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6. Maximum Likelihood Estimation for a Multivariate Standard Normal

Let $\mathbf{X}_1, \dots, \mathbf{X}_n \stackrel{i.i.d.}{\sim} \mathcal{N}(\mu, \mathbf{1})$, where $\mu \in \mathbb{R}^d$ and $\mathbf{1}$ is the $d \times d$ identity matrix. (The \mathbf{X}_i are random vectors.)

Recall the pdf defining the distribution $\mathcal{N}(\mu, \mathbf{1})$ is

$$f(\mathbf{x}) = \frac{1}{(2\pi)^{d/2}} \exp\left(-\frac{1}{2}(\mathbf{x} - \mu)^T \mathbf{1} (\mathbf{x} - \mu)\right)$$

(a)

1/1 point (graded)

What is the likelihood function $L(\mathbf{X}_1, \dots, \mathbf{X}_n, \mu)$ for μ ?

(Enter **(Sigma_i(norm(x_i-mu)^2))** for $\sum_{i=1}^n \|\mathbf{x}_i - \mu\|^2$.)

$L(\mathbf{X}_1, \dots, \mathbf{X}_n, \mu) =$

$$\exp(-(\text{Sigma}_i(\text{norm}(x_i - \mu)^2))/2)/(2\pi)^{(n*d)/2}$$



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You have used 1 of 3 attempts

✓ Correct (1/1 point)

(b)

1/1 point (graded)

Compute the maximum likelihood estimator $\hat{\mu}_{MLE}$ for μ .(Enter **barX_n** for the sample average.) $\hat{\mu}_{MLE} =$

barX_n



Prove to yourself that the result you obtained above indeed maximizes the likelihood function. Is this step necessary?

STANDARD NOTATION

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You have used 1 of 3 attempts

✓ Correct (1/1 point)

(c)

1/1 point (graded)

What is the distribution of $\hat{\mu}_{MLE}$?

☒ $\hat{\mu}_{MLE} \sim \mathcal{N}(\mu, \frac{1}{n} \mathbf{1})$

☐ $\hat{\mu}_{MLE} \sim \mathcal{N}(\mu, \mathbf{1})$

☐ $\hat{\mu}_{MLE} \sim \mathcal{N}(0, \frac{1}{n} \mathbf{1})$

☐ $\hat{\mu}_{MLE} \sim \mathcal{N}(\mu, \frac{1}{\sqrt{n}} \mathbf{1})$



You have used 1 of 2 attempts

✓ Correct (1/1 point)

(d)

1/1 point (graded)

What is the asymptotic variance of $\mathbf{A}\hat{\mu}_{MLE}$? (here, \mathbf{A} is a fixed $m \times d$ matrix)

(If applicable, enter **trans(A)** for the transpose of a matrix \mathbf{A} .)



You have used 1 of 3 attempts

✓ Correct (1/1 point)

(e)

1/1 point (graded)

What is the asymptotic variance of $\|\hat{\mu}_{MLE}\|^2$?(If applicable, enter **norm(v)** for the norm $\|\mathbf{v}\|$ of a vector \mathbf{v} , and **trans(v)** for the transpose \mathbf{v}^T of a vector \mathbf{v} .)

4*norm(mu)^2



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You have used 2 of 3 attempts

✓ Correct (1/1 point)

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Maximum Likelihood Estimation for a Multivariate Standard Normal

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A friendly tip for E

discussion posted 2 days ago by [LuisMasuelli](#)

While there is a method which involves using the $\mu \rightarrow \text{norm}(\mu)$ mapping as an estimator that will do the trick...

...the answer can be explained in TWO apparently different ways, which may confuse but their relationship is stated in the homework 0. Just don't forget to review the linear algebra part of homework 0 for this entire exercise (6).

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