



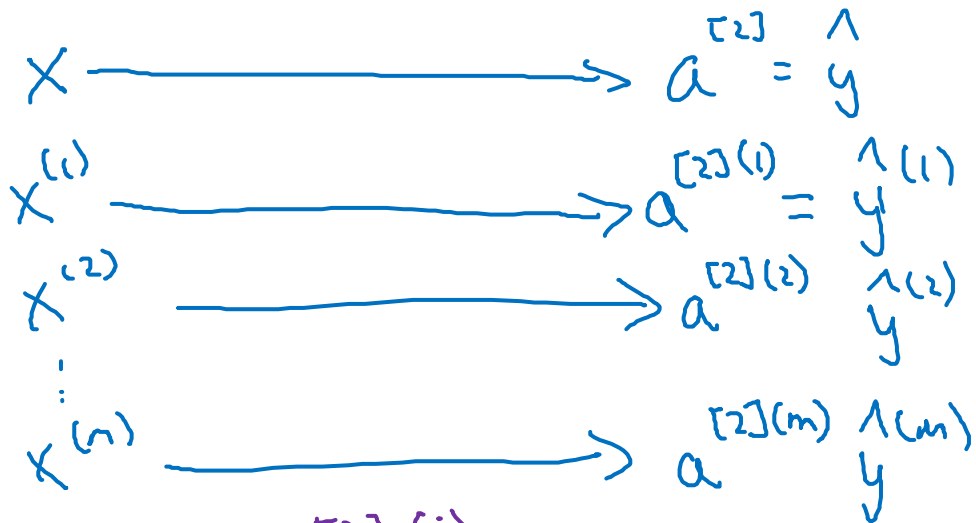
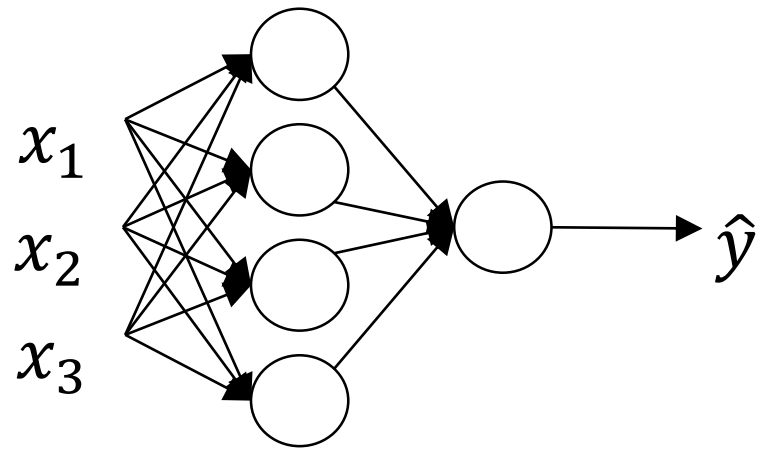
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One hidden layer  
Neural Network

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Vectorizing across  
multiple examples

