

$$1. \nabla f(x, y) = \langle a, b \rangle$$

$$2. \nabla f(x_1, x_2, x_3, \dots, x_N) = \langle a_1, a_2, a_3, a_4, \dots, a_N \rangle$$

$$3. f_x(x, y) = 2x - 2Ax_0$$

$$f_y(x, y) = 2y - 2By_0$$

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

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

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

$$x \cdot x = 26$$

$$x \cdot y^T = 15$$

$$x \times y = (-19 \ 5 \ 13)$$

$$y \times x = (19 \ -5 \ -13)$$

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

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

$$13. \text{reshape}(1, 6) = (3 \ 5 \ 1 \ 5 \ 2 \ 4), \quad [1 \times 6]$$

$$5. \ell(p) = \ell(m, b) = \sum_{i=1}^N (\hat{y}_i - mx_i - b)^2 = \sum_{i=1}^N \hat{y}_i^2 + \sum_{i=1}^N m^2 x_i^2 + \sum_{i=1}^N b^2 - 2 \sum_{i=1}^N \hat{y}_i m x_i - 2 \sum_{i=1}^N \hat{y}_i b + 2 \sum_{i=1}^N m x_i b$$

$$\partial \ell(m, b) / \partial m = 2m \sum_{i=1}^N x_i^2 - 2 \sum_{i=1}^N \hat{y}_i x_i + 2 \sum_{i=1}^N x_i b = 0$$

$$\Rightarrow \sum_{i=1}^N x_i y_i = m \sum_{i=1}^N x_i^2 + b \sum_{i=1}^N x_i$$

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

$$\partial L(m, b) / \partial b = 2b - 2 \sum_{i=1}^N y_i + 2 \sum_{i=1}^N m x_i = 0$$

$$\therefore b = \bar{y} - m \bar{x}$$

$$= \bar{y} - \frac{\text{cov}(x, y)}{\text{var}(x)} \cdot \bar{x}$$