

Biomarkers: Receiver Operating Characteristic Curves

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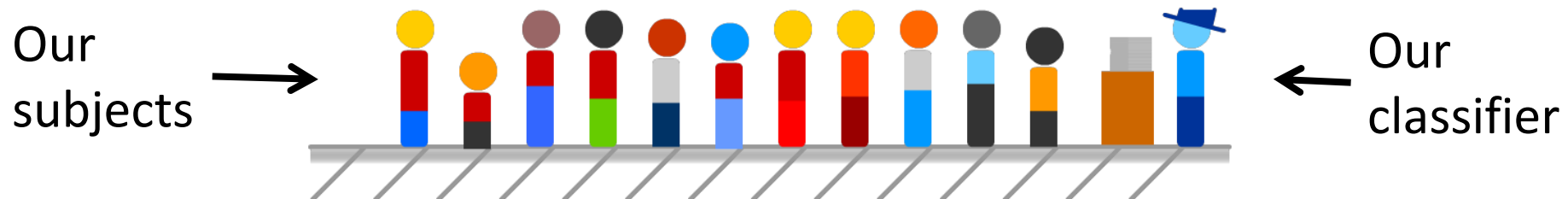
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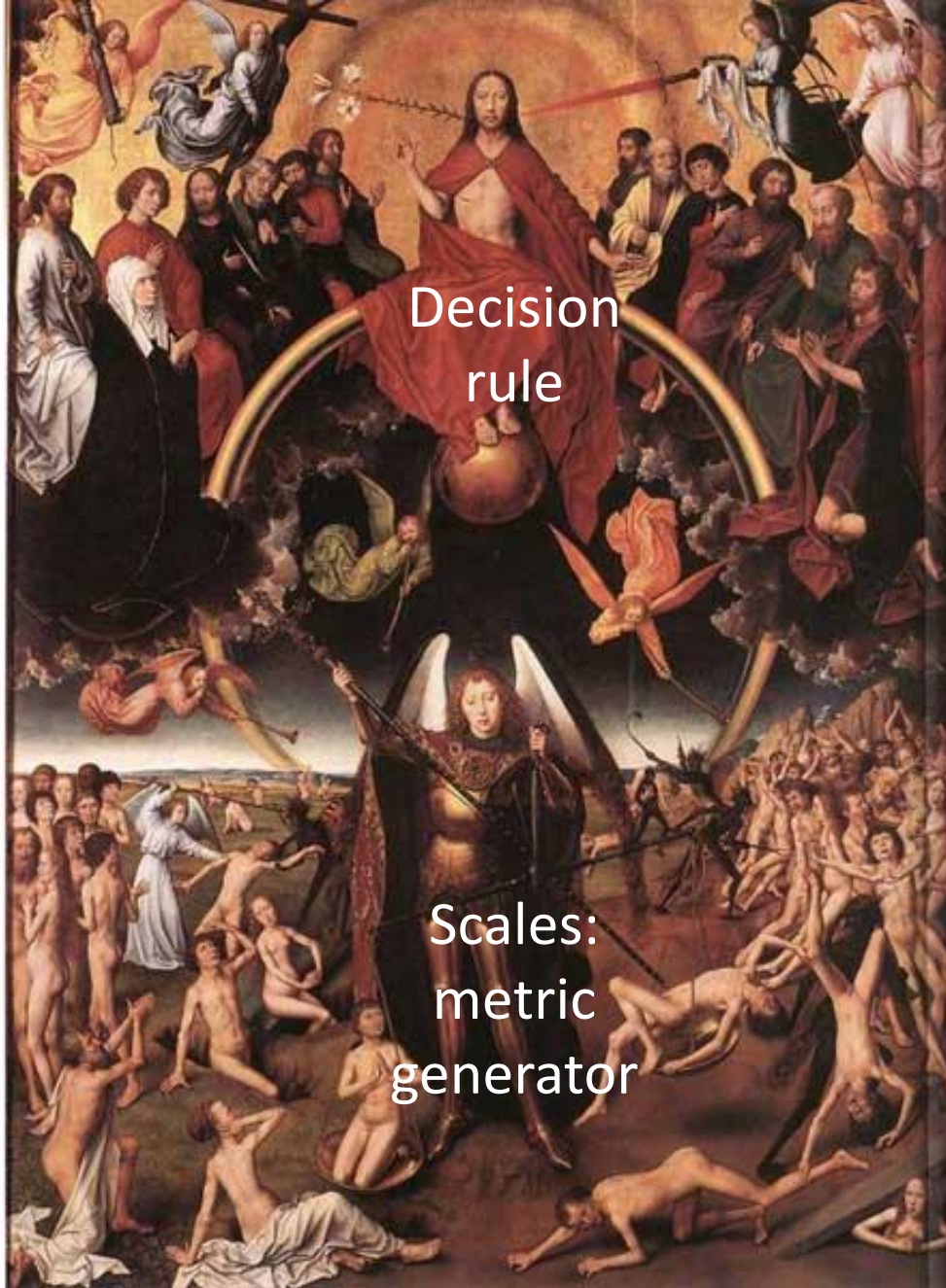
Overview

