

ID5030- Machine learning for Engineering and science applications

Homework 5 – Neural Networks & Backpropagation

Assignment Given on : March 3rd , 2023

Due Date : March 17th , 2023 (Online submission)

Context : The purpose of this assignment is to

- a) Understand neural networks forward pass
- b) Understand backpropagation algorithm for a fully connected neural network

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1. Write python code to implement a neural network with one hidden layer for classifying an XOR gate. Implement the backpropagation algorithm for this case from scratch. Use two neurons for the hidden layer.
2. Consider the Concrete Compressive Strength dataset from the first assignment ((For the downloading of the dataset please refer to this [Link](#)
 - a. Implement a single layer neural network for regression. Write backpropagation from scratch for this case in order to work for an arbitrary number of neurons in the hidden layer. Cross check your implementation by comparing with the Pytorch implementation of the same.
 - b. Perform hyperparameter optimization to determine the appropriate number of neurons. Do a 60-20-20 split of the dataset for training, validation and testing.
 - c. How does the goodness of fit for your optimal neural network compare with the fit obtained for linear and quadratic regression in the earlier assignments?
 - d. Modify your code to accommodate an arbitrary number of layers for a multilayer perceptron. Cross check your implementation by comparing with the Pytorch implementation of the same. Experiment with a few values of number of layers and comment on depth vs width of network.

3. Download the IRIS dataset (<https://archive.ics.uci.edu/ml/datasets/iris>)
 - a. Write gradient descent code to perform multiclass classification using the entire dataset for training
 - b. Report on the confusion matrix for this