

MIMO

$$f(x, y) = 2e^x + 3y$$

$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \quad y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

$$x = x_1$$

$$f(x_1, y) = 2e^{x_1} + 3y$$

$$\frac{\partial f(x_1, y)}{\partial x_1} = 2e^{x_1}$$

$$\frac{\partial f}{\partial x_2} = \frac{\partial 2e^{x_1}}{\partial x_2} + \frac{\partial 3y}{\partial x_2} = 0$$

similarly

$$\frac{\partial f}{\partial x_3} = 0$$

$$x = x_2$$

$$\frac{\partial f}{\partial x_1} = 0$$

$$\frac{\partial f}{\partial x_2} = 2e^{x_2}$$

$$\frac{\partial f}{\partial x_3} = 0$$

$$\frac{\partial f(\vec{x}, \vec{y})}{\partial \vec{x}} = \begin{bmatrix} \frac{\partial f(x_1, \vec{y})}{\partial x_1} & \frac{\partial f(x_2, \vec{y})}{\partial x_1} & \frac{\partial f(x_3, \vec{y})}{\partial x_1} \\ \frac{\partial f(x_1, \vec{y})}{\partial x_2} & \frac{\partial f(x_2, \vec{y})}{\partial x_2} & \frac{\partial f(x_3, \vec{y})}{\partial x_2} \\ \frac{\partial f(x_1, \vec{y})}{\partial x_3} & \frac{\partial f(x_2, \vec{y})}{\partial x_3} & \frac{\partial f(x_3, \vec{y})}{\partial x_3} \end{bmatrix}$$

$$= \begin{bmatrix} 2e^{x_1} & 0 & 0 \\ 0 & 2e^{x_2} & 0 \\ 0 & 0 & 2e^{x_3} \end{bmatrix}$$

$$\frac{\partial f(\vec{x}, \vec{y})}{\partial \vec{y}} = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

$$\text{if } f(\vec{x}, \vec{y}) = 2e^x + 3y + x_1 + x_2 + x_3 = 2e^x + 3y + \sum x$$

$$\frac{\partial f(\vec{x}, \vec{y})}{\partial \vec{x}} = \begin{bmatrix} 2e^{x_1} + 1 & 1 & 1 \\ 1 & 2e^{x_2} & 1 \\ 1 & 1 & 2e^{x_3} \end{bmatrix}$$