

Derivative Rules: Sum, Product and Quotient

Algebra of Derivatives

$$(u \pm v)'$$

$$(uv)'$$

$$(u/v)'$$

Limits

Derivatives are defined by limits. Therefore, they inherit limit properties.

$$\lim [f(x) + g(x)] = \lim f(x) + \lim g(x)$$

Derivation (Theorem 5)

Derivatives

Linearity transfers directly, but products and quotients require specialized algebraic expansion.

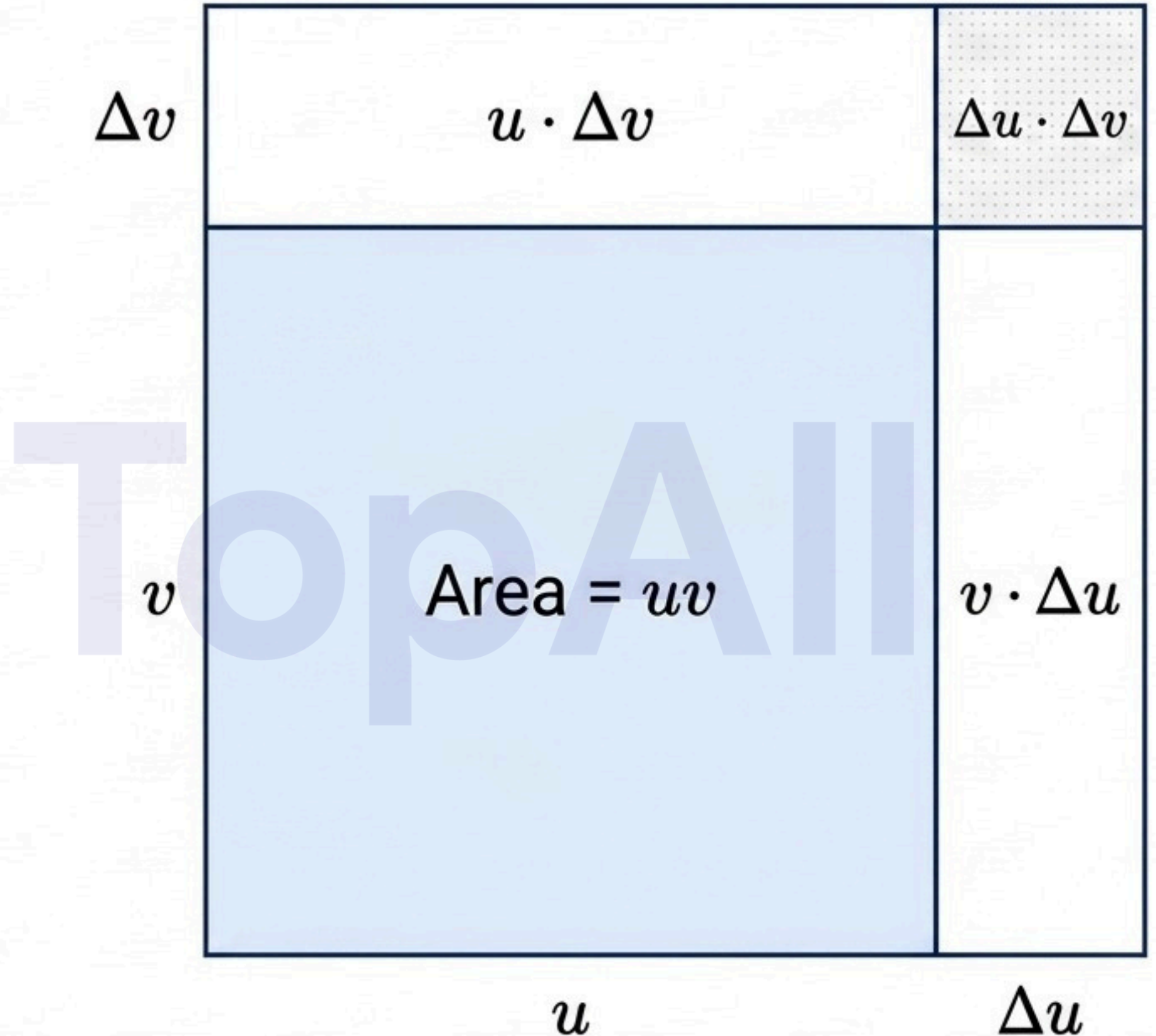
$$[f(x) + g(x)]' = f'(x) + g'(x)$$

Visualizing the Product Rule

When two factors change simultaneously, the total change is the sum of their individual contributions.

$$\Delta(uv) \approx u \cdot \Delta v + v \cdot \Delta u$$

(Dividing by Δx yields the derivative).





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Sum & Difference Rule

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

Power Rule (Theorem 6)

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

Product (Leibnitz) Rule

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

Quotient Rule

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

Note structure:
Always start numerator
with v, all over v^2 .



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$$(uv)' \neq u'v'$$

The Illusion of Linearity. The derivative of a product is
NOT the product of the derivatives.

Always use the Leibnitz rule: $u'v + uv'$.

Proving Consistency: $(x^2)' = 2x$

1 Express as a product: Let $f(x) = x \cdot x$

2 Set factors: $u = x, v = x$

3 Apply Product Rule: $(uv)' = u'v + uv'$

4 Substitute derivatives (knowing $x' = 1$):
 $= (1) \cdot x + x \cdot (1)$

5 Simplify: $= x + x = 2x$

Matches the Power Rule
 $(x^n)' = n \cdot x^{(n-1)}$ perfectly.

Don't rush to differentiate individual terms until the overarching algebraic rule is applied.

KEY TAKEAWAY: Strategy over Calculation

- 1 Choose the Rule First.** Look at the macroscopic structure of the function. Is it fundamentally a sum, a product, or a quotient?
- 2 Set Up the Framework.** Write out the empty skeleton of the formula first (e.g., $([]v - u[]) / v^2$).
- 3 Differentiate the Parts.** Fill in the inner derivatives (u' and v') only as the final step.



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