Machine Learning

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Lesson 4.2

Evaluation of Classification

Evaluation of Classification: Confusion Matrix

Confusion Matrix

A confusion matrix shows the number of correct and incorrect predictions made by the classification model compared to the actual outcomes (target value) in the data. The matrix is *NxN*, where *N* is the number of target values (classes). Performance of such models is commonly evaluated using the data in the matrix. The following table displays a 2×2 confusion matrix for two classes (Positive and Negative).

Confusion Matrix		**Target**			
		Positive	Negative		
Model	Positive	a	b	*Positive Predictive Value*	a/(a+b)
	Negative	c	d	*Negative Predictive Value*	d/(c+d)
		Sensitivity	*Specificity*	**Accuracy** = (a+d)/(a+b+c+d)	
		a/(a+c)	d/(b+d)		

Evaluation of Classification: Confusion Matrix

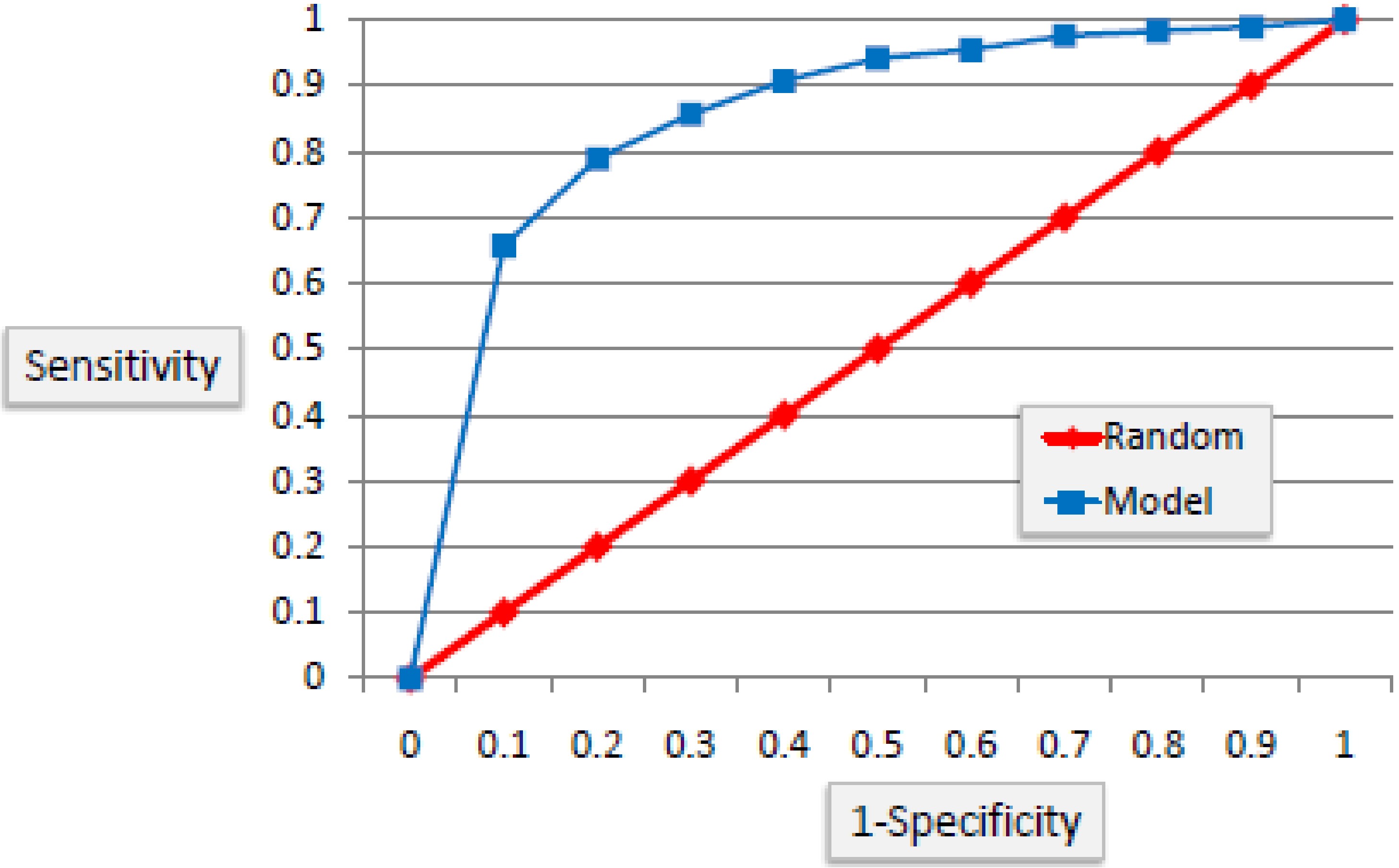
- **Accuracy:** the proportion of the total number of predictions that were correct.
- **Positive Predictive Value** or **Precision:** the proportion of positive cases that were correctly identified.
- **Negative Predictive Value:** the proportion of negative cases that were correctly identified.
- **Sensitivity** or **Recall:** the proportion of actual positive cases which are correctly identified.
- **Specificity:** the proportion of actual negative cases which are correctly identified.

