

# Machine Learning neural network Handwriting Recognition

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**Abstract-** The paper talks about one of the applications of machine learning, neural network handwriting recognition. For decades machine learning had shown its application in various things. Whether it is medical science, management companies, stocks or computer science. It is accurately shown results in the industries. Some applications even saved human time and money. From mathematical concepts to computer science, Machine learning has been applied to various things.

One of the applications is handwriting recognition, which is used in banks, and other companies for identifying the signature, recognizing street addresses and bank statements. A neural network for handwriting is the model that increases accuracy and improves results. This model took a dataset for handwriting recognition, then the model has been trained on a convolutional neural network. Models provide machines to detect and read the handwriting. The convolutional neural network has been used to read handwriting for this model. Talking about the accuracy of the model convolutional neural network is more accurate for recognizing handwriting.

**Keywords-** Machine learning, handwriting recognition, convolutional neural network.

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## I. Introduction

The paper talks about the use of a machine learning convolutional neural network that recognizes handwriting. Different machines have been used for handwriting recognition; Machine learning has played an important role in this. Handwriting recognition has become very important and needed in banks, companies. Handwriting recognition has become very important in the field of human-computer interaction. Many recognitions are done through it. It is also used to identify the true author of the handwriting, often used by police and handwriting experts, it is important for identifying the right author for the handwriting. Sometimes word analysis becomes hard to identify, several techniques have been used to get more accuracy, words that look similar creates a problem for machines to identify it, some words might not be recognized, some are not clear, Hence the accuracy of the model plays an important role to get the results. Convolutional neural networks are good for training the model, Convolutional neural networks are part of deep learning, the field that is often used in today's world for recognition photos, videos are often recognized using deep learning

Algorithms deep learning plays an important role. Deep learning is a part of machine learning in which the model learns from the dataset, several deep learning algorithms are used for training the model accuracy. Deep learning is often used for handwriting recognition, by using a convolutional neural network, further in a convolutional neural network is the type of deep learning algorithm that take photos as input and add weightage to them, hence further used for training. A convolutional neural network is used to find the differences between two photos, hence in this model, have used a Convolutional neural network for identifying and analyzing words so that model can be further used for training for neural network handwriting recognition. Handwriting recognition using a convolutional neural network includes several steps before getting the results the libraries that are been used in the model are NumPy, TensorFlow, Keras. The steps involved in it are preprocessing, preprocessing includes several steps for improving the accuracy of the model like importing libraries, importing datasets, one hot encoding which is used to convert string to integers, feature scaling which is used to convert the variables in the same range. Different handwriting recognition was made for different languages, for the recognition early Artificial neural network was used. Years ago, the handwriting was very important the business, work and companies were based on it, hence recognizing it became an issue later it was a task to convert handwritten languages to computer languages, further this problem was solved by a convolutional neural network. Handwriting recognition has become so important, the research paper talks about a model that has been designed to solve the problem of recognizing handwriting using machine learning, deep learning, a convolutional neural network which uses to recognize handwriting. In today's world, it has become very important to convert handwritten words into electronic language hence this model does the work simple and solve the problem of analyzing handwritten words, so that they can be converted electronically. Handwriting recognition is the area of study that comes under machine learning, deep learning algorithms like convolutional

neural networks can be used for handwriting recognition. The model works as an automatic converter by taking inputs and converting the handwriting into electronic handwriting. Dataset can be trained on several types of the neural network; speech recognition is trained on the recurrent neural network it works on time series dataset. The convolutional neural network is used in computer vision, hence now convolutional neural networks are used more in photo recognition.

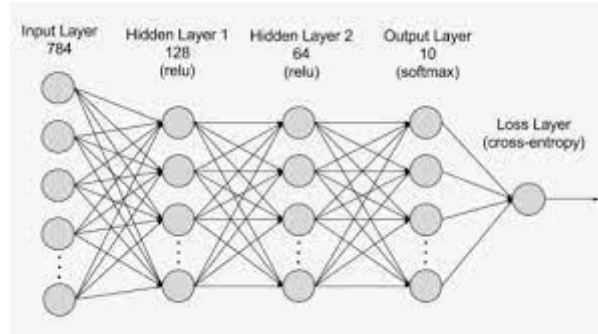


Figure 1: Convolutional neural network.

