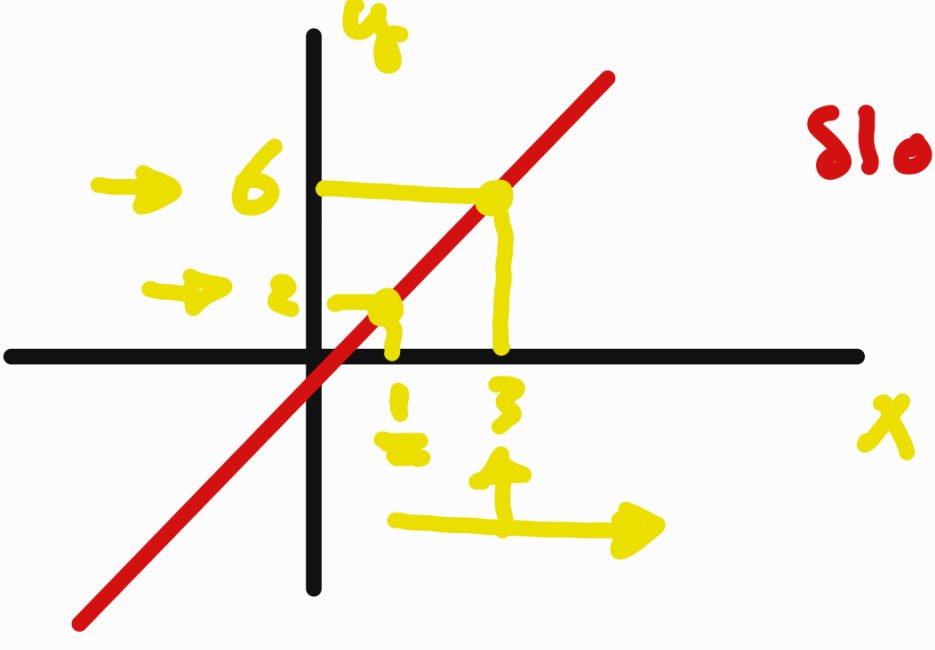
Multivariate Calculus for Data Science

Derivative

Gradient = Differentiation =

Derivative = Slop



Slop:

