CSF407 Artificial Intelligence

PROJECT TITLE : Handwritten Digit Recognition System

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ABSTRACT (max. 150 words)

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress in the field of science and technology, everything is being digitalized to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications.

MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. Many Machine Learning and Deep Learning Algorithms are developed which can be used for this digit classification. In this project, we will compare the results of some of the most widely used Machine Learning Algorithms like Support Vector Machine, K-Nearest Neighbor & Random Forest Classifier.

ANALYSIS DOCUMENT

INTRODUCTION

Handwriting recognition is one of the compelling and fascinating works because every individual in this world has their own style of writing. It is the capability of the computer to identify and interpret handwritten digits or characters automatically.

Handwritten digits recognition problem has been studied by researchers since 1998 with almost all the algorithms designed by then and even until now. The test error rate decreased from 12% in 1988 by linear classifier to 0.23% in 2012 by convolutional nets, and these days more and more data scientists and machine learning experts are trying to develop and validate unsupervised learning methods such as auto-encoder and deep learning model.

This recognition was implemented using many Machine Learning techniques like Random Forest, Naive Bayes and Support Vector Machine etc. Yet 100% accuracy is something that is to be achieved and the research is still actively going on in order to reduce the error rate. The accuracy and correctness are very crucial in handwritten digit recognition applications. Even 1% error may lead to inappropriate results in real-time applications

NECESSITY

Handwritten recognition of characters has been around since the 1980s.The task of handwritten digit recognition, using a classifier, has great importance and use such as – signature verification, online handwriting recognition on computer tablets, recognize zip codes on mail for postal mail sorting, bank check processing, numeric entries in forms filled up by hand (for example - tax forms) and so on. There are different challenges faced while attempting to solve this problem. The handwritten digits are not always of the same size, thickness, or orientation and position relative to the margins.

SCOPE

The main focus of this project is to use different classification machine learning algorithms to recognize the handwritten digits provided in the MNIST data set of

images of hand written digits (0-9) and compare their performance in this particular problem of handwritten digit recognition. The MNIST data set used for our application is composed of 60000 training images and 10000 testing images. Each image is a 28 x 28 grayscale (0-255) labelled representation of an individual digit.

LITERATURE STUDY

In 1959, Grimsdale made an effort in the area of character recognition. Later in 1968 Eden suggested an approach termed as analysis-by-synthesis method to carry on the research work. Eden showed that all handwritten characters have some schematic features

Parveen Kumar, Nitin Sharma and Arun Rana [1] made an attempt to recognize a handwritten character using SVM classifier and MLP Neural Network. Different kernel-based SVM like the linear kernel, polynomial kernel, and quadratic kernel-based SVM classifiers are used. In the SVM classifier model, there are two phases of training and testing. From each character, about 25 features are extracted with the help of which SVM is trained. Amongst the three kernels used the linear kernel gives an accuracy of 94.8%.

T.Siva Ajay [2] also proposed that the higher rate of accuracy in handwritten digit recognition task can be achieved by the use of convolutional neural networks. The implementation of CNN is made easy and simple by the use of LeNet engineering. As a result of this accuracy greater than 98% is obtained in this paper.

Ming Wu and Zhen Zhang [3] in 2010 made a comparison between different classifiers to conclude which gives better performance in the recognition task. The comparison is done between the six classifiers namely LDA (Linear Discriminant Analysis), GMM (Gaussian Mixture Models), QDA (Quadratic Discriminant Analysis), SVML (SVM with linear kernel function), SVMR (SVM with radial basis kernel function) and k-NN. Out of all the classifiers-NN (k=3) gives the lowest error rate.

Haider A.Alwzwazy, Haider M.Albehadili, Younes S.Alwan, and NazE. Islam [4] started a challenging task of recognition task of Arabic handwritten digits. For this, they decided to carry on the research using the Deep Convolutional Neural Networks. The accuracy of 95.7% is achieved as a result of this work.

In 2015, Saeed AL Mansoori [5] applied the Multi-Layer Perceptron model to identify handwritten digits. The samples from the data set are trained by employing gradient descent backpropagation algorithm and later feedforward algorithm. From the obtained results it can be observed that the digit 5 has the highest accuracy of 99.8% whereas digit 2 has the lowest accuracy of 99.04%. And the proposed system achieved an overall accuracy of 99.32%.

Shashank Mishra, D.Malathi and K.Senthil Kumar [6] attempted the handwritten recognition using Deep Learning. They used Convolutional Neural Network as a

result of which they concluded that accuracy is increased and there is a reduction in the computation time. The accuracy of 99.2% is obtained.

Current state-of-the-art research achieves around 99% of this same problem using more complex network architectures involving convolutional layers. These uses the 2D structure of the image to better represent the contents, unlike the method which we are going to use which flattens all the pixels into one vector of 784 units.

