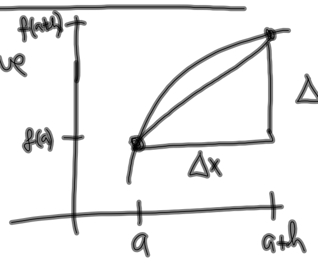
Leibniz notation

derivative

$\frac{\Delta y}{\Delta x}$



sort of taking the limit after $\frac{dy}{dx}$

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If $y=f(x)$, then $f'(x)$ can be denoted as

$\frac{dy}{dx}$ $\frac{df}{dx}$ $\frac{d}{dx}(f(x))$

If $s(t)$ is location, then velocity is

$\frac{ds}{dt}$

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$f'(5)$

If $f(x)=\ln x$, then $f'(x)=\frac{1}{x}$

$\frac{d}{dx}(\ln x)=\frac{1}{x}$

$\left.\frac{df}{dx}\right|_{x=5}$ same as $f'(5)$

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$\frac{d^k x^n}{dx^k} = k!\binom{n}{k}x^{n-k}$

We differentiate x^n k-times

If $f(x)$ is a function

$f'(x)$ $f'''(x)$ $f^{(5)}(x)$

$f''(x)$

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

If $f(x)=x^n$, then $f'(x)=nx^{n-1}$

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Chain Rule

If $f(x)=\sin x$

$g(x)=x^3-2x+1$

$f(g(x))=\sin(x^3-2x+1)$

$g(f(x))=\sin^3 x-2\sin x+1$

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decompose $f(x)=?$ $g(x)=?$

$f(g(x))=\sqrt{x^2+1}$

$g(x)=x^2+1$
$f(x)=\sqrt{x}$

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$f, g=?$ so that

$f(g(x))=\sin(3x-1)$

$g(x)=3x-1$
$f(x)=\sin x$

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$f(g(h(x)))=\log_3\sqrt{5x^2-1}$

$h(x)=5x^2-1$
$g(x)=\sqrt{x}$
$f(x)=\log_3 x$

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THE CHAIN RULE

$[f(g(x))]' = f'(g(x)) \cdot g'(x)$

$[f(g(h(x)))]' = f'(g(h(x))) \cdot g'(h(x)) \cdot h'(x)$

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$f(g(x))=\sqrt{x^2+1}$

$f(x)=\sqrt{x}$ $\quad g(x)=x^2+1$
$f'(x)=\frac{1}{2\sqrt{x}}$ $\quad g'(x)=2x$

$$[f(g(x))]' = f'(g(x)) \cdot g'(x) = \frac{1}{2\sqrt{x^2+1}} \cdot 2x = \frac{x}{\sqrt{x^2+1}}$$

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$f(g(x))=\sin(3x-1)$

$f(x)=\sin x$ $\quad g(x)=3x-1$
$f'(x)=\cos x$ $\quad g'(x)=3$

$$[f(g(x))]' = f'(g(x)) \cdot g'(x) = \cos(3x-1)\cdot 3 = 3\cos(3x-1)$$

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$$h(x)=(3x^4-2x+8)^{100}$$
$$=100(3x^4-2x+8)^{99}(12x^3-2)$$
$$h(x)=\ln(\sin(x^4+1))$$
$$h'(x)=\frac{1}{\sin(x^4+1)}\cdot\cos(x^4+1)\cdot(4x^3)$$

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$$h(x)=\log_3\sqrt{5x^2-1}=\log_3(5x^2-1)^{1/2}$$
$$h(x)=\frac{1}{2}\log_3(5x^2-1)=\frac{1}{2}\frac{\ln(5x^2-1)}{\ln 3}$$
$$h'(x)=\frac{1}{2\ln 3}\cdot\frac{1}{5x^2-1}\cdot 10x=\frac{5x}{\ln 3\cdot(5x^2-1)}$$

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$$\left[(1-x)^{20}\right]'=20(1-x)^{19}\cdot(-1)$$
$$\left(\frac{1}{2x+1}\right)'=\left[(2x+1)^{-1}\right]'=-1\cdot(2x+1)^{-2}\cdot 2$$

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5) $$f(x)=\frac{7}{3x^8-12x^3}=7(3x^8-12x^3)^{-1}$$
$$f'(x)=7(-1)\cdot(3x^8-12x^3)^{-2}(24x^7-36x^2)$$
$$=\frac{-7(24x^7-36x^2)}{(3x^8-12x^3)^2}=\frac{-7\cdot 12x^2(2x^5-3)}{[3x^3(x^5-4)]^2}$$
$$=\frac{-7\cdot 12x^2(2x^5-3)}{9x^6(x^5-4)^2}=\frac{-7\cdot 4(2x^5-3)}{3x^4(x^5-4)^2}$$
$$=\frac{-28(2x^5-3)}{3x^4(x^5-4)^2}$$

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$$\cos(-7x)=\cos(7x)$$
$$\sin(-7x)=-\sin(7x)$$
$$\cos^6(-7x)=\cos^6(7x)$$
$$\left[\cos^6(7x)\right]'=6\cos^5(7x)\cdot-\sin(7x)\cdot 7$$
$$=-42\cos^5(7x)\cdot\sin(7x)$$

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