

UNIT 6

NEURAL NETWORK AND DEEP LEARNING

Content Curated by Pollux M. Rey

FOR THIS UNIT...

01

What is a Neural Network?

02

Types of Neural Networks

03

Applications

Neural Network

The backbone
of deep learning algorithms.

Neural Network



ChatGPT

The image shows two screenshots of the ChatGPT web interface. The left screenshot displays a user input box containing the text "I'm opening a new bakery specializing in sourdough bread. Please create an illustration of sheaves of wheat for our packaging." Below this is a generated image of a golden wheat sheaf. The right screenshot shows a message box at the bottom with the text "Here is the illustration of sheaves of wheat". Both screenshots include a "Message ChatGPT" button at the bottom and a note at the bottom of each box stating "ChatGPT can make mistakes. Check important info."

ChatGPT

I'm opening a new bakery specializing in sourdough bread. Please create an illustration of sheaves of wheat for our packaging.

Here is the illustration of sheaves of wheat

Message ChatGPT

Message ChatGPT

ChatGPT can make mistakes. Check important info.

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Neural Network

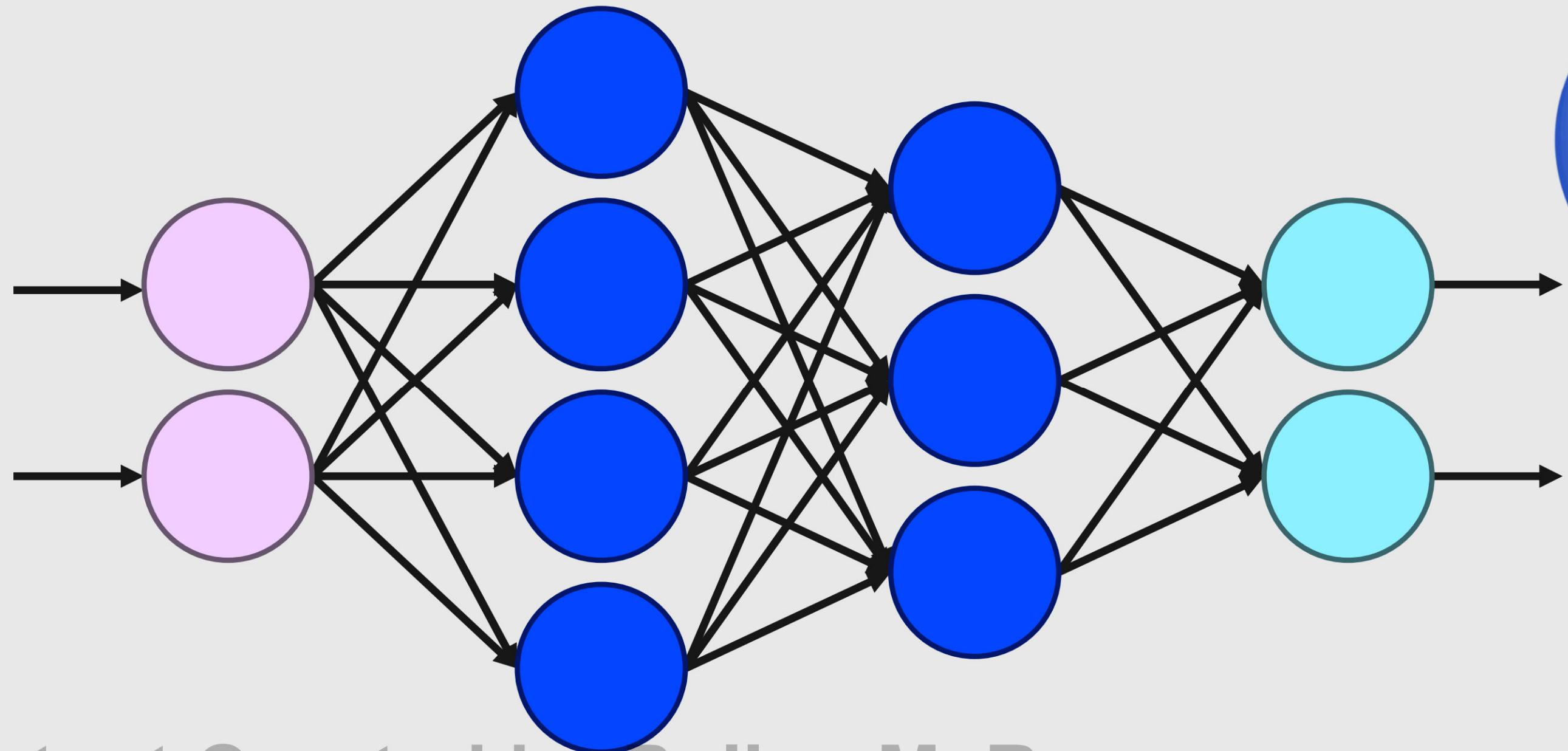


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Neural Network

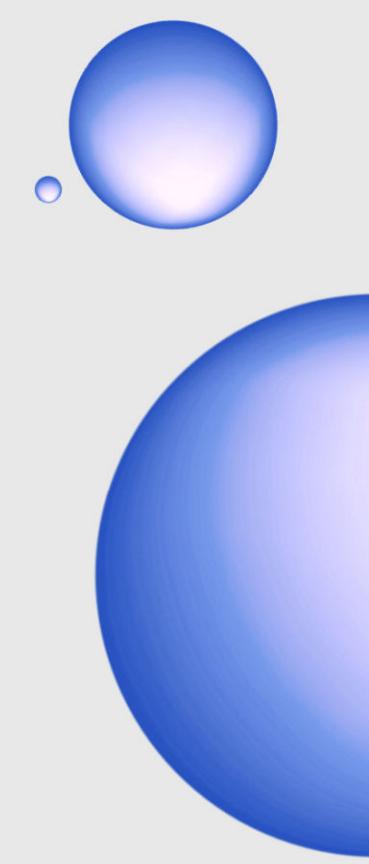
It consists of interconnected computational nodes, or neurons, arranged in layers.

Neural Network



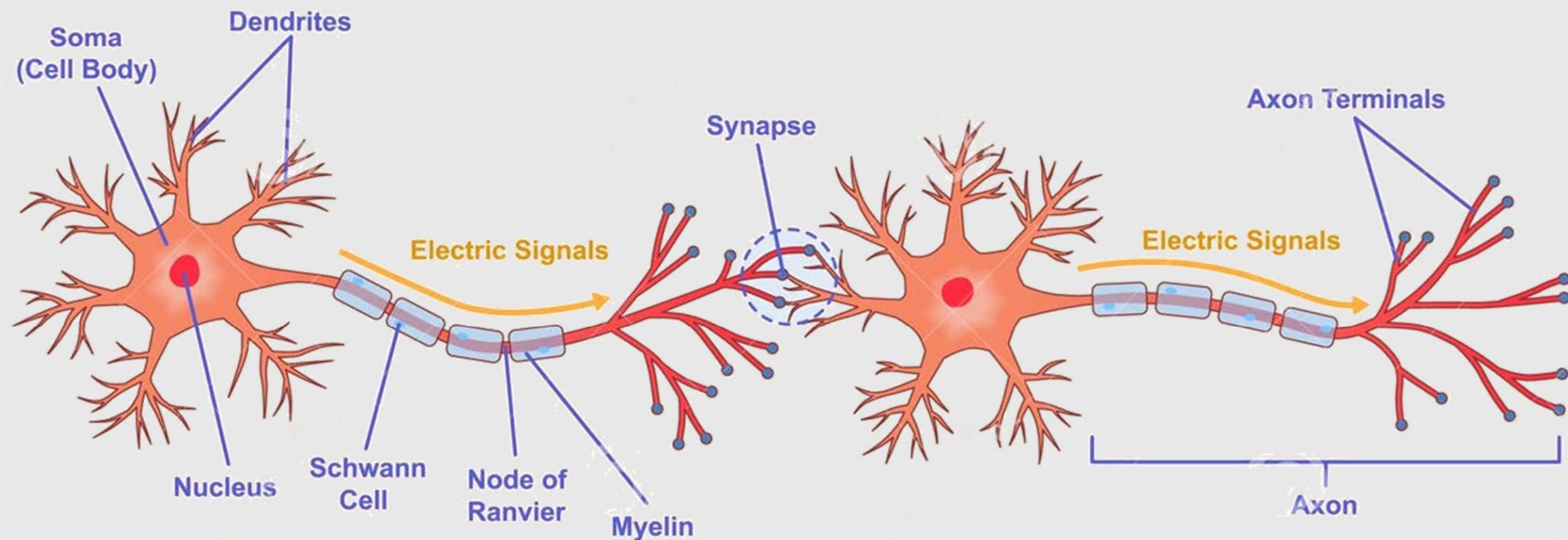
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Neural Network



- It mimics how neurons
- in the brain signal one another.

Neural Network

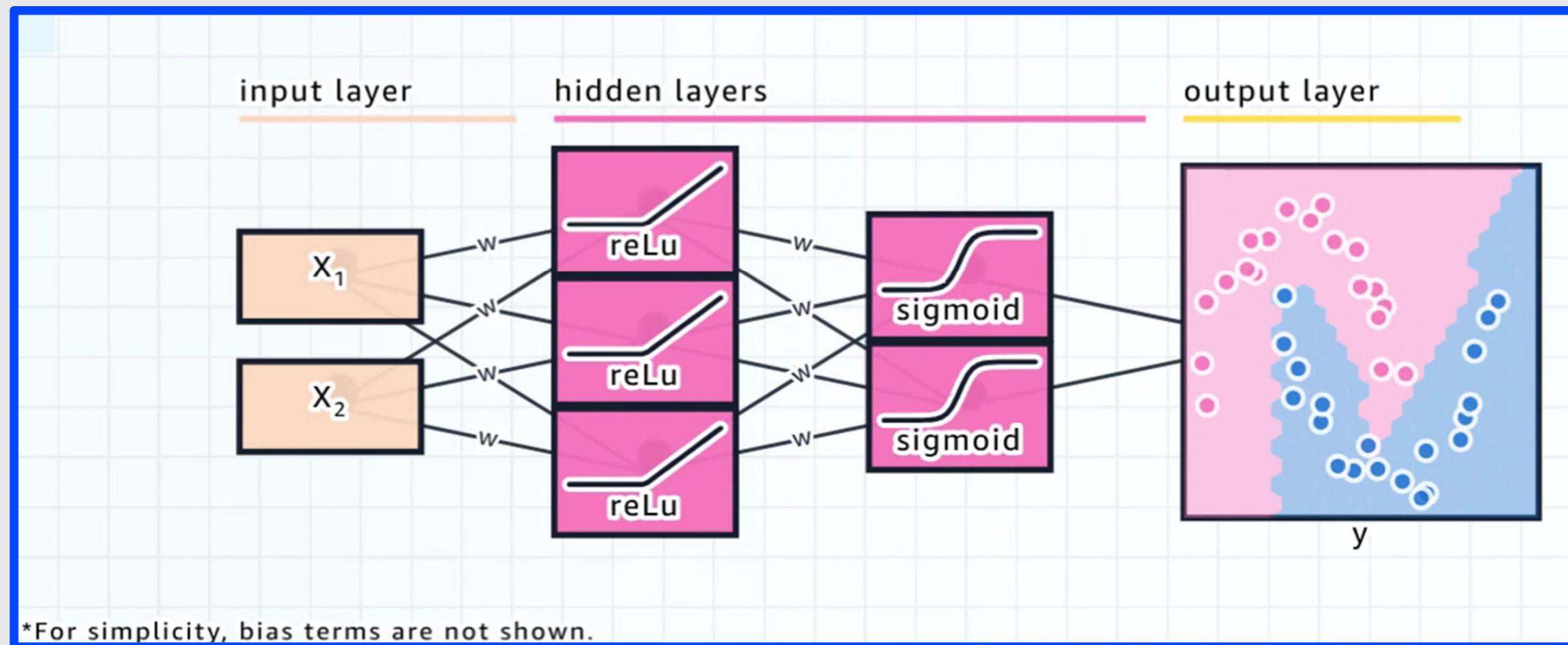


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<https://www.shutterstock.com/image-vector/neural-connection-diagram-structure-neuron-axon-2445508897>

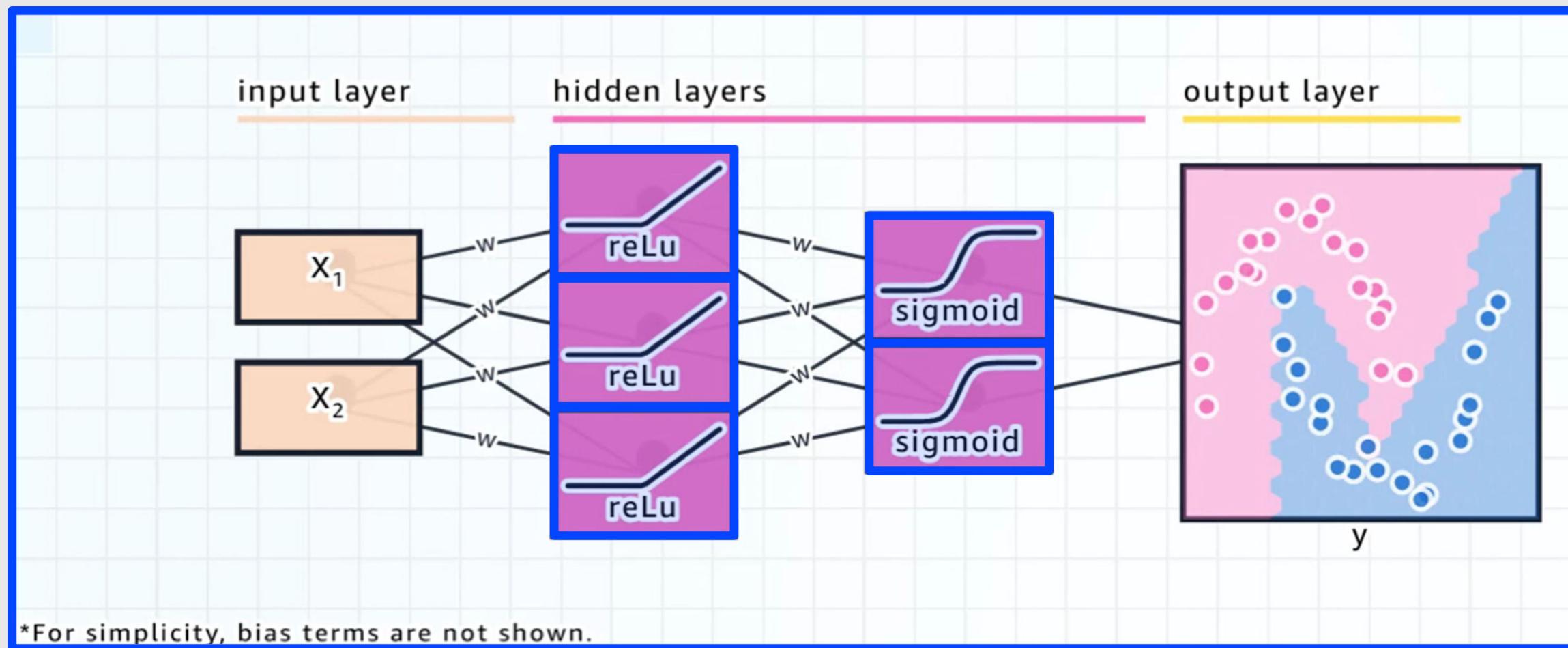
Neural Network

A neural network has one input layer, one output layer, and can have multiple hidden layers.