- Defining binary classifiers, sensitivity, and specificity
- Assembling a table from the scores and labels of our study participants
- Drawing and characterizing an ROC curve that corresponds to a scoring table
- Selecting a cutpoint and finding the threshold it implies

Binary Classifier

- A binary classifier attempts to separate a heterogeneous group of subjects into two different classes.
- Most classifiers give a score to each subject, reflecting the surety of its class assignment.
- Also known as “*dichotomous classifier*”





A table of scores and a rule

<i>Truth</i>	<i>Initial order</i>		<i>Truth</i>	<i>Sorted by score</i>		<i>Truth</i>	<i>Thresholded</i>	
-	Pt. A	0.273	+	Pt. D	0.869	+	Pt. D	0.869
-	Pt. B	0.394	+	Pt. H	0.742	+	Pt. H	0.742
-	Pt. C	0.478	+	Pt. I	0.655	+	Pt. I	0.655
+	Pt. D	0.869	-	Pt. C	0.478	-	Pt. C	0.478
+	Pt. E	0.424	+	Pt. F	0.426	+	Pt. F	0.426
+	Pt. F	0.426	+	Pt. E	0.424	+	Pt. E	0.424
-	Pt. G	0.136	-	Pt. B	0.394	-	Pt. B	0.394
+	Pt. H	0.742	-	Pt. A	0.273	-	Pt. A	0.273
+	Pt. I	0.655	-	Pt. J	0.167	-	Pt. J	0.167
-	Pt. J	0.167	-	Pt. G	0.136	-	Pt. G	0.136

Scoring the decision rule

		<i>Reality</i>		
		<i>TRUE</i>	<i>FALSE</i>	
<i>Judgment</i>	<i>TRUE</i>	TP	FP	<i>Positive Pred. Value</i> $=TP/(TP+FP)$
	<i>FALSE</i>	FN	TN	<i>Negative Pred. Value</i> $=TN/(FN+TN)$

Sensitivity

$$=TP/(TP+FN)$$

Specificity

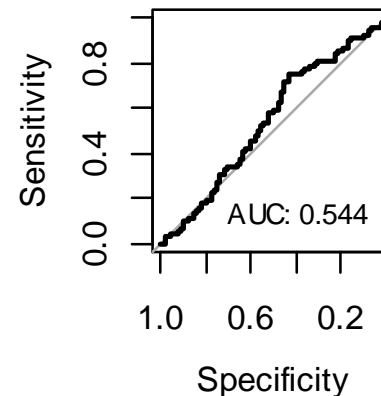
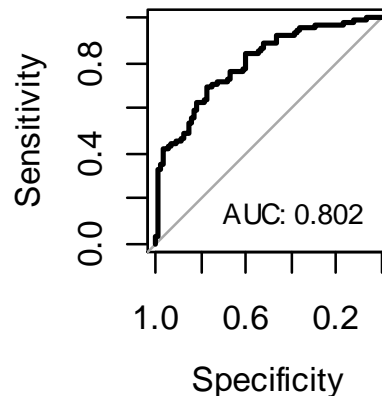
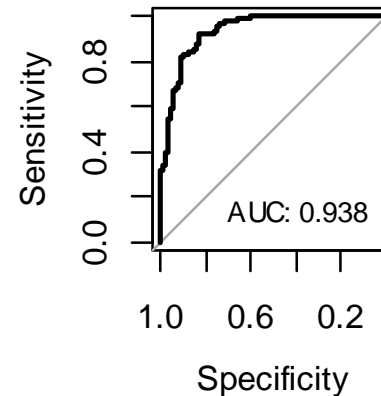
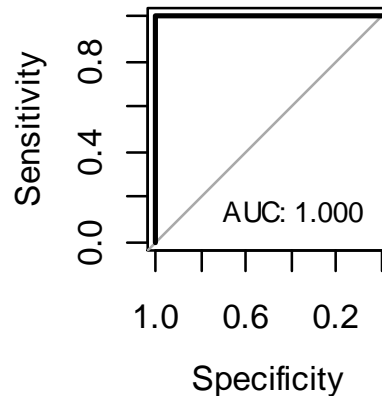
$$=TN/(FP+TN)$$

$y \rightarrow$ sensitivity
 $x \rightarrow$ specificity

- Studies frequently use different numbers of cases and controls; drawing the same distance for both results in a rectangle.
- The maximum of y axis becomes total number of cases; the maximum of x axis becomes the total number of controls.
- Now we are showing sensitivity on y and the reverse of specificity on x !

