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Recognition of Handwritten Digit using Convolutional Neural Network in Python on MNIST dataset

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Abstract

The project is about handwriting digital recognition which is one of the most important processes in pattern recognition applications. Some of the digital recognition requests are email filtering, processing of bank checks, data entry form, etc. The aim of our project is to create an efficient algorithm that can accurately detect handwritten and collected digits from scanners, tablets and other digital devices. This project discusses the solution to part of the problem as we limit the limit to only handwritten digits i.e. (0-9). We trained the model using Cumulative Neural Networks to obtain digital recognition. We have used 'MNIST DATABASE' which contains training and testing set of handwritten digits (0-9) of size (28x28) of pixels i.e. 784 pixels. Our set of training data contains 60,000 and test data contains 10,000. The limit for this model will be if the outside digits (0-9) given to the model will not be able to detect and distinguish it and the model will only be able to predict numbers in black and white images

1. INTRODUCTION

Our project aims to input handwritten numbers, process input numbers and process neural network algorithms. The project is designed as software to help identify marks. This project is strictly limited to marks only. One of the main ways to impart such human skills to computers is through neural networks. Neural networks are very useful in solving problems that cannot be identified as a series of steps such as sample identification, grouping, chain assessment and data mining.

Pattern recognition is probably the most common use of neural networks. The neural network is displayed with a directed vector and a sample description vector, which may be image and handwritten data. The neural network then tries to find out if the input data is similar to the pattern the neural network remembers. A neural network trained to perform is designed to take input samples and divide them into groups. These groups are confusing without clearly defined boundaries. This project is about getting free handwritten letters.

2. Literature Review

2.1 Neural Network:

A neural network is the network or a circuit of neurons, or in modern sense, it is an artificial neural network, composed of artificial neurons or nodes.

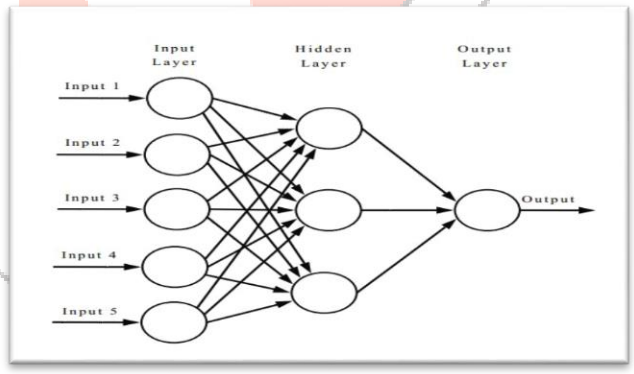

Figure 1-. Neural Network

2.2 Convolution Neural Network:

A Convolutional Neural Network (CNN) is the multi-layered neural feed-forward network with deep supervised learning architecture, which is the combination of two-parts: automatic feature extractor and trainable classifier.

CNN is utilized to learn complex, high-dimensional data, and differs in how the convolution and sub-sampling layers are queried.

2.2.1 Keras:

Keras library is the open-source library which provides an interface for artificial neural networks.

Keras library is used to implement neural networks, provides some tools and by using that tools you can work with images, text data, writing code for neural network etc.

2.2.2 Tensor Flow:

Tensor Flow library is the free open-source math library for machine learning Using Tensor flow library we can work with differential programming and dataflow

2.2.3 Pandas:

Pandas is a Python package that provides fast, flexible, and expressive data structures designed to make working with structured and time series. The main aim of using Pandas is for, real world data analysis in Python Programming language.

2.2.4Tkinter:

Tkinter is the Graphical User Interface (GUI) library for Python. You can create the Graphical User Interface (GUI) applications in python using Tkinter library.

2.2.5 NumPy:

NumPy is the array-processing package. The main aim of Numpy is to provide the multidimensional array object with high-performance, and also provides tools to work with these arrays.

3. Methodology

3.1 Pre-processing:

The method which is used to perform some operations on images, in order to get the enhanced image or to extract some useful features or information from the image is called as image processing. In Image processing the input is given as image and the output will be an image or some features or characteristics which is associated with that image.

3.2 Segmentation:

The process of dividing or partitioning a digital image into multiple segments (sets of pixels, also called as image object) are called as Segmentation. The main aim of Image Segmentation is to simplify the image and/or to change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is used to locate objects, boundaries, assigning a label to every pixel in an image. Image segmentation is the set of segments that collectively cover the full image, or a set of contours extracted from the image.

3.3 Feature Extraction:

Feature extraction is related to dimensionality reduction in which the large data is reduced to groups for processing. The process of determining a subset of initial features is called as feature selection. The selected features contains relevant information from the input data, so that desired task can be easily performed by using this reduced representation instead of the complete initial data.

3.4 Classification and Recognition:

Image Classification is the process of labelling objects in the image and sorting them into classes. For example, ask Google to find the pictures of cats and the network will fetch you many photos of cats.

Image Recognition is the combination of image detection and classification. In image recognition the Artificial Intelligence try to detect the object and then classify and then try to recognize the object.

3.5 Convolutional Neural Network:

A Convolutional Neural Network (CNN) is a multi-layer neural feedforward network with deep supervised learning architecture, which can be regarded as a two-part combination: Automatic feature extractor and trainable classifier. The classifier and weights of the backpropagation algorithm in the feature extractor are applied. Besides, CNN can also extract topology attributes from images.