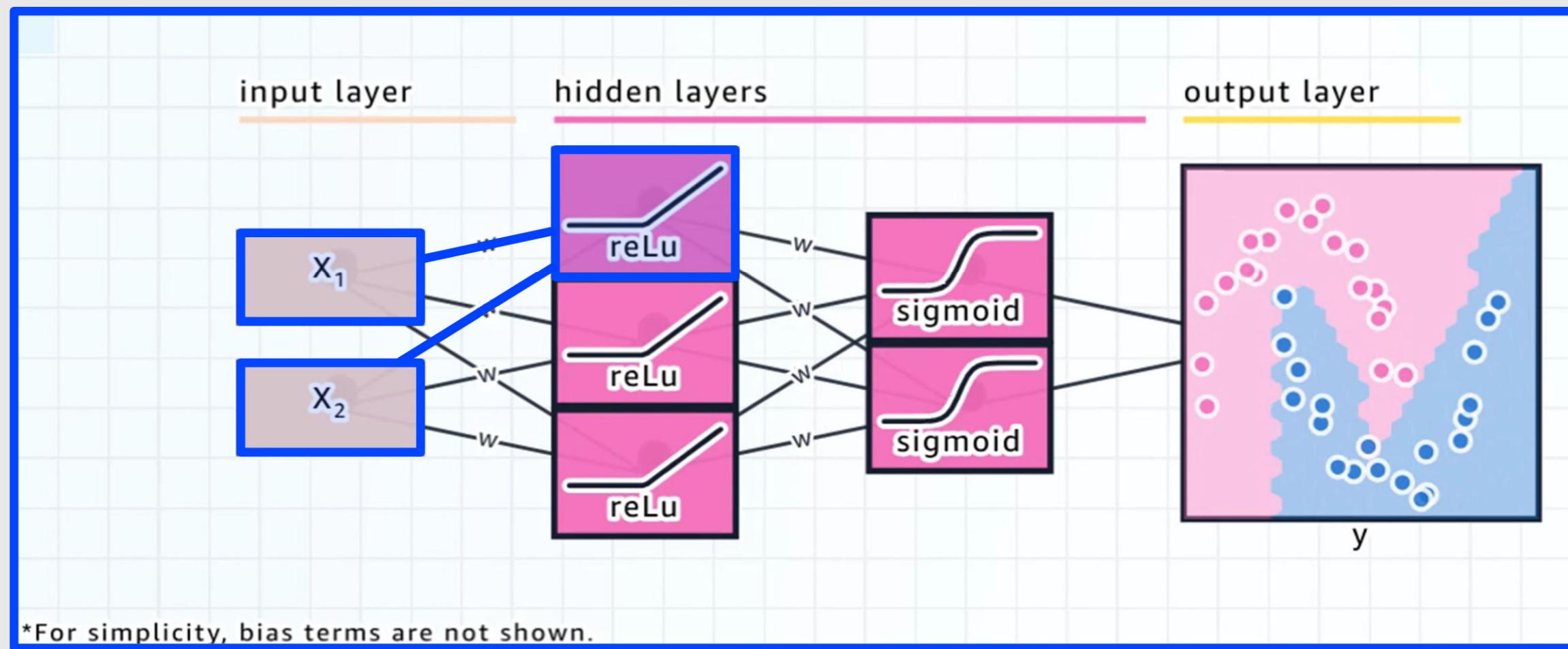
Neural Network

Each node in a hidden layer is called an **artificial neuron**.

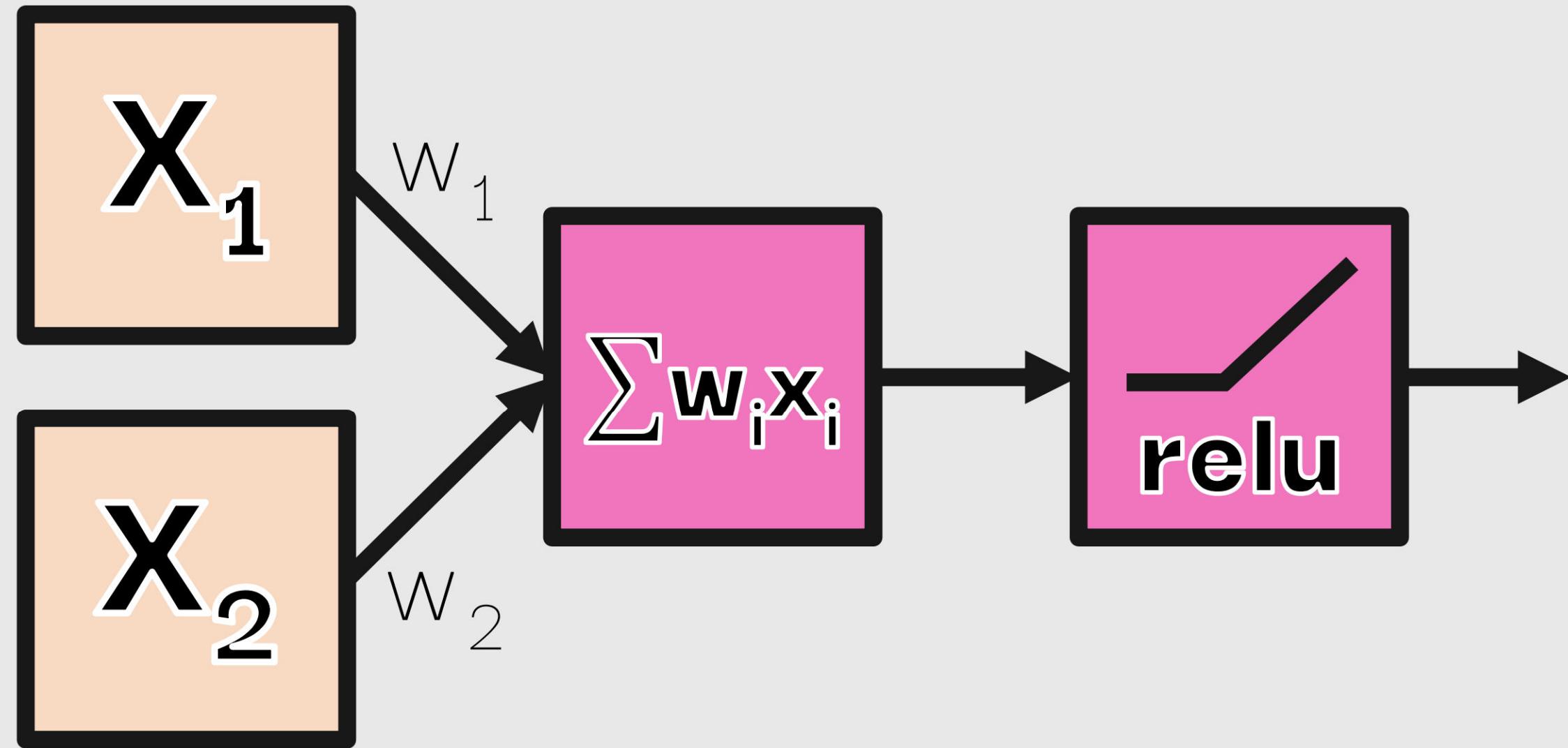


Neural Network

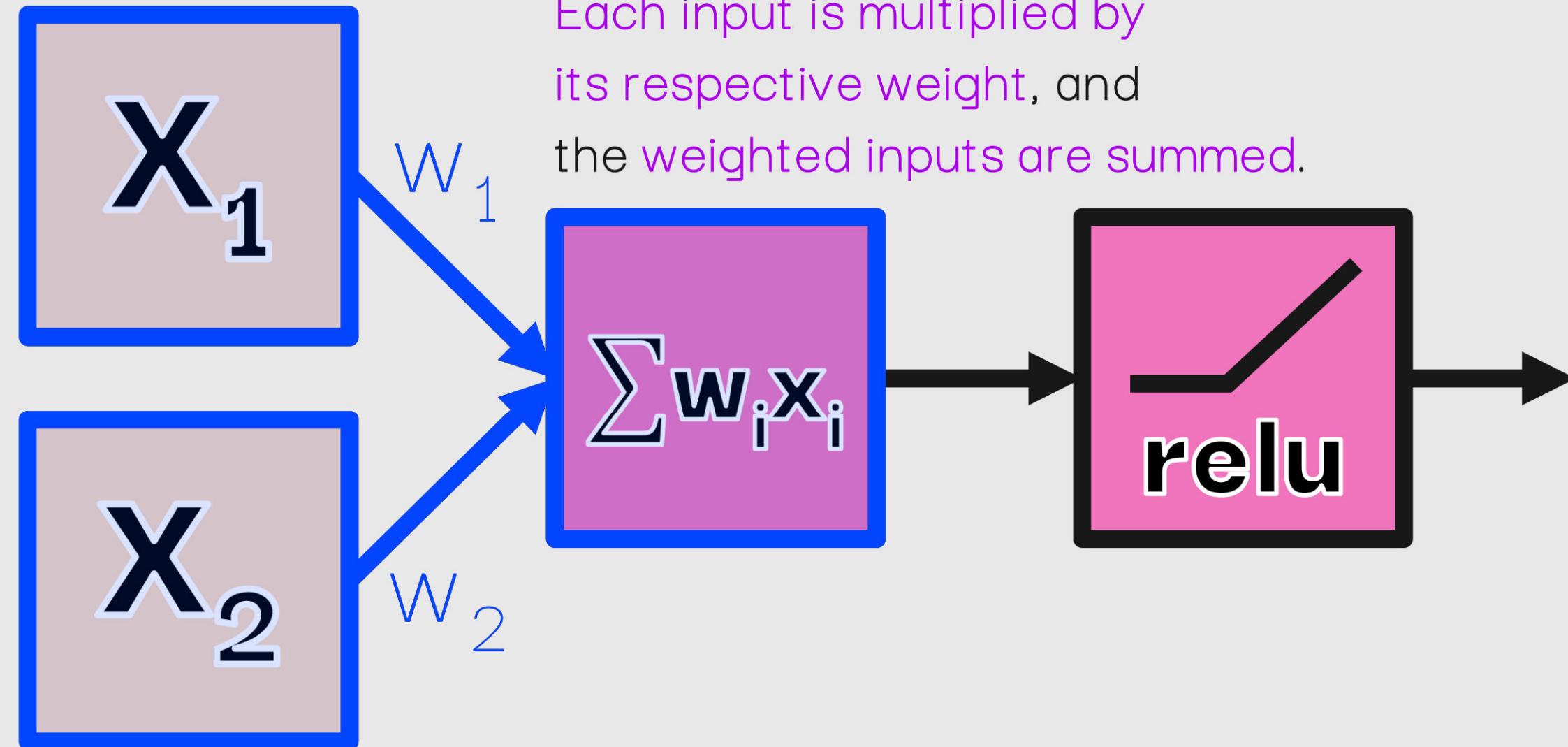
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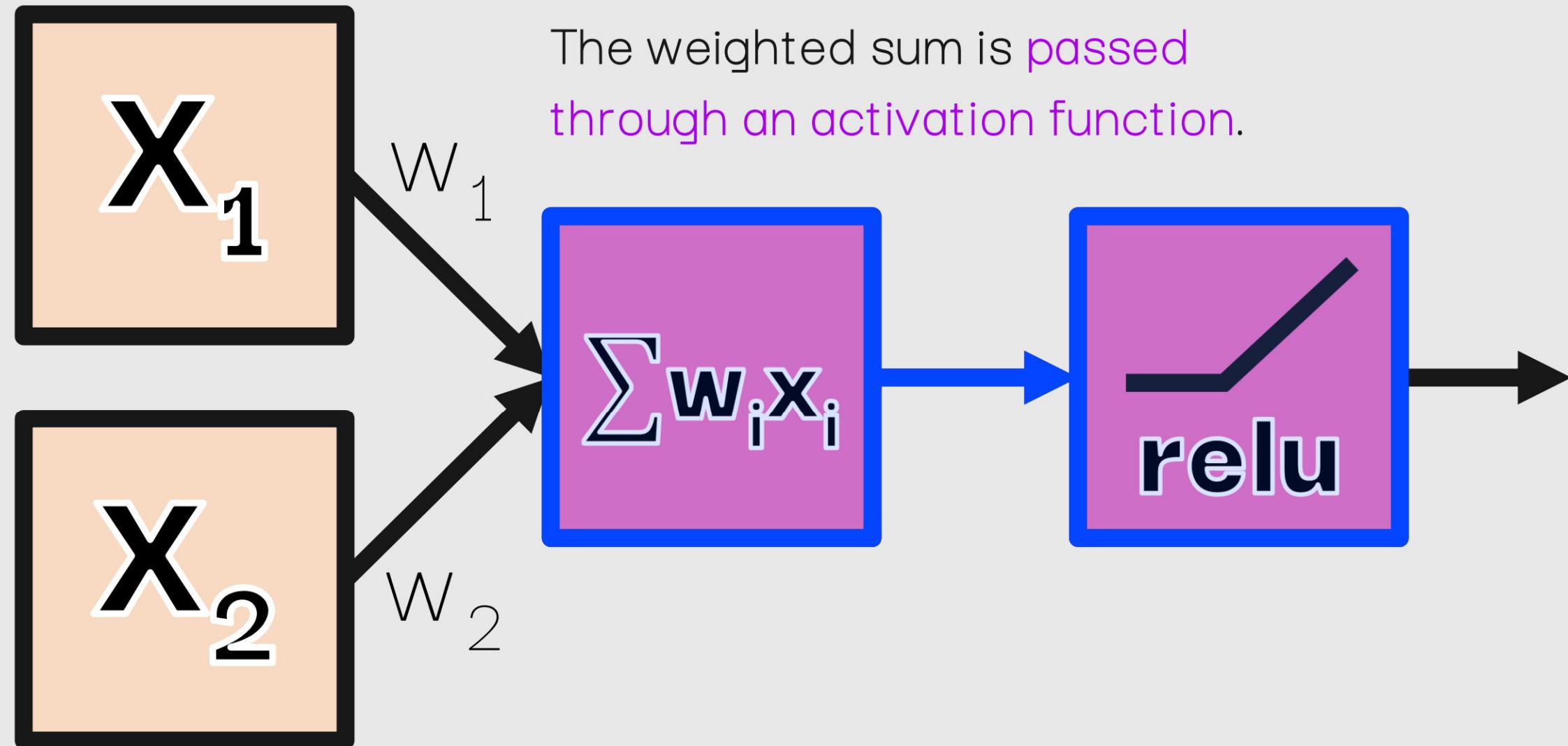
Neural Network



