3. Likelihood of an Exponential Distribution

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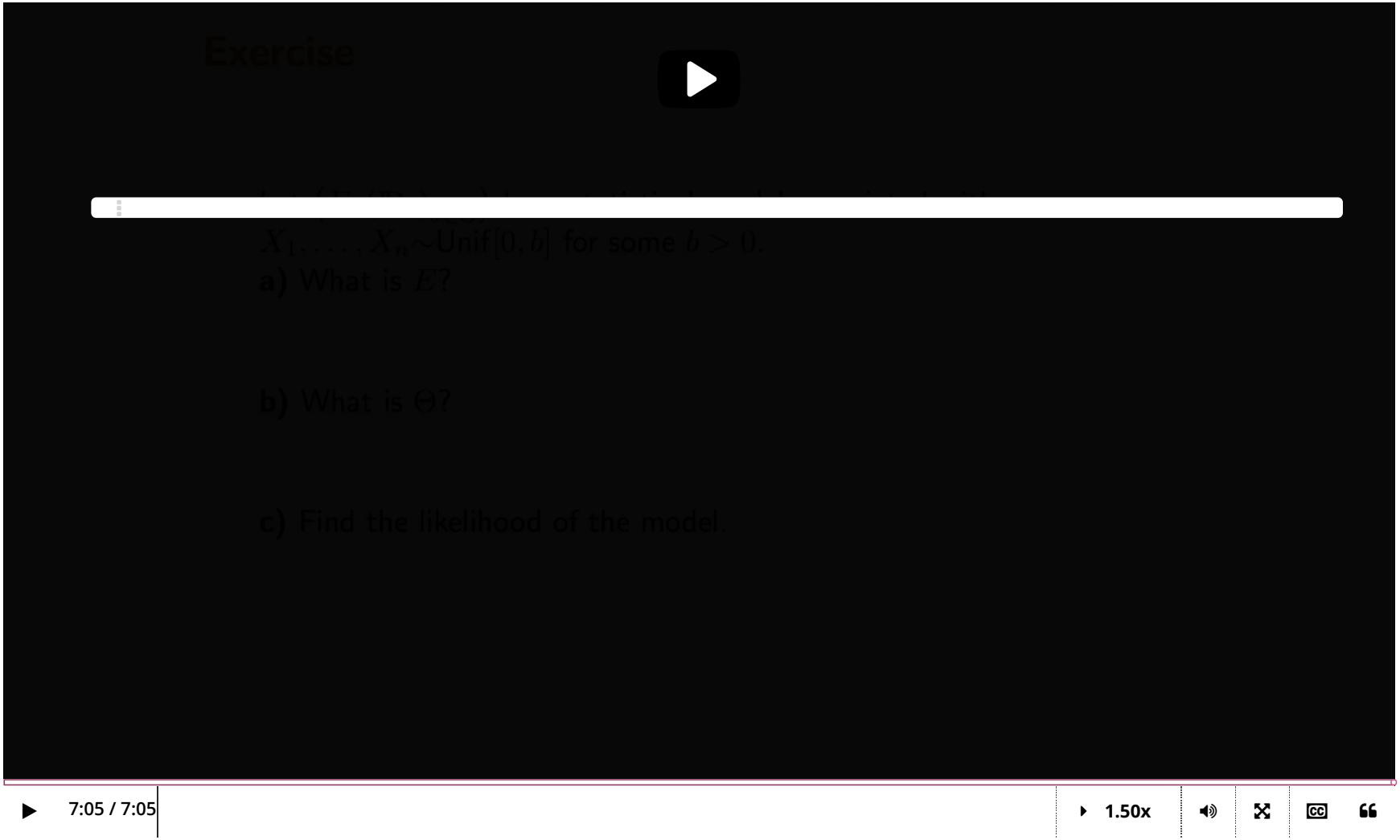

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Product of Indicators

1/1 point (graded)

Rewrite the product $\mathbf{1}(x_1 \leq 5)\,\mathbf{1}(x_2 \leq 5)$ as a single indicator function. That is, find $f(x_1, x_2)$ in the following equation:

$$\mathbf{1}(x_1 \leq 5)\,\mathbf{1}(x_2 \leq 5) \;=\; \mathbf{1}(f(x_1, x_2) \leq 5)\,.$$

(Choose all that apply.)

- [ ] $f(x_1, x_2) = x_1 x_2$
- [ ] $f(x_1, x_2) = \dfrac{x_1 + x_2}{2}$
- [ ] $f(x_1, x_2) = \operatorname{sign}(x_1)\operatorname{sign}(x_2)$
- [x] $f(x_1, x_2) = \max(x_1, x_2)$
- [ ] $f(x_1, x_2) = \min(x_1, x_2)$

✔

Solution:

We need to find $f(x_1, x_2)$ such that

$$f(x_1, x_2) \leq 5 \iff x_1 \leq 5 \text{ and } x_2 \leq 5$$

We go through the choices in order. We leave it to you to find counter examples:

1. $x_1, x_2 \leq 5$ does not imply $x_1 x_2 \leq 5$;
2. $\dfrac{x_1 + x_2}{2} \leq 5$ does not imply $x_1, x_2 \leq 5$;
3. $\operatorname{sign}(x_1)\operatorname{sign}(x_2) \leq 5$ for all $x_1, x_2,$ and in particular does not imply $x_1, x_2 \leq 5$;

4. $\max(x_1, x_2) \leq 5$ if and only if both $x_1, x_2 \leq 5$, so this is a valid choice for $f(x_1, x_2)$;

5. $\min(x_1, x_2) \leq 5$ implies one of x_1, x_2 to be at most 5 but not necessarily both.

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Answers are displayed within the problem

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Not fully following the indicator discussion near end of lecture

discussion posted 5 days ago by **derekgriffing**

Is Professor R. saying it should or not should be included? It's in the printed notes, and I would think the answer is it should be included because the exponential PDF yields 0 when x < 0, which would make a product involving this PDF equal zero.

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1 response

Erocha (Community TA)
4 days ago

If you observe a x that is smaller than zero, it means that the random variable was *not* produced by an exponential distribution (since the probability of a negative number is zero, as you said). This means that your model is not well specified if you use an exponential distribution. The Professor said that here we are only considering well specified models. Of course, if you use an indicator and observer a negative number the likelihood is zero, so you can't get a less likely result. However, this also means that no matter what you do with your parameter λ the likelihood will always be zero, so there is no point in trying to optimize its value. So, you better look for a different model.

Makes sense. Thanks.

posted 4 days ago by **derekgriffing**

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