

Comparing Diagnostic Methods

Active Learning Session #2

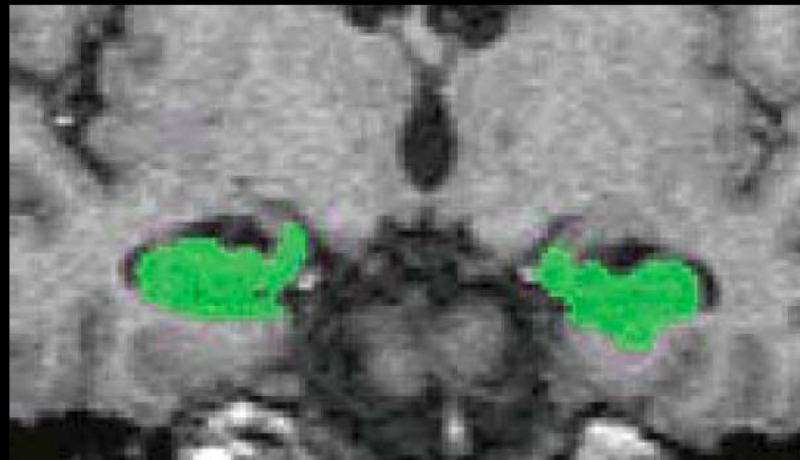
Shy Shoham, Biomedical Engineering, Technion

shy@technion.ac.il



Alzheimer's disease

- quantitative methods



Sn 85%, Sp 88% for differentiating AD versus Normal aging
Laakso, Neurobiol Aging 1998

Simple cancer diagnostic screen

A diagnostic screen is applied to 2030 people to look for a disorder with a population prevalence of 1.48%

		Patients with bowel cancer (as confirmed on endoscopy)	
		Condition positive	Condition negative
Fecal occult blood screen test outcome	Test outcome positive	True positive (TP) = 20	False positive (FP) = 180
	Test outcome negative	False negative (FN) = 10	True negative (TN) = 1820

Sensitivity and Specificity

- Sensitivity and specificity are the basic measures of the accuracy of a diagnostic test. They describe the abilities of a test to correctly diagnose disease when it is present and to correctly rule out disease when it is truly absent.
- Sensitivity (**true positive rate**): the percentage of positives (sick people) who are correctly identified as having the condition.
 - $\text{Sensitivity} = \text{TP} / (\text{TP} + \text{FN})$
- Specificity (**true negative rate**): the proportion of negatives (healthy people) who are correctly identified as not having the condition.
 - $\text{Specificity} = \text{TN} / (\text{TN} + \text{FP})$

Sensitivity and specificity (cont.)

		Patients with bowel cancer (as confirmed on endoscopy)	
		Condition positive	Condition negative
Fecal occult blood screen test outcome	Test outcome positive	True positive (TP) = 20	False positive (FP) = 180
	Test outcome negative	False negative (FN) = 10	True negative (TN) = 1820
		Sensitivity $= TP / (TP + FN)$ $= 20 / (20 + 10)$ $\approx 67\%$	Specificity $= TN / (FP + TN)$ $= 1820 / (180 + 1820)$ $= 91\%$

A slightly more complex (and realistic) scenario

TABLE 1
Results from Mammography Study with 100 Patients

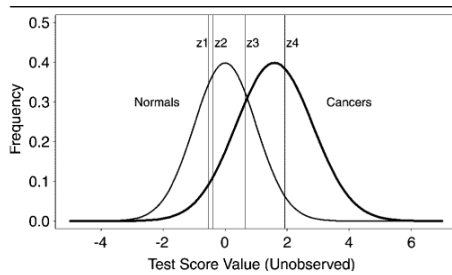
Cut Point and Reference Standard Result	Radiologist's Interpretation					Total
	Normal	Benign	Probably Benign	Suspicious	Malignant	
Cut point 1*						
Reference standard result						
Cancer present	2	0	10	18†	20†	50
Cancer absent	15	3	18	13‡	1‡	50
Cut point 2*						
Reference standard result						
Cancer present	2	0	10†	18†	20†	50
Cancer absent	15	3	18‡	13‡	1‡	50

Cut point 1: Sensitivity 76%, Specificity 72%

Cut point 2: Sensitivity 96%, Specificity 36%

Task #1

Help our radiologist understand how these measures relate to each other...



