# PROJECT DESIGN PHASE 1

# SOLUTION ARCHITECTURE

**Project Title: A Novel Method for Handwritten Digit Recognition System**

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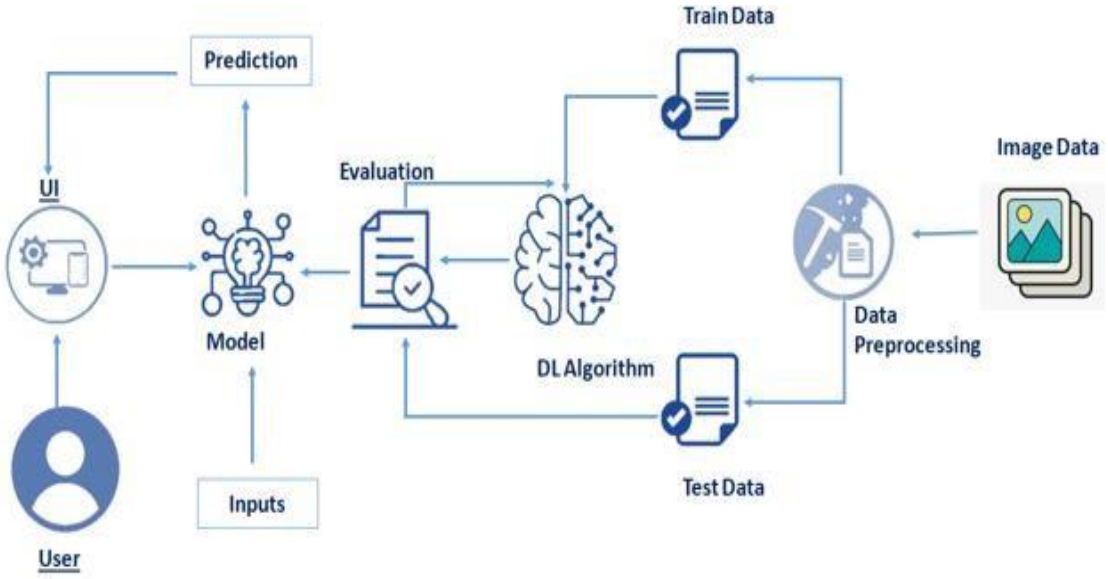
## INTRODUCTION:

Everyone in the world has a unique writing style, handwriting identification is one of the fascinating research projects now being conducted. It is the ability of a computer to automatically recognize and comprehend handwritten numbers or letters. Every aspect of life is being digitalized to lessen the need for human labor as a result of advancements in science and technology. Thus, handwritten digit recognition is required in many real-time applications. The MNIST data collection, which contains 70000 handwritten digits, is frequently utilized for this recognition method. In order to train these photos and create a deep learning model, we use artificial neural networks. A web application is developed that allows users to upload pictures of handwritten numbers. A web application is created that enables users to upload pictures of handwritten numbers.

