The Derivative

1. By definition: $f'(a) = \lim_{h\to 0} \frac{f(a+h)-f(a)}{h}$

Example: find $f'(x)$ of $f(x) = x^2 + 2x$

Solution:

$$
\begin{aligned}
f'(x) &= \lim_{h\to 0} \frac{f(x+h)-f(x)}{h} \\
&= \lim_{h\to 0} \frac{((x+h)^2+2(x+h))-(x^2+2x)}{h} \\
&= \lim_{h\to 0} \frac{x^2+2hx+h^2+2x+2h-x^2-2x}{h} \\
&= \lim_{h\to 0} \frac{2hx+h^2+2h}{h} \\
&= \lim_{h\to 0} 2x+h+2 \\
&= 2x+2
\end{aligned}
$$

Questions: Find the derivative of each of the following functions.

1. $f(x)=2x^2$
2. $f(x)=3x^2+2x-1$
3. $f(x)=\frac{1}{x}$

***$\frac{dy}{dx} = dy/dx$, $\frac{df(x)}{dx} = df(x)/dx$, $\frac{d}{dx}f(x)$ and $f'(x)$ all represent the derivative. They are all the same, just in different forms.

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The Derivative

By Simple Rule:

Derivative of a constant number is 0. $f(x) = A \rightarrow f'(x) = 0$

Compare the following two equations, notice that the additive constants disappear and multiplicative constants are preserved.

$$y = A + f(x) \rightarrow y' = f'(x)$$

$$y = Af(x) \rightarrow y' = A f'(x)$$

$f(x) = x^a \rightarrow f'(x) = ax^{a-1}$ (*a* can be any constant number)

Example: Find the derivative $f(x) = 3x^3 - 6x^2 + 2x - 29$

Solution: $f'(x) = 3*3x^{3-1} - 6*2x^{2-1} + 2x^{1-1} = 9x^2 - 12x^1 + 2x^0 = 9x^2 - 12x + 2$

Questions: Find the derivative of each of the following functions.

1. $f(x) = 2x^2$
2. $f(x) = 3x^2 + 2x - 1$
3. $f(x) = \frac{1}{x}$

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