

AI CLUB

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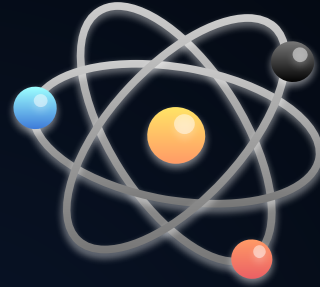


TABLE OF CONTENTS



01

Data Storage

Scalars
Vectors
Matrices

02

How does an
Artificial Neuron
work?

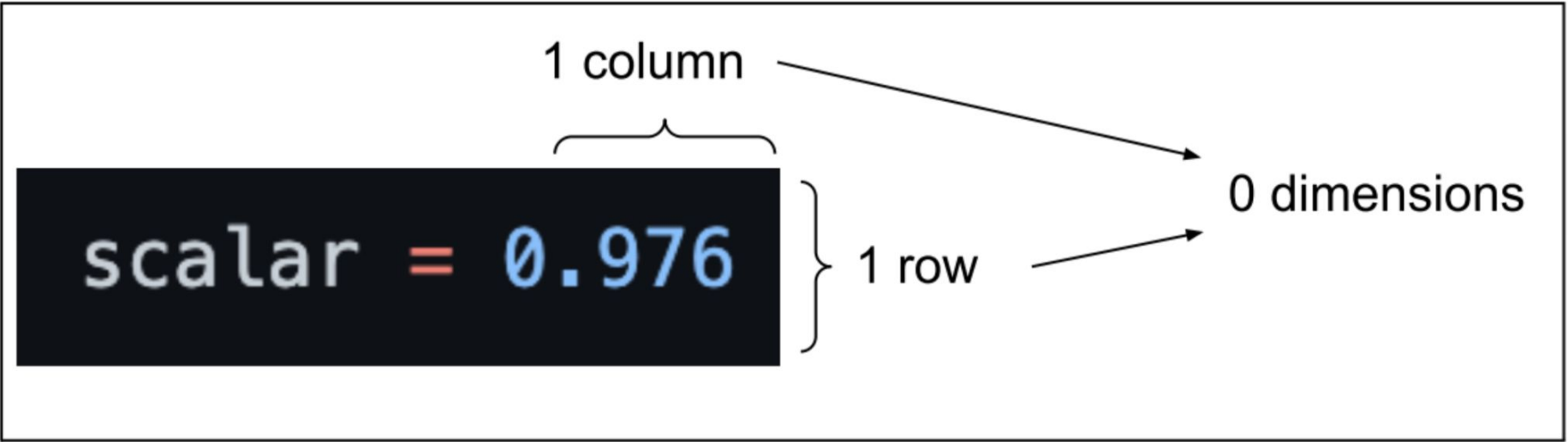
03

How does a
Layer of Neurons
work?

Scalar/Scalars

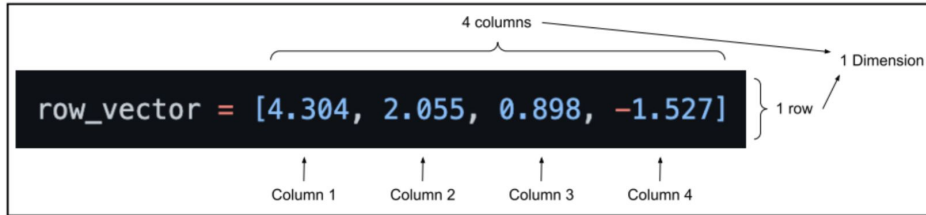
The Python name for scalar includes int, Float (decimal), or just any other type to STORE 1 VALUE.

Scalar in Python Example: This scalar is a float.



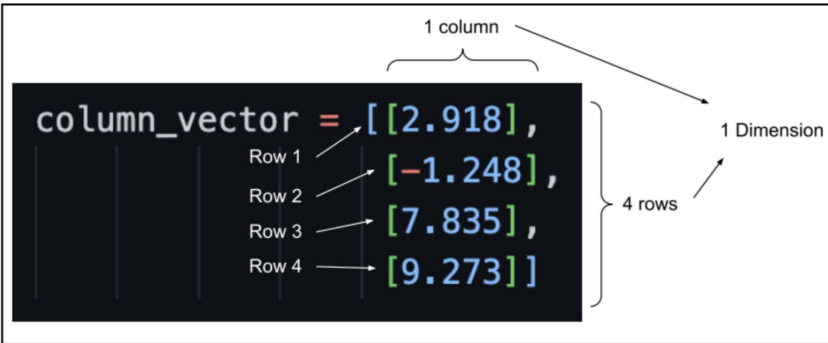
Vector/Vectors

Row Vector in Python Example: This is a 4-element vector (list containing 4 element



