# Efficient Estimators - Quiz

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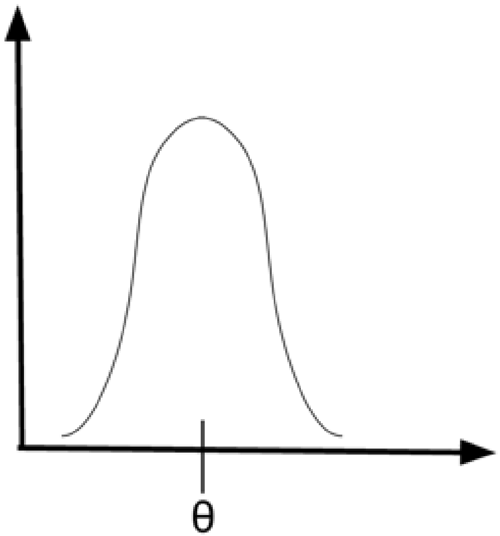
## Question 1

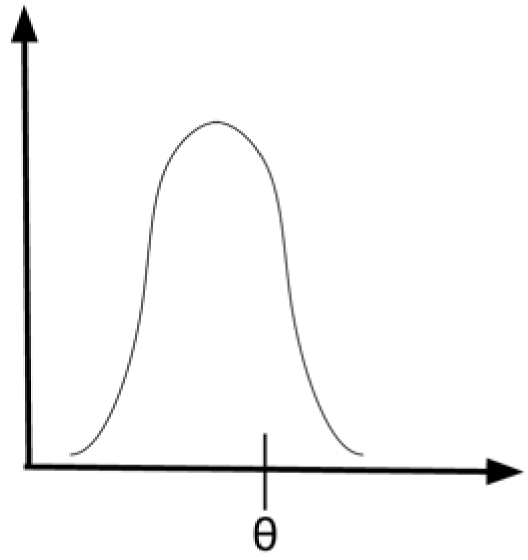
1.0/1.0 point (graded)

Assuming that the scale of these axes is consistent, select the unbiased estimator $\hat{\theta}$ that is **most efficient**. Recall that we have only defined efficiency for unbiased estimators. These graphs show PDFs of $\hat{\theta}$.

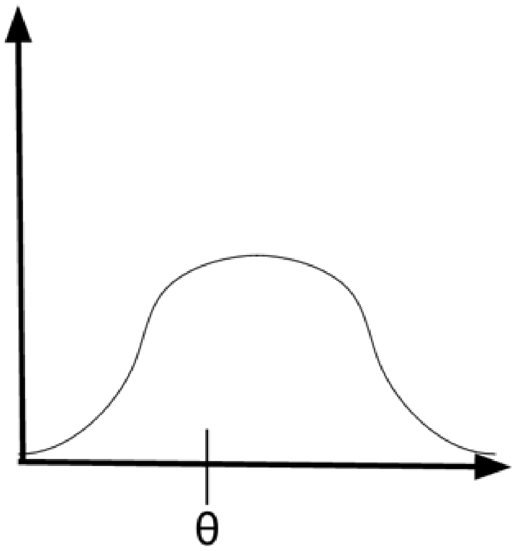
a.



b.




c.



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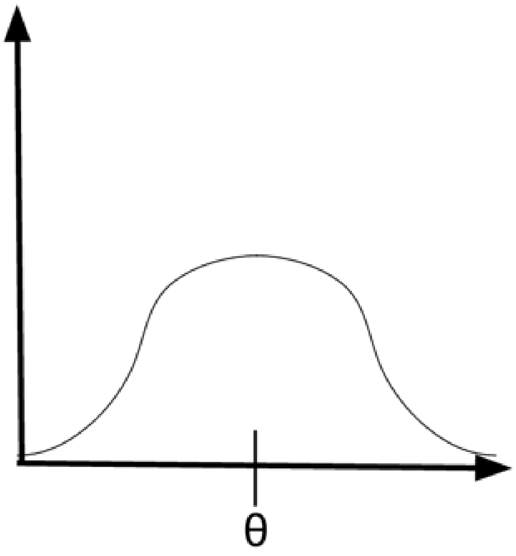
d.




**Explanation**

The estimators that are unbiased are (a) and (d). Of the two, (a) is more tightly distributed and therefore more efficient.

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## Question 2

1.0/1.0 point (graded)

How might we choose an estimator that gives us the best trade off between bias and efficiency?

- a. Maximize the mean squared error.
- b. Minimize the mean squared error. ✔
- c. Maximize the median squared error.
- d. Minimize the median squared error.

**Explanation**

The mean squared error $MSE[\hat{\theta}] = \text{Var}(\hat{\theta}) + (E[\hat{\theta}] - \theta)^2$ can be thought of as the sum of the estimator's variance and the square of the estimator's bias. In order to pick an estimator that has a low variance and bias, we want to minimize this sum.

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## Question 3

1.0/1.0 point (graded)

Which of the following is true about consistent estimators? (Select all that apply.)

- a. They are always unbiased.
- b. $\lim_{n\to\infty} P(|\theta - \hat{\theta}| < \delta) = 0$

- [x] c. $\lim_{n\to\infty} P(|\theta - \hat{\theta}| < \delta) = 1$
- [x] d. The distribution of the estimator collapses to a single point as $n$ goes to infinity.

✔

**Explanation**
The definition of a consistent estimator is given by (c). As $n$ goes to infinity, the distribution becomes more and more concentrated, collapsing to a single point. (a) is false because (c) could be true even if the estimator is biased.

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## Question 4

1.0/1.0 point (graded)
Which of the following is true about estimating the parameter $\theta$ of a $U[0, \theta]$ distribution?

- ( ) a. Estimating $\theta$ by doubling the sample mean is both more biased and more efficient than estimating $\theta$ using the $n^{th}$ order statistic.
- (•) b. Estimating $\theta$ by doubling the sample mean results in an unbiased estimator, but this method is less efficient than estimating $\theta$ using the $n^{th}$ order statistic. ✔

c. Estimating $\theta$ by doubling the sample mean results in a biased estimator, but we might still use this method because it is more efficient than estimating $\theta$ using the $n^{th}$ order statistic.

d. Estimating $\theta$ by doubling the sample mean results in a unbiased estimator that is more efficient than estimating $\theta$ using the $n^{th}$ order statistic.

**Explanation**

As we saw in the first lecture segment, doubling the sample mean is an unbiased estimator of $\theta$ in a $U[0,\theta]$ distribution. This rules out (a) and (c). In this lecture segment, we learnt that the $n^{th}$ order statistic is more tightly distributed (i.e. more efficient) than the sample mean as an estimator. Therefore (b) is correct.

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## Discussion

**Topic:** Module 7 / Efficient Estimators - Quiz

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