Evaluation of Classification: Confusion Matrix

Confusion Matrix		Target			
		Positive	Negative		
Model	Positive	70	20	*Positive Predictive Value*	0.78
	Negative	30	80	*Negative Predictive Value*	0.73
		Sensitivity	*Specificity*	**Accuracy** = 0.75	
		0.70	0.80		

Confusion Matrix		Target			
		Positive	Negative		
Model	Positive	a	b	*Positive Predictive Value*	a/(a+b)
	Negative	c	d	*Negative Predictive Value*	d/(c+d)
		Sensitivity	*Specificity*	**Accuracy** = (a+d)/(a+b+c+d)	
		a/(a+c)	d/(b+d)		

Evaluation of Classification: ROC



Evaluation of Classification: ROC

The ROC chart provides a means of comparison between classification models.

The ROC chart shows false positive rate on X-axis, the probability of target=1 when its true value is 0, against true positive rate on Y-axis, the probability of target=1 when its true value is 1.

Ideally, the curve will climb quickly toward the top-left meaning the model has correct predictions.

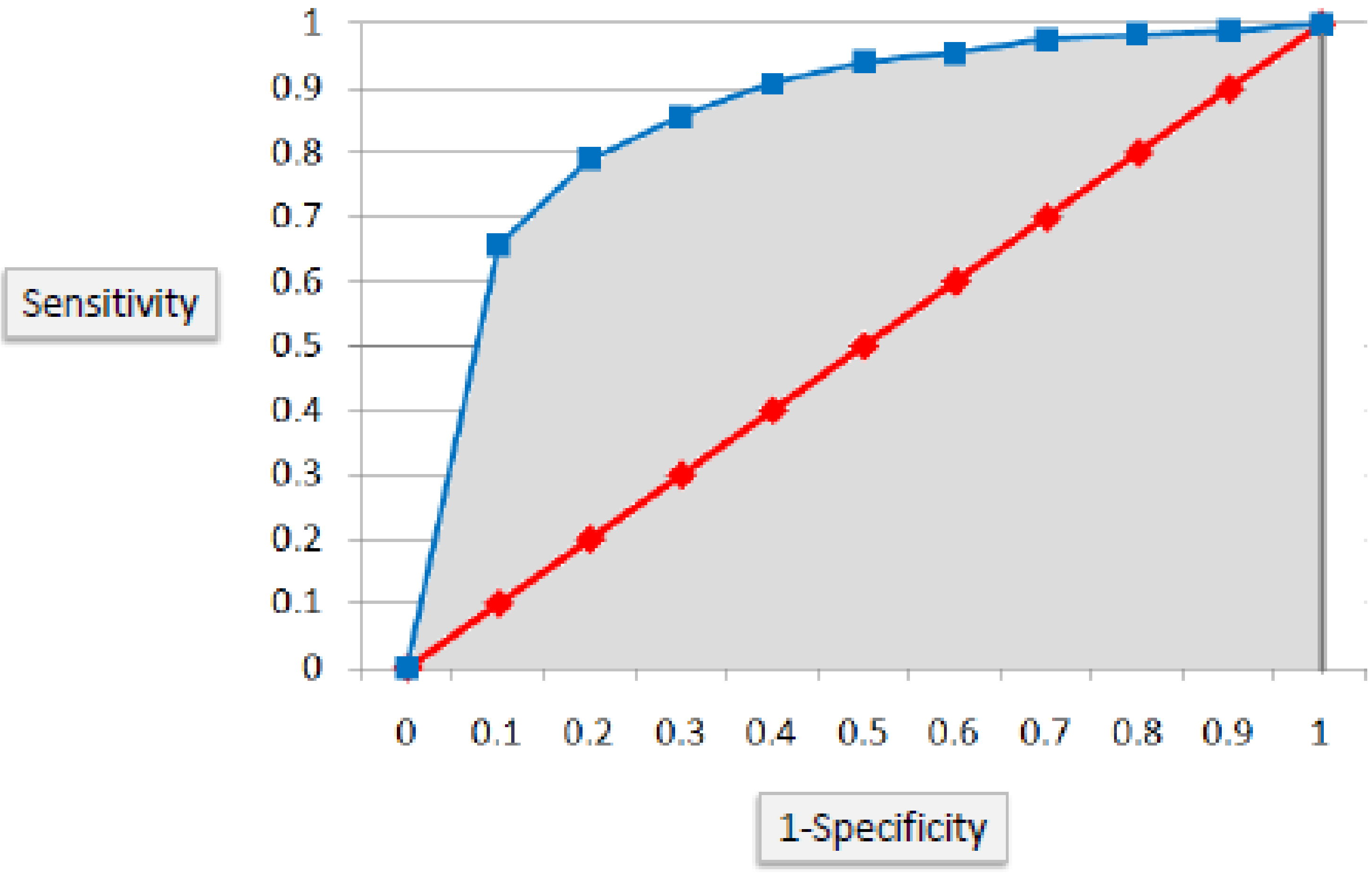
Furthermore, the diagonal red line is for a random model.

Evaluation of Classification: AUC

Area Under the Curve (AUC)

The area under the ROC curve is often a measure of the quality of the classification models. A random classifier has an area under the curve of 0.5, while AUC for a perfect classifier is equal to 1. In practice, most of the classification models have an AUC between 0.5 and 1.

Evaluation of Classification: AUC



Evaluation of Classification: AUC

An area under the ROC curve of 0.8, for example, means that a randomly selected case from the group with the target equals 1 has a score larger than that for a randomly chosen case from the group with the target equals 0 in 80% of the time. Furthermore, when a classifier cannot distinguish between the two groups, the area will be equal to 0.5 (will coincide with the diagonal). Also, when there is a perfect separation of the two groups, i.e., no overlapping of the distributions, the area under the ROC curve reaches to 1 (the ROC curve will reach the upper left corner of the plot).