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## 0.1 Differentiating natural number power functions

### 0.1.1 Other

$$\begin{aligned}\frac{\delta}{\delta x} x^n &= \lim_{\delta \rightarrow 0} \frac{(x+\delta)^n - x^n}{\delta} \\ \frac{\delta}{\delta x} x^n &= \lim_{\delta \rightarrow 0} \frac{(\sum_{i=0}^n x^i \delta^{n-i} \frac{n!}{i!(n-i)!}) - x^n}{\delta} \\ \frac{\delta}{\delta x} x^n &= \lim_{\delta \rightarrow 0} \sum_{i=0}^{n-1} x^i \delta^{n-i-1} \frac{n!}{i!(n-i)!} \\ \frac{\delta}{\delta x} x^n &= \lim_{\delta \rightarrow 0} x^{n-1} \frac{n!}{(n-1)!(n-n+1)!} + \sum_{i=0}^{n-2} x^i \delta^{n-i-1} \frac{n!}{i!(n-i)!} \\ \frac{\delta}{\delta x} x^n &= nx^{n-1}\end{aligned}$$