Date: 04/09/2025

ECE 5370 Machine Learning

Project 4 Report

Spring 2025

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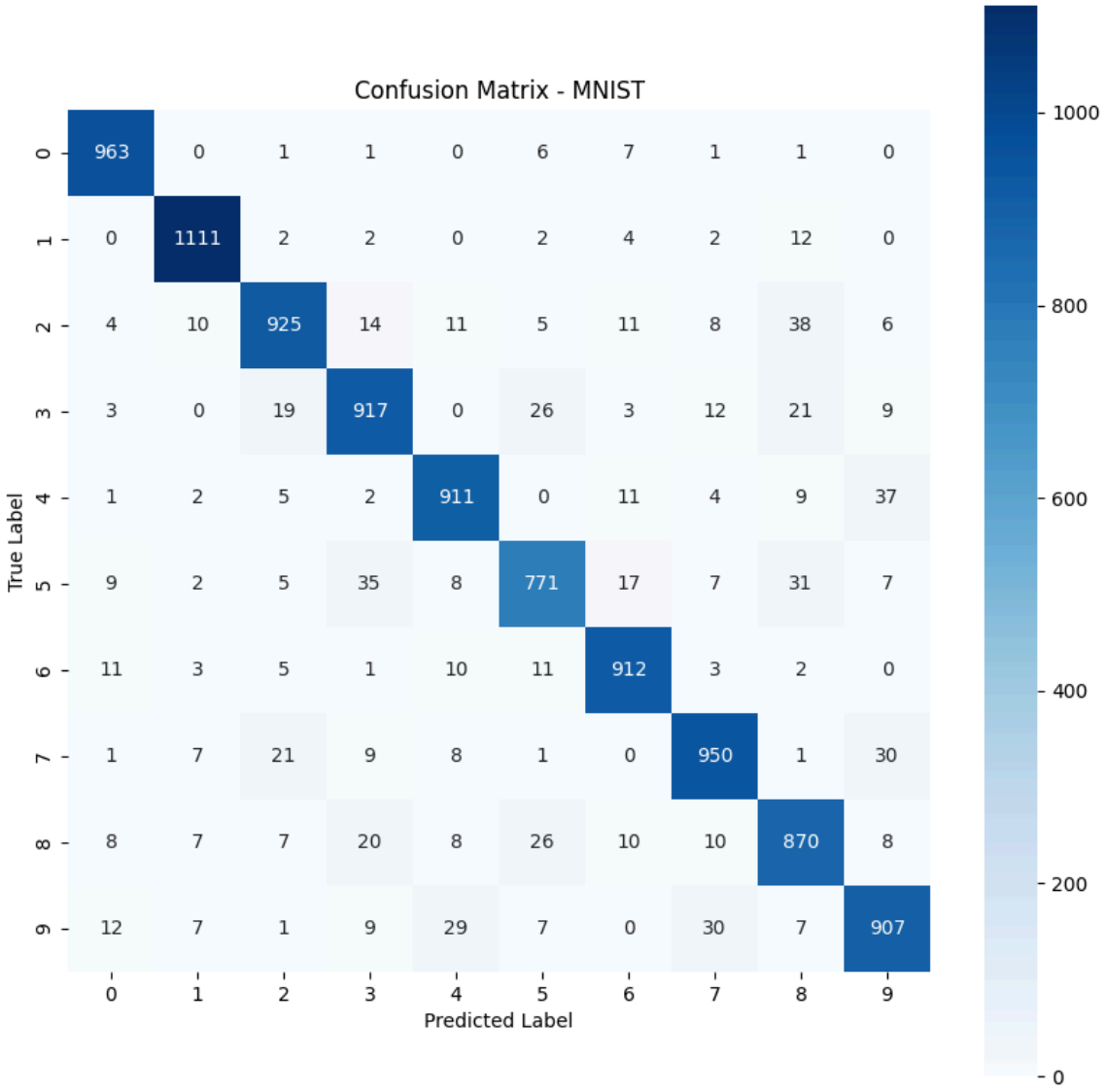
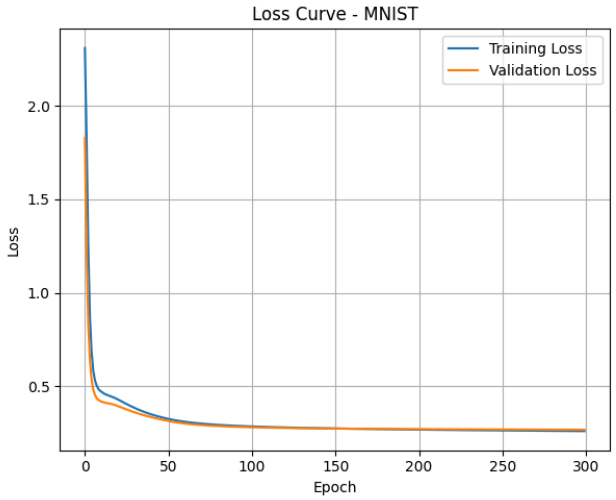
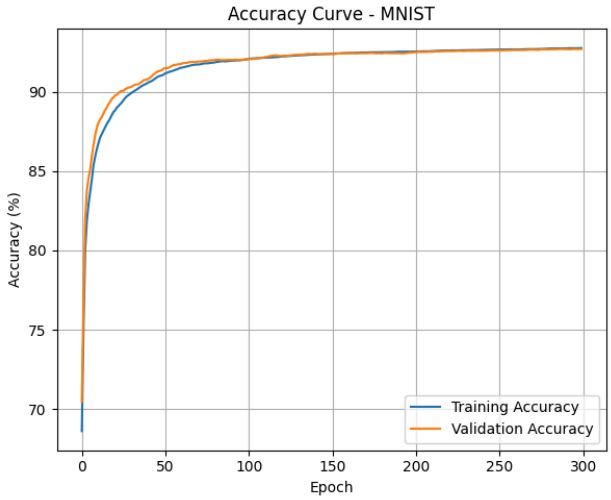
1. MNIST

