



# Recognizing Handwritten Digits and Alphabets Using Machine Learning on Python

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# Recognizing handwritten digits and alphabets using Machine Learning in python

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## Abstract:

Handwritten digit recognition has recently been a topic of interest among the researchers because of the evolution of various Machine Learning. Deep Learning and Computer Vision algorithms

Handwritten digit recognition is the ability of a computer system to recognize the handwritten inputs like dogs, characters etc from a wide variety of sources like emails, papers, images, letters etc. This has been a topic of research for decades. Some of the research areas include signature verification, bank check processing. postal address interpretation from envelopes etc.

In this project we try to demonstrate how by using modern libraries such as Scikit-Learn and NumPy and robust programming languages like Python, we can create our very own neural networks to recognize handwritten digits.

## Introduction:

The project uses forementioned modern technologies to create a working demonstration of the principle to neural networks and unsupervised machine learning techniques such as K-nearest neighbors to recognize handwritten digits, the same model can be trained to recognize other handwritten documents such as languages e.g. English.

The implication of Machine learning technologies in today's world are too many to list, we believe that the technology is of paramount importance and working on a project that deals with the applications of machine learning can greatly enhance our understanding of the topic while expanding our world-view on the subject.

Handwritten Text Recognition may be a technology that's much needed during this world as of today. Before proper implementation of this technology we've relied on writing texts with our own hands which may end in errors. It's difficult to store and access physical data efficiently . Manual labor is required so as to take care of proper organization of the info . Throughout history, there has been severe loss of knowledge due to the normal method of storing data. modern-day technology is letting people store the data over machines, where the storage, organization and accessing of knowledge is

comparatively easier. Adopting the utilization of Handwritten Text Recognition software, it's easier to store and access data that was traditionally stored. Furthermore, it provides more security to the info. One such example of Handwritten text Recognition software is that the Google Lens. The aim of our project is to form an application for mobile devices which will recognize the handwriting using concepts of deep learning.

The aim of this project is to further explore the task of classifying handwritten text and to convert handwritten text into the digital format. Handwritten text may be a very general term, and that we wanted to narrow down the scope of the project by specifying the meaning of handwritten text for our purposes. during this project, we took on the challenge of classifying the image of any handwritten word, which could be of the shape of cursive or block writing.

This project can be combined with algorithms that segment the word images during a given line image, which may successively be combined with algorithms that segment the road images during a given image of an entire handwritten page. With these added layers, our project can take the shape of a deliverable that might be used by an user, and would be a totally functional model that would help the user solve the matter of converting handwritten documents into digital format, by prompting the user to require an image of a page of notes. Note that even though there must be some added layers on top of our model to make a totally functional deliverable for an end user, we believe that the foremost interesting and challenging part of this problem is that the classification part, which is why we decided to tackle that rather than segmentation of lines into words, documents into lines, etc.

We approach this problem with complete word images because CNNs tend to figure better on raw input pixels rather than features or parts of a picture. Given our findings using entire word images, we sought improvement by extracting characters from each word image then classifying each character independently to reconstruct an entire word. In summary, in both of our techniques, our models absorb an image of a word and output the name of the word.

## Objective and Scope

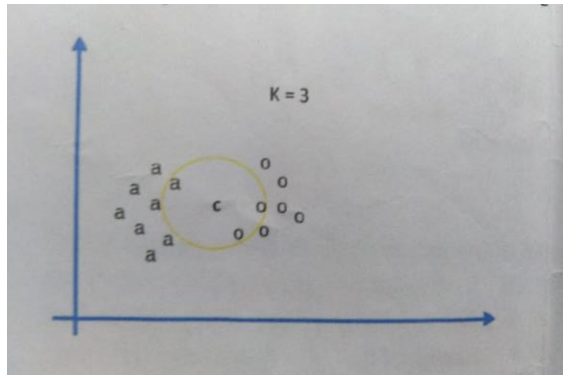
Our objective is to successfully create a model that takes image files of handwritten digits as input and then predicts what the digit is, our plan is to develop a high accuracy, high precision supervised learning model that will be able to accurately and effectively demonstrate the end goal i.e. to demonstrate the working of neural network in a real-life scenario.

There is immense scope of this project, as the same technology can be extended to generate more complex patterns and recognize different handwritten inputs.

