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Forward  
Propagation  
over 1 example

$$a^{[1]} = g(z) = \sigma(z^{[1]}) = \begin{cases} \sigma(z_1^{[1]}) \\ \sigma(z_2^{[1]}) \end{cases}$$

$$\begin{aligned} z_1 &= (w^{[1]})^T a^{[0]} + b^{[1]} \\ a_1 &= \sigma(z_1) \\ z_2 &= (w^{[2]})^T a^{[1]} + b^{[2]} \end{aligned}$$

$$a_2 = \sigma(z_2)$$

$$z_3 = (w^3)^T a^{[2]} + b^{[3]}$$

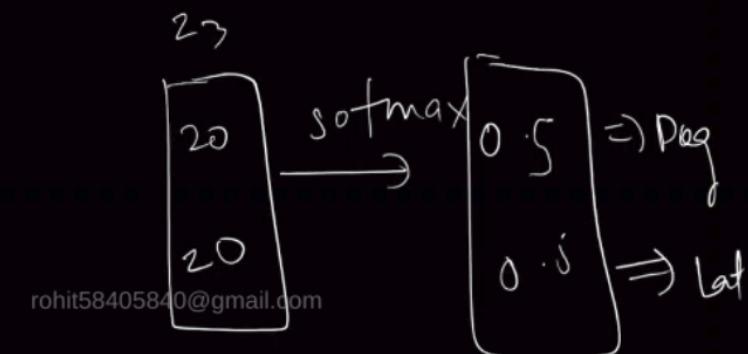
$$\hat{y} = \underline{\text{Softmax}}(z_3)$$

Outpt.  
after  
hidden  
layer

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$$\begin{aligned} z_3 &= \underline{w^T} \cdot \underline{u} \\ \hat{y} &= \underline{\text{softmax}}(z_3) \end{aligned}$$

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$$u = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix} \quad (n, 1)$$

$$X = \begin{bmatrix} x_1^{(1)} & x_2^{(1)} & \dots & x_n^{(1)} \\ \vdots & \vdots & \ddots & \vdots \\ x_1^{(m)} & x_2^{(m)} & \dots & x_n^{(m)} \end{bmatrix}$$

$\underline{m \times n}$

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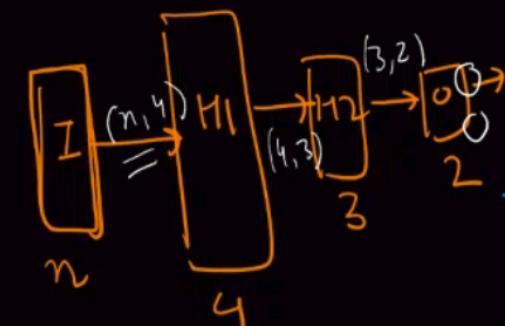


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$$\begin{bmatrix} x_3 \end{bmatrix}_{(n,1)} \xrightarrow{\quad} A^{[0]} = X \quad \begin{bmatrix} x^{(1)} \end{bmatrix}_{m \times n}$$

$$z_1 = \underbrace{A^{[0]} \cdot W^{[1]}}_{\substack{(m,n) \times (n,u) \\ (m,y)}} + b$$

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$$X = A^{[0]} = \begin{bmatrix} x_1^1 & x_2^1 & x_3^1 & \dots & x_n^1 \\ x_1^2 & x_2^2 & x_3^2 & & \\ & & & & \\ & & & & \end{bmatrix}_{m \times n}$$

$$W = \begin{bmatrix} w_{11} & w_{12} & w_{13} & \dots & w_{1n} \\ w_{21} & w_{22} & w_{23} & \dots & w_{2n} \\ & & & & \\ & & & & \end{bmatrix}_{n \times 4}$$

$w_{ij} =$   
 $w_{ij}^i = j^{\text{th}} \text{ feature}$   
 $\text{for } i^{\text{th}}$   
 $\text{example}$

$$Z^{[1]} = \left[ \begin{array}{c} x_1^1 w_{11} + x_2^1 w_{21} + \dots + x_n^1 w_{n1} \\ \vdots \\ . \\ \vdots \\ x_1^4 w_{14} + x_2^4 w_{24} + \dots + x_n^4 w_{n4} \end{array} \right]_{m \times 4} + b^{[1]}$$

