

DERIVATIVE AS INSTANTANEOUS VELOCITY

The Intuitive Foundation of Calculus

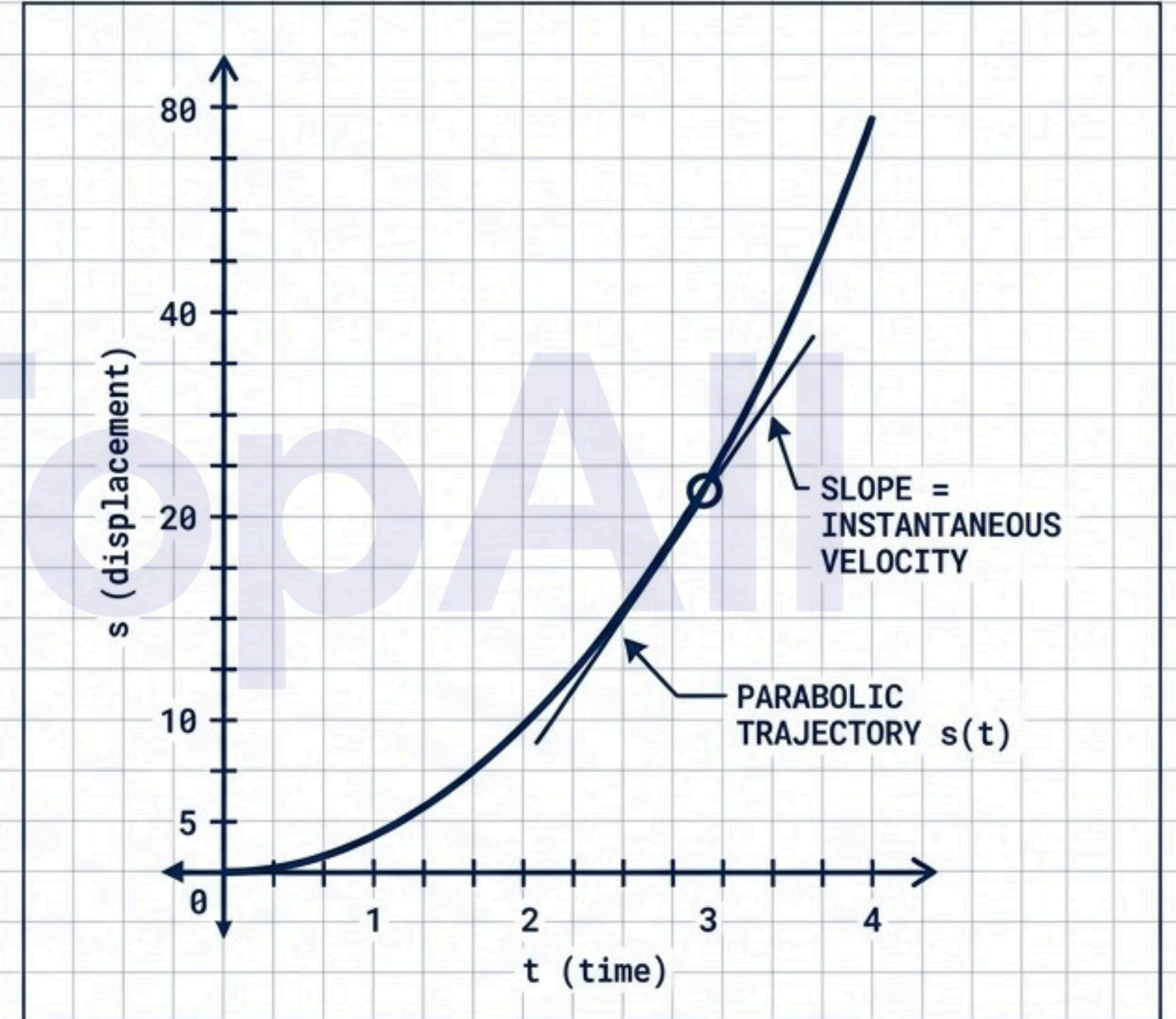
