1. Let $X_1, ..., X_n \overset{iid}{\sim} U(\theta, \theta + 1)$. Show that the minimal sufficient statistic $(X_1, X_n)$ observed in the class is not complete.

2. Let $X_1, ..., X_n \overset{iid}{\sim} N(\theta, a\theta^2)$ where $a$ is a known constant and $\theta > 0$. Show that the statistic $(\bar{X}, S^2)$ is a sufficient statistic for $\theta$, but the family of distributions is not complete.

3. Let $X$ takes values 0, 1, 2 with probabilities $p, 3p, 4p$. Determine if the family of distributions of $X$ is complete.

4. Let $X_1, ..., X_n$ be a random sample from the pdf $f_\mu(x) = e^{-(x-\mu)}, -\infty < \mu < x < \infty$. Show that $X_{(1)}$ and $S^2$ are independent.

5. Let $X_1, ...X_n \overset{iid}{\sim} Ber(p)$, and define the function $h(p) = P_p(\sum_{i=1}^n X_i > X_{n+1})$, the probability that the sum of first $n$ observations exceeds $(n + 1)$ th observation.

(a) Show that

$$T(X_1, ..., X_{n+1}) = \begin{cases} 1 & \text{if } \sum_{i=1}^n X_i > X_{n+1} \\ 0 & \text{o.w.} \end{cases}$$

is an unbiased estimator of $h(p)$.

(b) Find the best unbiased estimator for $h(p)$. 

1
6. \(X_1, ..., X_n \overset{iid}{\sim} \text{Gamma}(\alpha, \beta)\), with \(\alpha\) known. Find the best unbiased estimator of \(1/\beta\).

7. Suppose that \(X_1, ..., X_n \overset{iid}{\sim} \text{Ber}(p)\).

   (a) Show that variance of \(\bar{X}\) attains Cramer-Rao lower bound.

   (b) Find the best unbiased estimator of \(p^8\) when \(\sum_{i=1}^n X_i > 8\).

8. \(X_1, ..., X_n\) be a random sample from a population with p.d.f. \(f_\theta(x) = \frac{1}{2\theta}\) for \(-\theta < x < \theta\), \(\theta > 0\). Find the best unbiased estimator of \(\theta\).