

# CSCI 6751 V1 | Artificial Intelligence

## Quiz#2

Dec 2, 2025

Total 50 points

Time: 50 minutes

**GOOD LUCK**

**Group 1**

**Student Name & ID** \_\_\_\_\_

1	2	$\Sigma$	
/40	/60	/100	

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### Question 1. (40 points)

A binary classifier is used to detect *spam emails* (Positive class). You evaluate the model on **200 emails** and observe the following:

- The model predicted 70 emails as spam.
- Of those 70, 50 were actually spam.
- Out of the 130 emails predicted as not spam, 20 were actually spam.
- The remaining emails were legitimate.

#### Tasks:

- a) Construct the confusion matrix (TP, FP, FN, TN).
- b) Compute the following metrics: Precision, Recall, Accuracy, F1-Score
- c) In the context of spam detection, which metric is most important—precision, recall, or accuracy? Explain *why* that metric should be prioritized in this problem.

**Question 2.** (60 points) Consider a small neural network for regression: Input layer: 3 neurons ( $x_1, x_2, x_3$ ), Hidden layer: 2 neurons ( $h_1, h_2$ ) with sigmoid activation, Output layer: 1 neuron (no activation function); You are given **one training sample**:  $x=[x_1, x_2, x_3]=[0.5, -1.0, 2.0], y_{\text{true}}=1.5$

### Weights

**First-layer weights (input  $\rightarrow$  hidden):**

$$\mathbf{W}_{\text{hidden}} = \begin{bmatrix} 0.2 & -0.1 \\ 0.4 & 0.5 \\ -0.3 & 0.2 \end{bmatrix}, \quad \mathbf{b}_{\text{hidden}} = [0.1, -0.2]$$

**Last-layer weights (hidden  $\rightarrow$  output):**

$v=[v_1, v_2]=[0.3, -0.2], b_o=0.05$ ;  $v_1 \rightarrow$  weight from  $h_1$  to output and  $v_2 \rightarrow$  weight from  $h_2$  to output

a) Compute the **network output**  $y^\wedge$ .

b) Using **MSE loss**:  $L=1/2(y^\wedge - y_{\text{true}})^2$

Calculate the gradients of the loss w.r.t only the last-layer weights  $v_1, v_2$  and the output bias  $b_o$ .

Hint :

$z$	$\sigma(z) \approx$
-1.0	0.27
-0.8	0.31
-0.5	0.38
-0.35	0.41
0	0.50
0.35	0.59
0.5	0.62
0.8	0.69
1.0	0.73



