**XOR LOGIC**

Outputs true (1) only when inputs differ. This is expressed as:

A XOR B = (A AND NOT B) OR (NOT A AND B)

0 XOR 0 = (0 AND NOT 0) OR (NOT 0 AND 0) = (0 AND 1) OR (1 AND 0) = 0 OR 0 = 0

**MATRIX COMPUTATION OF OR GATE**

Input matrix logic_inputs:

$$\begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix}$$

Weights vector W1:

$$\begin{bmatrix} 20 \\ 20 \end{bmatrix}$$

In layer:

inputs * weights + bias then apply activation function to result

z = inputs * weights + bias then sigmoid(z)

z = logic_inputs * weights + bias

$$z = \begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} 20 \\ 20 \end{bmatrix} + (-10) = \begin{bmatrix} 0 \cdot 20 + 0 \cdot 20 \\ 0 \cdot 20 + 1 \cdot 20 \\ 1 \cdot 20 + 0 \cdot 20 \\ 1 \cdot 20 + 1 \cdot 20 \end{bmatrix} - 10 = \begin{bmatrix} 0 \\ 20 \\ 20 \\ 40 \end{bmatrix} - 10 = \begin{bmatrix} -10 \\ 10 \\ 10 \\ 30 \end{bmatrix}$$

$$\text{sigmoid}(\begin{bmatrix} -10 \\ 10 \\ 10 \\ 30 \end{bmatrix}) = \begin{bmatrix} 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$