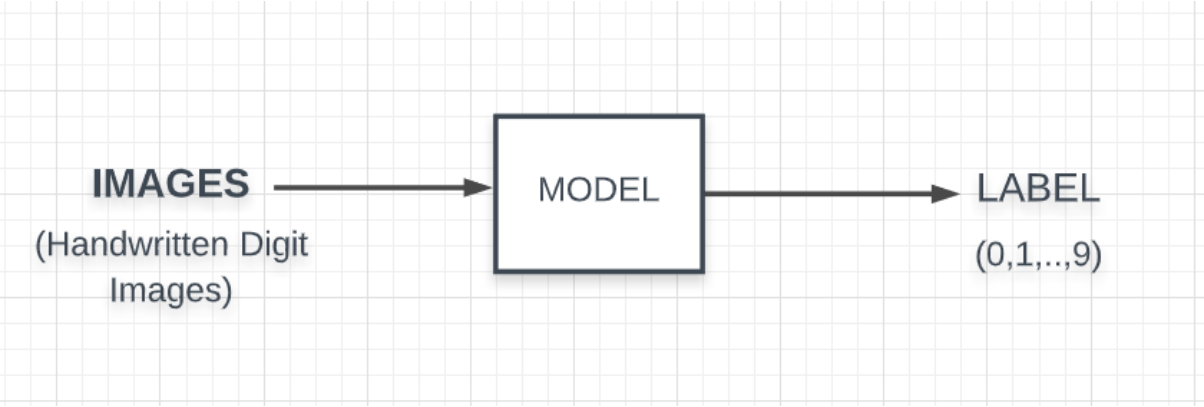
FROM AN AI VIEWPOINT

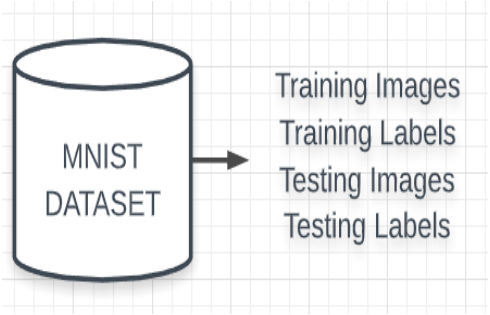
Our model converts images to a feature matrix of size 784 based on the pixel intensity. During training, each of the training images is analysed and the respective label is associated with all the similar images which represent that particular digit. On training with such big dataset, different writing variations of the same digit are more closely associated to the correct label, so during testing, even if a newer variation of the same digit is encountered, the model will recognize the variation and associate it with its correct label with a higher probability.

References –

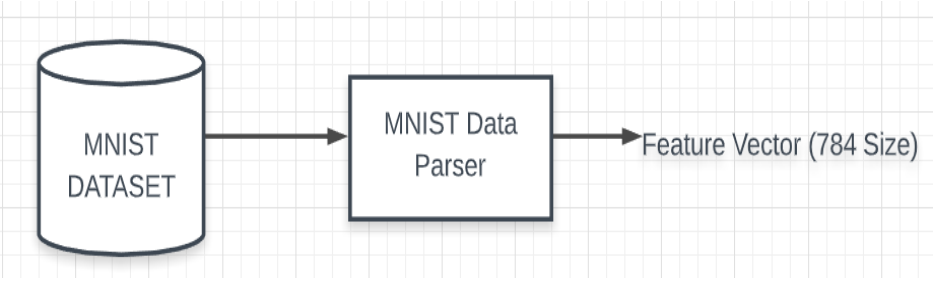
1. Parveen Kumar, Nitin Sharma, and Arun Rana. Article: Handwritten Character Recognition using Different Kernel-based SVM Classifier and MLP Neural Network (A COMPARISON).
2. T Siva Ajay, “Handwritten Digit Recognition Using Convolutional Neural Networks”
3. Wu, Ming & Zhang, Zhen. (2019). Handwritten Digit Classification using the MNIST Data Set.
4. Al-Wzwazy, Haider& M Albehadili, Hayder&Alwan, Younes& Islam, Naz& E Student, M &, Usa. (2016). Handwritten Digit Recognition Using Convolutional Neural Networks.
5. AL-Mansoori, Saeed. (2015). Intelligent Handwritten Digit Recognition using Artificial Neural Network.
6. Mishra, Shashank&Malathi, D &Senthilkumar, K. (2018). DIGIT RECOGNITION USING DEEP LEARNING.

DESIGN DOCUMENT





Each Image is represented as 28x28 matrix each representing pixel intensity (any integer between 0 and 255).
Each Label is a number between 0 and 9 corresponding to the respective image.
MNIST data set contains 60,000 training images and 10,000 testing images.



Each image is now represented as an array of size 784.

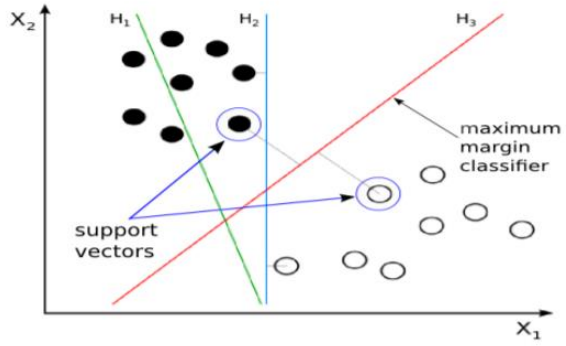
Number of features to are 784.

We will use three different machine learning classification algorithms K-Nearest Neighbors, SVM Classifier, Random Forest Classifier and use MNIST training images as input to our model and testing images are given to the classifiers to predict the labels and compare the testing accuracy which is obtained.

CLASSIFICATION ALGORITHMS

1. Support Vector Machine (SVM) Classifier

Support Vector Machine is a supervised machine learning technique which is applied for classification and regression. It is nothing but the representation of the input data into points in the space and mapped thus classifying them into classes. The SVM classifies or separates the classes using the hyper-plane concept. The separation margin should be equidistant from the classes.



It is basically used for two class classification problems. But it can be used for multi-class problems by one-against-rest approach.

2. K-Nearest Neighbor (KNN) Classifier

K-Nearest Neighbors is an algorithm in which the best estimate among all the values is the value that has maximum number of neighbors with smallest Euclidian or Hamming distance.

KNN is an instance-based learning. To work well, this algorithm requires a training dataset which is a set of well labelled data points.

3. Random Forest Classifier

Random Forest Classifier is an ensemble method used for classification or regression. Random Forest Classifier works using a huge collection of de-correlated decision trees.