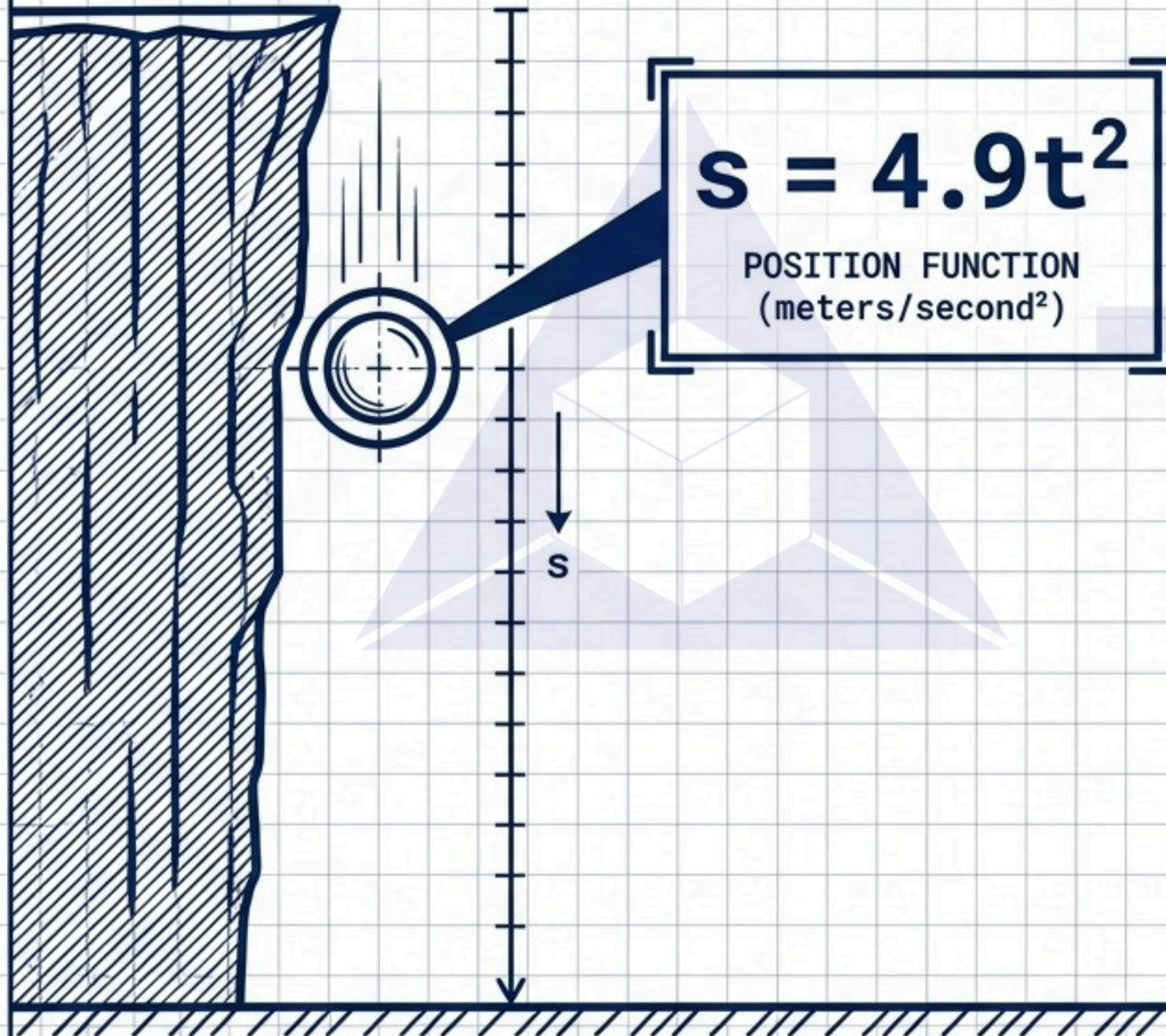
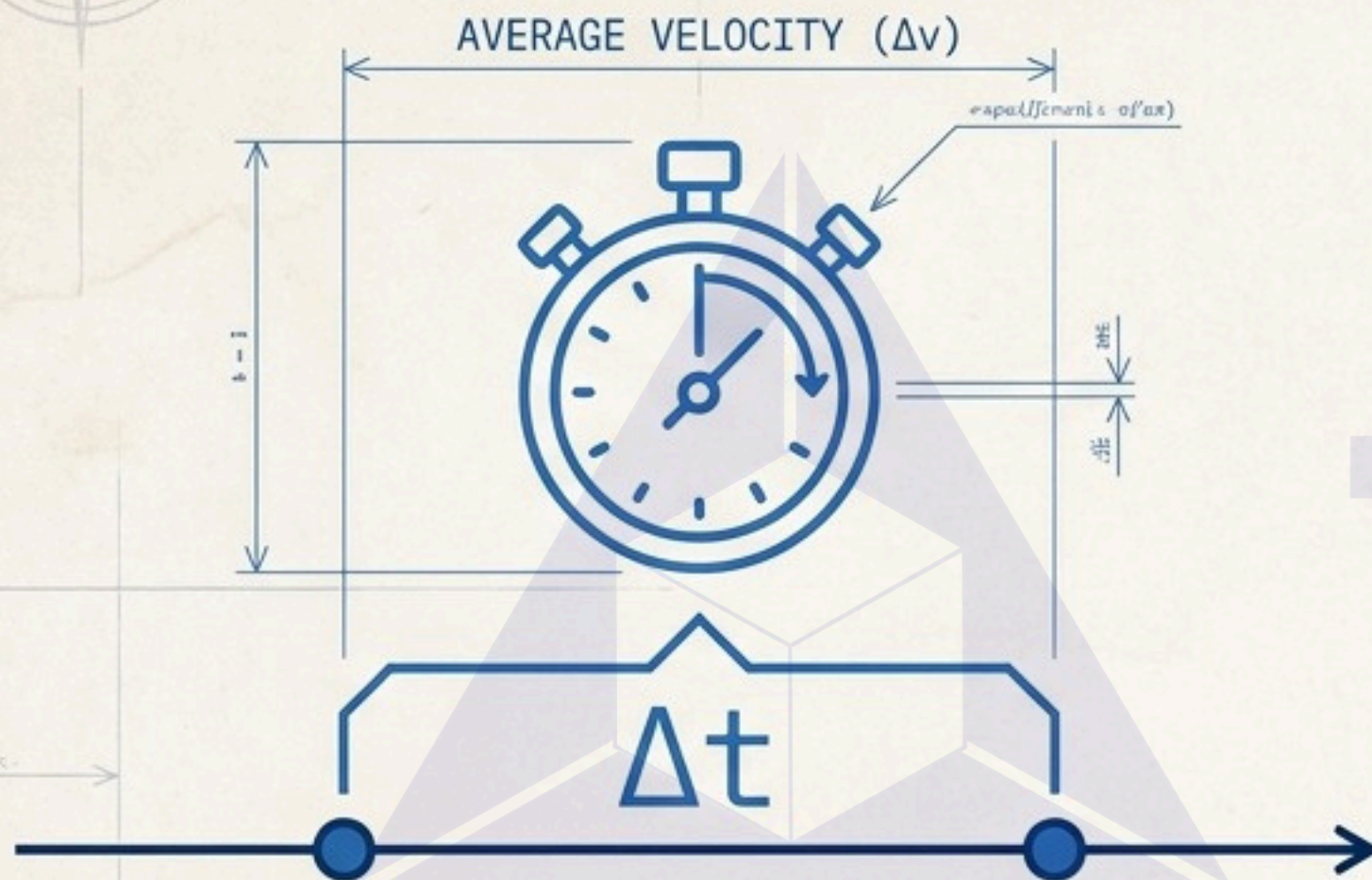
