§ 2.8 - The Derivative as a Function, Part 2.

In this video, we will:

- List alternative notations for $f'(x)$
- Find higher Derivatives
- Finding where $f'(x)$ D.N.E.

The derivative of $f(x)$ can be written

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

$\frac{df}{dx}$: Leibniz

$f'(x)$: Lagrange (Euler)

$Df(x)$: Euler

The derivative of y can be written

$$\frac{dy}{dx} = y' = \dot{y}$$

$\dot{y}$: Newton

Is there a derivative of a derivative?

- Yes, the 2nd derivative:

$$\frac{d^2f}{dx^2} = f''(x) = D^2(x), \quad \ddot{y}$$

$$\frac{d^2y}{dx^2}$$

Find the 2nd Derivative of $f(x) = 10x^2 - x - 1$

$$f'(x) = \lim_{h\to 0} \frac{[10(x+h)^2 - (x+h)] - [10x^2 - x]}{h}$$

- $$= \lim_{h\to 0} \frac{10x^2 + 20xh + 10h^2 - 10x^2 - h}{h} = \underline{20x - 1}$$

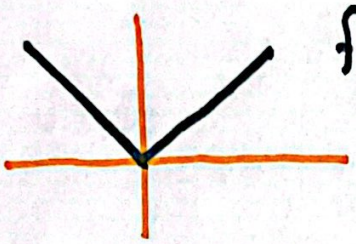
$$f'' = \lim_{h\to 0} \frac{[20(x+h) - 1] - [20x - 1]}{h} = \lim_{h\to 0} \frac{20h}{h} = 20$$

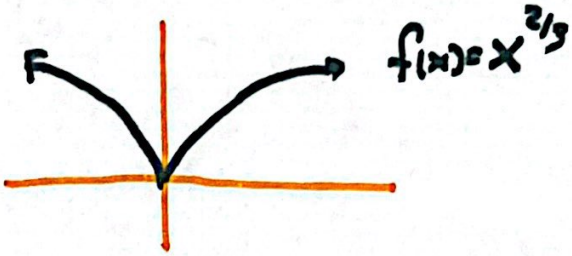
$$f''(x) = 20$$

Warning: Just because $f(x)$ exists does not mean $f'(x)$ also exists.

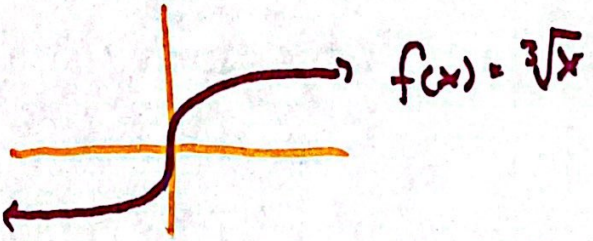
① If $f(x)$ is not continuous at a, then $f'(a)$ DNE.

② $f'(a)$ DNE if f has a cusp at $x=a$.





③ If the graph of $f(x)$ is perfectly vertical at a, $f'(a)$ DNE



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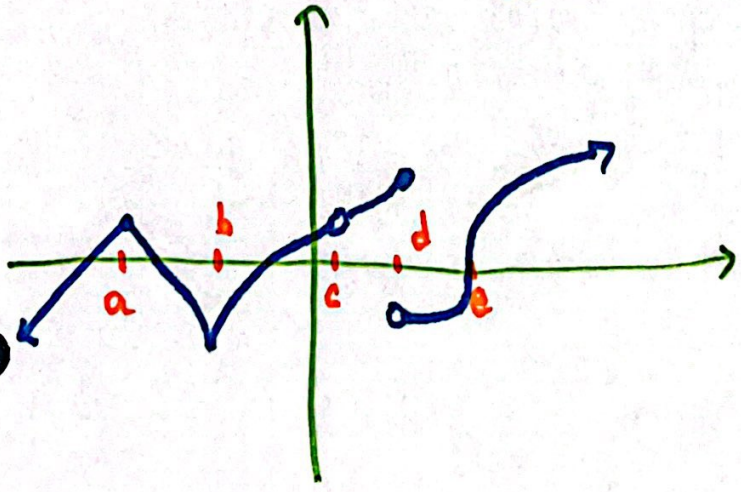
where does $f'(x)$ not exist?



$x=a, b, c, d, e$