National University of Computer and Emerging Sciences
Lahore Campus

Applied Machine Learning (CS4104)

Sessional-II Exam

Total Time (Hrs):	1
Total Marks:	35
Total Questions:	2

Date: 9th April 2025

Course Instructor(s)

Dr Kashif Zafar

Mr Razi Uddin

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Roll No   Section   Stud

Instructions:

- Attempt all questions on answer book
- Show complete working step by step

CLO # 1: Describe basic machine learning concepts, theories and applications.

Q1: A school wants to understand how two factors—**study hours** and **sleep hours**—affect student performance on exams. As a data analyst, you are asked to build a **multiple linear regression model** to predict students' exam scores based on these two input features.   **[Marks: 10]**

You are provided with the following data from 3 students:

x_1 (Study Hours)	x_2 (Sleep Hours)	y (Exam Score)
1	6	60
2	7	65
3	8	70

In this task, you will create a model of the form: $y = \theta_0 + \theta_1 x_1 + \theta_2 x_2$

where:

- y is the predicted exam score,
- x_1 is the number of study hours,
- x_2 is the number of sleep hours,
- θ_0 is the intercept (bias term),
- θ_1, θ_2 are the coefficients for the input features.

Tasks:

1. Estimate the parameters θ_0, θ_1, θ_2 for multiple linear regression model. Clearly show your calculation steps. You may use any suitable method to compute the coefficients.(6 Marks)

2. Use your trained model to **predict the exam score** for a new student who **studies 4 hours and sleeps 9 hours**. (2 Marks)

3. Based on your model, explain in one or two sentences how each variable (study hours and sleep hours) affects the predicted exam score. What does each coefficient represent? (2 Marks)

CLO # 2: Apply supervised learning techniques to solve classification problems [Marks: 25]

Q2: You are given a Feedforward Neural Network with the following structure:
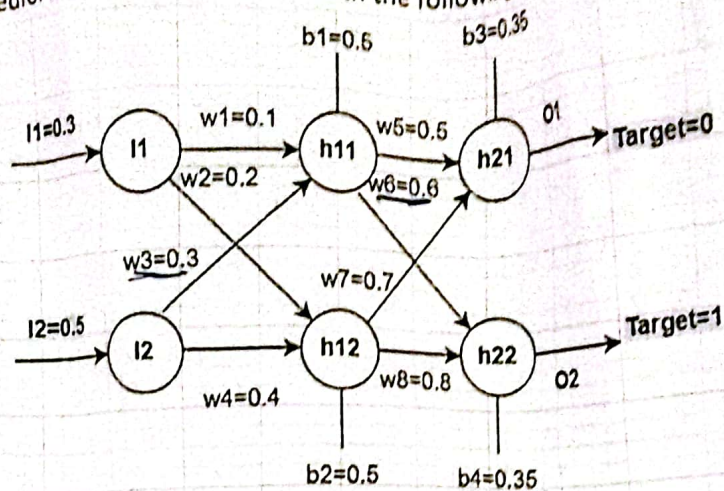
Input Vector: [I_1 = 0.3 , I_2 = 0.5]

Target vector: [y_1 = 0 , y_2 = 1]

Initial Weights:
W_1 = 0.1 , W_2 = 0.2 , W_3 = 0.3, W_4 = 0.4
W_5 = 0.5 , W_6 = 0.6 , W_7 = 0.7 , W_8 = 0.8

Bias Values:
b_1 = 0.5, b_2 = 0.5
b_3 = 0.35, b_4 = 0.35

Tasks:

a) Perform the **forward pass** of the network. Calculate the output of the network for the give input vector. Apply the **sigmoid** activation function at each layer. **[8 Marks]**

b) Compute the loss using the **Mean Squared Error** (MSE) loss function. **[3 Marks]**

c) Perform **backpropagation** to calculate the gradients for the weights W_3, and W_6 using the chain rule. **[10 Marks]**

d) Update the weights W_3 and W_6 using the computed gradients and the **learning rate** of 0.1. **[4 Marks]**

Note: To get the full credits:
Show all steps for the forward pass, loss calculation, backpropagation, and weight update for W_3 and W_6.