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1. Asymptotic Variance of MLE for Curved Gaussian

(a)

3/3 points (graded)

Let X_1, \dots, X_n be n i.i.d. random variables with distribution $\mathcal{N}(\theta, \theta)$ for some unknown $\theta > 0$.

In the last homework, you have computed the maximum likelihood estimator $\hat{\theta}$ for θ in terms of the sample averages of the linear and quadratic means, i.e. \bar{X}_n and \bar{X}_n^2 , and applied the CLT and delta method to find its asymptotic variance.

In this problem, you will compute the asymptotic variance of $\hat{\theta}$ via the Fisher Information.

Denoting the log likelihood for one sample by $\ell(\theta, x)$, compute the second derivative $\frac{d^2}{d\theta^2} \ell(\theta, x)$.

$$\frac{d^2}{d\theta^2} \ell(\theta, x) = \boxed{1/2/\theta^2 - x^2/\theta^3} \quad \checkmark$$

$\frac{1}{2 \cdot \theta^2} - \frac{x^2}{\theta^3}$

Then, compute the Fisher information $I(\theta)$.

as

$$I(\theta) = -\mathbb{E} \left[\frac{d^2}{d\theta^2} \ell(\theta, X) \right].$$

$$I(\theta) = \boxed{1/2/\theta^2 + 1/\theta} \quad \checkmark$$

$\frac{1}{2 \cdot \theta^2} + \frac{1}{\theta}$

Finally, what does this tell us about the asymptotic variance of $\hat{\theta}$?

$$V(\hat{\theta}) = \boxed{2 \cdot \theta^2 / (1 + 2 \cdot \theta)} \quad \checkmark$$

$\frac{2 \cdot \theta^2}{1 + 2 \cdot \theta}$

STANDARD NOTATION

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barX_n^2

question posted about 7 hours ago by [nbourbon](#)

is it expected that I continue to have a $\text{bar}(X_n)^2$ after the second derivative? .. since the grader is not translating that then I believe it's not expecting it... so I'm wondering how can that term go away?. Unless I need to replace that with it's expectation at that point?

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1 response

DriftingWoods

about 4 hours ago

"Denoting the log likelihood for one sample by ..."

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