Project Report

Handwritten Digit Recognition

Group Name: ApplePy

Group Members:

First name	Last Name	Student number
Parag	**Dhanawade**	**C0846849**
Vitor	**Gomes**	**C0852679**
Raghavendra	**Reddy**	**C0851724**
Mehul	**Kakadiya**	**C0849255**

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Abstract

Humans' reliance on technology has never been higher, to the point that deep learning and machine learning algorithms can conduct everything from object detection in images to adding sound to silent movies. Similarly, handwritten digit recognition is a major area of research and development with a plethora of possibilities. The ability of a computer to receive and interpret comprehensible handwritten input from sources such as paper documents, pictures, touch-screens, and other devices is known as handwritten digit recognition. Apparently, we used MNIST datasets to conduct handwritten digit recognition using Multi-Layer Perceptron (MLP) and Convolution Neural Network (CNN) models in this paper. Our main objective is to develop system that will recognize the handwritten digits from provided input image and display the digit written in the input as an output after processing image.

Keywords : Deep learning, Handwritten Digit Recognition, MNIST datasets, Convolution Neural Network.

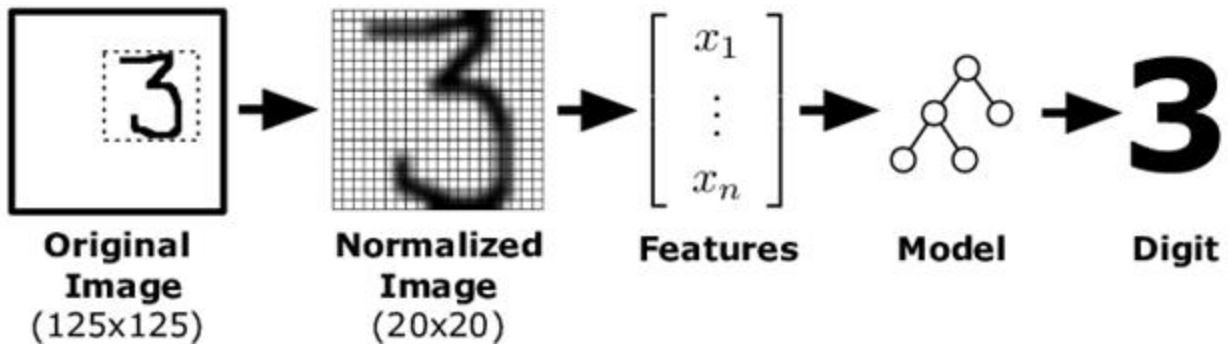
Introduction

Handwritten digit recognition refers to a computer's capacity to recognise human handwritten digits from a variety of sources, such as photographs, papers, and touch displays, and classify them into ten specified categories (0-9). Handwritten digit recognition faces many challenges because it is not optical character recognition because the writing style varies from person to person. Numerous applications exist for digit recognition, including number plate identification, postal mail sorting, and bank check processing. The accuracy of any model is paramount, as a more accurate model makes better decisions. Inaccurate models are not suitable for real-world applications. Example: High accuracy is very important for an automated banker's check processing system where the system recognizes the amount and date of the check. If the system misidentifies the numbers, it can cause significant and undesired damage. Therefore, these real-world applications require high-precision algorithms.There are a few different ways to train a CNN for handwritten digit recognition. One popular approach is to use a dataset of labeled images, where each image has been labeled with the correct digit. The CNN is then trained to minimize the error on this dataset. The handwritten digit recognition is a difficult problem, but it is possible to get good results with a convolutional neural network. Finally, we implemented a web application that is used by user for digit recognition.