Visual Verification of Input Data	N/A
Training, Validation, and Testing Data Split	MNIST: 80% train / 20% val, separate test
Input image size user for training/testing	28x28 pixels
Image Processing	None
Parameters of Logistic Regression	Random weight init, zero bias, L2 regularization (λ=0.01)
Optimizer Type and Corresponding Parameters	Gradient descent with momentum (β=0.9), learning rate (MNIST: 0.5), Epochs: 300

Training Time: 91.97 seconds
Testing Time: 7.03 seconds
Train Accuracy: 92.72%, Val Accuracy: 92.64%


Confusion Matrix - MNIST
True Label
Predicted Label
0 963 0 1 1 0 6 7 1 1 0
1 0 1111 2 2 0 2 4 2 12 0
2 4 10 925 14 11 5 11 8 38 6
3 3 0 19 917 0 26 3 12 21 9
4 1 2 5 2 911 0 11 4 9 37
5 9 2 5 35 8 771 17 7 31 7
6 11 3 5 1 10 11 912 3 2 0
7 1 7 21 9 8 1 0 950 1 30
8 8 7 7 20 8 26 10 10 870 8
9 12 7 1 9 29 7 0 30 7 907
0 1 2 3 4 5 6 7 8 9
1000
800
600
400
200
0


Loss Curve - MNIST
Training Loss
Validation Loss
Loss
Epoch
2.0
1.5
1.0
0.5
0
50
100
150
200
250
300


Accuracy Curve - MNIST
Training Accuracy
Validation Accuracy
Accuracy (%)
Epoch
90
85
80
75
70
0
50
100
150
200
250
300