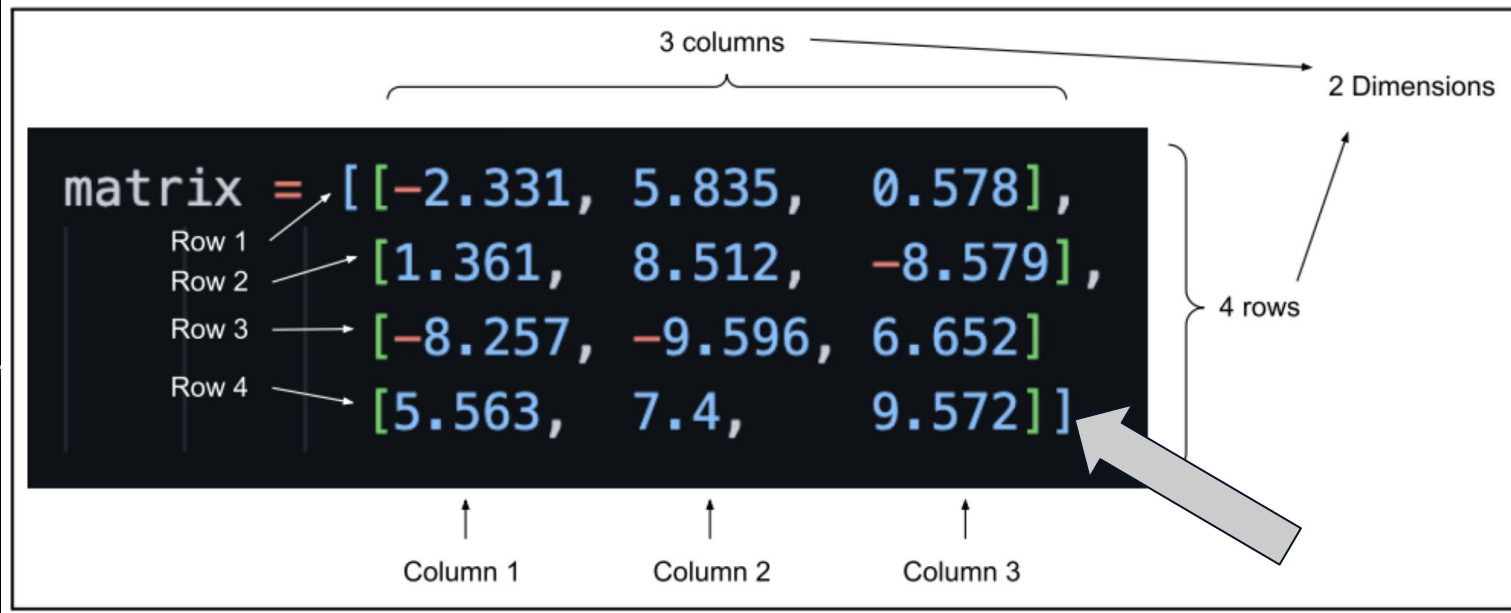
This vector has **one dimension** since there is only 1 row, which makes the row dimension insignificant. Because it has **1 row**, we call this a **4-element row vector**.

Column Vector in Python Example: This is another 4-element vector.



Matrix/Matrices

Matrix in Python Example: This is a (4, 3) or 4 by 3 matrix.



