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The Basics of Integration (Integrals)

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What is an Integral?

- An integral represents the accumulation of quantities, often visualized as the area under a curve. It can be thought of as the reverse operation of differentiation. While differentiation gives the rate of change, integration gives the total amount accumulated over an interval.

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How to Compute an Integral

- **The integral of a function $f(x)$ from a point a to b is written as**

$$\int_a^b f(x)\,dx$$

This integral represents the area under the curve of $f(x)$ from $x = a$ to $x = b$.

Example:

If $f(x) = x^2$, then the integral from 0 to 2 is: $$\int_0^2 x^2\,dx = \left[\frac{x^3}{3}\right]_0^2 = \frac{8}{3} - 0 = \frac{8}{3}$$

This means that the area under the curve of $f(x) = x^2$ from $x = 0$ to $x = 2$ is $\frac{8}{3}$.

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Geometric Interpretation of an Integral

- Imagine the graph of a function. The integral calculates the total area under the curve between two points. This is useful when determining total quantities, such as distance traveled by an object moving at varying speeds.