Week 5 - Modeling & Evaluation

1. Evaluation metrics used for regression algorithms:

a) Mean Absolute Error (MAE)

- Measures the average absolute difference between predicted and actual values.
- Formula: MAE=1n∑|Yactual−Ypredicted|MAE = \frac{1}{n} \sum |y_{actual} - y_{predicted}|

b) Mean Squared Error (MSE)

- Measures the average of the squared differences between actual and predicted values.
- Formula: MSE=1n∑(yactual−ypredicted)2MSE = \frac{1}{n} \sum (y_{actual} - y_{predicted})^2

c) Root Mean Squared Error (RMSE)

- The square root of MSE.
- Formula: RMSE=MSERMSE = \sqrt{MSE}

d) R-squared (R^2)

- Measures the proportion of variance in the target that is explained by the model.
- Ranges from 0 to 1.

2. Confusion Matrix Explanation:

- A confusion matrix is used in classification to summarize the performance of a model.
- It shows:
    - **True Positives (TP):** Correctly predicted positives.
    - **True Negatives (TN):** Correctly predicted negatives.
    - **False Positives (FP):** Incorrectly predicted positives (Type I error).
    - **False Negatives (FN):** Incorrectly predicted negatives (Type II error).

3. Example AI Model:

"My AI model predicts if an email is spam (1) or not (0)."

Input #	Actual	Predicted
1	0	0
2	1	1
3	1	1
4	0	1
5	1	0
6	0	0
7	1	1
8	0	0
9	1	1
10	0	1

4. Confusion Matrix:

	Predicted Spam (1)	**Predicted Not Spam (0)**
Actual Spam (1)	TP = 4	FN = 1
Actual Not Spam (0)	FP = 2	TN = 3

5. Calculations:

- **Precision (Positive Predictive Value):** Precision=TPTP+FP=44+2=0.67\text{Precision} = \frac{TP}{TP + FP} = \frac{4}{4 + 2} = 0.67
- **Recall (Sensitivity):** Recall=TPTP+FN=44+1=0.80\text{Recall} = \frac{TP}{TP + FN} = \frac{4}{4 + 1} = 0.80
- **F1 Score (Harmonic mean of precision and recall):** F1=2×Precision×RecallPrecision+Recall=2×0.67×0.800.67+0.80≈0.73F1 = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} = 2 \times \frac{0.67 \times 0.80}{0.67 + 0.80} \approx 0.73

6. Meaning of the results:

- **True Positives (TP = 4):**
  The model correctly identified 4 emails as spam. These are successful detections.
- **False Positives (FP = 2):**
  The model incorrectly classified 2 non-spam emails as spam. This could annoy users because their important emails might get flagged.
- **False Negatives (FN = 1):**
  One spam email slipped through without detection, meaning a potentially harmful email reached the user's inbox.
- **True Negatives (TN = 3):**
  The model correctly classified 3 emails as not spam. These are correct rejections.

→ Interpretation of Results:

- The model has **80% recall**, meaning it catches 80% of spam emails — good coverage.
- The **precision is 67%**, meaning around one-third of the predicted spam emails were actually not spam (false positives).
- The **F1 score of 0.73** indicates a balanced model but suggests room for improvement in reducing false positives.