Int 248 **ADVANCED MACHINE LEARNING**

CA-2 Handwritten Character recognition using CNN

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The project is done with the help of MD.Imran Hussain.

Github link of the project:
https://github.com/raghuln26/HANDWRITTREN-CHARACTER-RECOGNITION/blob/main/Char1_.ipynb
Dataset link:
https://www.kaggle.com/sachinpatel21/az-handwritten-alphabets-in-csv-format

Introduction:

In this present digital world, handwriting recognition plays a vital role in information processing. A Lot of data is accessible on paper, and handling computerized records is less expensive than handling conventional paper documents. The aim of a handwriting recognition system is to convert handwritten characters into machine-readable formats. The principal applications are vehicle license-plate recognition, postal letter-sorting services, Cheque truncation system (CTS) scanning and historical document preservation in archaeology departments, old documents automation in libraries and banks, etc.

Recognition is identifying or distinguishing a thing or an individual from past experiences or learning. Similarly, Character Recognition is nothing but recognizing or identifying the Character in any document. The character recognition framework is simply the working of a machine to prepare itself or interpret the characters. Handwritten Character Recognition is the capacity of a computer to interpret manually written characters.

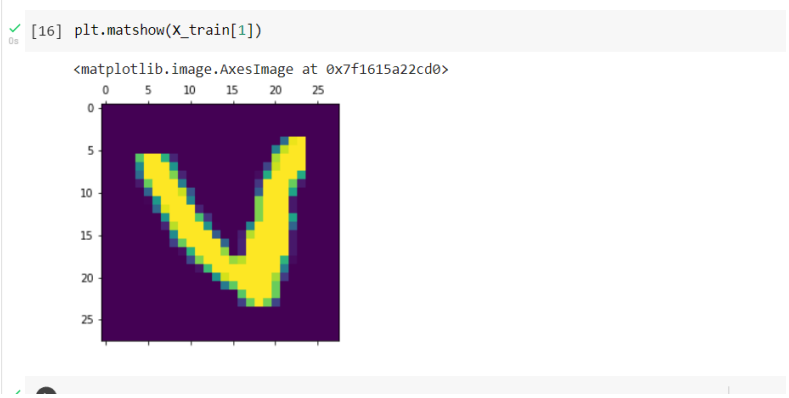
The artificial neural network is used in various pattern recognition/identification. Handwritten Characters or digits differ from person to person due to the handwriting of each person differs. Handwritten character recognition comes under the field of pattern recognition. Artificial neural networks play a very important role in the field of handwritten character or digit recognition.

Dataset:

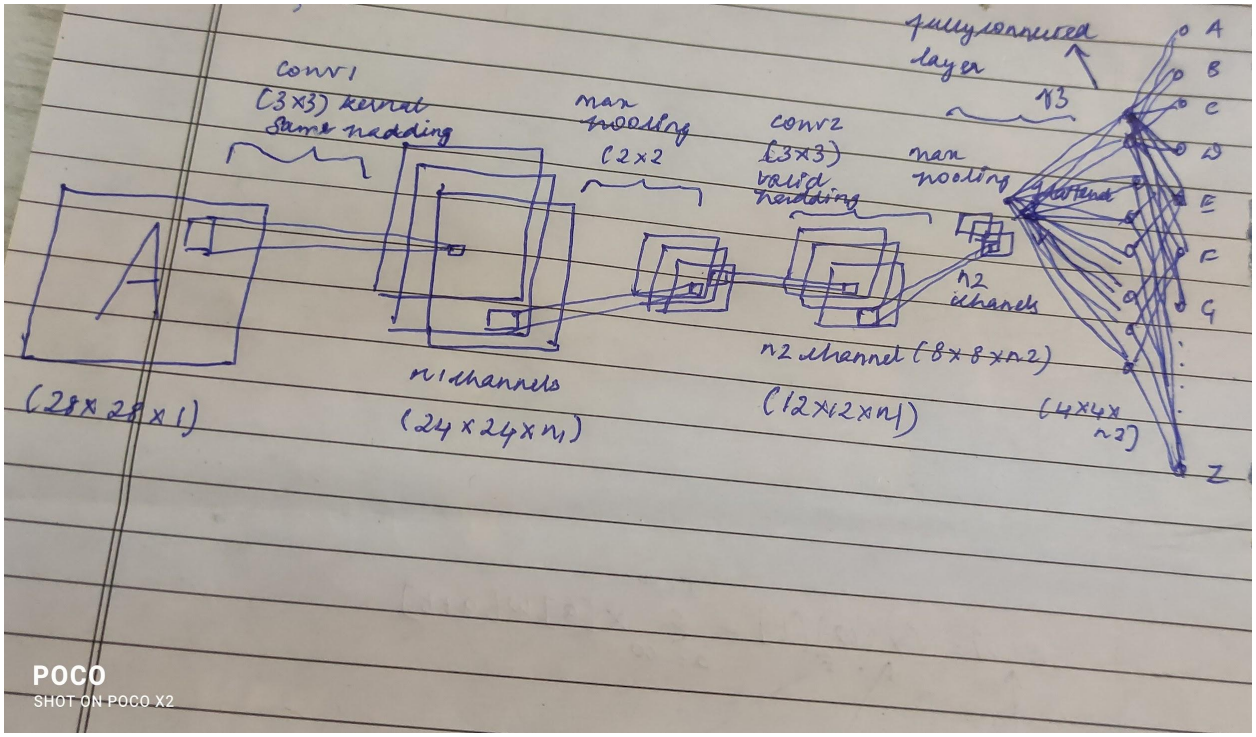
In this project, we have used Kaggle A-Z handwritten character recognition dataset. This dataset contains 372450 samples of each of 26 English characters written by different sets of people. The dataset contains a wide variety of distinct characters because of different peoples with different styles.

