SOLUTION ARCHITECTURE

Project Name: A Novel Method for Handwritten Digit Recognition System

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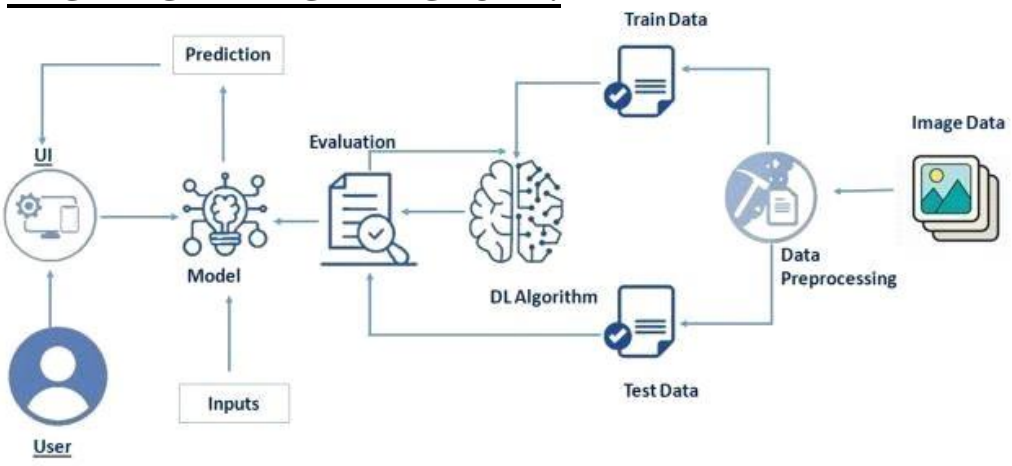
PROJECT DESCRIPTION:

Handwriting detection is one of the most fascinating scientific topics currently under progress since everyone has a unique writing style. It is the ability of the computer to automatically recognise and comprehend handwritten numbers or characters. Everything is becoming digitalized to minimise human effort as a result of scientific and technological advancements. In many real-time applications, handwritten digit identification is therefore necessary. This recognition algorithm frequently makes use of the MNIST data collection, which comprises 70000 handwritten digits. Artificial neural networks are used to train these pictures and develop a deep learning model. The user can submit a picture of a handwritten digit using a web application that has been created.

TECHNICAL ARCHITECTURE:



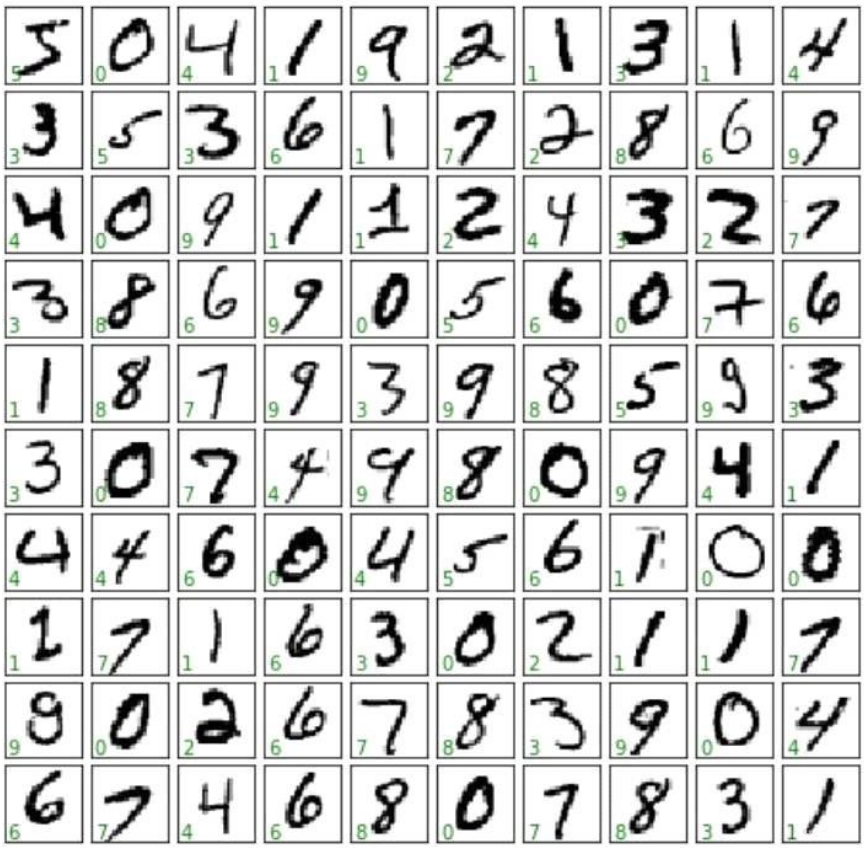
SOLUTION:

