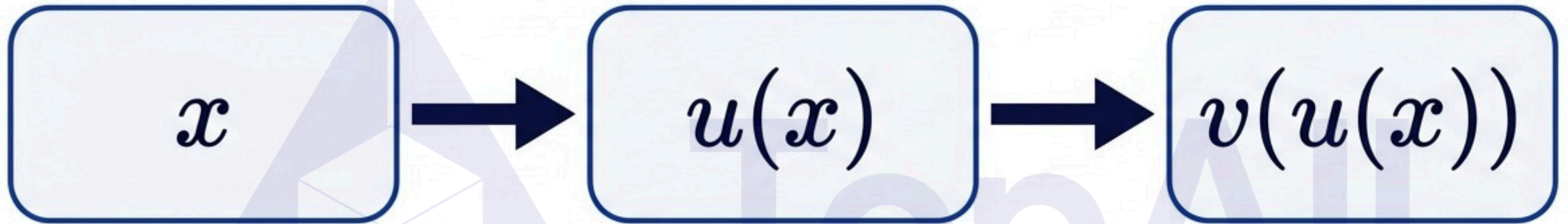


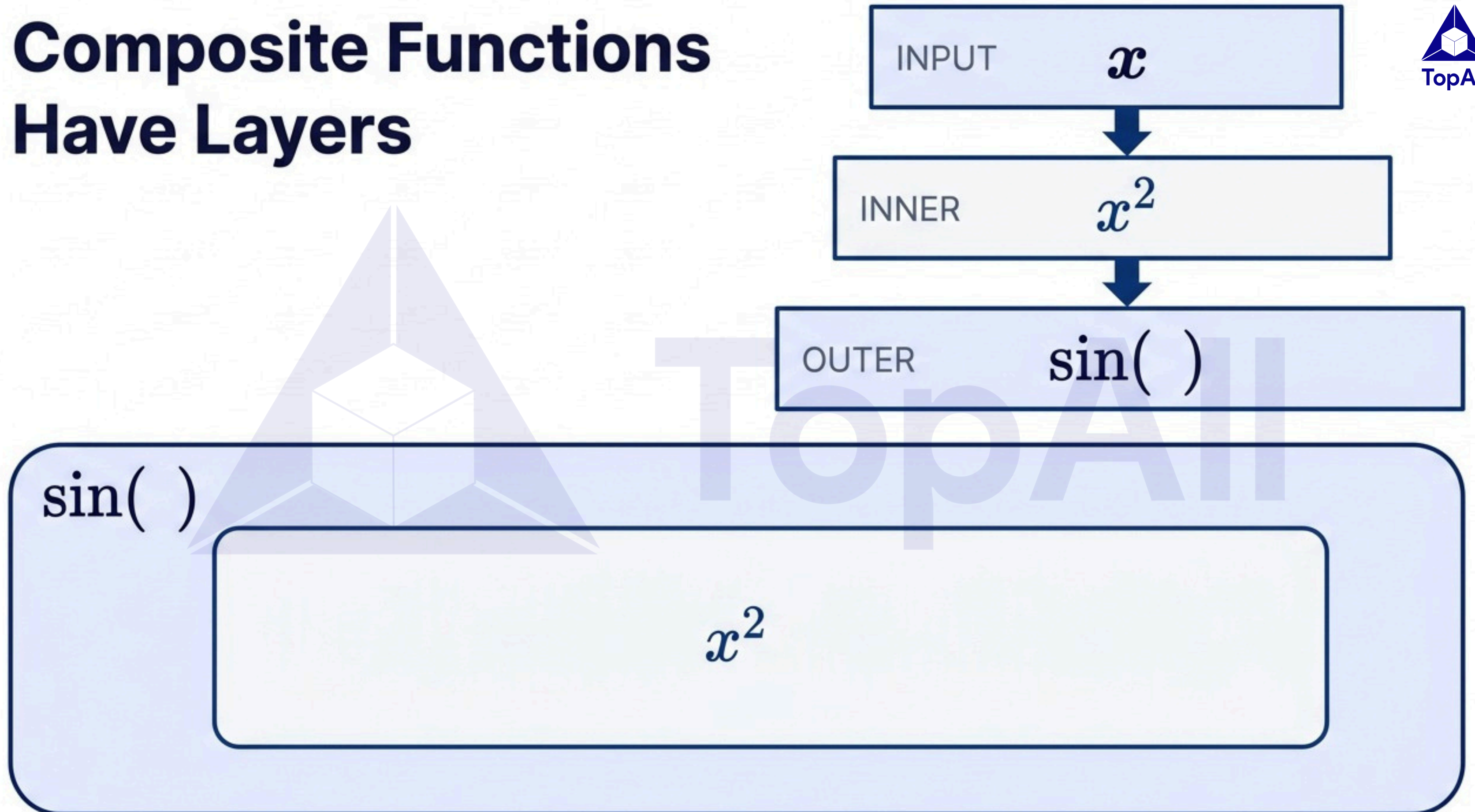
The Chain Rule

Differentiate functions built inside other functions

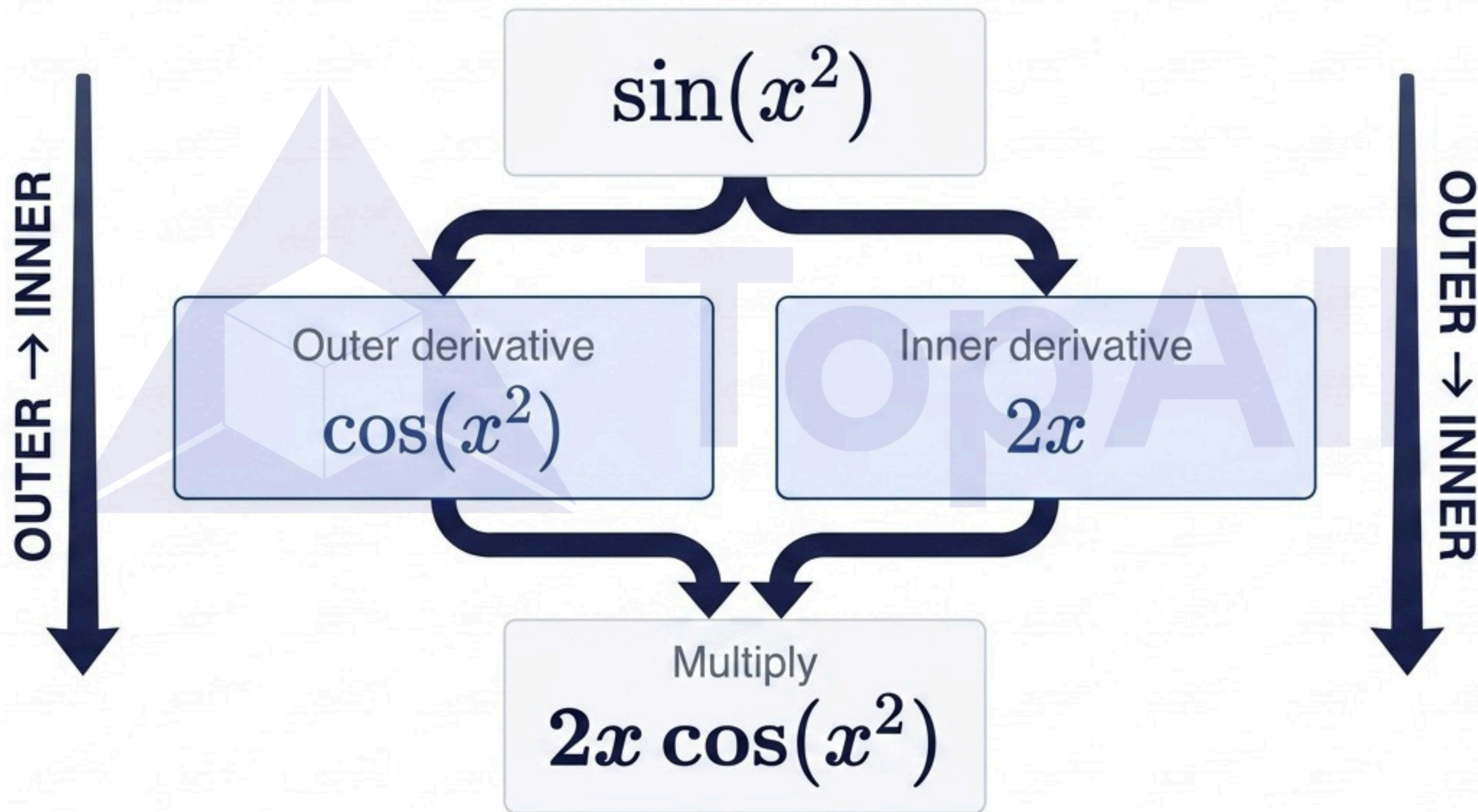


$$\frac{df}{dx} = \frac{dv}{dt} \times \frac{dt}{dx}$$

Composite Functions Have Layers



The Core Pattern





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$$E=mc^2$$



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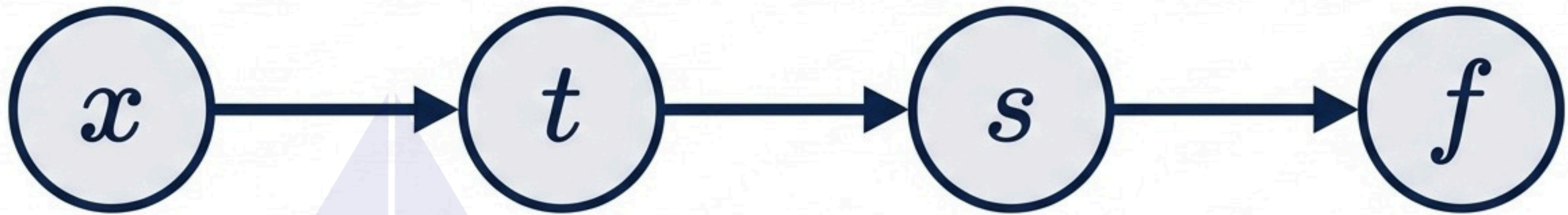
Example: $(2x + 1)^3$

$$\text{Let } t = 2x + 1$$

$$\text{Let } f = t^3$$

$$\begin{aligned}\frac{df}{dx} &= \frac{df}{dt} \times \frac{dt}{dx} \\ &= 3t^2 \times 2 \\ &= 6(2x+1)^2\end{aligned}$$

The Chain Can Continue



$$\frac{df}{dx} = \frac{df}{ds} \times \frac{ds}{dt} \times \frac{dt}{dx}$$



Condition: Do not skip any inner derivative. Every nested function must yield a multiplier.

Chain Rule in 3 Steps

[1] Differentiate the outside

[2] Keep the inside expression unchanged $\frac{df}{dv} \cdot \frac{dv}{dx}$

[3] Multiply by the derivative of the inside

✗ **TRAP** $\cos(x^2)$ alone is an incomplete derivative for $\frac{d}{dx}[\sin(x^2)]$. You must multiply by the inner derivative ($2x$).



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