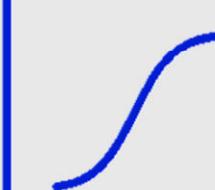
Neural Network



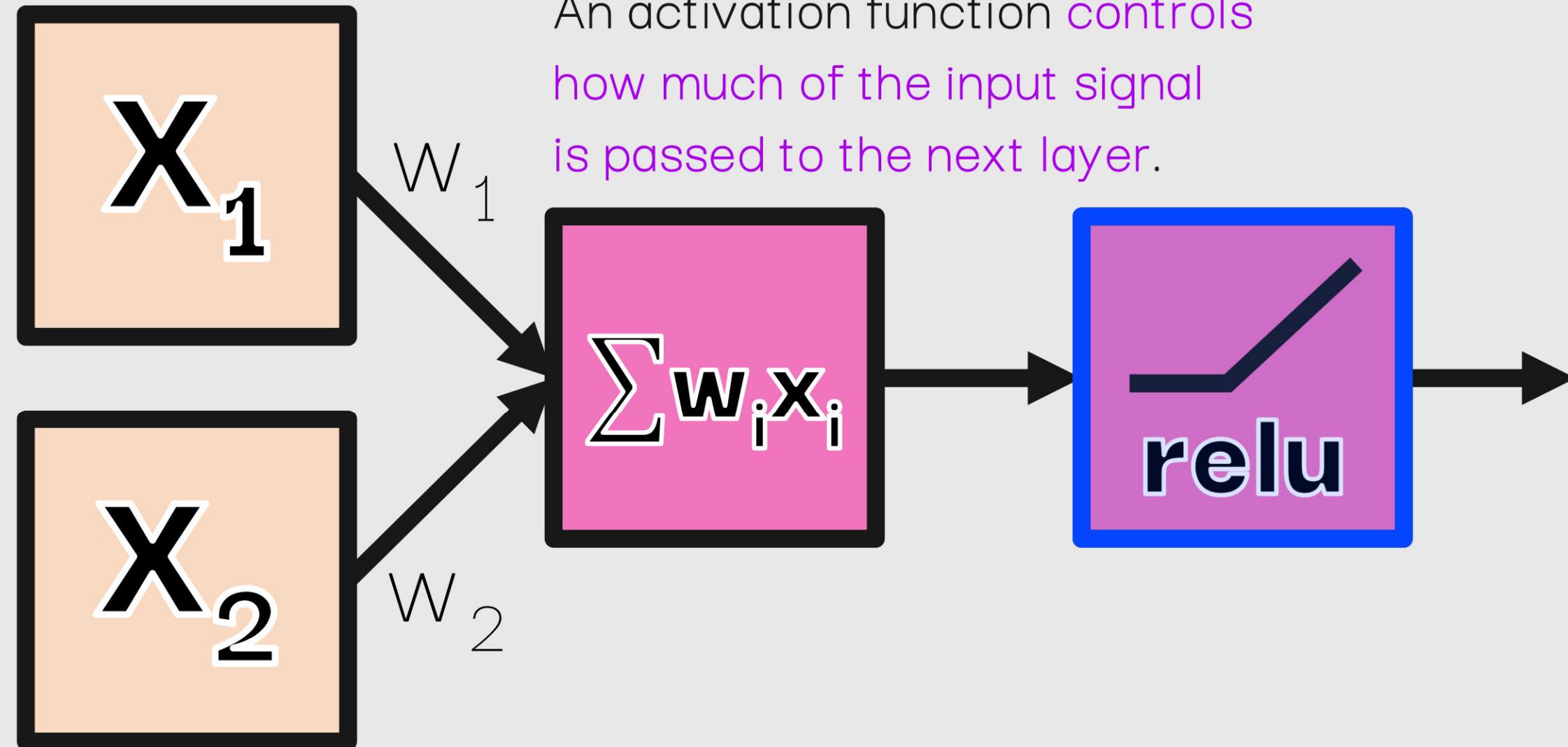
Neural Network



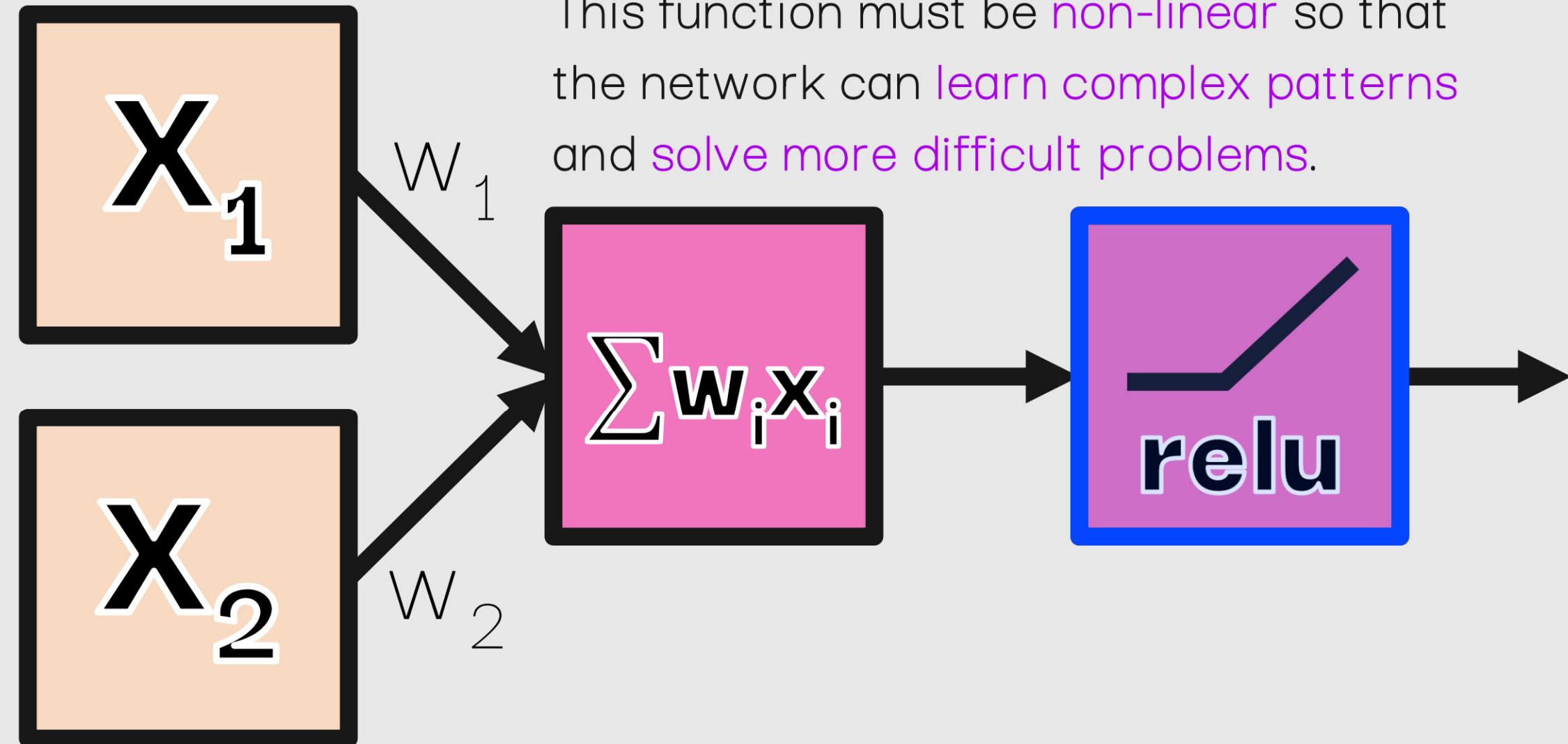
Neural Network - Activation Functions

Name	Plot	Function	Description
Sigmoid (logistic)		$f(x) = \frac{1}{1 + e^{-x}}$	Squashes input to (0, 1).
Hyperbolic Tangent (tanh)		$f(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$	Squashes input to (-1, 1).
Rectified Linear Unit (ReLu)		$f(x) = \begin{cases} 0, & \text{if } x < 0 \\ x, & \text{if } x \geq 0 \end{cases}$	Only keep positive values.
Step Function (Perceptron) ^[ii]		$f(x) = \begin{cases} +1, & \text{if } x \geq 0 \\ -1, & \text{if } x < 0 \end{cases}$	Returns only -1 or 1 (neuron fires or doesn't fire).

Neural Network

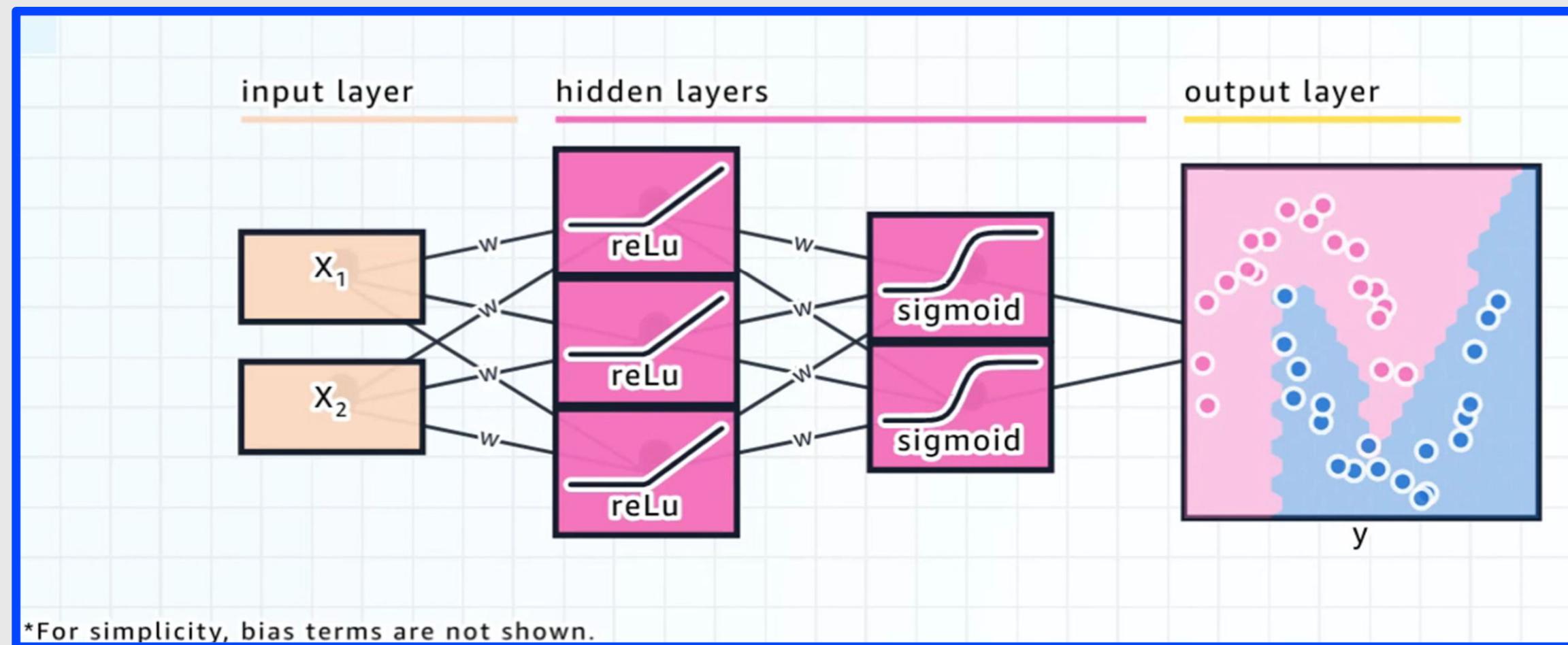


Neural Network



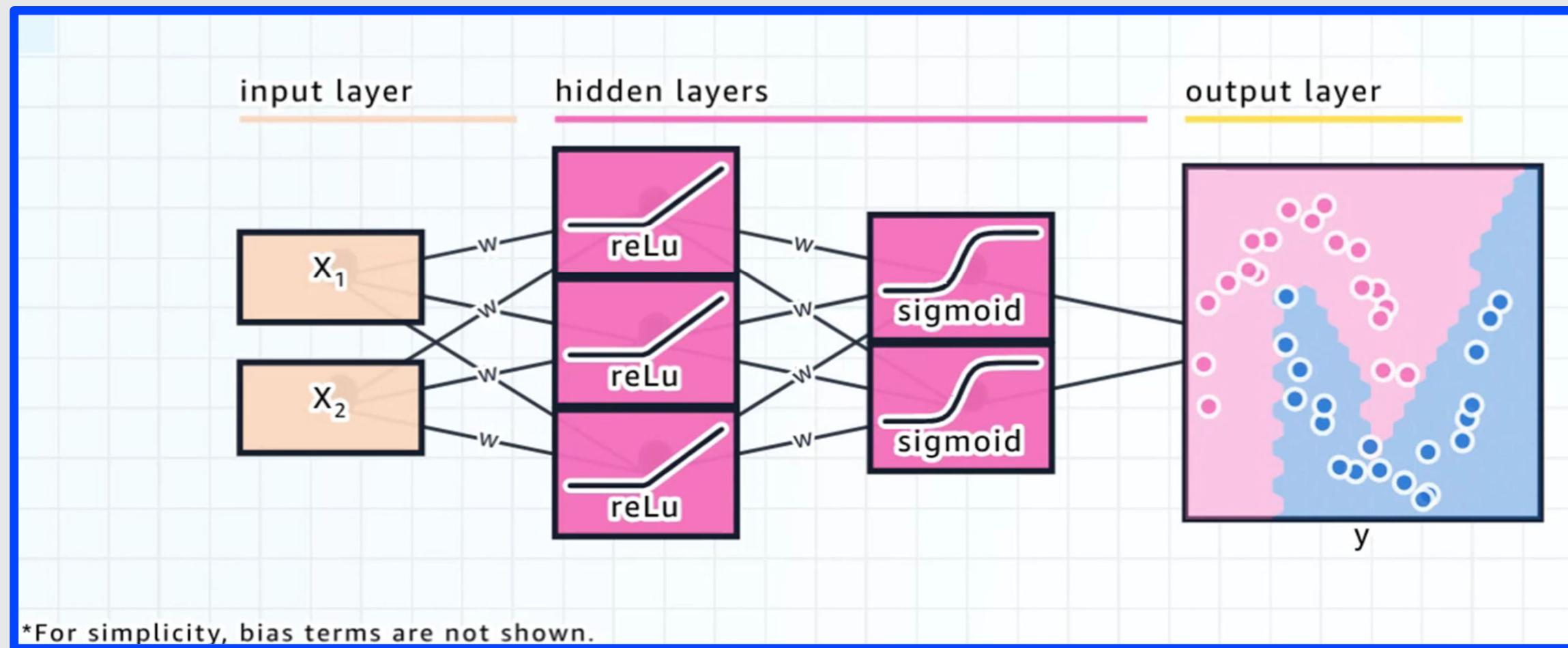
Neural Network

A neural network can be wide (many neurons in a layer)
or deep (many layers).