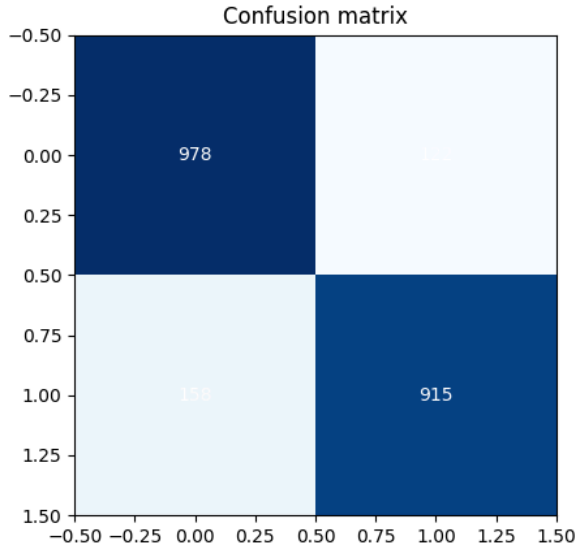
2. C. ELEGANS

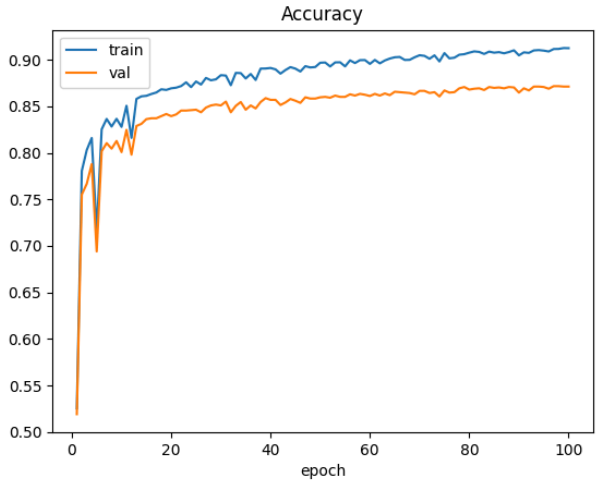
Visual Verification of Input Data	N/A
Training, Validation, and Testing Data Split	MNIST: 80% train / 20% val, separate test
Input image size user for training/testing	101x101 pixels
Image Processing	CLAHE → median-blur(3) → Canny edges blended (0.8/0.2)
Parameters of Logistic Regression	learning-rate=0.1, epochs=100, batch=256, weights init $\sim\mathcal{N}(0,0.01)$
Optimizer Type and Corresponding Parameters	Stochastic Gradient Descent (hand-coded)

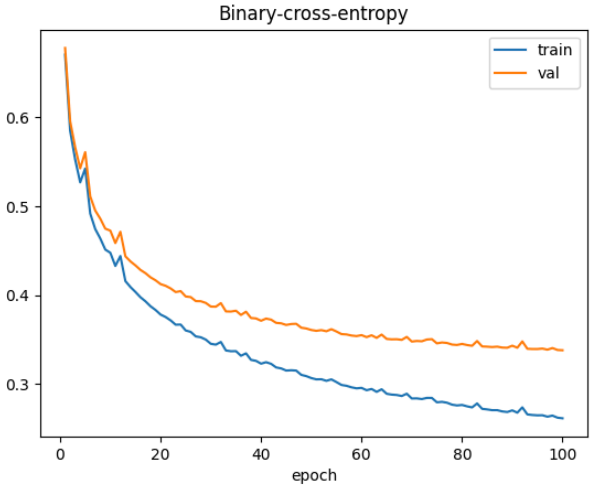
	precision	recall	f1-score	support
0	0.8609	0.8891	0.8748	1100
1	0.8824	0.8527	0.8673	1073
accuracy			0.8711	2173
macro avg	0.8716	0.8709	0.8710	2173
weighted avg	0.8715	0.8711	0.8711	2173

Confusion matrix
[[978 122]

[158 915]]


Confusion matrix
978
915
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00
1.25
1.50


Accuracy
train
val
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0
20
40
60
80
100
epoch


Binary-cross-entropy
train
val
0.6
0.5
0.4
0.3
0
20
40
60
80
100
epoch