

# **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.

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. 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, a SVM, Random Forest classifier, and an AdaBoost classifier were also trained on the MNIST dataset. Weak linear classifiers were also used.

The t-SNE distribution of the dataset and the embedding layer of the best-performing neural network were also extracted and analysed, optimising for perplexity.

## **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.