CSE140-W2025: Introduction to Intelligent Systems
Quiz-2

Date: 18/02/2025 **Total Time:** 45 mins **Total Marks:** 10 Marks

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Instructions

- Attempt all questions.
- MCQs have a single correct option.
- State any assumptions you have made clearly.
- Standard institute plagiarism policy holds.
- No evaluations without suitable justifications for MCQs.

Section 1: Multiple Choice Questions

Q 1: Consider the sentence: "The representative from IBM discussed the latest advancements in artificial intelligence at the Apple conference in Cupertino." What is the correct **NER** tag for the token **Apple**? **1 Mark**

(A) ORGANIZATION (B) PERSON (C) PRODUCT (D) LOCATION

Answer : (A) ORGANIZATION

Q 2: What's the correct **POS** tag for the word "operating" in these different contexts? **1 Mark**

1. "The operating system crashed."
2. "She is operating the machine."
3. "The company's operating costs increased."

(A) 1:VBG, 2:VBG, 3:NN
(B) 1:JJ, 2:VBG, 3:VBG
(C) 1:JJ, 2:VBG, 3:JJ
(D) 1:VBG, 2:VBG, 3:VBG

Where: JJ = Adjective (modifies nouns) VBG = Verb, Gerund/Present Participle (action/-continuous tense) NN = Noun (names of things/concepts)

Answer: B is correct :

- In context 1, "operating" modifies "system" as an adjective.
- In context 2, it's part of present continuous tense (verb gerund).
- In context 3, it functions as a gerund modifying "costs".

Q 3: You have collected tweets mentioning several popular smartphone brands, categorized as expressing positive, negative, or neutral sentiments. Analyzing the sentiment of tweets about a newly released smartphone model is an example of **1 Mark**

(A) unsupervised learning
(B) semi supervised learning
(C) supervised learning
(D) reinforcement learning

Answer: (C) supervised learning

Q 4: Which of the following are not classification problems? **1 Mark**

1. Predicting price of house
2. Predicting patient has tumor
3. Predicting who will hold the title in football league
4. Predicting percentage of student for next semester

(A) 1 and 2 (B) 1 and 4 (C) 2 and 3 (D) 3 and 4

Answer: (B) 1 and 4

Section 2: Short Answer Questions

Q 1: Match each scenario with the most appropriate type of machine learning **(Supervised Learning, Unsupervised Learning, or Reinforcement Learning)** and justify briefly: **1 Mark**

(a) A pharmaceutical company is developing a drug discovery system. They have a database of millions of unlabeled molecular structures and need to group them based on their chemical properties, potential binding sites, and structural similarities to help identify promising new drug candidates. The system should discover patterns that human researchers might miss.

Scenario A → Unsupervised Learning

- No labeled training data
- Goal is to discover natural groupings
- Needs to find hidden patterns/relationships
- No predefined output categories
- Focus on structural similarities

(b) A robotic manufacturing system needs to learn how to assemble complex electronics products. It starts with no knowledge but receives a small positive signal when components are correctly placed and a negative signal when mistakes are made. The system needs to discover optimal assembly sequences and adapt to slight variations in component positions and orientations.

Scenario B → Reinforcement Learning

- Learning through trial and error
- Clear reward/penalty signals
- Sequential decision-making process
- Needs to optimize a strategy
- Environment provides feedback

Q 2: The Mean Squared Error (MSE) and Mean Absolute Error (MAE) are two common metrics used to measure the accuracy of a regression model. The MSE is calculated by taking the average of the squares of the differences between the actual values and the predicted values, while the MAE is the average of the absolute differences between the actual and predicted values.Calculate the MSE and MAE values for the data given below in **Figure 2**. In what scenario would you prefer to use MSE as a loss function and why?

