

Part-1:

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$$1) \frac{dz}{dx} = a \quad \frac{dz}{dy} = b \quad \therefore \text{vector} = \begin{bmatrix} a \\ b \end{bmatrix}$$

$$2) \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{bmatrix}$$

$$3) f_x(x, y) = \frac{\partial f(x, y)}{\partial x} = 2A(x - x_0)$$

$$f_y(x, y) = \frac{\partial f(x, y)}{\partial y} = 2B(y - y_0)$$

$$4) x^T = \begin{bmatrix} 3 & 1 & 4 \end{bmatrix} \quad [1 \times 3]$$

$$y^T = \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} \quad [3 \times 1]$$

$$B^T = \begin{bmatrix} 3 & 5 & 1 \\ 5 & 2 & 4 \end{bmatrix} \quad [2 \times 3]$$

$$x \cdot x = \begin{bmatrix} 9 \\ 1 \\ 16 \end{bmatrix} \quad [3 \times 1]$$

~~$x \cdot y^T$ is not defined~~

$$x \cdot y^T = \begin{bmatrix} 6 \\ 5 \\ 4 \end{bmatrix} \quad [3 \times 1]$$

$$x \times y = \begin{bmatrix} 6 & 15 & 3 \\ 2 & 5 & 1 \\ 8 & 20 & 4 \end{bmatrix} \quad [3 \times 3]$$

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$[1 \times 1]$

$$y \times x = 6 + 5 + 4 = 15$$

$$A \times x = \begin{bmatrix} 25 \\ 30 \\ 34 \end{bmatrix} \quad [3 \times 1]$$

$$A \times B = \begin{bmatrix} 39 & 38 \\ 19 & 37 \\ 41 & 50 \end{bmatrix} \quad [3 \times 2]$$

$$B. \text{reshape}(1, 6) = [3, 5, 5, 2, 1, 4] \quad (1 \times 6)$$

$$[3 \times 1] \quad [4 \quad 1 \quad 5] = x^T$$

$$[1 \times 3] \quad \begin{bmatrix} 5 \\ 2 \\ 1 \end{bmatrix} = x^T$$

$$[5 \times 3] \quad \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} = B^T$$

$$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = x \cdot x$$

$$\begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} = x^T \cdot x$$

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$$L(m, b) = \sum_{i=1}^N [y_i - (mx_i + b)]^2$$

$$\frac{\partial L}{\partial m} = \sum -2(y_i - mx_i - b)x_i = 0$$

$$\frac{\partial L}{\partial b} = \sum -2(y_i - mx_i - b) = 0$$

$$\therefore m = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2} = \frac{\text{cov}(x, y)}{\text{var}(x)}$$

$$b = \frac{\sum y_i - m \sum x_i}{N} = \bar{y} - m \bar{x}$$

$$\text{where } \bar{x} = \frac{1}{N} \sum_{i=1}^N x_i, \quad \bar{y} = \frac{1}{N} \sum_{i=1}^N y_i$$