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

1. Introduction:

This assignment focuses on designing, training, and evaluating a fully connected feed-forward neural network built from scratch using NumPy

2. Dataset Design Explanation:

The dataset is generated using Scikit-Learn's make_blobs()

Dataset Characteristics

Number of samples: 2000

Number of features: 6

Number of classes: 5

Cluster standard deviation: 3.0

Random state: 42 (ensures reproducibility)

3. Neural Network Architecture Description:

Architecture: Input -> 32 -> 16 -> 8 -> Output

4. Mathematical Formulas:

Forward Propagation, ReLU, Softmax, Cross-entropy, Backpropagation, Gradient Descent

5. Code Modifications Explanation:

Manual NN class, accuracy function, plotting utilities

6. Training Process:

Initialize parameters with small random values.

Loop for 300 epochs:

Forward propagate training inputs.

Compute loss.

Backpropagate errors.

Update weights and biases.

Track and store the loss for plotting.

7. Evaluation Metrics:

Accuracy, confusion matrix, classification report, ROC curves

8. Visualizations Explanation:

Loss curve, confusion matrix, ROC curves, dataset scatter

9. Observations & Analysis:

Network learns non-linear boundaries, ReLU effective, high accuracy

10. Conclusion:

NN implemented from scratch demonstrates strong learning performance.