Answer:

The Mean Squared Error (MSE) is calculated using the formula:

$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$$

Substituting the given values:

$$\begin{aligned}
\text{MSE} &= \frac{1}{5}\left[(10-12)^2 + (20-18)^2 + (30-32)^2 + (40-38)^2 + (50-48)^2\right] \\
&= \frac{1}{5}\left[(-2)^2 + (2)^2 + (-2)^2 + (2)^2 + (2)^2\right] \\
&= \frac{1}{5}\left[4+4+4+4+4\right] \\
&= \frac{20}{5} \\
&= 4.0
\end{aligned}$$

$$\boxed{\text{MSE} = 4.0}$$

The Mean Absolute Error (MAE) is calculated using the formula:

$$\text{MAE} = \frac{1}{n}\sum_{i=1}^{n}|Y_i - \hat{Y}_i|$$

Substituting the given values:

$$\begin{aligned}
\text{MAE} &= \frac{1}{5}\left[|10-12| + |20-18| + |30-32| + |40-38| + |50-48|\right] \\
&= \frac{1}{5}\left[2+2+2+2+2\right] \\
&= \frac{10}{5} \\
&= 2.0
\end{aligned}$$

$$\boxed{\text{MAE} = 2.0}$$

The Mean Squared Error (MSE) is generally preferred over MAE when:

- It is crucial to penalize large errors more heavily. Since MSE squares the errors, larger errors contribute more to the final loss.
- The dataset does not contain significant outliers or when it is important to ensure that large errors are minimized, as MSE is more sensitive to outliers.

2 Marks

Q 3: A hospital is developing an AI system to detect cancer in patients based on medical images. The system uses a machine learning model that classifies whether a patient has cancer (Positive) or does not have cancer (Negative) based on X-ray scans. The hospital has tested two different versions of this model on patient data and wants to determine which one performs better.You are provided with two Cartesian plane graphs in **Figure 1**representing the classification results of both models.Some of the points are correctly classified, while others are misclassified. Your task is to analyze these models and help the hospital decide which one to use. **3 Marks**

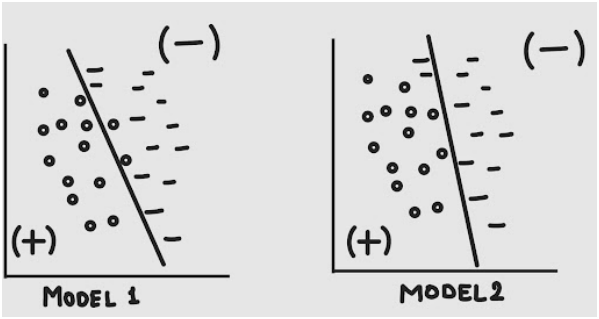

Figure 1: (o) - actual cancer , (-) non cancer

	Y	$\hat{Y}$
1	10	12
2	20	18
3	30	32
4	40	38
5	50	48

Figure 2: Actual vs Predicted Values

(a) Compute Evaluation Metrics for Each Model. Calculate the following for both models:
i. Type I Error ii. Type II Error

Hint: **Type I** error occurs when the model incorrectly predicts a positive outcome when the actual outcome is negative.**Type II** error occurs when the model fails to predict a positive outcome when the actual outcome is positive.

(b) If the hospital prioritizes minimizing false negatives (i.e., they want to ensure that no cancer case is missed), which model should they choose and why? Justify your answer based on the calculated metrics.

(a) Model 1 Confusion Matrix

	PP	**PN**
AP	12 (TP)	2 (FN)
AN	0 (FP)	13 (TN)

Type 1 Error = 0 Type 2 Error = 2

Model 2 Confusion Matrix

	PP	**PN**
AP	14	0
AN	2	11

Type 1 Error = 2 Type 2 Error = 0

(b) Minimizing false negatives is crucial. Recall is the appropriate evaluation metric to check which model has lower false negatives. The formula for recall is:

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

Recall for Model 1:

$$\text{Recall}_1 = \frac{12}{12+2} = \frac{6}{7}$$

Recall for Model 2:

$$\text{Recall}_2 = \frac{14}{14} = 1$$

Model 1 has a low recall rate, whereas Model 2 has a high recall rate. Therefore, the hospital will adopt Model 2 for its higher accuracy in detecting true positives.