Math Review

(Partial) Derivatives

- **Definition:** The partial derivative of a multivariate function is its derivative with respect to one of those variables, with the others held constant.
- **Notation:**

$$\frac{\partial f(x_1, x_2)}{\partial x_1} = \frac{\partial f}{\partial x_1} = f_1'(x_1, x_2) = f_{x_1}(x_1, x_2)$$

- Common derivative rules:

$$\text{Product rule: } \frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x).$$

$$\text{Quotient rule: } \frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}.$$

$$\text{Chain rule: } \frac{d}{dx}f(g(x)) = f'(g(x)) \cdot g'(x).$$

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Common Derivatives

$$\frac{dx^n}{dx} = nx^{n-1}$$

$$\frac{dax^n}{dx} = a \cdot nx^{n-1},$$

$$\frac{de^x}{dx} = \frac{d\exp(x)}{dx} = \exp(x) = e^x$$

$$\frac{da}{dx} = 0, \text{for } a \in \mathbb{R},$$

$$\frac{d}{dx}\left[x^n + a\right] = \frac{d}{dx}x^n + \frac{d}{dx}a = nx^{n-1} + 0 = nx^{n-1}$$

$$\frac{d\ln(x)}{dx} = \frac{1}{x} \quad (\text{for } x > 0)$$