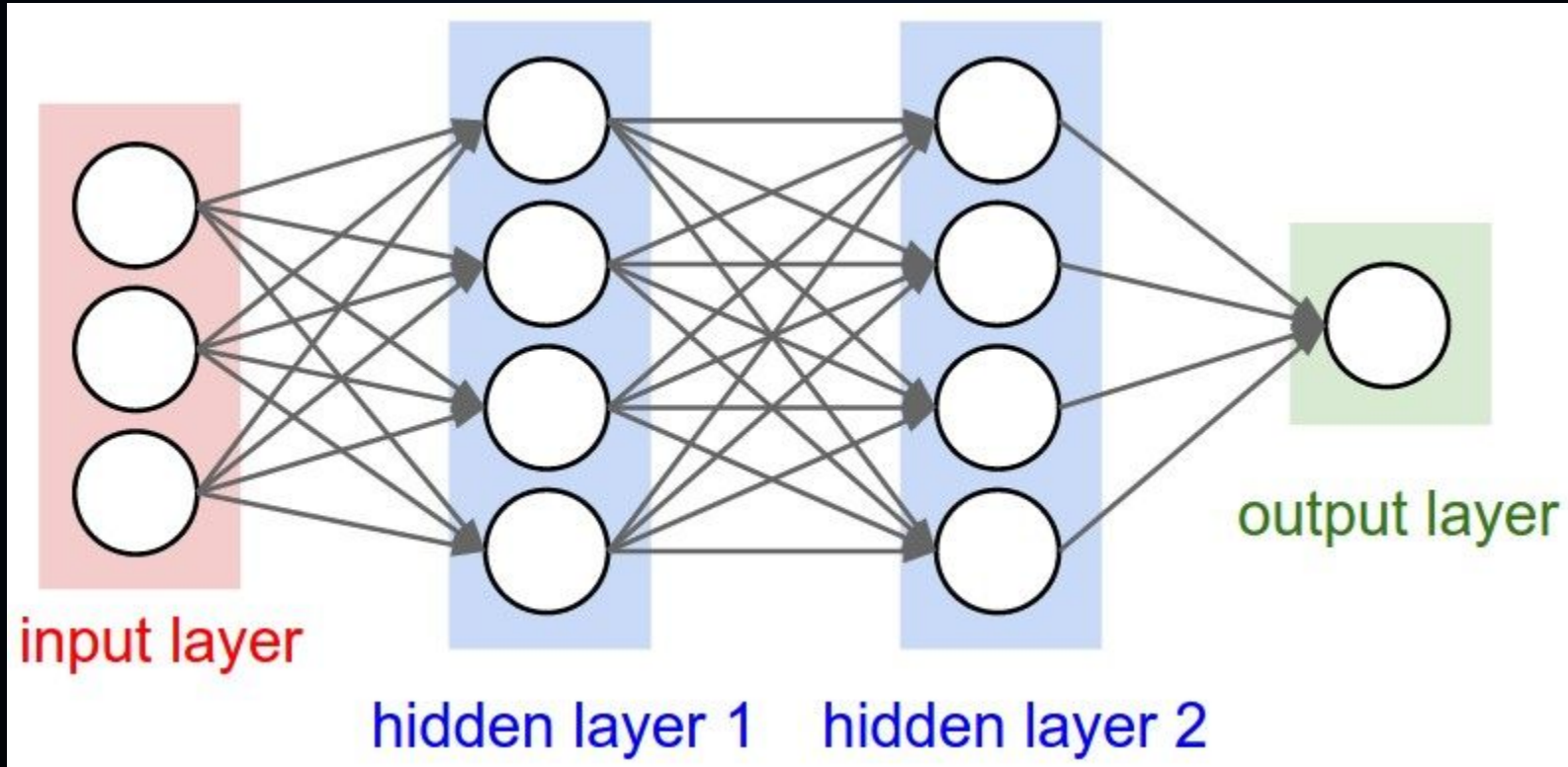
Steps for Artificial Neural Network

Step 1:

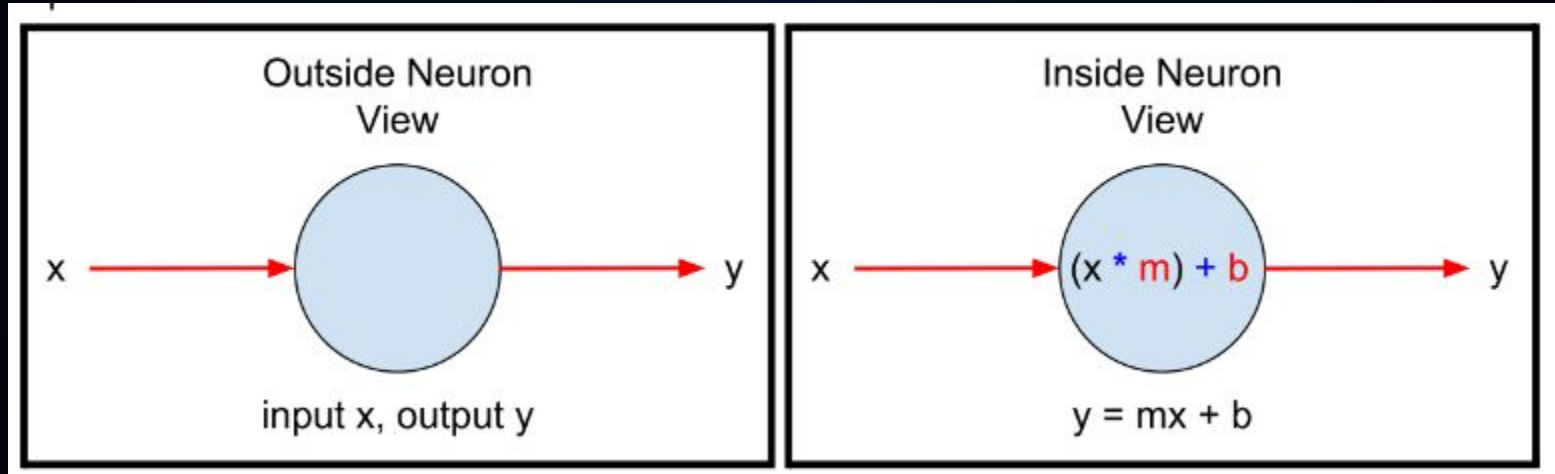
Step 2:

