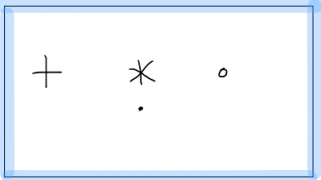


Mon wk 6

Last week: product rule, quotient rule, basic app.

Today: higher derivatives, chain rule



Ex Find  $f'(x), f''(x)$   $\approx 35x^4 + 5x^3 + 7x^2 + x$

$$f(x) = (5x^3 + x)(7x + 1) \quad \underbrace{35x^3 + 7x \rightarrow 105x^2 + 7}$$

$$f'(x) = (15x^2 + 1)(7x + 1) + (5x^3 + x)(7)$$

$$f''(x) = \underbrace{(30x)(7x + 1) + (15x^2 + 1)(7)}_{=0} + (15x^2 + 1) \cdot 7 + \underbrace{(5x^3 + x) \cdot 0}_{=0}$$

$$= 210x^2 + 30x + 105x^2 + 7 + 105x^2 + 7$$

$$= 420x^2 + 30x + 14$$

$$f'(x) = 140x^3 + 15x^2 + 14x + 1$$

$$f''(x) = 420x^2 + 30x + 14 \quad ( \ddot{ } )$$

$$f'''(x) = 840x + 30$$

Higher Derivatives

$$f'(x) = \frac{d}{dx}(f(x))$$

$$f''(x) = \frac{d}{dx}(f'(x))$$

$$f'''(x) = \frac{d}{dx}(f''(x))$$

$$f^{(4)}(x) = \frac{d}{dx}(f'''(x))$$

why?

often,  $f(x) \sim$  position @ time  
 $\sim ft$

$f'(x) \sim ft/sec \sim$  velocity

$f''(x) \sim ft/sec^2 \sim$  acceleration

$f'''(x) \sim ft/sec^3 \sim$  jerk

	Addition	vs.	Multiplication	vs.	Composition
①	$5x^3 + e^x$ $\downarrow d/dx$ $15x^2 + e^x$		$5x^3 \cdot e^x$ $\downarrow d/dx$ $5 \cdot 3x^2 \cdot e^x + 5x^3 \cdot e^x$		$5(e^x)^3 = 5e^{3x}$ $\downarrow d/dx$ $5 \cdot 3(e^x)^2 \cdot e^x = 15 \cdot e^{2x} \cdot e^x$ $= 15e^{2x+1}$
②	$e^x + 5x^3$		$e^x \cdot 5x^3$		$e^{5x^3}$ $\xrightarrow{d/dx}$
					$e \cdot 15x^2$

derivative of outside fun  
 evaluated @ inside - derivative of inside evaluated @ x

$$\frac{d}{dx} (F(G(x))) = \frac{dF}{dG} \cdot \frac{dG}{dx} = \frac{dF}{dx}$$

# Practise

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$$\textcircled{1} (3x+4)^5 \rightarrow 5(3x+4)^4 \cdot 3$$

$$\textcircled{2} e^{\sqrt{x}}$$

$$\textcircled{3} \frac{1}{e^x}$$

$$\textcircled{4} ((3x+4)(6\sqrt{x} + e^x))^5$$

$$x^5 \rightarrow 5x^4 \cdot 1$$

$$\boxed{e^x} \rightarrow \boxed{e^x} \cdot \boxed{1}$$