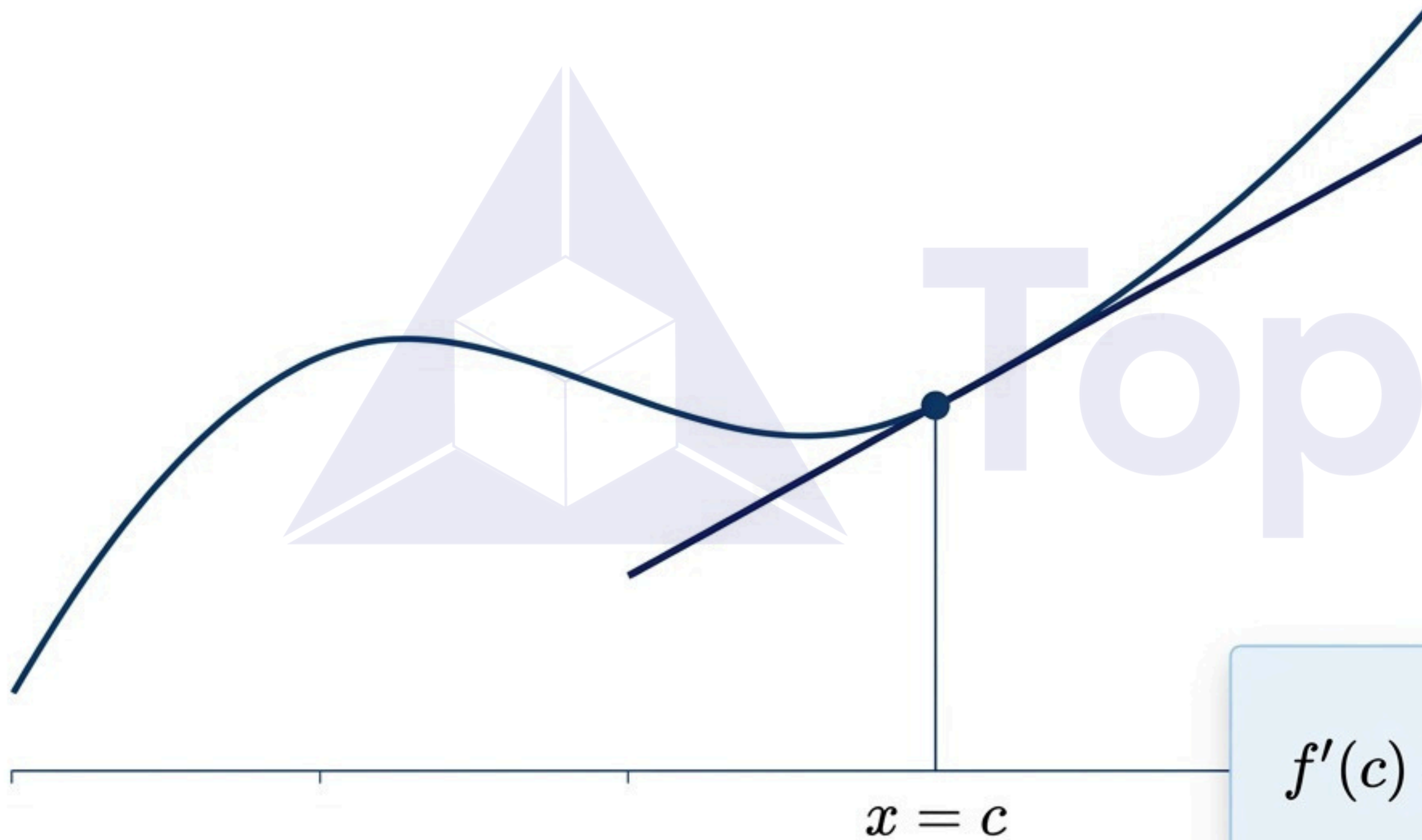


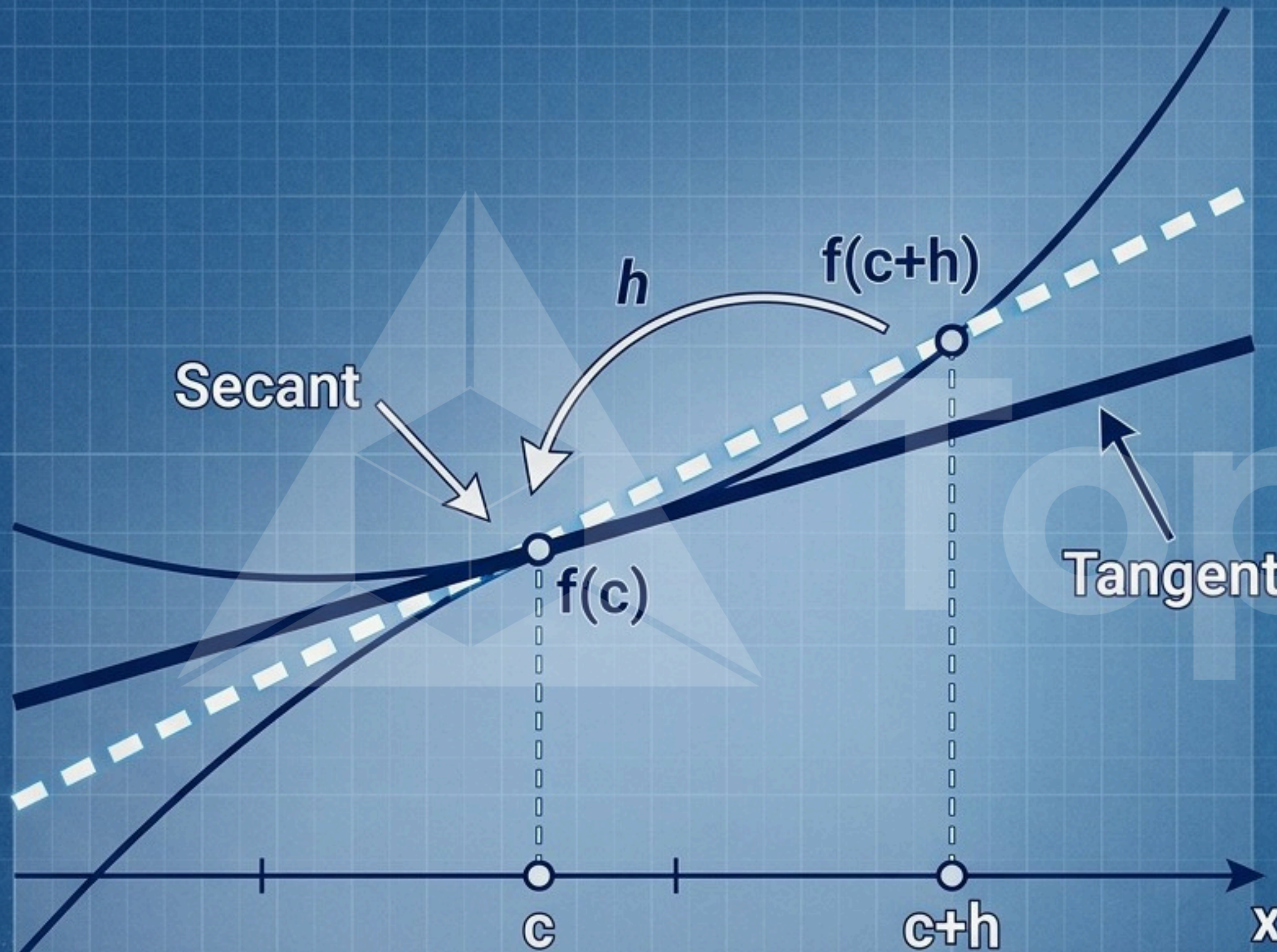
Differentiability

Does a unique derivative exist at the point?