ROC curve

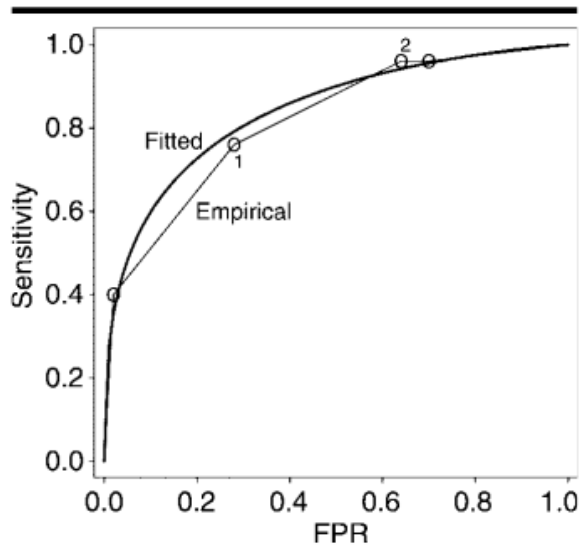


TABLE 3
Construction of Empirical ROC Curve for Mammography Study

Cut Point	Sensitivity*	FPR†
Between normal and benign	0.96 (48/50)	0.70 (35/50)
Between benign and probably benign	0.96 (48/50)	0.64 (32/50)
Between probably benign and suspicious	0.76 (38/50)	0.28 (14/50)
Between suspicious and malignant	0.40 (20/50)	0.02 (1/50)

Note.—These data represent estimations of the points on the empirical ROC curve marked with open circles and depicted in Figure 1. The ROC curve in Figure 1 was constructed on the basis of the data in Table 1, with sensitivity and the FPR estimated at each possible cut point.

* Data in parentheses are those used to calculate the sensitivity value.

† Data in parentheses are those used to calculate the FPR (or $1 - \text{specificity}$) value.

Task #2

What's more important sens. or spec.?

Which point to select?

What will be effect of radiologist?

What will be effect of *better* algorithm?

How to quantify?

Radiology

Nancy A. Obuchowski, PhD

Index terms:
Diagnostic radiology
Statistical analysis

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Receiver Operating Characteristic Curves and Their Use in Radiology¹

Lusted LB. Signal detectability and medical decision-making. *Science* 1971; 171: 1217-1219.

Task #2: comparing methods

TABLE 1
Results from Mammography Study with 100 Patients

Cut Point and Reference Standard Result	Radiologist's Interpretation					Total
	Normal	Benign	Probably Benign	Suspicious	Malignant	
Cut point 1*						
Reference standard result						
Cancer present	2	0	10	18†	20†	50
Cancer absent	15	3	18	13‡	1‡	50
Method #1						
	1	1	3	28	17	50
Method #2	17	4	18	10	1	50

Using the ROC curve

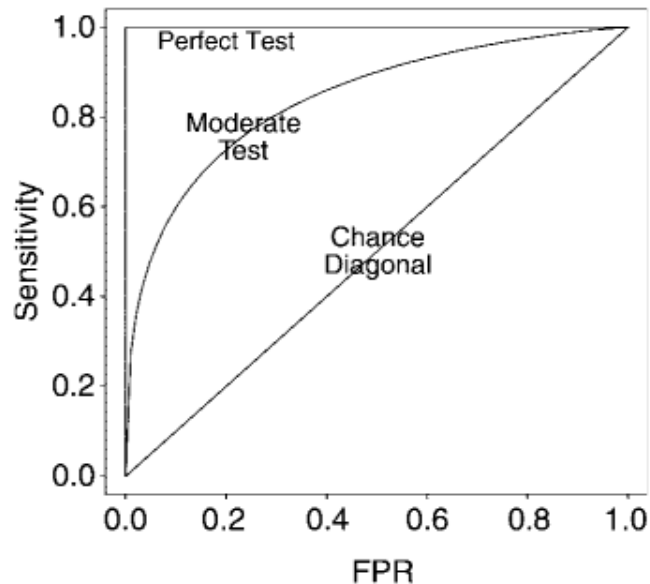


Figure 3. Graph shows comparison of three ROC curves. A perfect test has an area under the ROC curve of 1.0. The chance diagonal has an ROC area of 0.5. Tests with some discriminating ability have ROC areas between these two extremes.

