Neural Net Report

Your Name: Vidit Pokharna

Your GT Username: 903772087

Question 5: Learning With Restarts

1. **testPenData**:
   - Max accuracy: 0.907947
   - Average accuracy: 0.9037736
   - Standard deviation: 0.0024473
2. **testCarData**:
   - Max accuracy: 0.99
   - Average accuracy: 0.982
   - Standard deviation: 0.00758288

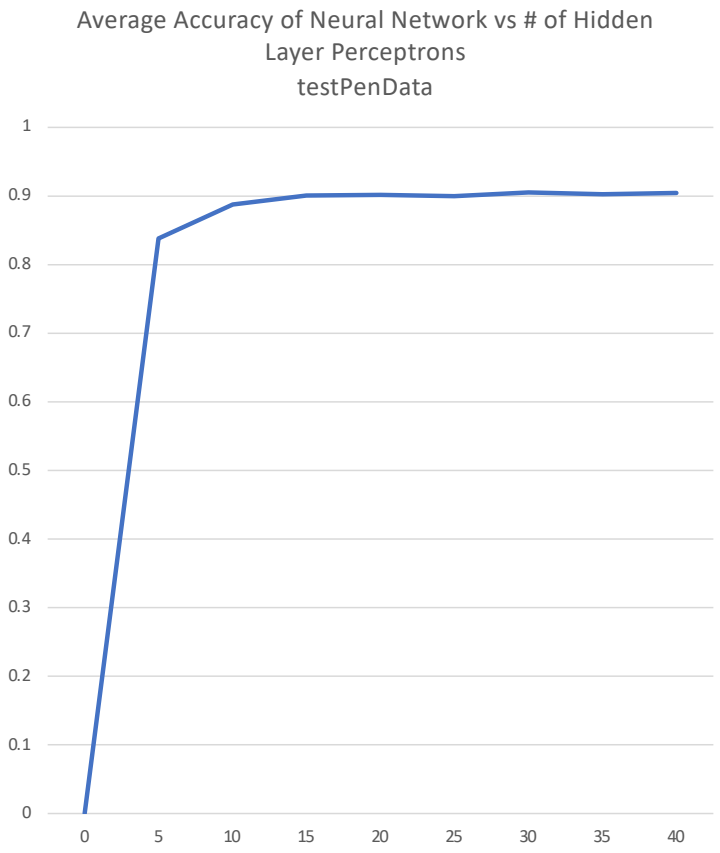
Question 6: Varying the Hidden Layers

Statistic table for **testPenData** – report the max, average, and standard deviation at various amount of perceptrons.

	Number of Perceptrons at the Hidden Layer								
	0	5	10	15	20	25	30	35	40
Max Accuracy	0.00000	0.87679	0.90023	0.90795	0.90938	0.90823	0.91052	0.90652	0.90738
Avg Accuracy	0.00000	0.83808	0.88776	0.90051	0.90143	0.89994	0.90520	0.90217	0.90446
Standard Deviation	0.00000	0.02484	0.00843	0.00737	0.00593	0.00718	0.00399	0.00237	0.00192

Question 6: Varying the Hidden Layers

Create a learning curve for **testPenData** where the number of hidden layer perceptrons is the independent variable and the average accuracy is the dependent variable.



Question 6: Varying the Hidden Layers

For **testPenData**, discuss any notable trends you saw related to increasing the size of the hidden layers in your neural net.

Answer: For this dataset, the improvement in average accuracy for the neural networks dramatically slows down after 5 hidden layer perceptrons. There is no functionality with 0 perceptrons.

Question 6: Varying the Hidden Layers

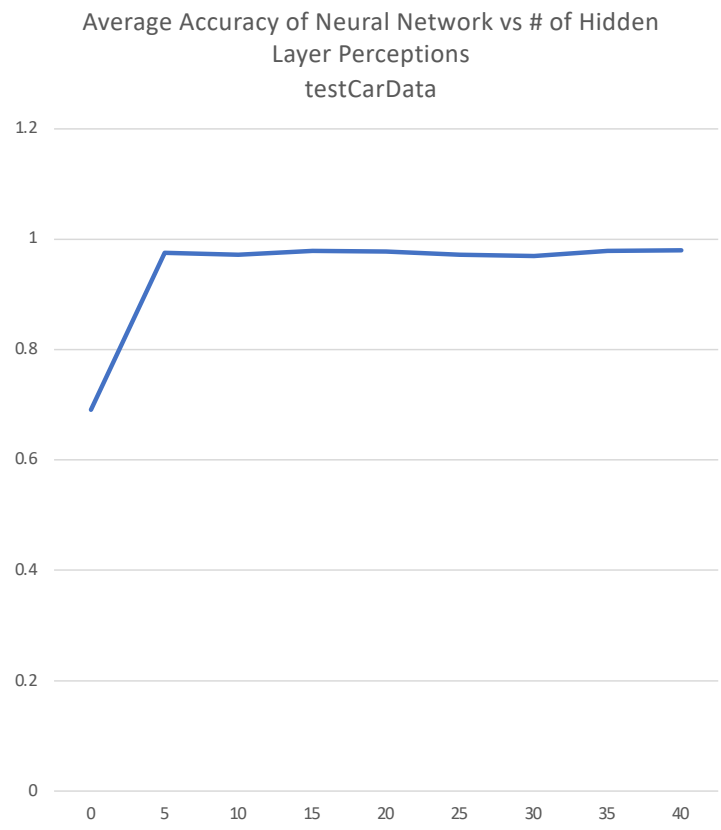
Statistic table for **testCarData** – report the max, average, and standard deviation at various amount of perceptrons.