Positive

Slop: P/N

Rise over Run

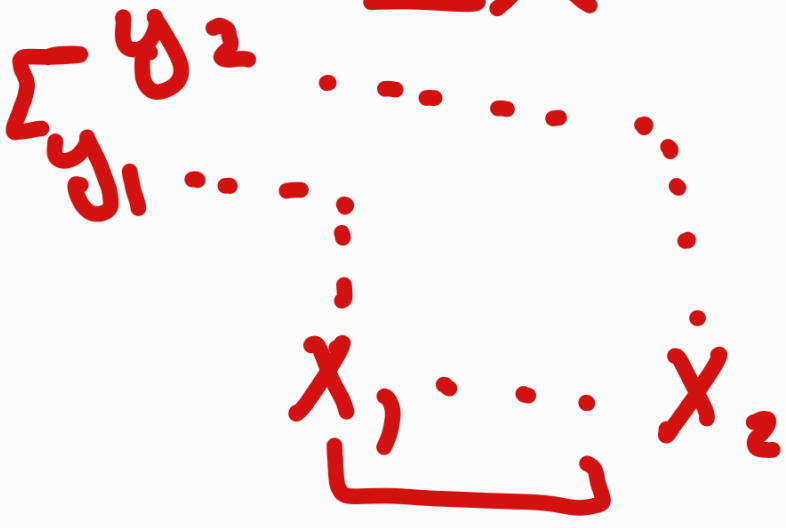
Rise → مقدار التغير y

Run → مقدار التغير x

$$\frac{\Delta y}{\Delta x}$$

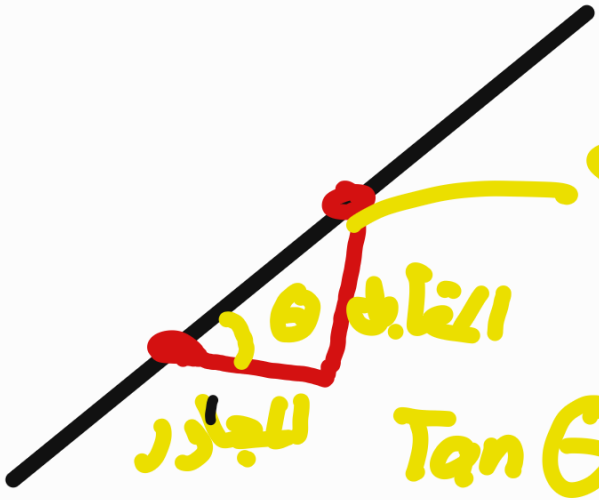
$\Delta y = y_2 - y_1$

$\Delta x = x_2 - x_1$



Gradient $\equiv \frac{\text{Rise}}{\text{Run}} \equiv$ Slope $\equiv \frac{\Delta y}{\Delta x}$

$\equiv$ Tan θ $\equiv$ Derivative $\equiv$ Diff. $\equiv$ التفاضل $\equiv$ الاشتقاق

