Classification Error Metrics

Choosing the Right Error Measurement

- You are asked to build a classifier for leukemia
- **Training data:** 1% patients with leukemia, 99% healthy
- **Measure accuracy:** total % of predictions that are correct

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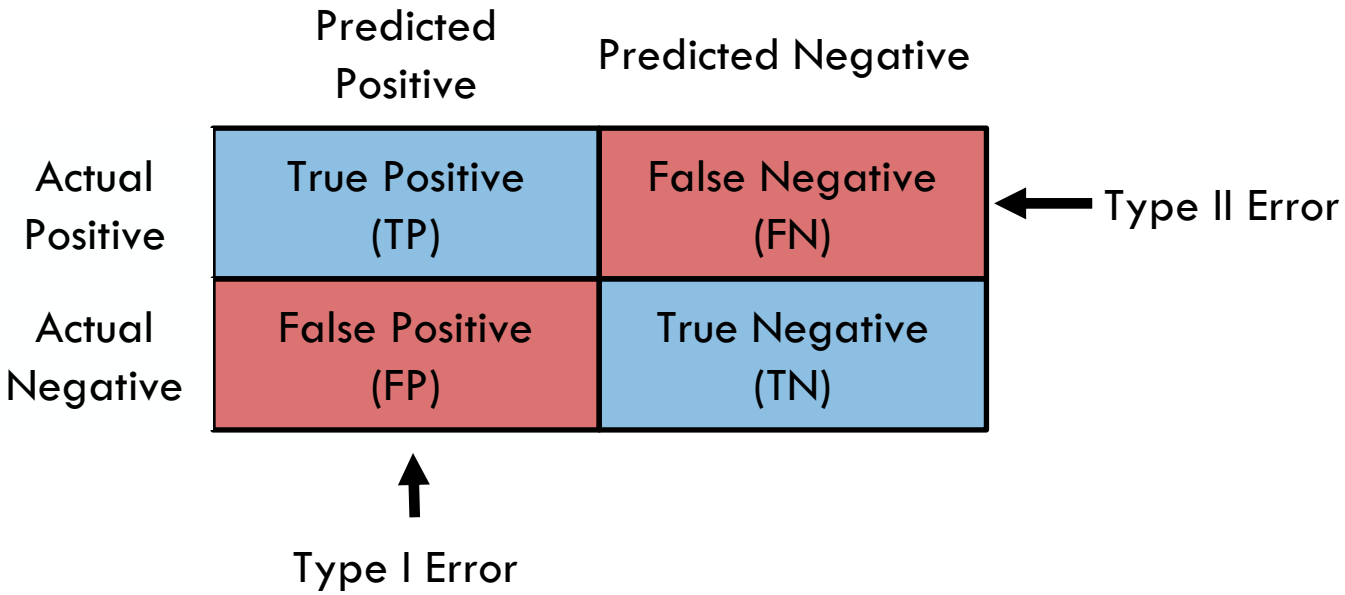
- You are asked to build a classifier for leukemia
- **Training data:** 1% patients with leukemia, 99% healthy
- **Measure accuracy:** total % of predictions that are correct
- Build a simple model that always predicts "healthy"
- Accuracy will be 99%...