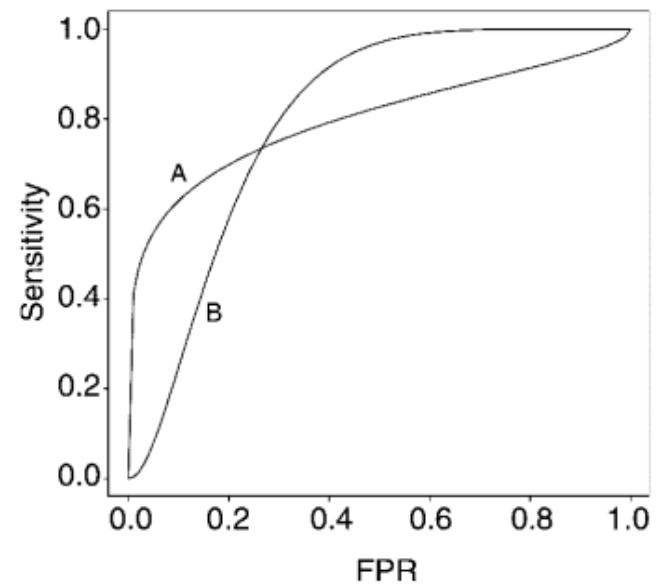
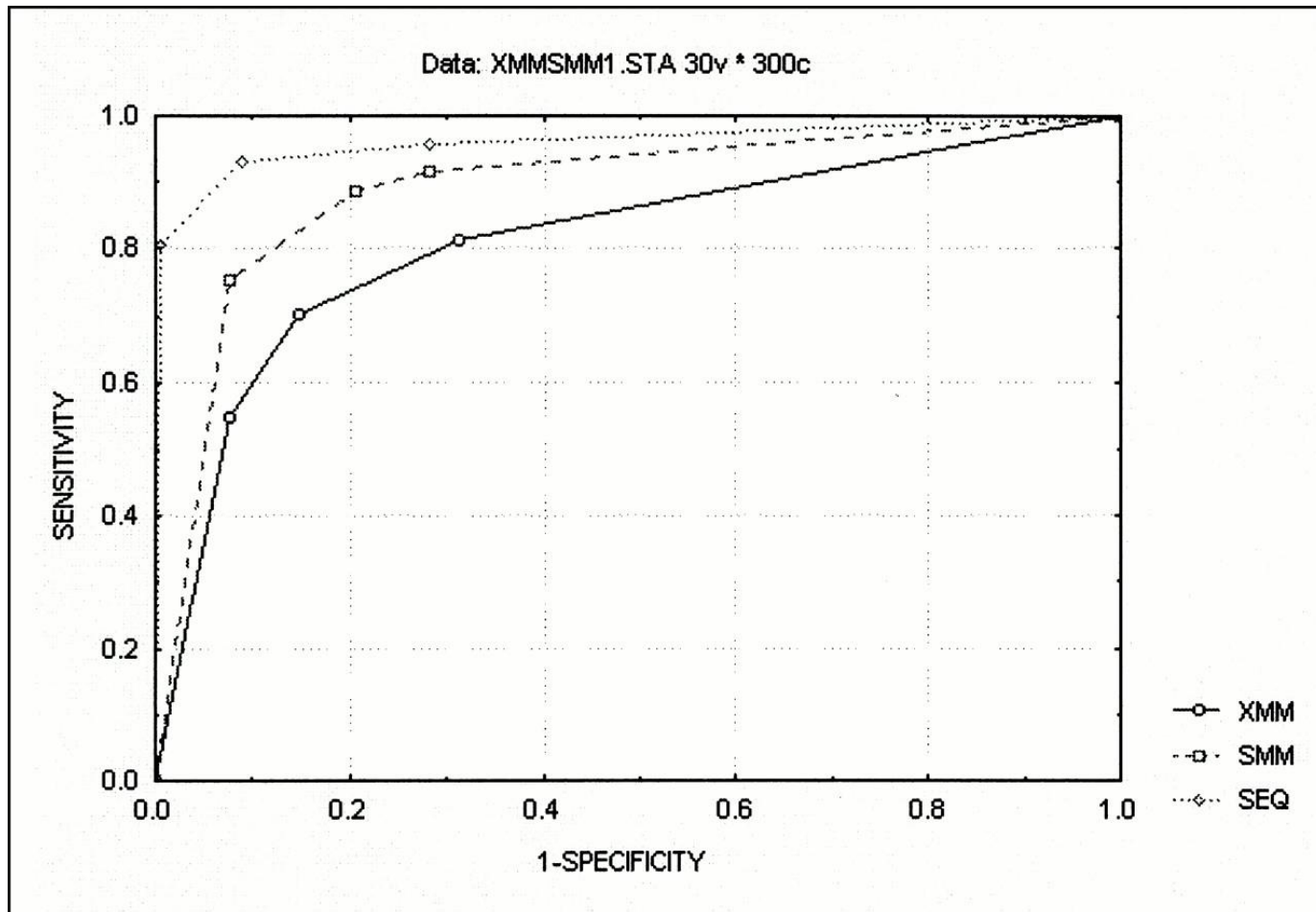
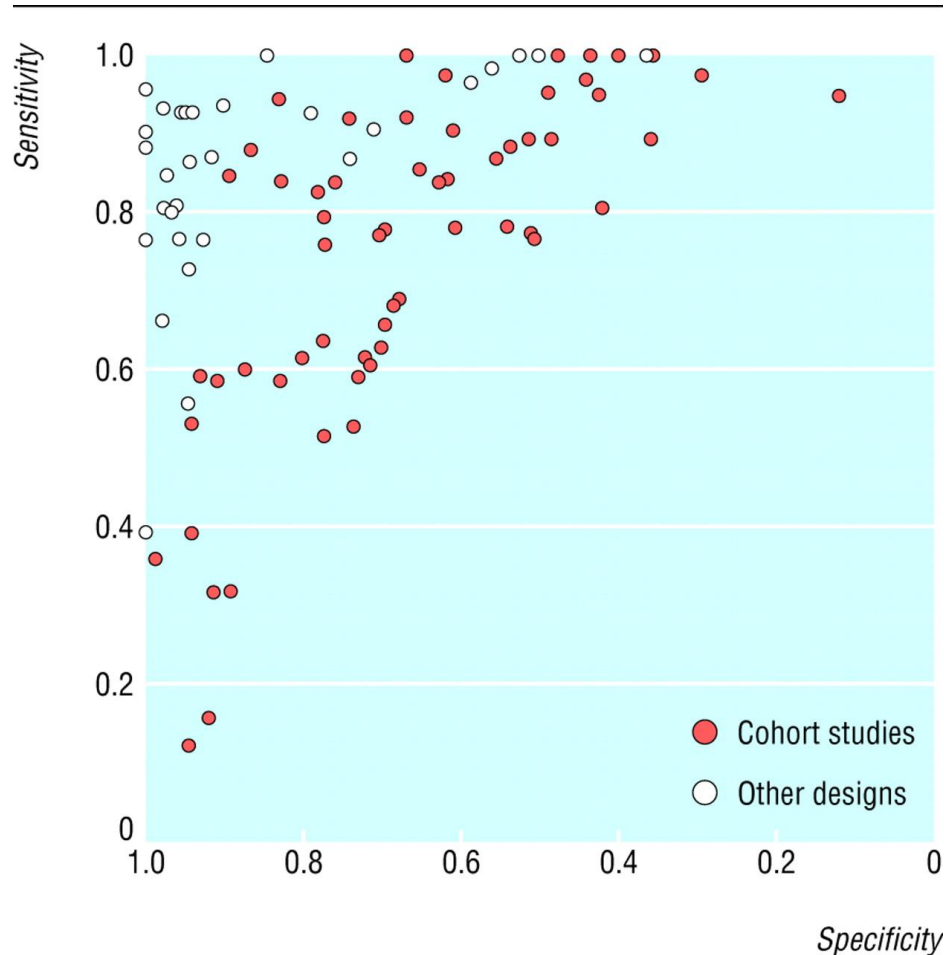


Figure 4. Graph shows two crossing ROC curves. The ROC areas of the two tests are the same at 0.80; however, for the clinically important range (ie, an FPR of less than 0.20), test A is preferable to test B.

Prediction of the Usefulness of Combined Mammography and Scintimammography in Suspected Primary Breast Cancer



Meta-analysis of MS detection by MR



$$\text{DOR} = \frac{\text{sensitivity} \times \text{specificity}}{(1 - \text{sensitivity}) \times (1 - \text{specificity})}$$