It abstracts features from the primary image in the first layer and classifies the pattern with the last layer.

The best property on pattern recognition mission was implemented. CNN is utilized to learn complex, high-dimensional data, and differs in how the convolution and subsampling layers are queried. The difference is in their structure. Generally, the first 34 layer is an alternation of the convolutional layer and the sub-sampled layer or convolutional filtering and down-sampling. The convolutional layer is used to extract basic visual features from the local receptive domain. It is organized in a plane called a simple unit of neurons, also known as feature mapping. Each group has 25 inputs connected to the 5×5 area in the input image, which is the local receptive area. Furthermore, the down-sampling operation through convolution filtering has a ratio of 2. Many CNN constructions are proposed for distinct problems such as object recognition and handwriting character recognition. Furthermore, to ensure some level of invariance of scope, shift and distortion, CNN mixes three primary hierarchical fields such as local receptive area, weight sharing and spatial sub-sampling. Trainable weights are assigned to each connection for the standard neural network, but all elements of a feature map share the equal weight. This characteristic is evidenced by the fact that the primary feature detectors useful on a portion of the image may be helpful throughout the image. Also, weight sharing techniques allow for a reduction in the number of trainable parameters. For instance, LeNet5 has only 60,000 trainable parameters out of 345 308 links.

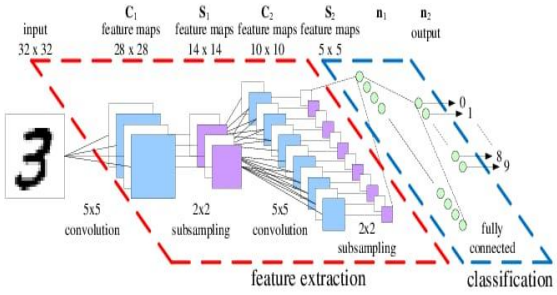

Figure 2- LeNet 5 Architecture

LeNet5 adopts an original image of 32 × 32 pixels as input. It consists of two convolutional layers (C1 and C2), two sub-sampling layers (S1 and S2), one fully connected layer (N1) and an output layer (N2). It can be seen from above figure that the convolution and sub-sampling layers are interlaced. In particular, the first convolutional layer C1is composed of six 28×28 units feature maps. The following S1 reduces the resolution by 2, while the next layer C2 expands the number of feature maps to 16. Here, each feature map of S2 is not connected to each feature map of C2. Each unit of C2 is connected to several receiving fields at the identical position in the subset of S1. These combinations are random, but they also decrease the number of free parameters and compel the different feature maps to draw different features when different inputs are obtained. The layer S2 is used as S1, and the size of the feature map is reduced to 5x5. Finally, the minimum output provides the class of the input mode.

4. Result

The main objective of this investigation is to find a representation of isolated handwritten digits that allow their effective recognition.

In this research paper, the variations of accuracies for handwritten digit were observed for 10 epochs by varying the hidden layers. The maximum and minimum accuracies were observed for different hidden layers variation with a batch size of 300. Among all the observation, the maximum accuracy in the performance was found 99.09% for 10 epochs. This low loss will provide CNN better performance to attain better image resolution and noise processing. In the future, we plan to observe the variation in the overall classification accuracy by varying the number of hidden layers and batch size.

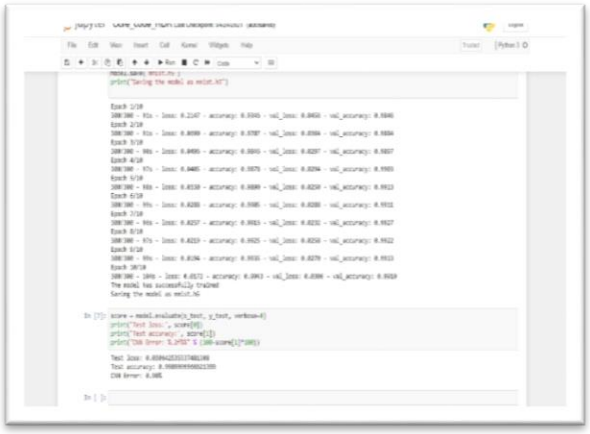

Figure 3- Result of Trained Model

According to table 1, the highest accuracy is 98.37% and the lowest is 81.85%. Other algorithm produces an average accuracy of around 83.89%. In fact, the highest accuracy belongs to the CNN, followed by Multilayer Perceptron separator with 90.37%, Support Vector Machine with 87.97% and after that Random Forest Algorithm 85.75%, Bayes Net 84.35%, random tree 85.06% and Naïve Bayes 81.85%. Kappa's statistical value ranges from 0 to 1. Value 0 means complete disagreement and 1 means complete agreement. It checks the reliability of the Editing algorithm in the database.

5. Conclusion

The main conclusion of this study is to find out or, to the best of handwritten numbers for the department's success able to tell the difference. In this article, no other author, use
a machine learning system, and to accept the
an array of numbers. In each of the speech recognition process. An important issue is to make the decision on a lack of and how to evaluate them. The proposed the system is trying to address both of these aspects, and it is in good condition the accuracy and time complexity. All
with a maximum accuracy of 99.09%, as it turns out, when you receive in the process, with a multi-layer perceptron. For this to work it is carried out in the very first attempt, and for the purpose of this article is to facilitate the recognition of hand-written volume of the input, in the open air
with the help of a common separation method.

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