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L

$m \times n$

$n \times 4$

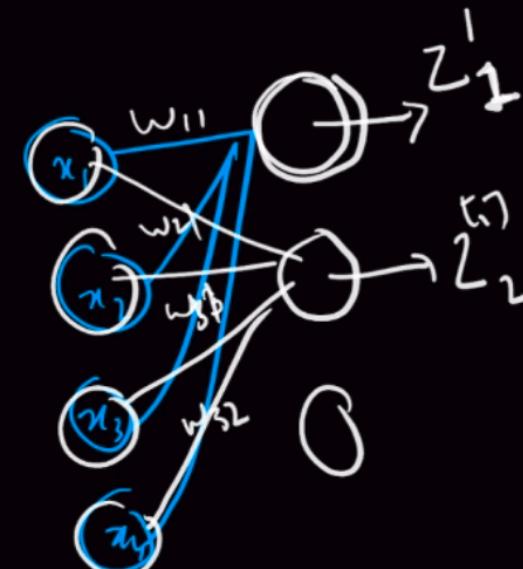
$x_j^i = j^{th}$  feature  
for  $i^{th}$  example

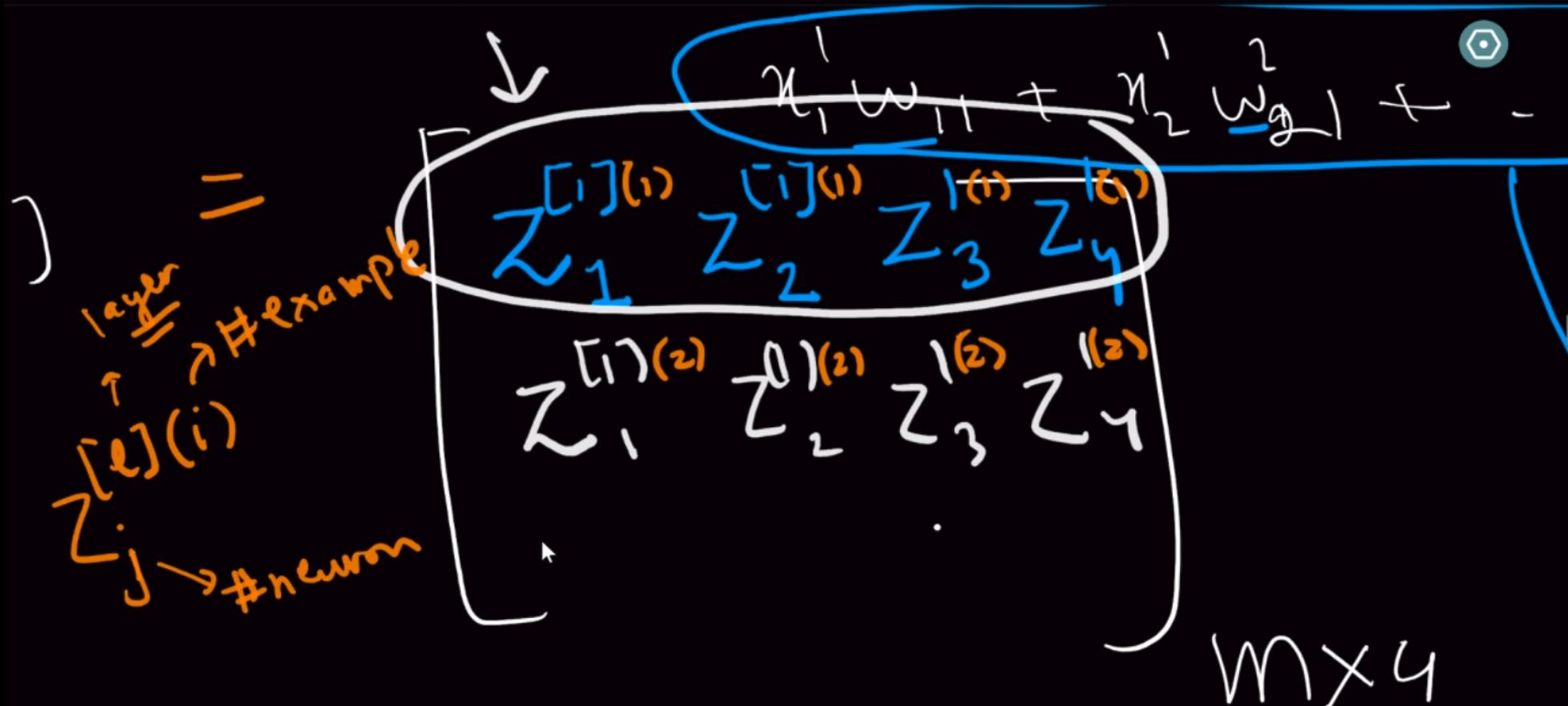


$$Z^{[1]} = \begin{bmatrix} Z_1^{[1]} & Z_2^{[1]} & Z_3^{[1]} & Z_4^{[1]} \end{bmatrix}_{m \times 4}$$

$\sum_{j=1}^n x_j^i w_{j1} + b_1$

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$$A^{[0]} = \begin{bmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{bmatrix}$$

$m \times n$

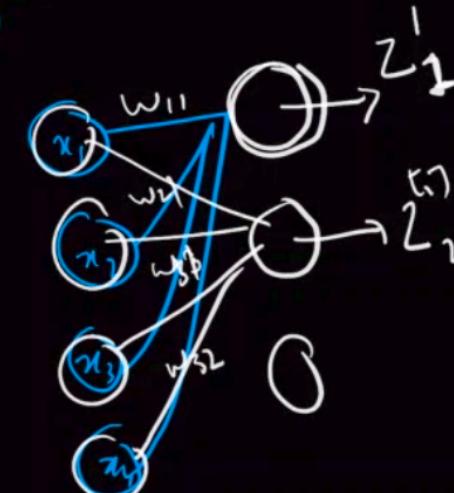
$n \times 4$        $n_j^{[i]} = j^{\text{th}} \text{ feature}$   
for  $i^{\text{th}}$  example

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$$Z^{[1]} = \begin{bmatrix} z_1^{[1](1)} & z_2^{[1](1)} & z_3^{[1](1)} & z_4^{[1](1)} \\ z_1^{[1](2)} & z_2^{[1](2)} & z_3^{[1](2)} & z_4^{[1](2)} \end{bmatrix}_{m \times 4}$$

