ECEN 935 – Computational Intelligence
Fall 2024

Homework # 1

Posted on Canvas: Tuesday, September 17, 2024
Report (electronic copy) due: 11:59 pm, Friday, September 27, 2024

Problem

Train a feedforward multilayer perceptron neural network (MLPNN) using an appropriate training dataset and the backpropagation training algorithm to learn the function

$$y = 2x^2 + 1$$

for $x = [-1, 1]$.

1. Use 5 neurons in the hidden layer and the delta weight update strategy with a learning gain $\gamma_g \in [0.01, 1]$ and a momentum gain $\gamma_m \in [0, 1]$. Use a bias term of 1. Train the MLPNN using different combinations of learning and momentum gains. In each case of combination, test the trained MLPNN using a set of input $x = [-1: 0.01: 1]$, which should contain data samples that are not used for training. Plot the training and testing results for each combination of learning and momentum gains, respectively. In the plot of training result, show the mean square error (MSE) versus number of epochs through the training process, where an epoch is the presentation of the entire training set to the MLPNN and the MSE is calculated for each epoch. In the plot of testing result, compare the actual function values and the function values approximated by the trained MLPNN for the testing set. Provide a table or tables to compare the minimum MSE, average MSE, when the training starts to converge, and when the convergence slows down during the entire training process of the MLPNN for different combinations of learning and momentum gains. Determine the best values of the learning and momentum gains based on the comparison.
2. Use the best values of the learning and momentum gains obtained in Question 1 and different numbers of neurons in the hidden layer. Plot the training and testing results for the MLPNN using different numbers of hidden-layer neurons. Show two plots for each case, one showing the MSE versus number of epochs through the training process, and the other showing the actual function values and the function values approximated by the trained MLPNN for a testing input set $x = [-1: 0.01: 1]$. Provide a table to compare the minimum MSE, average MSE, when the training starts to converge, and when the convergence slows down during the entire training process of the MLPNN with different numbers of hidden-layer neurons. Determine the best number of neurons in the hidden layer based on the comparison.

Report

Your report should include at least the following sections and should be no more than 10 pages (excluding appendix). The minimum font size used in your report is 11.

- Abstract
- Introduction
- Solution methods/approaches
- Simulation results and discussions: explain the results presented in the report
- Conclusion
- References (if applicable)
- Appendix: Attach a copy of your MATLAB code as an annexure at the end of your report

Draw conclusions on different cases and summarize your findings on variations of learning and momentum gains and number of hidden-layer neurons. Points will be given for well-presented results and well-reasoned evaluation of results. Describe every decision you take, and the reason for taking it. You can use basic MATLAB functions but cannot use any MATLAB toolbox in your code.