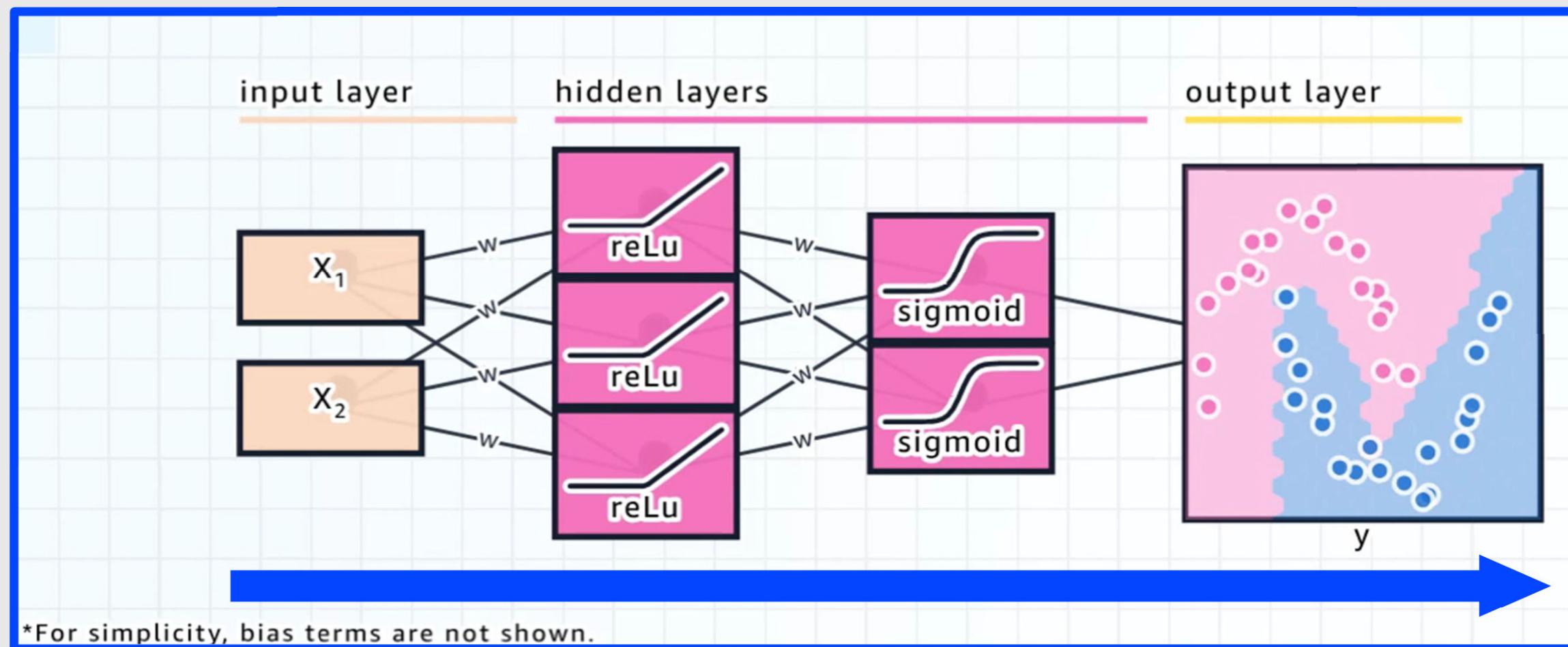
Neural Network

Balancing neuron count enhances performance
but can increase the risk of overfitting and computational costs.



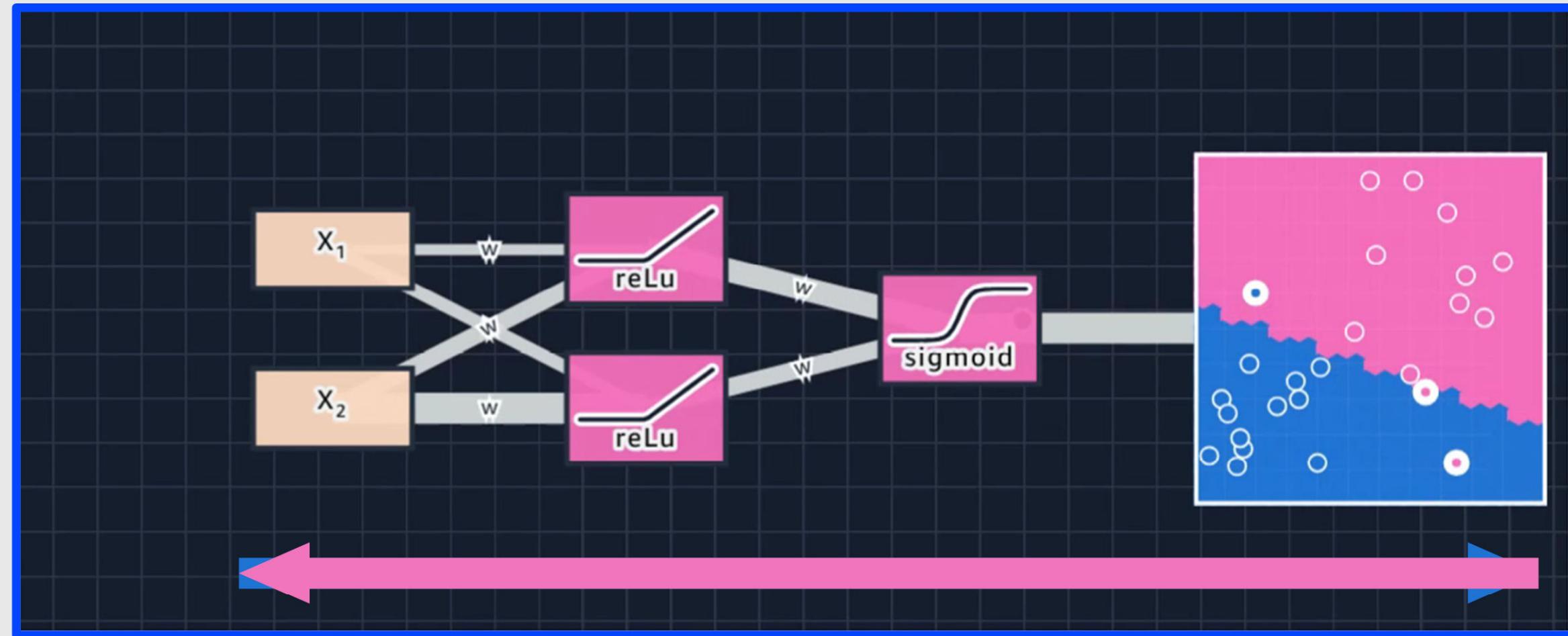
Neural Network - Forward Pass

The process of feeding inputs through the network to generate output predictions is called the forward pass.



Neural Network - Backpropagation

A neural network learns using **backpropagation**,
a method that **updates its weights** to make better predictions.



Neural Network



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<https://www.youtube.com/watch?v=3JQ3hYko51Y>

Types of Neural Networks

Feedforward Neural Networks

A neural network where values flow forward and gradients flow backward in a linear path.

Types of Neural Networks

Neural Network Architecture	Distinct Features	Use Cases
Recurrent Neural Networks	With built-in memory for processing data sequences.	<ul style="list-style-type: none">• Natural Language Processing• Time Series Prediction
Convolutional Neural Networks	Designed for processing spatial data, like images.	<ul style="list-style-type: none">• Image Recognition• Object Detection
Generative Adversarial Networks	Consists of two neural networks, a generator and a discriminator, that compete with each other.	<ul style="list-style-type: none">• Image Synthesis• Style Transfer• Data Augmentation

Types of Neural Networks

Neural Network Architecture	Distinct Features	Use Cases
Graph Neural Networks	Operates on graph-structured data; designed to learn and encode the relationships between nodes in a graph.	<ul style="list-style-type: none">• Social Network Analysis• Molecular Property Prediction• Recommendation Systems

Types of Neural Networks

Neural Network Architecture	Distinct Features	Use Cases
Transformer Architectures	<p>Uses self-attention to understand how different parts of the data relate to each other; incorporates feed-forward neural networks.</p>	<ul style="list-style-type: none">• Generative Pre-trained Transformer (GPT)• Bidirectional Encoder Representations from Transformers (BERT)

Neural Network - Applications



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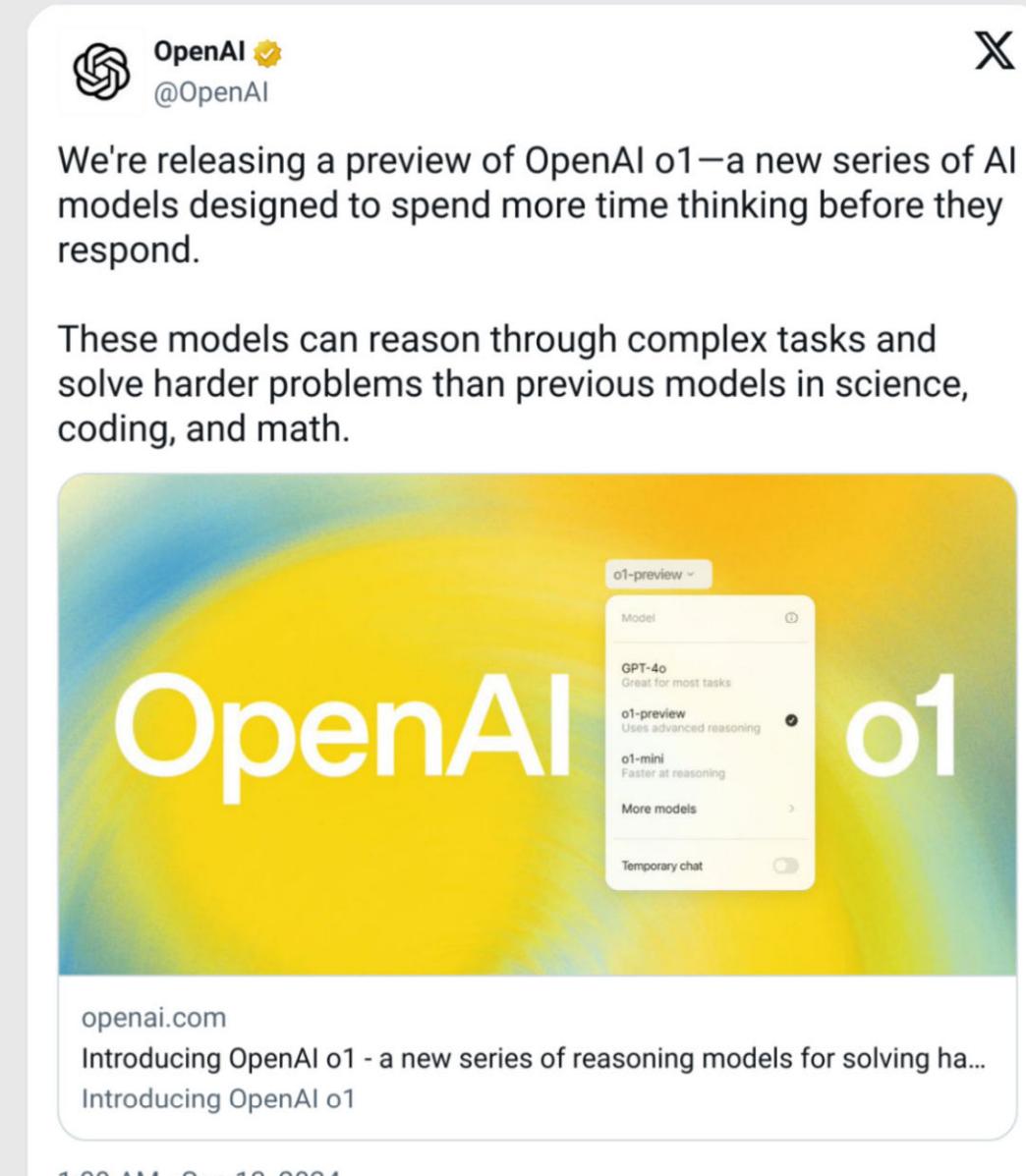
Neural Network - Applications



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<https://www.youtube.com/watch?v=UZDiGooFs54>

Neural Network - Applications



1:09 AM · Sep 13, 2024

<https://x.com/OpenAI/status/1834278217626317026>

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Neural Network - Applications



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<https://openai.com/index/introducing-openai-o1-preview/>

