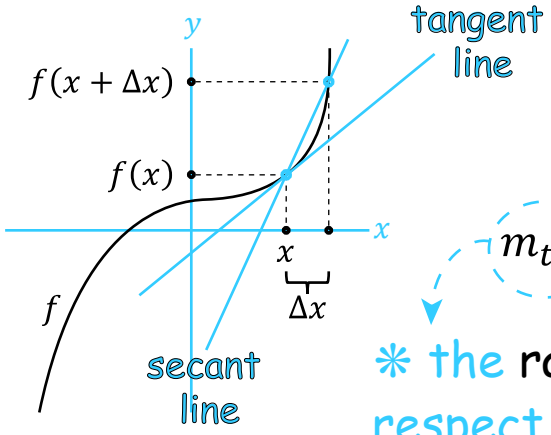
→Lec. 9 ‡ Differentiation

"Calculus is the mathematics of change" *a famous quote*

2 Calculus

* we can find the slope of a tangent line by using the concept of **Limits**



$$m_{sec} = \frac{f(x+\Delta x) - f(x)}{\Delta x} \quad \text{as } \Delta x \to 0$$

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

* the **rate of change** of the function $f(x)$ with respect to x, or the **Derivative** of $f(x)$

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

* other notations *

$\frac{dy}{dx}$ $\quad$ $\frac{d}{dx}[f(x)]$ $\quad$ $\dot{y}$ $\quad$ y' $\quad$ $f'(x)$

* using the above defentition, we can find some **Basic Rules**:-

① Power rule

$$\frac{d}{dx}[x^n] = n \cdot x^{n-1}$$

② Constant rule

$$\frac{d}{dx}[c] = 0$$

③ Sum and Difference rule

$$\frac{d}{dx}[f(x) \pm g(x)] = f'(x) \pm g'(x)$$

④ Constant Multiple rule

$$\frac{d}{dx}[c \cdot f(x)] = c \cdot f'(x)$$

⑤ Product rule

$$\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$$

⑥ Quotient rule

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x)g(x) - f(x)g'(x)}{(g(x))^2}$$

⑦ Chain rule

$$\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$$

also written as: $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$