

the symmetry of second partial derivatives

example

$$f(x, y) = x^2y + 3xy^3$$

$$\frac{\partial f}{\partial x} = 2xy + 3y^3$$

$$\frac{\partial f}{\partial y} = x^2 + 9xy^2$$

$$\begin{aligned}\frac{\partial^2 f}{\partial x^2} &= \frac{\partial}{\partial x} \left(\frac{\partial f}{\partial x} \right) \\ &= 2y\end{aligned}$$

$$\begin{aligned}\frac{\partial^2 f}{\partial xy} &= \frac{\partial}{\partial x} \left(\frac{\partial f}{\partial y} \right) \\ &= 2x + 9y^2\end{aligned}$$

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$$\begin{aligned}\frac{\partial^2 f}{\partial yx} &= \frac{\partial}{\partial y} \left(\frac{\partial f}{\partial x} \right) \\ &= 2x + 9y^2\end{aligned}$$

$$\begin{aligned}\frac{\partial^2 f}{\partial y^2} &= \frac{\partial}{\partial y} \left(\frac{\partial f}{\partial y} \right) \\ &= 18xy\end{aligned}$$