	Number of Perceptrons at the Hidden Layer								
	0	5	10	15	20	25	30	35	40
Max Accuracy	0.71000	0.99000	0.98500	0.99000	0.99000	0.98000	0.98500	0.98000	0.99000
Avg Accuracy	0.69100	0.97500	0.97200	0.97900	0.97800	0.97200	0.97000	0.97900	0.98000
Standard Deviation	0.02154	0.01000	0.00980	0.00800	0.00678	0.00812	0.01049	0.00200	0.00707

Question 6: Varying the Hidden Layers

Create a learning curve for **testCarData** where the number of hidden layer perceptrons is the independent variable and the average accuracy is the dependent variable.

[attach your image/graph here]



Question 6: Varying the Hidden Layers

For **testCarData**, discuss any notable trends you saw related to increasing the size of the hidden layers in your neural net.

Answer: For this dataset, the improvement in average accuracy for the neural networks slightly slows down after 5 hidden layer perceptrons. However, another difference seen is almost a 70% accuracy with 0 perceptrons.

Question 7 (extra credit): Learning XOR

Report the max accuracy, average accuracy, and standard deviation of the neural net that you have trained with 1) no hidden layer, and 2) a hidden layer with various amount of perceptrons (at least 3 different amounts)

	No Hidden Layer	Hidden Layer		
		1 perceptrons	3 perceptrons	6 perceptrons
Max Accuracy	0.5000	0.7500	0.7500	1.0000
Avg Accuracy	0.5000	0.5500	0.5500	0.6000
Standard Deviation	0.0000	0.1000	0.1000	0.2000

Question 7 (extra credit): Learning XOR

Report the behavior of the trained neural net **without a hidden layer**.

Answer:

Accuracy: The accuracy of the neural network without a hidden layer is relatively low. It struggles to capture the XOR function's non-linear relationship between inputs and outputs.
Convergence: The network can converge to a solution, but this solution is suboptimal for XOR. It might perform well on some inputs but fail on others.
Decision Boundary: The decision boundary learned by the single-layer perceptron is a straight line. It can only separate data linearly, which is insufficient for solving the XOR problem.
Limited Capacity: The neural network without hidden layers has limited capacity to represent complex functions. It can only model linearly separable problems effectively.

Question 7 (extra credit): Learning XOR

Report the behavior of the trained neural net **with a hidden layer**. Are the results what you expected? Explain your observation.

Answer:

1.Accuracy: As we increase the number of perceptrons in the hidden layer, the accuracy of the neural network improves significantly. With an appropriate number of perceptrons, the network can achieve near-perfect accuracy on the XOR problem.
2.Convergence: The neural network with a hidden layer can converge to a solution much faster than a single-layer perceptron. This is evident by the rapid increase in accuracy during training iterations.
3.Decision Boundary: With a hidden layer, the neural network can learn a non-linear decision boundary. It can capture the XOR function's complexity, allowing it to correctly classify XOR inputs.
4.Capacity: The presence of a hidden layer increases the network's capacity to represent complex functions. It can learn and model non-linear relationships between inputs and outputs, making it suitable for solving non-trivial problems like XOR.
5.Results vs. Expectations: The results are as expected. Neural networks with hidden layers are known to excel in capturing non-linear patterns in data. In the case of XOR, we expected that increasing the number of perceptrons in the hidden layer would lead to improved accuracy. This behavior aligns with the fundamental capability of neural networks to learn and approximate complex functions.

Question 8 (extra credit): Novel Dataset

List the name and the source of the dataset that you've chosen.

- Name: _____
- Source (e.g., URLs): _____
- Briefly describe the dataset: _____

Question 8 (extra credit): Run Stats

- Max accuracy: _____
- Average accuracy: _____
- Standard deviation: _____

Question 8 (extra credit): Novel Dataset

Describe how to run the code that you've set up to train the selected dataset.

Answer: