



## Arab Academy for Science, Technology and Maritime Transport College of Artificial Intelligence

Course	Machine Learning (IN221)	Feb 2024
Lecturer	Dr. Mahmoud Gamal	
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### Performance measures – Confusion Matrix

#### Introduction to confusion matrix:

A Confusion matrix is an  $N \times N$  matrix used for evaluating the performance of a classification model, where  $N$  is the number of target classes. The matrix compares the actual target values with those predicted by the machine learning model.

The following 4 are the basic terminology which will help us in determining the metrics we are looking for.

- **True Positives (TP):** When the actual value is Positive and predicted is also Positive.
- **True negatives (TN):** When the actual value is Negative, and prediction is also Negative.
- **False positives (FP):** When the actual is Negative, but prediction is Positive. Also known as the Type 1 error
- **False negatives (FN):** When the actual is Positive, but the prediction is Negative. Also known as the Type 2 error

#### Rules:

- $Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$
- $Precision = \frac{TP}{TP+FP}$
- $Recall = \frac{TP}{TP+FN}$
- $F1Score = \frac{2*Recall*Precision}{Recall+Precision}$



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#### Question 1:

Suppose you are working on a spam email classification system, and you have developed a machine learning model to classify emails as either spam or not spam. You want to evaluate the performance of your model using a confusion matrix. You have a test dataset consisting of 1000 emails, 500 of which are spam and 500 of which are not spam. The confusion matrix you obtain from your model is shown below:

	Predicted Spam	Predicted Not Spam
Actual Spam	450	50
Actual Not Spam	25	475

- Define the true positive (TP), false positive (FP), true negative (TN), and false negative (FN).
- Calculate the precision, recall, accuracy and F1 score of the model using the confusion matrix.
- Explain the meaning of precision and recall in the context of this example.

#### Question 2:

Suppose you are working on a medical diagnosis system that predicts whether a patient has a certain disease based on their symptoms. You have developed a machine learning model that takes in a patient's symptoms as input and outputs a prediction of either "disease" or "no disease". You want to evaluate the performance of your model using a confusion matrix. You have a test dataset consisting of 100 patients, 40 of whom have the disease and 60 of whom do not have the disease. The confusion matrix you obtain from your model is shown below:

	Predicted Disease	Predicted No Disease
Actual Disease	35	5
Actual No Disease	10	50

- Define the true positive (TP), false positive (FP), true negative (TN), and false negative (FN).
- Calculate the precision, recall, accuracy, and F1 score of the model using the confusion matrix.
- Explain the meaning of precision and recall in the context of this example.