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Parameter Estimation Assignment

Q1. normal distribution

given mean $= \theta_1$

variance $= \theta_2$

$$PDF = f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \cdot e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$L = \prod_{i=1} \frac{1}{\sqrt{2\pi\sigma^2}} \cdot e^{-\frac{(x_i-\mu)^2}{2\sigma^2}}$$

$$= \left(\frac{1}{2\pi\sigma^2}\right)^n \cdot e^{-\frac{1}{2}\sum_{i=1}^{n}\left(\frac{x_i-\mu}{\sigma}\right)^2}$$

take ln

$$\ln(L) = n \cdot \ln\left(\frac{1}{\sqrt{2\pi\sigma^2}}\right) + \ln\left(e^{-\frac{1}{2\sigma^2}(x_i-\mu)^2}\right)$$

$$= n(\ln(1) - \ln(\sqrt{2\pi\sigma^2}) - \frac{1}{2\sigma^2}\sum(x_i-\mu)^2$$

$$= -n \ln(\sqrt{2\pi\sigma^2}) - \frac{1}{2\sigma^2}\sum(x_i-\mu)^2$$

For μ

$$\frac{\partial \ln(L)}{\partial \mu} = 0 \Rightarrow \frac{-1}{2\sigma^2}\sum 2(x_i-\mu)(-1)$$

$$= \frac{1}{\sigma^2}\sum(x_i-\mu) = 0$$

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$\mu = \frac{\Sigma(x_i)}{n} = \bar{x} = \text{Sample mean}$

For σ^2

$\frac{\partial \ln(L)}{\partial \sigma^2} = 0$

$\Rightarrow \frac{-n}{2} \times \frac{1}{2\pi\sigma^2} \times 2\pi + \frac{1}{2\sigma^4} \Sigma(x_i - \mu)^2 = 0$

$\left(\sigma^2 = \sum_{i=1}^{n} \frac{(x_i - \mu)^2}{n}\right)$

Q2. $\text{Pdf} = {}^mC_{x_i}\, \theta^{x_i}(1-\theta)^{m-x_i}$

$L = \prod_{i=1}^{n} {}^mC_{x_i}\, \theta^{x_i}(1-\theta)^{m-x_i}$

$\ln(L) = \sum_{i=1}^{n} \left(\ln({}^mC_{x_i}) + x_i \ln\theta + ((m-x_i)\ln(1-\theta))\right)$

$\sum_{i=1}^{n} \left(\frac{x_i}{\theta} - \frac{(m-x_i)}{1-\theta}\right) = 0$

$\frac{\Sigma x_i}{\theta} - \frac{n \cdot m - \Sigma x_i}{1-\theta} = 0$

$\frac{\Sigma x_i}{\theta} = \frac{n \cdot m - \Sigma x_i}{1-\theta}$

$\theta = \frac{\Sigma x_i}{n \cdot m}$