EE5342 Detection Theory (Jan-May 2021)
Programming Assignment (20 Marks)

Due on 15 Mar, 6am

Important:

1. Please go through this handout carefully.

2. Copying is strictly prohibited, and will attract penalties, including possibly a fail grade. You are allowed to consult your peers and discuss technically. However, the programs must be your own, and must be written originally by you. You are NOT allowed to share your original script file/code or consult your peer's files.

You can use any programming environment (including Matlab or python) for this assignment.

Submission Instructions:

You can work alone or in teams of size 2. Either both team members should be crediting this course, or both team members must be auditing this course. One submission per team, consisting of the following two files

1. Your script file (Matlab or python) that generates the required output.
2. One figure (as a pdf file) that shows $V(\pi_0)$ versus π_0 for the hypothesis testing problem described below. Your plot must contain horizontal and vertical grid lines.

Please use filenames in the following format: rollnumber1_rollnumber2.m, rollnumber1_rollnumber2.pdf.

Problem Statement:

For this problem the observation $Y = (Y_1, Y_2)$ is a vector of two random variables Y_1, Y_2. The hypotheses are as follows

$$H_0 : Y_1 \sim \mathcal{N}(3,1), Y_2 \sim \mathcal{N}(-1,1)$$
$$H_1 : Y_1, Y_2 \sim P_x,$$

where $\mathcal{N}(\mu, \sigma^2)$ is the Gaussian distribution with mean μ and variance σ^2, and P_x is the distribution with the following probability density function

$$p(x) = \frac{1}{2}\exp(-|x|), \text{ for all } x \in \mathbb{R}.$$

In both the hypotheses, the random variables Y_1 and Y_2 are independent of each other. Use uniform cost, i.e., $C_{00} = C_{11} = 0$, $C_{10} = C_{01} = 1$.

You must use Monte Carlo simulation to find and plot $V(\pi_0)$ versus π_0, for $\pi_0 = 0.1, 0.2, \ldots, 0.9$.

Simulation Details:

- For each value π_0, you must generate 10^6 instances of Y and apply the Bayes decision rule to perform detection. Use the average cost of these 10^6 instances as your estimate for $V(\pi_0)$.
- In each instance, you must randomly generate Y according to either H_0 (with probability π_0) or H_1 (with probability $1 - \pi_0$).
- Ensure that the observation vectors generated for H_0 and H_1 indeed satisfy the probability distributions described above.
- Reference value: at $\pi_0 = 0.25$, $V \approx 0.0755$.