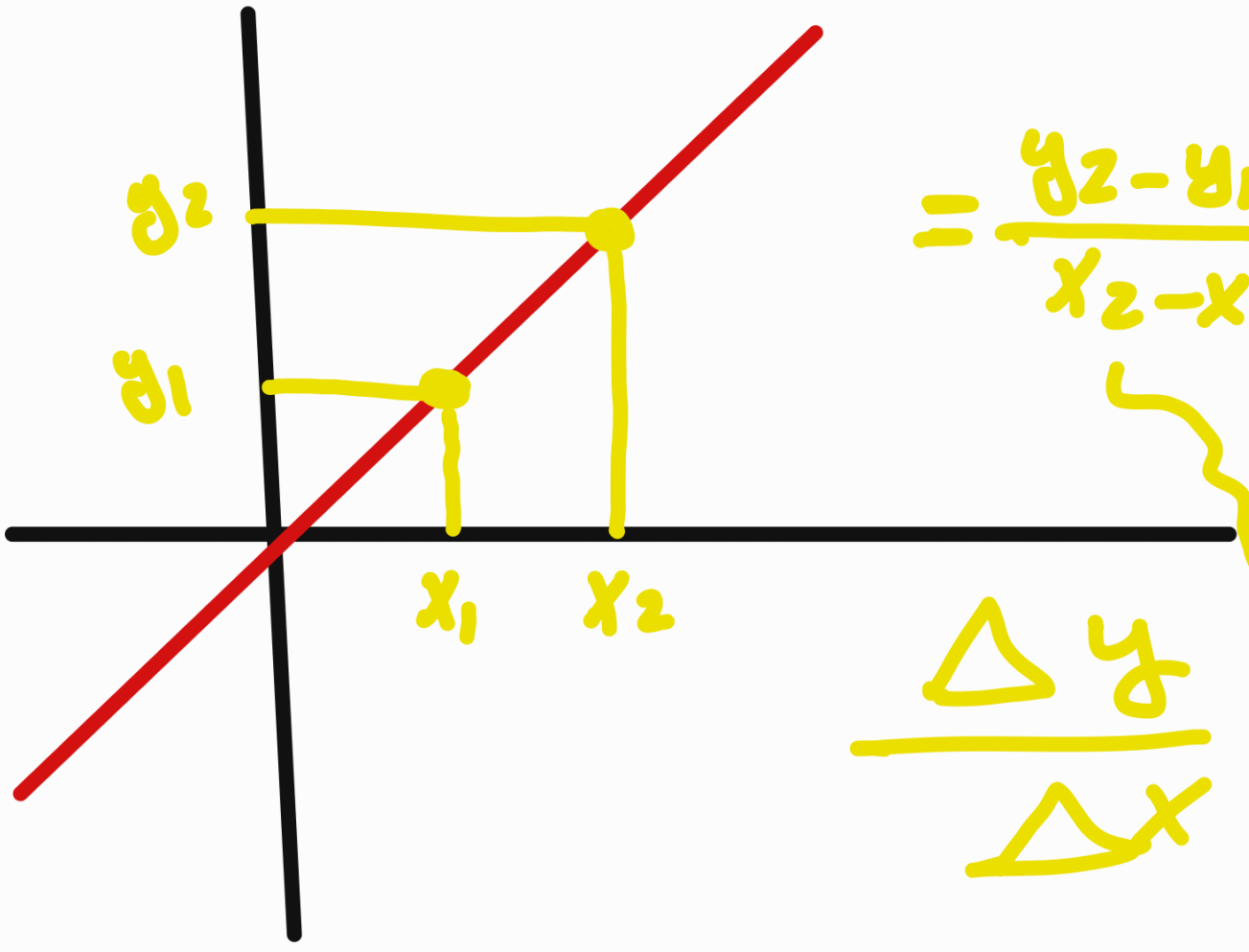


$slop = \frac{\Delta y}{\Delta x}$

$= D = D$

Tan θ

$= 6$

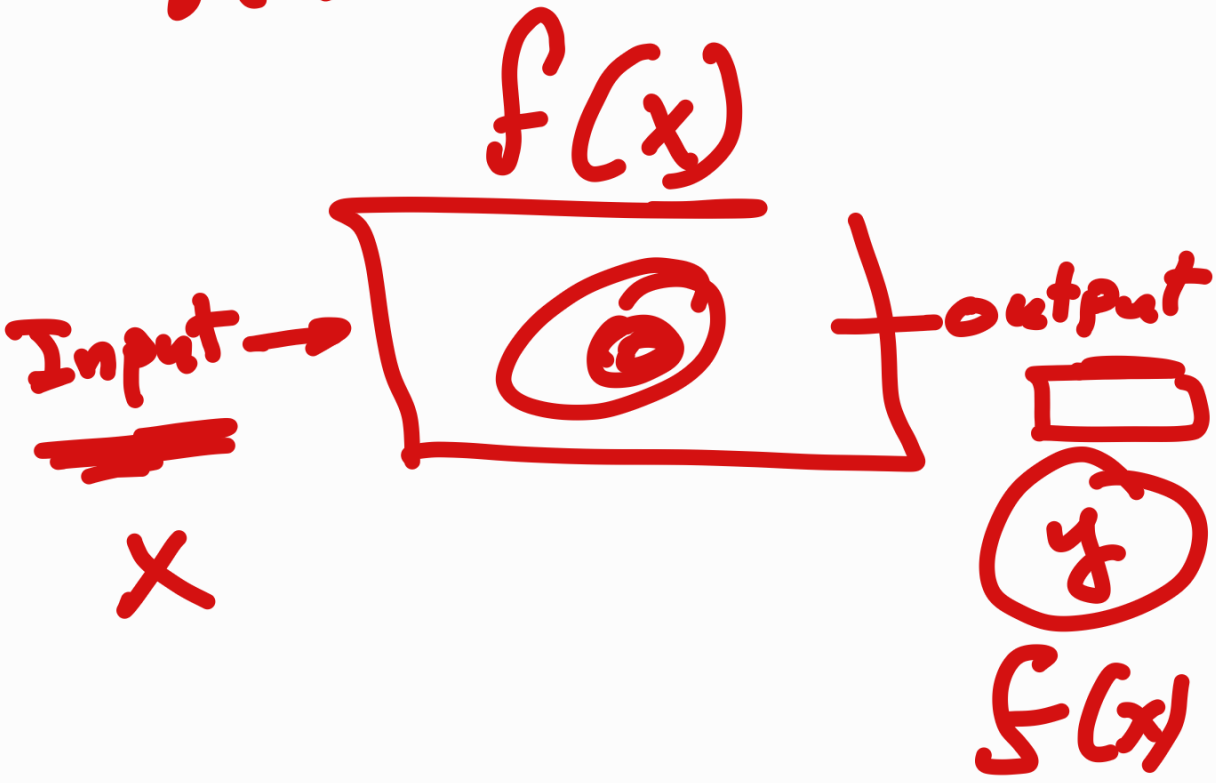


slop

