DS 542 - Fall 2025 - 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.

$$\begin{aligned} L[\varphi] &= \sum_{i=1}^{I} (f[x_i, \varphi] - y_i)^2 \\ &= \sum_{i=1}^{I} (\varphi_0 + \varphi_1 x_i - y_i)^2 \end{aligned}$$

   (a) Derive the formula for $\partial L / \partial \varphi_0$.

   (b) Derive the formula for $\partial L / \partial \varphi_1$.

2. Answer the following questions about the following equation.

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

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

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

3. Answer the following questions about ordinary least squares linear regression.

   (a) What is the mean residual on the training data?

   (b) Why?