$$f'(c) = \lim_{h \rightarrow 0} \frac{f(c+h) - f(c)}{h}$$

What the Derivative Limit Represents



As $h \rightarrow 0$

[Secant Line]



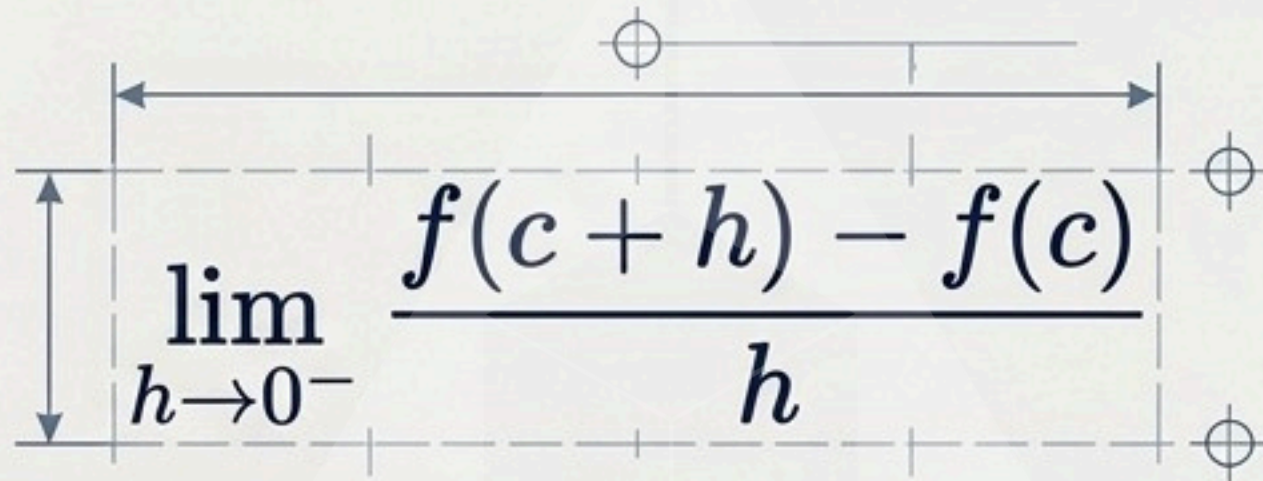
[Tangent Line]

