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Exercise: LLMS without a constant term

(2/2 points)

Suppose that instead of estimators of the form $aX + e$, we consider estimators of the form $\widehat{\Theta} = aX$ and ask for the value of a that minimizes the mean squared error. Mimic the derivation you have just seen and find the optimal value of a. Your answer should be an algebraic expression involving some of the constants b, c, d, where $b = \mathbf{E}[\Theta^2]$, $c = \mathbf{E}[\Theta X]$, $d = \mathbf{E}[X^2]$.

c/d

✔ **Answer:** c/d

Answer:
The mean squared error is

$$\mathbf{E}\left[(\Theta - aX)^2\right] = \mathbf{E}[\Theta^2] - 2a\mathbf{E}[\Theta X] + a^2\mathbf{E}[X^2].$$

By setting to zero the derivative with respect to a, we find that

$$a = \frac{\mathbf{E}[\Theta X]}{\mathbf{E}[X^2]} = \frac{c}{d}.$$

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