INFOSYS SPRINGBOARD

PROJECT REPORT

HANDWRITTEN DIGIT RECOGNITION

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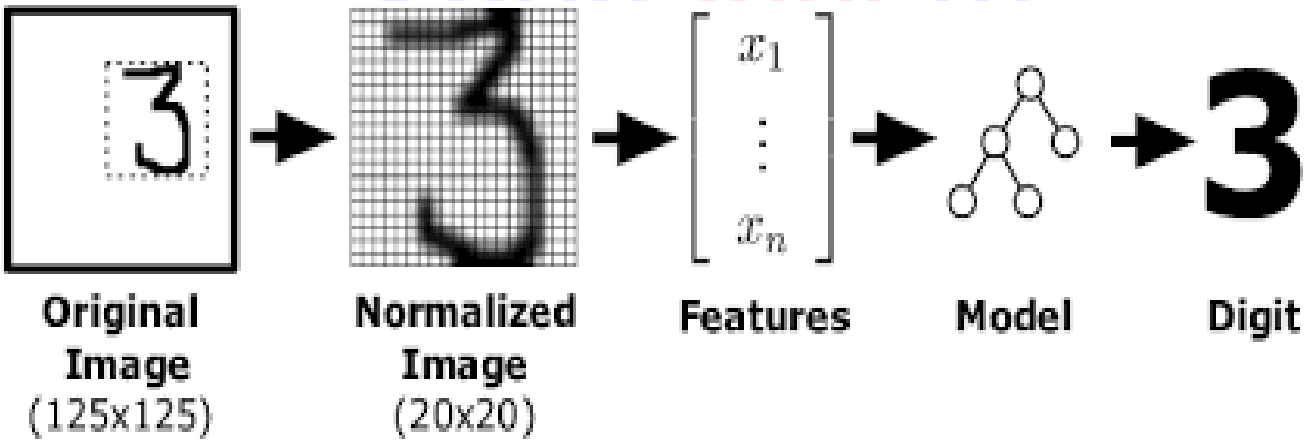
Comparative study of the employed models:

(I) Introduction:

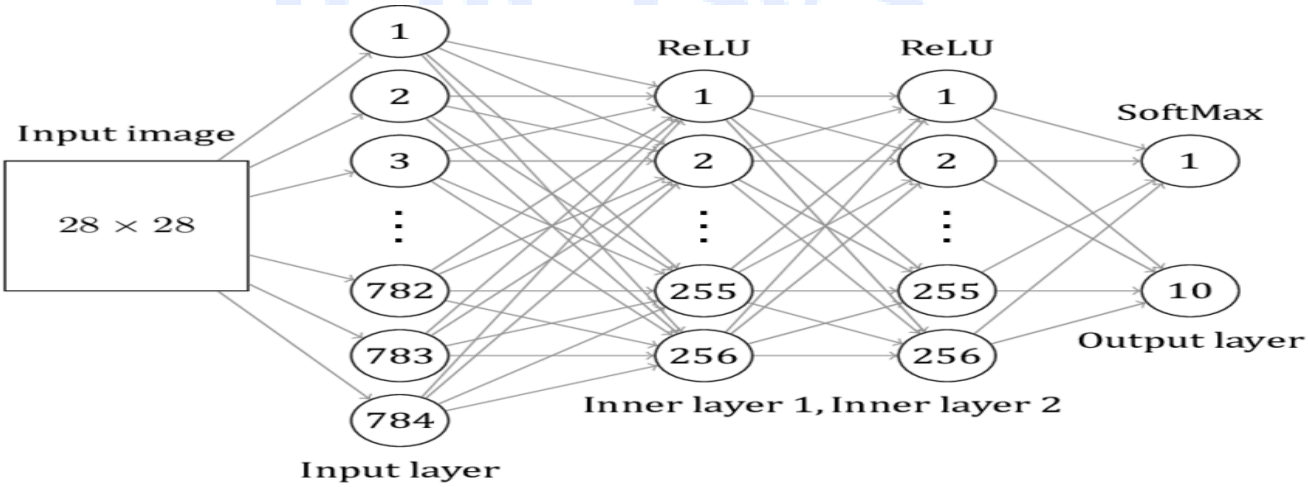
A popular demonstration of the capability of deep learning techniques is object recognition in image data. One of the most fundamental projects of object recognition for machine learning and deep learning is the MNIST dataset for handwritten digit recognition. Handwritten digit recognition is a multiclass supervised learning problem. In our work, we have additionally used various variants of the EMNIST dataset , which has more labels and data points, that aims to add a level of complexity to the project.