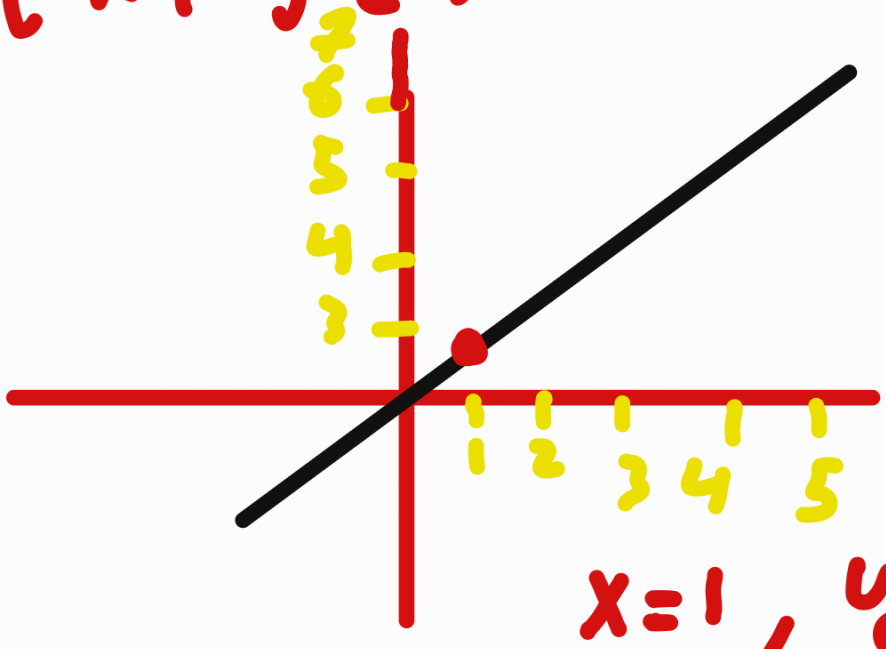
$$= \frac{y_2 - y_1}{x_2 - x_1}$$

$$\frac{\Delta y}{\Delta x}$$

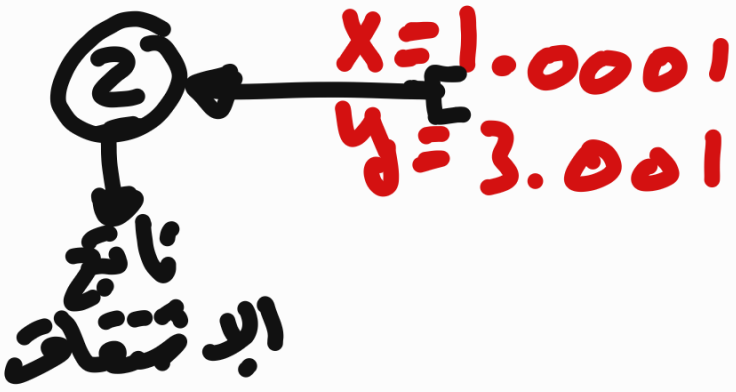
Ex: $f(x) =$



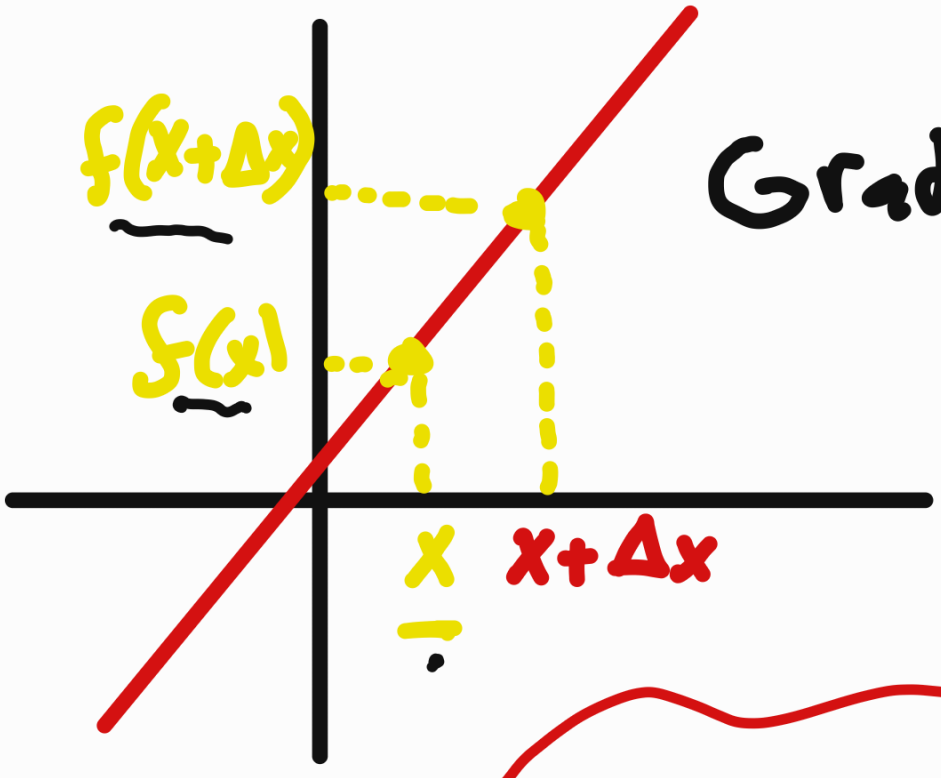
