



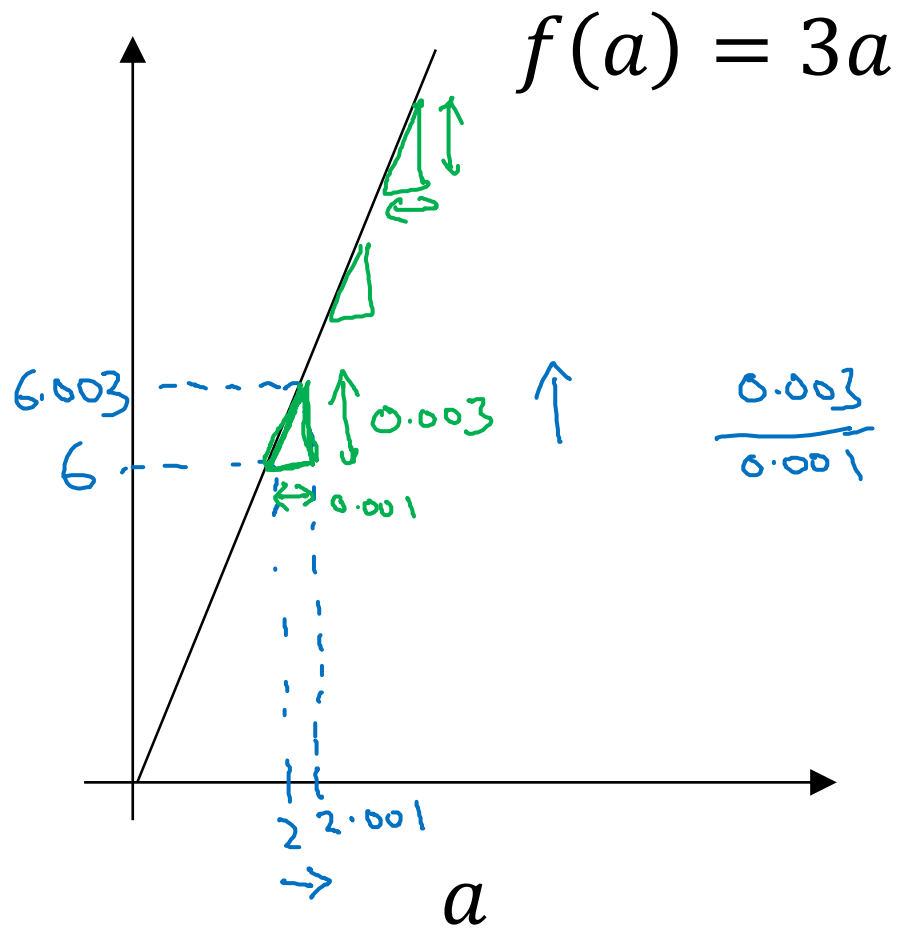
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# Basics of Neural Network Programming

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## Derivatives

# Intuition about derivatives



$\rightarrow a = 2$        $f(a) = 6$   
 $a = 2.001$        $f(a) = 6.003$

$\rightarrow$  slope (derivative) of  $f(a)$   
 at  $a = 2$  is  $3$

$\rightarrow a = 5$        $f(a) = 15$   
 $a = 5.001$        $f(a) = 15.003$   
 slope at  $a = 5$  is also  $3$