Neural Network - Applications



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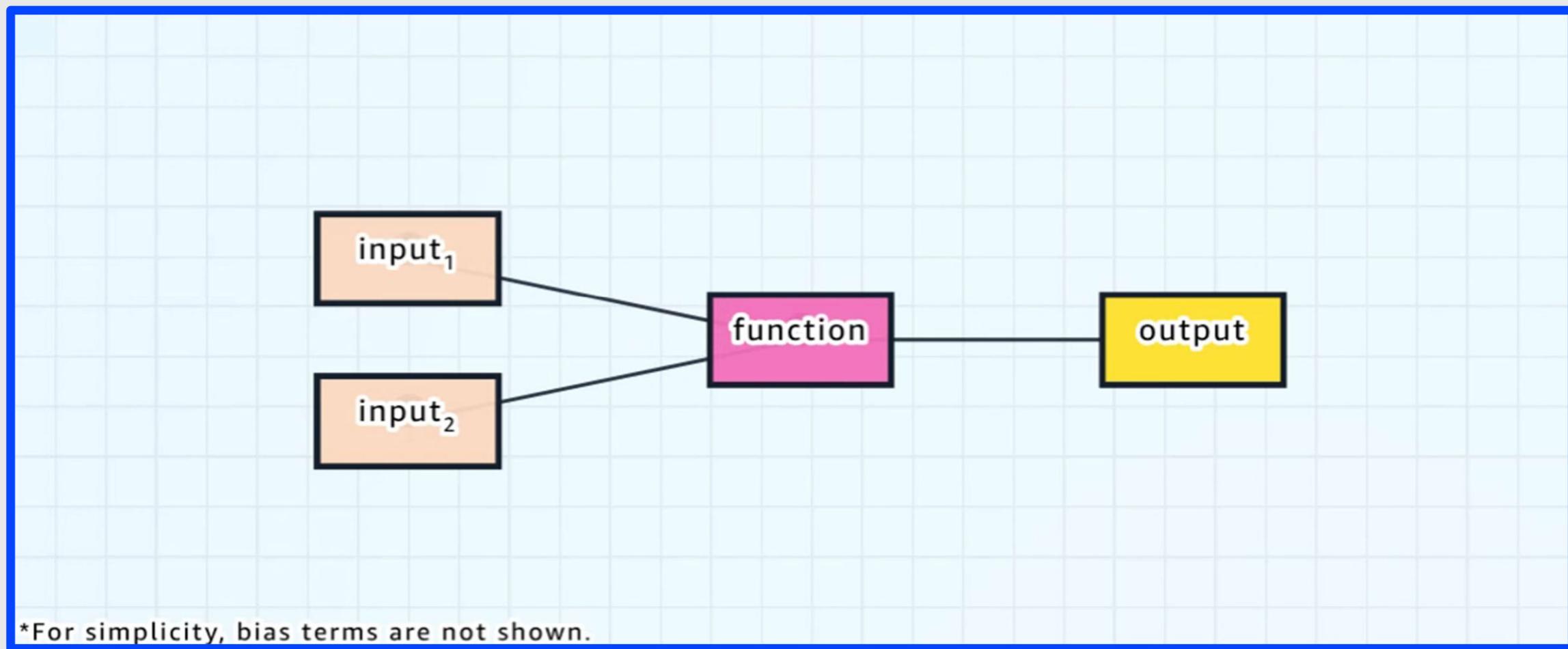
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THANK YOU!

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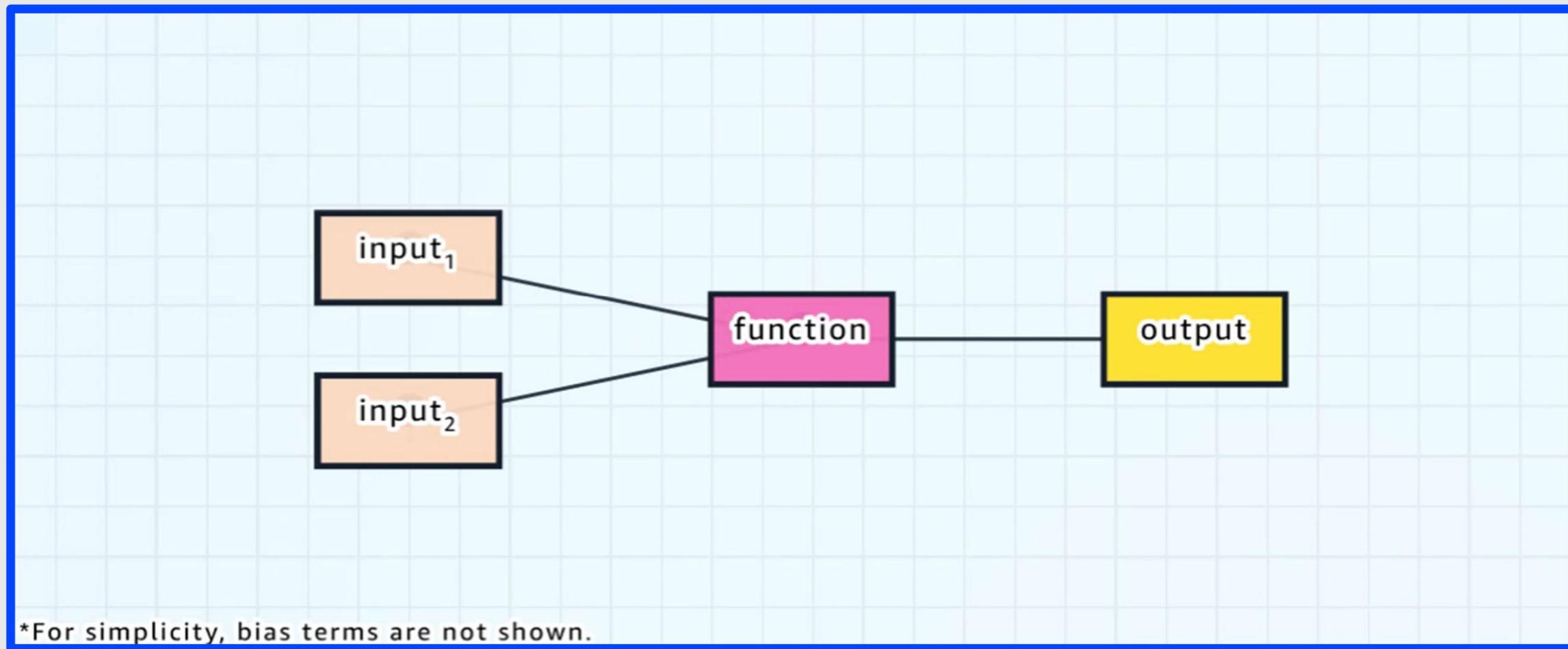
Neural Network - Intuition

Let's create a neural network using a basic computational graph.



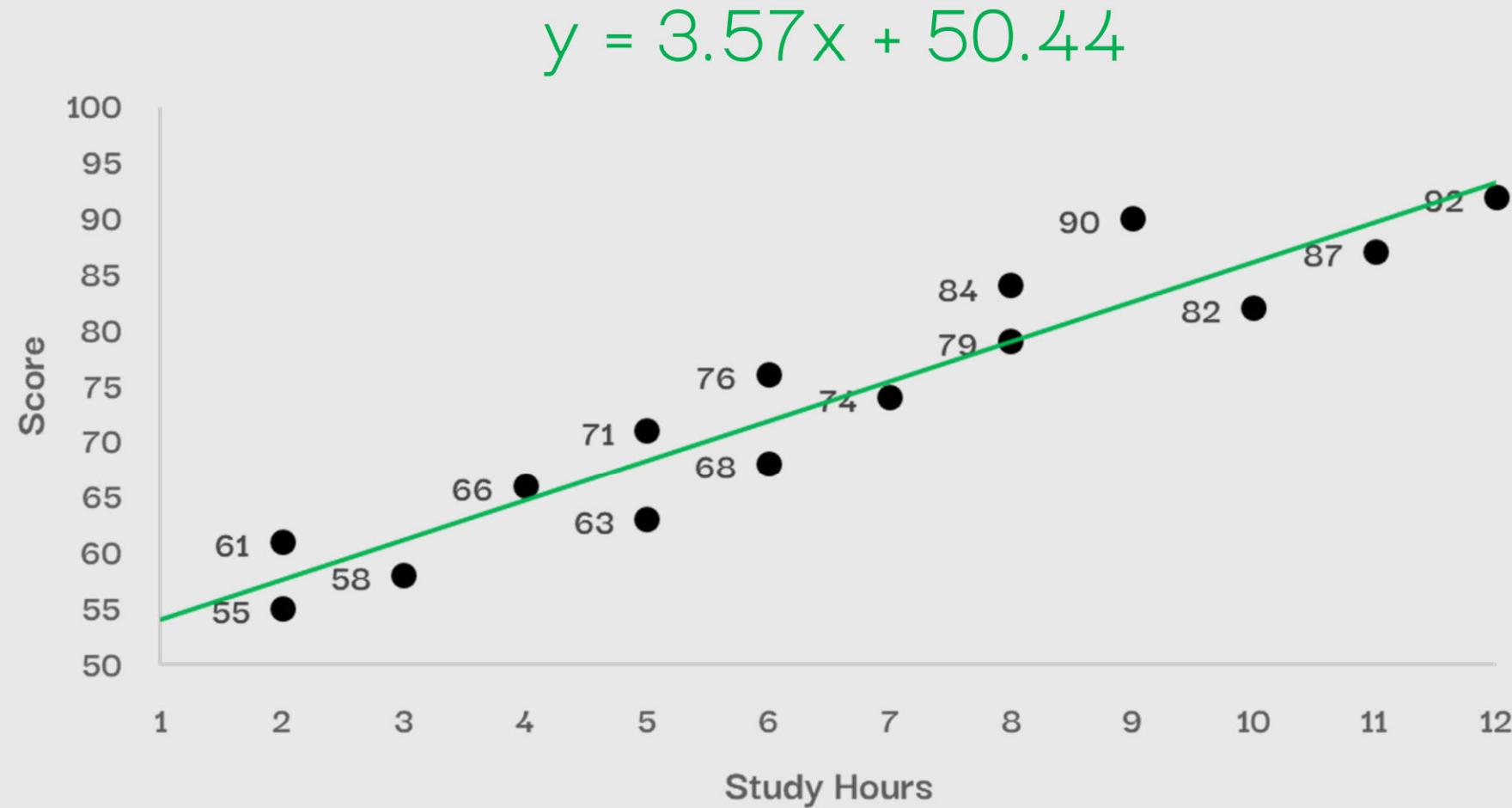
Neural Network - Intuition

A computation graph has input, function, and output nodes.



Recall: Linear Regression

Study Hours (x)	Test Score (y)
2	55
2	61
3	58
4	66
5	63
5	71
6	68
6	76
7	74
8	79
8	84
9	90
10	82
11	87
12	92



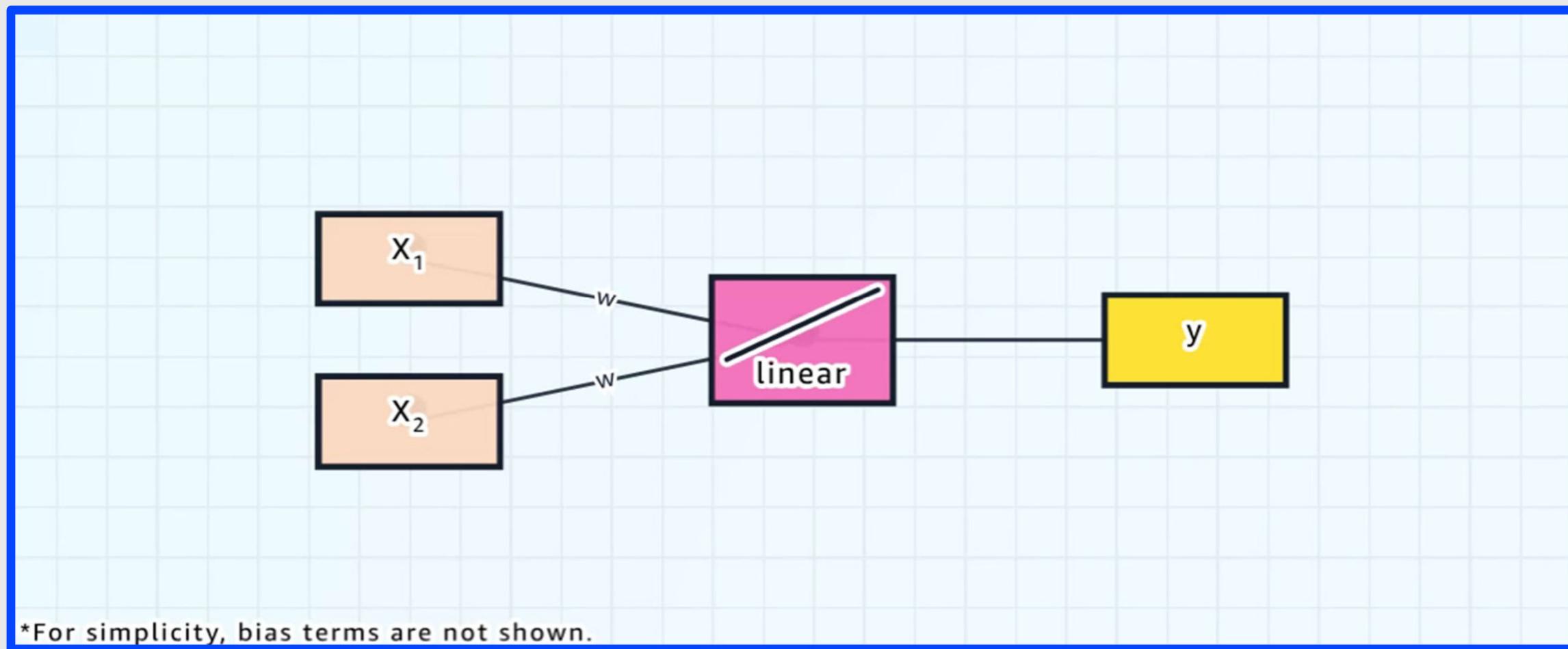
Recall: Linear Regression

$$y = m_1 * x_1 + m_2 * x_2 + \dots + b$$

We need determine m and b to minimize
the difference between the actual
data points and the surface.