Ex: $f(x) = x + 2$



$x = 1, y = 3$



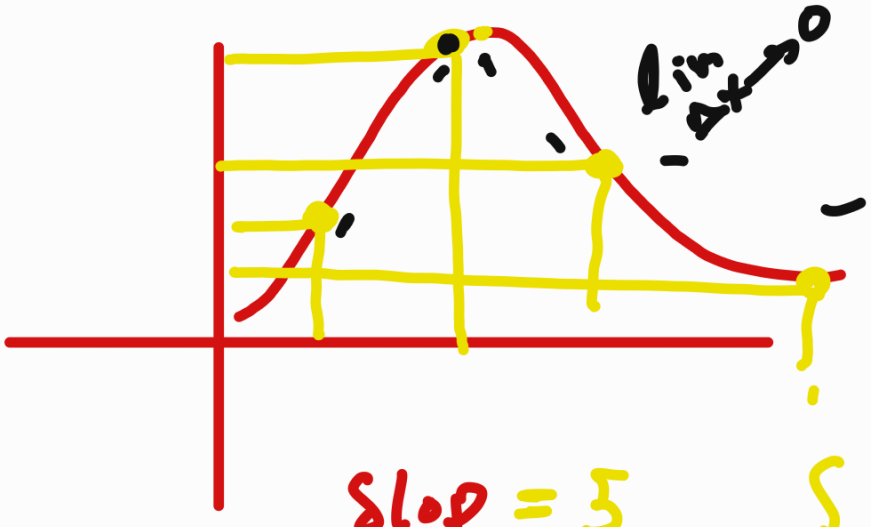
$$*\text{Gradient} = \frac{f(x+\Delta x)-f(x)}{(x+\Delta x)-x}$$



