- Performance is computed as the difference between Expectation and Prediction.
- Error is difference between actual and expected result.

- Lowest Error ↔ Good Performance
- Higher Error ↔ Poor Performance

UNDERSTANDING PERFORMANCE METRICS

Measuring the performance of the supervised algorithm is a very important step to estimate the quality of results achieved. In order to evaluate supervised algorithm on their performance, several standard metrics are used.

1. Popular Classification Metrics

- Confusion Matrix
- Accuracy
- Precision
- Recall
- True Positive rate
- False Positive rate
- Sensitivity
- Specitivity
- Area under curve (AUC)

2. Popular Regression Metrics

- R-Squared
- Mean Absolute Error
- Mean Absolute Error

Performance metrics should be chosen based on the problem domain, project goals, and the business objectives

CLASSIFICATION METRICS I

- **Confusion matrix**
  - As the name suggest, confusion matrix produces the performance of the model in the form of a matrix. As we have studied, Classification model predict the class labels for given input data.
  - The problem we are given may be binary or a multi-class classification where, we have two output classes and more than two output classes, respectively.
  - In standard notation of confusion matrix, the classes present in the data set is labelled as positive and negative. The positive class is usually represented by 1 whereas, negative class is indicated by 0.

Let us understand the confusion matrix with the help of a simple example

Example

Suppose we are given a problem where we need to predict the class of incoming email as a "spam" or "ham".

In standard notation of confusion matrix, the problem can be addressed as follows:

1. When an incoming email is a "ham", we refer it as "positive" and is represented by 1 in confusion matrix
2. When an incoming email is a "spam", we refer it as "negative" and is represented by 0 in confusion matrix

CLASSIFICATION METRICS II

Confusion matrix Illustration

- The confusion matrix is a table with two dimensions namely, "Actual" and "Predicted".
- Actual represents the true class present in the data whereas, Predicted indicates the prediction made by the model.
- In the table, Actual classifications are columns and Predicted ones are Rows.
- In Figure 49, the format of confusion matrix is presented.

Figure 49: Confusion Matrix

CLASSIFICATION METRICS III

Entries in Confusion matrix

There are four important terms associated with confusion matrix namely, True positive (TP), False positive (FP), True negative (TN) and False Negative (FN).

These entries take fixed position in the confusion matrix as represented in Figure 50.

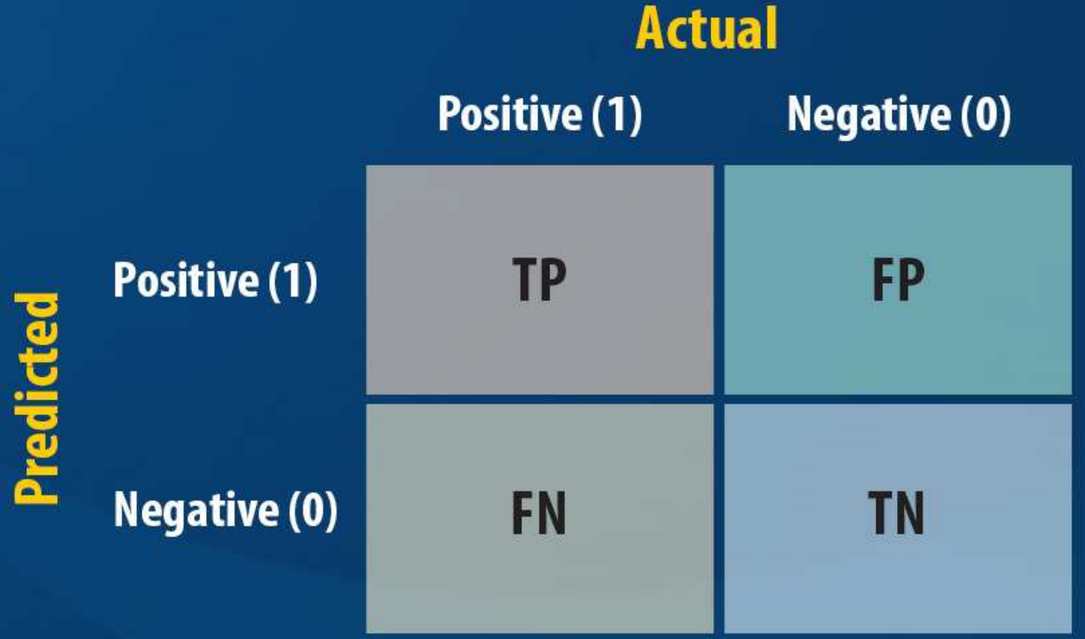

Figure 50: Confusion Matrix with four important terms namely, TP, FP, TN and FN

CLASSIFICATION METRICS IV

The terms TP, FP, TN and FN are explained below with respect to the the classification problem on predicting the class of incoming email.

