Course Code: AI-802

Assignment 4.3 — Week-2 Submission

Fully Connected Neural Network

Course: Machine Learning

Instructor: Dr. Adeel Nisar

Total Marks: 20

Guidelines:

- **No plagiarism.** All content must be written in your own words.
- **This assignment carries marks** which will be added to your **final project grade**.
- **Weekly submissions are mandatory.**
- Every week you must submit your project progress in the form of an assignment.
- **All group members must contribute.**
- **Late submissions will not be accepted** unless approved by the instructor.
- **Use proper formatting**, headings, and clear structure.
- Make sure to submit the code file in **run-output** form
  (Your file must include both code and the execution results.)
- **Any copied text, copied code, or AI-generated text without modification will result in deduction of marks.**

Objective

Students must **manually implement** a Fully Connected Neural Network (FCNN) using **NumPy** for a **classification task**.

Tasks to Complete

1. Dataset Preparation

- Use your project dataset.
- Perform:
  - Normalization / standardization
  - Train-test split
  - One-hot encoding for labels

2. Build a Fully Connected Neural Network (from scratch)

Your network must include:

Network Structure

- Input Layer
- At least **1 hidden layer**
- Output Layer
- Activation Functions:
  - ReLU or Sigmoid (hidden layer)
  - Softmax (output layer)

You MUST implement manually

- ✓ Forward Pass
- ✓ Loss Function (Cross-Entropy)
- ✓ Backward Pass (Gradient Computation)
- ✓ Parameter Updates (Gradient Descent)
- ✓ Training Loop
- ✓ Accuracy calculation

Required Code Components

A. Parameter Initialization

Manually initialize:

- W1, b1
- W2, b2
  (or more if extra layers)

B. Forward Propagation

You must compute:

- Z = WX+b
- ReLU/Sigmoid activation
- Softmax output
- Loss

C. Backward Propagation

Manually compute gradients:

- dW1, db1
- dW2, db2
- Update parameters using gradient descent

D. Training Loop

Include:

- Epochs (e.g., 200–500)
- Learning rate
- Print loss every 20 epochs
- Final accuracy