```matlab
echo on
%
% Problem Statement: Consider the log-likelihood detection problem of
 two
% scalar Gaussians with different means u0 and u1, and common variance
% sigma^2. d = abs(u0 - u1) and z = (sigma*eta/d) + d/(2*sigma). The
 false
% alarm probability alpha = Q(z) and the probability of correct
 detection
% PD = Q(z - d) = 0.75. Compute and plot the threshold eta vs alpha.
% Explain the plot and interpret the result.
echo off

% Find Q(x)
z=[-6:0.001:6]; q=erfc(z);
PD = 0.75;
% Find the closest value of z-d for Q(z-d)=0.75
closest_vals = abs(q-PD);
min_idx = find(closest_vals == min(closest_vals));
z_d = z(min_idx);
alpha = [];
eta = [];
% Generate alpha vs eta
for z = 0:0.1:3
    d = z + z_d;
    eta = [eta, z*d - (d^2)/2];
    alpha = [alpha, erfc(z)];
end
figure;
plot(alpha, eta, 'x');
title('\alpha vs. \eta for P_D = 0.75');
ylabel('Threshold (\eta)'); xlabel('Test size (\alpha)');

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% Interpretation: Fixing PD = 0.75 also sets the SNR (and therefore
 the
% separator of the two Gaussians, represented by d). For this fixed
 PD, a
% lower threshold results in a large probability of false alarm alpha.
 I
% plotted alpha all the way up to 1, but in reality we would only
 allow
% alpha to reach 0.5 before simply switching the meaning of our
 hypotheses;
% the maximum error for binary detection should be 0.5. As alpha
 approaches
% zero, the corresponding threshold becomes large at an increasing
 rate. Of
% course, we cannot choose a threshold that results in an alpha of
 zero
% since Gaussian tails are infinite.
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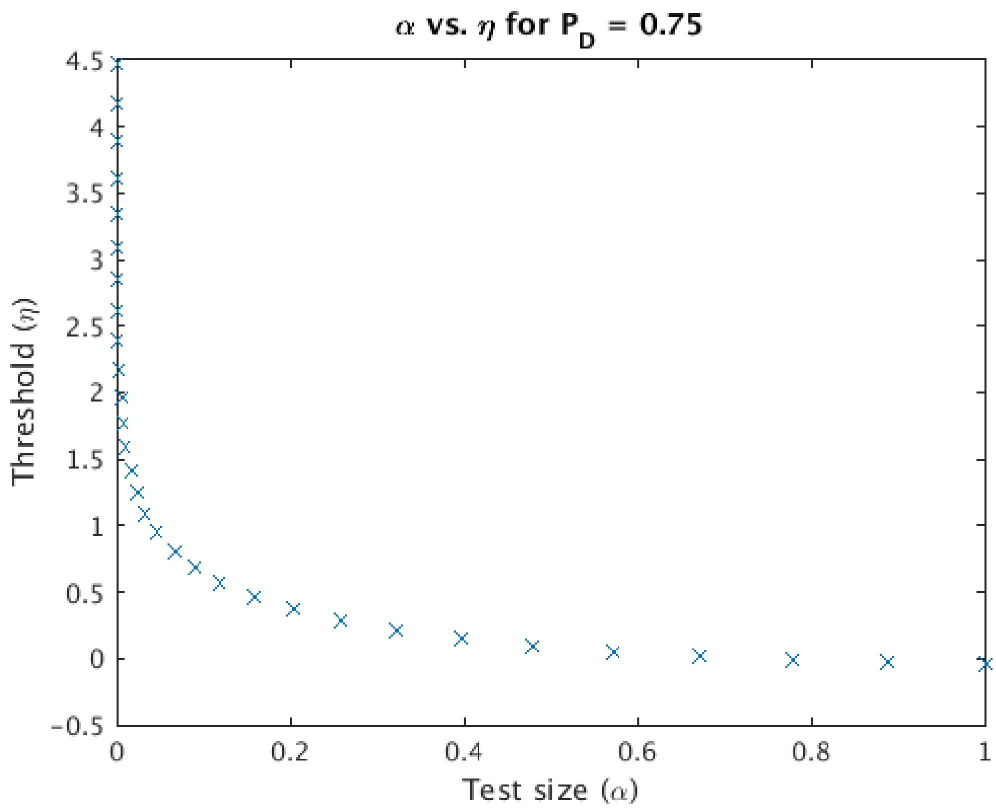

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