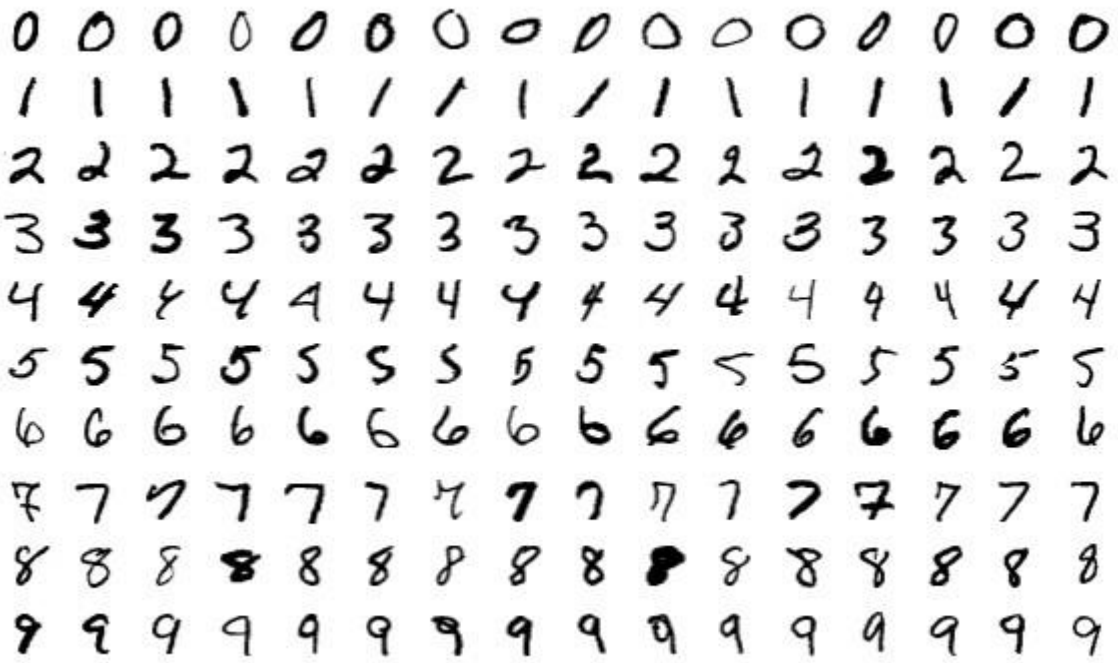
## TECHNOLOGY ARCHITECTURE




## SOLUTION:

### Description of MNIST dataset:

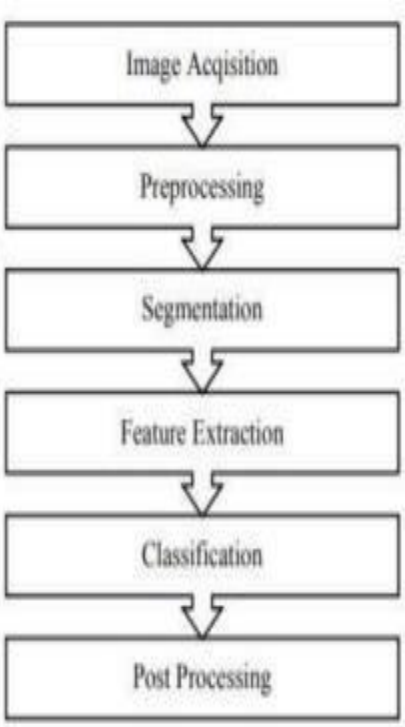
10,000 test handwritten digit images and 60,000 training handwritten digit images make up the MNIST Handwritten Digit Recognition Dataset. The total number of pixels in each image is 784 (2828), with a height of 28 pixels and a width of 28 pixels. A single pixel value connects every pixel. It displays the brightness or darkness of that pixel (larger numbers indicates darker pixel). The integer for this pixel value ranges from 0 to 255.



*Various styles of writing the digits 0-9*

**PROCEDURE:**

Generally Handwriting Character Recognition (HCR) is categorized into six phases which are acquisition of image, pre-processing of enter image, segmentation, feature extraction, classification and put up processing.




*Block Diagram of Handwriting Character Recognition*

**1.Image Acquisition**

The input photo is supplied to the consciousness gadget at the Image Acquisition stage. The input can be either in a photograph layout such as JPEG, BMT, etc., or a scanned image, or any other gorgeous digital input machine.

**2. Pre-Processing**

The 2nd method, known as pre-processing, is the entry approach for personality cognizance and is very essential in finding out the focus quality. Preprocessing operates to normalize strokes and also to take away deviations that can minimize the accuracy rate. Preprocessing works usually on distinctive distortions such as irregular textual content size,

missing points at some point of pen movement, jitters, left — proper bend and uneven spaces.

### 3. Segmentation

Segmentation is used to transform the enter representation of many characters to the individual characters. The methods used are the segmentation of words, strains and characters. Typically, it is carried out by way of isolating a single persona from a word picture. In addition, the contents are processed in a way that is like a tree. In the initial scenario, the line histogram is used to phase the lines. After that, each level, the characters are retrieved by a approach known as histogram, and subsequently they are retrieved.

### 4. Feature Extraction

The aim of the extraction characteristic is to permit the extraction of the sample that is most important for classification. Some of the Extraction Function techniques such as Principle Component Analysis (PCA), Scale Invariant Feature Extraction (SIFT), Linear Discriminant Analysis (LDA), Histogram, Chain Code (CC), Zoning and Gradient-based applied sciences can also be used to get rid of the traits of character characters .Each of the segmented pictures is taken with a pixel of dimension 28* 28 .By flattening the array into a vector of 28 * 28 = 784 numbers, the photograph now converges to a minimal bunch of arrays in a quite high-quality structure 784-cell dimension. The photograph now turns into a n dimensional array tensor.

### 5. Classification

Decision-making takes vicinity at some point of the classification process. The extracted attributes are used to become aware of the characters. Different classifiers algorithms are used, such as SVM and Neural Networks. The classifiers sort the precise input function with reserved sample and find the best matching input classification for which Soft Max Regression is being used. Soft Max regression assigns each result with the probability so classification will become easy. This essentially incorporates all the proof this obtains through using components and then transforms it into the conceivable chances.

