

# DATA SCIENCE

## DRAWING AN ROC CURVE

Email Score	True Label
0.99	Spam
0.82	Spam
0.65	Spam
0.65	Ham
0.52	Spam
0.22	Spam
0.11	Ham
0.02	Ham

Imagine we have a classifier that assigns every a “spamminess” score to emails.

Since an email is either spam or not (ham), to actually make our predictions, we choose a numeric cutoff for classifying as spam.

An ROC curve will help us to visualize how well our binary classifier is doing without having to choose a cutoff!

Email Score	True Label	Predicted Label Using 0.5 Cutoff
0.99	Spam	Spam
0.82	Spam	Spam
0.65	Spam	Spam
0.65	Ham	Spam
0.52	Spam	Spam
0.22	Spam	Ham
0.11	Ham	Ham
0.02	Ham	Ham

Specificity: When true label is **ham**, how often is the prediction **correct**?

Sensitivity: When true label is **spam**, how often is the prediction **correct**?

Email Score	True Label
0.99	Spam
0.82	Spam
0.65	Spam
0.65	Ham
0.52	Spam
0.22	Spam
0.11	Ham
0.02	Ham

Cutoff	Specificity	Sensitivity
1		
0.9		
0.8		
0.6		
0.5	$2/3 = 0.66$	$4/5 = 0.8$
0.2		
0.1		
0		

Specificity: When true label is **ham**, how often is the prediction **correct**?

Sensitivity: When true label is **spam**, how often is the prediction **correct**?

Email Score	True Label
0.99	Spam
0.82	Spam
0.65	Spam
0.65	Ham
0.52	Spam
0.22	Spam
0.11	Ham
0.02	Ham

Cutoff	Specificity	Sensitivity
1	$3/3 = 1$	$0/5 = 0$
0.9	$3/3 = 1$	$1/5 = 0.2$
0.8	$3/3 = 1$	$2/5 = 0.4$
0.6	$2/3 = 0.66$	$3/5 = 0.6$
0.5	$2/3 = 0.66$	$4/5 = 0.8$
0.2	$2/3 = 0.66$	$5/5 = 1$
0.1	$1/3 = 0.33$	$5/5 = 1$
0	$0/3 = 0$	$5/5 = 1$

Specificity: When true label is **ham**, how often is the prediction **correct**?

Sensitivity: When true label is **spam**, how often is the prediction **correct**?

Email Score	True Label
0.99	Spam
0.82	Spam
0.65	Spam
0.65	Ham
0.52	Spam
0.22	Spam
0.11	Ham
0.02	Ham

Cutoff	FPR (x-axis)	TPR (y-axis)
1	0	0
0.9	0	0.2
0.8	0	0.4
0.6	0.33	0.6
0.5	0.33	0.8
0.2	0.33	1
0.1	0.66	1
0	1	1

FPR (x-axis) = 1-Specificity

TPR (y-axis) = Sensitivity

Q: On the ROC curve, can you see the cutoff that was used to generate a point?

A: No, that information is not visible.

Email Score	True Label
0.99	Spam
0.98	Spam
0.97	Spam
0.97	Ham
0.96	Spam
0.03	Spam
0.02	Ham
0.01	Ham

Q: Would the ROC curve (and AUC) change if the scores changed but the ordering remained the same?

A: Not at all! The ROC Curve is only sensitive to rank ordering and does not require calibrated scores.