$$f'(c) = \lim_{h \rightarrow 0} \frac{f(c+h) - f(c)}{h}$$

Both Directions Must Agree

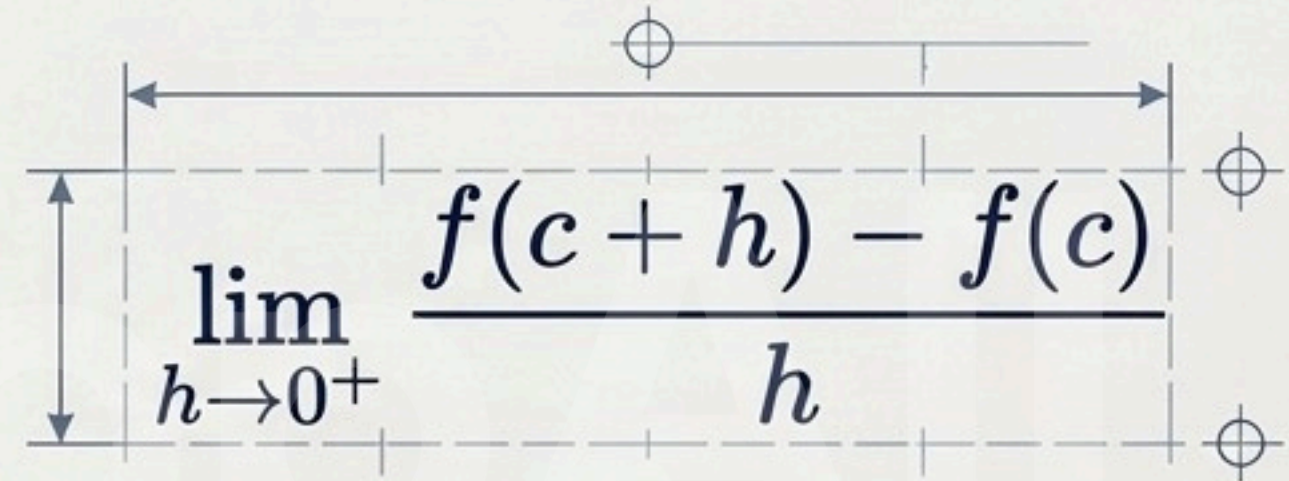
LEFT: $h \rightarrow 0^-$

Left-Hand Derivative (LHD)


$$\lim_{h \rightarrow 0^-} \frac{f(c+h) - f(c)}{h}$$

RIGHT: $h \rightarrow 0^+$

Right-Hand Derivative (RHD)


$$\lim_{h \rightarrow 0^+} \frac{f(c+h) - f(c)}{h}$$

Differentiable at c only if:

$$\mathbf{LHD = RHD}$$

and both are finite.



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$$E=mc^2$$



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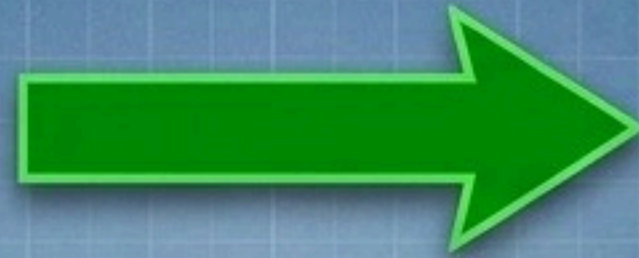
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The One-Way Relationship

[DIFFERENTIABLE]



[CONTINUOUS]

Every differentiable function is continuous.

