

## Function's derivative definition

Function derivative is defined by following formula:

$$\frac{dy(x)}{dx} = \lim_{\Delta x \rightarrow 0} \frac{y(x + \Delta x) - y(x)}{\Delta x}$$

Let's consider following example function  $y(x) = x^2$

$$\begin{aligned}\frac{dy(x)}{dx} &= \frac{d(x^2)}{dx} = \lim_{\Delta x \rightarrow 0} \frac{(x + \Delta x)^2 - x^2}{\Delta x} = \\ \lim_{\Delta x \rightarrow 0} \frac{(x + \Delta x)^2 - x^2}{\Delta x} &= \lim_{\Delta x \rightarrow 0} \frac{x^2 + 2 \cdot x \cdot \Delta x + \Delta x^2 - x^2}{\Delta x} = \\ \lim_{\Delta x \rightarrow 0} \frac{2 \cdot x \cdot \Delta x + \Delta x^2}{\Delta x} &= \lim_{\Delta x \rightarrow 0} \frac{2 \cdot x \cdot \Delta x}{\Delta x} + \lim_{\Delta x \rightarrow 0} \frac{\Delta x^2}{\Delta x} = \\ 2 \cdot x \cdot \lim_{\Delta x \rightarrow 0} \frac{\Delta x}{\Delta x} + \lim_{\Delta x \rightarrow 0} \Delta x &= 2 \cdot x \\ \frac{d(x^2)}{dx} &= 2 \cdot x\end{aligned}$$