# Vectorizing across multiple examples



$a^{[2](i)}$   
 $\nwarrow$  example  $i$   
 $\swarrow$  layer 2

$$z^{[1]} = W^{[1]}x + b^{[1]}$$

$$a^{[1]} = \sigma(z^{[1]})$$

$$z^{[2]} = W^{[2]}a^{[1]} + b^{[2]}$$

$$a^{[2]} = \sigma(z^{[2]})$$

for  $i = 1$  to  $m$ ,

$$z^{[1](i)} = W^{[1]}x^{(i)} + b^{[1]}$$

$$a^{[1](i)} = \sigma(z^{[1](i)})$$

$$z^{[2](i)} = W^{[2]}a^{[1](i)} + b^{[2]}$$

$$a^{[2](i)} = \sigma(z^{[2](i)})$$

# Vectorizing across multiple examples

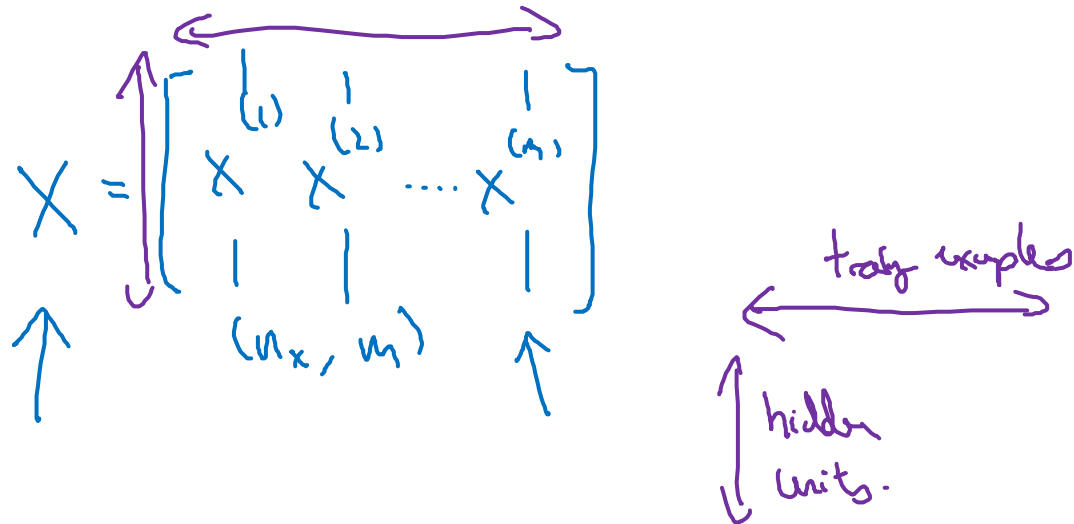
for  $i = 1$  to  $m$ :

$$z^{[1]}(i) = W^{[1]}x^{(i)} + b^{[1]}$$

$$a^{[1]}(i) = \sigma(z^{[1]}(i))$$

$$z^{[2]}(i) = W^{[2]}a^{[1]}(i) + b^{[2]}$$

$$a^{[2]}(i) = \sigma(z^{[2]}(i))$$

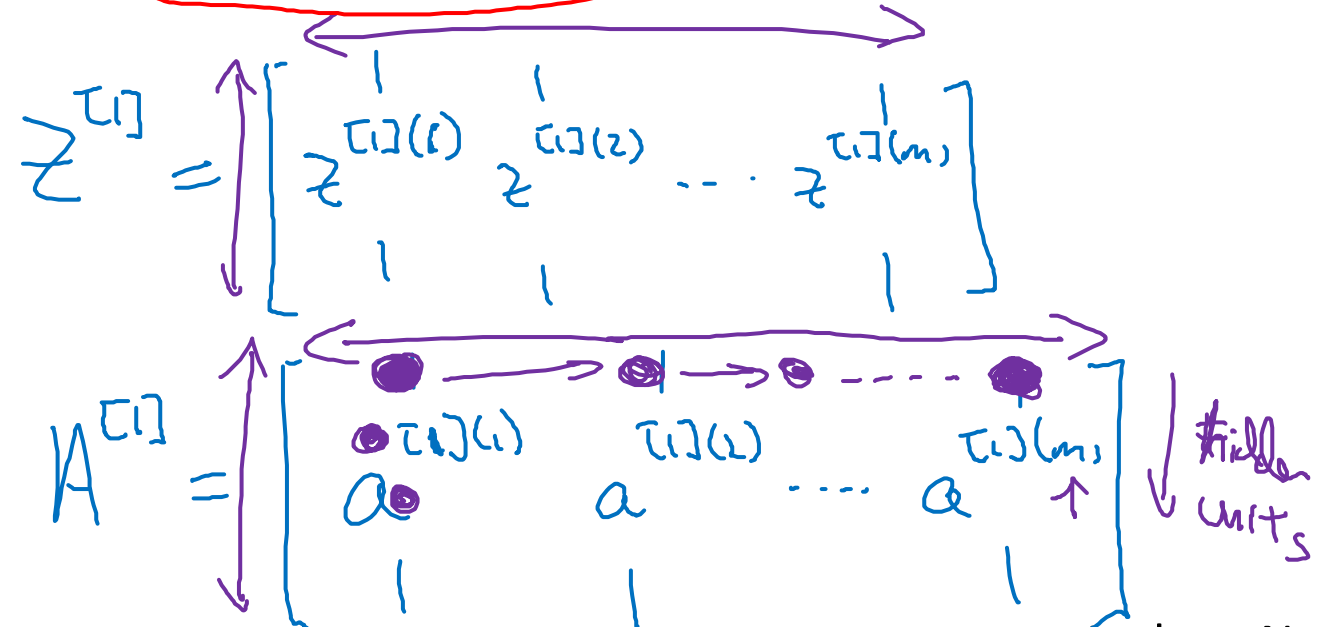


$$z^{[1]} = W^{[1]}X + b^{[1]}$$

$$\rightarrow A^{[1]} = \sigma(z^{[1]})$$

$$\rightarrow z^{[2]} = W^{[2]}A^{[1]} + b^{[2]}$$

$$\rightarrow A^{[2]} = \sigma(z^{[2]})$$





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# One hidden layer Neural Network