MNIST Dataset Description:

There are 60,000 training and 10,000 testing handwritten digit pictures in the MNIST

Handwritten Digit Recognition Dataset. Per picture is 784 (2828) pixels in size and has a height and width of 28 pixels each. A single pixel value links every pixel together. It tells whether a pixel is bright or dark (larger numbers indicates darker pixel). An integer

between 0 and 255 makes up this pixel value.



PROCEDURE:

- Install the TensorFlow library.
- Prepare the model's dataset.
- For the purpose of classifying the handwritten digits, create a single layer perceptron model.
- Plot the accuracy change over time.
- Analyse the test data to evaluate the model.
- Speculate on the model summary.
- To make the model a multi-layer perceptron, add a hidden layer.
- To avoid overfitting and assess its impact on accuracy, include Dropout.
- Increase the number of hidden layer neurons and assess how accuracy is affected.

- Test the impact of various optimizers on accuracy.
- Increase the hidden layers and assess the accuracy impact.
- Change the batch size and epochs, then assess the impact on accuracy.

For handwritten digit recognition, the MNIST dataset is a popular choice. Ten thousand test photos make up the dataset, which includes sixty thousand training images. Artificial neural networks, which are a crucial component of the image processing industry, can most closely resemble the human brain. A significant experiment employing neural networks was the handwritten digit recognition using the MNIST dataset. The handwritten numerals on scanned photographs are essentially detected.

In addition to reading handwritten numbers from scanned photos, we've gone a step further and developed handwritten digit recognition software that lets you write numbers on a screen and have them read by a built-in GUI.

Approach: We will approach this project by using a three-layered

Neural Network.

- **The input layer**: It distributes the features of our examples to the next layer for calculation of activations of the next layer.
- **The hidden layer**: They are made of hidden units called activations providing nonlinear ties for the network. A number of hidden layers can vary according to our requirements.
- **The output layer**: The nodes here are called output units. It provides us with the final prediction of the Neural Network on the basis of which final predictions can be made.

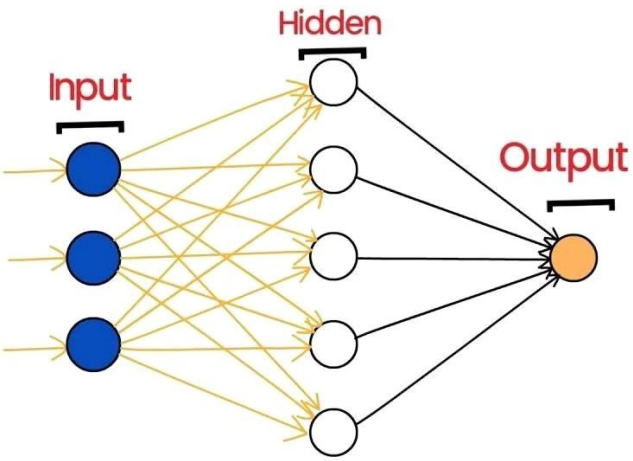
A neural network is a representation of the way the brain works. It has several layers and various activations, which resemble the neurons in our brain. An effort by a neural network to learn a set of parameters from a batch of data may help identify underlying connections. Without needing to reconsider the output criteria, neural networks can offer the greatest outcomes since they can adjust to changing input.

