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HAND WRITTEN RECOGNITION

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Abstract

Handwriting character recognition is one of the most important practical issues in pattern recognition experiments. The main objective of this project is to develop a handwritten digit recognition method with handwritten strings. In order to perform the score identification task, the scores will first be divided into individual scores. Then, the digit recognition module is used to classify each segmented digit by completing a manual digit string recognition task. Digit recognition applications include postal mail sorting, bank check processing, form data entry, etc. The heart of the problem lies in the ability to develop an efficient algorithm that can recognize handwritten digits and users scanners, tablets and other digital devices.

Keywords: pattern recognition, digit recognition, artificial neural networks, Deep learning machine learning

I INTRODUCTION

Machine learning and deep learning plays an important role in computer technology and artificial intelligence. With the use of deep learning and machine learning, human effort can be reduced in recognizing, learning, predictions and many more areas. This article presents recognizing the handwritten digits (0 to 9) from the famous MNIST dataset, comparing classifiers like ANN and convolution neural network on basis of performance, accuracy, time, sensitivity, positive productivity, and specificity with using different parameters with the classifiers. Hand Written digit recognition is the ability of a computer to recognize the human handwritten digits from different sources like images, papers, touch screens, etc, and classify them into 10 predefined classes (0-9). This has been a topic of boundless-research in the field of deep learning. Digit recognition has many applications like number plate recognition, postal mail sorting, bank check processing, etc. In Handwritten digit recognition, we face many challenges because of different styles of writing of different peoples as it is not an Optical character recognition. This research provides a comprehensive comparison between different machine learning and deep learning algorithms for the purpose of handwritten digit recognition. For this, we have used Support Vector Machine, Multilayer Perceptron, and Convolutional Neural Network. The comparison between these algorithms is carried out on the basis of their accuracy, errors, and testing-training time corroborated by plots and charts that have been constructed using matplotlib for visualization. The accuracy of any model is paramount as more accurate models make better decisions.

In the field of Machine Learning, recognition of objects has become most sought one. Some of the examples of object recognition are Face recognition, Hand write recognition, Disease detection etc. All these things can happen through large set of image data set. These image data set will contain both positive and negative data regarding that domain. This helps the algorithm to classify the unknown data in better ways. Hand write recognition is a new technology that will be useful in this 21st century. It can act as base functionality for the birth of new requirements. For example, a blind man cannot read news paper unless braille format exists. In this case we can train the algorithm to recognize characters in the news

paper, store them as text and convert the text to speech. This can help lot of blind people to ease their daily work. The second application of hand write recognition could be language translation. In this case when a person is dealing with non-native language, he can just take a image of a document and send it to the hand write recognition algorithm. This algorithm can recognize the characters in image and convert them to text. Then the text can be converted to desired language of choice.

One more application of hand write recognition would be, processing of large set of paper document like answer scripts. With the help of hand-write recognition and AI, the answer scripts can be evaluated without human involvement. For all above mentioned scenarios, hand write recognition acts as base case to be resolved. Hand write recognition is one of the type of Optical Character Recognition(OCR). OCR is identification of text, which may be printed or hand-written. In OCR, the document is captured via camera as image and can be converted to desired formats like PDFs. Then the file is fed to the algorithm for character recognition. This can drastically reduce human involvement in certain scenarios.

II LITERATURE SURVEY

The An early notable attempt in the area of character recognition research is by Grimsdale in 1959. The origin of a great deal of research work in the early sixties was based on an approach known as analysis by synthesis method suggested by Eden in 1968. The great importance of Eden's work was that he formally proved that all handwritten characters are formed by a finite number of schematic features, a point that was implicitly included in previous works. This notion was later used in all methods in syntactic (structural) approaches of character recognition.