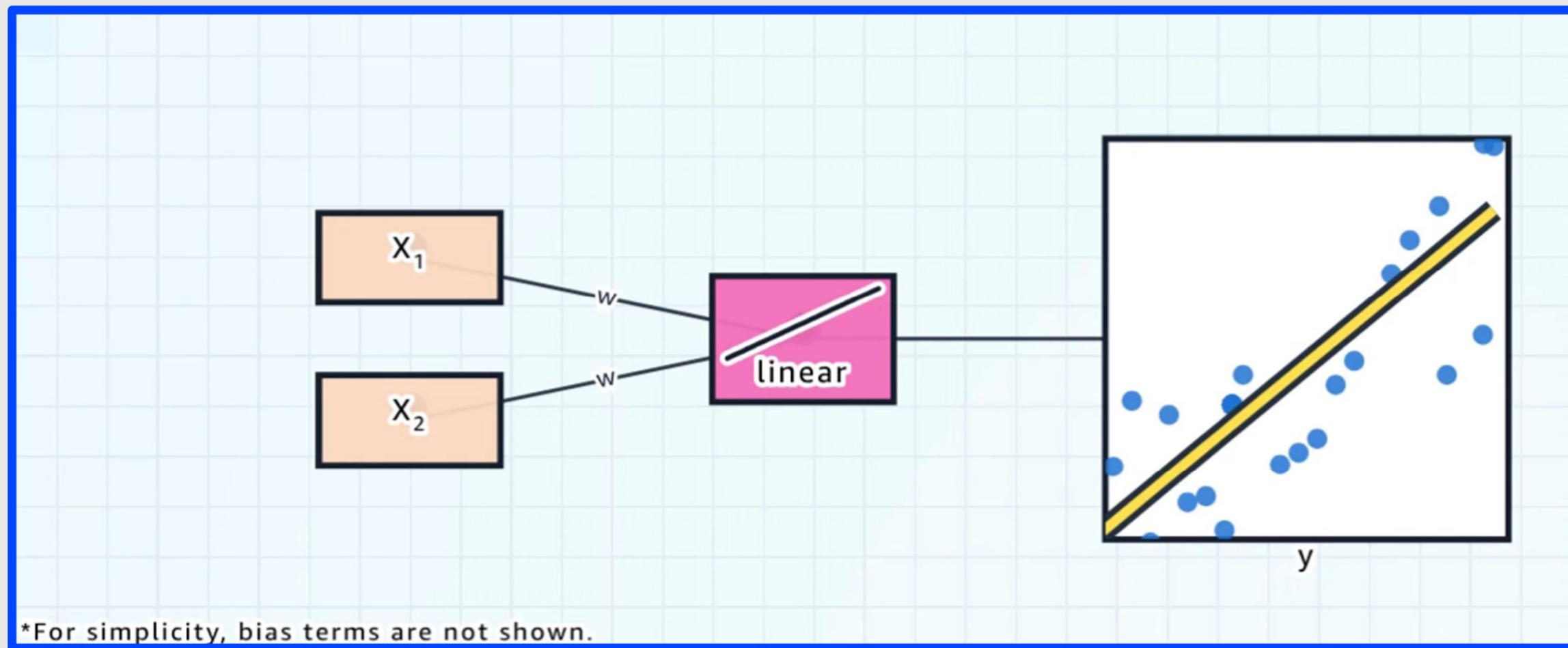
Neural Network - Intuition

We can represent all sorts of machine learning algorithms, like Linear Regression, using computational graphs.



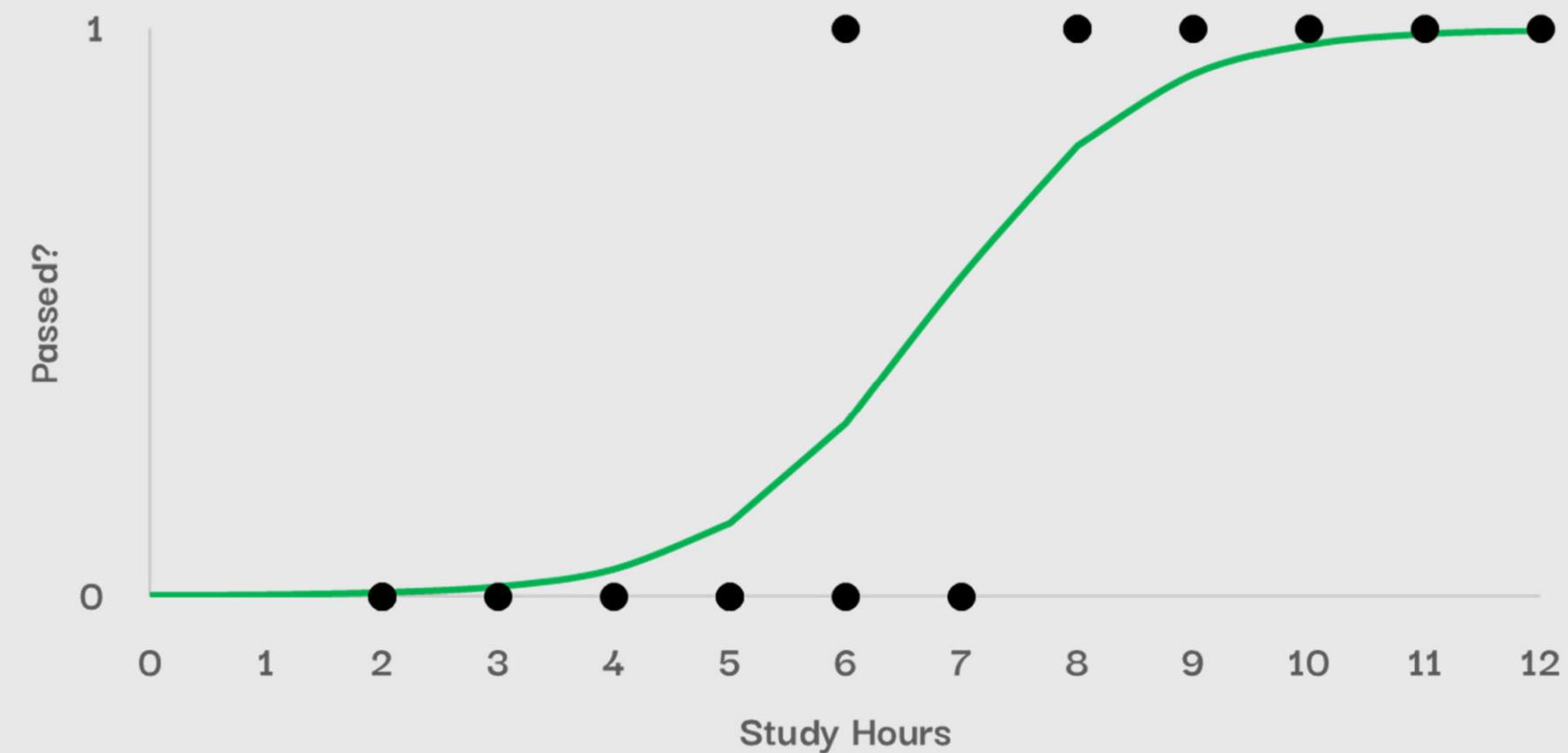
Neural Network - Intuition

We can represent all sorts of machine learning algorithms, like Linear Regression, using computational graphs.



Recall: Logistic Regression

Study Hours (x)	Passed? (y)
2	No
2	No
3	No
4	No
5	No
5	No
6	No
6	Yes
7	No
8	Yes
8	Yes
9	Yes
10	Yes
11	Yes
12	Yes



Recall: Logistic Regression

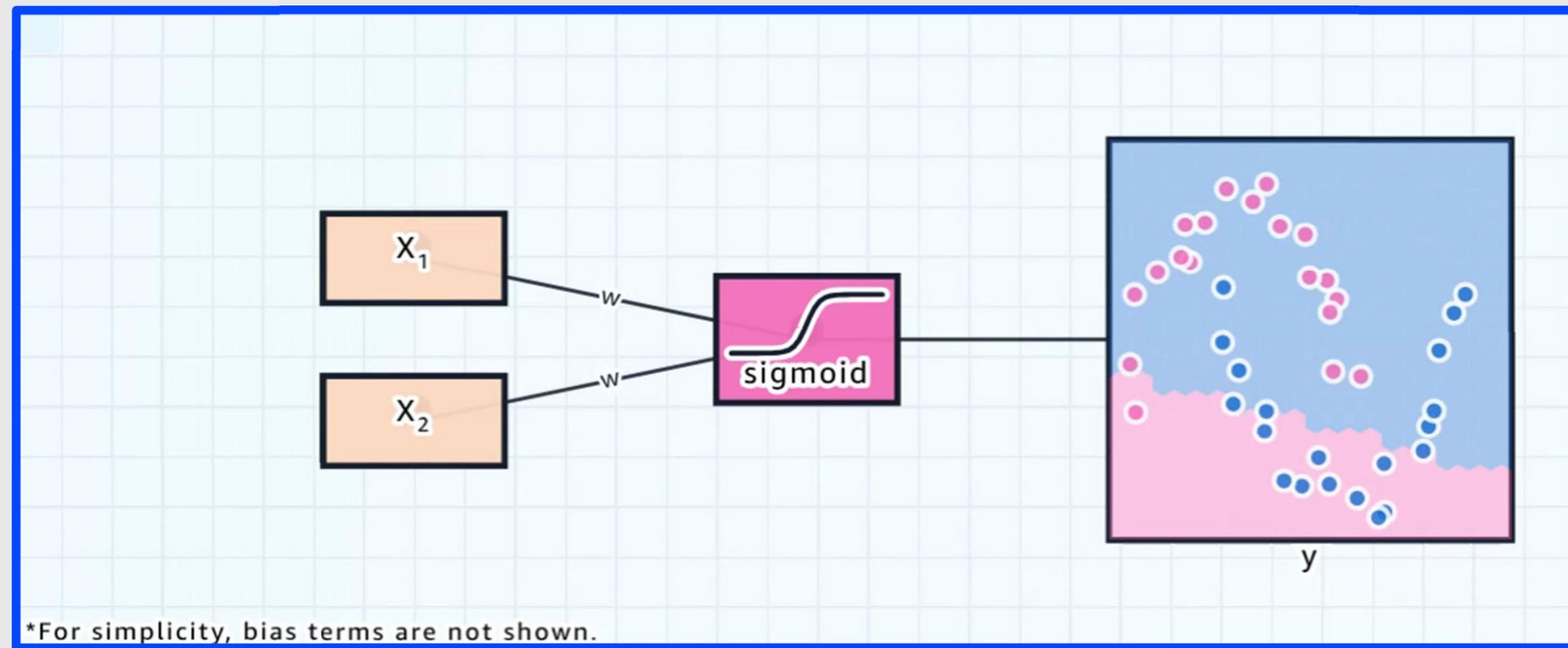
$$p = \frac{1}{1 + e^{-y}}$$

where

$$y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n$$

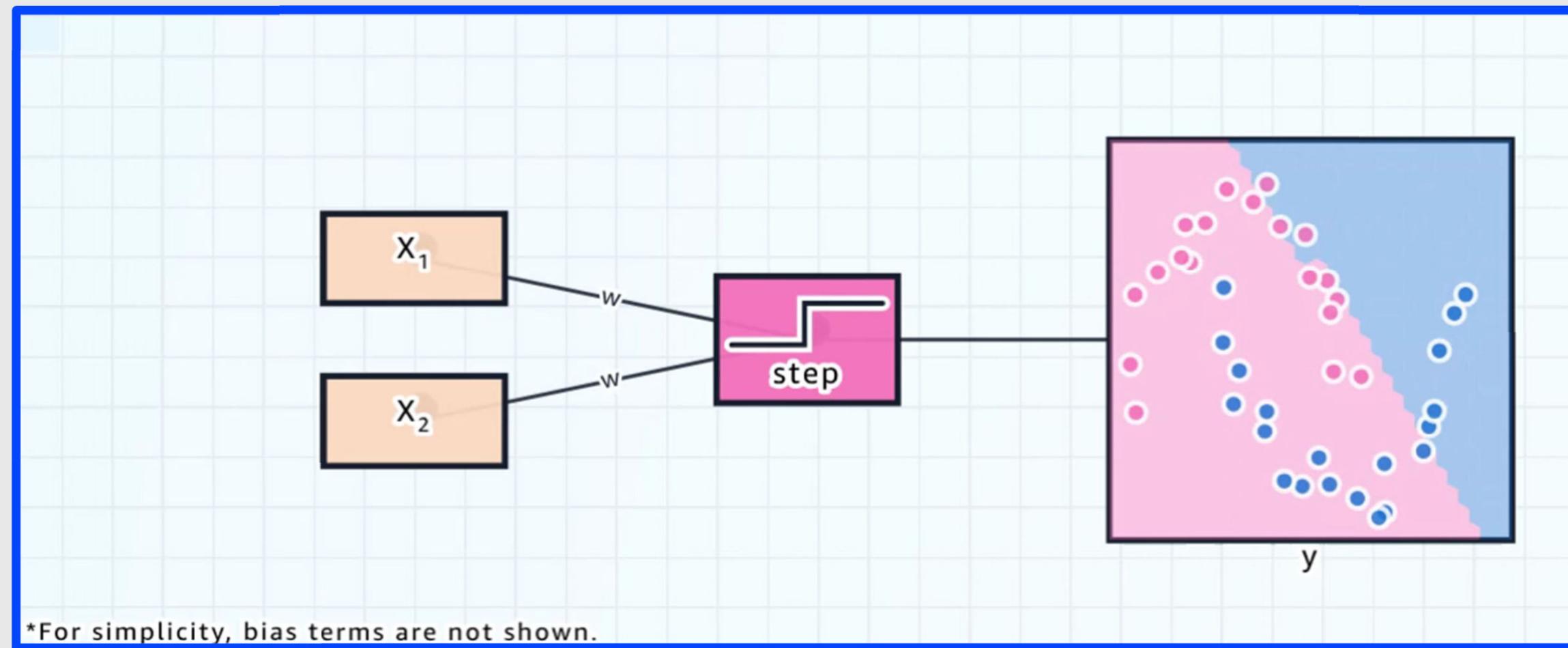
Neural Network - Intuition

If we switch to a classification problem, we can update our computational graph with a sigmoid function for Logistic Regression.



