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

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

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

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

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

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

$[3 \times 3]$

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

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[1×1]

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

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

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

B.reshape(1, 6) = [3, 5, 5, 2, 1, 4]

(1×6)

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

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

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

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

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

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