

DS 542 - Spring 2026 - Homework 1

Feel free to write your answers by hand. No need for LaTeX; just make sure it is legible.

1. Equation 2.5 in the textbook (Understanding Deep Learning) gives the equation for linear regression with one input variable using the least-squares loss.

$$\begin{aligned} L[\phi] &= \sum_{i=1}^I (f[x_i, \phi] - y_i)^2 \\ &= \sum_{i=1}^I (\phi_0 + \phi_1 x_i - y_i)^2 \end{aligned}$$

- (a) **(2 points)** Derive the formula for $\partial L / \partial \phi_0$.

- (b) **(2 points)** Derive the formula for $\partial L / \partial \phi_1$.

2. Answer the following questions about the following equation.

$$\begin{bmatrix} 1 & 2 \\ 4 & 3 \end{bmatrix} \begin{bmatrix} 8 & 7 \\ 5 & 6 \end{bmatrix} = \begin{bmatrix} x_{0,0} & x_{0,1} \\ x_{1,0} & x_{1,1} \end{bmatrix}$$

(a) **(2 points)** What is the mathematical operation on the lefthand side of the equation?

(b) **(2 points)** Write out the formula to calculate $x_{1,0}$.

3. **(2 points)** Answer the following questions about ordinary least squares linear regression, where y_i is the target value and \hat{y}_i is the predicted value. What is the equation for the mean residual on the training data?

4. Answer the following questions about basic probability.

(a) **(2 points)** Suppose A and B are events with $P(A) = 0.4$, $P(B) = 0.5$, and $P(A \cap B) = 0.2$. Compute $P(A \mid B)$ and $P(A \cup B)$.

(b) **(2 points)** Let X be a Bernoulli random variable with $P(X = 1) = p$. What are $\mathbb{E}[X]$ and $\text{Var}(X)$?