$\downarrow$

$$\sum_{j=1}^4 (x_j w_{j1} + x_j w_{j2} + \dots + x_j w_{jn}) + b^{[1]}$$

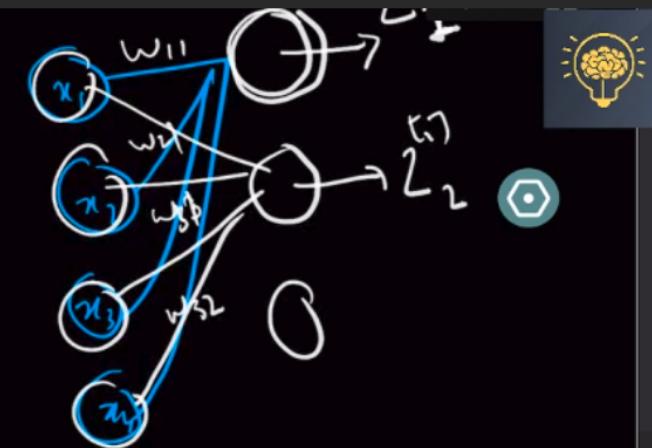


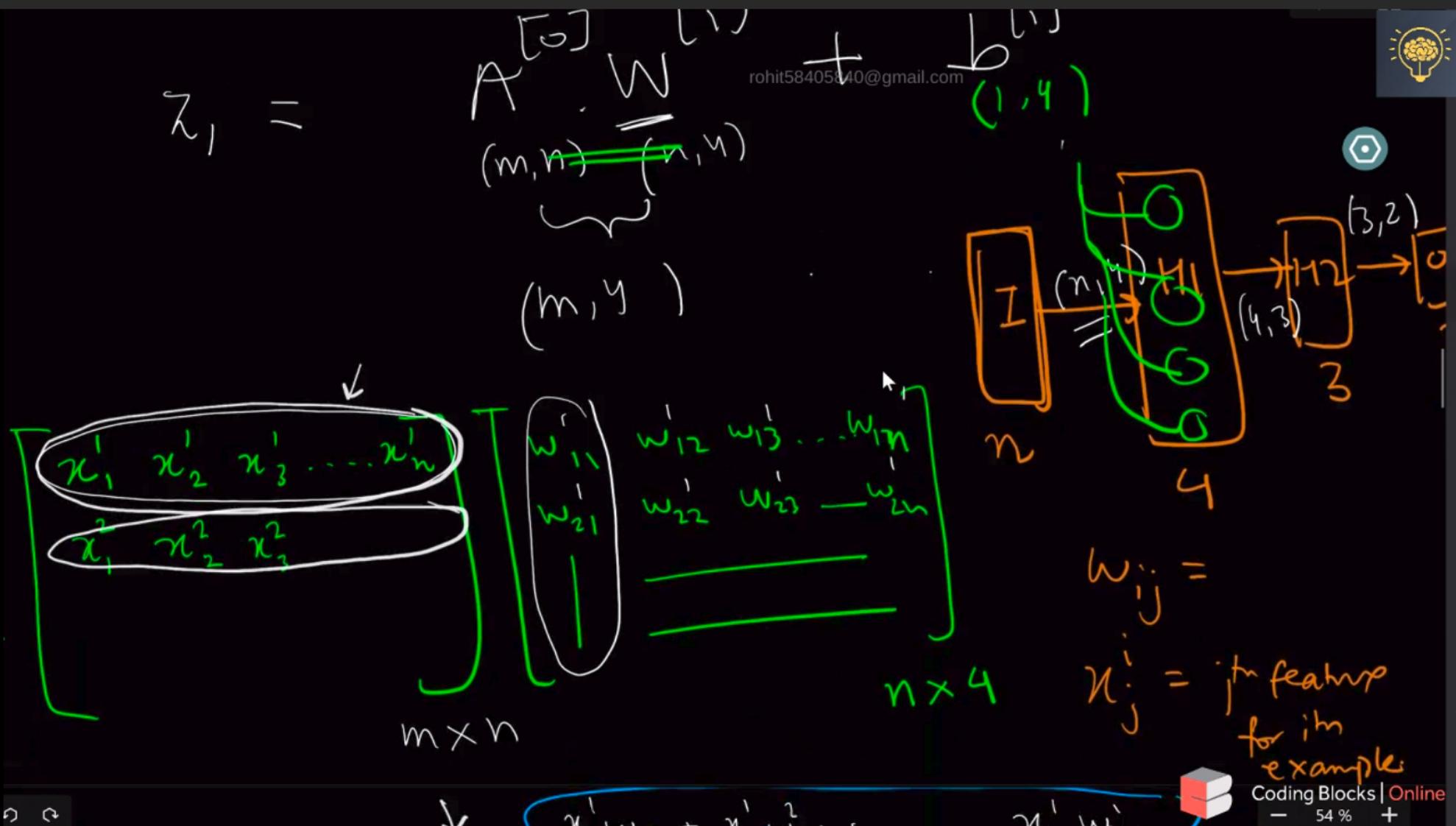
$\hookrightarrow \text{j} \rightarrow \# \text{neuron}$