$$\text{Gradiant} = \frac{f(x+\Delta x)-f(x)}{x+\Delta x - x}$$

$\Delta x \to 0$

$$\text{Gradient} = \frac{f(x+\Delta x)-f(x)}{\Delta x}$$

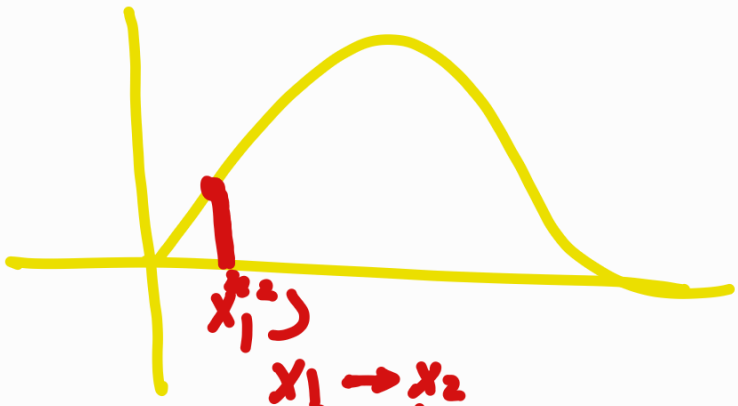


slop = 5

slop ≠ 5

slop 0.5

slop



$\lim_{\Delta x \to 0}$ $\quad x_2 - x_1$

$$F(x)$$

$$f'(x) = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}$$

$$f(x) = 3x + 2$$

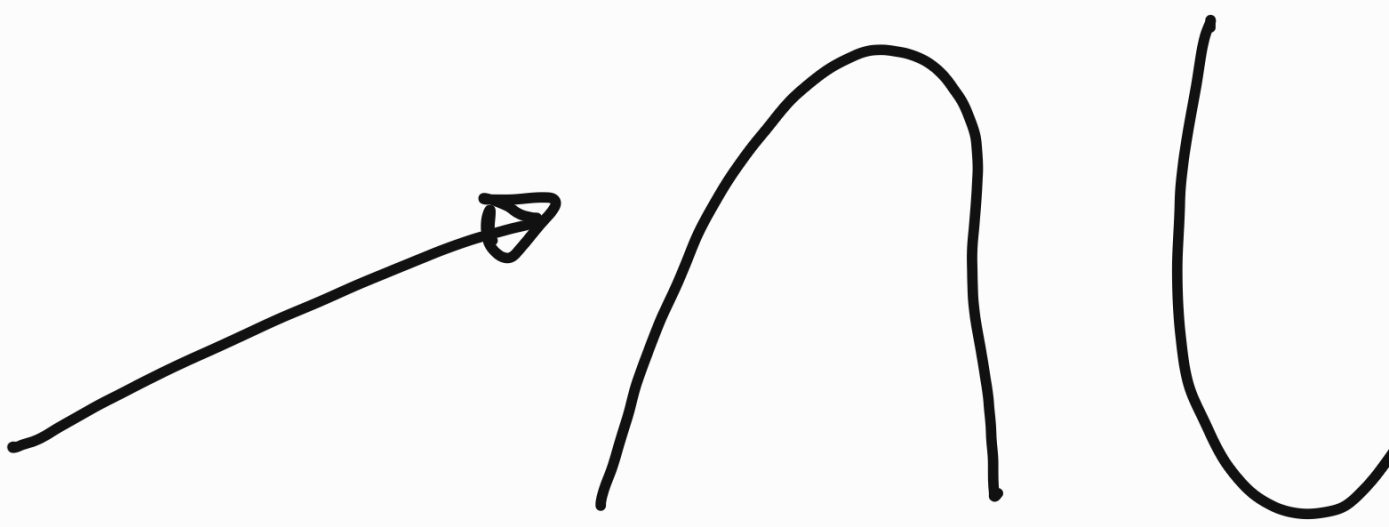
$$f'(x) = \lim_{\Delta x \to 0} \frac{3(x+\Delta x) + 2 - 3x - 2}{\Delta x}$$

