

Handwritten digit recognition using CNN

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Abstract:

The idea is to train a computer system to first understand the handwritten images of digits and then test the system to predict new handwritten images correctly on MNIST dataset using convolutional neural network.

Resources Used:

- Jupyter Notebook
- Keras
- Python 3
- MNIST Dataset

The Jupyter Notebook is an open-source IDE that allows users to share and create the documents that contain live code, narrative text, etc. Keras is a high-level neural network API focused on user friendliness, fast prototyping, modularity and extensibility.

The MNIST data set is a large database of handwritten digits (0 to 9). It contains 60,000 training images and 10,000 testing images each of size 28x28.

Introduction:

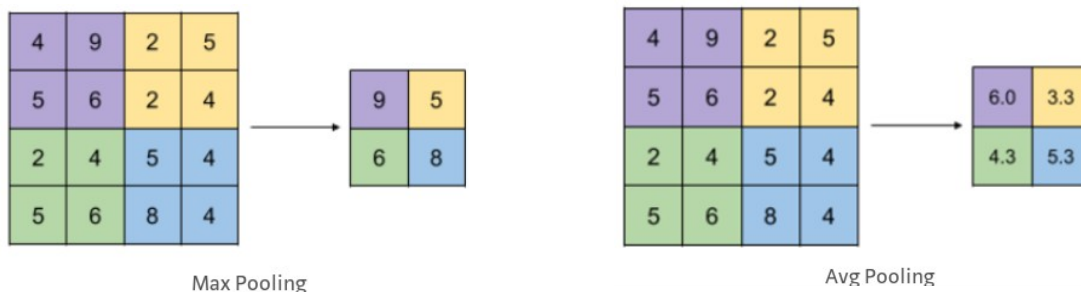
The Convolutional Neural Network has been used to implement the proposed model. This model has been implemented using a high-level neural network API Keras. The CNN consists of following layers:

- Convolution Layer and Pooling Layer (Usually considered as same Layer)
- Fully Connected Layer

Convolution Layer and Pooling Layer:

Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data.

Pooling layers reduces the dimensionality of each feature map and retains the most important information of an image and increases the speed of computation. Max pooling is the most commonly used pooling technique than average pooling. In Max pooling the filter selects the maximum value from the set of elements under consideration while In average pooling technique the average value is selected.



Fully Connected Layer:

The fully connected layer is just like a single NN layer. The output of the previous layer is given as an input to this layer. This layer gets its name from the fact that each unit of the previous layer is connected to each unit in this layer.

Implementation:

The proposed model to recognize handwritten digits (0-9) as been implemented using CNN with the help of a high-level neural network API Keras which runs on the top of tensorflow. The Configurations used for CNN model are as follow:

- Image Size : 28x28

- 2 Convolution Layer

 - Filter : 3x3x1

 - Activation Function : relu

 - Relu function : $f(x) = \max(0, x)$.

 - ReLU's purpose is to introduce non-linearity in our ConvNet.

 - Pool Size : 2x2

- 2 Fully Connected Layer

 - Activation Function : relu, softmax

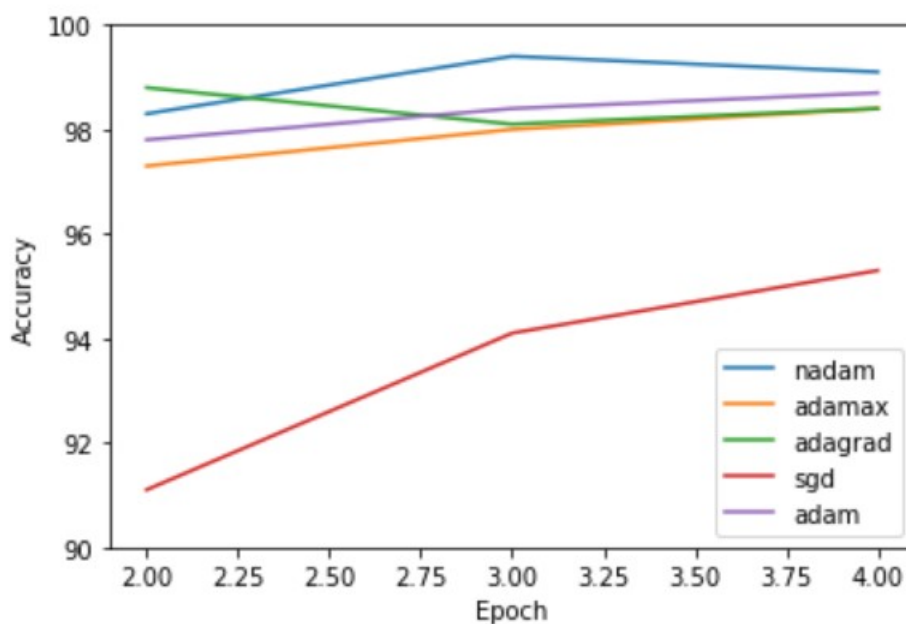
 - Nodes : 128

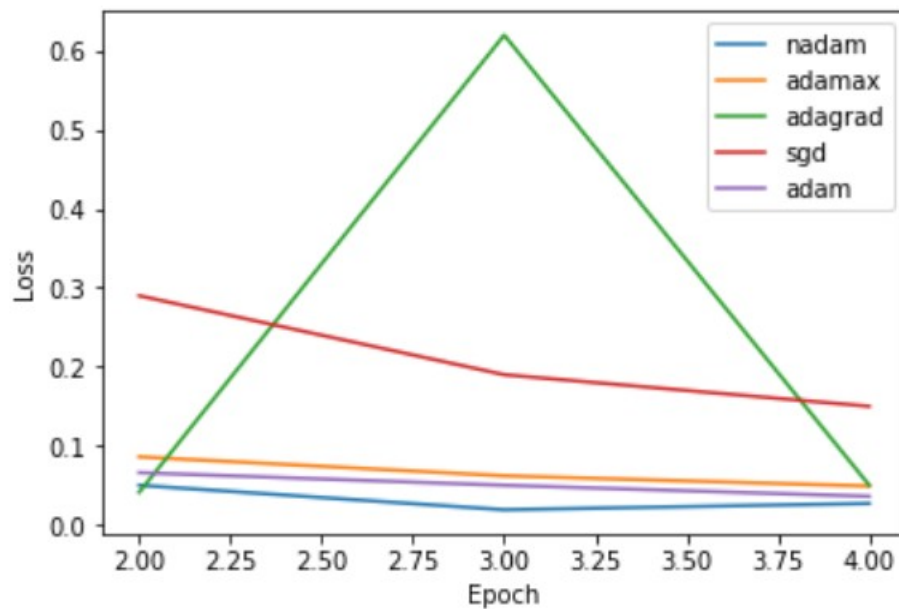
Result:

The designed model was run using different optimizer. Following table shows the obtained result.

OPTIMIZER	LOSS	ACCURACY	EPOCH
adam	0.066	97.8	2
	0.050	98.4	3
	0.036	98.7	4
sgd	0.29	91.1	2
	0.19	94.1	3
	0.15	95.3	4
adagrad	0.041	98.8	2
	0.62	98.1	3
	0.05	98.4	4
adamax	0.086	97.3	2
	0.062	98.0	3
	0.049	98.4	4
nadam	0.05	98.3	2
	0.019	99.4	3
	0.027	99.1	4

It is observed from the result that accuracy generally increases and loss decreases with increase in number of epoch.





Conclusion:

A model has been implemented using CNN and MNIST data set to recognize handwritten digit. This model give good accuracy (correct answer) only with MNIST dataset.