REPORT

Comparing CNN with MLP on MINST dataset

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I. INTRODUCTION & MOTIVATION

The MINST database formally knows as Modified National institute of standard of technology database are used in image processing systems to contain a lots of handwritten digits, machine learning algorithms is used to train and test the datasets. In this project we will use two algorithms technique to critically evaluate the datasets and the two algorithm we used is convolutional neural network (CNN) and Backpropagation to determine the accuracy of the model through testing and training the data.

In a typical simple NN an artificial neuron activates its output when more than a certain number of its inputs are active.[2] In this paper it will include a detailed presentation and methodology of the dataset used, its analysis, data processing, training and testing the models. A brief discussion of the pros and cons of the two algorithms is presented and how I gathered the hypotheses on the two methods, and finally I have critically evaluated the results and accuracy of the models and explain if they back up our hypothesis presented from the outset.

II. ABOUT DATASET

The Dataset is used is from MINST database website [1] it includes of handwritten digits is a 70000 images collection. It's splitted to 60000 training images and 10000 test images. It is got 28 by 28 pixels. The image has got number digits written 0-9.

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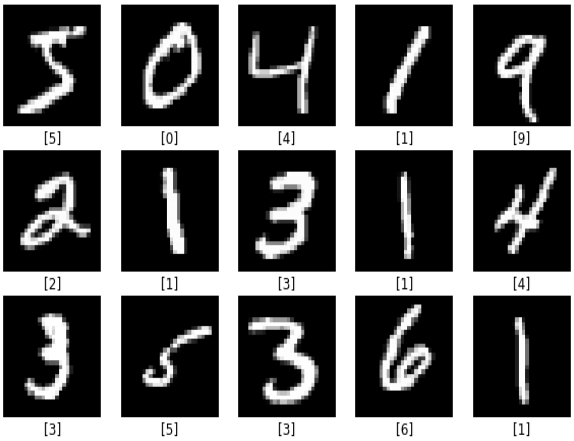
A. Data Wrangling and Exploratory Analysis

From the data we articulate that are 28 x 28 and in each line there is an image which includes digit number. The image are grey and dark this could have been better with feature engineering, also we could change the pixel with 0 or 1. Since the digits are written in numerical in this case we can use supervised machine learning algorithm to train classifier . Normally the most accurate models and are CNN which research shows that they have achieve around 99% accuracy with 0.2 – 0.4 % error rate, and here we are going to prove this and compare between the two models as in CNN and MLP.



III. SUMMARY OF THE ALGORITHMS (MLP and CNN)

A. Multi-Layer Perceptron (MLP)

Multi-layer perceptron are very commonly used and its one of the most implemented machine learning algorithms. The are also called artificial neural network, a supervised learning which consists of input, output and hidden layers to extract useful information and learns from given input variable.

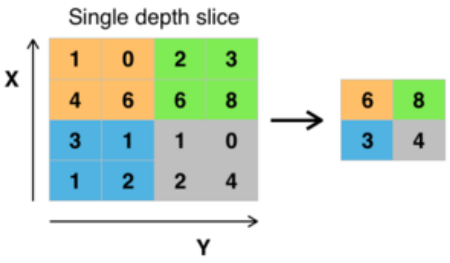
The backpropagation is used and trained with the gradient decent to work out any error signal (y) by taking away the output varible (x)from the target value (Z). In this case the biases and wights learns by iterative process through the network input and this is known as propagation, the training process is called epoch. Below is the table showing the pros and cons of the MLP technique.

PROS	CONS
• A useful and strong universal approximator as it can model any function with one hidden layer. • The hidden neurons act as feature extractors. • Its both classification and regression • After it Learns input data it automatically extract features w • Robust to noise data	• Can overfit due to its complexity • Lots of training data (expensive computation) • Difficult learning rate • Too many hyper-parameters • Technically difficult to explain due to its many network. -

B. CONVOLUTIONAL NEURAL NETWORK (CNN)

CNN are artificial neural network which are fully connected layers inspired by biological process. In our analysis CNN are very common to be used ie image recognition and so according to MINST databse its got 0.23% error rate also the learning speed is faster when there is a lots of data and so therefore MINST dataset is very relevant.

PROS	CONS
• They are very speedy • Can be used to detected things such emjois and bytes • Often accurate and better results • Not required prior knowledge and human intervention •	• Requires a lots of computing power ie it could be expensive to invest GPU • CNN doesn't encode the position or orientation of a object when predicting • High Complexity



IV. HYPOTHESIS STATEMENT

One of the objectives in this report was to compare the differences between CNN and MPL algorithms pre modelling. The following are the hypotheses.