$$A^{(1)} = \sigma \left[ -z^{(1)} - \right]$$

$\hookrightarrow m \times 4$

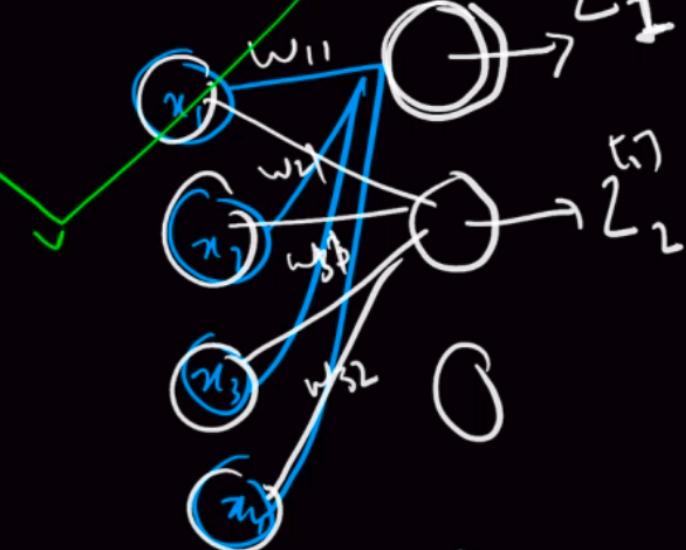