$$\frac{3x + 3\Delta x + 2 - 3x - 2}{\Delta x}$$

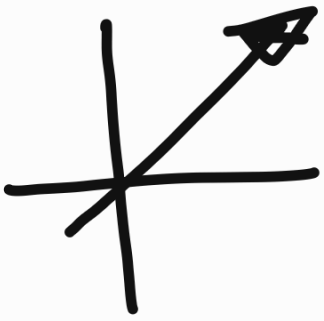
$$\frac{3\Delta x}{\Delta x}$$

$f(x)$

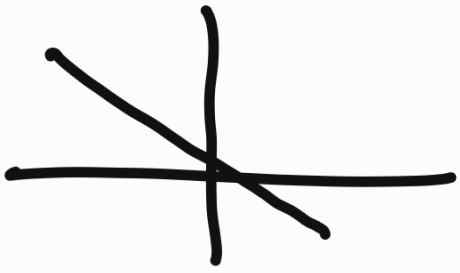
$$f'(x) = \frac{df}{dx}$$



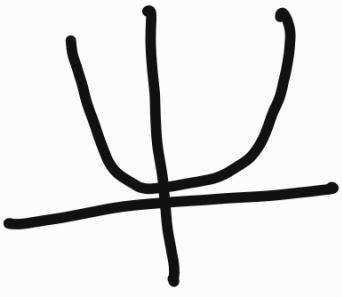
$f(x) = x$



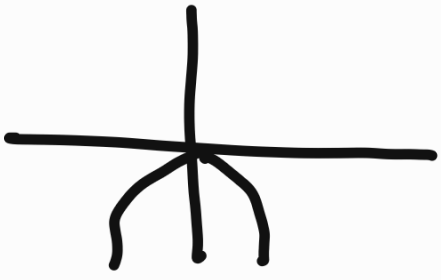
$f(x) = -x$



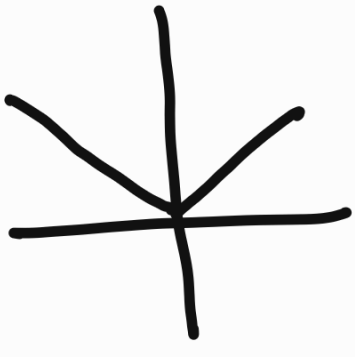
$f(x) = x^2$



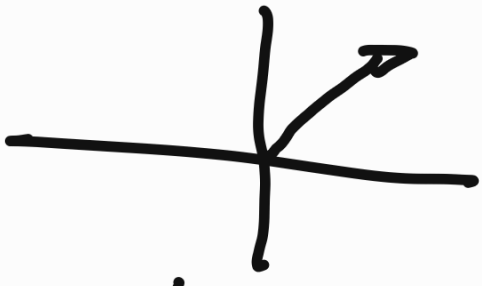
$f(x) = -x^2$



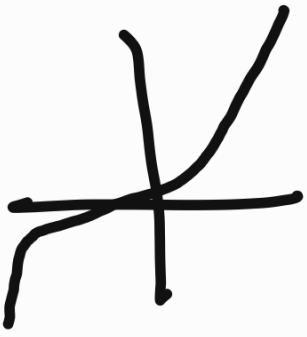
$y = |x|$



$y = \sqrt{x}$



x^3



Chain Rule & Partial Differentiation

***Chain Rule :**

$$f(x) \rightarrow \underset{1}{h}\left(\underset{2}{p}(m)\right)$$

$h(p) = \frac{1}{3}p^2 + p + \frac{1}{5}$

$p(m) = e^m - 1$

$h(m)$

find $\frac{dh}{dm}$

$$\frac{dh}{dp} \cdot \frac{dp}{dm} \rightarrow \frac{dh}{dm}$$

$$\frac{dh}{dm} = \frac{dh}{dp} \times \frac{dp}{dm} =$$

