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## 10. MLE for Gaussian Distribution

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Exercises due Apr 19, 2023 08:59 -03 Completed

**MLEs for Gaussian Distribution****Video** [Download video file](#)**Transcripts** [Download SubRip \(.srt\) file](#) [Download Text \(.txt\) file](#)**MLE for the Gaussian Distribution**

1/1 point (graded)

In this problem, we will derive the maximum likelihood estimates for a Gaussian model.

Let  $X$  be a Gaussian random variable in  $d$ -dimensional real space ( $R^d$ ) with mean  $\mu$  and  $\sigma^2$ .

Note that  $\mu, \sigma$  are the parameters of a Gaussian generative model.

Recall from the lecture that, the probability density function for a Gaussian random variable is

$$f_X(x|\mu, \sigma^2) = \frac{1}{(2\pi\sigma^2)^{d/2}} e^{-\|x-\mu\|^2/2\sigma^2}$$

Let  $\mathbf{x} = (x(1), x(2), \dots, x(n))$  be  $n$  i.i.d. random variables following a Gaussian distribution.

$$= -\frac{nd}{2} \log(2\pi\sigma^2) - \frac{1}{2\sigma^2} \sum_{t=1}^n \|x^{(t)}\|^2$$

Compute the partial derivative  $\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \mu}$  using the above derived expression for log-likelihood.

Choose the correct expression from options below.

☐  $\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \mu} = -\frac{1}{\sigma^2} \sum_{t=1}^n (x^{(t)} - \mu)$

☒  $\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \mu} = \frac{1}{\sigma^2} \sum_{t=1}^n (x^{(t)} - \mu)$

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☐  $\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \mu} = -\frac{1}{\mu^2} \sum_{t=1}^n (x^{(t)} - \mu)$



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You have used 1 of 2 attempts

## MLE for the Mean

1/1 point (graded)

Use the answer from the previous problem in order to solve the following equation

$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \mu} = 0$$

Compute expression for  $\hat{\mu}$  that is a solution for the above equation.

Choose the correct expression from options below

☐  $\hat{\mu} = \prod_{t=1}^n x^{(t)}$

## MLE for the Variance I

1/1 point (graded)

Compute the partial derivative  $\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2}$  using the above derived expression for  $\log P(S_n | \mu, \sigma^2)$  restated below as well:

$$\log P(S_n | \mu, \sigma^2) = -\frac{nd}{2} \log(2\pi\sigma^2) - \frac{1}{2\sigma^2} \sum_{t=1}^n \|x^{(t)} - \mu\|^2$$

Choose the correct expression from options below.

☐ 
$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2} = \frac{nd}{2\sigma^2} + \frac{\sum_{t=1}^n \|x^{(t)} - \mu\|^2}{2(\sigma^2)^2}$$

☒ 
$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2} = -\frac{nd}{2\sigma^2} + \frac{\sum_{t=1}^n \|x^{(t)} - \mu\|^2}{2(\sigma^2)^2}$$

☐ 
$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2} = \frac{nd}{2\sigma^2} - \frac{\sum_{t=1}^n \|x^{(t)} - \mu\|^2}{2(\sigma^2)^2}$$

☐ 
$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2} = \frac{\sum_{t=1}^n \|x^{(t)} - \mu\|^2}{2(\sigma^2)^2}$$




You have used 1 of 2 attempts

## MLE for the Variance II

1/1 point (graded)

Using the answer from the previous problem in order to solve the equation

$$\frac{\partial \log P(S_n | \mu, \sigma^2)}{\partial \sigma^2} = 0$$

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Compute expression for  $\sigma^2$  that is a solution for the above equation.

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## Discussion

**Topic:** Unit 4. Unsupervised Learning (2 weeks) :Lecture 15. Generative Models / 10.  
MLE for Gaussian Distribution

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