Step 3:

Artificial Neural Networks



Artificial Neuron (1 Input Feature)



Variables in AI

Variable	Math Meaning	AI Conversion
x	input	Denoted with letter X , meaning input to the neuron
m	slope	Denoted with letter w , which is the weight variable
b	y-intercept	Denoted with letter b , which is the bias variable
y	output	Denoted with \hat{y} (y_hat) , meaning the neuron's prediction

Working with Scalars

$X = 2$ (scalar)
 $w = 5$ (scalar)
 $b = -10$ (scalar)

$$\hat{y} = \underbrace{wX}_{\substack{5 * 2 = 10 \\ \text{scalar} * \text{scalar} = \text{scalar}}} + b \longrightarrow \hat{y} = 0 \text{ (scalar)}$$
$$\substack{10 + (-10) = 0 \\ \text{scalar} + \text{scalar} = \text{scalar}}$$

Multiple Examples

$X = [2, -2, 5, 3]$ (vector)

$w = 5$ (scalar)

$b = -10$ (scalar)

$$\hat{y} = wX + b$$

$5 * [2, -2, 5, 3]$

5
 $[2, -2, 5, 3]$

$[5*2, 5*-2, 5*5, 5*3]$

$[10, -10, 25, 15]$

scalar * vector = vector

$X = [2, -2, 5, 3]$ (vector)

$w = 5$ (scalar)

$b = -10$ (scalar)

$5 * [2, -2, 5, 3] = [10, -10, 25, 15]$
 scalar * vector = vector

$$\hat{y} = wX + b$$

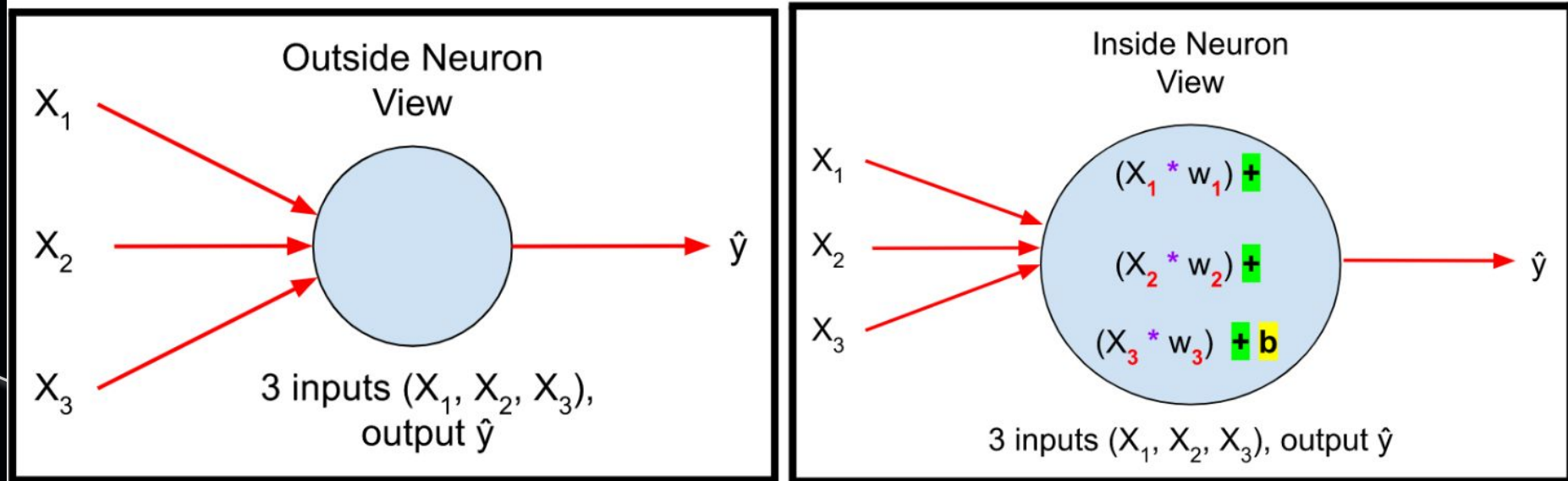
$[10, -10, 25, 15] + -10$

$= [10-10, -10-10, 25-10, 15-10]$

vector + scalar
 = vector

$= [0, -20, 15, 5] = \hat{y}$

Artificial Neuron (Multiple Inputs)