$F(x) = 5x + 3$

$x(g) = g + 2$

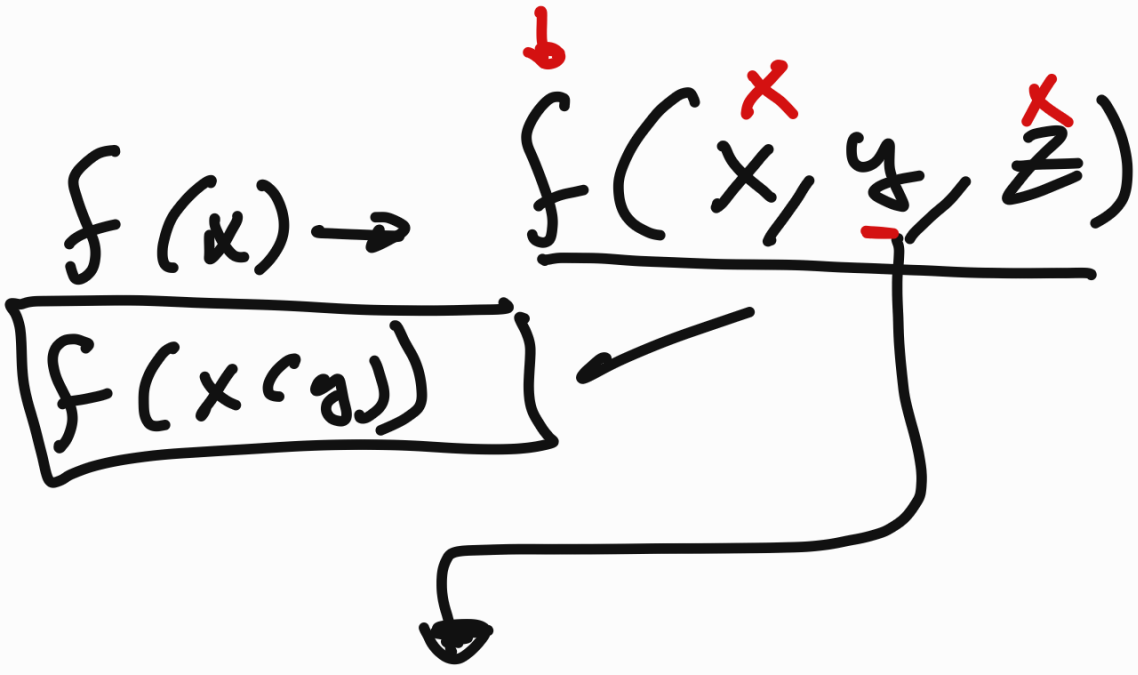
$$\frac{df}{dg} \quad F(x(g))$$

$$\frac{df}{dg} = \frac{df}{dx} \cdot \frac{dx}{dg}$$

$\frac{df}{dx} = 5$

$\frac{dx}{dg} = 1$

$= 5$



$$f(x,y,z) = \sin(x) \cdot e^{yz^2}$$

$$\frac{\partial f}{\partial x} = \cos(x) \cdot e^{yz^2}$$

$$\frac{\partial f}{\partial y} = \sin(x) \cdot e^{yz^2} \cdot z^2$$

$$f(x, y, z) = \sin(x) \cdot e^{yz^2}$$

$$x = t - 1, \quad y = t^2, \quad z = \frac{1}{t}$$

$$\frac{df}{dt}$$

$$f(x(t), y(t), z(t))$$

$$= \_\_\_\_\_$$

$$\frac{df}{dt}$$

$$x(t) = t - 1, \quad y(t) = t^2$$

$$z(t) = \frac{1}{t}$$

$$f(x(t)\ y(t)\ z(t)) =$$

$$\sin(x) \cdot e^{y \cdot z^2}$$

$$\frac{df}{dt} = \frac{\partial f}{\partial x} \cdot \frac{dx}{dt} + \frac{\partial f}{\partial y} \cdot \frac{dy}{dt} + \frac{\partial f}{\partial z} \cdot \frac{dz}{dt}$$