DERIVATIVES PART 2

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Examples:

① $f(x) = (3x^2 + 2x)(2x+1)^2$

$g(x) = (3x^2+2x)$, $h(x) = (2x+1)^2$

$g'(x) = 3 \cdot 2x^{2-1} + 2 \cdot 1x^{1-1}$

$= 6x + 2$

$h'(x) = (2x+1)^2$

$= 2 \cdot (2x+1)^{2-1} \cdot 2$

$2x+1$ ↙ → $2 \cdot 1x^{1-1} + 0$

② $= 4(2x+1) = 8x+4$

$f'(x) = (6x+2)(2x+1)^2 + (3x^2+2x)(8x+4)$

$g'(x)\ h(x) \quad + \quad g(x)\ h'(x)$

Product Rule: $F(x) = g(x)h(x)$

$F'(x) = g'(x)h(x) + g(x)h'(x)$

Chain Rule: $F(x) = g(h(x))$

$F'(x) = g'(h(x)) \cdot h'(x)$

Sum Rule: $F(x) = g(x) + h(x)$

$F'(x) = g'(x) + h'(x)$

$3x^2 \to 3 \cdot 2x^{2-1}$, $6x$ ($3x^2$: c, $g(x)$)

$2x^1 \to 2 \cdot 1x^{1-1}$, $2 \cdot 1x^0$, 2 ($2x^1$: $g(x)$)

② $f(x) = \dfrac{\sin(2x)}{x^2+1}$

Quotient Rule: $f(x) = \dfrac{g(x)}{h(x)}$

$F'(x) = \dfrac{g'(x)h(x) - g(x)h'(x)}{(h(x))^2}$

$g(x) = \sin(2x)$

$h(x) = x^2 + 1$

$\frac{d}{dx}(2x)$

$g'(x) = \cos(2x) \cdot \frac{d}{dx}(2x)$

sin → cos

sin(2x) → cos

$2x \to 2 \cdot 1x^0$

② $= \cos(2x) \cdot 2$

$= 2\cos(2x)$

$h'(x) = 2x + 0$

$= 2x$

$x^{2-1} \to 2 \cdot x^{2-1}$

$g'(x)\ h(x)$, $g(x)\ h'(x)$

$f'(x) = \dfrac{2\cos(2x)(x^2+1) - (\sin(2x))(2x)}{(x^2+1)^2 \to (h(x))^2}$

$= \dfrac{(2\cos(2x))(x^2+1) - (2x\sin(2x))}{(x^2+1)^2}$

Chain rule: $f(x) = g(h(x))$

$F'(x) = g'(h(x)) \cdot h'(x)$

Sum rule: $f(x) = g(x) + h(x)$

$f'(x) = g'(x) + h'(x)$

③ $f(x) = \ln(x^2+1)$

$\ln(u)$, u

Chain Rule: $F(x) = g(h(x))$

$F'(x) = g'(h(x)) \cdot h'(x)$

$\ln(u) = \frac{1}{u} \cdot \frac{du}{dx}$

$u = x^2 + 1$

$u' = 2x + 0$

$u' = 2x$

$f'(x) = \dfrac{2x}{x^2+1}$

$\frac{d}{dx}(u)$

sin → cos

$\ln(u) \to \frac{1}{u} \cdot \frac{du}{dx}$

$x^2 \to 2 \cdot x^{2-1}$

$2x$

$1 \to 0$

$\ln(u) = \frac{1}{u} \cdot \frac{du}{dx}$

$= \frac{u'}{u}$

$= \dfrac{2x}{x^2+1}$