

Assignment Report: Implementation of a Three Hidden Layer Neural Network for Multi-Class Classification

(https://github.com/arnabishakh/ML_Spring_23_24/tree/2791ed76f43dab3c477bc428b3735266c9523c65/Mid)

Introduction:

Using a synthetic dataset consisting of five different classes, the assignment's goal was to build a three hidden layer neural network for multi-class classification. In order to handle multi-class classification, the provided codebase had to be modified. Additionally, the network architecture and parameters had to be adjusted, the model had to be trained, its performance assessed, and the procedure had to be documented.

Dataset Generation:

A fictitious dataset with matching class labels and input feature sets was produced. It made verified the input attributes were appropriate for neural network training and that the dataset contained five different classes.

Task Execution:

The multi-class classification feature was added to the NeuralNetwork class that was already offered. One class was represented by each of the five neurons that now make up the output layer. The multi-class scenario required adjustments to the activation functions and loss computation. An adaptation of the backpropagation method was made to manage several classes. There were training and testing sets inside the dataset. The testing data was used to assess the neural network after it had been trained using the training set. Evaluation measures that are pertinent, like accuracy, precision, recall, and F1-score, were computed for every class as well as the total.

Documentation:

The code now includes comprehensive comments that explain the intent behind each section as well as any pertinent mathematical calculations. A detailed documentation of the changes performed to apply multi-class classification was made. Implementation-related difficulties, including changing the backpropagation algorithm, were discussed and recorded.

Results and Analysis:

The performance of the neural network model on the testing data is as follows:

Accuracy: 0.18

Precision: Class 0: 0.16, Class 1: 0.24, Class 2: 0.00, Class 3: 0.25, Class 4: 0.25

Recall: Class 0: 0.61, Class 1: 0.22, Class 2: 0.00, Class 3: 0.09, Class 4: 0.04

F1-score: Class 0: 0.25, Class 1: 0.23, Class 2: 0.00, Class 3: 0.13, Class 4: 0.07

It was also determined what the precision, recall, and F1-score macro-average and weighted-average values were. Relevant visualisations were also provided, including ROC curves and confusion matrices.

Conclusion:

To sum up, the testing results showed an accuracy of 0.18 for the three hidden layer neural network implementation used for multi-class classification. The model performed differently in each class; its precision and recall were higher in some than in others. To enhance the model's performance, more testing with various configurations and hyperparameters might be required.

Reflection:

Implementation challenges like changing the multi-class classification code and customising the backpropagation algorithm were insightful teaching moments. The assignment emphasised how crucial it is to have a solid understanding of neural network methods and structures.