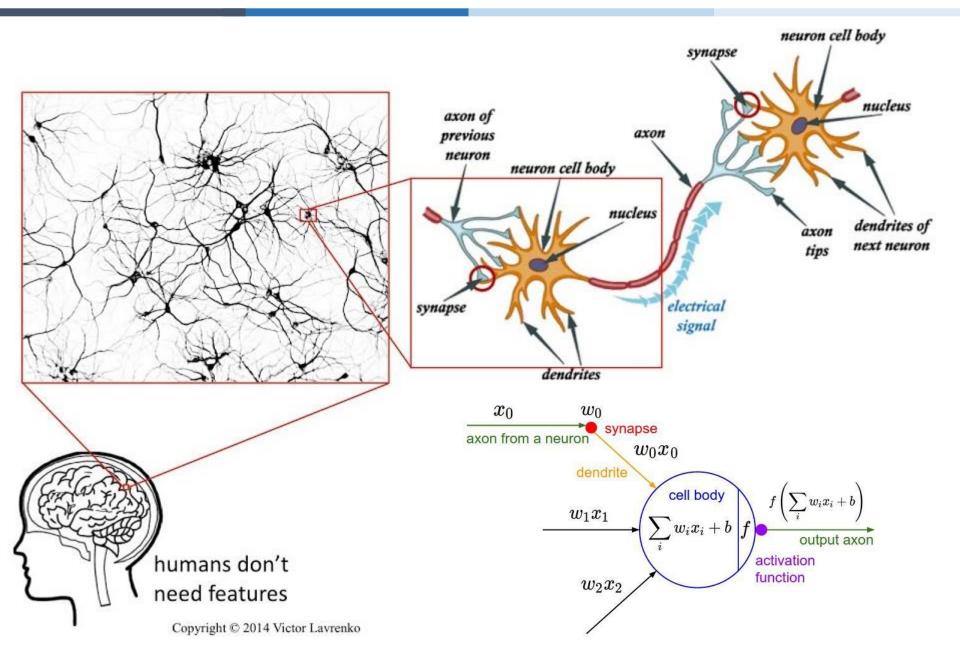
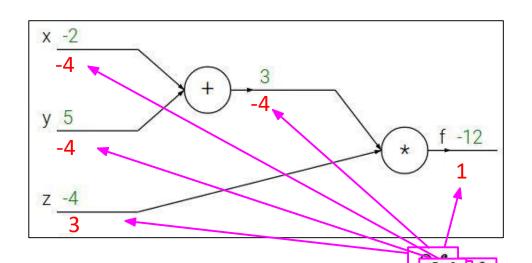
Neurons and the Brain



Backpropagation example 1

$$f(x, y, z) = (x + y)z$$

e.g. x = -2, y = 5, z = -4



$$q=x+y \qquad rac{\partial q}{\partial x}=1, rac{\partial q}{\partial y}=1$$

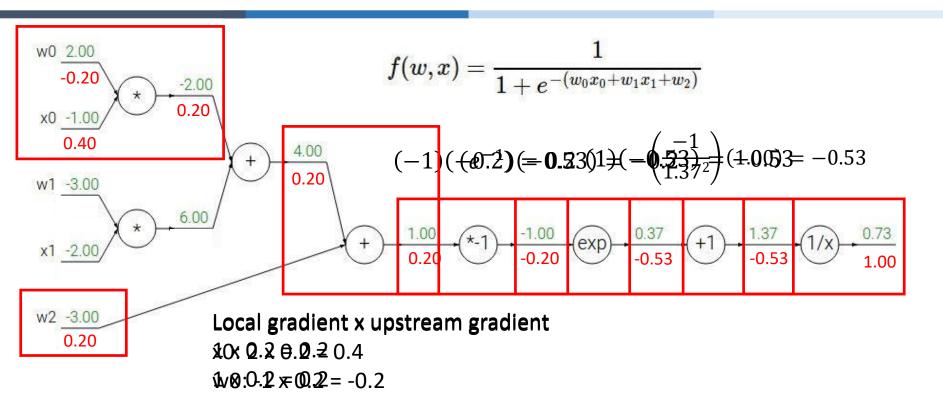
$$f=qz$$
 $rac{\partial f}{\partial q}=z, rac{\partial f}{\partial z}=q$

Want: $\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z}$

Chain rule:

$$\frac{\partial f}{\partial x} = \frac{\partial f}{\partial q} \frac{\partial q}{\partial x}$$

Backpropagation example 2



$$egin{aligned} f(x) = e^x &
ightarrow & rac{df}{dx} = e^x \ & \ f_a(x) = ax &
ightarrow & rac{df}{dx} = a \end{aligned}$$

$$f(x)=rac{1}{x} \qquad \qquad
ightarrow \qquad rac{df}{dx}=-1/x^2 \ f_c(x)=c+x \qquad \qquad
ightarrow \qquad rac{df}{dx}=1$$

Backpropagation example 2

$$f(w,x)=rac{1}{1+e^{-(w_0x_0+w_1x_1+w_2)}}$$

$$\sigma(x) = rac{1}{1+e^{-x}}$$

sigmoid function

$$rac{d\sigma(x)}{dx} = rac{e^{-x}}{(1+e^{-x})^2} = \left(rac{1+e^{-x}-1}{1+e^{-x}}
ight) \left(rac{1}{1+e^{-x}}
ight) = \left(1-\sigma(x)
ight)\sigma(x)$$

