

Understanding Model Performance: Confusion Matrix & Evaluation Metrics

		Predicted Label		
		Negative (Benign)	Positive (Malignant)	
True Label	Negative (Benign)	TN 83	FP 5	N = TN + FP = 88 negative (benign) cases
	Positive (Malignant)	FN 15	TP 27	P = FN + TP = 42 positive (malignant) cases
		TN + FN = 98 cases predicted negative (benign)	FP + TP = 32 cases predicted positive (malignant)	

- **True Positive (TP):** Case was predicted to be positive (malignant), and it actually is *positive*.
- **False Positive:** Case was predicted to be positive (malignant) and it actually is *negative (benign)*.
- **True Negative:** Case was predicted to be negative (benign), and it actually is *negative (benign)*.
- **False Negative:** Case was predicted to be negative (benign), and it actually is *positive (malignant)*.

Metric	Formula	Results	Interpretation	What it means
Accuracy	$\frac{(TP + TN)}{(N + P)}$	84.62%	The model correctly identified 83% of cases	Overall, how often is the model correct?
Sensitivity (Recall)	$\frac{TP}{(TP + FN)}$	64.29%	Out of all positive cases, the model correctly identified 78.7% of them,	How well does it catch all actual positives?
Specificity	$\frac{TN}{(TN + FP)}$	94.32%	The model correctly identified 78.7% of negative cases	How well does it avoid false alarms?
Precision	$\frac{TP}{(TP + FP)}$	84.38%	Out of all the cases the model predicted as positive, 86.4.2% were correct.	When it says “positive”, how often is it right?
F1 score	$\frac{2 \cdot (Sensitivity \times Precision)}{(Sensitivity + Precision)}$	72.97%	Achieved 80.3% considering negative and positive cases.	Balances false positives and false negatives

Receiver Operating Characteristics Curve (ROC Curve):

1. The ROC curve shows how well a model can **separate positive cases from negative ones** at different thresholds.

The curve plots:

- i) **Sensitivity** (true positive rate) on the Y-axis
- ii) **1 - Specificity** (false positive rate) on the X-axis

Note: A good model has a curve that **hugs the top-left corner** of the graph — meaning high sensitivity and low false positives.

What the diagonal line means:

- The diagonal line represents a model that is **guessing randomly** — like flipping a coin.
- If your curve is close to this line, the model is **no better than random chance**
- The **farther the curve is from the diagonal**, the **better the model** is at making accurate predictions

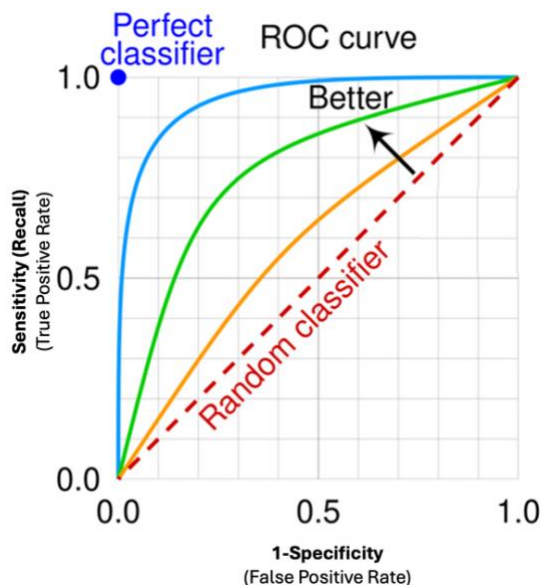


Figure 1. ROC Curve

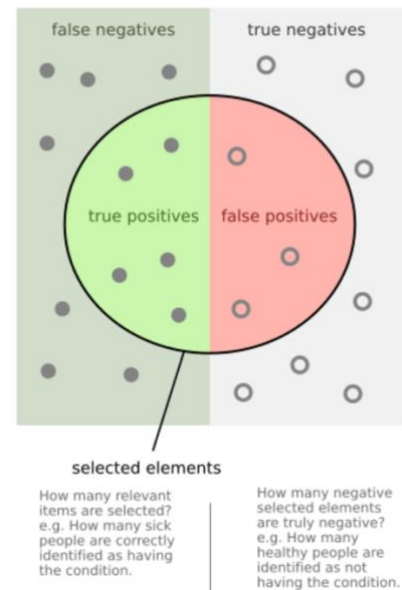


Figure 2. Predictions and Ground Truth