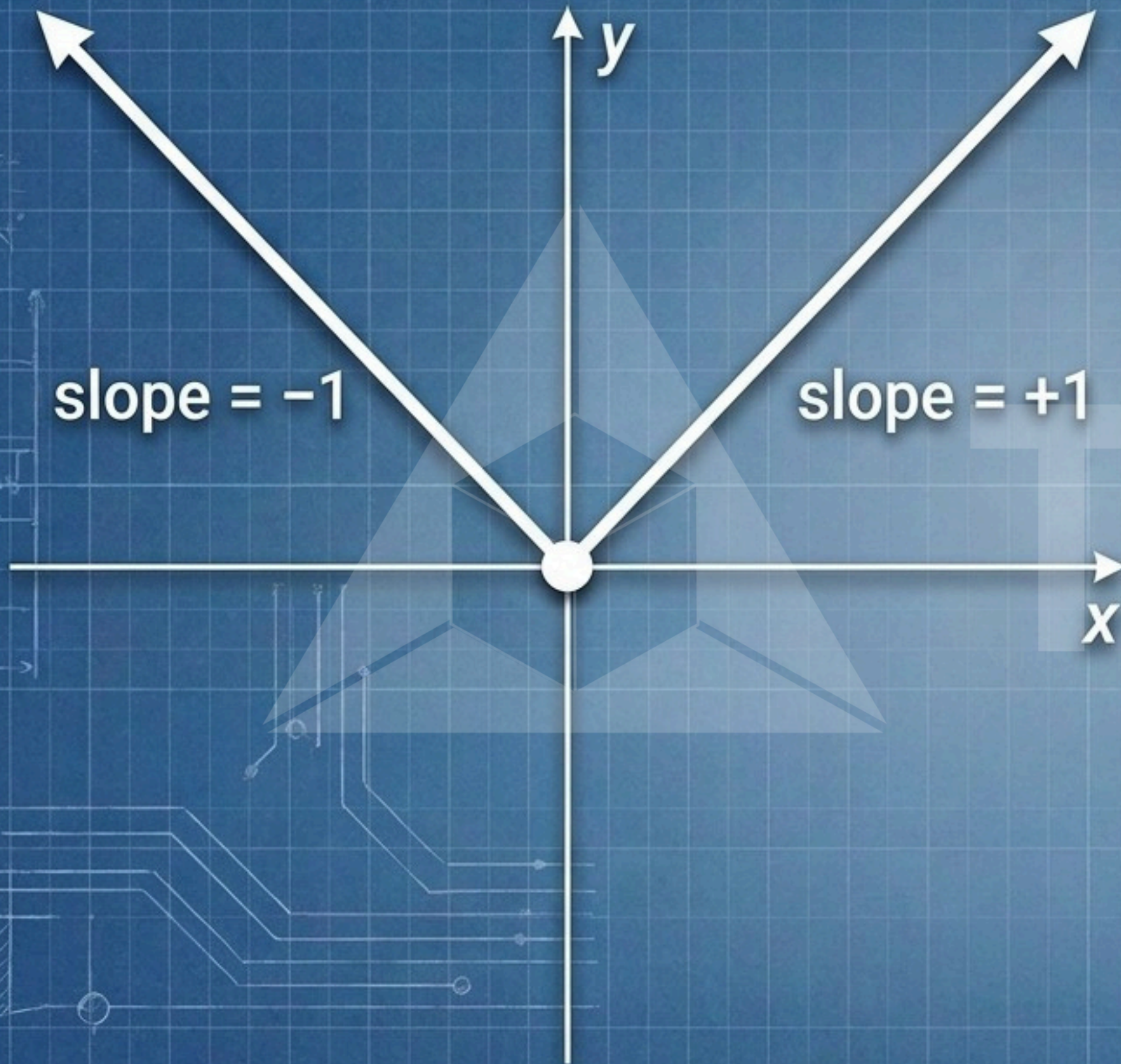
[CONTINUOUS]



[DIFFERENTIABLE]

The converse is not always true.

Continuous — But Not Differentiable



At $x = 0$:

Function is continuous ✓

Left derivative: -1

Right derivative: +1

Since $-1 \neq +1 \Rightarrow$
Not differentiable at 0 ✗

Core Rules You Already Use

$$(u \pm v)' = u' \pm v'$$

$$(uv)' = u'v + uv'$$

$$\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}$$

Condition: $v \neq 0$

$$(x^n)' = nx^{n-1}$$

$$(\sin x)' = \cos x$$

$$(\cos x)' = -\sin x$$

$$(\tan x)' = \sec^2 x$$

Differentiability Checklist

To check differentiability at $x = c$:

1. Find **Left-Hand Derivative** (LHD)
2. Find **Right-Hand Derivative** (RHD)
3. Ensure both are finite
4. Check they are **equal**

Final Relationship

Differentiable $\Rightarrow$ Continuous 

Continuous $\nRightarrow$ Differentiable 



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