## Methodology

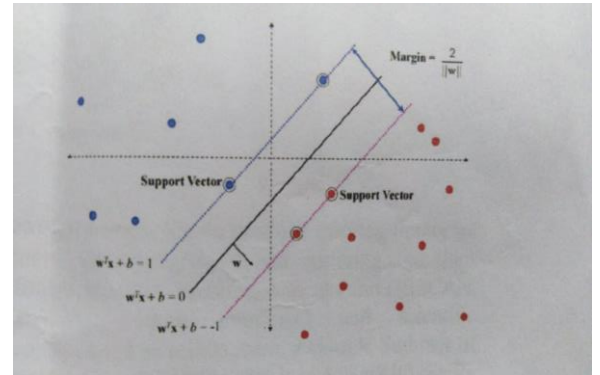
Our Methodology is based on the program driven and result oriented approach. We use cutting edge open source technologies combined with the myriad functionalities of Python to develop deep learning networks and training them to produce optimum results for our given problem statements. A brief introduction of the technologies we are going to use are as follows:

**KNN:** In pattern recognition, the k-nearest neighbors algorithm (kNN) is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. kNN is a type of instance-based learning, or lazy learning where the function is only approximated locally and all computation is deferred until classification. The k-NN algorithm is among the simplest of all machine learning algorithms.

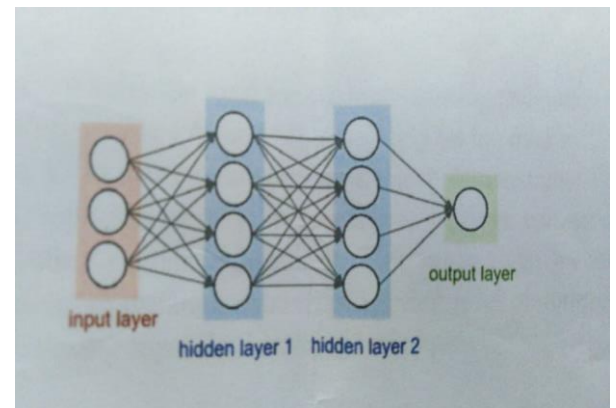


**SVM:** In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods

such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.



**CNN:** In machine learning, a convolutional neural network (CNN, or ConvNet) is a class of deep, feed-forward artificial neural networks, most commonly applied to analyzing visual imagery. CNNs use a variation of multilayer perceptrons designed to require minimal preprocessing. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics. Convolutional networks were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field.



## Literature Review

Research within the region of word recognition, being done from Grimsdale within the year 1959 is soonest endeavor to perceive the handwritten character. This mid-sixty research exhibited the use of examination by combination strategy being proposed by the eden in 1968. He demonstrated that each single handwritten character is limited to number of schematic highlights. This hypothesis was later utilized as a neighborhood of just about all strategies for auxiliary methodologies within the region of character recognition

Sandhya Arora in, during this paper specifically four highlights like shadow, histogram of chain code crossing point and horizontal line fitting highlights being portrayed. Among these highlights the shadow was registered all around for picture character, the remainder three were processed by partitioning the character picture into the distinctive sections. within the one useful execution utilizing the dataset of 4900 examples demonstrated the exactness rate of 90.8 % for Devanagari handwritten characters.

R. Bajaj, S. Chaudhari, L. Dey, et al , for grouping the Devanagari numerals, distinctive highlights like clear part, thickness and minute highlights were utilized. Additionally, to increase the popularity capacity, the paper proposes multi classifier unwavering quality for handwritten Devanagari numerals.

To perceive the disconnected handwritten numerals of six prominent Indian language, a changed quadratic classifier is employed . an identical paper likewise manages perceiving English letters so as . For both of those, a multilayer perceptron was utilized and Boundary following and Fourier descriptors were utilized for the component extraction. By examining the form and searching at their highlights, the characters were identified. Also, to make a decision the quantity of concealed layers, back spread system was utilized. With this very calculation, a recognition rate of 94% are accounted for with less preparing time.:

Salvador España-Boquera, The analysts proposed the utilization of hybrid or half plus half concealed markov show (HMM) to perceive the handwritten content in disconnected mode. The optical model's basic part was prepared with Markov chain procedure and a multilayer perceptron was likewise wont to gauge the possibilities.

K. Gaurav and Bhatia P. K , proposed different prehandling systems being related to the popularity of the characters. The procedure took an attempt at the varied types of pictures from a basic picture-based report back to a hue and changed forces including foundation. Different systems of pre-handling and standardization like skew remedy, differentiate evacuation, commotion expulsion and numerous other upgrade procedures were recommended. They reached the choice that a solitary procedure cannot be connected for preprocessing the

image . Yet additionally there were a couple of disparities that utilizing all of those systems likewise can't give the simplest exactness comes about.