The English contain **5 are vowels and the rest 21 are consonants**. The 5 vowels include a, e, I, o, and u. A vowel sound is produced by a free flow of breath out of the mouth.

Figure 1:



The architecture of CNN:



The architecture of CNN consists of two main parts:

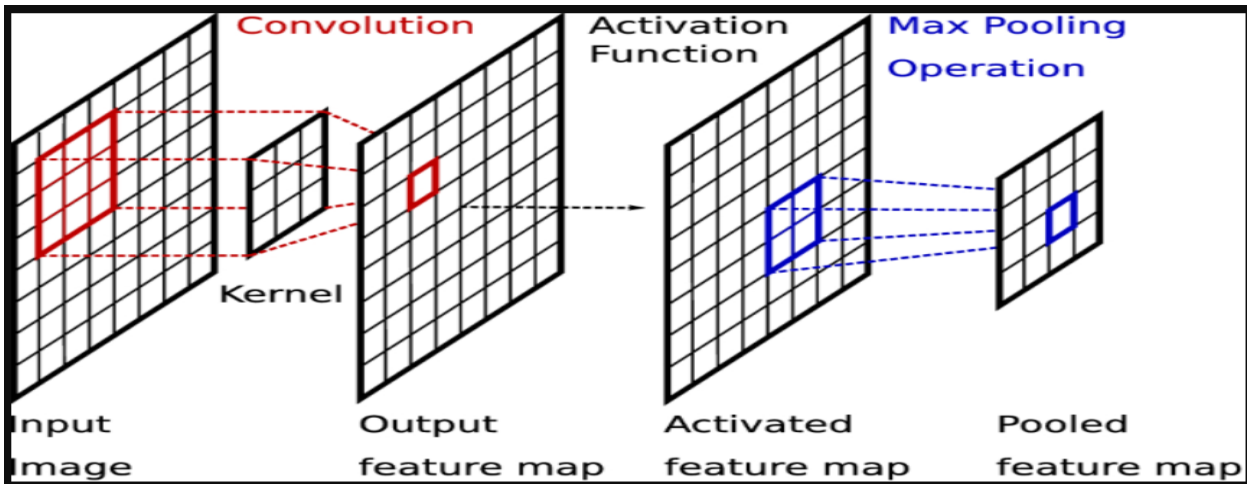
1. feature extraction

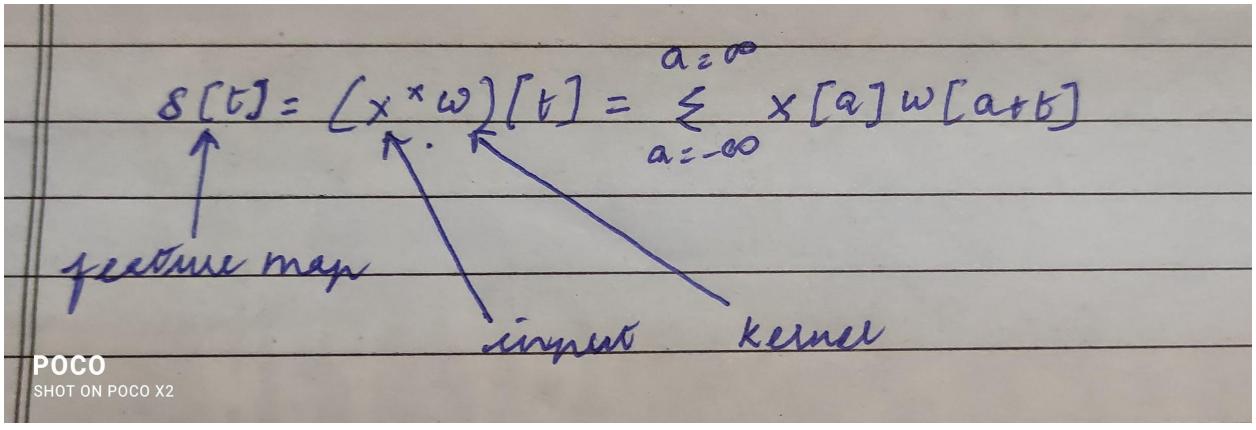
2. classification.

In the feature extraction layers, each layer of the network receives the output from its immediate previous layer as its input and passes the current output as input to the next layer. The CNN architecture is composed of the combination of three types of layers: convolution, max-pooling, and classification. The convolutional layer and max-pooling layer are two types of layers in the low and middle-level of the network. The even-numbered layers work for convolution and odd-numbered layers work for the max-pooling operation. The output nodes of the convolution and max pooling layers are grouped into a 2D plane which is called feature mapping. Each plane of the layer is usually derived with the combination of one or more planes of the previous layers. The node of the plane is connected to a small region of each connected plane of the previous layer. Each node of the convolution layer extracts features from the input images by convolution operation on the input nodes. The