**ECE511/PSY511 PSYCHOPHYSICS**
A Joint Offering by the School of Electrical and Computer Engineering
And the Department of Psychological Sciences
Purdue University
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HW #4
Topic: Signal Detection Theory, ROC, Rating Experiment

(1)   Given the figure below:

   a. Shade and label the following areas: hit rate (H), false alarm rate (FA), correct
       rejection rate (CR), miss rate (M), response rate of "Yes, the signal was present",
       and response rate of "No, the signal was not present". Note that X_c is the
       response criterion.
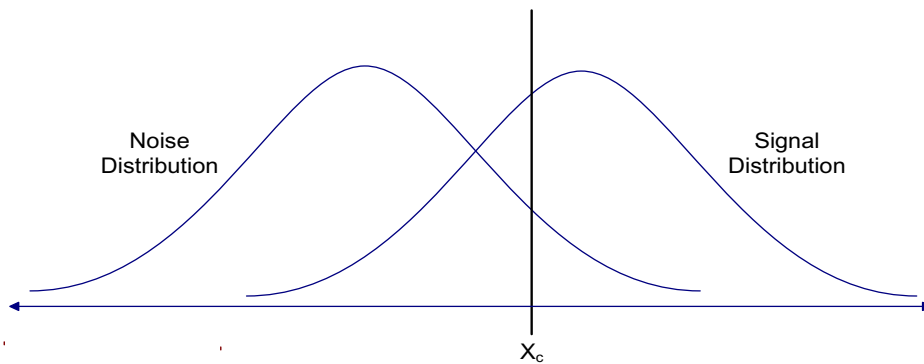
   b. Discuss whether the participant has a liberal (tend to produce false alarms) or
       conservative (tend to miss the signals) response behavior based on the plot shown
       above. Are there ways to modify this behavior?

   c. Let Pc be the probability of a correct response. Determine an expression for Pc in
       terms of the *a priori* stimulus presentation probabilities P(S1) & P(S2), hit rate
       (H), and false alarm rate (F).

(2)   Plot ROCs, on linear (H versus F) coordinates, **and** on z-score coordinates [z(H) versus z(F)], for the data points shown in the table below. The table entries are the H values for the corresponding F and d′ values. Explain how you can use the z-score plots to confirm the values of d′.

F \ d′	0.5	1.0	2.0	3.0
0.01	0.03392	0.09244	0.37222	0.74984
0.02	0.06012	0.14598	0.47850	0.82790
0.10	0.21712	0.38894	0.76358	0.95704
0.25	0.43094	0.62778	0.90756	0.98998
0.50	0.69150	0.84130	0.97720	0.99870

(3)   The following data were collected from three airport baggage examiners whose job is to decide whether to pull a bag for manual examination based on X-ray images. In this context, pulling a bag that contains suspicious objects is considered a hit. In the first experiment, the examiners were asked to be liberal in order to avoid misses. In the second experiment, they were asked to remain neutral (i.e., unbiased). In the last experiment, they were asked to be conservative in order to minimize false alarms.

Participant	Criterion	H rate	FA rate
1	Liberal	0.85	0.65
	Unbiased	0.65	0.30
	Conservative	0.50	0.25
2	Liberal	0.9	0.45
	Unbiased	0.55	0.15
	Conservative	0.25	0.05
3	Liberal	0.80	0.75
	Unbiased	0.65	0.50
	Conservative	0.35	0.20

a. Plot the ROC curve in terms of z(H) and z(F) for each participant and put all the curves on the same graph.

b. Based on the data, did all three participants adopt criteria that were consistent with the instructions? Discuss.

c. Which participant has the highest sensitivity? Justify.