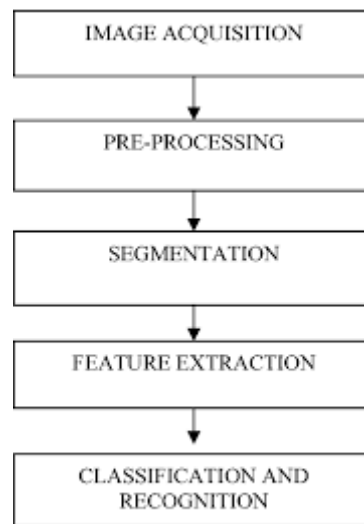


Figure 1: Stages in OCR

Figure 2: the process of handwriting recognition.

## II. Working of convolutional neural network-

the convolutional neural network has the first convolutional layer which is these layers are fully connected. Simple features are focused on these layers such as colours and edges. The convolutional layer is the most important part of the convolutional neural network, it takes the input and uses it for the training of the model. The kernel is another part that is used in the analysis. Several filters affect the results; stride is another thing the kernel works on. In a convolutional neural network, all the layers are connected. The next layer is the pooling layer, this layer is used after the convolutional layer each layer has its use. The pooling layer reduces the dimensionality it converts features into information that can be further used in training the model. The pooling layer is of two types pooling and average pooling. Feature extraction and pooling are used in convolutional neural networks. The pooling layer operates every side of the model and resizes it,

Feature maps have patches, each patch is calculated by average pooling. Patches average value can be calculated by average pooling, the convolutional layer is first applied to the model of convolutional neural network for handwriting recognition and after that pooling layer translational invariance can be added by it. Edges that are more pronounced feature are extracted by max-pooling which is not as smooth as average pooling.

Convolutional output is downsampled by a max-pooling operator, R operators of maximum value are passed by max pooling.

Fully connected layer In the other layers output node is not directly connected to the input layer but in the fully connected layer output

### III. Convolutional neural network and computer vision-

Computer vision is the area of study under machine learning that takes photos as inputs and give results. It is the same as human vision. For several tasks machines are trained on computer vision, the dataset is given to computer vision used for training and then it gives results. Computers are trained on algorithmic models in machine learning. Models are converted into pixels and then a convolutional neural network helps machine learning for training the model. Convolutions are run by a neural network for prediction. Scientists have tried to analyse the data, in 1963 machines were trained on the first thing that was developed, the study of object recognition was started in 2000. Computer vision is very important in today’s life, human activities were launchpads from training computer vision model. Many speech recognition and deep learning models can be trained using deep learning through a convolutional neural network.

Modest computation cost is related to the high-performance network discussed in the paper, talking about the convolutional neural network pooling layer is a very important part of it.

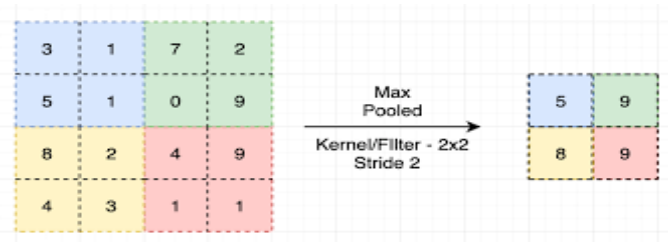


Figure 3: Pooling layer.

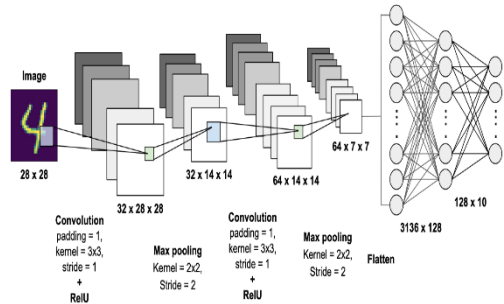


Figure 4: Pooling layer equation.