### 6. Post-Processing

The Post-processing is the last and ultimate phase of persona recognition. It is the procedure whereby herbal language is used to right the misclassified output. It procedures output by means of getting it after a recognition of the shape. If the shape is diagnosed basically then the accuracy can be increased in accordance to language knowledge. For exclusive handwriting inputs, shape recognizers behave differently. Since 1998, researchers have been learning the hassle of handwritten digit focus with almost all the algorithms developed with the aid of then and even up till now. The rate of test blunders reduced from 12% in 1988 per linear classifier to 0.23% in 2012 through Convolutionary networks, and extra and extra facts scientists and computer studying experts are attempting to increase and validate unsupervised getting to know methods such as auto encoders and deep getting to know models.

**MNIST DATABASE:**

The MNIST database consists of 70000 handwritten digitized numerals dispensed in ten different classes. For training purposes, the entire dataset is divided into 60,000 images, and the ultimate ten thousand is reserved for the check collection. In this work in the interval [0,1], the gray level values of every pixel are coded the use of a price of 0 for white pixels and 1 for black pixel. In the MNIST dataset, the records is already properly prepared: the pics have been founded in a 28x28 picture by computing the core of the pixel mass and translating the picture to role this point at the core of the 28x28 field. The coaching set consists of 30,000 patterns from SD-3 and 30,000 patterns from SD-1 and the take a look at set consisted of 5,000 SD-3 patterns, and 5,000 SD-1 patterns

**ALGORITHM:**

Convolutional Neural Networks (CNN) is used to train the model for the character recognition process. CNN consists of a lot of layers. These layers when used repeatedly, lead to a formation of a Deep Neural Network. The fundamental types of layers used to build a CNN are:

**1. Input**

This layer holds the uncooked pixel values of photograph and convert it to grayscale pics using 28x28 matrix of pixels.

**2. Convolutional Layer**

This layer gets the effects of the neuron layer that is linked to the enter regions. The wide variety of filters to be used in this layer is described

here. Each filter may additionally be a 5x5 window that slider over the input records and receives the pixel with the most intensity as the output.

### 3. Rectified Linear Unit (ReLU) Layer

This layer applies a thing smart activation function on the picture records and makes use of again propagation techniques. ReLU function is utilized in order to preserve the equal values of the pixels and not being changed by means of the returned propagation.

### 4. Fully Connected Layer

This layer is used to compute the score instructions that potential which class has the maximum score corresponding to the enter digits. The category label with the largest likelihood is chosen as the ultimate classification from the network and proven in the output.

## WORKING:

### 1. Tensorflow

The application for this project uses Tensorflow as its backend. In 2015, the Google Brain Team released TensorFlow, a fantastic records library in the Machine Learning Library, for free. It is intended to be simple to use and very applicable to both problems with numerical and neural gadgets, just like other spaces. TensorFlow is essentially a low-level math-entangled tool that encourages specialists who know what they're doing to create experimental studying structures, play about with them, and turn them into operating programmes. Generally speaking, it may be said that equations can be referred to as graphs in programming context. Graph nodes are

used to speak mathematical operations, and multidimensional edges are included.

### 2. Python

Python is used for the duration of the implementation of assignment the place several traces of code had been brought in order to accomplish the assignment requirements. Python is typically used globally, and is a high-level programming language. It was once implemented in particular for application dominance, and its language shape allows software program engineers to carry thoughts in fewer traces of code. Python is a programming language which gives the chance to work shortly and more correctly organize frameworks.

### 3. NumPy

For the mathematical calculations needed to print out the predict records for this project, NumPy is employed. The foundational Python and NumPy package for scientific computing. It is a flexible, high-end (broadcasting) software programme with N-dimensional array object characteristics that combines Fortran, C/C++, and beneficial linear algebra with Fourier transformation and random number capabilities.

### 4.Matplotlib

Matplotlib is used to plot model accuracy and loss in a graphical view in this project. Matplotlib is a Python 2D plotting library that produces pleasant figures for the publication throughout platforms in a variety of hardcopy formats and interactive environments. Matplotlib can be used in

Python scripts, Python and IPython shells, Jupyter notebook, Web software servers, and four interface toolkits for graphical users.

## RESULT:

As with any study or project conducted in the fields of machine learning and image processing, we do not consider our results to be perfect. Because machine learning is a field that is constantly evolving, there is always room for improvement in your approaches. There will always be a brand new concept that more successfully addresses a certain issue. The application was evaluated using three models: Multi-Layer Perceptron (MLP), Convolution Neural Network, and (CNN). With each model, we get a different classifier accuracy, showing which is better.