(II) Algorithms used:

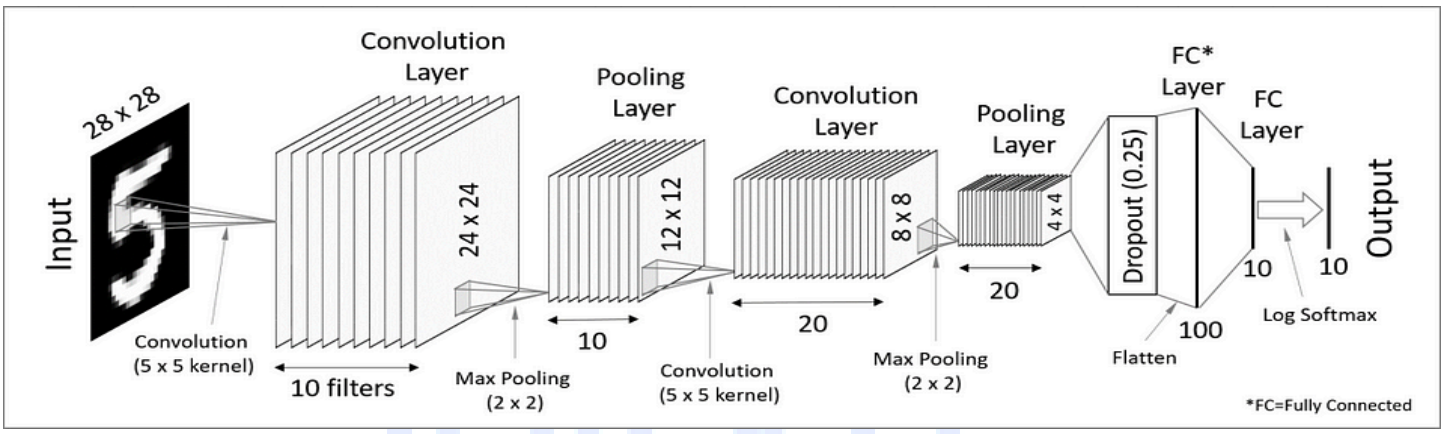
1. Baseline MLP:

The model is a simple neural network with one hidden layer with the same number of neurons as there are inputs (784). A rectifier activation function is used for the neurons in the hidden layer. The output of this model are **logits**, meaning they are real numbers which can be transformed into probability-like values using a softmax function.



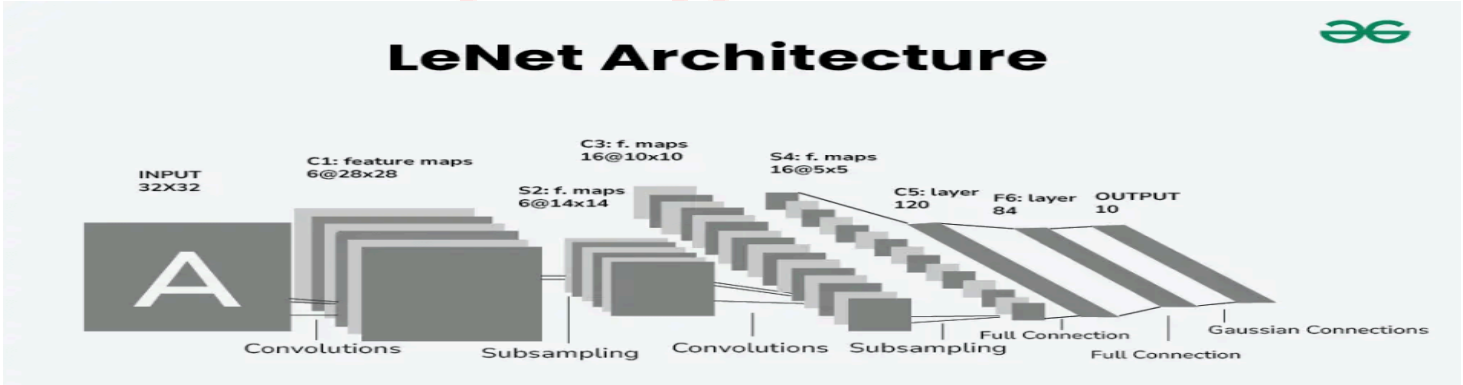
2. CNN:

A convolutional neural network that has more layers than the baseline MLP was employed, which was successfully able to increase the accuracy . This model consists of convolution, pooling , fully connected layers in addition to Relu for activation.



3. Lenet5:

One of the earliest demonstrations of the effectiveness of convolutional layers in neural networks is the “LeNet5” model. This model is developed to solve the MNIST classification problem. It has three convolutional layers and two fully connected layers to make up five trainable layers in the model.