1. **K. Gaurav, Bhatia P. K.**, his paper deals with the various pre-processing techniques involved in the character recognition with different kind of images ranges from a simple handwritten form based documents and documents containing colored and complex background and varied intensities.In this, different preprocessing techniques like skew detection and correction, image enhancement techniques of contrast stretching, binarization, noise removal techniques, normalization and segmentation, morphological processing techniques are discussed.
2. **Sandhya Arora**, used four feature extraction techniques namely, intersection, shadow feature, chain code histogram and straight line fitting features. Shadow features are computed globally for character image while intersection features, chain code histogram features and line fitting features are computed by dividing the character image into different segments. On experimentation with a dataset of 4900 samples the overall recognition rate observed was 92.80% for Devanagari characters.
3. **Brakensiek, J. Rottland, A. Kosmala, J. Rigoll**, in their paper a system for off-line cursive handwriting recognition is described which is based on Hidden Markov Models (HMM) using discrete and hybrid modelling techniques

Handwriting recognition experiments using a discrete and two different hybrid approaches, which consist of a discrete and semi-continuous structures, are compared. It is found that the recognition rate performance can be improved of a hybrid modelling technique for 15 HMMs, which depends on a neural vector quantizer (hybrid MMI), compared to discrete and hybrid HMMs, based on tired mixture structure (hybrid - TP), which may be caused by a relative small data set.

4. **R. Bajaj, L. Dey, S. Chaudhari**, employed three different kinds of features, namely, the density features, moment features and descriptive component features for classification of Devanagari Numerals. They proposed multi classifier connectionist architecture for increasing the recognition reliability and they obtained 89.6% accuracy for handwritten Devanagari numerals.
5. **G. Pirlo and D. Impedovo**in his work on , presented a new class of membership functions, which are called Fuzzymembership functions (FMFs), for zoning-based classification. These FMFs can be easily adapted to the specific characteristics of a classification problem in order to maximize classification performance. In this research, a realcoded genetic algorithm is presented to find, in a single optimization procedure, the optimal FMF, together with the optimal zoning described by Voronoi tessellation. The experimental results, which are carried out in the field of handwritten digit and character recognition, indicate that optimal FMF performs better than other membership functions based

on abstract level, ranked-level, and measurement-level weighting models, which can be found in the literature.

6. Sushree Sangita Patnaik and Anup Kumar Panda May 2011, this paper proposes the implementation of particle swarm optimization (PSO) and bacterial foraging optimization (BFO) algorithms which are intended for optimal harmonic compensation by minimizing the undesirable losses occurring inside the APF itself.

The efficiency and effectiveness of the implementation of two approaches are compared for two different conditions of supply. The total harmonic distortion (THD) in the source current which is a measure of APF performance is reduced drastically to nearly 1% by employing BFO. The results demonstrate that BFO outperforms the conventional and PSO based approaches by ensuring excellent functionality of APF and quick prevail over harmonics in the source current even under unbalanced supply.

7. Renata F. P. Neves have proposed SVM based offline handwritten digit recognition. Authors claim that SVM outperforms the Multilayer perceptron classifier. Experiment is 12 carried out on NIST SD19 standard dataset. Advantage of MLP is that it is able to segment non-linearly separable classes. However, MLP can easily fall into a region of local minimum, where the training will stop assuming it has achieved an optimal point in the error surface. Another hindrance is defining the best network architecture to solve the problem, considering the number of layers and the number of perceptron in each hidden layer. Because of these disadvantages, a digit recognizer using the MLP structure may not produce the desired low error rate.

III CEXISTING SYSTEM

Traditional approaches to stock market analysis and stock price prediction include fundamental analysis, which looks at a stock's past performance and the general credibility of the company itself, and statistical analysis, which is solely concerned with number crunching and identifying patterns in stock price variation. The latter is commonly achieved with the help of Genetic Algorithms (GA) or Artificial Neural Networks (ANN's), but these fail to capture correlation between stock prices in the form of long-term temporal dependencies. Another major issue with using simple ANNs for stock prediction is the phenomenon of exploding vanishing gradient, where the weights of a large network either become too large or too small(respectively), drastically slowing their convergence to the optimal value. This is typically caused by two factors: weights are initialized randomly, and the weights closer to the end of the network also tend to change a lot more than those at the beginning. An alternative approach to stock market analysis is to reduce the dimensionality of the input data and apply feature selection algorithms to short list a core set of features (such as GDP, oil price, inflation rate, etc.) that have the greatest impact on stock prices or currency exchange rates across markets. However, this method does not consider long term trading strategies as it fails to take the entire history of trends into account; furthermore, there is no provision foroutlier detection.