$X = [X_1, X_2, X_3]$ (vector)
 $w = [w_1, w_2, w_3]$ (vector)

$$[w_1, w_2, w_3] * [X_1, X_2, X_3] = [w_1 * X_1, w_2 * X_2, w_3 * X_3]$$

vector * vector = vector

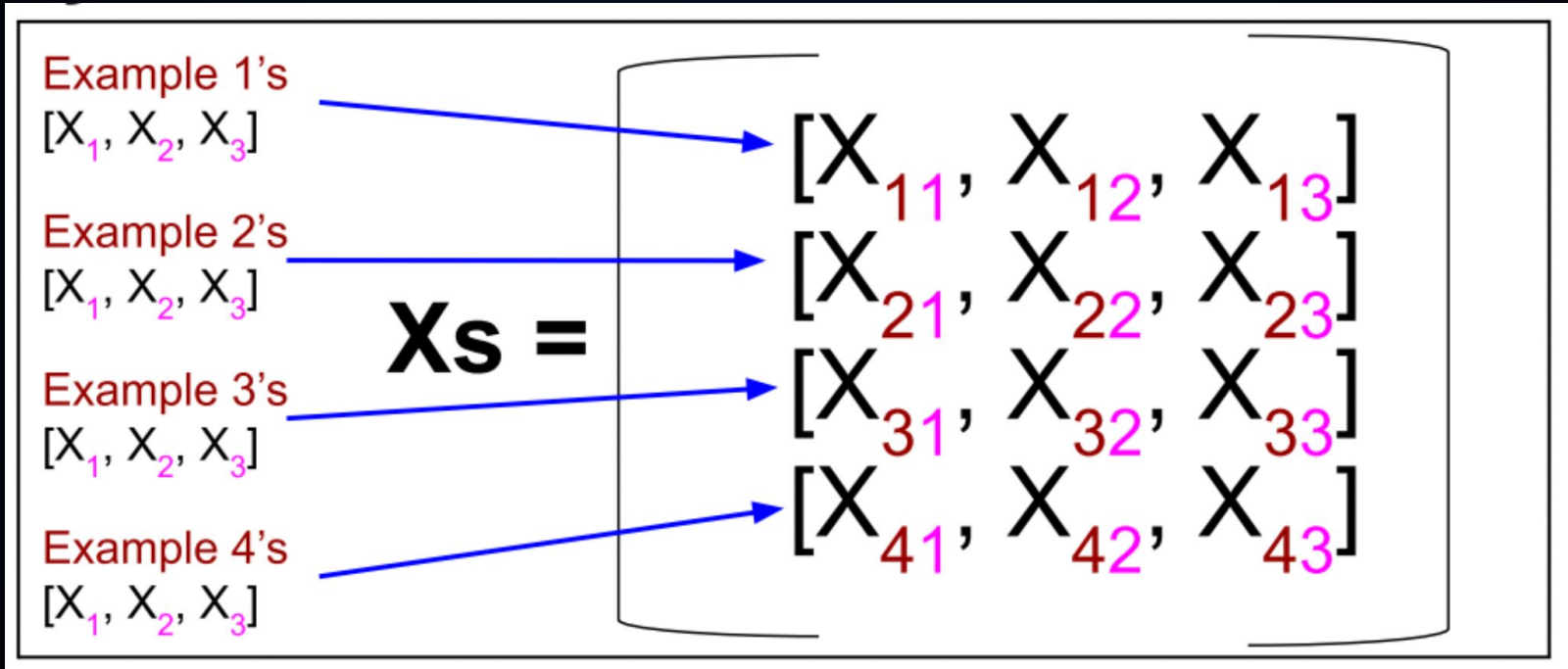
$$\hat{y} = \underbrace{wX} + b$$

$$\hat{y} = w_1 X_1 + w_2 X_2 + w_3 X_3 + b$$



$$\hat{y} = \text{sum}(wX) + b.$$

Multiple Examples



Multiple Examples (Multiplication)

$$\hat{y} = \text{sum}(wX) + b$$

$[w_1, w_2, w_3]$



$\begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \\ X_{41} & X_{42} & X_{43} \end{bmatrix}$

Example 1

Example 2

Example 3

Example 4



$\begin{bmatrix} w_1 * X_{11} & w_2 * X_{12} & w_3 * X_{13} \\ w_1 * X_{21} & w_2 * X_{22} & w_3 * X_{23} \\ w_1 * X_{31} & w_2 * X_{32} & w_3 * X_{33} \\ w_1 * X_{41} & w_2 * X_{42} & w_3 * X_{43} \end{bmatrix}$

Example 1

Example 2

Example 3

Example 4

Multiple Examples (Addition)

