

HANDWRITTEN DIGIT RECOGNITION

(A Convolutional Neural Network Approach)

MAIN GOAL & APPLICATIONS

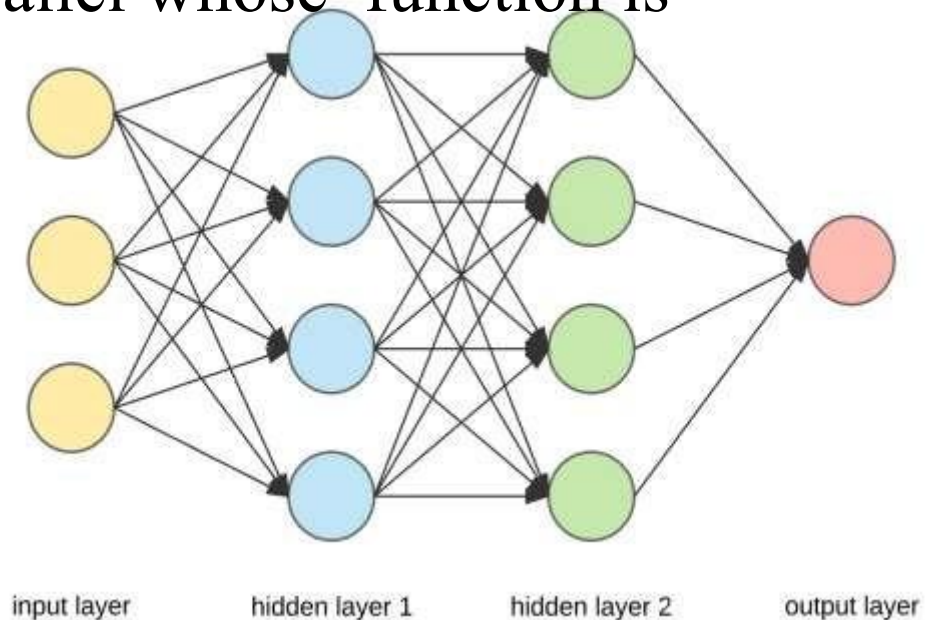
- Handwritten Digit Recognition is used to recognize the Digits which are written by hand.
- A handwritten digit recognition system is used to visualize artificial neural networks.
- It is already widely used in the automatic processing of bank cheques, postal addresses, in mobile phones etc

