

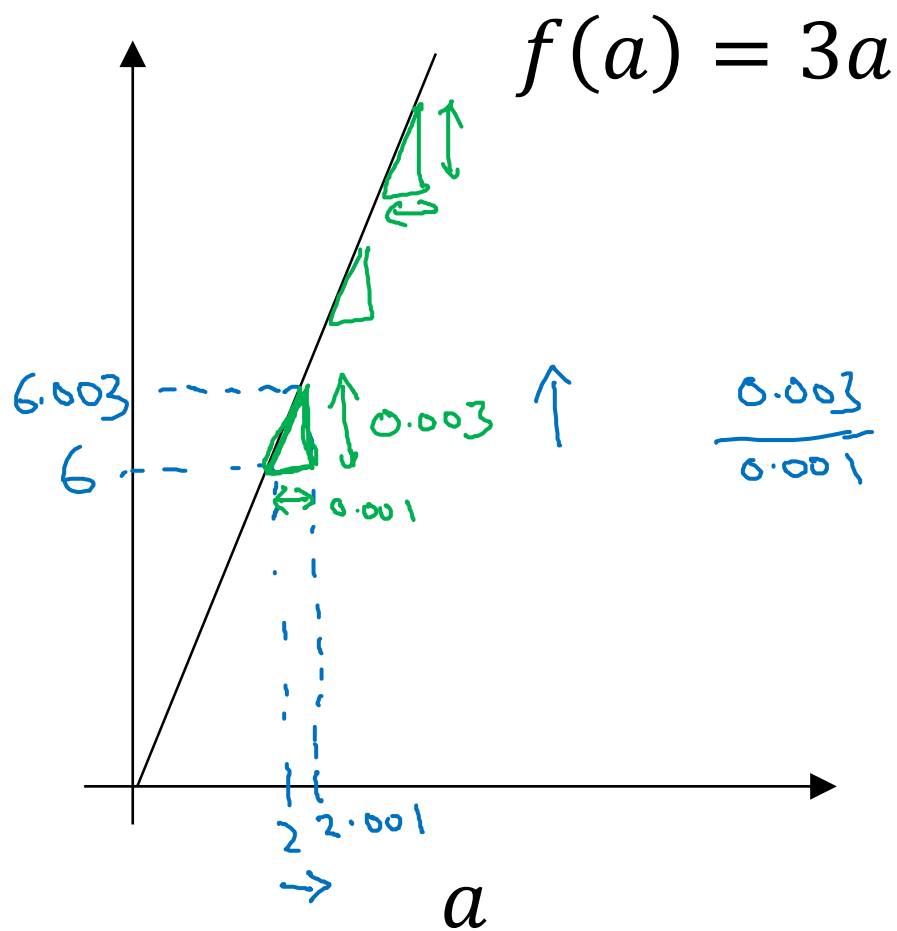


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Basics of Neural Network Programming

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

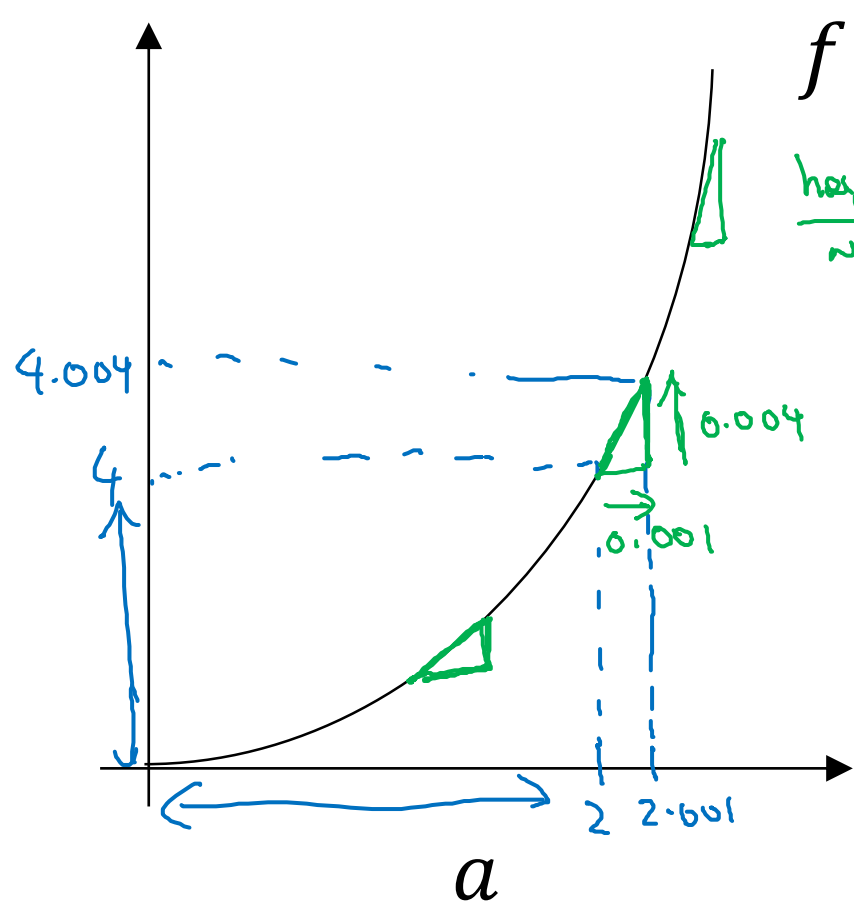


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Basics of Neural Network Programming

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

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

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

$$a = 2$$

$$f(a) = 4$$

$$a = 2.001$$

$$f(a) \approx 4.004$$

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

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

$$a = 2$$

$$f(a) = 8$$

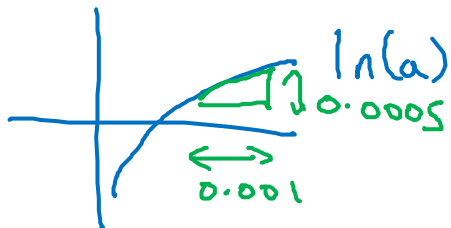
$$a = \underline{2.001}$$

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

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

$$\ln(a)$$

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



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

$$a = 2$$

$$f(a) \approx 0.69315$$

$$a = \underline{2.001}$$

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

$$\downarrow$$

$$0.0005$$

$$\swarrow$$

$$\underline{0.0005}$$