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

In this assignment, you will implement a three hidden layer neural network for multi-class classification. You will generate a synthetic dataset with five classes to train and test your neural network model. Your task involves modifying the provided codebase (<https://github.com/debajyotikarmaker/ML/blob/main/05_neural_network.ipynb> ) to accommodate the multi-class classification problem and evaluating the performance of your model.

**Dataset Generation:**

* Generate a synthetic dataset containing input features and corresponding class labels.
* Ensure that the dataset has five distinct classes.
* The input features should be suitable for training a neural network.

**Task:**

* Implement a neural network with three hidden layers to classify the generated dataset.
* Modify the provided code to support multi-class classification with five classes.
* Adjust the network architecture and parameters as necessary for handling the multi-class problem.

**Code Modification:**

* Extend the NeuralNetwork class provided in the code to support multi-class classification.
* Update the output layer to have five neurons, each corresponding to one class.
* Modify the activation function and loss calculation to suit the multi-class scenario.
* Ensure that the backpropagation algorithm is adapted to handle multiple classes.

**Training and Testing:**

* Split the generated dataset into training and testing sets.
* Train the neural network using the training data.
* Evaluate the performance of the trained model using the testing data.
* Calculate relevant evaluation metrics such as accuracy, precision, recall, and F1-score for each class and overall.

**Documentation:**

* Provide a detailed explanation of the modifications made to the code to implement multi-class classification.
* Include comments within the code to describe the purpose of each section and any relevant mathematical formulas.
* Document any challenges faced during implementation and how they were addressed.

**Results and Analysis:**

* Present the results of training and testing, including performance metrics and any relevant visualizations (e.g., confusion matrix, ROC curves).
* Analyze the performance of the neural network and discuss any observations or insights gained from the experiment.
* Compare the performance of your model with different configurations and hyperparameters.

**Conclusion:**

* Summarize the key findings of the assignment, highlighting the performance of your multi-class classification model.
* Reflect on the challenges encountered and lessons learned during the implementation.
* Discuss potential improvements or further experiments that could enhance the performance of the neural network for multi-class classification tasks.

**Note:**

* You have the flexibility to experiment with different dataset sizes, network architectures, activation functions, and optimization techniques to improve the model's performance.
* Avoid plagiarism or copying of code from external sources. Originality and understanding of the implemented algorithms will be evaluated.

**Submission:**

* Submit your code as python script/s and provide instructions in the script to execute your code. If instructions to execute your code is not clear, I may not be able to execute it, leading to loss of points.
* Provide your results and analysis for the assignment in a report in pdf or word doc format.
* Upload your code and report, as well as any relevant documents/scripts in a zipped folder to the submission link.