INTRODUCTION

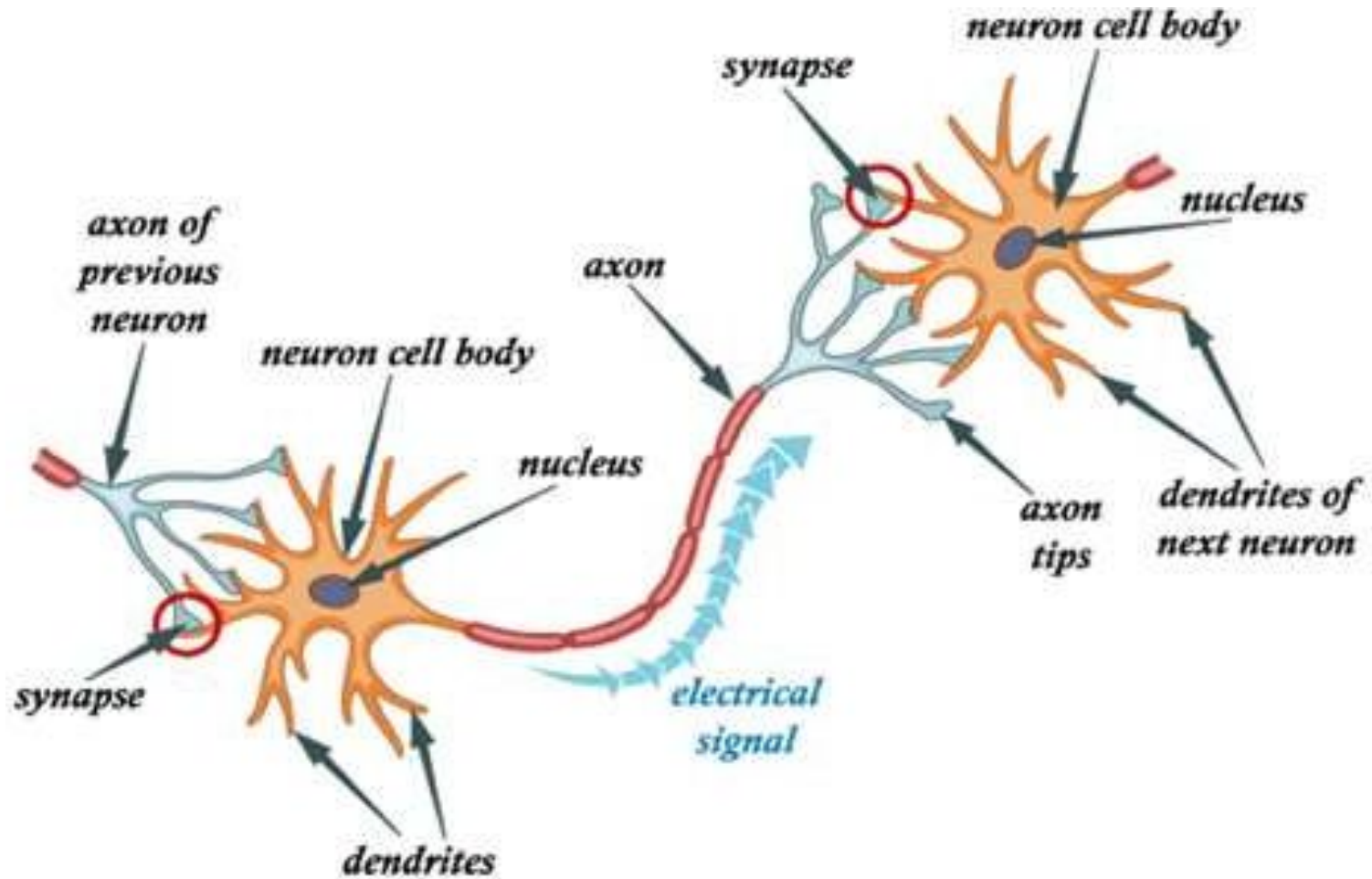
- Scientists believe that the most intelligent device is the Human Brain.
- There is no computer which can beat the level of efficiency of human brain. These Inefficiencies of the computer has lead to evolution of “Artificial Neural Network”.
 - They differ from conventional systems in the sense that rather than being programmed these system learn to recognize pattern.

What are Neural Networks?

- Artificial neural networks, usually called neural networks (NNs), are interconnected systems composed of many simple processing elements (neurons) operating in parallel whose function is determined by-
 - 1) Network Structure
 - 2) Connection Strengths
 - 3) The Processing performed at Computing elements or nodes.



A neural cell in the brain



TRAINING DATASET

- Training of the network is done by a dataset named MNIST dataset.
- MNIST dataset has a training set of 60,000 examples, and a test set of 10,000 examples.
- All the images in the dataset are of 28x28 pixels.

- It is a good database for people who want to try learning techniques and pattern recognition methods on real-world data while spending minimal efforts on preprocessing and formatting.