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Explanation  
for vectorized  
implementation

# Justification for vectorized implementation

$$z^{[1](1)} = \omega^{[1]} x^{(1)} + \cancel{b^{[1]}} \quad , \quad z^{[1](2)} = \omega^{[1]} x^{(2)} + \cancel{b^{[1]}} \quad , \quad z^{[1](3)} = \omega^{[1]} x^{(3)} + \cancel{b^{[1]}}$$

↑ ↘ 0
↑ ↘ 0
↑ ↘ 0

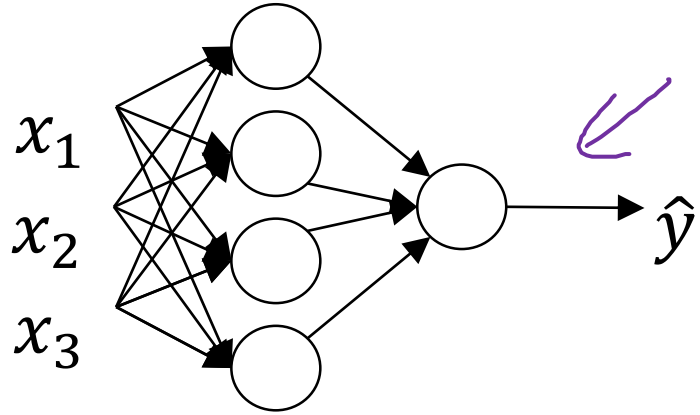
$$\omega^{[1]} = \begin{bmatrix} \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \end{bmatrix} \quad \omega^{[1]} x^{(1)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix} \quad \omega^{[1]} x^{(2)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix} \quad \omega^{[1]} x^{(3)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix}$$

$$\omega^{[1]} \begin{bmatrix} | & | & | & \dots \\ x^{(1)} & x^{(2)} & x^{(3)} & \dots \\ | & | & | & \dots \end{bmatrix} = \begin{bmatrix} \bullet & \bullet & \bullet & \dots \\ \bullet & \bullet & \bullet & \dots \\ \bullet & \bullet & \bullet & \dots \\ \bullet & \bullet & \bullet & \dots \end{bmatrix} = \begin{bmatrix} | & | & | & \dots \\ z^{[1](1)} & z^{[1](2)} & z^{[1](3)} & \dots \\ | & | & | & \dots \end{bmatrix} = z^{[1]}$$

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$\hat{z} = \omega^{[1]} X + b^{[1]}$

# Recap of vectorizing across multiple examples



$$X = \begin{bmatrix} | & | & \dots & | \\ x^{(1)} & x^{(2)} & \dots & x^{(m)} \\ | & | & \dots & | \end{bmatrix}$$

A purple arrow points from this matrix towards the right.

$$\underline{A^{[1]}} = \begin{bmatrix} | & | & \dots & | \\ a^{[1]}(1) & a^{[1]}(2) & \dots & a^{[1]}(m) \\ | & | & \dots & | \end{bmatrix}$$

A purple arrow points from this matrix towards the right.

for  $i = 1$  to  $m$

$$z^{[1]}(i) = W^{[1]}x^{(i)} + b^{[1]}$$

$$a^{[1]}(i) = \sigma(z^{[1]}(i))$$

$$z^{[2]}(i) = W^{[2]}a^{[1]}(i) + b^{[2]}$$

$$a^{[2]}(i) = \sigma(z^{[2]}(i))$$

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

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

$$Z^{[2]} = W^{[2]}A^{[1]} + b^{[2]}$$

$$A^{[2]} = \sigma(Z^{[2]})$$

$$x = a^{[0]} \quad x^{(i)} = a^{[0]}(i)$$

$$W^{[1]}A^{[0]} + b^{[1]}$$