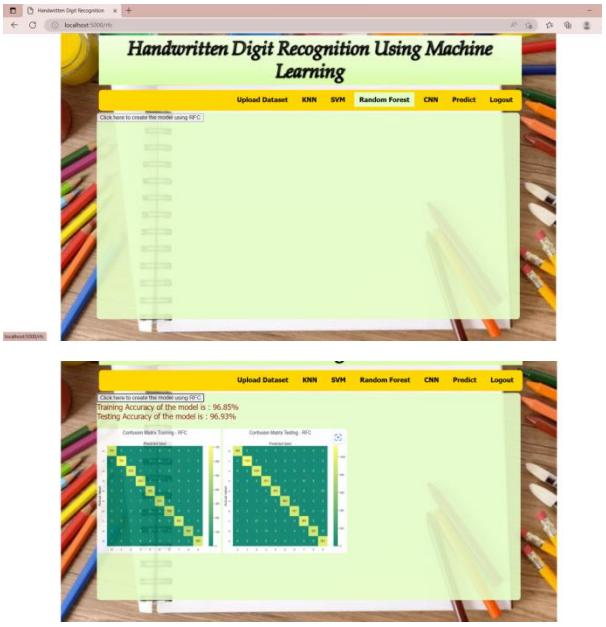


Fig: Random Forest

Convolutional Neural Network:

When the dataset is feed to Convolutional Neural Network algorithm we observe that the Training Accuracy of the Model is 98.98% and Test Accuracy of the Model is 99.5%.

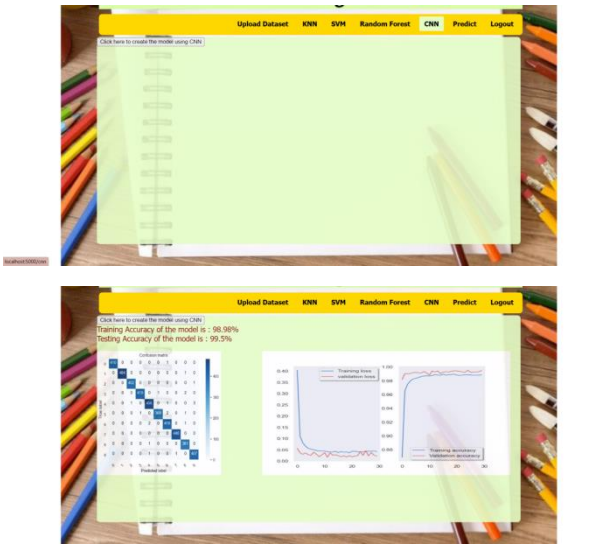


Fig: Convolutional Neural Network

KNN Predictions:

Randomly chosen sample test images of hand written digits are implicitly fed to KNN Predictions so that predicted labels are retrieved using KNN algorithm.

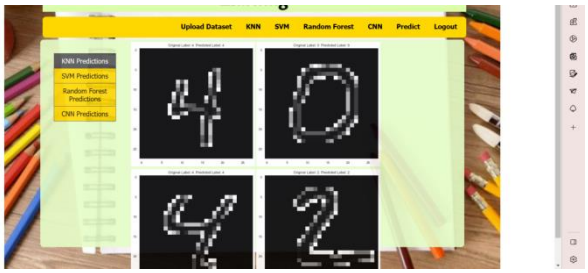


Fig: KNN Predictions

SVM Predictions:

Randomly chosen sample test images of hand written digits are implicitly fed to SVM Predictions so that predicted labels are retrieved using SVM algorithm.

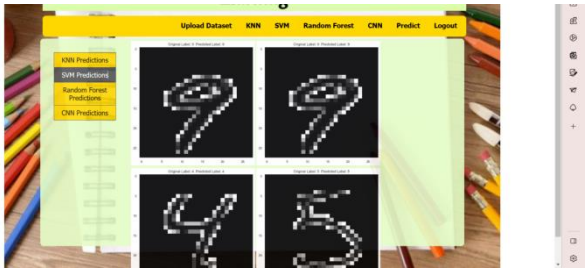


Fig: SVM Predictions

Random Forest Predictions:

Randomly chosen sample test images of hand written digits are implicitly fed to Random Forest Predictions so that predicted labels are retrieved using Random Forest Predictions.

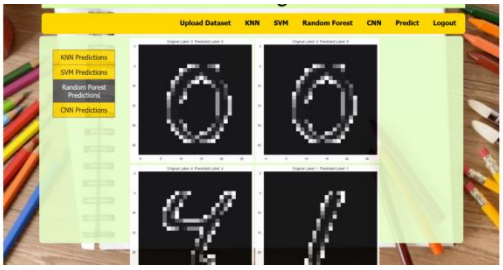


Fig: Random Forest Predictions

CNN Predictions:

Randomly chosen sample test images of hand written digits are implicitly fed to CNN Predictions so that predicted labels are retrieved using **CNN** Predictions.

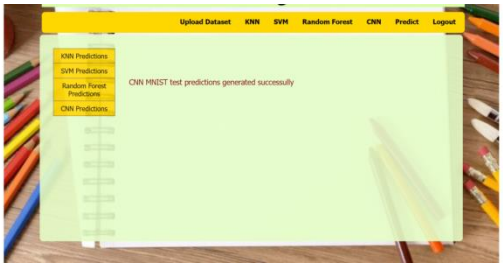


Fig: CNN Predictions

VII. CONCLUSION

We were successful in creating and implementing a machine learning model for this project that forecasts sales of various products in a superstore. We have used the Big Mart sales data set from kaggle.com, an open source data set, in order to accomplish this. The data has been cleaned and preprocessed, divided into training and test data, and fed to a variety of regression algorithms, including Linear regression, Support vector regression, Ridge regression, Lasso regression, Decision Trees regression, Random Forest regression, Adaboost regression, and Xgboost regression. That transaction, which we have seen, provides the highest level of accuracy. As a result, we improved the xG boost regressor, which now provides an accuracy of roughly 98%. For this data set, our model performs better than any other machine learning models we have used. Future plans call for expanding this research to include time series analysis using ARIMA.

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