AUC = “Area under the curve”

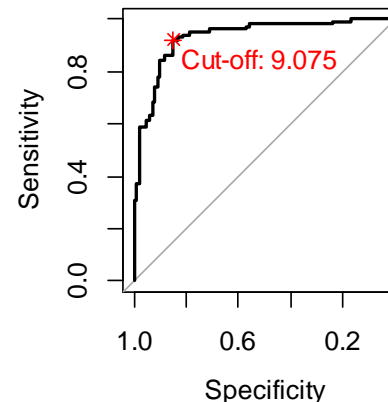
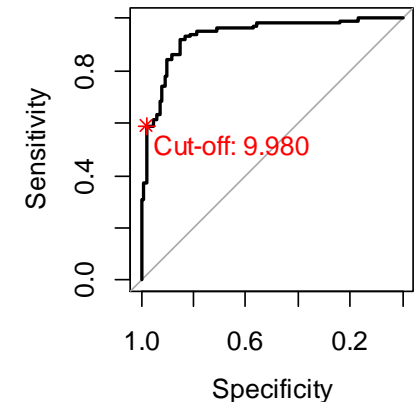
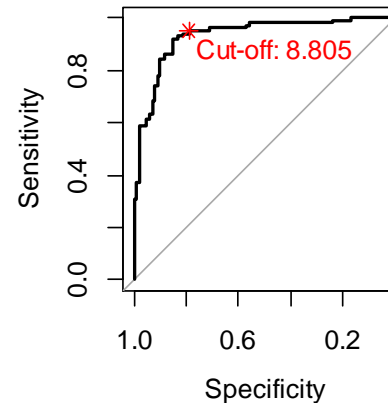
Perfect
separation



Random
separation

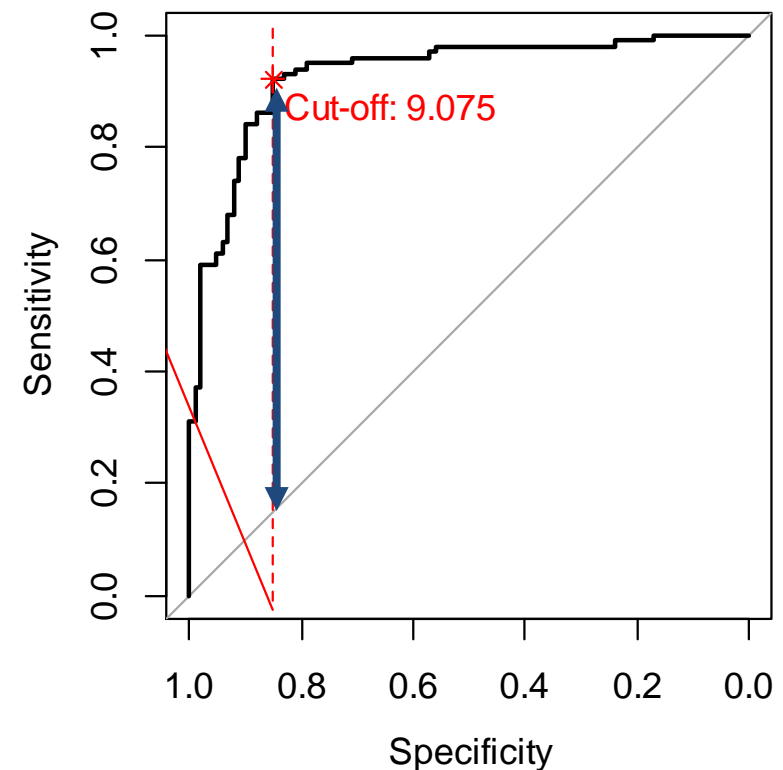
How do we pick a threshold?

- Screening for Ebola: prioritize sensitivity
- Sending for surgery: prioritize specificity
- Most cases: balance in middle!



Balance: Youden's J

- J finds highest sum of sensitivity and specificity.
- Maximizes vertical distance from curve to diagonal.
- Threshold is score from source table that produces this mix.



Takeaway Messages

- ROC curves show us the discrimination achieved by a biomarker measurement.
- AUC values [0.5-1.0] reflect the distance achieved away from random decisions.
- Selecting a threshold requires perspective on the balance of sensitivity and specificity.