(III) **COMPARISON:**

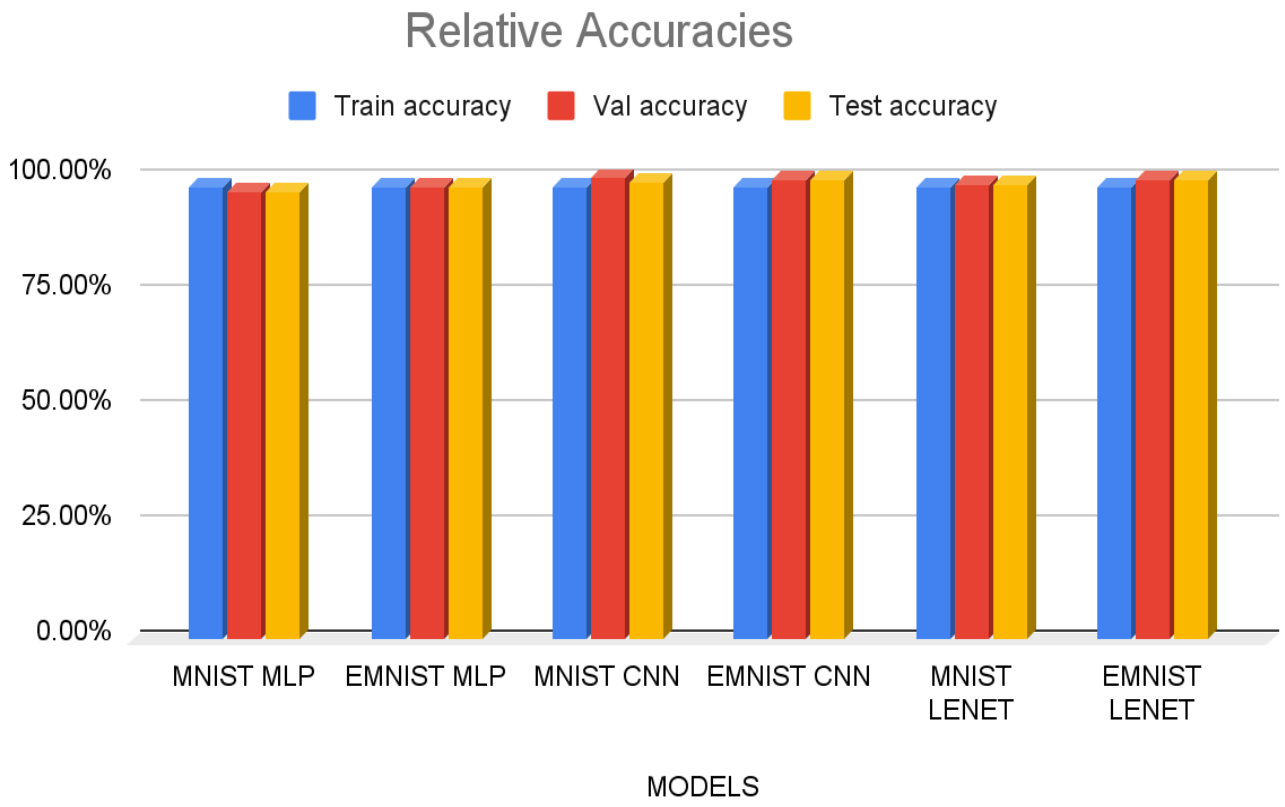
On experimenting with different datasets , specified models and tweaking various variables**,** we have tried to sum up our conclusions in the following table. Every model , takes an input image of 28*28 pixels.

Dataset Used	**Mode**	**Descriptio**	**Type of model**	**Train accur**	**Validati accurac**	**Testing accurac**	**Lay -ers***	**Epoc**	**Ac tivat ion**	**Optim- izer**	**Normaliza -tion**	**Paramet**
1.MNIST	MLP	10 labels, 70,000 data points	Simple n network	97.94%	96.88%	96.87%	4	10	Relu	Adam	YES ((0.5),(0.5))	109,386
2.EMNIST (digits)	MLP	10 labels, 280,000 datapoints	Simple neural network	98.97%	98.28%	98.28%	4	10	Relu	Adam	YES ((0.5),(0.5))	109,386
3.MNIST	CNN	10 labels, 70000 data points	Convolut -ed neural network	99.65%	99.98%	99.09%	12	10*	Relu	Adam	YES ((0.5),(0.5))	80,202
4.EMNIST (digits)	CNN	10 labels, 280,000 data points	Convolu -ted Neural network	99.79%	99.43%	99.41%	12	10*	Relu	Adam	YES ((0.5),(0.5))	80,202

5.MNIST	Lenet	10 labels, 70000 data points	Deep neural network	99.42%	98.84%	98.77%	7	10	Relu	Adam	YES ((0.5),(0.5))	44,186
6.EMNIST (digits)	Lenet	10 labels, 280,000 datapoints	Deep Neural network	99.62%	99.37%	99.39%	7	10	Relu	Adam	YES ((0.5),(0.5))	44,186
7.EMNIST (letters)	MLP	26 labels,1 data points	Simple Neural network	90.46%	Nil	90.88%	4	10	Relu	Adam	YES ((0.5),(0.5))	109,386
8.EMNIST class)	Lenet	62 classes, 814,255 datapoints	Deep neural network	85%	Nil	85.80%	7	10	Relu	Adam	YES ((0.5),(0.5))	44,186

(IV) OBSERVATIONS :

- CNN and Lenet models outperformed the baseline MLP, across all datasets that were used.



- As the complexity of the dataset increases, performance decreases. So, we chose MNIST trained models for our final UI as they performed better .

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