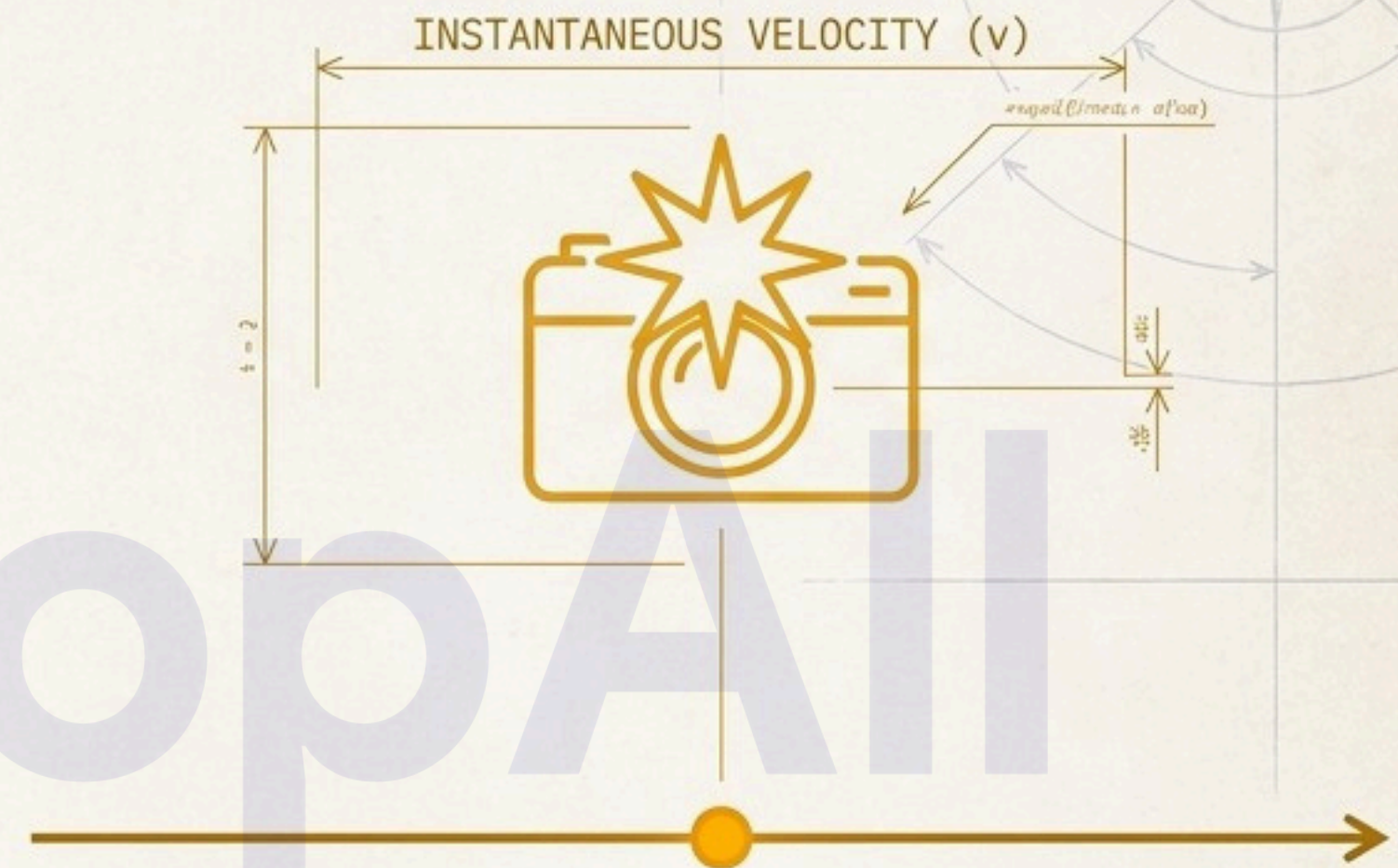