ALGORITHM:

Forward Propagation Architecture:

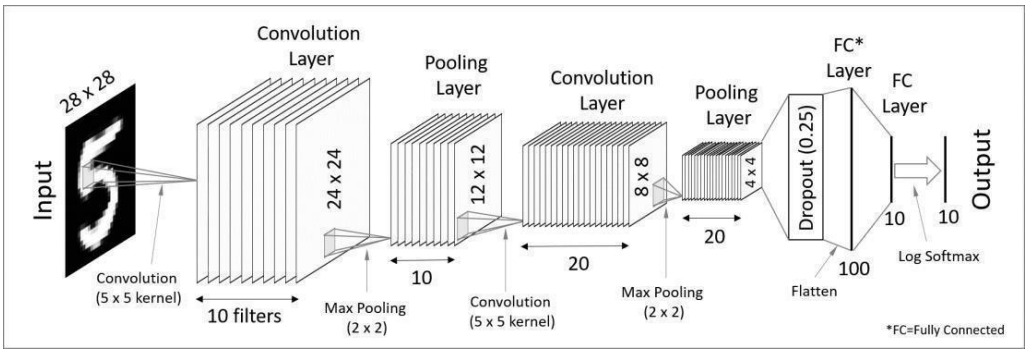
It is a brief description of how the CNN module will extract features and categorize the image based on them. The network's input layer, hidden layers, and output layer are depicted in the

design. The feature extraction phase of the network involves multiple layers, including convolution and resampling.



Explanation:

- The User layer in the architecture is the top layer. People who interact with the app and need the desired results will be included in the user layer.
- The open-source platform for HTML, CSS, and JavaScript will be used to create the application. The localhost, which is displayed in the browser, is where the programme is deployed. The user will be able to upload images of the handwritten numbers to the app to have them digitalized.
- The one in between the database and view layer is the business layer which is the logical calculations on the basis of the request from the client side. It also has the service interface.
- The backend layer consists of two datasets: Training Data and Test Data. The MNIST database has been used for that which is already divided into training set of 60,000 examples and test of 10,000 examples.
- Convolution neural network is the training algorithm employed. By doing this, the trained model will be ready to be used to categorise the digits found in the test data. As a result, the digits in the photos may be categorised as Class 0,1,2,3,4,5,6,7,8,9.



WORKING:

- Neural networks modify information using a number of hidden layers after receiving it.
- The connections between every group of neurons in a buried layer and every other neuron in the layer above it are perfect.
- Neurons in one layer are completely independent of one another.
- The last layer to be fully linked is the output layer.

Convolution Layer:
The foundational component of a CNN is the convolutional layer. The parameters of the layer are a collection of learnable filters (or kernels) that cover the whole depth of the input volume but have a narrow receptive field. Each filter is convolved over the width and height of the input volume during the forward pass, computing the dot product between each filter entry and the input to create a two-dimensional activation map of the filter. As a consequence, the

network picks up filters that turn on when they spot a certain kind of feature at a particular location in the input.

Feature Extraction:
The weights of each neuron in a feature are the same. In this manner, the same feature is recognised by all neurons at various locations in the input picture. Limit the number of unrestricted parameters.

Subsampling Layer:
Reducing the total size of a signal is referred to as subsampling, sometimes known as down sampling. Each feature map's spatial resolution is reduced by the subsampling layers. Shift or distortion invariance is attained, and the impact of sounds is lessened.

Pooling layer:
In a Convent architecture, it is typical to sporadically introduce a Pooling layer between succeeding Conv layers. In order to decrease the number of parameters and computation in the network and, as a result, control overfitting, it gradually shrinks the spatial size of the representation. Every depth slice of the input is individually processed by the Pooling Layer, which then applies the MAX operation to enlarge each slice spatially.

TensorFlow:
Open-source machine learning library TensorFlow is used in both research and production. For developers of all skill levels, TensorFlow provides APIs for desktop, mobile, web, and cloud platforms. To begin, look at the parts below. Text and sound output may be obtained by scanning the number digit and converting it to png format using the python3 command at the terminal.

RESULT:

There is always space for improvement in our methods because machine learning is a discipline that is always changing. There will always be a fresh idea that better deals with a certain problem. The application was evaluated using three models—Multi-Layer Perceptron (MLP), Convolution Neural Network, and (CNN). The classifier accuracy for each model varies, demonstrating which is more accurate.