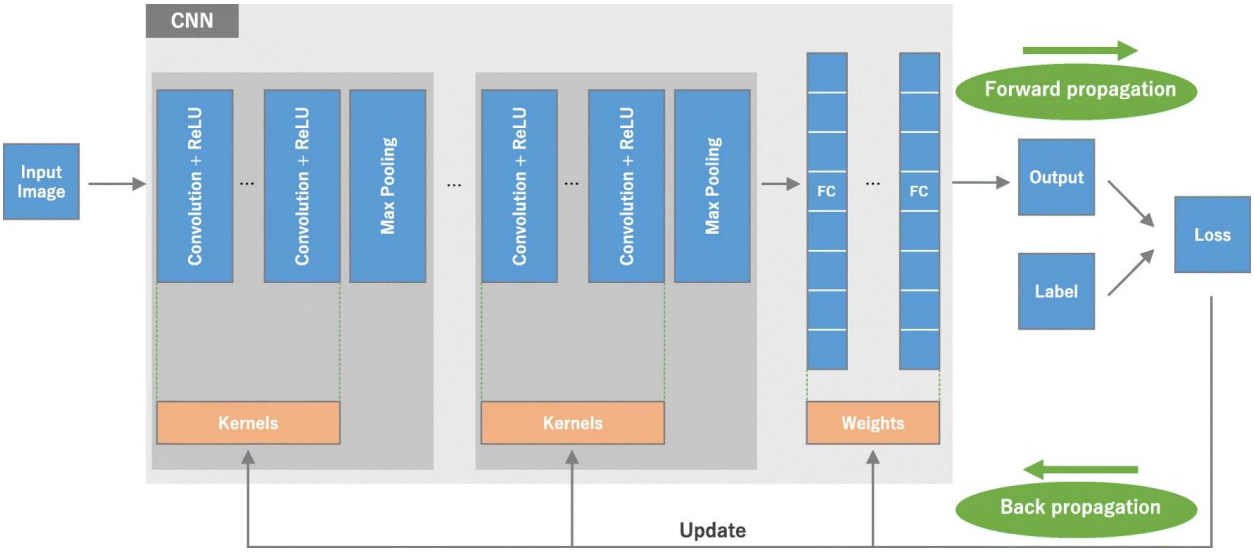
Methods

In the beginning, we did much research for our project regarding technologies and different libraries going to be used further. we divide works accordingly and started watching tutorials and collects information that are being used to build project. First we decided to use **brython** that is another library written in python3. Use Brython, and you run python straightforwardly inside your internet browser. The Brython expects to supplant the javascript. Brython is a better approach for javascript. Brython is not difficult to reasonable and usable. You effectively communicate with dom(Dom Object Model) and change dom help of python. However, we did not get desired outcome therefore we changed our library to pywebio. PywebIO makes it simple to create simple web apps in Python without needing HTML or Javascript. This package's concept is straightforward: it provides input and output functions that can be used to develop simple GUI or web apps. Then, using interactive execution environments like Python shell, IPython, or Jupyter notebook, you may serve web applications in your browser locally or on the cloud. For model building there are many different ways to approach HDR, but one common approach is to use a convolutional neural network (CNN). To build model using CNN we need tensorflow that is well suited for distributed training and prediction, which is important for handwritten digit recognition because it allows you to train and predict on a large dataset in a reasonable amount of time. CNNs are a type of deep learning neural network that are particularly well suited for image classification tasks. The first step in using a CNN for HDR is to pre-process the images. This typically involves converting the images to a standard size and format, and then normalizing the pixel values. Once the images are pre-processed, they are then fed into the CNN. The CNN will learn to extract features from the images that are relevant for the task of recognition.

For example, it may learn to identify edges, shapes, and patterns. The output of the CNN is then fed into a classification algorithm, which will learn to map the features extracted by the CNN to the correct labels.



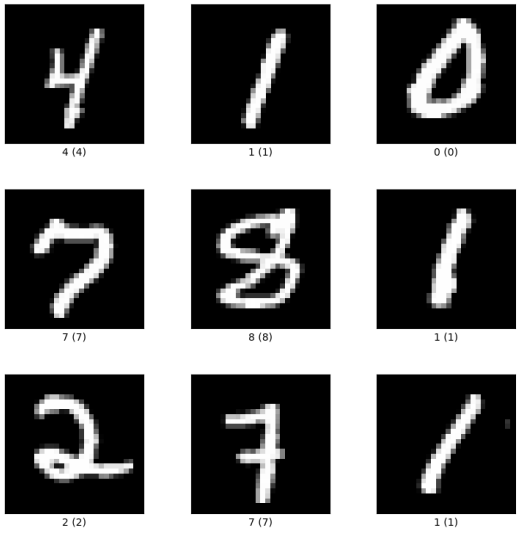
As there is single input and single output we have used Sequential model that is appropriate for a plain stack of layers where each layer has exactly one input tensor and one output tensor. To get high accuracy we have done variations through some parameters of the model such as kernel size, activation function, and input shape.



MNIST Dataset:

The MNIST dataset is an acronym that stands for the Modified National Institute of Standards and Technology dataset. It is a dataset of 60,000 small square 28×28 pixel grayscale images of handwritten single digits between 0 and 9. Specialty dataset consist of the numbers written by. High school students and US Census Bureau staff. MNIST contains a total of 70,000 handwritten digit images (60,000 training sets and 10,000 test sets) using antialiasing in a 28x28 pixel bounding box. All of these images have a corresponding Y value that indicates what the numbers are. It is a widely used and deeply understood dataset and, for the most part, is "*solved*." Top-performing models are deep learning convolutional neural networks that achieve a classification accuracy of above 99%, with an error rate between 0.4 %and 0.2% on the hold-out test dataset.

Here is some samples from dataset:



Results

The convolutional layer was able to learn features that allowed it to distinguish between different handwritten digits. The fully connected layer then took these features and made predictions about which digit was being shown in the image. Overall, the sequential model worked quite well for this task. The system was able to correctly identify handwritten digits with an accuracy of 96.7% with 23% loss and 98% and 4% value accuracy and value loss respectively. Overall, The model was able to correctly identify the handwritten digits with a high degree of accuracy. We also anlyze the confusion matrix for predicted data of our model. However, there were a few instances where the model was not able to correctly identify the handwritten digit. The web application can take an image as input from the user and send that to the model for processing and at last, it will display the predicted correspondent digit shown in the image. The 'pywebio' library worked well to make this possible.

```
array([[[9010,   10],
        [  15,  965]],

       [[8853,   12],
        [  15, 1120]],

       [[8949,   19],
        [  32, 1000]],

       [[8951,   39],
        [   7, 1003]],

       [[9004,   14],
        [   7,  975]],

       [[9087,   21],
        [  13,  879]],

       [[9037,    5],
        [  26,  932]],

       [[8907,   65],
        [  10, 1018]],

       [[9019,    7],
        [  45,  929]],

       [[8975,   16],
        [  38,  971]]])
```

Fig. Confusion Matrix

Conclusions and Future Work

In conclusion, the handwritten digit recognition using CNN is a great way to quickly and accurately identify handwritten digits. This method is accurate and efficient, and it can be used to identify digits with a high degree of accuracy. The handwritten digit recognition model is a powerful tool that can be used to automate the process of identifying handwritten digits. This can be extremely useful in a variety of applications, such as identifying numbers on documents or recognizing handwritten addresses.Though the performance of the system is good, it predicts the wrong digit sometimes. To increase accuracy and make it more efficient we need to train this model using more sample images. As of now it only detects handwritten digits so in the future we would like to expand this project with handwritten text recognition and make it possible for the user to access on mobile devices.

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