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Differentials

$dSymbol := "d"$

Enter an expression, and say that have some constants

$z := x \cdot y^2 + \frac{y}{a \cdot x}$ $da := 0$

Total differential

$dz := d(z) = \frac{-y \cdot (1 - x^2 \cdot y \cdot a) \cdot dx + (1 + 2 \cdot x^2 \cdot y \cdot a) \cdot dy \cdot x}{a \cdot x^2}$

Partial derivatives

$d(dz, dx) = -\frac{y \cdot (1 - x^2 \cdot y \cdot a)}{a \cdot x^2}$ $d(dz, dy) = \frac{1 + 2 \cdot x^2 \cdot y \cdot a}{x \cdot a}$

or

$d(z, x) = -\frac{y \cdot (1 - x^2 \cdot y \cdot a)}{a \cdot x^2}$ $d(z, y) = \frac{1 + 2 \cdot x^2 \cdot y \cdot a}{a \cdot x}$

Notice that

$d(dz, dy^2) = 0$ because $d(d(dz, dy), dy) = 0$

but

$d(dz, y^2) = 2 \cdot dx$

Some examples

$dSymbol := "\partial."$

$$d\left(\begin{bmatrix} r \cdot \cos(\theta) \\ r \cdot \sin(\theta) \end{bmatrix}\right) = \begin{bmatrix} \cos(\theta) \cdot \partial_r - r \cdot \sin(\theta) \cdot \partial_\theta \\ \sin(\theta) \cdot \partial_r + r \cdot \cos(\theta) \cdot \partial_\theta \end{bmatrix}$$

$dSymbol := "\partial"$ $\partial a := 0$

$$d(a \cdot e^{b \cdot x}) = e^{b \cdot x} \cdot a \cdot (x \cdot \partial b + b \cdot \partial x)$$

$$d(a \cdot e^{\sin(x)}) = e^{\sin(x)} \cdot \cos(x) \cdot a \cdot \partial x$$

$$d(x^2 \cdot \ln(x \cdot y)) = \frac{x \cdot ((1 + 2 \cdot \ln(x \cdot y)) \cdot \partial x \cdot y + x \cdot \partial y)}{y}$$

$Clear(\partial a) = 1$

$$d1 := d(a \cdot b) = b \cdot \partial a + a \cdot \partial b$$

$$d2 := d(d1) = \partial a \cdot (\partial b + b \cdot \partial a + \partial b) + a \cdot \partial b^2$$

$$d3 := d(d2) = 2 \cdot ((\partial b + b \cdot \partial a) \cdot \partial a^2 + (\partial a + \partial b \cdot a) \cdot \partial b^2) + \partial b \cdot \partial a \cdot (\partial b + \partial a)$$

$\partial a := 0$

$$d1 := d(a \cdot b) = a \cdot \partial b$$

$$d2 := d(d1) = a \cdot \partial b^2$$

$$d3 := d(d2) = 2 \cdot \partial b^3 \cdot a$$

Chain rule

$$c := d\left(a \cdot f\left(g\left(x\right)\right)\right) = a \cdot \frac{d}{d\ x} f\left(g\left(x\right)\right) \cdot \partial x$$

$$f(x) := \ln(x) \qquad g(x) := \cos(x) \qquad c = -a \cdot \tan(x) \cdot \partial x$$

$$d\left(a \cdot \ln\left(\cos\left(x\right)\right)\right) = -\frac{\sin(x) \cdot a \cdot \partial x}{\cos(x)}$$

Total differential

$$d\left(f\left(t, x, x'\right)\right) = \frac{d}{d\ t} f\left(t, x, x'\right) \cdot \partial t + \frac{d}{d\ x} f\left(t, x, x'\right) \cdot \partial x + \frac{d}{d\ x'} f\left(t, x, x'\right) \cdot \partial x'$$

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