### IV. Loss function

Loss function in machine learning tells how accurate the model is. The machine learning or deep learning model trained using datasets are further trained and machine learning algorithms like a convolutional neural network. The accuracy of the model loss function is important it talks about the accuracy by analysing the square of the difference between the actual value and the predicted value. Through the loss function, we can analyse how good our dataset has worked on the model, if we want to change the algorithm and try to improve our model the loss function will analyse and tell us if our model is been improved or not. Using a mathematic equation, our loss function will calculate the difference between our values after training the model to the actual value. The difference in the prediction doesn’t matter in the loss function but the machine learning we are applying to it matter. Mean squared error is one of the type losses functions and it is easy to calculate it, mean squared error is the square of the difference of your prediction and actual value and mean to the dataset.

### V. Methodology

In the paper, we have discussed machine learning its application on handwriting recognition, convolutional neural network and its working for handwriting recognition. Now we will discuss the working of the model, libraries that I have imported, dataset, training of the model. The model is designed so that it can analyse handwritten words and can convert them electronically. There are some other models as well which uses automatic detection for handwriting recognition, several models are made using a machine learning convolutional neural network which made sure that the machine can read handwritten words. Computer vision is the area of study under machine learning that takes photos as inputs and give results. It is the same as human vision. For several tasks machines are trained on computer vision, the dataset is given to computer vision used

for training and then it gives results. Computers are trained on algorithmic models in machine learning. Models are converted into pixels and then a convolutional neural network helps machine learning for training the model. Convolutions are run by a neural network for prediction. The first step was importing libraries for the model I have used TensorFlow, Keras, Dense, Layers, matplotlib. Many machine learning models are made using TensorFlow. After importing the libraries, the next step is to import the dataset, after importing the dataset I have trained the model, for accuracy of the model training of the data is very important I'm sure you're sick of hearing that AI is one of the century's defining developments, and that it's arguably the primary focus of high-tech experts. However, this appears to be the case. The COVID-19's self-isolation mode has distilled the major difficulties confronting modern civilization and demonstrated that artificial intelligence is capable of solving problems that can make our lives easier, more convenient, and much more comfortable. However, it's important to realise that no problem can be solved without putting up appropriate effort. In the case of AI, the focus is on the thorough, intelligent design of machine learning models, as well as the process of obtaining high-quality training data. The latter is most likely the only option. It's enough to show a child a single picture to teach them what a cat is. To teach a computer to recognise a cat, you'll need to show thousands of photographs of different cats in all sizes, colours, and forms for it to distinguish between a cat and, say, a dog. When an ML model is sufficiently advanced, it can, on the other hand, offer more accurate findings than a human. This may seem paradoxical, but it has to do with how humans and machines interpret information differently. However, it appears that this is the case. The self-isolation mode of the COVID-19 has distilled the major challenges facing modern society and proved that artificial intelligence is capable of solving them. The convolutional neural network (CNN) is a sort of neural network model created for working with two-dimensional picture data, while it can also be utilised with one-dimensional and three-dimensional data. The convolutional layer, which gives the network its name, is at the heart of the convolutional neural network. This layer performs a process known as "convolution". A convolution is a linear process in a convolutional neural network that involves the multiplication of a set of weights with the input, similar to a standard neural network. The multiplication is done between an array of input data and a two-dimensional array of weights, called a filter or a kernel, because the approach was created for two-dimensional input. The system will employ a convolutional neural network (CNN), a type of deep neural network that is used to recognise characters in images. CNN's basic architecture, which will be used in the OCR system. The architecture depicts various strata, each with its own set of characteristics. The input layer is the first, while the output layer is the final. A layer of the output convolutional layer is the second layer. Pooling layers and convolutional layers come after that. The following is a description of the CNN architecture. Input layer: The input layer is where the system gets fed with the handwriting on the image, it is possible to colour the layer. Grayscale or picture (RGB values). It has the potential to be multidimensional.