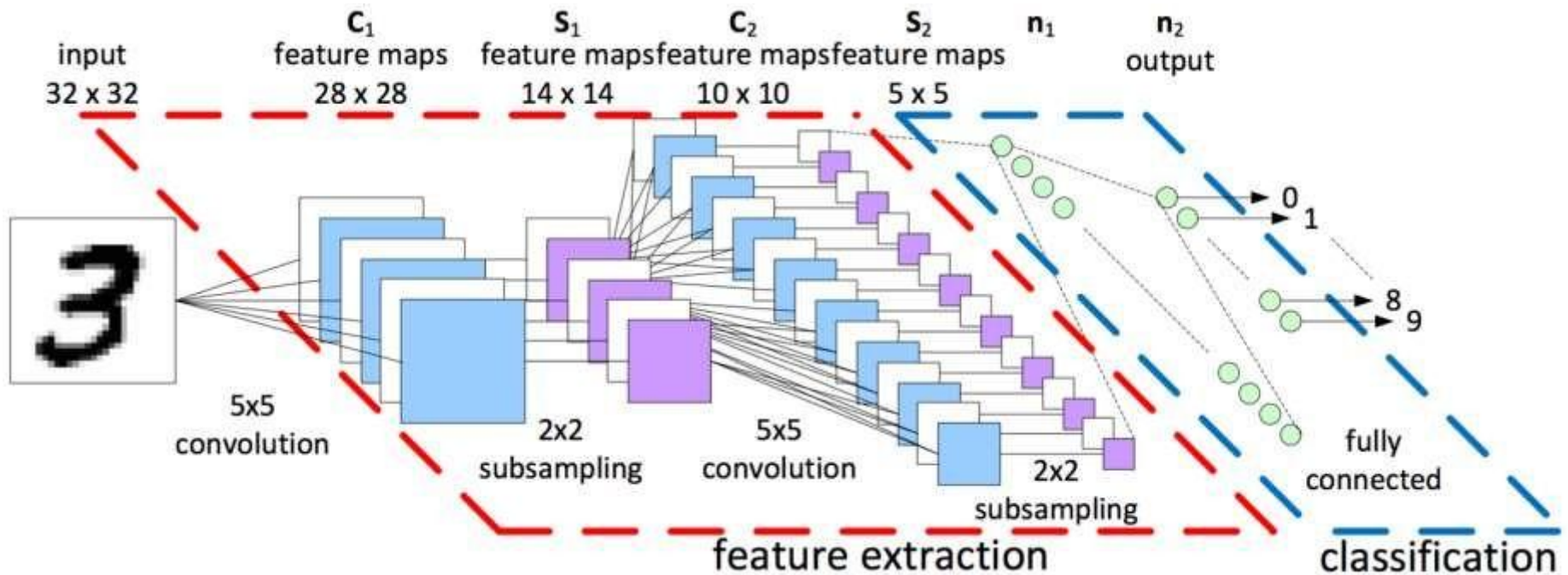
Why Convolutions?

Convolution is a simple mathematical operation between two matrices in which one is multiplied to the other element wise and sum of all these multiplications is calculated.

Convolutions are performed for various reasons-

- Convolutions provide better feature extraction
- They save a lot of computation compared to ANNs.
- Less number of parameters are created than those in pure fully connected layers.
- Due to less number of required parameters, lesser fully connected layers are needed.

Architecture of a Convolutional Neural Network



Convolutional Neural Network Architecture

This model's architecture consists of three main parts, two convolutional blocks and one fully connected neural network layer.

The inputs to this model are 28x28 images.

First Convolutional Block:

A 28x28 image is taken as input to this block. A padding of 2 units is added to the image so as to retain its dimensions after a convolution operation on the image by 16 5x5 filters/kernels.

The output of the convolution gives $16 \times 28 \times 28$ volume, which is then input to a ReLU activation function followed by a MaxPool operation. ReLU activation is used to introduce some non-linearity. This block outputs a $16 \times 14 \times 14$ volume.

Second Convolutional Block:

First step is again a convolution operation on $16 \times 14 \times 14$ by 32 5×5 kernels with padding of 2 units, obtaining a $32 \times 14 \times 14$ volume. It is passed through a ReLU activation followed by a MaxPool operation. Second convolutional block outputs a $32 \times 7 \times 7$ volume.

Fully connected Neural Layer:

Here, a single hidden layer of 10 nodes is taken as the fully connected layer.

Finally, the output of the fully connected layer is passed to a softmax function to obtain the output result of recognition.