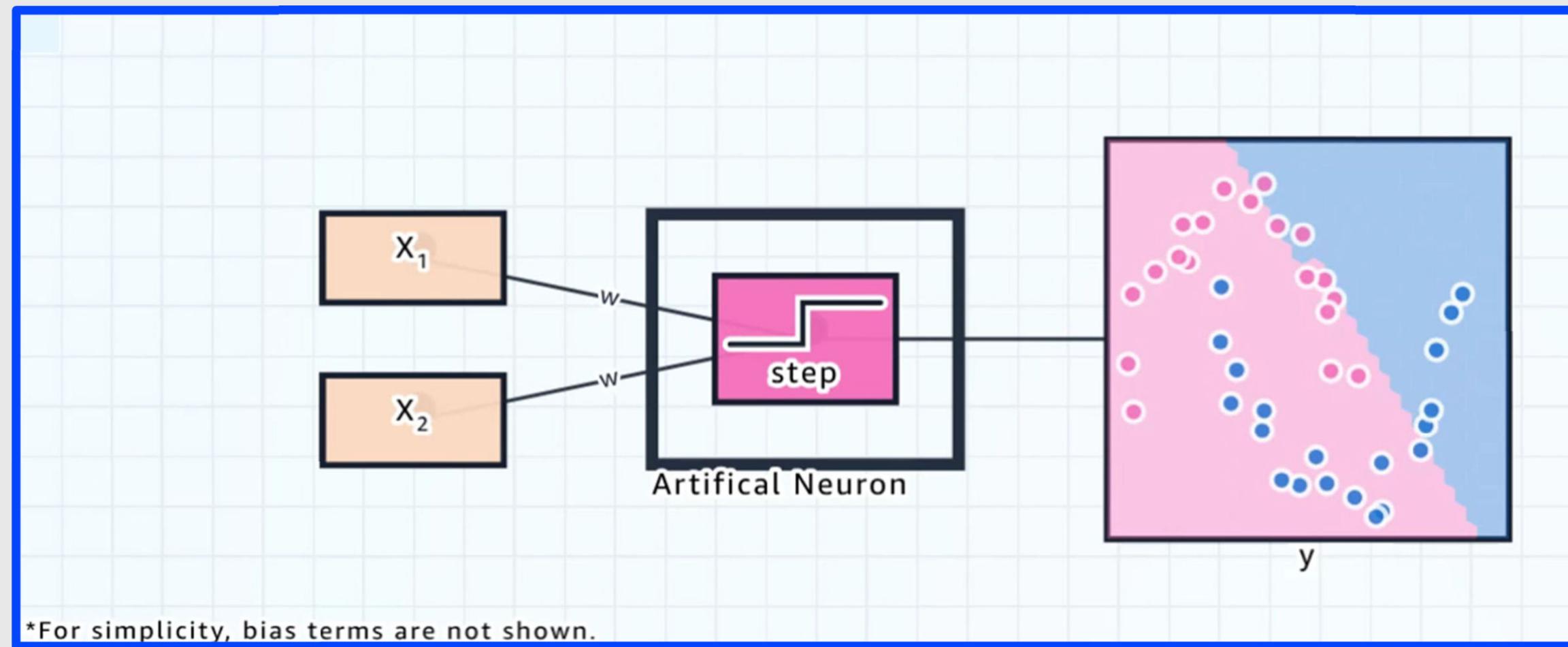
Neural Network - Intuition

We can use a step function for binary classification if the data can be separated by a line.



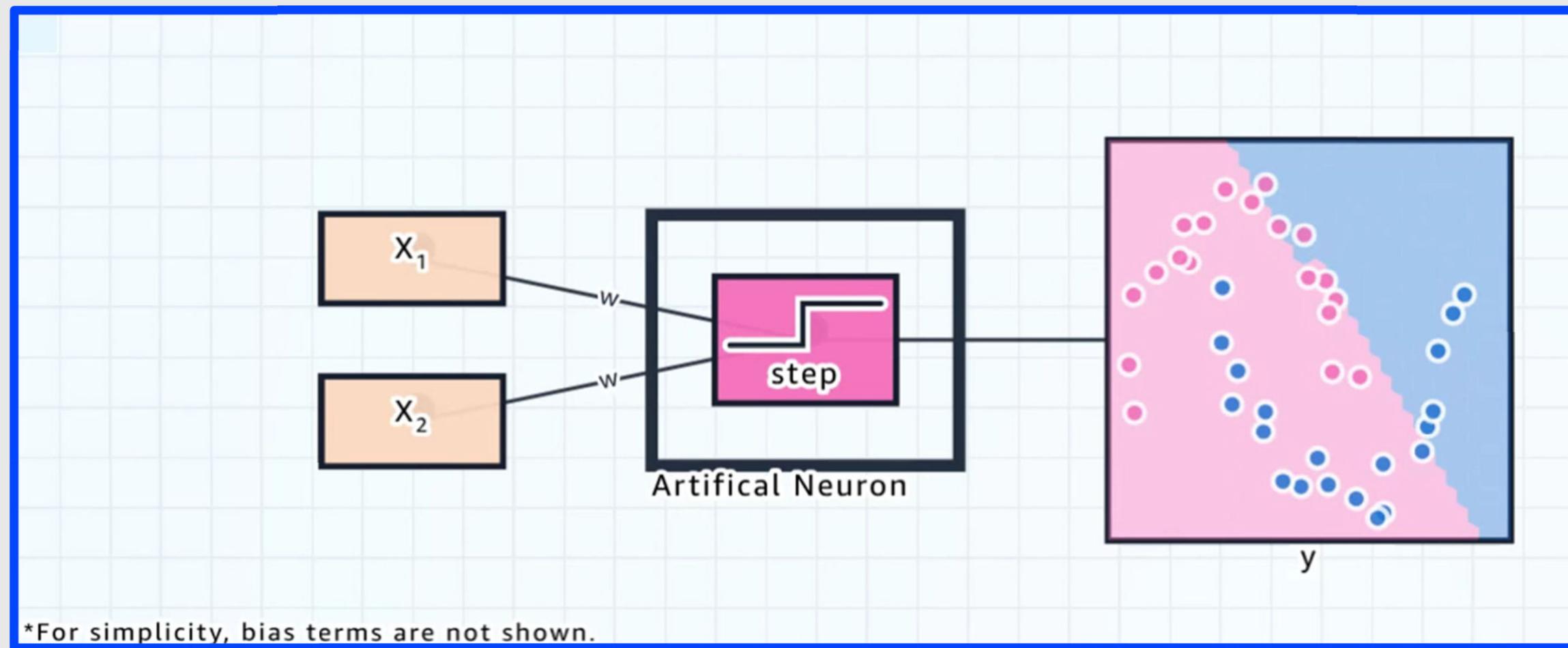
Neural Network - Intuition

Each of these nodes is called an **artificial neuron**, and the functions applied within these nodes, known as **activation functions**, must be non-linear.



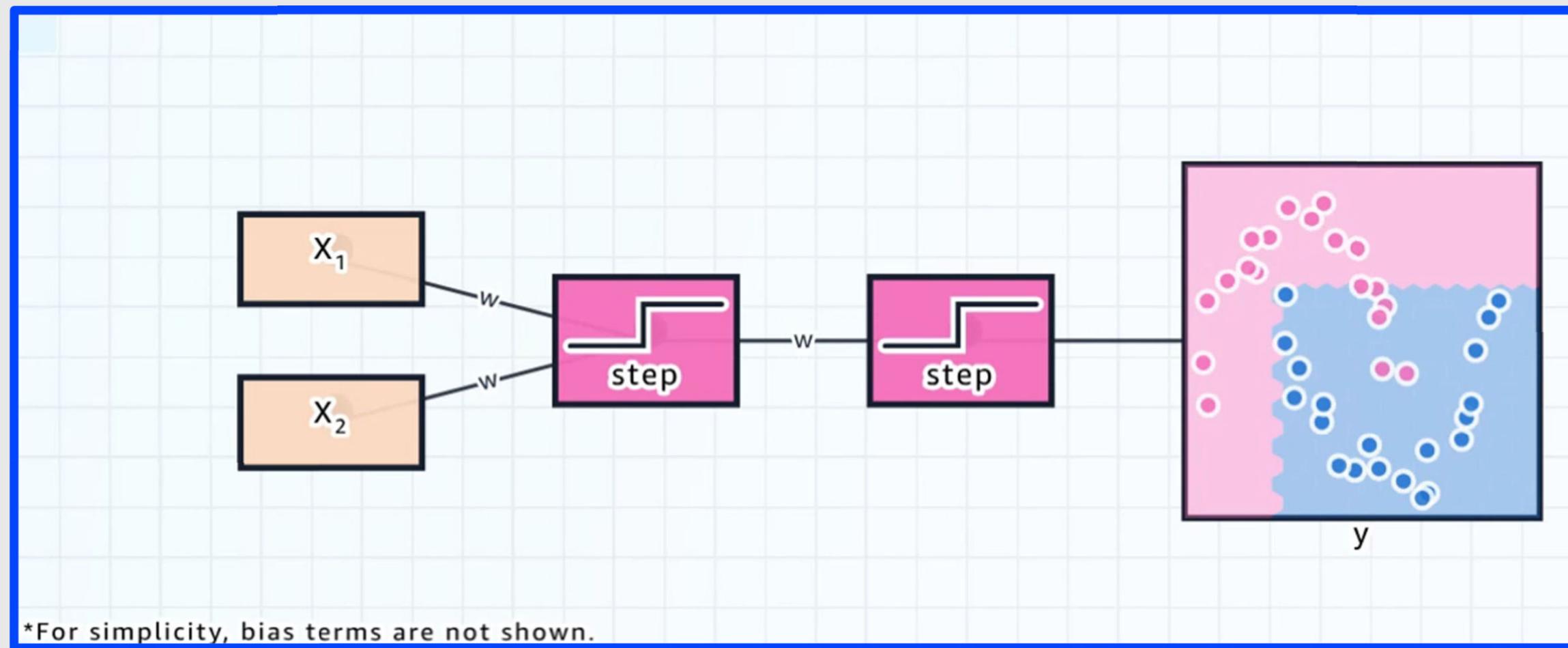
Neural Network - Intuition

These functions enable the network to learn complex patterns and solve intricate problems.



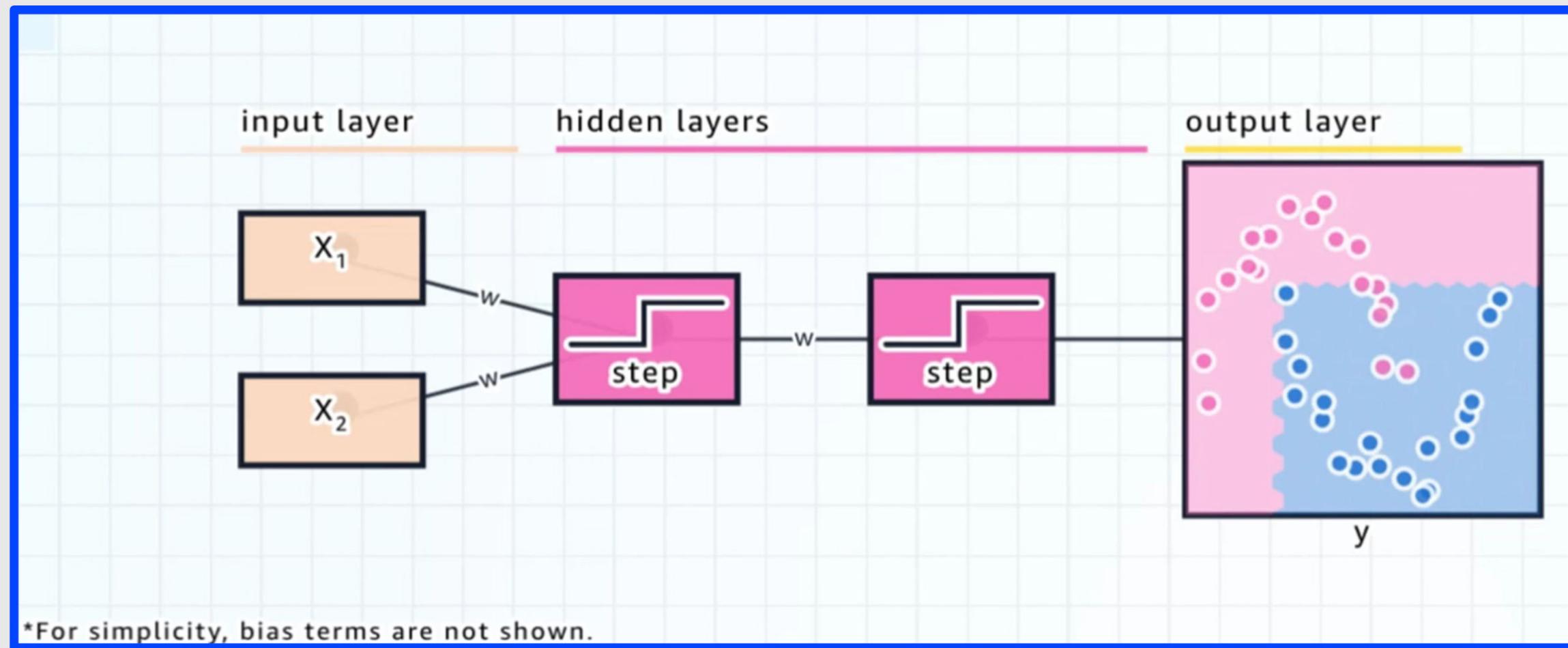
Neural Network - Intuition

We can chain multiple artificial neurons together, each feeding into the next, which is what defines a neural network.