FIGURE 1.2: DISPLACEMENT vs. TIME GRAPH

Average vs. Instantaneous Velocity



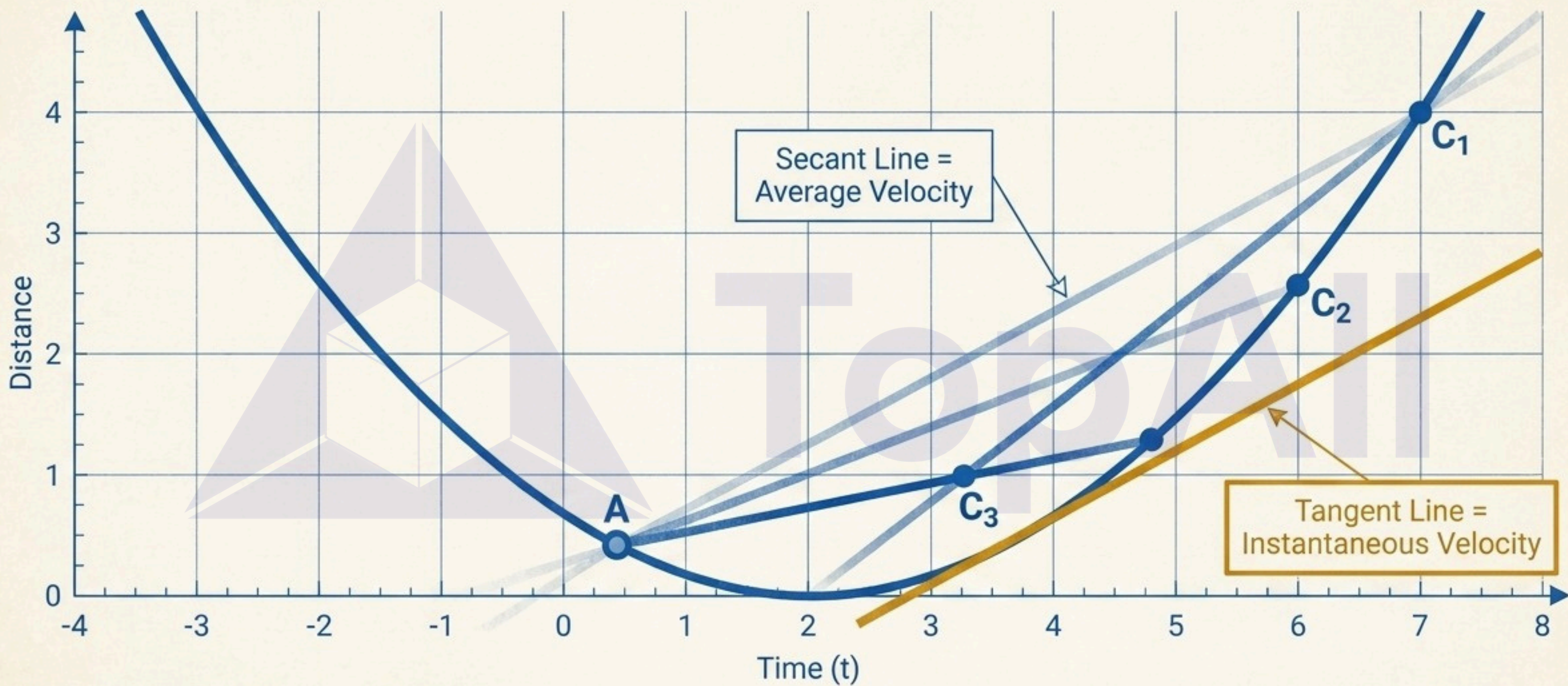
The rate of change over a duration of time. Requires two distinct points to calculate.



The exact rate of change at a specific instant. The mathematical challenge: dividing by zero.