IV PROBLEM STATEMENT

The goal of this project is to create a model that will be able to recognize and determine the handwritten digits from its image by using the concepts of Convolution Neural Network. Though the goal is to create a model which can recognize the digits, it can be extended to letters and an individual’s handwriting. The major goal of the proposed system is understanding Convolution Neural Network, and applying it to the handwritten recognition system. In today's digitized world, handwritten digit recognition plays a vital role in various applications such as postal services, financial transactions, and automation. The aim of this project is to develop a robust and accurate system capable of recognizing and classifying handwritten digits into their respective numerical values (0-9)

V PROPOSED SYSTEM

We propose an online learning algorithm for predicting the end-of-day price of a given stock with the help of Long Short Term Memory (LSTM),a type of Recurrent Neural Network(RNN).

LSTM's are a special subset of RNN's that can capture context-specific temporal dependencies for long periods of time. Each LSTM neuron is a memory cell that can store other information i.e., it maintains its own cell state. While neurons in normal RNN's merely take in their previous hidden state and the current input to output a new hidden state, an LSTM neuron also takes in its old cell state and outputs its new cellst ate. An LSTM memory cell, has the following three components, or gates:

1. Forget gate: the forget gate decides when specific portions of the cell state are tobe replaced with more recent information. It outputs values close to 1 for parts of the cellst ate that should be retained,and zero for values that should be neglected.
2. Input gate : based on the input (i.e., previous output o(t-1), input x(t), and previous cell state c(t-1)), this section of the network learns the conditions under which any information should be stored (orupdated)in the cell state
3. Output gate: depending on the input and cell state, this portion decides what information is propagated forward (i.e., output o(t) and cell state c(t)) to the next no dein the network.

Thus, LSTMnetworksareidealforexploringhowvariationinonestock'spricecan affect the prices of several other stocks over a long period of time. They can also decide (in a dynamic fashion) for how long information about specific past trends in stock price movement needs to be retained in order to more accurately predict future trends in the variation of stock prices

V IMPLEMENTATION

The dataset used for Hand Written Recognition, obtained from MNSIT, he MNIST database (Modified National Institute of Standards and Technology database) is a large database of handwritten digits that is commonly used for training various image processing systems. The database is also widely used for training and testing in the field of machine learning. It was created by "re-mixing" the samples from NIST's original datasets. The creators felt that since NIST's training dataset was taken from American Census Bureau employees, while the testing dataset was taken from American high school students, it was not well-suited for machine learning experiments. Furthermore, the black and white images from NIST were normalized to fit into a 28x28 pixel bounding box and anti-aliased, which introduced grayscale levels

Pre-processing

The raw data, depending on the data acquisition type, is subjected to a number of preliminary processing steps to make it usable in the descriptive stages of character analysis. Preprocessing aims to produce data that are easy for the CR systems to operate accurately. The main objectives of preprocessing are:

1. Noise reduction,
2. Normalization of the data,

Segmentation

Segmentation is an important stage, because the extent one can reach in separation of words, lines or characters directly affects the recognition rate of the script. The two types of segmentation are

-External Segmentation
-Internal Segmentation
-Explicit Segmentation
-Implicit Segmentation

Representation

Image representation plays one of the most important roles in a recognition system. In the simplest case, gray-level or binary images are fed to a recognizer. However, in most of the recognition systems, in Order to avoid extra complexity and to increase the accuracy of the algorithms, a more compact and characteristic representation is required. A good survey on feature extraction methods for character Recognition can be found in [13]. Hundreds of document image representation methods are categorized in three major groups as:

-Global Transformation and Series Expansion

- Statistical Representation
-Geometrical and Topological Representation

Training and Recognition Techniques

CR systems extensively use the methodologies of pattern recognition, which assigns an unknown sample into a predefined class. Numerous techniques for CR can be investigated in four general approaches of Pattern Recognition, as suggested as -Template Matching,
-Statistical Techniques,
-Structural Techniques,
-Neural Networks