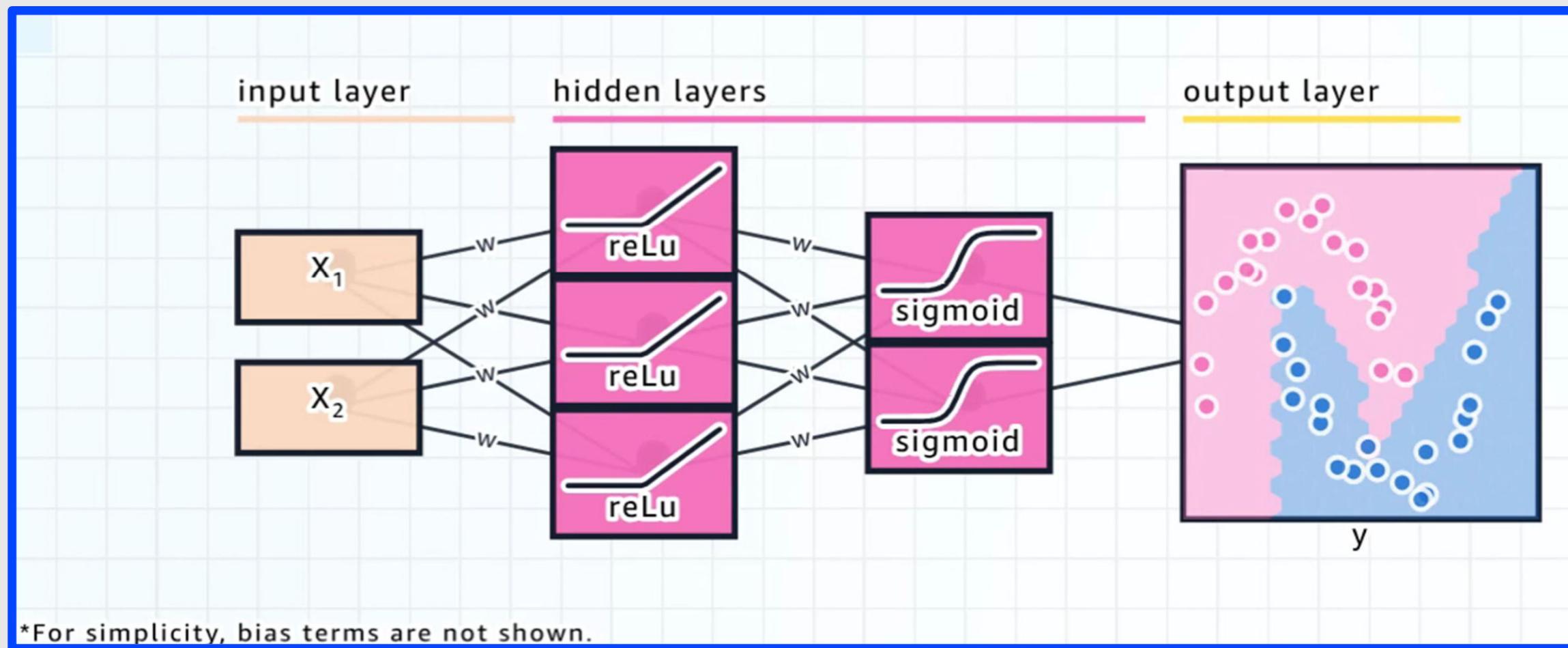
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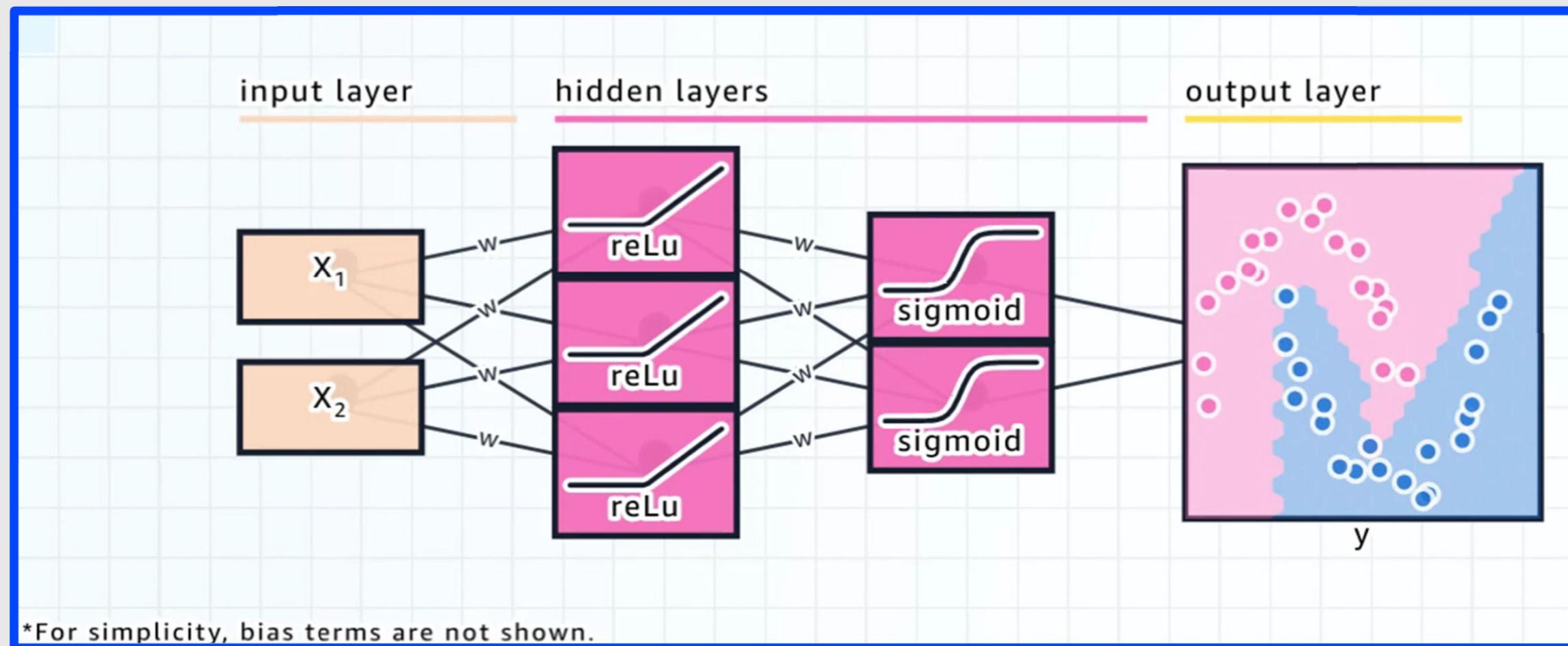
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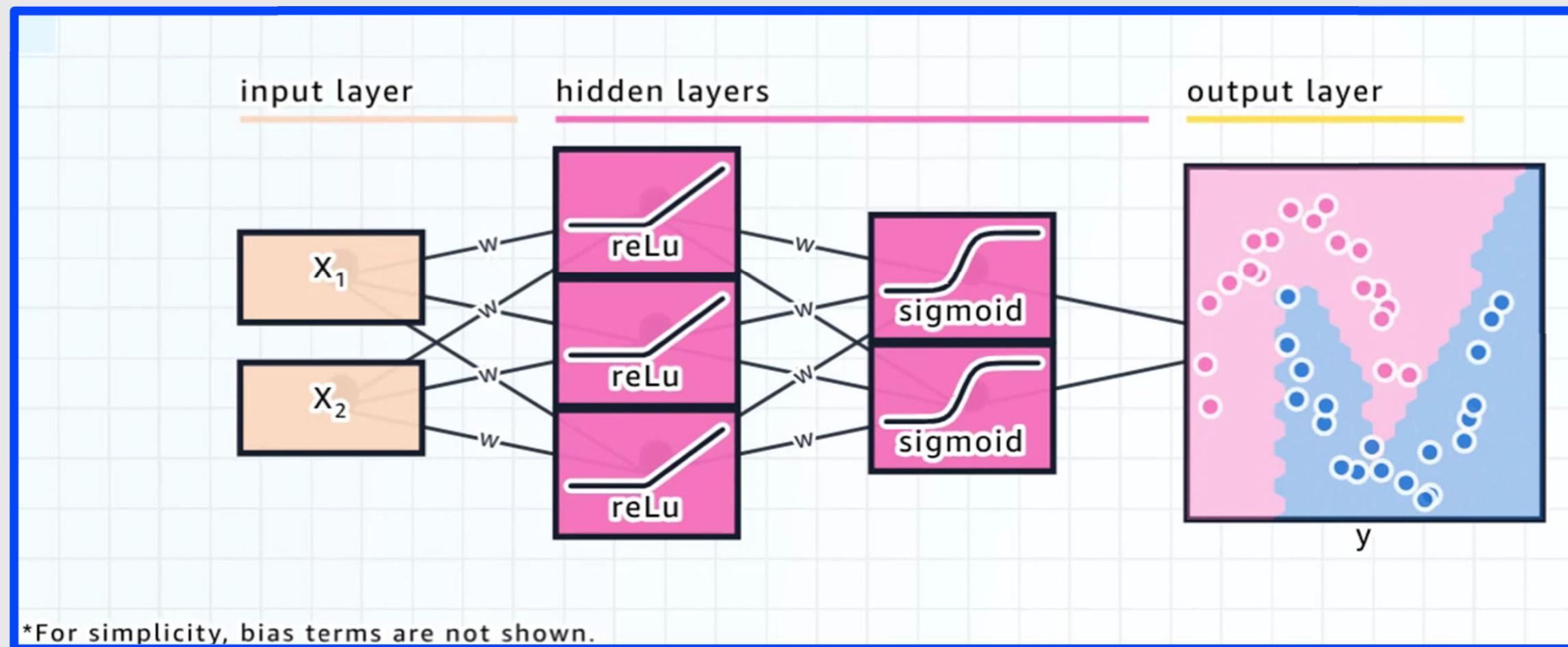
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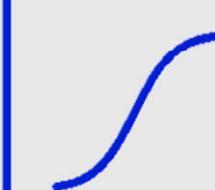


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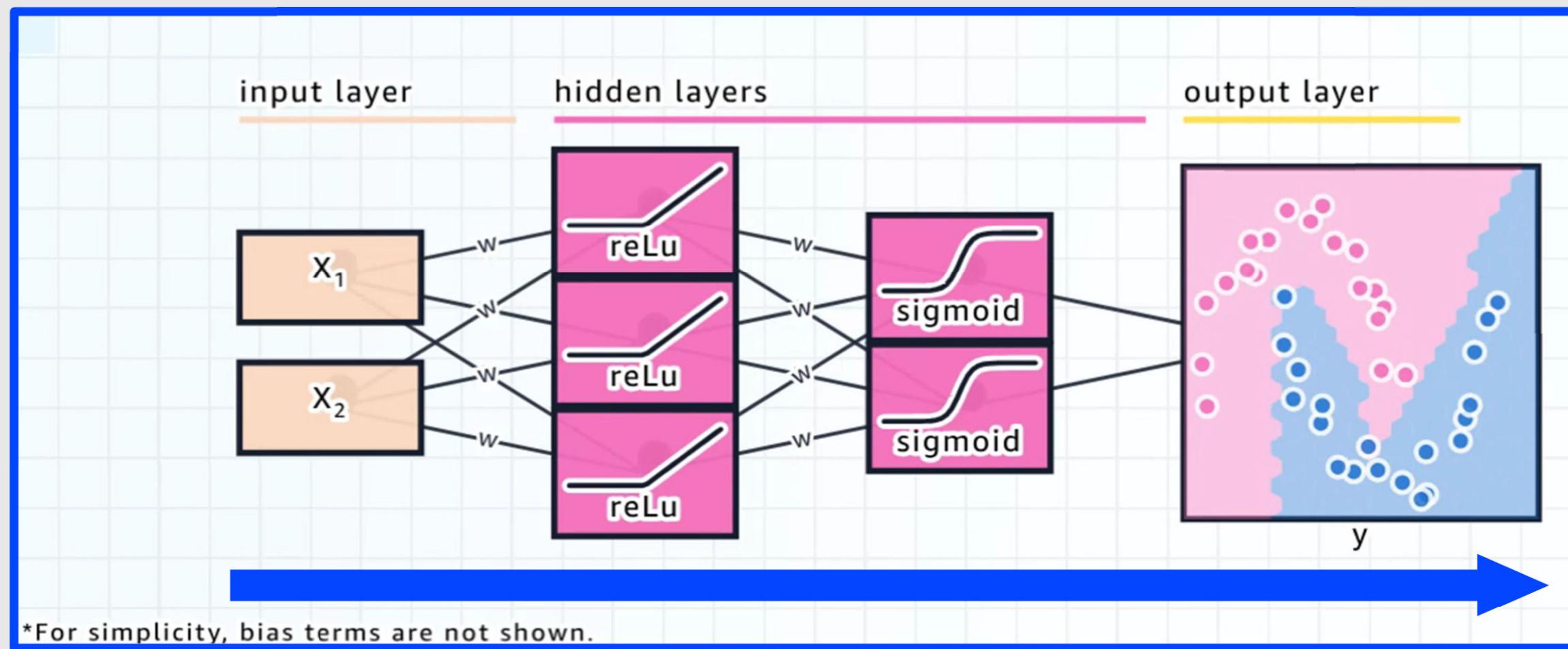


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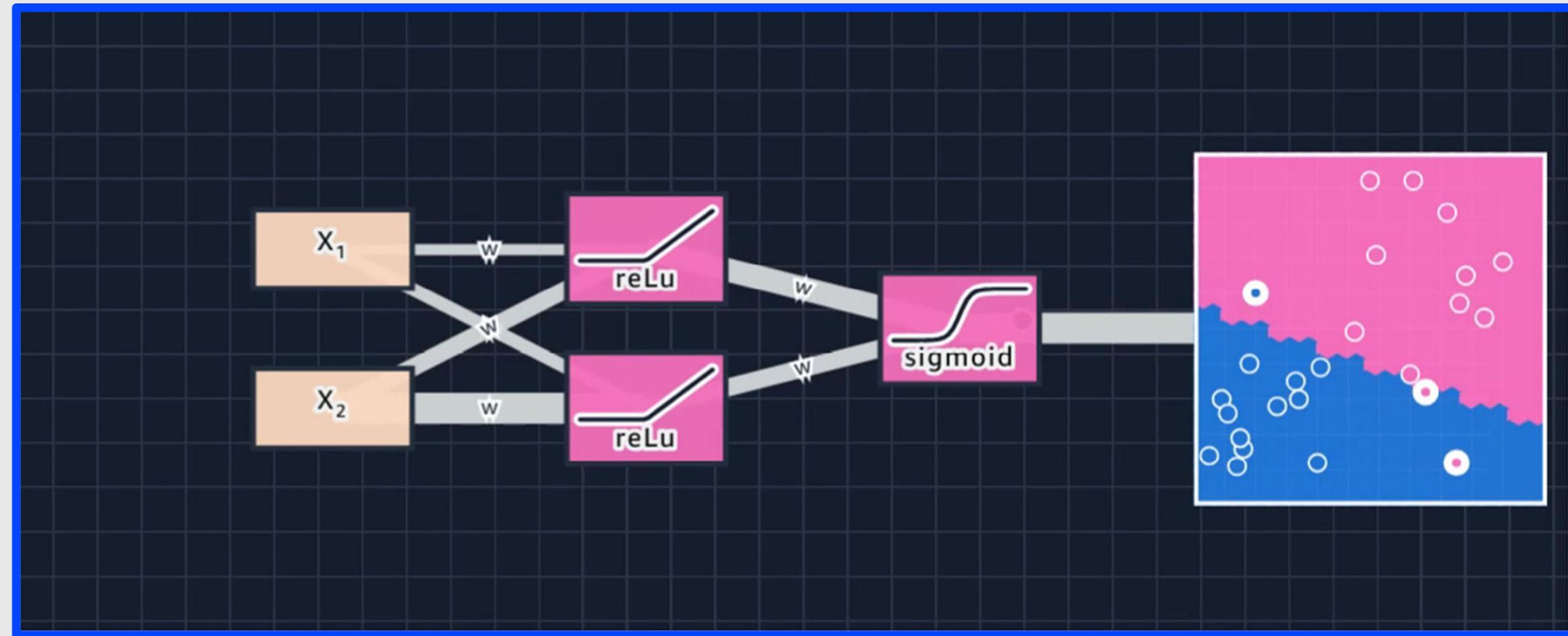
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