max-pooling layer abstracts feature through average or propagating operation on the input nodes. The higher-level features are derived from the propagated features of the lower-level layers. As the features propagate to the highest layer, the dimension of the features is mapping the extreme reduction depending on the size of the convolutional and max-pooling masks. However, the number of feature mapping usually increased for suitable features of the input images to achieve better classification accuracy. The

outputs of the last feature maps of CNN are used as input to the fully connected network which is called the classification layer. In the classification layer, the desired number of features can be obtained using feature selection techniques depending on the dimension of the weight matrix of the final neural network, then the selected features are set to the classifier to compute the confidence of the input images. Based on the highest confidence, the classifier gives outputs for the corresponding classes that the input images belong to. Mathematical details of different layers of CNN are discussed in the following section.

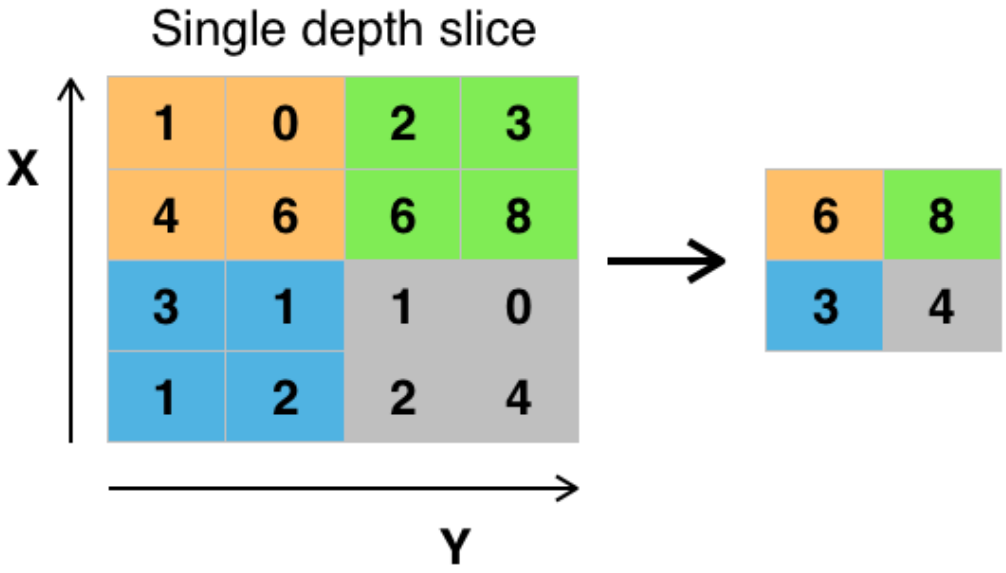
CONVOLUTION LAYER:





In this layer, the feature maps of the previous layer are convolved. The outputs of the kernel go through nonlinear activation functions to form the output feature maps.