Confusion Matrix

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

Confusion Matrix

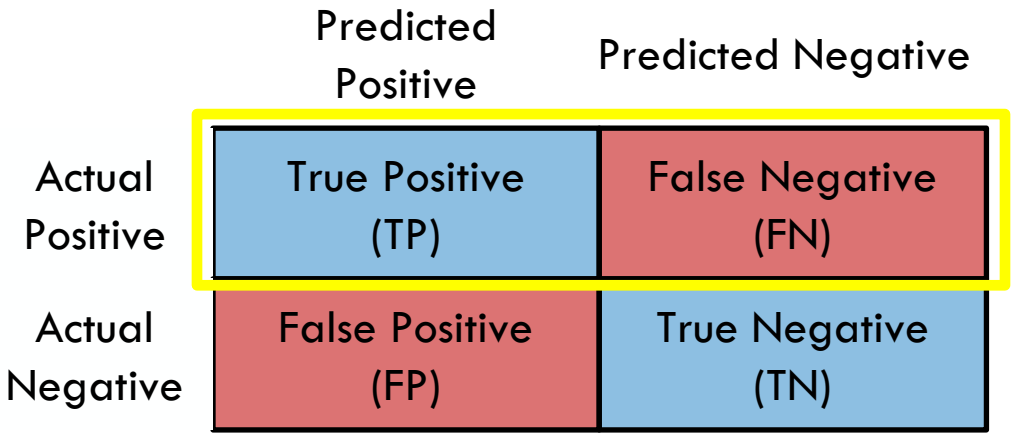


Accuracy: Predicting Correctly

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

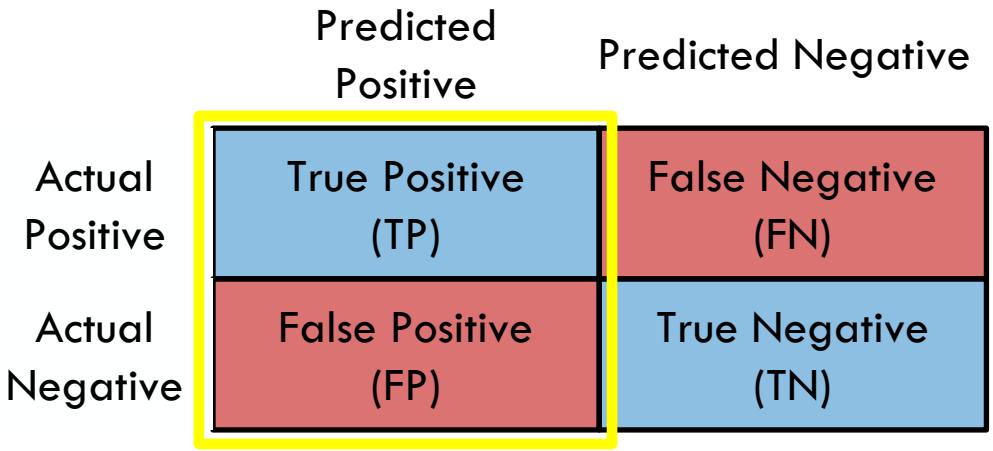
$$\text{Accuracy} = \frac{TP + TN}{TP + FN + FP + TN}$$

Recall: Identifying All Positive Instances



$$\text{Recall or Sensitivity} = \frac{TP}{TP + FN}$$

Precision: Identifying Only Positive Instances



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

Specificity: Avoiding False Alarms

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

$$\text{Specificity} = \frac{TN}{FP + TN}$$

Error Measurements

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

$$\text{Accuracy} = \frac{TP + TN}{TP + FN + FP + TN}$$

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

Error Measurements

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

$$\text{Accuracy} = \frac{TP + TN}{TP + FN + FP + TN}$$

$$\text{Recall or Sensitivity} = \frac{TP}{TP + FN}$$

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

$$\text{Specificity} = \frac{TN}{FP + TN}$$

Error Measurements

	Predicted Positive	Predicted Negative
Actual Positive	True Positive (TP)	False Negative (FN)
Actual Negative	False Positive (FP)	True Negative (TN)

$$\text{Accuracy} = \frac{TP + TN}{TP + FN + FP + TN}$$

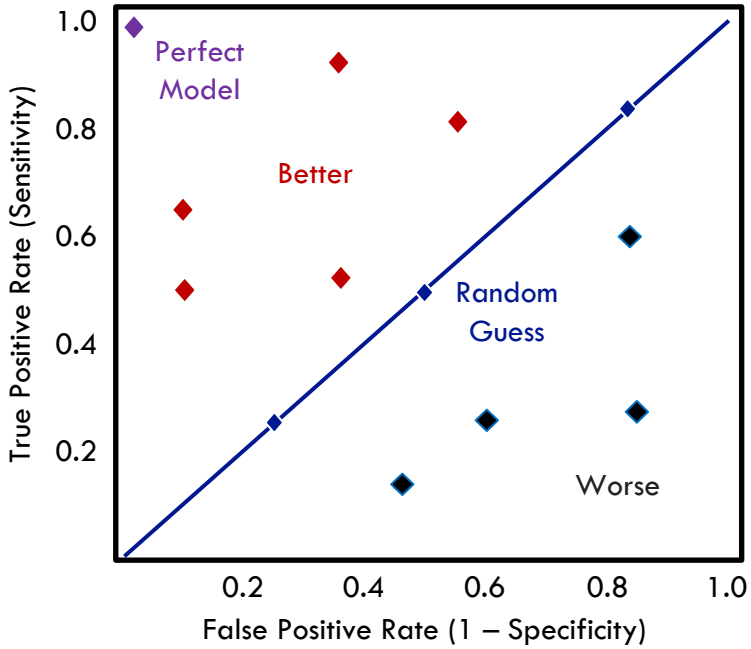
$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall or Sensitivity} = \frac{TP}{TP + FN}$$

