**How to Run the file**

- Run the main.py file

- As long as the dataset and the Training.py and Testing.py file are present it will run

**Model Description**

This neural network consists of an input layer, a hidden layer, and an output layer. The input layer has 784 neurons, the hidden layer has 10 neurons, and the output layer also has 10 neurons (for the 10 classes 0-9).

During the forward propagation method, the input is multiplied by the weight matrix W1 and added to the bias vector b1 to produce the first hidden layer. (h1 = W1+b1) This layer is then passed through the ReLU methoed to make it nonlinear. The output of the ReLU method is then multiplied by the weight matrix W2 and added to the bias vector b2 to produce the output layer. (ReLU \* W2 + b2) The output layer is then passed through the softmax method to produce a probability distribution over the 10 possible classes.

During the backpropagation method, the error between the predicted and actual values is calculated and the weights are adjusted to minimize the error. The derivatives of the activation functions are used to propagate the error back through the layers and compute the gradients of the weights. The weights are then updated using the gradients and a learning rate alpha. This process is repeated iteratively until the error is minimized or a maximum number of iterations is reached.

**Sample Run Output**

Iteration: 0

[8 8 8 ... 8 8 8] [4 9 8 ... 1 9 7]

0.09809756097560976

Iteration: 10

[7 6 2 ... 1 7 2] [4 9 8 ... 1 9 7]

0.15973170731707317

Iteration: 20

[7 3 2 ... 1 7 2] [4 9 8 ... 1 9 7]

0.23114634146341465

Iteration: 30

[5 3 5 ... 1 7 2] [4 9 8 ... 1 9 7]

0.2879512195121951

Iteration: 40

[5 3 6 ... 1 7 2] [4 9 8 ... 1 9 7]

0.3432926829268293

Iteration: 50

[5 3 6 ... 1 7 2] [4 9 8 ... 1 9 7]

0.4028048780487805

Iteration: 60

[5 9 6 ... 1 4 2] [4 9 8 ... 1 9 7]

0.4517560975609756

Iteration: 70

[5 9 6 ... 1 4 2] [4 9 8 ... 1 9 7]

0.4968048780487805

Iteration: 80

[5 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.5370975609756098

Iteration: 90

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.5739268292682926

Iteration: 100

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.6061951219512195

Iteration: 110

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.6352926829268293

Iteration: 120

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.6590487804878049

Iteration: 130

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.677609756097561

Iteration: 140

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.6939512195121951

Iteration: 150

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7070243902439024

Iteration: 160

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7177560975609756

Iteration: 170

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7291463414634146

Iteration: 180

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.737780487804878

Iteration: 190

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7465853658536585

Iteration: 200

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7545121951219512

Iteration: 210

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7612682926829268

Iteration: 220

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7675365853658537

Iteration: 230

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7734146341463415

Iteration: 240

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7789268292682927

Iteration: 250

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7844146341463415

Iteration: 260

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7887073170731708

Iteration: 270

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7932439024390244

Iteration: 280

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.7972926829268293

Iteration: 290

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.800829268292683

Iteration: 300

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8051219512195122

Iteration: 310

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8085365853658537

Iteration: 320

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8120731707317074

Iteration: 330

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8152682926829268

Iteration: 340

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8180731707317073

Iteration: 350

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8209756097560975

Iteration: 360

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8234634146341463

Iteration: 370

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8259756097560975

Iteration: 380

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.828170731707317

Iteration: 390

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8301463414634146

Iteration: 400

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8319268292682926

Iteration: 410

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8338048780487805

Iteration: 420

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.835780487804878

Iteration: 430

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8371463414634146

Iteration: 440

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8386585365853658

Iteration: 450

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8402926829268292

Iteration: 460

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.841609756097561

Iteration: 470

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8432926829268292

Iteration: 480

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8448292682926829

Iteration: 490

[4 9 6 ... 1 4 7] [4 9 8 ... 1 9 7]

0.8462926829268292

Prediction: [4]

Label: 4

Prediction: [9]

Label: 9

Prediction: [6]

Label: 8

Prediction: [7]

Label: 7

[5 1 5 2 7 4 1 6 0 3 4 8 7 5 2 9 2 2 0 5 4 1 0 3 6 8 1 8 5 9 7 4 3 5 7 1 7

4 9 3 2 4 8 7 1 3 5 9 9 8 7 0 9 5 7 0 9 4 9 6 2 7 2 8 2 3 7 8 4 3 9 9 6 8

2 6 0 2 0 8 2 4 6 0 0 5 8 6 7 5 6 6 8 2 8 0 0 6 4 7 8 0 2 4 2 0 0 0 5 9 1

4 7 3 1 9 1 2 9 9 3 4 1 9 2 5 2 3 4 6 9 1 0 8 5 2 5 8 0 9 1 0 4 6 6 2 6 2

4 6 2 4 5 0 4 4 7 4 9 1 2 0 2 2 0 8 6 1 9 5 4 1 8 9 9 6 5 1 8 8 2 8 7 4 7

5 1 9 2 0 9 5 7 0 7 9 2 7 3 9 1 1 9 9 9 9 8 2 3 1 1 8 8 0 6 8 3 1 0 7 3 0

4 3 8 0 6 9 7 3 0 9 4 9 4 5 8 2 1 4 1 2 8 3 6 9 2 2 7 7 2 9 2 7 4 4 3 3 7

4 3 7 8 0 0 1 9 5 6 7 7 5 8 3 8 0 5 6 4 0 1 7 4 5 4 3 9 8 4 5 6 0 2 9 5 4

2 3 6 7 6 2 8 6 6 7 4 6 2 7 6 0 0 2 5 3 0 1 3 2 0 3 8 3 2 8 3 4 9 5 1 3 7

2 1 9 7 2 9 0 6 5 9 8 1 4 8 0 9 0 3 8 0 4 0 0 4 0 1 1 0 5 7 7 0 2 6 9 5 7

3 1 6 4 4 8 7 6 4 1 2 4 9 1 4 3 9 6 9 3 4 2 3 4 7 9 3 8 2 3 5 1 4 0 1 7 7

3 2 6 6 3 3 1 3 6 3 2 4 8 6 0 1 9 4 8 3 5 0 7 1 3 9 6 8 7 7 6 2 7 1 0 0 7

4 9 2 2 4 1 2 7 6 1 1 7 1 4 1 9 0 0 1 6 5 6 8 0 3 1 2 5 7 7 4 2 8 9 1 9 7

8 6 5 8 1 5 7 3 3 1 0 1 7 9 6 4 9 8 1 2 1 7 7 5 9 8 0 7 4 7 0 4 2 0 7 1 8

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9 3 8 7 0 7 6 8 7 9 0 0 9 5 3 0 4 8 3 1 1 9 9 8 2 1 8 0 3 2 9 6 2 7 8 2 1

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4 7 2 8 1 9 1 2 4 0 9 1 7 3 2 6 9 7 4 3 0 2 0 9 2 7 8 5 3 6 6 0 2 9 8 1 2

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9]

0.851