$\downarrow$   
 $\frac{df(a)}{da} = 3 = \frac{d}{da} f(a)$   
 $\uparrow$

$0.001 \leftarrow$   
 $0.000000001$   
 $0.0000000001$



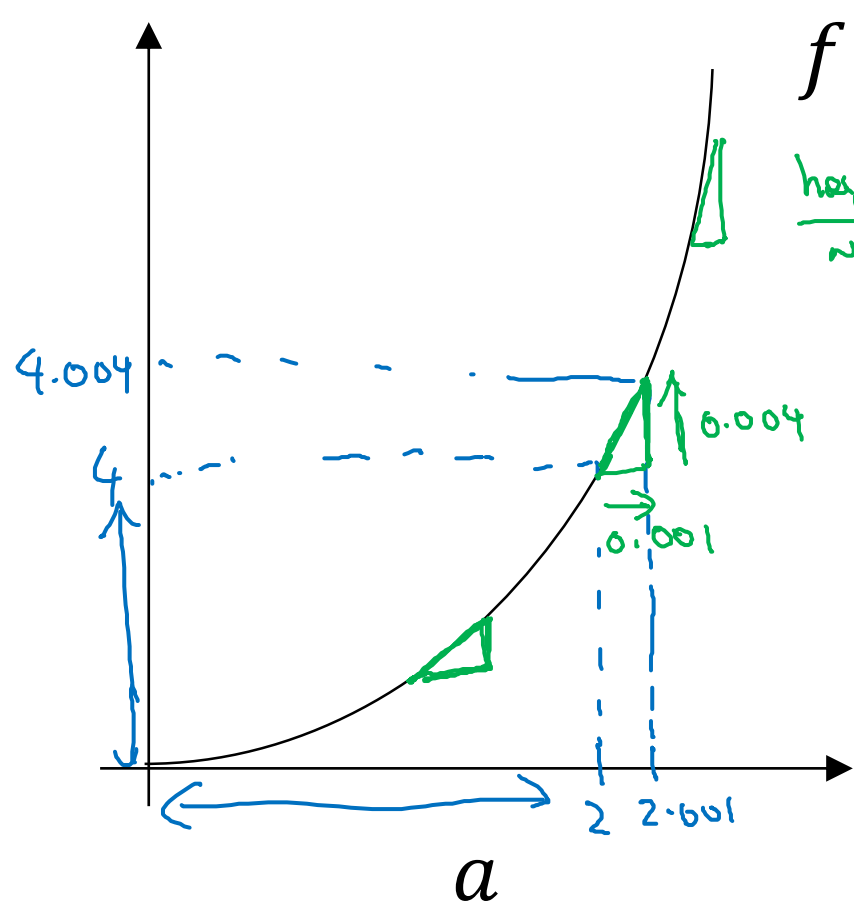
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# Basics of Neural Network Programming

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More derivatives  
examples

# Intuition about derivatives



$$f(a) = a^2$$

height  
width

$$\frac{d}{da} a^2 = 2a$$

$$0.001$$

$$(2a) \times 0.001$$

0.001 ←  
0.000000...01 ←

$a = 2$        $f(a) = 4$   
 $a = 2.001$        $f(a) \approx 4.004$   
 (4.004001) ←  
 slope (derivative) of  $f(a)$  at  
 $a = 2$  is 4.

$$\frac{d}{da} f(a) = 4 \quad \text{when } a = 2.$$

$a = 5$        $f(a) = 25$   
 $a = 5.001$        $f(a) \approx 25.010$

$$\frac{d}{da} f(a) = 10 \quad \text{when } a = 5$$

$$\frac{d}{da} f(a) = \frac{d}{da} a^2 = 2a$$

# More derivative examples

$$f(a) = a^2$$

$$\frac{d}{da} f(a) = \frac{2a}{4}$$

$$a = 2$$

$$f(a) = 4$$

$$a = 2.001$$

$$f(a) \approx 4.004$$

$$f(a) = a^3$$

$$\frac{d}{da} f(a) = \frac{3a^2}{3 \times 2^2 = 12}$$

$$a = 2$$

$$f(a) = 8$$

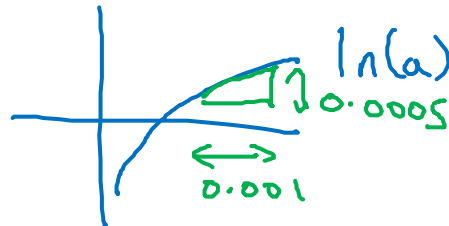
$$a = \underline{2.001}$$

$$f(a) \approx \underline{8.012}$$

$$f(a) = \log_e(a)$$
  

$$\ln(a)$$

$$\frac{d}{da} f(a) = \frac{1}{a}$$



$$\frac{d}{da} f(a) = \boxed{\frac{1}{2}}$$

$$a = 2$$

$$f(a) \approx 0.69315$$

$$\downarrow$$
  

$$a = \underline{2.001}$$

$$\downarrow$$
  

$$\underline{f(a) \approx 0.69365}$$

$$\downarrow$$
  

$$0.0005$$

$$\swarrow$$
  

$$\underline{0.0005}$$