Assignment 6

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Download the python code from

https://github.com/SavaranaDatta/AI1103/tree/main/assignment_6.py

and latex-tikz code from

https://github.com/SavaranaDatta/AI1103/tree/main/assignment_6.tex

1 Problem

Let X_1 and X_2 be a random sample of size two from a distribution with probability density function

$$f_\theta(x) = \theta\left(\frac{1}{\sqrt{2\pi}}\right)e^{-\dfrac{1}{2}x^2} + (1-\theta)\left(\frac{1}{2}\right)e^{-|x|},$$

$-\infty < x < \infty$,
where $\theta \in \left\{0, \dfrac{1}{2}, 1\right\}$. If the observed values of X_1 and X_2 are 0 and 2, respectively, then the maximum likelihood estimate of θ is

1) 0
2) $\frac{1}{2}$
3) 1
4) not unique

2 Solution

Let $x_1, x_2, \ldots, x_n$ be observations from an independent and identically distributed random variables drawn from a Probability Distribution f_0 ,where f_0 is known to be from a family of distributions f that depend on some parameters θ.
The goal of MLE is to maximize the likelihood function:

$$L = f(x_1, x_2, \ldots, x_n \mid \theta) \tag{2.0.1}$$
$$= f(x_1 \mid \theta) \times f(x_2 \mid \theta) \times .... \times f(x_n \mid \theta) \tag{2.0.2}$$

The likelihood function for given data is given by

$$L(\theta \mid X_1 = 0, X_2 = 2) = f_\theta(X_1 = 0) \times f_\theta(X_2 = 2) \tag{2.0.3}$$
$$= \left(\theta\left(\frac{1}{\sqrt{2\pi}} - \frac{1}{2}\right) + \frac{1}{2}\right)^2 e^{-2} \tag{2.0.4}$$

But $\theta \in \left\{0, \dfrac{1}{2}, 1\right\}$

1) At $\theta = 0$ $\quad L(\theta = 0) = \frac{1}{4}e^{-2} = 0.0338$
2) At $\theta = 1$ $\quad L(\theta = 1) = \frac{1}{2\pi}e^{-2} = 0.0215$
3) At $\theta = \frac{1}{2}$ $\quad L(\theta = \frac{1}{2}) = \left(\frac{1}{2\sqrt{2\pi}} + \frac{1}{4}\right)^2 e^{-2} = 0.0273$

$\therefore$ Required option is **1**.