ECE 751 Detection and Estimation theory

Homework -3

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Using a random seed to generate the same set of random numbers and make the code reproducible.
As I had A= 16, I = 256 and U =1024, and I have 4 A's and 1 I and 1 U, my total is 1344.

My no. of trials (N) is 1000, which means that I have 1000 random samples generated from the normal distribution. Taking sigma constant from deflection ratios, I have my mu values. Since, for H1, m added to the gaussian noise just shifts the mean of the pdf.

I take 2 loops, one iterates over my thresholds and the other over my deflection values. I have equally spaced threshold values using logspace.
After initializing my arrays of Pd (probability of detection) and Pf (probability of false alarm) for both simulation and theoretical values. I generate my N random numbers. And my r_H0 is n and r_H1 is m +n i.e signal + noise which is my shifted mean gaussian pdf.

If my sample from r_H1 lies above the threshold value, we classify it as a false alarm. Taking the sum/ N i.e the mean of the values we plot the graph. Similarly, if my samples from r_H0 lie above the threshold, we classify it as detection of probability. The theoretical ROC curve for Pd and Pf can be plotted using 1 - normcdf. Since the values range from -infinity to the threshold value. Then we simply plot the ROC curves. Thus, we can see that the simulation and theoretical curves are similar.

```
seed = 1344;
rng(seed,'twister');
clc;
clear;
close all;

% no. of trials for monte carlo simulation
N = 1000;
sigma =1;
% mu/sigma values for d values
ms = [0.5, 1, 2];
% different thresholds in logspace
thresholds = logspace(-5,5,50);
% Initialize ROC curve arrays
% simulation
Pd = zeros(length(ms), length(thresholds));
Pf = zeros(length(ms), length(thresholds));
% theoretical
tPf = zeros(length(ms), length(thresholds));
tPd = zeros(length(ms), length(thresholds));
% Loop over deflection ratios
for i = 1:length(ms)
   m = ms(i); % Current mu/sigma value

   % Generate N noise samples
   n = normrnd(0, sigma, N, 1);

   % Calculate r values for H0 and H1
   r_H0 = n;
   r_H1 = m + n;   %shift the mean for H1

   % Loop over thresholds
   for j = 1:length(thresholds)
       threshold = thresholds(j);
       Pd(i, j) = mean(r_H1 > threshold);
       Pf(i, j) = mean(r_H0 > threshold);
       tPf(i, j)=1-normcdf(threshold,0,sigma);
       tPd(i, j)=1-normcdf(threshold,m,sigma);
   end
end

% Plot ROC curves
figure;
hold on;
for i = 1:length(ms)
   plot(Pf(i, :), Pd(i, :),'--','LineWidth',2);
   plot(tPf(i, :), tPd(i, :),'LineWidth',2);
end
xlabel('Pf');
```

```
ylabel('Pd');
legend('Theoretical ROC1,d=0.5','Simulation ROC1,d=0.5','Theoretical
ROC2,d=1','Simulation ROC2,d=1','Theoretical ROC3,d=2','Simulation ROC3,d=2');
```