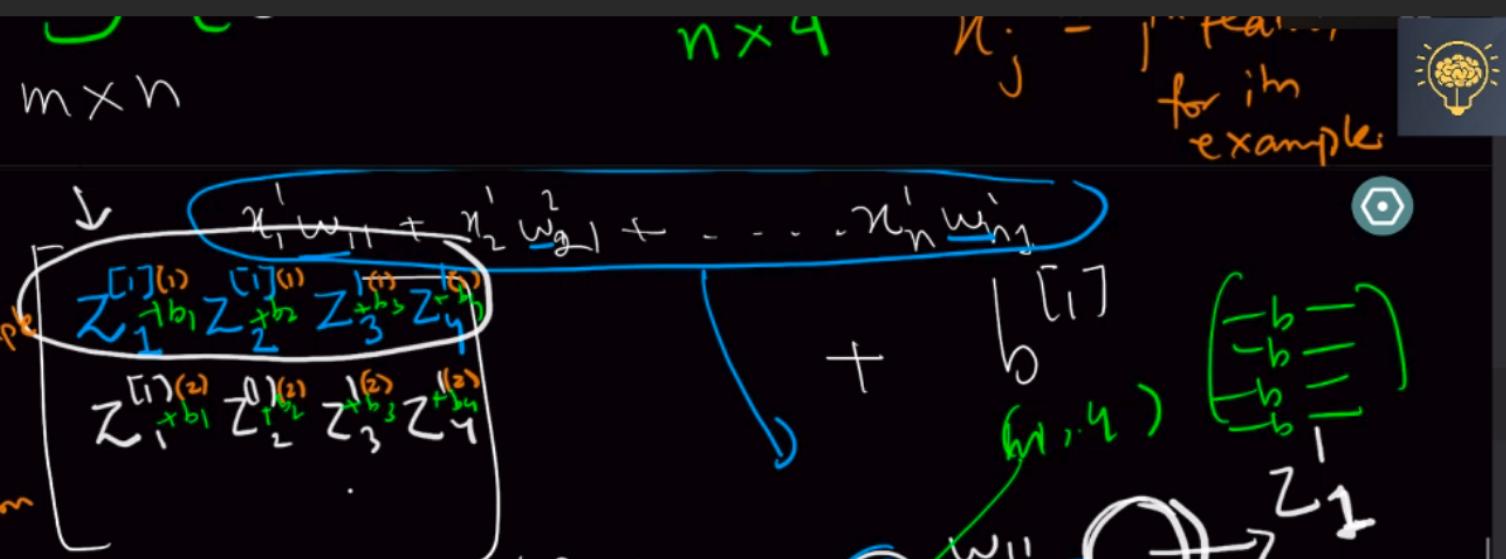
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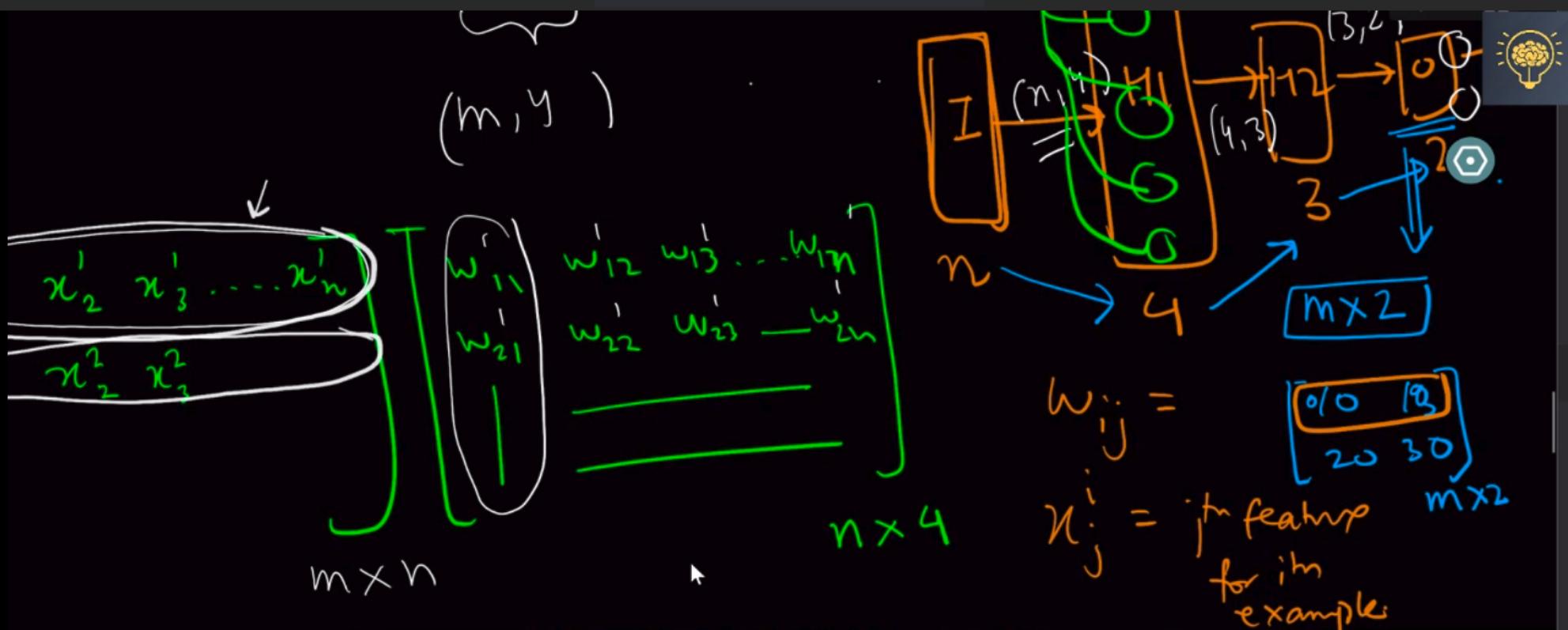


