1 Introduction

MNIST is a dataset consisting of handwritten digits and their labels commonly used for training machine learning models and image processing systems [1]. The classical problem represented by the MNIST dataset is for machine learning algorithms to be able to learn to recognise handwritten digits, no matter how they are shaped.

For this project, the problem at hand is not just for the inference pipeline to learn to recognise MNIST digits accurately, it must also learn addition.

Previous work has been done on this by Hoshen and Peleg in 2015 [2] and Bloice et al. in 2019 [3]. Hoshen and Peleg focused on end-to-end visual learning of arithmetic operations using pictures, first learning on recognising the image, then learning the arithmetic operation [2]. Bloice et al. were more concerned with .

The way in which the inference pipeline will do this is simple: first, a stratified dataset of paired MNIST digits will be generated, along with the label denoting their sum. The object of this dataset is to get an even distribution of digit pair permutations, such that the resulting model will not be biased to learning on the extremes. Then, a neural network will be trained and perform supervised learning on this dataset. In order to get an accurately-performing neural network, hyper-parameter tuning will also be performed using `Optuna`.

To explore this problem further,

2 Dataset generation

3 Neural network pipeline

4 Other inference algorithms

5 Weak linear classifiers

6 t-SNE distributions in neural networks

References

[1] Deng L. The mnist database of handwritten digit images for machine learning research. IEEE Signal Processing Magazine. 2012;29(6):141-2.

[2] Hoshen Y, Peleg S. Visual Learning of Arithmetic Operations; 2015. Available from: `https://arxiv.org/abs/1506.02264`.

[3] Bloice MD, Roth PM, Holzinger A. Performing Arithmetic Using a Neural Network Trained on Digit Permutation Pairs; 2019. Available from: `https://arxiv.org/abs/1912.03035`.