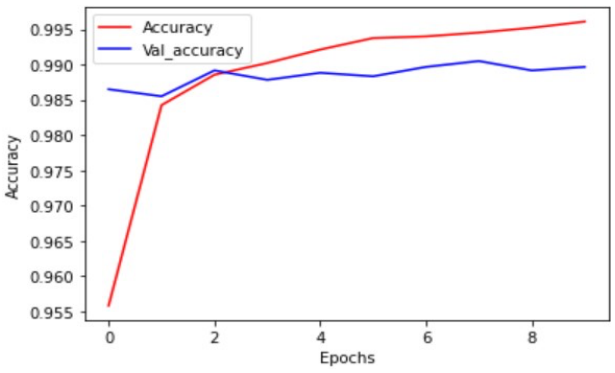
- Hypothesised CNN would achieve greater accuracy score compare to MPL with short training time and its associated noise in the input. Although MPL are generally better dispute noise data, however both models tends to score significantly better.
- Solved imbalance problem on the dataset through the data exploratory analysis and explained the differences between MPL and CNN.
- From the CNN algorithms we can problem solve the areas of uncertainties by using decision boundaries and provides useful information learning methods power.

V. EXPERIMENTS AND EVALUATION METHODOLOGY

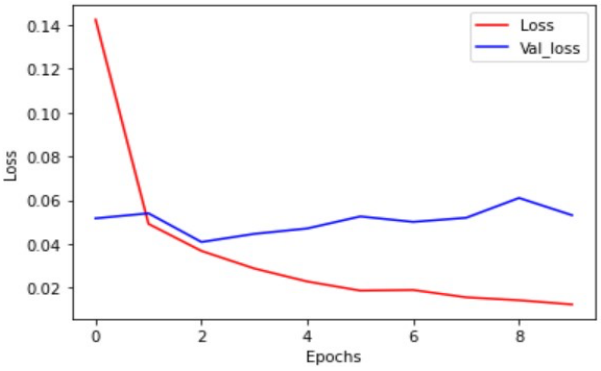
To meet the aim and object of the report, a several training and testing was done specially our build in regression to predict wine using tensorflow learn including but limited to linear regression, pandas and more. The data imbalance problem was a hard one in this case resulted in around 98% accuracy for CNN and less for the other algorthims. The reason I have used feature selection such as Pearson's correlation was to get the best result, the features selection process adds an extra bias to the activation function so the outcome be overfitting model. The Pearson's correlation matrix was created to define the differences in relationship of its correlation by using positive and negative label between the strength of the variable. I performed feature selection to make my life easier when traning and testing the models as it can become difficult due to the imbalance data.

I have built a simple CNN model. The first layer is the input layer; the size of the input image is 28 × 28. The second layer is the convolution layer, it can obtain 32 different feature maps by convolution with the input image. The second layer is the pooling layer. It computes the local maximum of the input feature maps.

The next convolution layer and pooling operate the same way except for the number and size of the convolution kernels. The next if the flatten layer to convert the 2D feature maps into 1D. Then, 2 fully connected layers with 10 neurons as the output of the classifier. [4]



Due to expensive computation I split train and test and used the MLP with 4 hidden layers to start with and when up until 32 neurons to get be a good accuracy result. The model reached an accuracy of 99.61% and a loss of value 1.24% on the training set. For the validation set it reached an accuracy of 98.97% and loss of 5.32% which indicates that it's working great without overfitting nor underfitting the data. This also indicates that this model outperformed the MLP model.