$$\text{Specificity} = \frac{TN}{FP + TN}$$

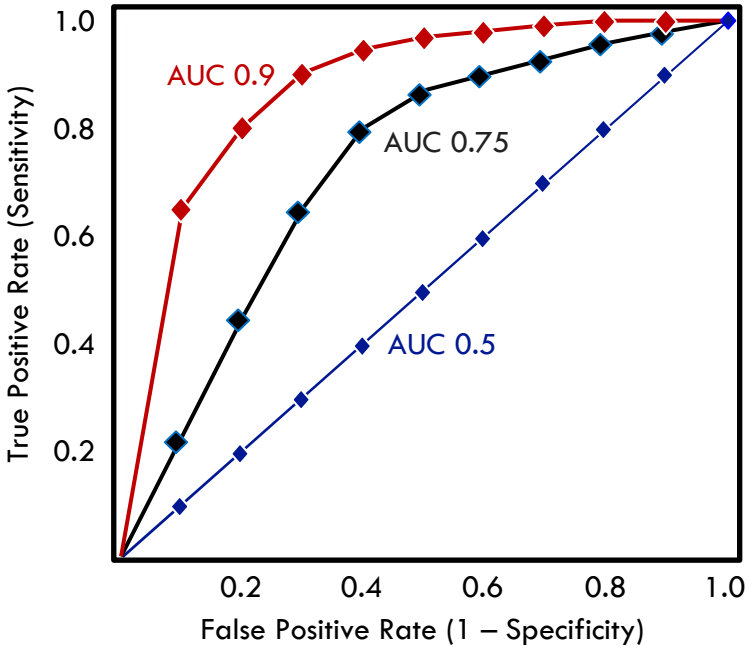
$$F1 = 2\,\frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

Receiver Operating Characteristic (ROC)



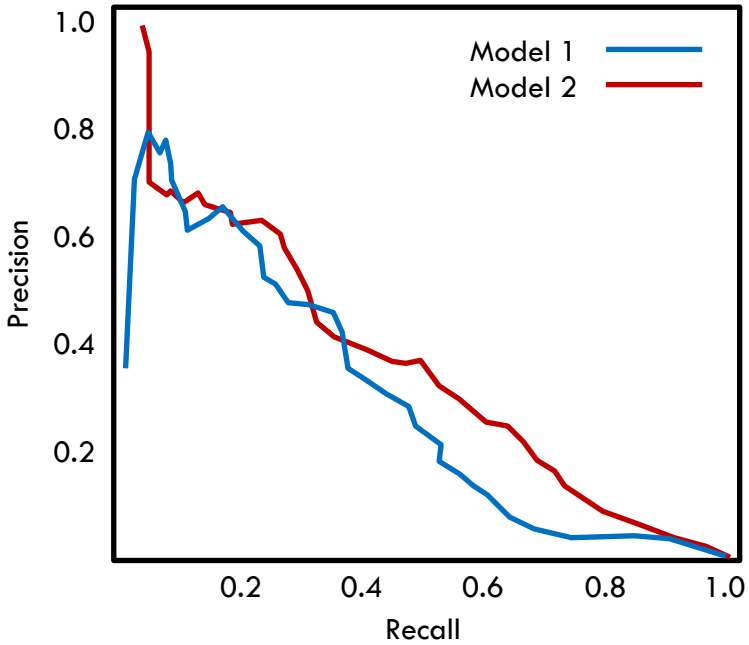
Evaluation of model at all possible thresholds

Area Under Curve (AUC)



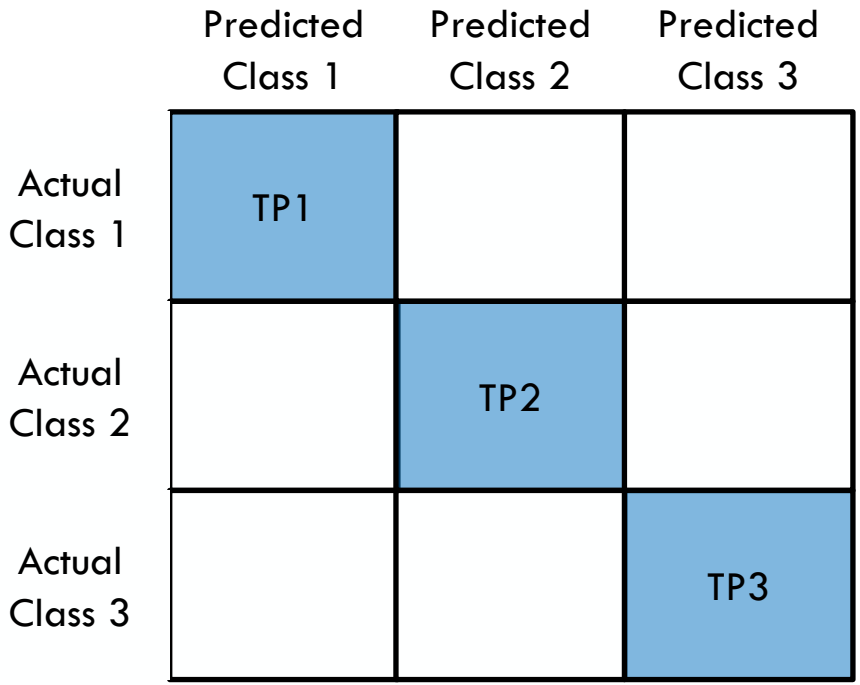
Measures total area under ROC curve

Precision Recall Curve (PR Curve)

