deeplearning.ai

# One hidden layer Neural Network

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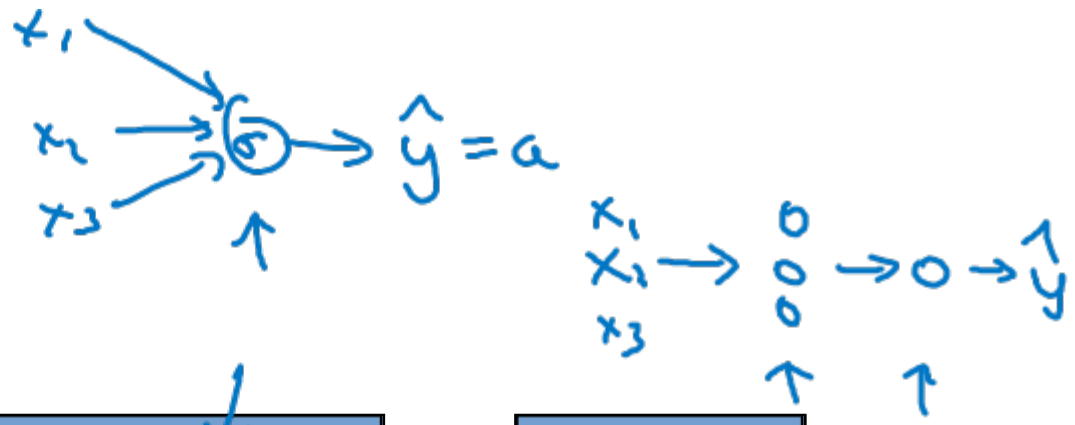
# Backpropagation intuition (Optional)

# Computing gradients

## Logistic regression



$x$

$w$

$b$

$z = w^T x + b$

$a = \sigma(z)$

$\mathcal{L}(a, y)$

$dz = a - y$

$dw = dz \cdot x$

$db = dz$

$dz = da \cdot g'(z)$

$da = \frac{d}{da}\mathcal{L}(a,y) = -y\log a - (1-y)\log(1-a)$

$= -\frac{y}{a} + \frac{1-y}{1-a}$

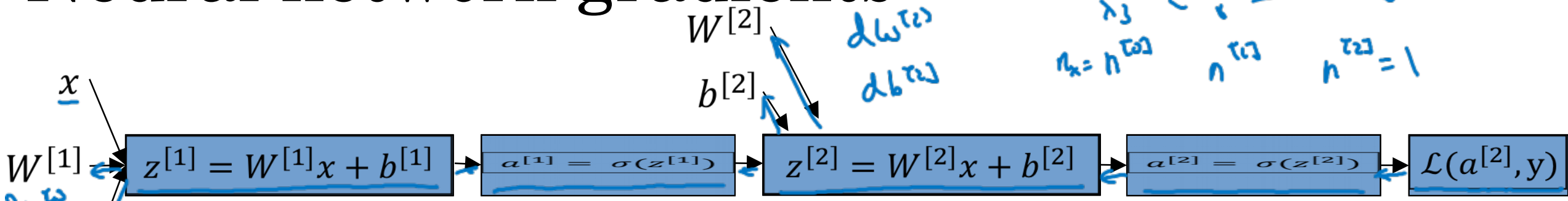
$g(z) = \sigma(z)$

$\frac{\partial \mathcal{L}}{\partial z} = \frac{\partial \mathcal{L}}{\partial a} \cdot \frac{da}{dz}$

"$dz$" = "$da$"

$\frac{d}{dz} g(z) = g'(z)$

# Neural network gradients





$n_x = n^{[0]}$ $n^{[1]}$ $n^{[2]} = 1$

$dW^{[1]}$ $db^{[1]}$ $dW^{[2]}$ $db^{[2]}$

$dz^{[1]} = W^{[2]T} dz^{[2]}$ $da^{[1]} = \ldots$ $dz^{[2]} = a^{[2]} - y$ $da^{[2]}$

$* g^{[1]'}(z^{[1]})$ ← element-wise product

$dW^{[2]} = dz^{[2]} a^{[1]T}$ $db^{[2]} = dz^{[2]}$

"$dw = dz \cdot x$"

$W^{[2]}$ $(n^{[2]}, n^{[1]})$

$z^{[1]}, dz^{[1]}$ $(n^{[1]}, 1)$ $-(1,1)$

$z^{[2]}, dz^{[2]}$ $(n^{[2]}, 1)$

$dz^{[1]} = W^{[2]T} dz^{[2]} * g^{[1]'}(z^{[1]})$

$(n^{[1]}, 1) = (n^{[1]}, n^{[2]})\ (n^{[2]}, 1) * (n^{[1]}, 1)$

foo
dfoo

$W^{[1]}$
$dW^{[1]}$

$dW^{[1]} = dz^{[1]} \cdot x^T$ $a^{[0]T}$

$db^{[1]} = dz^{[1]}$

# Summary of gradient descent

$$dz^{[2]} = a^{[2]} - y$$

$$dW^{[2]} = dz^{[2]} a^{[1]T}$$

$$db^{[2]} = dz^{[2]}$$

$$dz^{[1]} = W^{[2]T} dz^{[2]} * g^{[1]\prime}(z^{[1]})$$

$$dW^{[1]} = dz^{[1]} x^{T}$$

$$db^{[1]} = dz^{[1]}$$

Vectorized Implementation:

$$Z^{[1]} = W^{[1]} X + b^{[1]}$$

$$A^{[1]} = g^{[1]}(Z^{[1]})$$

$$Z^{[1]} = \begin{bmatrix} | & | & & | \\ z^{[1](1)} & z^{[1](2)} & \cdots & z^{[1](m)} \\ | & | & & | \end{bmatrix}$$

# Summary of gradient descent

$$dz^{[2]} = a^{[2]} - y$$

$$dW^{[2]} = dz^{[2]} a^{[1]T}$$

$$db^{[2]} = dz^{[2]}$$

$$dz^{[1]} = W^{[2]T} dz^{[2]} * g^{[1]\prime}(z^{[1]})$$

$(n^{[1]}, 1)$

$$dW^{[1]} = dz^{[1]} x^T$$

$$db^{[1]} = dz^{[1]}$$

$$dZ^{[2]} = A^{[2]} - Y$$

$$J(\cdot) = \frac{1}{m} \sum_{i=1}^{n} \mathcal{L}(\hat{y}, y)$$

$$dW^{[2]} = \frac{1}{m} dZ^{[2]} A^{[1]T}$$

$$db^{[2]} = \frac{1}{m} np.sum(dZ^{[2]}, axis = 1, keepdims = True)$$

$$dZ^{[1]} = W^{[2]T} dZ^{[2]} * g^{[1]\prime}(Z^{[1]})$$

$(n^{[1]}, m)$ $(n^{[1]}, m)$ $(n^{[1]}, m)$

elementwise product

$$dW^{[1]} = \frac{1}{m} dZ^{[1]} X^T$$

$$db^{[1]} = \frac{1}{m} np.sum(dZ^{[1]}, axis = 1, keepdims = True)$$