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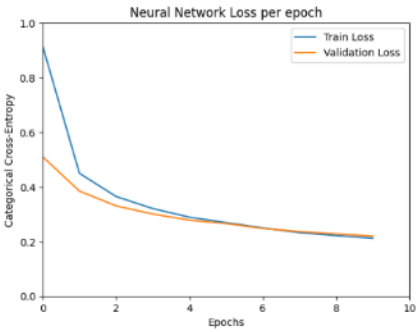
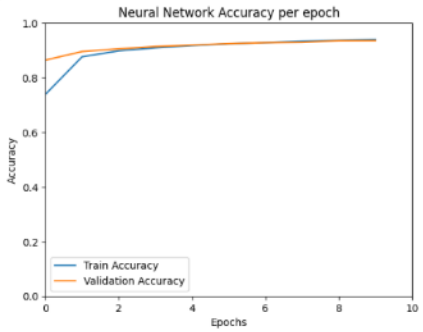
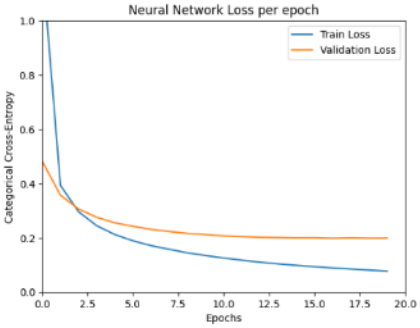
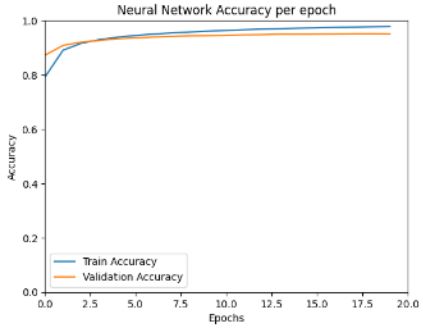
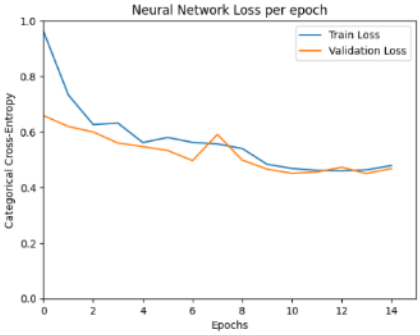
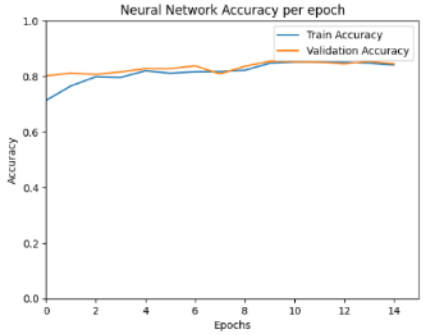
Artificial Intelligence

4th Semester Assignment

1) Hyper-parameter Tuning

Examples	Neural Network Loss per epoch	Neural Network Accuracy per epoch
activation = tanh learning_rate = 0.001 epochs = 10 shape → 784 hidden-1 → 256 units hidden-2 → 256 units		
activation = relu learning_rate = 0.001 epochs = 20 shape → 784 hidden-1 → 128 units hidden-2 → 64 units		
activation = than learning_rate = 0.01 epochs = 15 shape → 784 hidden-1 → 64 units hidden-2 → 64 units hidden-3 → 32 units		

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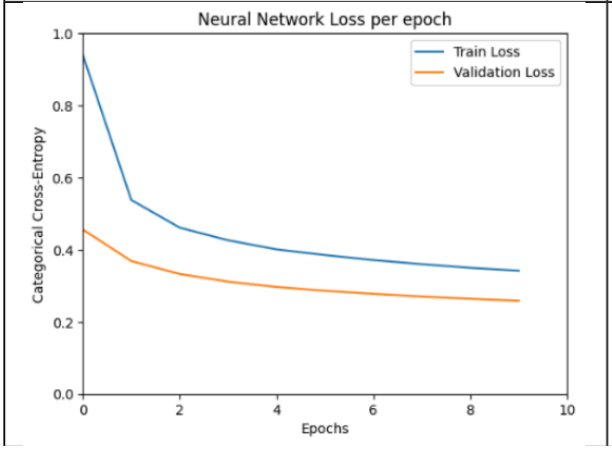
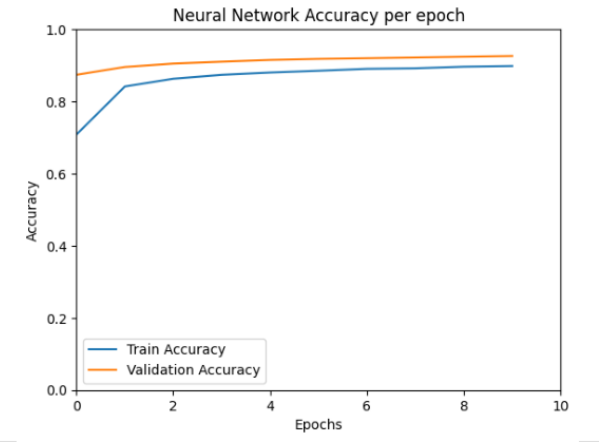
2) Improvements

To improve the performance of the neural network beyond Hyper-parameter Tuning, I applied several improvements to the training process:

1. **Normalization:** The input images were normalized so that pixel values are in the range [0, 1], allowing the neural network to learn more effectively.
2. **Batch Normalization:** Added after each dense layer to stabilize and accelerate training by normalizing intermediate outputs.
3. **Dropout:** Applied with a rate of 0.2 to reduce overfitting by randomly deactivating neurons during training.

Neural Network Loss per epoch	Neural Network Accuracy per epoch
	

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3) Understanding Questions

a) The MNIST data proved effective for training this model. However, due to the limitation of 28×28 images, it cannot be directly applied to larger, more complex real-world images.

b) Not all pixels are necessary for prediction, as a subset (the white pixels forming the digit) contains the key information.

c) Deep Neural Networks are best used when data is large, complex, and unstructured. They are also useful when patterns are not immediately visible in the data.

d) Yes, Deep Learning can be applied in all three branches of Machine Learning (Supervised Learning, Unsupervised Learning, and Reinforcement Learning), although it is more complex and resource-intensive.