Template Matching

The simplest way of character recognition is based on matching the stored prototypes against the character or word to be recognized (group of pixels, shapes,curvature etc.). Matching techniques can be studied in three classes:
-Direct Matching
-Deformable Templates and Elastic Matching
-Relaxation Matching

Statistical Techniques

The major statistical approaches, applied in the CR field are the followings:
-Non-parametric Recognition
-Parametric Recognition
-Clustering Analysis
-Hidden Markov Modeling (HMM)

Hidden Markov Models are the most widely and successfully used technique for handwritten character recognition problem. There are two basic approaches to CR systems using HMM:
-Model Discriminant HMM
-Path Discriminant HMM

Structural Techniques

These patterns are used to describe and classify the characters in the CR systems.The characters are represented as the union of the structural primitives. The following structural methods are applied to the CR Problems:
-Grammatical Methods
-Graphical Methods

Neural Networks (NN)

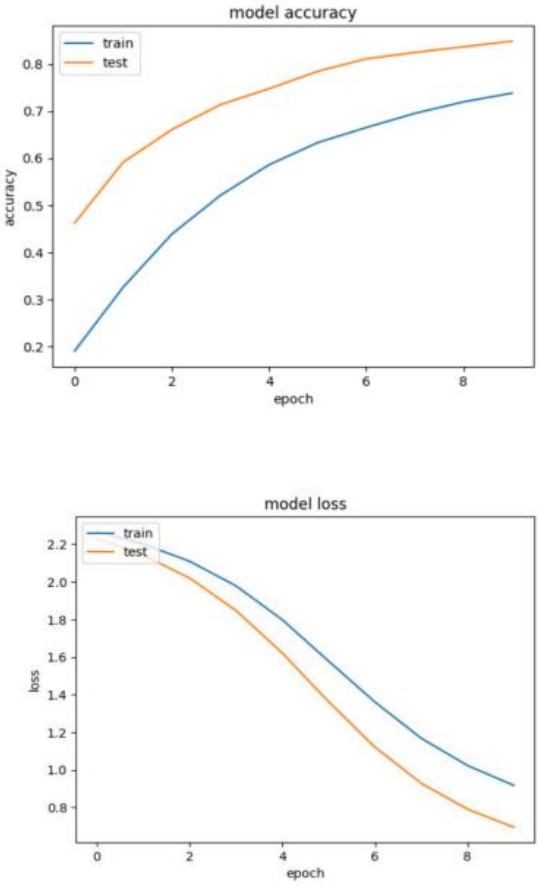
A neural network is defined as a computing architecture that consists of massively parallel interconnection of adaptive 'neural' processors. Because of its parallel nature, it can perform computations at a higher rate compared to the classical techniques. Because of its adaptive nature, it can adapt to changes in the data and learn the characteristics of input signal. A neural network contains many nodes. Neural network architectures can be classified into two major groups, namely, feed-forward and feedback(Recurrent) networks. The most common neural networks used in the CR systems are the multilayer perception of the feed forward networks. Some of the connections are variable and can be modified by learning.

Post Processing:

It is well known that humans read by context up to 60% for careless handwriting. While preprocessing tries to clean" the document in a certain sense, it may remove important information, since he context information is not available at this stage. The review of the recent CR research indicates minor improvements, when only shape recognition of the character is considered. Therefore, the incorporation of context and shape information in all the stages of CR systems is necessary for meaningful improvements in recognition rates. This is done in the post processing stage with a feedback to the early

stages of CR. The simplest way of incorporating the context information is the utilization of a dictionary for correcting the minor mistakes of the CR systems.

