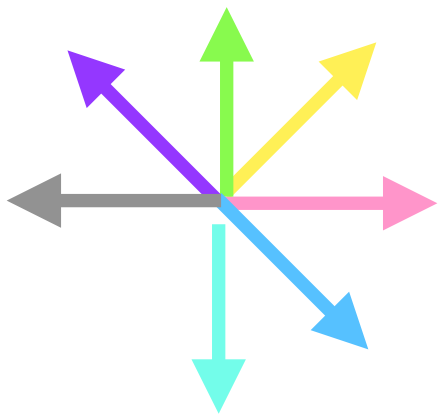


gradient





















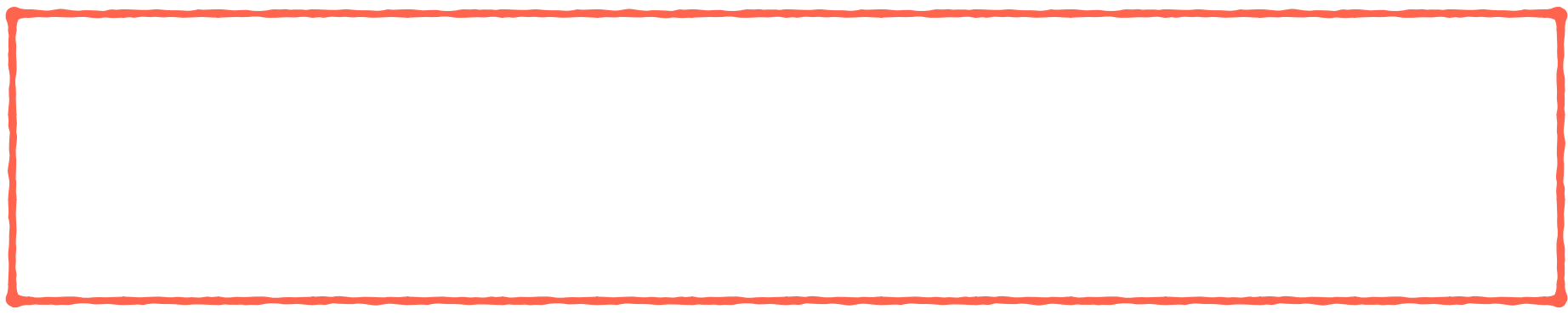








direct | derivatives







# gradient

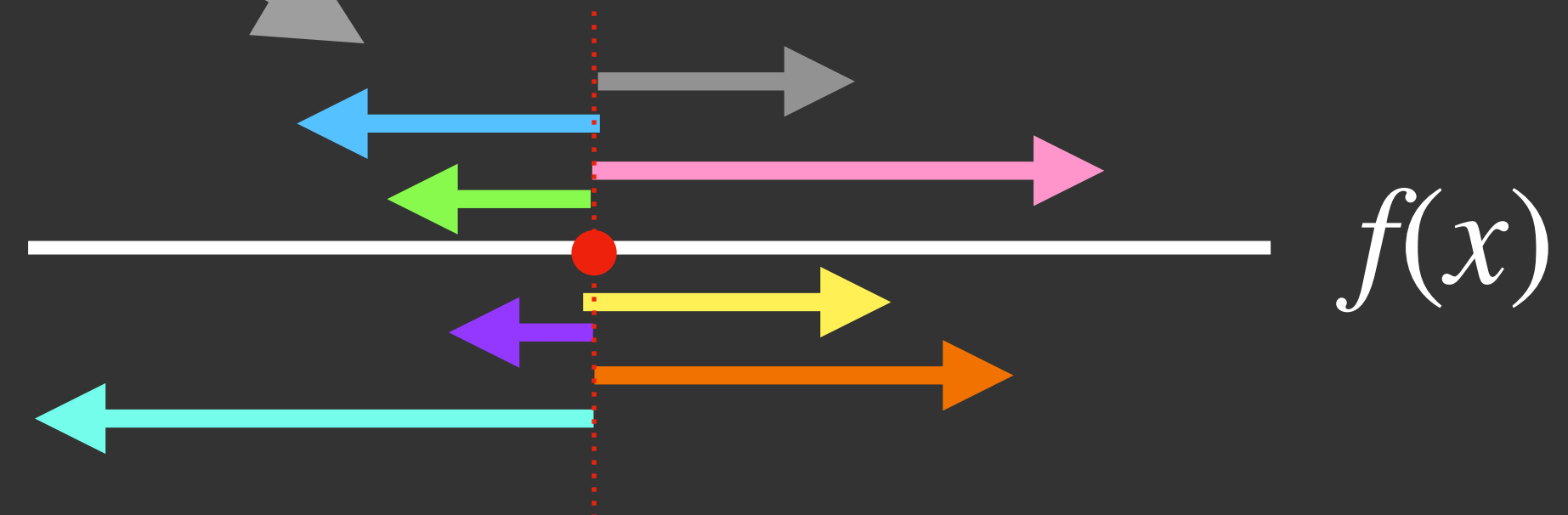
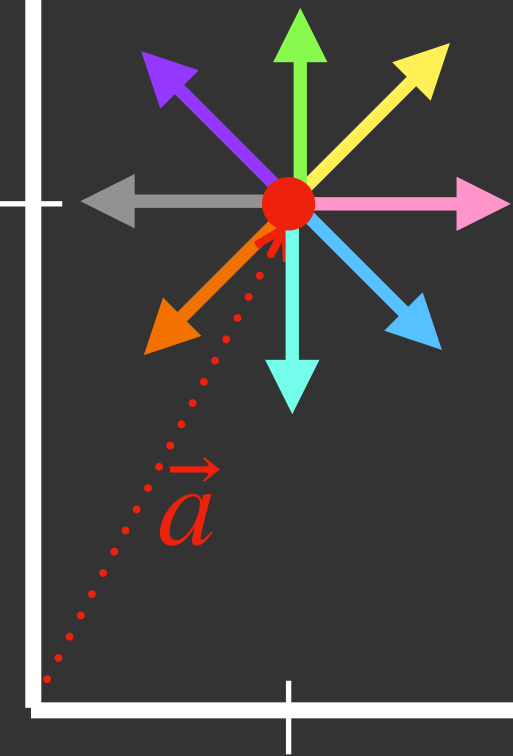
$$f(x, y) = x^2 + y^2 \implies \nabla f = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} = \begin{bmatrix} 2x \\ 2y \end{bmatrix}$$

directional derivatives

$$\nabla_{\vec{v}} f(\vec{a}) = \lim_{h \rightarrow 0} \frac{f(\vec{a} + h \cdot \vec{v}) - f(\vec{a})}{h}$$

not a graphical function!

$$\nabla_{\vec{v}} f = v_1 \frac{\partial f}{\partial x} + v_2 \frac{\partial f}{\partial y} \quad \text{where} \quad \vec{v} = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$



# gradient

## Zero Gradient:

If  $\nabla f = 0$ , the point is a critical point (max, min, or saddle point)

## example

For  $f(x, y) = x^2 + y^2$ , the gradient is:

$$\nabla f = \left( \frac{\partial f}{\partial x}, \frac{\partial f}{\partial y} \right) = (2x, 2y)$$

Find minimum (we see from image):

$$\nabla f = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} = \begin{bmatrix} 2x \\ 2y \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \vec{0}$$