Nafiz Arica et al. This paper gave the technique because of which it had been less demanding to take care of a strategic distance from the preprocessing stage along these lines lessening the loss of imperative data. the simplest one proposed was calculation of capable division. What's more, the different strategies supporting this calculation were utilizing neighborhood maxima and minima, additionally other, for instance , stroke tallness which clothed to be ideal and furthermore character limit. What's more, these were altogether connected on a grayscale picture. Utilizing this approach, superfluous division was decreased bit by bit.

Alongside that, the paper additionally proposed another model called shrouded markov demonstrate (HMM) preparing for estimation of worldwide and highlight space parameters alongside estimation of model parameters. Additionally, to rank the individual characters and furthermore to urge the form data, this preparation show was utilized. Additionally, by utilizing the one-dimensional portrayal of a 2-D character picture tremendously builds the energy of HMM for shape perceiving.

A way was proposed to perceive the individually Tamil written character by utilizing the grouping within the strokes. Principally a strokes' format or shape-based portrayal is employed spoken to as a string of shape highlights. Utilizing this strategy, the unrecognized stroke was perceived by contrasting it and a dataset of strokes by the string coordinating method in an adaptable mode. Utilizing this, a private character was perceived by distinguishing all of the strokes and its segments.

## Summary/Conclusion:

To say that there is an immense need for machine learning technologies in today's world would be an understatement as AI and ML are slowly taking over even conventional roles that were thought to be solely human. Our paper demonstrates that using available technologies and applying them in practical applications can open a vast door of opportunities for other similar applications. This paper can be further expanded to incorporate multitudes of different datasets of varying level of complications and provide accurate predictions using supervised learning techniques

This project contributes to the very basic needs of our human psyche to replace conventional jobs by machines to make our lives easier. Throughout the millennia humans have slowly replaced our hands with tools, our tools with machines, or machines with complex power tools; now is the time to replace our mind.

## References:

1. <http://en.wikipedia.org/wiki/Scikit-learn>
2. <https://en.wikipedia.org/wiki/NumPy>
3. <https://en.wikipedia.org/wiki/Matplotlib>
4. [https://en.wikipedia.org/wiki/Convolutional\\_neural\\_network](https://en.wikipedia.org/wiki/Convolutional_neural_network)
5. [https://en.wikipedia.org/wiki/Support\\_vector\\_machine](https://en.wikipedia.org/wiki/Support_vector_machine)
6. [https://en.wikipedia.org/wiki/K-nearest\\_neighbors\\_algorithm](https://en.wikipedia.org/wiki/K-nearest_neighbors_algorithm)
7. Sandhya Arora, "Combining Multiple Feature Extraction Techniques for Handwritten Devnagari Character Recognition", IEEE Region 10 Colloquium and the Third ICIS, Kharagpur, INDIA, December 2008.
8. Nafiz Arica, and Fatos T. Yarman-Vural, —Optical Character Recognition for Cursive Handwriting, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.24, no.6, pp. 801-113, June 2002
9. K. H. Aparna,, Vidhya Subramanian, M. Kasirajan, G. Vijay Prakash, V. S. Chakravarthy, Sriganesh Madhvanath, "Online Handwriting Recognition for Tamil", IWFHR, 2004, Proceedings. Ninth International Workshop on Frontiers in Handwriting Recognition, Proceedings. Ninth International Workshop on Frontiers in Handwriting Recognition 2004, pp. 438-443, doi:10.1109/IWFHR.2004
10. K. Gaurav and Bhatia P. K., "Analytical Review of Preprocessing Techniques for Offline Handwritten Character Recognition", 2nd International Conference on Emerging Trends in Engineering & Management, ICETEM, 2013.
11. Salvador España-Boquera, Maria J. C. B., Jorge G. M. and Francisco Z. M., "Improving Offline Handwritten Text Recognition with Hybrid HMM/ANN Models", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 33, No. 4, April 2011
12. U. Pal, T. Wakabayashi and F. Kimura, "Handwritten numeral recognition of six popular scripts," Ninth International conference on Document Analysis and Recognition ICDAR 07, Vol.2, pp.749-753, 2007.
13. Reena Bajaj, Lipika Dey, and S. Chaudhury, "Devnagari numeral recognition by combining decision of multiple connectionist classifiers", Sadhana, Vol.27, part. 1, pp.-59-72, 2002.