

Part-1:

1. $z = f(x, y) = ax + by + c$

$$\Delta f(x, y) = (a, b)$$

2. $z = f(x) = f(x_1, \dots, x_N) = \sum_{i=1}^N a_i(x_i - b_i) + S = a_1x_1 + a_2x_2 + \dots + a_Nx_N + S$

$$\Delta f(x) = (a_1, a_2, \dots, a_N)$$

3. $z = f(x, y) = A(x - x_0)^2 + B(y - y_0)^2 + c$

$$f_x(x, y) = \left(\frac{\partial f(x, y)}{\partial x} \right) = 2Ax + 2Ax_0$$

$$f_y(x, y) = \left(\frac{\partial f(x, y)}{\partial y} \right) = 2By + 2By_0$$

4.

$$x^T = (3, 1, 4) \quad y^T = \begin{pmatrix} 2 \\ 5 \\ 1 \end{pmatrix}$$

$$B^T = \begin{pmatrix} 3 & 5 & 1 \\ 5 & 2 & 4 \end{pmatrix}$$

~~$$x \cdot x = (6 + 1 + 9 = 26)$$~~

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$$x \cdot y^T = 6 + 5 + 4 = 15$$

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

$$A \times x = \begin{pmatrix} 12 + 5 + 8 \\ 9 + 1 + 20 \\ 18 + 4 + 12 \end{pmatrix} = \begin{pmatrix} 25 \\ 30 \\ 34 \end{pmatrix}$$

$$A \times B = \begin{pmatrix} 12 + 25 + 2, 20 + 10 + 8 \\ 9 + 5 + 5, 15 + 2 + 20 \\ 18 + 20 + 3, 30 + 8 + 2 \end{pmatrix}$$

$$B \cdot \text{reshape}(1, 6) = (3, 5, 1, 2, 1, 4)$$

$$= \begin{pmatrix} 39, 38 \\ 19, 37 \\ 41, 50 \end{pmatrix}$$