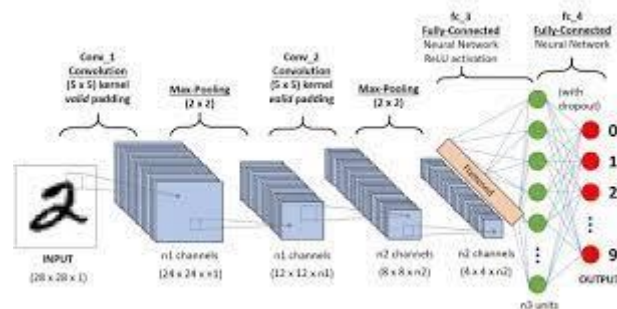


Figure 5: Convolutional neural network training.

## VI. Deep neural network

Handwriting recognition software is effective. A statistical Markov model (HMM) is a model that is employed in a system that is expected to follow the Markov process. It's possible. believed to be the simplest dynamic Bayesian Hidden Markov Network Models belong to the probabilistic class. graphical models for guessing hidden sequence variables derived from a set of observed variables as an example, these models can be used to forecast the weather based on historical data. on the various sorts of attire worn by humans in this scenario, the weather isn't cooperating. the unspoken variable, whereas people's clothing is what has been observed. HMMs, on the other hand, have Speech recognition has been effectively implemented, and because the models can assist systems in recognising characters, predict complicated, and debugging is also straightforward. The programme was chosen because it is simple to use, unproblematic, and unis not essential to write codes to develop software. module. Pattern matching is the algorithm utilised, and the method is for recognition, segmentation based on neural networks is used. Finally, OCR was used as a technique. The project was completed successfully. The alphabets, numerical, and special characters are recognised by the

algorithm.chars, double chairs, and so on. The outcomes are excellent.promising, implying that neural networks can be used to solve problems.Recognition can result in up to 99.9% recognition rates. Precision in handwritten words and cursiveHandwriting with a 70-80% accuracy rate. And it was even acknowledged.for the completion of a sentence, the outcomes are based on tiny sample size.Words typed by hand are stored in a database. The work can be done in the future.

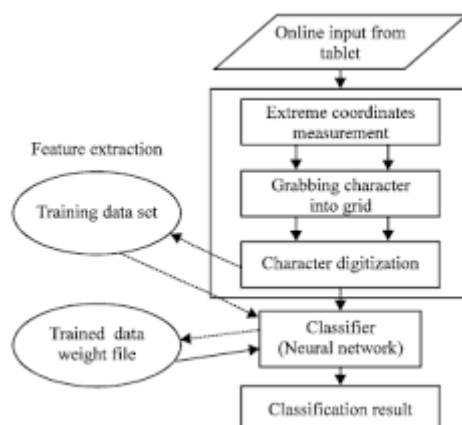


Figure 6: Neural network handwriting recognition.

## VII. Results

I introduced a new method for implementing the ANN backpropagation algorithm in this paper. Rapid matrix multiplication is used in this method. Combining an algorithm with quick execution of other operations calls to the graphics library. The benefits of doing so. Because the weights are always between 0 and 1, the precision problem is less of an issue in ANNs and OCR.

Typically, 8 bits of accuracy suffice. The weights of synaptic connections the issue could be shown in, the problem has been lessened and will be resolved soon in hardware, because the manufacturers have already begun using complete floating-point precision throughout the project. The full graphics processing pipeline is the most compelling argument in favour of utilising the cost of GPUs. The cost of a CPU is slightly more than the cost of a computer. The cost of high-capacity graphics cards. Furthermore, applications that require a lot of processing power and large memory are required that are not included in the cost of a computer processor. Aside from the above-mentioned considerations, ANN algorithms and general-purpose applications.

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