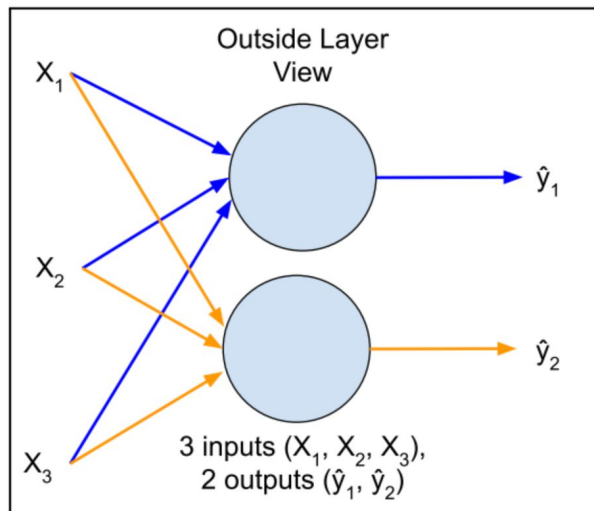
$$\text{sum} \left(\begin{bmatrix} w_1 * X_{11} & w_2 * X_{12} & w_3 * X_{13} \\ w_1 * X_{21} & w_2 * X_{22} & w_3 * X_{23} \\ w_1 * X_{31} & w_2 * X_{32} & w_3 * X_{33} \\ w_1 * X_{41} & w_2 * X_{42} & w_3 * X_{43} \end{bmatrix} \right) + \mathbf{b} = \begin{bmatrix} w_1 * X_{11} + w_2 * X_{12} + w_3 * X_{13} \\ w_1 * X_{21} + w_2 * X_{22} + w_3 * X_{23} \\ w_1 * X_{31} + w_2 * X_{32} + w_3 * X_{33} \\ w_1 * X_{41} + w_2 * X_{42} + w_3 * X_{43} \end{bmatrix} + \mathbf{b}$$

$$\begin{bmatrix} w_1 * X_{11} + w_2 * X_{12} + w_3 * X_{13} + \mathbf{b} \\ w_1 * X_{21} + w_2 * X_{22} + w_3 * X_{23} + \mathbf{b} \\ w_1 * X_{31} + w_2 * X_{32} + w_3 * X_{33} + \mathbf{b} \\ w_1 * X_{41} + w_2 * X_{42} + w_3 * X_{43} + \mathbf{b} \end{bmatrix}$$

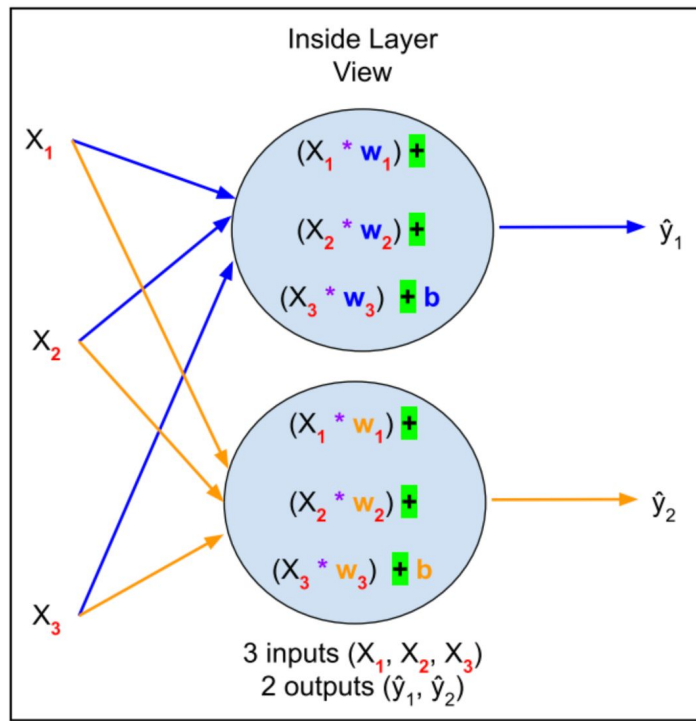
Example 1
 Example 2
 Example 3
 Example 4

Layer of Neurons:

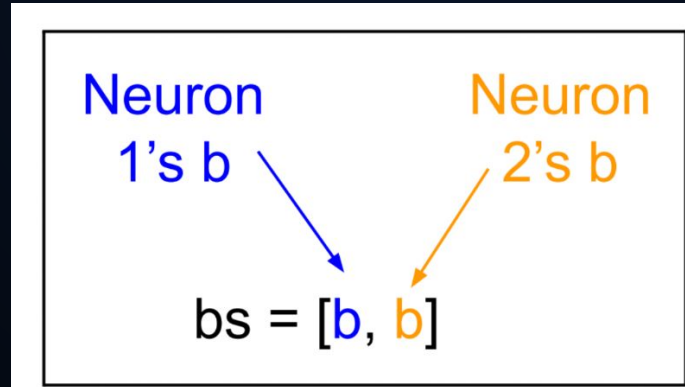
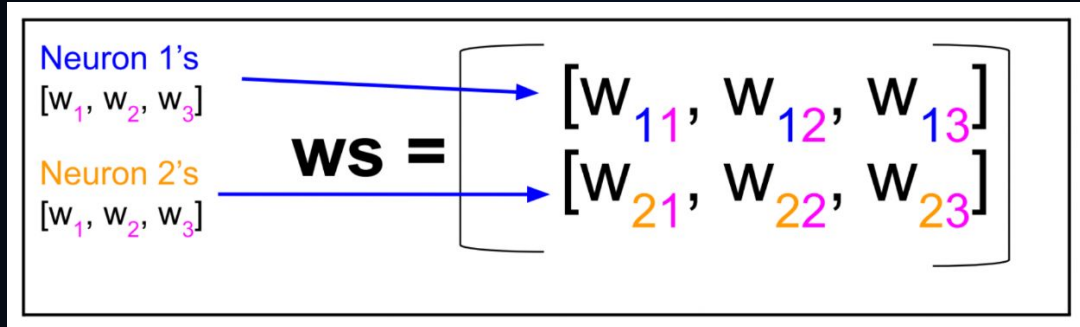
Let's take a look at the outside and inside view of a layer of artificial neurons:



Each neuron in a layer receives all input features. They receive the same 3 input features and output one value for each example.



Vectorization



$$\hat{y} = \text{sum}(wX) + b$$

Diagram illustrating the calculation of the linear combination $\hat{y} = \text{sum}(wX) + b$ for a specific input x_1 (highlighted in yellow).

The input vector X is $[x_1, x_2, x_3]^T$. The weight matrix w is $\begin{bmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \end{bmatrix}$.

The calculation involves the dot product of the first row of w and the input vector X (highlighted in yellow):

$$[w_{11}, w_{12}, w_{13}] \times [x_1, x_2, x_3]^T = w_{11}x_1 + w_{12}x_2 + w_{13}x_3$$

The result is then summed with the bias b to produce the output \hat{y} .

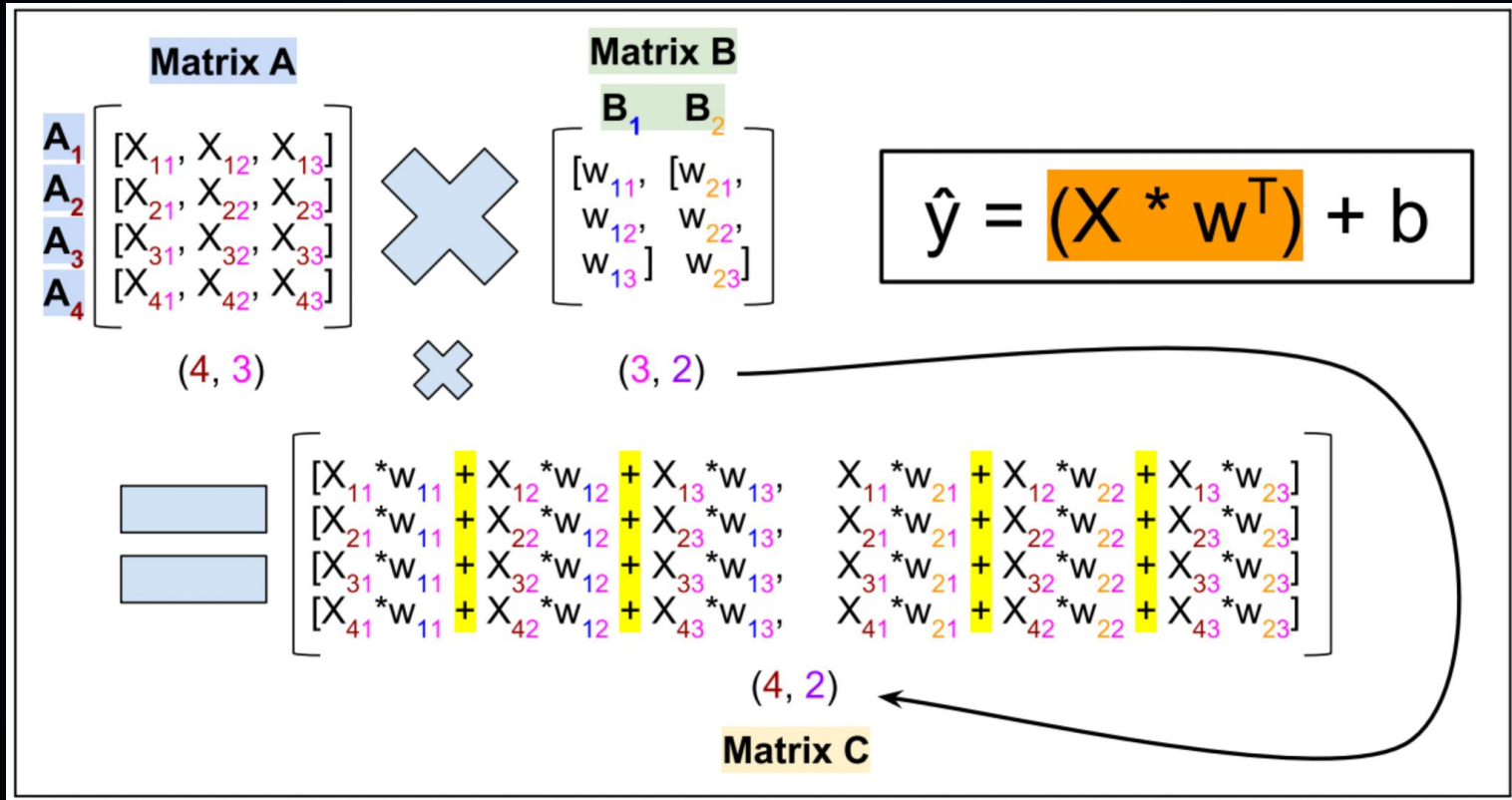
Diagram illustrating the dot product operation between two vectors. A 2x3 matrix of weights (w_{11}, w_{12}, w_{13} ; w_{21}, w_{22}, w_{23}) is multiplied by a 3x1 vector of inputs (x_1, x_2, x_3). The result is a 2x1 vector of sums ($w_{11}x_1 + w_{12}x_2 + w_{13}x_3$; $w_{21}x_1 + w_{22}x_2 + w_{23}x_3$). The diagram highlights the specific elements involved in the dot product for the first row: w_{12} (blue), x_2 (blue), and their product $w_{12}x_2$ (blue). The final result vector is $(2, 1)$.