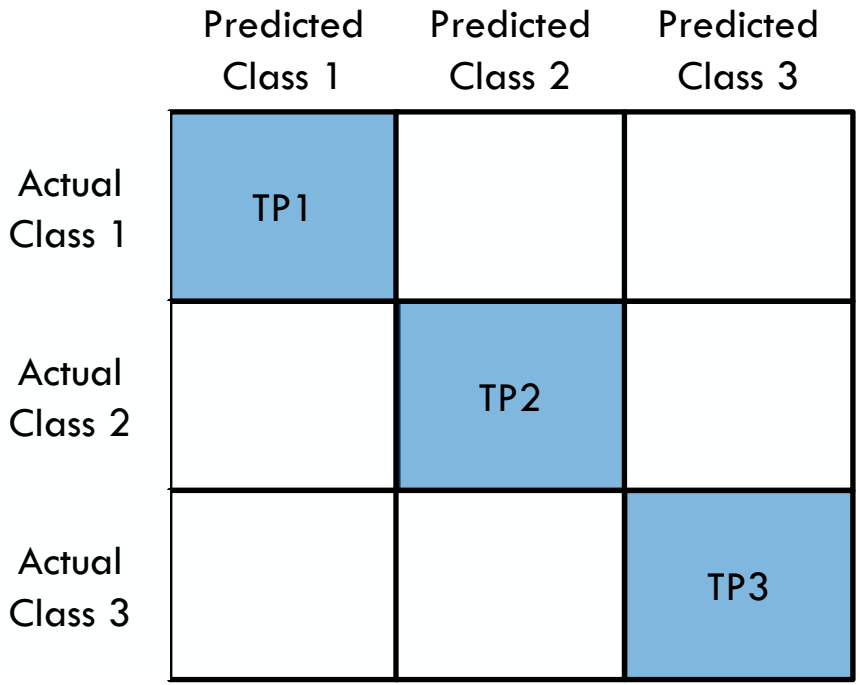


Measures trade-off between precision and recall

Multiple Class Error Metrics

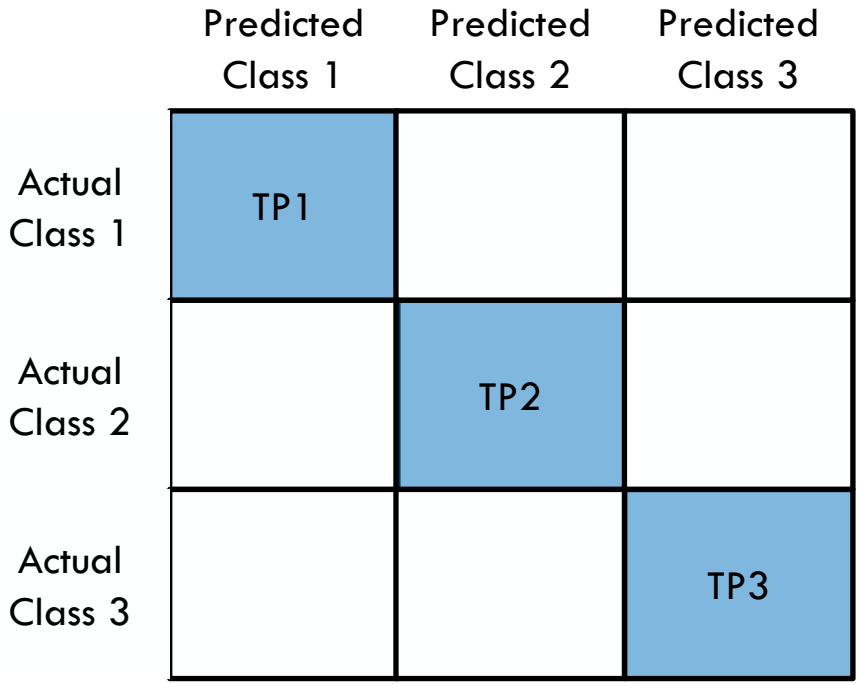


Multiple Class Error Metrics



$$\text{Accuracy} = \frac{TP1 + TP2 + TP3}{\text{Total}}$$

Multiple Class Error Metrics



$$\text{Accuracy} = \frac{TP1 + TP2 + TP3}{\text{Total}}$$

Most multi-class error metrics are similar to binary versions— just expand elements as a sum