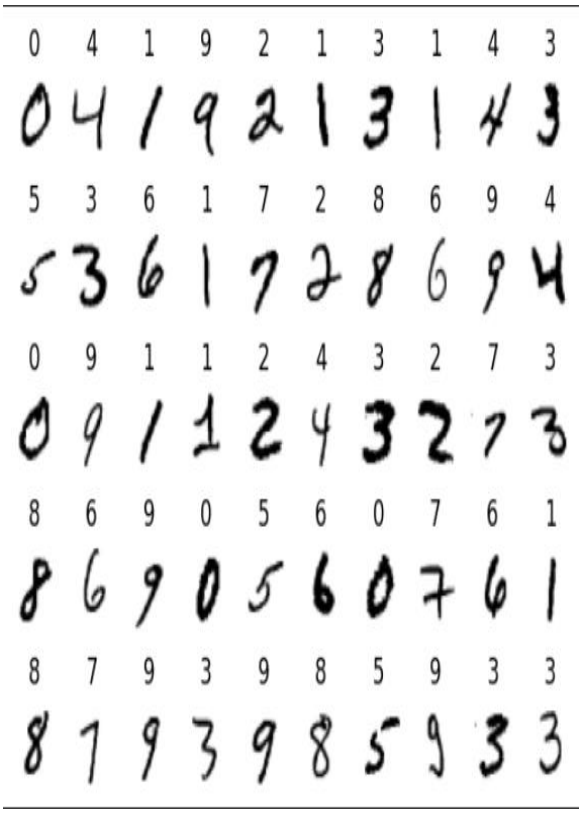
VII RESULTS

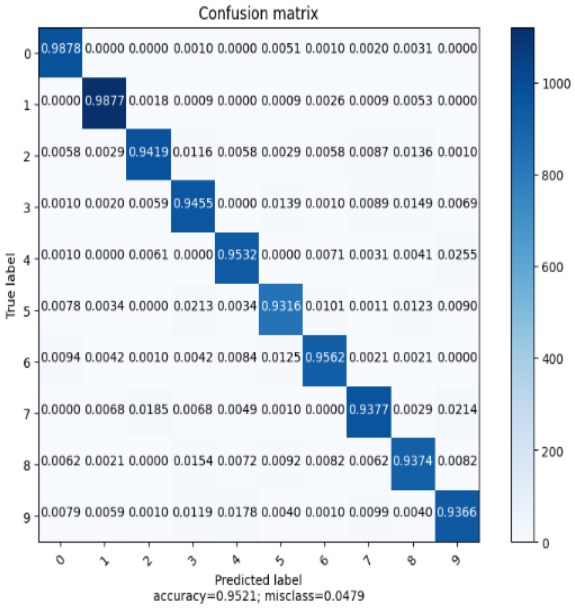


Sample Result

RESULTS

Accuracy and Loss of Hand Written Recognition





VIII CONCLUSION

There are many approaches for hand writing recognition. Some of them are incremental, Zoning, Convolutional Neural Network (CNN), semi-incremental segmentation, slope and slant correction. Among these methods, highest accuracy is achieved from Convolutional Neural Network (CNN) and the least accuracy is achieved from Slope and Slant Correction method. When the images are trained with CNN, we will achieve good accuracy and this is one of the successful method for hand writing recognition and only disadvantage with this method is that training time of the model is too high because lot of image samples are included. In Zoning method, if zones which are achieved after dividing input image and if the count of these zones are lesser then accuracy will decrease. Main disadvantage of this method is that developers will face lot of problems while segmentation process but this method is too simple for hand writing recognition. This method only sees the Lat and which makes it simple. Hand writing recognition is very challenging because all the individuals have different hand writing and it becomes more complex to detect when these are compared to that of computer. The effectiveness of handwritten digit recognition using a convolutional neural network has been demonstrated to be quite high. It outperforms all other algorithms, even artificial neural networks. We show a model that can recognize hand written digits in this video. It can later be expanded to include character recognition and real-time handwriting analysis. The recognition of handwritten digits is the initial step toward the wide field of Artificial Intelligence and Computer Vision. As may be observed from the outcomes of the experiment, CNN outperforms other classifiers. With more convolution layers and buried neurons, the findings can be made more precise. It has the potential to fully eliminate the necessity for typing. The problem of digit recognition is a good model for learning about neural networks. It also provides an excellent platform for the development of more advanced deep learning algorithms. We intend to develop a real-time handwritten digit recognition system in the future.

Handwritten Digit Recognition deals with identifying the digits. The main purpose of this project is to build an automatic handwritten digit recognition method for the recognition of handwritten digit strings. In this project, different machine learning methods, which are ANN (Artificial Neural Networks), and CNN (Convolutional Neural Networks) architectures are used to achieve high performance on the digit string recognition problem

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