

Confusion matrix:

Confusion matrix is used to measure the performance of any Machine Learning classification problem.

Predicted value

		Actual	
		Positive	Negative
Predicted value	Positive (1)	TP	FN
	Negative (0)	FP	TN

TP, TN \rightarrow ML model predicted correctly.

FP (False positive) \rightarrow ML model predicted it as Positive but it is actually negative. This is also known as Type I error.

FN (False Negative) \rightarrow ML model predicted it as negative but it is actually positive. This is also known as Type II error.

Recall :- Also known as sensitivity. Out of all positive classes how much we predicted correctly.

$$\text{Recall/Sensitivity/True positive rate} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

Precision : Out of all positive prediction how many of them are actual positive.

$$\text{Precision} = \frac{TP}{TP + FP}$$

F-measure :

It is difficult to compare two model having multiple comparable parameters. So it is better to compare model using a single value. F-measure capture both the precision & recall and provides a single output.

$$F\text{-measure} = \frac{2 \times \text{Recall} \times \text{Precision}}{\text{Recall} + \text{Precision}}$$

		Predicted Class		
		Positive	Negative	
Actual Class	Positive	True Positive (TP)	False Negative (FN) Type II Error	Sensitivity $\frac{TP}{(TP + FN)}$
	Negative	False Positive (FP) Type I Error	True Negative (TN)	Specificity $\frac{TN}{(TN + FP)}$
		Precision $\frac{TP}{(TP + FP)}$	Negative Predictive Value $\frac{TN}{(TN + FN)}$	Accuracy $\frac{TP + TN}{(TP + TN + FP + FN)}$

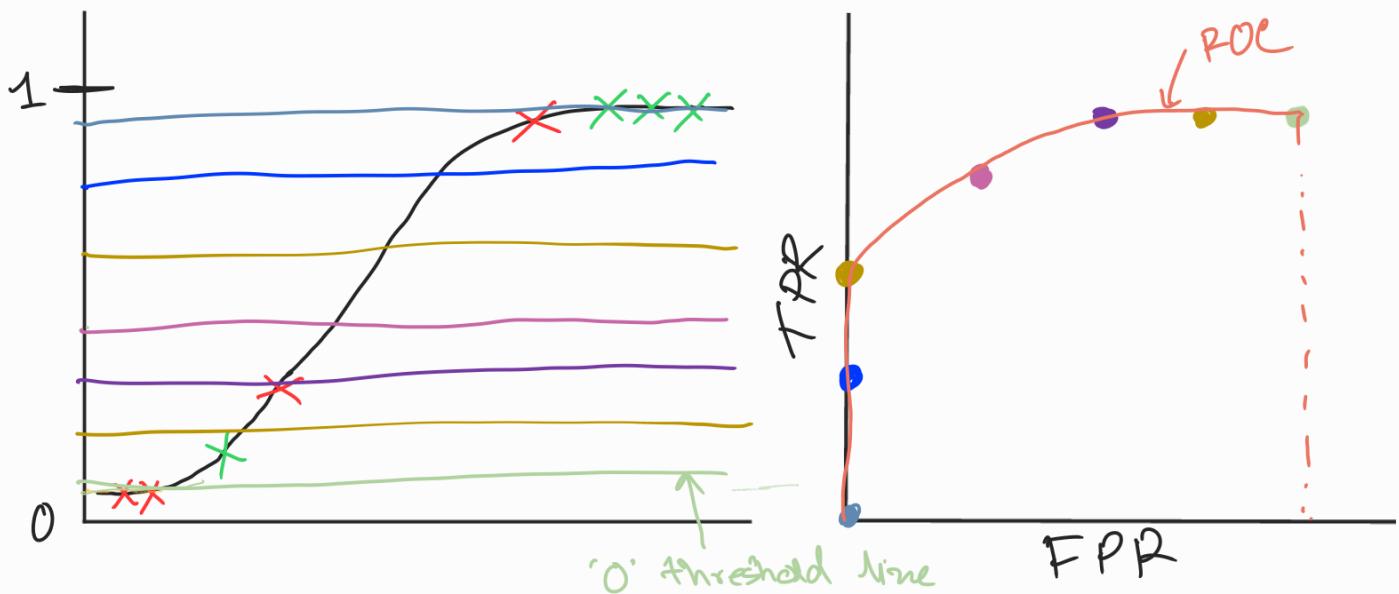
inversely proportional.

ROC / AUC :-

Receiver operating characteristic (ROC) & Area Under Curve(AUC) is one of the most important evaluation metrics of classification model performance. Together it is also called (AUROC). This measures the performance of the model at various thresholds' settings. For example at logistic regression we can use different threshold value to say if any data have negative or positive output. ROC is a probability curve and AUC represents measure of separability. It tells how much a model is capable of distinguishing between classes.

