

## ST102 Exercise 15

In this exercise you will practice aspects of asymptotic distributions and interval estimation. Question 1 requires you to obtain the asymptotic sampling distribution of the maximum likelihood estimator of the Bernoulli parameter,  $\pi$ . Question 2 uses the sample standard deviation for determining a confidence interval for the population mean. In Question 3, think about using a response (a Bernoulli) distribution. Finally, Question 4 requires you to evaluate whether “ $s$ ” of the sample standard deviation is appropriate to calculate a confidence interval.

Your answers to this problem set should be submitted as a pdf file uploaded to Moodle. Submission is expected during the week of Monday 15 February 2021 as directed by your class teacher. It will be covered by your class teacher in your Microsoft class, which will take place in the week commencing Monday 22 February 2021.

1.\* Let  $\{X_1, X_2, \dots, X_n\}$  be a random sample from a Bernoulli distribution with parameter  $\pi$ , where  $0 < \pi < 1$ . By computing Fisher information, determine the asymptotic distribution of the maximum likelihood estimator of  $\pi$ , which is  $\hat{\pi} = \bar{X}$ .

$$f(x; \pi) = \begin{cases} \pi & \text{for } x = 1 \\ 1 - \pi & \text{for } x = 0 \end{cases}$$

$$f(x; \pi) = \pi^x (1 - \pi)^{1-x}$$

$$\ln(p(x; \pi)) = x \ln \pi + (1 - x) \ln(1 - \pi)$$

$$\frac{d \ln(p(x; \pi))}{d\pi} = \frac{x}{\pi} - \frac{1-x}{1-\pi}$$

$$\frac{d^2 \ln(p(x; \pi))}{d\pi^2} = \frac{-x}{\pi^2} - \frac{1-x}{(1-\pi)^2}$$

$$\begin{aligned} \text{Option 1: } I(\pi) &= - \sum_x (\pi^x (1 - \pi)^{1-x}) \left( \frac{-x}{\pi^2} - \frac{1-x}{(1-\pi)^2} \right) \\ &= \sum_x (\pi^x (1 - \pi)^{1-x}) \left( \frac{x}{\pi^2} + \frac{1-x}{(1-\pi)^2} \right) \\ &= \frac{1}{\pi^2} \sum_x x f(x; \pi) + \frac{1}{(1-\pi)^2} \left( \sum_x f(x; \pi) - \sum_x x f(x; \pi) \right) = \frac{1}{\pi} + \frac{1-\pi}{(1-\pi)^2} \\ &= \frac{1}{\pi} + \frac{1}{1-\pi} = \frac{1-\pi}{\pi(1-\pi)} + \frac{\pi}{\pi(1-\pi)} = \frac{1}{\pi(1-\pi)} \end{aligned}$$

$$\begin{aligned} \text{Option 2: } I(\pi) &= - \sum_x (\pi^x (1 - \pi)^{1-x}) \left( \frac{-x}{\pi^2} - \frac{1-x}{(1-\pi)^2} \right) \\ &= \sum_x (\pi^x (1 - \pi)^{1-x}) \left( \frac{x}{\pi^2} + \frac{1-x}{(1-\pi)^2} \right) = E \left( \frac{x}{\pi^2} + \frac{1-x}{(1-\pi)^2} \right) \\ &= \frac{\pi}{\pi^2} + \frac{1-\pi}{(1-\pi)^2} = \frac{1}{\pi(1-\pi)} \end{aligned}$$

$\hat{\pi} \sim N \left( \pi, \frac{\pi(1-\pi)}{n} \right)$  is the asymptotic distribution of the MLE of  $\pi$  ( $\hat{\pi}$ ).

# Elementary Statistical Theory For Behavior Scientists

**DJ Losen**



## **Elementary Statistical Theory For Behavior Scientists:**

## **Elementary Statistical Theory For Behavior Scientists** Book Review: Unveiling the Power of Words

In a world driven by information and connectivity, the ability of words has become more evident than ever. They have the capability to inspire, provoke, and ignite change. Such could be the essence of the book **Elementary Statistical Theory For Behavior Scientists**, a literary masterpiece that delves deep to the significance of words and their impact on our lives. Published by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we will explore the book's key themes, examine its writing style, and analyze its overall effect on readers.

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