CSCI 6751 V1 | Artificial Intelligence

Quiz#2

Dec 2, 2025

Total 50 points **Time: 50 minutes**

GOOD LUCK ***Group 2***

Student Name & ID ________________________________

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/40	/60	/100

Question 1. (40 points) A medical test is used to detect a certain disease (Positive class). You evaluate the test on 150 patients and observe the following:

- The test predicted 40 patients as having the disease.
- Of those 40, 30 actually had the disease.
- Out of the 110 patients predicted as disease-free, 10 actually had the disease.
- The remaining patients were healthy.

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 disease detection, which metric is the most important; Precision, recall, or accuracy? Explain why that metric should be prioritized in this problem.

Solution:

(a) Confusion Matrix

	Predicted Disease	Predicted Healthy
Actual Disease	TP = 30	FN = 10
Actual Healthy	FP = 10	TN = 100

(b) Evaluation Metrics

- Precision

$$\frac{TP}{TP+FP} = \frac{30}{40} = 0.75$$

- Recall

$$\frac{TP}{TP+FN} = \frac{30}{40} = 0.75$$

- Accuracy

$$\frac{TP+TN}{150} = \frac{130}{150} = 0.867$$

- F1-score

$$F1 = 0.75$$

(c) Recall, because missing sick patients (false negatives) is more dangerous than false positive.

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**: $x=[x_1,x_2, x_3]=[0.5,-1.0,2.0]$,$y_{true}=1.5$

Weights

First-layer weights (input → hidden):

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

Last-layer weights (hidden → output):

$v=[v_1,v_2]=[0.3,-0.2], b_o=0.05$; v1 → weight from h1 to output and v2 → weight from h2 to output

a) Compute the **network output** y^.

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

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	σ(z) ≈
-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

Solution:

a) Forward Pass

Hidden layer pre-activations:

$z1=0.2(0.5)+0.4(-1)+(-0.3)(2)+0.1=-0.8$
$z2=-0.1(0.5)+0.5(-1)+0.2(2)-0.2=-0.35$

Hidden activations (sigmoid):

$h1=\sigma(-0.8)=0.310$

$h2=\sigma(-0.35)=0.413$

Output:

$y^{\wedge}=0.3(0.310)-0.2(0.413)+0.05=0.060$

Loss

$L=12(0.060-1.5)^2=1.04$

b) Gradients (Last Layer)

$(y^{\wedge}-y_{true})=-1.44$

$$\frac{\partial L}{\partial v_1} = -1.44(0.310) = -0.446$$

$$\frac{\partial L}{\partial v_2} = -1.44(0.413) = -0.595$$

$$\frac{\partial L}{\partial b_o} = -1.44$$