



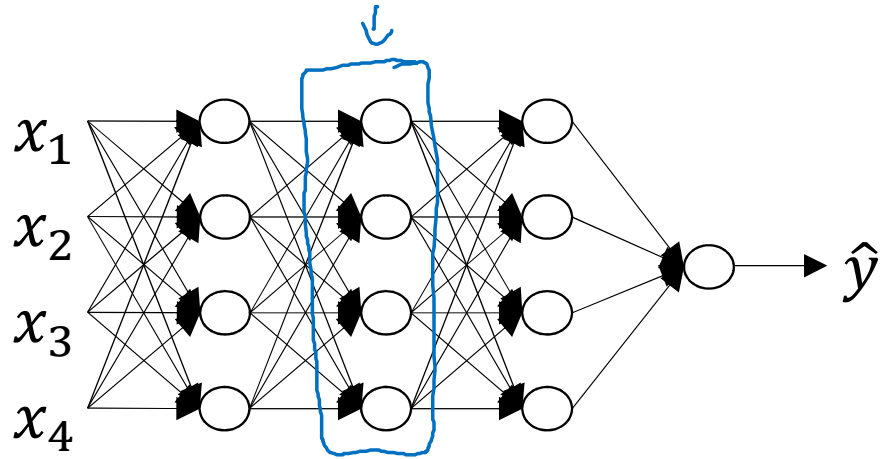
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# Deep Neural Networks

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Building blocks of  
deep neural networks

