Handwritten Digit Recognition

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Abstract :

Machine learning and deep learning approaches are being explored to better equip machines with intelligence. Humans learn how to execute things by rehearsing them again and over, so that the knowledge gets set in their memory. The neurons in his brain will start firing, allowing him to do the task without conscious thought. As you might imagine, deep learning is somewhat similar. It employs many forms of neural network designs, depending on the sort of challenge it is facing. For example, image classification, object identification, object categorization, etc. Human handwritten digits are often able to be easily detected by humans. However, computers often have difficulty in differentiating similar numbers. Handwritten numerals are different, with various strokes in the same number; it is difficult for the computer to distinguish these varieties. The visual identification of a number that identifies what number is in it is the solution to this challenge. In this project, we will develop a program to detect handwritten digit recognition app using power of deep learning. The project can have multiple application like number plate recognition, postal mail sorting, bank check processing.

Keywords :

Handwritten digit recognition, Neural network, classification, Deep learning, Machine learning

1 Introduction :

Handwritten digit recognition is the ability of computer to recognize the human handwritten digits from different different sources like images, papers, touch screens and classify them into ten predefined classes (0-9). This has been topic of boundless-research in the field of the deep learning. Digit recognition has so many applications like vehicle number plate recognition, postal mail sorting, bank check processing. In Handwritten digit recognition, everyone faces many challenges like different styles of writing of different peoples as it is not an Optical character recognition.

This research provides a comprehensive comparison between the different machine learning and deep learning algorithms for purpose of handwritten digit recognition while using the Support of Vector Machine, Multilayer Perceptron, and Convolutional Neural Network for the same purpose of The comparison between these algorithms is carried out on the basis of the accuracy, errors, and testing-training time corroborated by plots and charts that have been constructed using the matplotlib for visualization.

The accuracy of any of the model is paramount as more accurate models are able to make better decisions. The models with low accuracy aren't suitable for real-world

applications. Example - For an automatic bank cheque processing system where system recognizes that quantity and date that on the check, high accuracy is additionally in very critical. suppose If the system incorrectly recognizes a digit, it can result in the foremost damage which isn't desirable. that's why an algorithm with high accuracy is required in these real -world quite applications. Hence this research paper deals with providing a comparison of various algorithms supported their accuracy in order that the foremost accurate algorithm with the smallest amount chances of errors is employed in various applications of handwritten digit recognition.

This research paper provides a reasonable understanding of the machine learning and the deep learning algorithms like CNN, SVM, and MLP for handwritten digit recognition. It further more gives you information about which algorithm is efficient for the performing the task of digit recognition. In further sections of this research paper will be discussing the related work that has been done in this field followed by the methodology and implementation of all the three algorithms for the understanding of them. Next, it presents conclusion and result bolstered by various graphs. Moreover, it will also provide information about some of the potential future enhancements that can be done in this field.

2 Related Work :

With all of the humanization of machines, there has been substantial amount of the research and development work that has given a surge to deep learning and machine learning together with the AI (artificial intelligence). With time, machines have gotten more sophisticated, from calculating basic addition to doing retina recognition they need made our lives rather

more than secure and manageable. Likewise, handwritten text or digit recognition is a very important application of deep learning and machine learning which is more helpful in detecting forgeries and a good range of research has already been done that encompasses a comprehensive study and implementation of varied popular algorithms to match different models of CNN with the elemental ML algorithms on different grounds like performance rate, execution time, complexity then to induce to assess each algorithm explicitly. Multilayer Perceptron classifier gave you the foremost accurate results with less error rate followed by the Support Vector Machine, Random Forest Algorithm, Bayes Net, Naïve Bayes and Random Tree respectively. A comparison between SVM, CNN, KNN, RFC so we were ready to achieve the best accuracy of 98.72% using CNN (takes maximum execution time) and lowest accuracy using RFC. The detailed study comparison on SVM, KNN & MLP models to classify all of the handwritten text/digit and concluded that KNN and SVM predict all classes of dataset correctly with 99.25% accuracy but the thing process goes little complicated with MLP when it absolutely was having trouble classifying number 9(nine), that the authors suggested to use CNN with Keras to boost classification. Incorporating the diagnostic features into CNN could be a promising direction for future research.

