Exercise: Mean squared error

(4/4 points)

As in an earlier exercise, we assume that the random variables Θ and X are described by a joint PDF which is uniform on the triangular set defined by the constraints $0 \leq x \leq 1$, $0 \leq \theta \leq x$.

a) Find an expression for the conditional mean squared error of the LMS estimator given that $X = x$, valid for $x \in [0, 1]$. Express your answer in terms of x using standard notation .

x^2/12 ✔ **Answer:** x^2/12

b) Find the (unconditional) mean squared error of the LMS estimator.

1/24 ✔ **Answer:** 0.04167

Answer:

a) We saw that the conditional PDF of Θ is uniform on the range $[0, x]$. Hence, the conditional variance is $x^2/12$.

b) This is given by the integral of the conditional variance, weighted by the PDF of X. The PDF of X is found using the formula for going from the joint to the marginal, and is $f_X(x) = 2x$, for $x \in [0, 1]$. Thus, the mean squared error is

$$\int_0^1 \frac{x^2}{12} \cdot 2x \, dx = \frac{1}{6} \int_0^1 x^3 \, dx = \frac{1}{24}.$$

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