To find the velocity at a single frozen instant ($t=2$), we must shrink the time interval until it approaches zero.

The Geometric View: Secants Approaching Tangent



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PROJECT: KINEMATICS ANALYSIS	
DRAWING NO: VEL-COMP-G02	SCALE
SCALE: NTS	DATE: OCT 26, 2024



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The Mathematical Engine

$$v_{\text{avg}} = \frac{[s(t_2) - s(t_1)]}{(t_2 - t_1)}$$

Numerator = Distance travelled (Δs)

Denominator = Time interval (Δt)

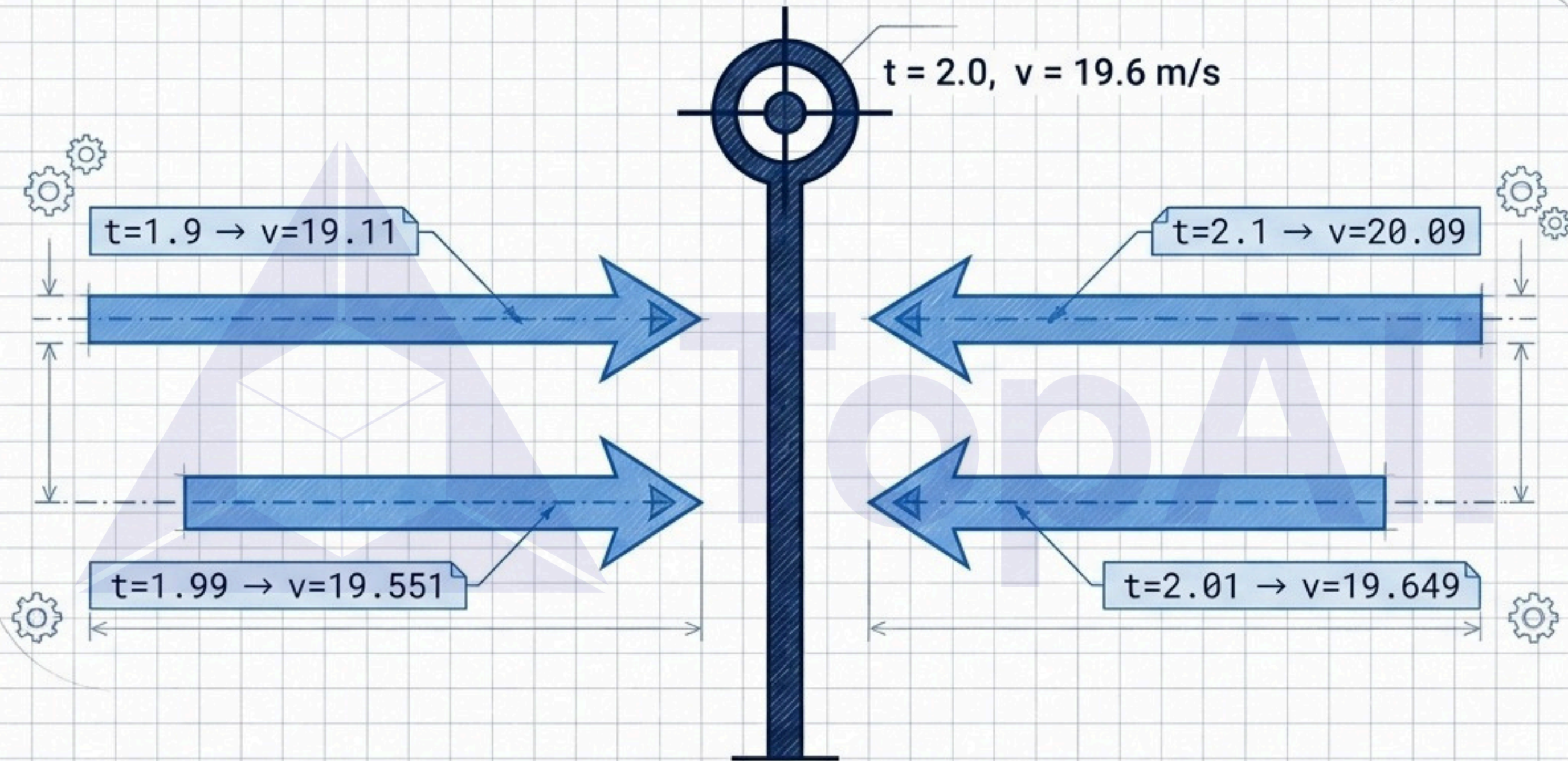


Conceptual Pitfall

The Trap: Assuming that computing the velocity over a ‘very small’ time interval is mathematically identical to instantaneous velocity.