ROC curve is plotted with True positive rate (Recall) vs against False positive rate (1-specificity)

Let's say in logistic regression we use different threshold & we calculate TPR & FPR for that threshold and plot that point in ROC graph. If we connect all those point we get a line. The Area under those line is our AUC



Confusion matrix '0':

	Positive	negative
Positive	4	4
negative	0	0

$$\begin{aligned} TPR &= \frac{TP}{TP + FN} \\ &= \frac{4}{4+0} = 1 \end{aligned}$$

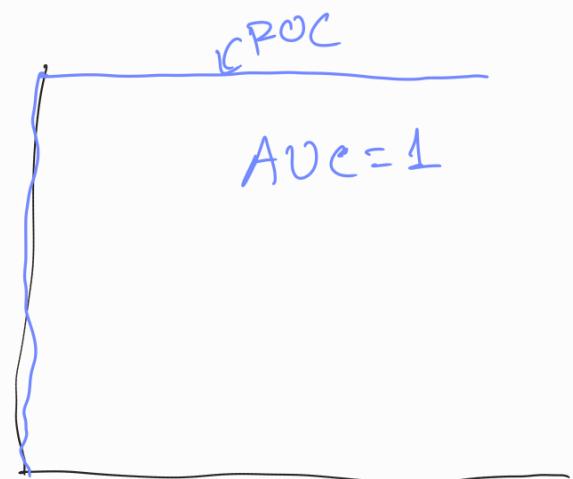
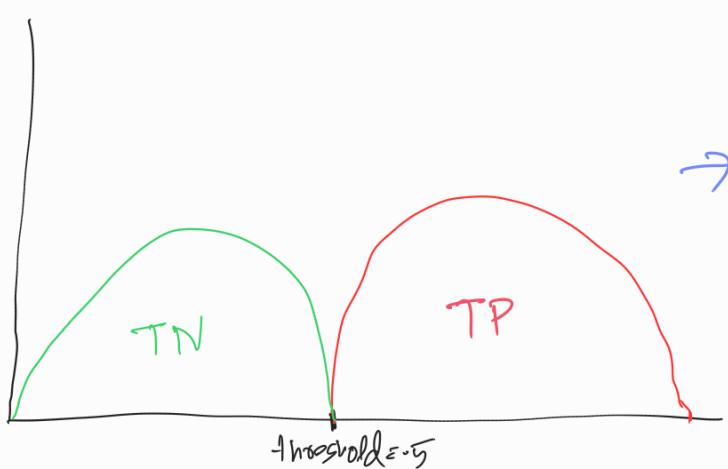
AUC $\approx 1 \rightarrow$ Good model.

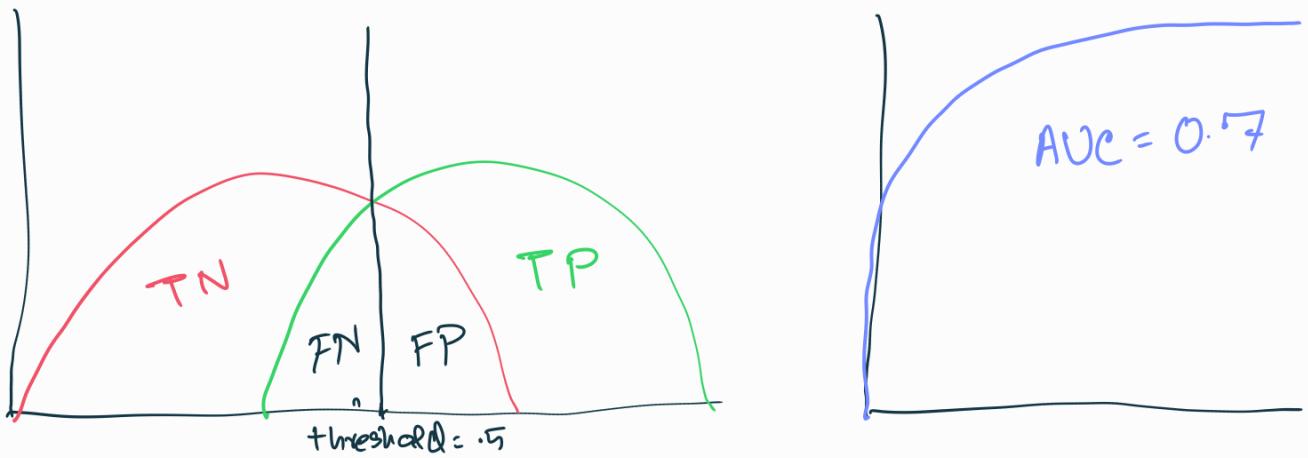
AUC $\approx 0.5 \rightarrow$ no class separation capacity

AUC $\approx 0 \rightarrow$ model is worst.

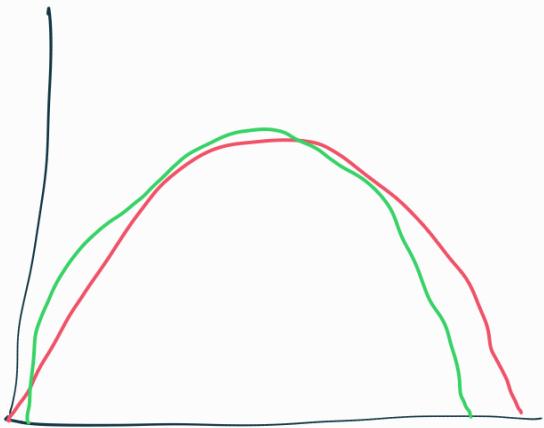
$$\begin{aligned} FPN &= 1 - \text{Specificity} \\ &= \frac{FP}{TN + FP} \\ &= \frac{4}{4} = 1 \end{aligned}$$

Different scenarios :-





$AUC = 0.7$



$AUC = 0.5$