$$\sum_{j=1}^n \text{layer}(j) = \text{example}(i)$$

$$A^{(1)} = \sigma \begin{bmatrix} 1 \\ -z^{(1)} \\ 1 \end{bmatrix}$$



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$$z^{(1)} = \sum_{j=1}^4 x_j^1 w_{1j} + b_1$$

Example:

$$z^{(1)(1)} = x_1^{(1)} z_1^{(1)} + x_2^{(1)} z_2^{(1)} + x_3^{(1)} z_3^{(1)} + x_4^{(1)} z_4^{(1)} + b_1$$

$$z^{(1)(2)} = x_1^{(2)} z_1^{(2)} + x_2^{(2)} z_2^{(2)} + x_3^{(2)} z_3^{(2)} + x_4^{(2)} z_4^{(2)} + b_2$$

$$\vdots$$

$$z^{(1)(n)} = x_1^{(n)} z_1^{(n)} + x_2^{(n)} z_2^{(n)} + x_3^{(n)} z_3^{(n)} + x_4^{(n)} z_4^{(n)} + b_n$$

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C1      C2  
0.5      0.5

$$\text{out}_3 = \begin{bmatrix} 10 & 10 \\ 20 & 30 \\ 0.1 & 0.9 \end{bmatrix} \text{ m} \times \text{k}$$

3<sup>rd</sup> example

$K=2$  no of classes