1. **True positive:** True positives are the cases when the actual class of the data point was positive (1) and the predicted is also positive (1) .

   Eg. When the actual class of an incoming email is "ham" and is predicted as "ham" by the classifier.

2. **True Negative:** True negative are the cases when the actual class of the data point was negative (0) and the predicted is also negative (0) .

   Eg. When the actual class of an incoming email is "spam" and is predicted as "spam" by the classifier.

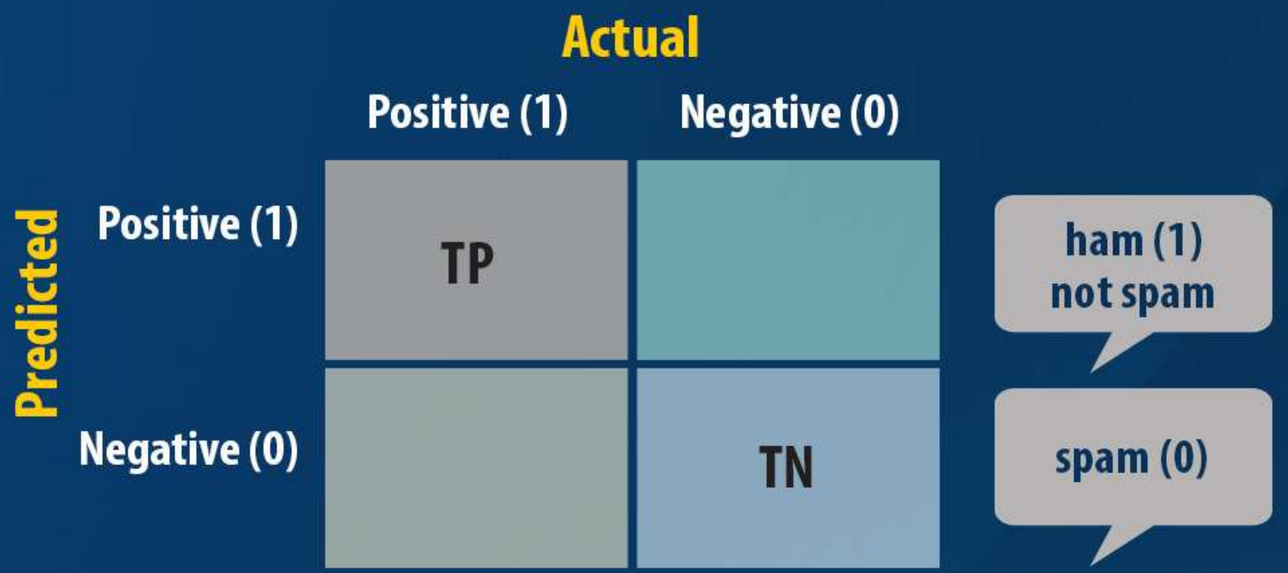

Figure 51: Confusion Matrix with entries namely, TP and TN

CLASSIFICATION METRICS VI

Confusion matrix-Example Illustration on email classification as "ham" or "spam"

1. Total number of samples in the data set = 71+7+10+62 = 150
2. Total number of positive class (ham) in the data set = 71+10 = 81
3. Total number of negative class (spam) in the data set = 62+7 = 69 = 69
4. Number of correct predictions of the positive class = 71 (TP)
5. Number of correct predictions of the negative class = 62 (TN)
6. Number of incorrect predictions of the positive class = 10 (FN)
7. Number of incorrect predictions of the negative class = 7 (FP)

Confusion Matrix forms the basis for the other types of metrics.