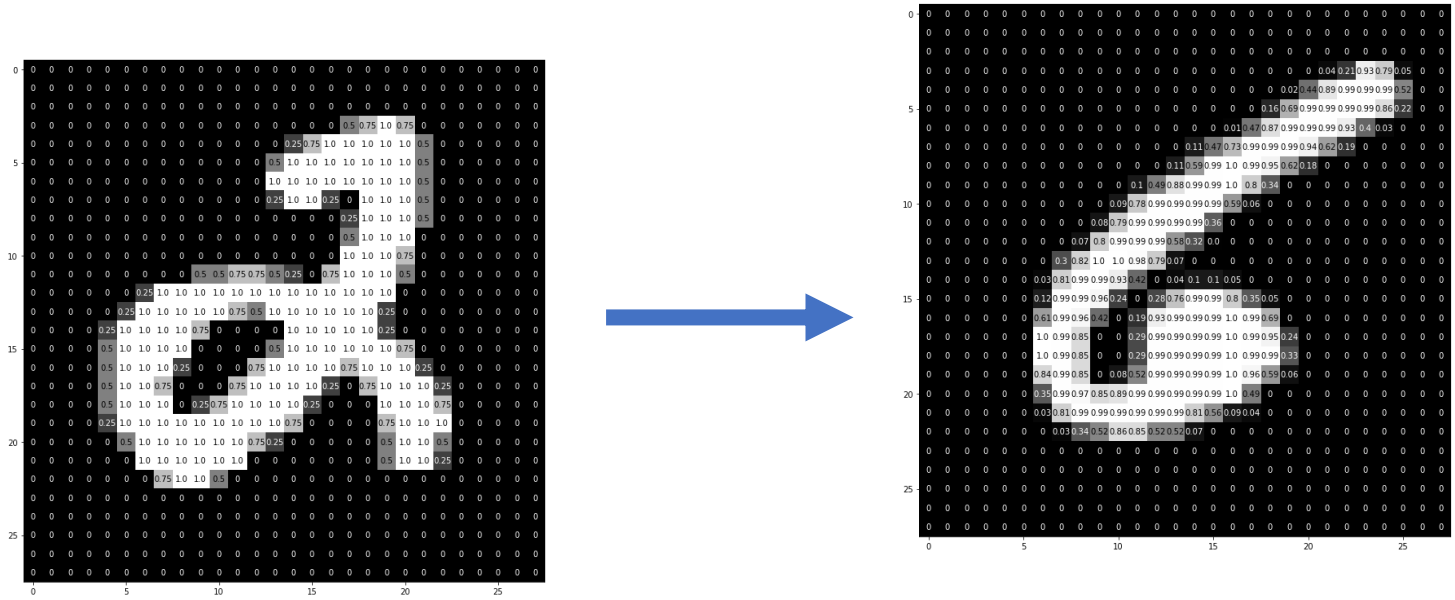


A hidden neurons and hidden layer were used to obtain an optimum outcome in respect to the algorithms deployed for example the graph illustrated the level of accuracies and convergence in traning and validation and so therefore the hyper-parameters were important to be used here

To compare CNN and MLP a grid search was used to obtain the ideal results for the C, kernel and gemma value. Finally, this might not be the best accuracy result but the problem solving ablity in complex dataset was worth the try and with respect to the best knowledge.

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 28, 28, 32)        320
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 14, 14, 32)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 14, 14, 64)        18496
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 7, 7, 64)          0
_________________________________________________________________
dropout (Dropout)            (None, 7, 7, 64)          0
_________________________________________________________________
flatten_1 (Flatten)          (None, 3136)              0
_________________________________________________________________
dense_2 (Dense)              (None, 128)               401536
_________________________________________________________________
dense_3 (Dense)              (None, 10)                1290
=================================================================
Total params: 421,642
Trainable params: 421,642
Non-trainable params: 0
_________________________________________________________________
```

Here below is the first plot of of using MLP model where the image is not what we wanted after preforming the testing and training bit. Therefore we experimenting again to get better result.



VI. CONCLUSION AND FUTURE WORK

When critically evaluating and experimenting both models on the test data it was proven that MLP got an accuracy of 97.87%. But when we added convolution and pooling layers to the vey same architecture our convolutional neural network could reach an accuracy of 99.7%. This is the same result we got from the validation sample. Where CNN got 9 8.97%. Which prove that in an image classification problem a CNN can make a better performance. For better results of both models, we could use data augmentation techniques. We could change the learning rate parameter to reach better accuracy faster. For faster analysis of data we could convert the model input stream to tensors instead of vector

VII. REFERNCES

[1] N. Yann LeCun, Courant Institute, N. Y. Corinna Cortes, Google Labs, and R. Christopher J.C. Burges, Microsoft Research, ‘THE MNIST DATABASE of handwritten digits’. [Online]. Available: http://yann.lecun.com/exdb/mnist/.

[2] Geron, Aureìlien. 2019. *Hands-on Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*. 2nd ed. CA 95472: O’Reilly.

[3] Ghosh, Mahmoud M. Abu, and Ashraf Y. Maghari. "A comparative study on handwriting digit recognition using neural networks." *2017 international conference on promising electronic technologies (ICPET)*. IEEE, 2017.