POOLING LAYER:



In this layer, it performs a downsampling operation on the input maps. In this layer, the input and output maps don't change. For instance, if there are M no of input maps, there will be precisely M no of output maps. Because of the downsampling activity, the size of the output will be decreased relying upon the size of the downsampling cover.
There is two types of pooling techniques are there:

1. **Max pooling**
2. **Average pooling**

The pooling layer sums up m×m from the previous layers and selects the average value or the maximum values among the m×m. Accordingly, the output map dimension is reduced to X times with respect to both dimensions of the feature maps. The output maps finally go through linear or non-linear
activation functions.

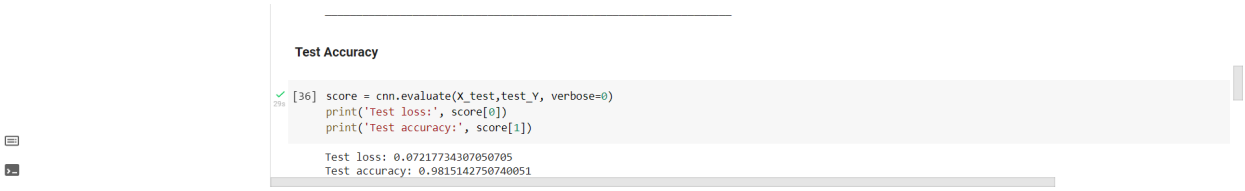
Classification Layer:

This is a completely associated layer that registers the score for each class of the items utilizing the extricated highlights from the convolutional layer. In this work, the size of the component map is viewed as a feed-forward neural net is utilized for order. With respect to the enactment work, softmax.

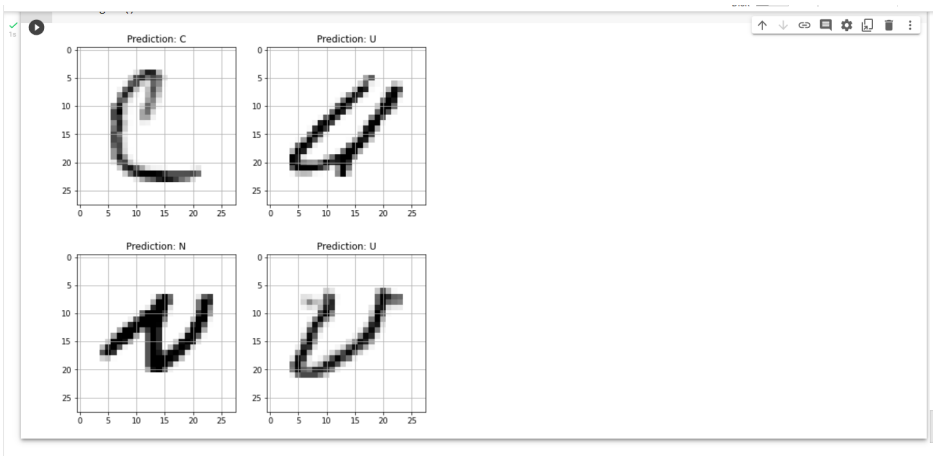
Result:

In my project I have got test accuracy of **98.15%** and a training accuracy of **98.78%** on English handwritten character dataset with epochs of 5, to increase the accuracy we can increase the

number of epochs for 1 epoch I have 95 accuracies in training and 94 testing accuracy. To increase the accuracy I have increased the number of epochs. The loss was also reduced from 9.04 to 07 as the training precessed.



Output Screenshots:



Conclusion:

In this project, the Handwritten Character Recognition using Deep learning methods has been implemented. The most widely used deep learning technique like CNN have been trained and tested on the same data in order to acquire the comparison between the classifiers. Utilizing these deep learning techniques, a high amount of accuracy can be obtained. Using Keras as backend and Tensorflow as the software, a CNN model is able to give an accuracy of about 98.15%.

Reference:

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