

All About Confusion Matrix

- Confusion Matrix
- Accuracy
- Precision
- Recall
- F1 Measure
- Harmonic Mean
- Specificity
- Sensitivity
- AUC Curve
- ROC Curve

All About Confusion Matrix



All About Confusion Matrix



		Prediction	
		1	0
Actual Output	1	True Positive (TP)	False Negative (FN)
	0	False Positive (FP)	True Negative (TN)

True positive (TP).

- Equivalent with hit.

True negative (TN).

- Equivalent with correct rejection.

False positive (FP).

- Equivalent with false alarm, type I error or underestimation.

False negative (FN) .

- Equivalent with miss, type II error or overestimation.

All About Confusion Matrix



		<i>Actual</i>	
		<i>Positive</i>	<i>Negative</i>
<i>Predicted</i>	<i>Positive</i>	True Positive <i>Predicted has cancer Has Cancer</i>	False Positive <i>Predicted has cancer/Does not have cancer</i>
	<i>Negative</i>	False Negative <i>Predicted not cancer Has cancer</i>	True Negative <i>Predicted not cancer Does not have cancer</i>

Accuracy

- $\text{Accuracy} = (\text{TP} + \text{TN}) / (\text{TP} + \text{FP} + \text{TN} + \text{FN})$
- Condition positive (P).
 - The number of real positive cases in the data.
- Condition negative (N).
 - The number of real negative cases in the data.

Precision or Positive Predictive Value (PPV)

$$\text{PPV} = \text{True Positive} / (\text{True Positive} + \text{False Positive})$$

$$\text{Precision} = \text{tp} / (\text{tp} + \text{fp})$$

Sensitivity, Recall, Hit Rate, or True Positive Rate (TPR)

$$\text{TPR} = \text{True Positive} / (\text{True Positive} + \text{False Negative})$$

False Positive Rate (FPR) or 1-Specificity

$$\text{FPR} = \text{FP} / (\text{FP} + \text{TN})$$

F1 Measure

$$\text{F1 Measure} = (\text{Precision} + \text{Recall}) / 2$$

Harmonic Mean, F1 Score

$$F1 = (2 * \text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall})$$

Specificity, Selectivity or True Negative Rate (TNR)

$$\text{Specificity} = \text{True Negative} / (\text{True Negative} + \text{False Positive})$$

Threat Score (TS) or Critical Success Index (CSI)

$$\text{CSI} = \text{TP} / (\text{TP} + \text{FN} + \text{FP})$$

False Discovery Rate (FDR)

$$\text{FDR} = \text{FP} / (\text{TP} + \text{FP})$$

All About Confusion Matrix

**accuracy (ACC)**

$$ACC = \frac{TP + TN}{P + N} = \frac{TP + TN}{TP + TN + FP + FN}$$

balanced accuracy (BA)

$$BA = \frac{TPR + TNR}{2}$$

informedness or bookmaker informedness (BM)

$$BM = TPR + TNR - 1$$

markedness (MK) or deltaP (Δp)

$$MK = PPV + NPV - 1$$

Matthews correlation coefficient (MCC)

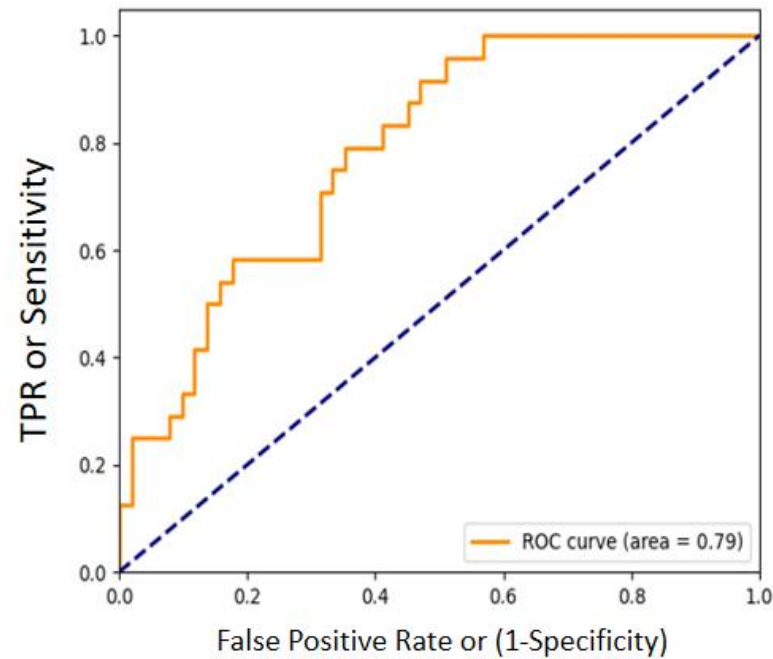
$$MCC = \frac{TP \times TN - FP \times FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$

Fowlkes–Mallows index (FM)

$$FM = \sqrt{\frac{TP}{TP + FP} \times \frac{TP}{TP + FN}} = \sqrt{PPV \times TPR}$$

ROC & AUC Curve

Receiver Operating Characteristic (ROC): Since, **TPR is equivalent to Sensitivity** and **FPR is equal to $1 - \text{specificity}$** , the ROC graph is sometimes called the sensitivity vs ($1 - \text{specificity}$) plot.



All About Confusion Matrix



The Area Under the Curve (AUC)

The Area Under the Curve (AUC) is the measure of the ability of a classifier to difference between classes and is used as a summary of the ROC curve. The higher the AUC, the better the performance of the model at distinguishing between the positive and negative classes.

All About Confusion Matrix



What's a good AUC?

In general, an AUC of 0.5 suggests no discrimination (like, ability to diagnose patients with and without the disease or condition based on the test), 0.7 to 0.8 is considered **acceptable**, 0.8 to 0.9 is considered **excellent**, and more than 0.9 is considered **outstanding**.