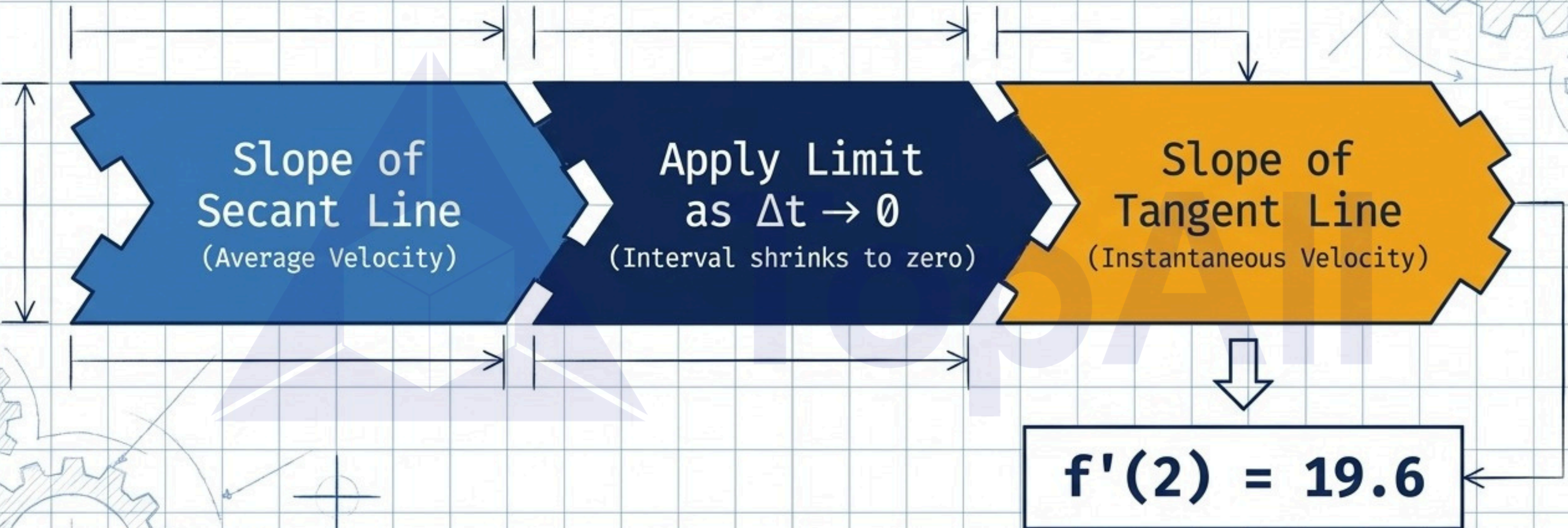
The Reality: No matter how small the interval, $\Delta s/\Delta t$ is ALWAYS the slope of a Secant Line (Average Velocity). It never mathematically becomes the Tangent Line (Instantaneous Velocity) until the theoretical operation of a limit is applied.

Converging on the Instant ($t \rightarrow 2$)



Whether we shrink the interval from the past (left) or the future (right), the average velocity physically restricts into a single, identical limit: 19.6 m/s.

The Core Logic of Derivatives



The Derivative is simply the mathematical tool that transforms average rates of change into instantaneous rates of change.



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