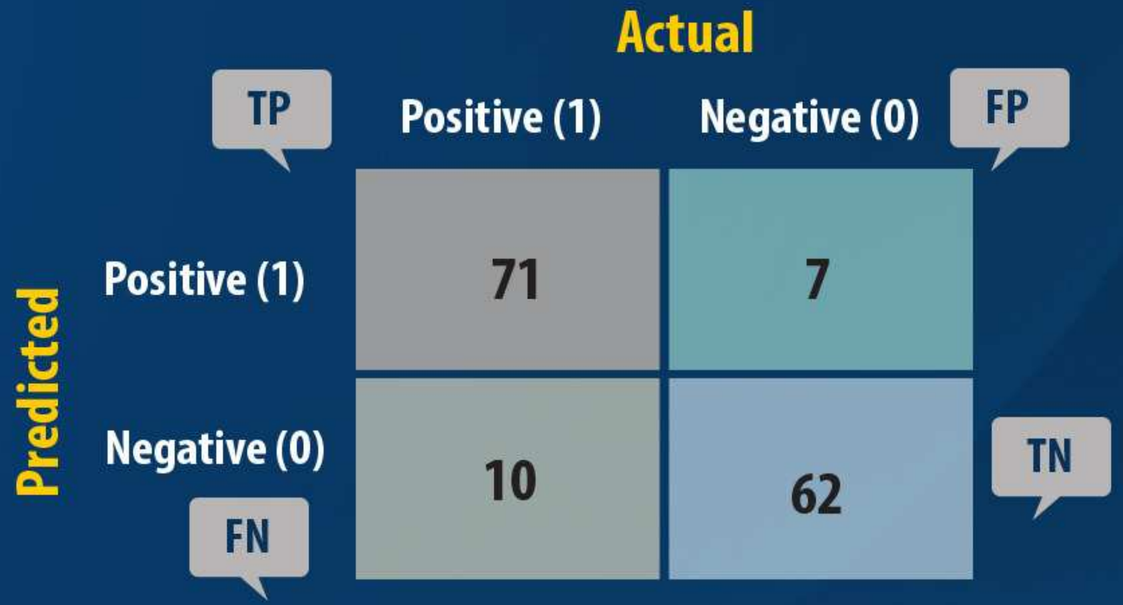

Figure 53: Confusion Matrix Example

CLASSIFICATION METRICS V

3. **False Positive:** False positives are the cases when the actual class of the data point was negative (0) and the predicted is positive (1).

   Eg. When the actual class of an incoming email is "spam" and is predicted as "ham" by the classifier.

4. **False Negative:** False negative are the cases when the actual class of the data point was positive (1) and the predicted is negative (0).

   Eg. When the actual class of an incoming email is "ham" and is predicted as "spam" by the classifier.

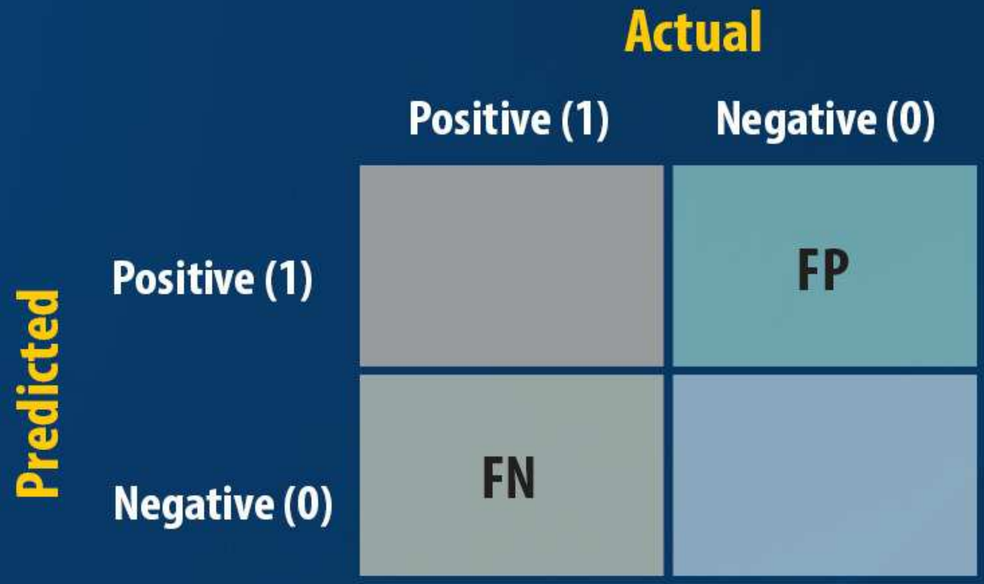

Figure 52: Confusion Matrix with entries namely, FP and FN