Equation Vectorization (cont.)

$$\begin{bmatrix} w_{11}x_1 + w_{12}x_2 + w_{13}x_3 \\ w_{21}x_1 + w_{22}x_2 + w_{23}x_3 \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} w_{11}x_1 + w_{12}x_2 + w_{13}x_3 + b_1 \\ w_{21}x_1 + w_{22}x_2 + w_{23}x_3 + b_2 \end{bmatrix}$$

Neuron 1's Prediction
Neuron 2's Prediction

Matrix Multiplication (Dot Product)



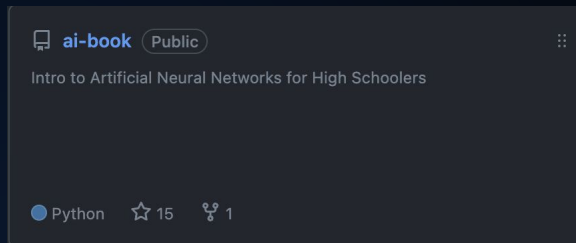
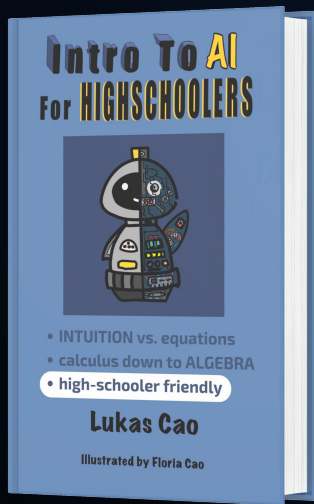
Equation Vectorization

$$\begin{bmatrix} [X_{11} * w_{11} + X_{12} * w_{12} + X_{13} * w_{13}, & X_{11} * w_{21} + X_{12} * w_{22} + X_{13} * w_{23}] \\ [X_{21} * w_{11} + X_{22} * w_{12} + X_{23} * w_{13}, & X_{21} * w_{21} + X_{22} * w_{22} + X_{23} * w_{23}] \\ [X_{31} * w_{11} + X_{32} * w_{12} + X_{33} * w_{13}, & X_{31} * w_{21} + X_{32} * w_{22} + X_{33} * w_{23}] \\ [X_{41} * w_{11} + X_{42} * w_{12} + X_{43} * w_{13}, & X_{41} * w_{21} + X_{42} * w_{22} + X_{43} * w_{23}] \end{bmatrix} + [b, b]$$

$$\begin{bmatrix} [X_{11} * w_{11} + X_{12} * w_{12} + X_{13} * w_{13} + b, & X_{11} * w_{21} + X_{12} * w_{22} + X_{13} * w_{23} + b] \\ [X_{21} * w_{11} + X_{22} * w_{12} + X_{23} * w_{13} + b, & X_{21} * w_{21} + X_{22} * w_{22} + X_{23} * w_{23} + b] \\ [X_{31} * w_{11} + X_{32} * w_{12} + X_{33} * w_{13} + b, & X_{31} * w_{21} + X_{32} * w_{22} + X_{33} * w_{23} + b] \\ [X_{41} * w_{11} + X_{42} * w_{12} + X_{43} * w_{13} + b, & X_{41} * w_{21} + X_{42} * w_{22} + X_{43} * w_{23} + b] \end{bmatrix}$$

Homework

Chapter 01



<https://github.com/ohhh25/ai-book/blob/main/Chapter%2001/Chapter%2001.pdf>