

# **A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION**

## **PROBLEM SOLUTION FIT**

### **PROBLEM STATEMENT:**

Handwritten digit recognition is the ability of computer system to recognize the handwritten characters from wide variety of sources like emails, papers, images, etc. Manually written digits are of different sizes, styles, orientation, thickness and position. The model should be able to identify them and predict the output correctly. To solve this problem, we are going to use Convolutional Neural Network. The Convolutional Neural Network (CNN or ConvNet) is a subtype of the Neural Networks that is mainly used for applications in image and speech recognition. Its built-in convolutional layer reduces the high dimensionality of images without losing its information. That is why CNNs are especially suited for this use case

### **DATASET USED:**

MNIST (Modified National Institute of Science and Technology database) is probably one of the most popular datasets among machine learning and deep learning enthusiasts. The MNIST dataset contains 60,000 small square 28×28 pixel grayscale training images of handwritten digits from 0 to 9 and 10,000 images for testing. So, the MNIST dataset has 10 different classes.

### **STEPS:**

- 1) Import the libraries and load the dataset: Importing the necessary libraries, packages, and MNIST dataset
- 2) Preprocess the data
- 3) Create the model
- 4) Train and Evaluate the Model
- 5) Saving the model
- 6) Make Predictions

#### **1.Importing dataset:**

The Keras library already contains some datasets and MNIST is one of them, so it can be imported through keras. The `mnist.load_data()` method returns the training data, its labels along with the testing data and its labels.

#### **2.Preprocess the data:**

normalize inputs from 0–255 to 0–1 as to change the values of numeric columns in the dataset to a common scale, without distorting differences in the ranges of value. This involves first converting the data type from unsigned integers to floats, then dividing the pixel values by the maximum value.

### **3.Create the model:**

CNN is an artificial neural network that specializes in picking out or detect patterns and make sense of them. Thus, CNN has been most useful for image classification. A CNN model has various types of filters of different sizes and numbers. These filters are essentially what helps us in detecting the pattern.

### **4.Train and evaluate the model:**

We use **cross-validation** which divides the data set into  $k$  subsets and looks for the best test to train data ratio. In our case, value of  $k$  is 5. Thus, each test set will be 20% of the training dataset, or about 12,000 examples.

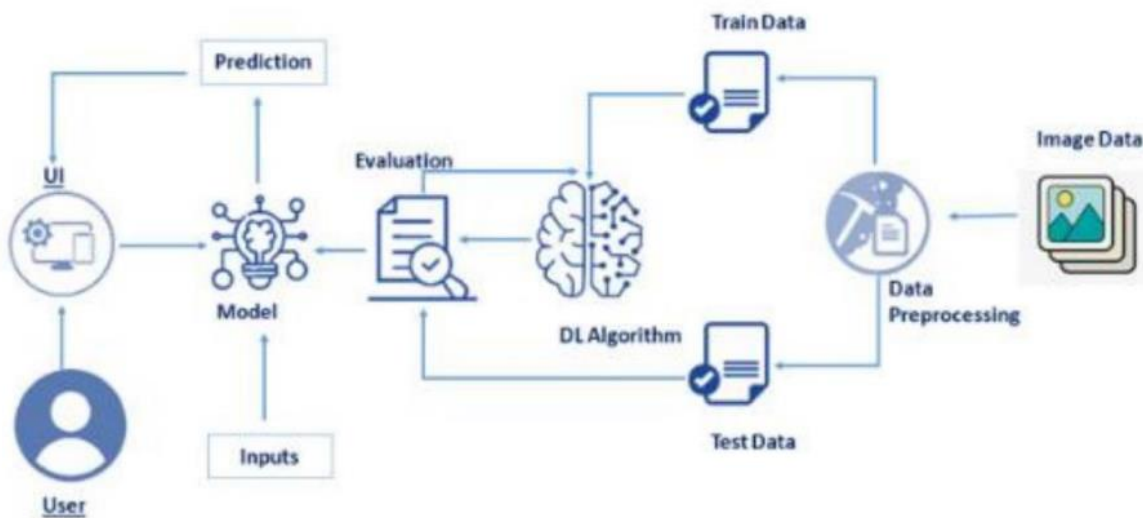
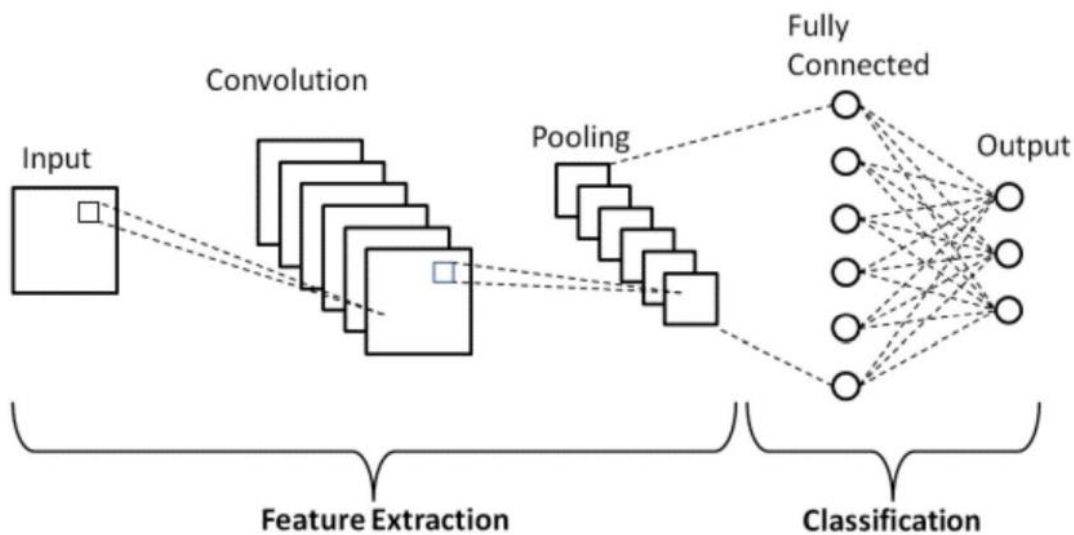
### **5.Save the model:**

Save the model in disk so that we can load it directly and predict.

### **6.Prediction:**

We need to resize and reshape the image to **(1, 28, 28, 1)** and provide the test image. Predictions will be made.

### **ARCHITECTURE:**



### PROBLEM SOLUTION FIT:

Everyone of us have different styles of writing and perception. Manually recognizing the handwritten digits are error prone due to various factors. So if this digit recognition is done manually in business organizations, even if a single error occurs, it may cause severe damage to the organization. So here, we have proposed a solution to automate the digit recognition process. A deep learning model is trained with images of different styles, sizes, orientation and then the model is based to predict based on previous learning. We can extend this project into

providing solutions to various other problems like solving handwritten mathematical equation by making some changes with the training data and final code. Organizations such as banks, revenue departments, accounting sectors are facing issues in recognizing written digits such as in cheques. This can be handled by our handwritten digit recognition project as they expand into different business domains without impacting performance. Our proposed solution is thus scalable and can fit into different domains and solve different problems.