Building Handwritten Digit Recognition

1. Import the libraries and load the dataset

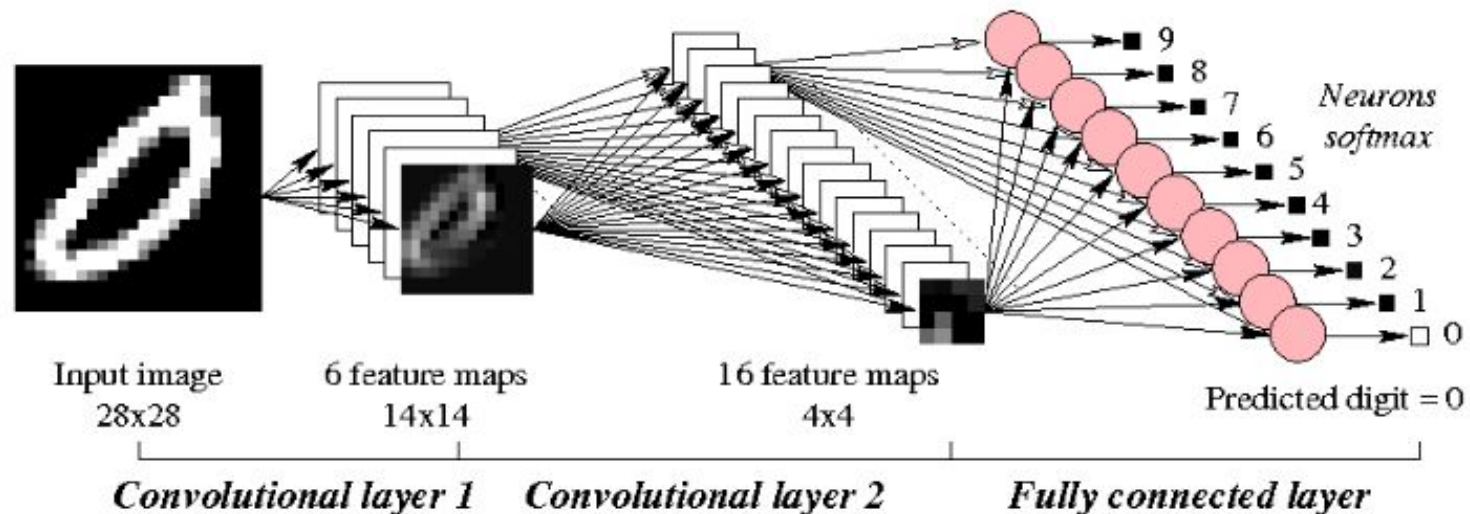
First, we are going to import all the modules that we are going to need for training our model. The Keras library already contains some datasets and MNIST is one of them. So we can easily import the dataset and start working with it.

2. Preprocess the data

The image data cannot be fed directly into the model so we need to perform some operations and process the data to make it ready for our neural network. The dimension of the training data is (60000,28,28). The CNN model will require one more dimension so we reshape the matrix to shape (60000,28,28,1).

3. Create the model

Now we will create our CNN model. A CNN model generally consists of convolutional and pooling layers. The model type that we will be using is *Sequential*. Sequential is the easiest way to build a model in Keras. It allows to build the model layer by layer. *add()* function is used for adding successive layers.



Model Architecture

4. Train the model

The `model.fit()` function of Keras will start the training of the model. It takes the training data, validation data, epochs, and batch size. It takes some time to train the model. Number of epochs is set 3. The number of epochs can be increased for better accuracy but here with even 3 epochs a remarkable accuracy gets achieved..

5. Evaluate the model

We have 10,000 images in our dataset which will be used to evaluate how good our model works. The testing data was not involved in the training of the data therefore, it is new data for our model. The MNIST dataset is well balanced so after training the model we achieved a remarkable validation accuracy of 97.92%

Conclusion

- The handwritten digit recognition using convolutional neural network has proved to be of a fairly good efficiency.
- It works better than any other algorithm, including artificial neural networks.

THANK YOU!