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### Lecture 4: Parametric Estimation

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## 4. Variance of Estimators

### Variance of Estimators

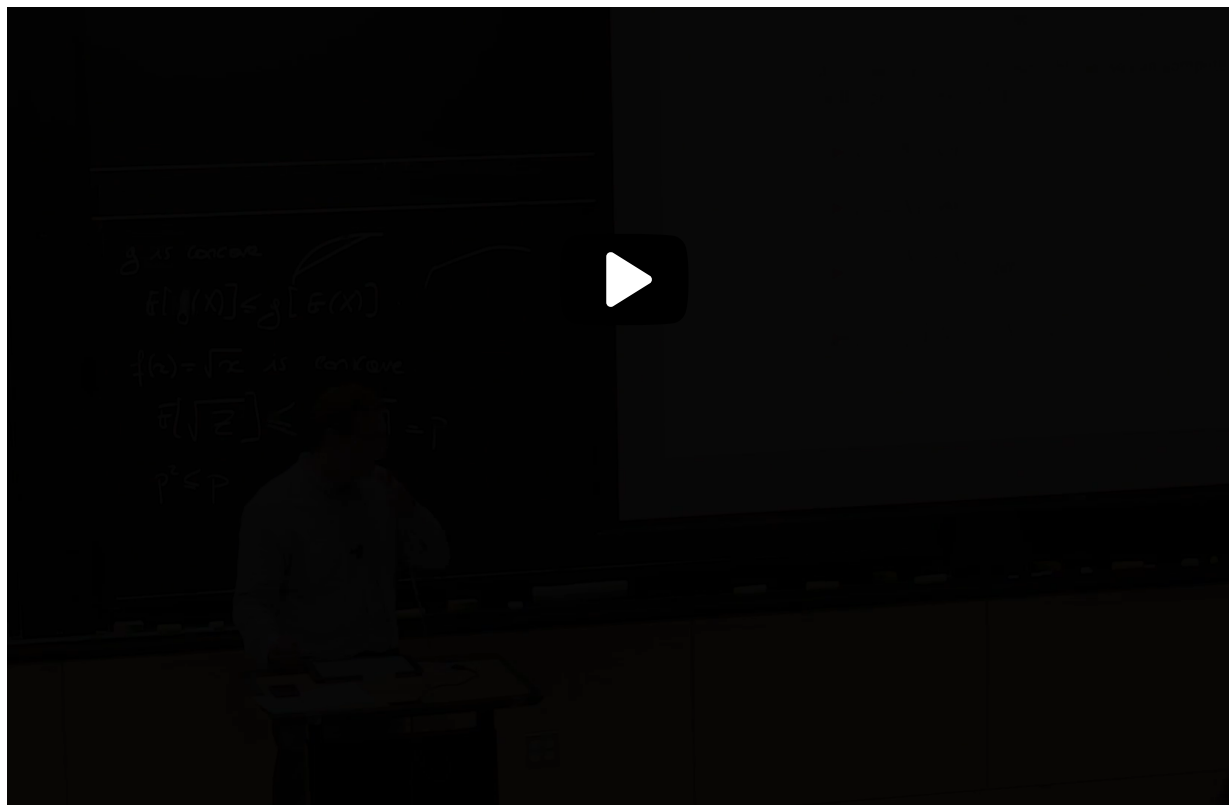
less than one half

or larger than one half.

So it might be if  $p$  is larger than  $1/2$ ,  
this one has less variance.

If  $p$  is smaller than  $1/2$ , this one has less  
variance.

Keep this picture in mind.  $p$  1 minus  $p$



will be a function that we want to know a little bit.

**Any questions about those bias and variance computations?**

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## Variance of the Sample Mean

1/1 point (graded)

Again, let  $X_1, \dots, X_n \stackrel{iid}{\sim} \mathcal{U}([a, a+1])$  where  $a$  is an unknown parameter. In terms of  $n$ , what is the variance of the estimator  $\bar{X}_n$ ?

Var  $\left[ \bar{X}_n \right] =$   ✔ Answer: 1/(12\*n)

**Solution:**

Since  $X_1, \dots, X_n$  are independent, the variance is additive. Hence,

$$\text{Var}(\bar{X}_n) = \frac{1}{n^2} \sum_{i=1}^n \text{Var}(X_i) = \frac{1}{n} \text{Var}(X_1)$$

Note that we used the fact that the  $X_i$ 's are identically distributed. Next,

$$\text{Var}(X_1) = \mathbb{E}[X_1^2] - (\mathbb{E}[X_1])^2 = \int_a^{a+1} x^2 dx - \left(a + \frac{1}{2}\right)^2 = a^2 + a + 1/3 - a^2 - a - 1/4 = 1/12.$$

Hence,

$$\text{Var}(\bar{X}_n) = \frac{1}{n} \text{Var}(X_1) = \frac{1}{12n}.$$

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**i** Answers are displayed within the problem

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☒ Is computation in the end of the segment correct? What is smaller:  $p(1-p)$  vs.  $p^2(1-p^2)$ ?

10 ▼

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