**Executions**

**A screenshot of a computer

AI-generated content may be incorrect.**

**A screenshot of a computer program

AI-generated content may be incorrect.**

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**Observations**

1. Final Test Accuracy

The final test accuracy achieved by the model is approximately 69 percent. This means that about 7 out of 10 handwritten digits in the MNIST test set were correctly identified by the model.

2. Misclassified Images

Some images were misclassified by the model. These errors often occurred for digits that are visually similar or written in an unclear way. Displaying these images helped me understand where the model struggles, such as distinguishing between “3” and “8” when they are not written neatly.

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3. Effect of Hidden Neurons

Using more hidden neurons (like 512 or 1024) generally improved accuracy because the model could learn more detailed patterns. Fewer hidden neurons (like 128) reduced the model’s capacity, leading to a slight drop in accuracy.

4. Effect of Different Learning Rates

The learning rate affects how quickly the model learns:

A high learning rate (for example, 0.5) can make the model’s accuracy fluctuate and even fail to converge.

A low learning rate (for example, 0.001) slows training but can achieve better final accuracy because it fine-tunes more carefully.

The best learning rates for this task are typically in the 0.01 to 0.1 range.

5. Adding Another Hidden Layer

Adding a second hidden layer improved the model’s ability to learn complex patterns, leading to higher accuracy. This is because multiple layers help the model extract more meaningful features from the pixel data.

6. Effect of Different Batch Sizes

Smaller batch sizes (like 50) typically yield slightly better accuracy because they help the model generalize better through more frequent updates.

Larger batch sizes (like 500) can speed up training, but may slightly reduce accuracy as the updates are less frequent.

7. Best Achievable Accuracy

With optimized parameters—such as two hidden layers, 512–1024 neurons per layer, a learning rate around 0.01, and a batch size around 100—the model can achieve up to 96–97 percent accuracy on MNIST. In this specific run, I achieved 69 percent accuracy, which suggests that further tuning of the model architecture and hyperparameters is needed.