# ECE 4370 Project 4 Report
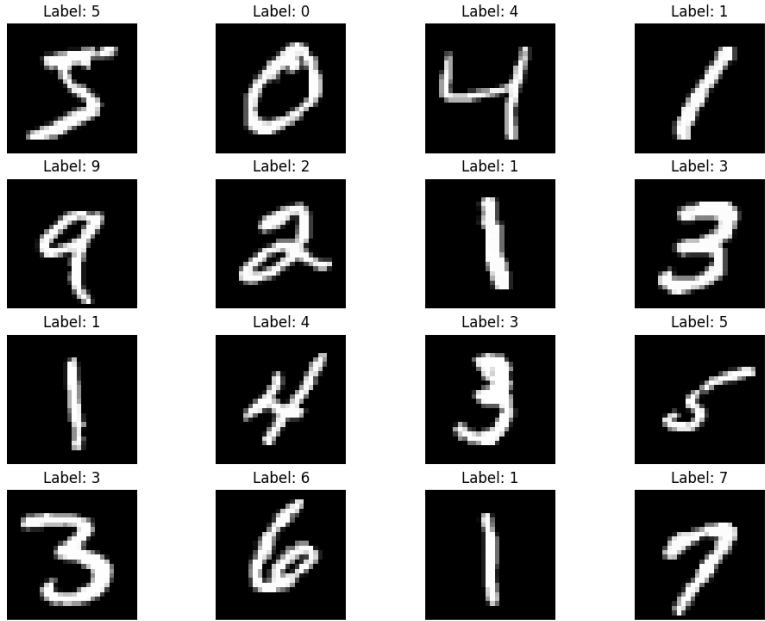
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1. MNIST dataset
a. Training information

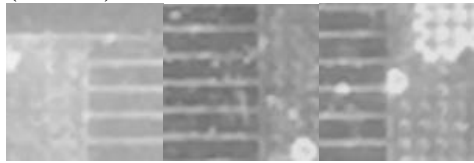| | |
|---|---|
| Visual verification of input data | Figure 1: Visual verification of MNIST dataset for first 16 training images<br><br>Figure 1 illustrates visually the data held by the MNIST dataset as handwriting samples. This verification demonstrates that the training labels (i.e. the classifiers) match up with the training data for the dataset. |
| Training, validation, and testing data splits | Training set – 60,000 images<br>Test set – 10,000 images<br><br>Splits: 85.7% training data, 14.3% testing data. |
| Input image size used for training/ testing | Input images are size 28x28 pixels for training set, and 28x28 pixels for test set. |
| Image pre-processing | No image pre-processing was used for this dataset. |
| Parameters of logistic regression | Logistic regression parameters:<br>• K (number of classes) = 10<br>• N (number of images) = 60,000 |
| Optimizer type and corresponding parameters | Optimizer chosen was gradient descent with momentum.<br><br>Optimizer parameters:<br>• rho (learning rate) = 0.01<br>• Beta (momentum constant) = 0.9<br>• Termination criterion: $w_n - w_{n-1} < 8e\text{-}3$ |

b. Confusion matrix

| n = 10,000 | Actual K = 0 | Actual K= 1 | Actual K = 2 | Actual K = 3 | Actual K = 4 | Actual K = 5 | Actual K = 6 | Actual K = 7 | Actual K = 8 | Actual K = 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Predicted K= 0 | 950 | 0 | 6 | 3 | 2 | 10 | 13 | 2 | 8 | 5 |
| Predicted K = 1 | 0 | 1104 | 5 | 0 | 2 | 2 | 2 | 6 | 11 | 5 |
| Predicted K = 2 | 3 | 4 | 938 | 15 | 4 | 6 | 5 | 26 | 6 | 1 |
| Predicted K = 3 | 4 | 2 | 18 | 921 | 2 | 37 | 4 | 10 | 42 | 11 |
| Predicted K = 4 | 0 | 0 | 7 | 0 | 915 | 7 | 11 | 5 | 9 | 36 |
| Predicted K = 5 | 7 | 4 | 8 | 27 | 0 | 772 | 15 | 1 | 47 | 6 |
| Predicted K = 6 | 5 | 3 | 13 | 1 | 8 | 14 | 898 | 0 | 10 | 0 |
| Predicted K = 7 | 1 | 2 | 10 | 8 | 8 | 4 | 4 | 946 | 6 | 34 |
| Predicted K = 8 | 2 | 15 | 21 | 25 | 8 | 34 | 6 | 3 | 286 | 15 |
| Predicted K = 9 | 0 | 1 | 6 | 10 | 33 | 6 | 0 | 29 | 9 | 896 |

c. Training and testing execution times
- Training time: 3 minutes, 18 seconds
- Testing time: 7 ms

2. C. elegans dataset
a. Training information (see table on page below)

| | |
|---|---|
| Visual verification of input data | <br>Figure 2: Training images classified as 1 (worms)<br><br>Figure 3: Training images classified as 0 (no worms)<br><br>Figure 2 represents three images classified with the label 1, corresponding to containing a worm. Figure 3 shows three images classified as a 0, corresponding to no worms present. Visual verification was performed across the entirety of the dataset. |
| Training, validation, and testing data splits | Training set – 8,301 images<br>Test set – 2,075 images<br><br>Splits: 80.0% training data, 20.0% testing data. |
| Input image size used for training/ testing | Input images are sized down from 101x101 pixels to 28x28 pixels for both sets. |
| Image pre-processing | Canny Edge detection was used to pre-process the images before training. |
| Parameters of logistic regression | Logistic regression parameters:<br>• K (number of classes) = 2<br>• N (number of images) = 8,301 |
| Optimizer type and corresponding parameters | Optimizer chosen was gradient descent with momentum.<br><br>Optimizer parameters:<br>• rho (learning rate) = 0.001 (1e-3)<br>• Beta (momentum constant) = 0.85<br>• Termination criterion: $w_n - w_{n-1} < 1e-7$ |

b. Confusion matrix

| n = 2,075 images | Actual K = 0 | Actual K = 1 |
|---|---|---|
| Predicted K = 0 | 963 | 128 |
| Predicted K = 1 | 75 | 909 |

c. Training and testing execution times
- Training time: 0 minutes, 36 seconds
- Testing time: 35 ms