



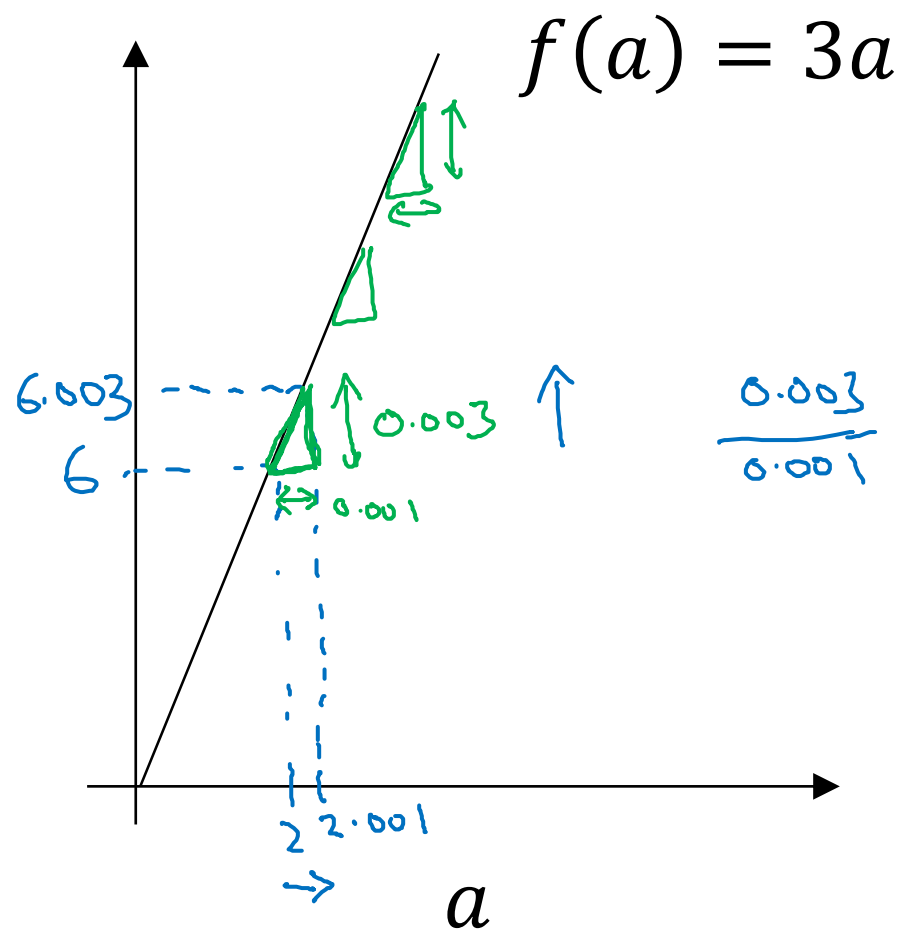
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# Basics of Neural Network Programming

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## Derivatives

# Intuition about derivatives



$$\frac{0.003}{0.001} \quad \frac{\text{height}}{\text{width}}$$

$\rightarrow a = 2 \quad f(a) = 6$   
 $a = 2.001 \quad f(a) = 6.003$   
 slope (derivative) of  $f(a)$  at  $a = 2$  is  $3$

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

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

$0.001 \leftarrow$   
 $0.000000001$   
 $0.0000000001$



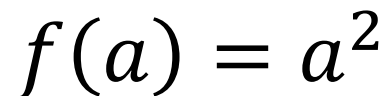
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# Basics of Neural Network Programming

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More derivatives  
examples

0.001 ←  
0.000000...01 ←


$$\frac{\text{height}}{\text{width}}$$

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

$$0.001$$
$$(2a) \times 0.001$$

$a = 2$                        $f(a) = 4$   
 $a = 2.001$                  $f(a) \approx 4.004$   
     $(4.004 \text{ } \boxed{004})$    
 slope (derivative) of  $f(a)$  at  
 $a = 2$  is 4.

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

$$\begin{array}{ll} a=5 & f(a)=25 \\ a=5.001 & f(a) \approx 25.010 \end{array}$$

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

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

# More derivative examples

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

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

$$a = 2$$

$$f(a) = 4$$

$$a = 2.001$$

$$f(a) \approx 4.004$$

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

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

$$a = 2$$

$$f(a) = 8$$

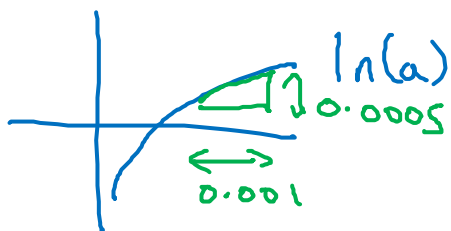
$$a = \underline{2.001}$$

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

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

$$\ln(a)$$

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



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

$$a = 2$$

$$f(a) \approx 0.69315$$

$$\downarrow$$
  

$$a = \underline{2.001}$$

$$\downarrow$$
  

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

$$\downarrow$$
  

$$0.0005$$
  

$$\swarrow$$
  

$$0.0005$$