# Forward and backward functions



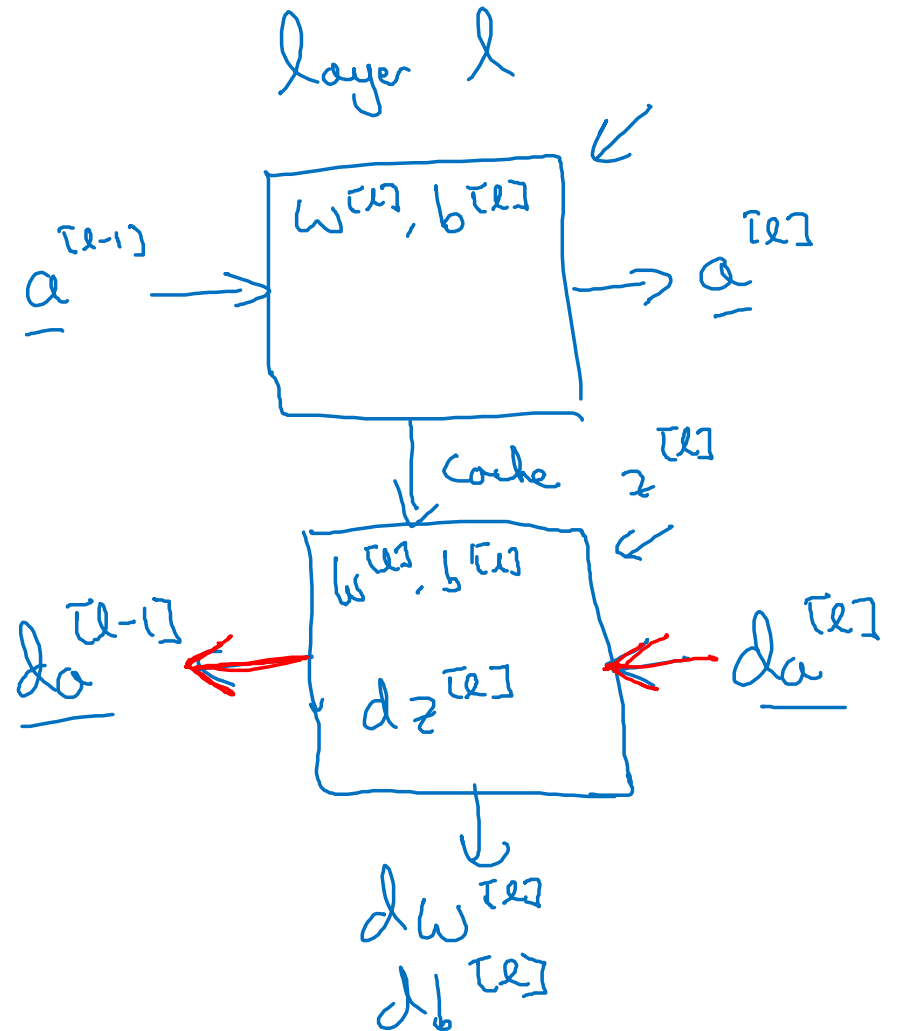
Layer  $l$ :  $W^{[l]}, b^{[l]}$

→ Forward: Input  $a^{[l-1]}$ , output  $a^{[l]}$

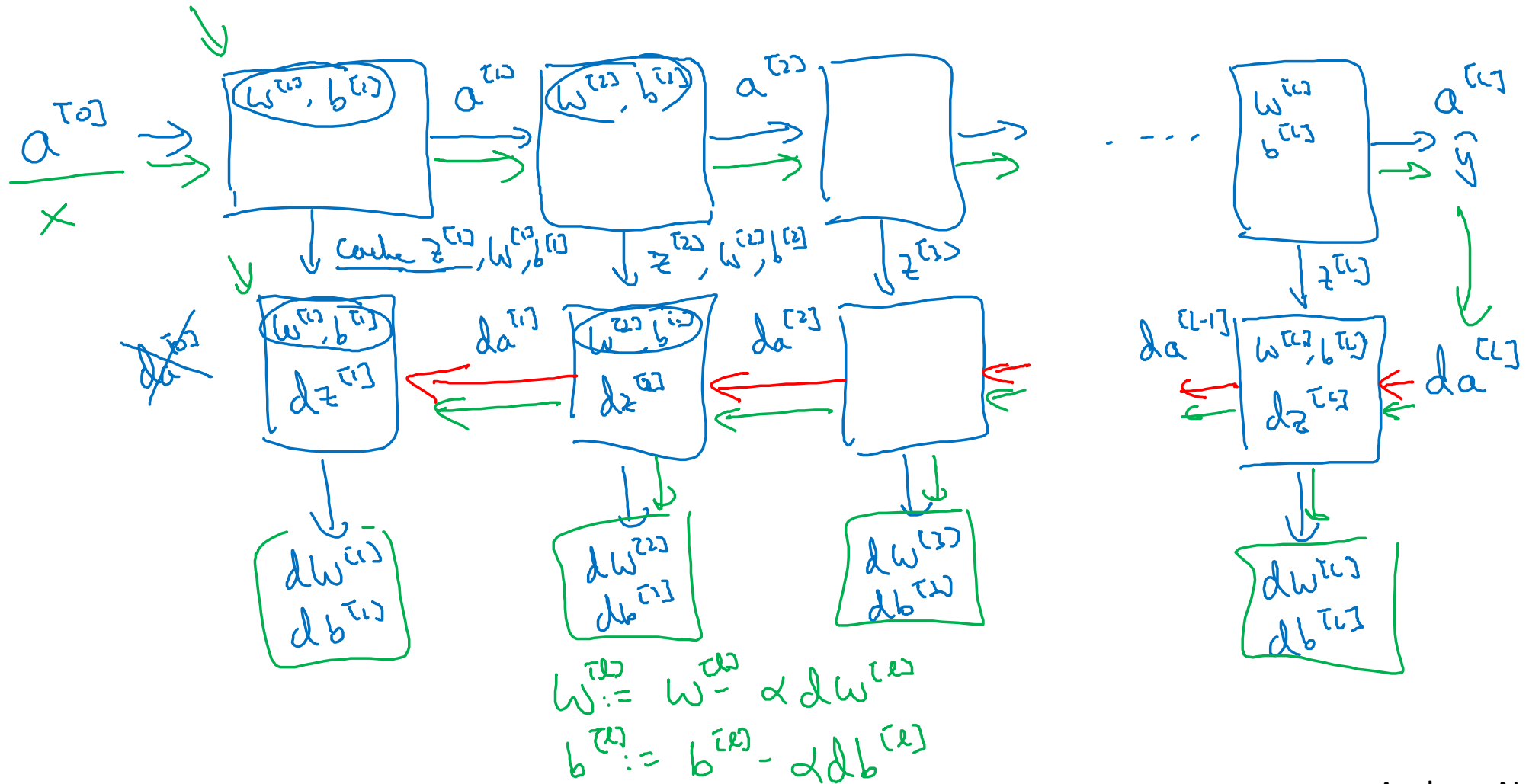
$$z^{[l]} = W^{[l]} a^{[l-1]} + b^{[l]} \quad \text{cache } z^{[l]}$$

$$a^{[l]} = g^{[l]}(z^{[l]})$$

→ Backward: Input  $da^{[l]}$ , output  $da^{[l-1]}$   
 cache  $(z^{[l]})$   
 $\frac{dW^{[l]}}{db^{[l]}}$



# Forward and backward functions





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Forward and backward  
propagation

# Forward propagation for layer $l$

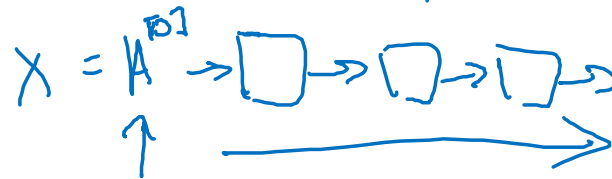
→ Input  $a^{[l-1]}$  ←

→ Output  $a^{[l]}$ , cache ( $z^{[l]}$ )

$$z^{[l]} = W^{[l]} \cdot a^{[l-1]} + b^{[l]}$$

$$a^{[l]} = g^{[l]}(z^{[l]})$$

$a^{[0]}$   
 $A^{[0]}$



Vectorized:

$$z^{[l]} = W^{[l]} \cdot A^{[l-1]} + b^{[l]}$$

$$A^{[l]} = g^{[l]}(z^{[l]})$$

# Backward propagation for layer $l$

→ Input  $da^{[l]}$

→ Output  $da^{[l-1]}$ ,  $dW^{[l]}$ ,  $db^{[l]}$

$$dz^{[l]} = da^{[l]} * g^{[l]'}(z^{[l]})$$

$$dW^{[l]} = dz^{[l]} \cdot a^{[l-1]}$$

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

$$da^{[l-1]} = W^{[l]T} \cdot dz^{[l]}$$

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

$$dz^{[l]} = dA^{[l]} * g^{[l]'}(z^{[l]})$$

$$dW^{[l]} = \frac{1}{n} dz^{[l]} \cdot A^{[l-1]T}$$

$$db^{[l]} = \frac{1}{n} \text{np.sum}(dz^{[l]}, \text{axis}=1, \text{keepdims}=True)$$

$$dA^{[l-1]} = W^{[l]T} \cdot dz^{[l]}$$

# Summary

