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One hidden layer Neural Network

Explanation
for vectorized
implementation

Justification for vectorized implementation

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

Handwritten notes show the bias term $b^{[1]}$ being crossed out with a red line and a red arrow pointing to a zero, indicating it is added to each element of the vector $w^{[1]} x$.

$$w^{[1]} = \begin{bmatrix} \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \end{bmatrix}$$

$$w^{[1]} x^{(1)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix}$$

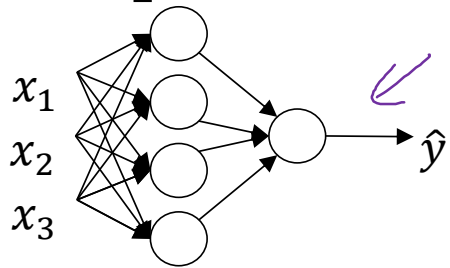
$$w^{[1]} x^{(2)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix}$$

$$w^{[1]} x^{(3)} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix}$$

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

Handwritten notes show the bias term $b^{[1]}$ being added to each element of the vector $w^{[1]} x$ to get $z^{[1]}$. The final result is labeled $z^{[1]}$.

Recap of vectorizing across multiple examples



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

A purple arrow points to the matrix X .

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

A purple arrow points to the matrix $A^{[1]}$.

for $i = 1$ to m

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

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

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

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

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

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

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

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

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

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