3 METHODOLOGY :

The comparison of all the algorithms like support vector machines, Multi-layered perceptron & Convolutional neural network is all supported characteristic chart of every of the algorithm. On common grounds like dataset, the quantity of epochs, complexity of algorithm, accuracy of every of the algorithm, specification

of the device accustomed execute the program and runtime of algorithm, under the best condition

3.1 Dataset

Handwritten character recognition is normally an expansive research area that is already contains very detailed ways of implementation which include more learning datasets, popular algorithms, features scaling & various feature extraction methods. Modified National Institute of Standards and Technology database is the subset of the NIST dataset which is combination of two of NIST's databases: Special Database one and Special Database three.

3.2 Support Vector Machines

SVM (Support Vector Machine) is supervised machine learning algorithm. There is generally plotting of data items in (n)-dimensional space where (n) is number of features, a particular co-ordinate represents value of a feature, we perform the classification by finding the hyperplane that distinguishes these two classes. It will choose hyperplane that separates the classes correctly. SVM (support vector machine) chooses extreme vectors that help in the creating of the hyperplane. These extreme cases are called as the support vectors, and hence algorithm is termed as the Support Vector Machine. There are two main types of SVMs, 1st linear and 2nd non-linear SVM.

3.3 Multilayer Perceptron

MLP (A multilayer perceptron) is a class of the feedforward artificial neural networks (ANN). It consists of three different layers: 1.input layer, 2.hidden layer & output layer. In each layer consists of several various nodes that are also formally referred to as the neurons and each node

is in interconnected to every other node of that next layer. In basic MLP there are 3 layers but actual number of hidden layers can increase to any number as per problem with no restriction on number of each nodes. The number of nodes in input and output layer depends upon the number of attributes and apparent classes in dataset respectively. The particular number of the hidden layers or numbers of nodes in hidden layer is difficult to determine due to model erratic nature and therefore that selected experimentally. Every hidden layer of model can have that different activation functions for the processing. For learning purposes, it uses supervised learning technique that the called backpropagation. In MLP, connection of the nodes consists of a weight that gets to adjusted to synchronize with each connection in training process of the model.

3.4 Convolutional Neural Network

CNN (Convolutional Neural Network) is a deep learning algorithm that is widely used for image recognition and the classification. It is a class of deep neural networks that requires minimum to minimum pre-processing. It inputs image in the form of small chunks rather than inputting one single pixel at a time, so that the network can detect uncertain patterns (edges) in image more efficiently. CNN(Convolutional Neural Network) contains 3 layers namely, 1.input layer, 2.output layer, and multiple hidden layers which include the following Convolutional layers, Pooling layers(Max and Average pooling), Fully connected layers (FC), and normalization layers. CNN uses a filter (kernel) which is an array of the weights to extract features from input image. CNN employs different activation functions at the each layer to add some non-linearity. Further, we observe height and width decrease while the number of channels increases. Finally, the

generated column matrix is used to predict that output.

3.5 Visualizations

This paper has used the MNIST dataset that is handwritten digit dataset to compare the different level algorithm of deep learning and machine learning (i.e. SVM, ANN-MLP, CNN) on basis of execution time, complexity, accuracy rate, number of epochs and number of hidden layers (in case of deep learning algorithms). To visualize information obtained by the detailed analysis of the algorithms we have used bar graphs and tabular format charts using the module matplotlib, which gives us the most precise visuals of step by step advances of the algorithms in recognizing digit.

FUTURE ENHANCEMENTS

The future development of applications based on the algorithms of the deep learning and machine learning is practically boundless. In future, work on a denser or hybrid algorithm than current set of algorithms with more manifold data to achieve solutions to many problems to be done. In future, the application of these algorithms varies from the public to high-level authorities, as from differentiation of the algorithms above and with the future development one can attain high-level functioning applications which can be used in classified or government agencies as well as for the common people, these algorithms can be used in the hospitals application for the detailed medical diagnosis, treatment and monitoring patients, it can be used in a surveillance system to keep the tracks of the suspicious activity under system, in fingerprint & retinal scanners, database filtering applications, Equipment checking for the national forces and many more problems of both major category and minor category. The advancement in this field can help to create an

environment of safety, awareness & comfort by using these algorithms in day to day application and the high-level application that is Corporate level or Government level. Application-based on artificial intelligence & deep learning is future of the technological world because of their absolute accuracy and advantages over many major problems.

8. REFERENCES

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