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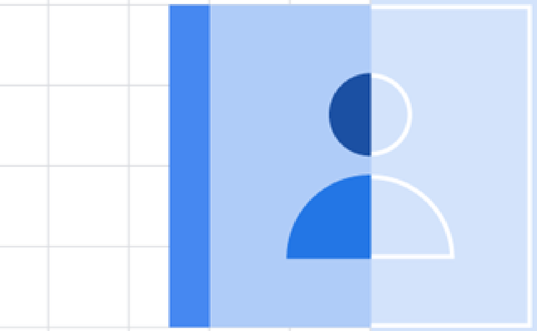

Google Developers

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Neural Networks

#ExploreML – Program by Google AI

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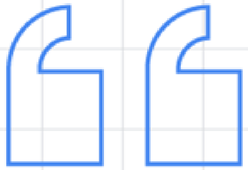
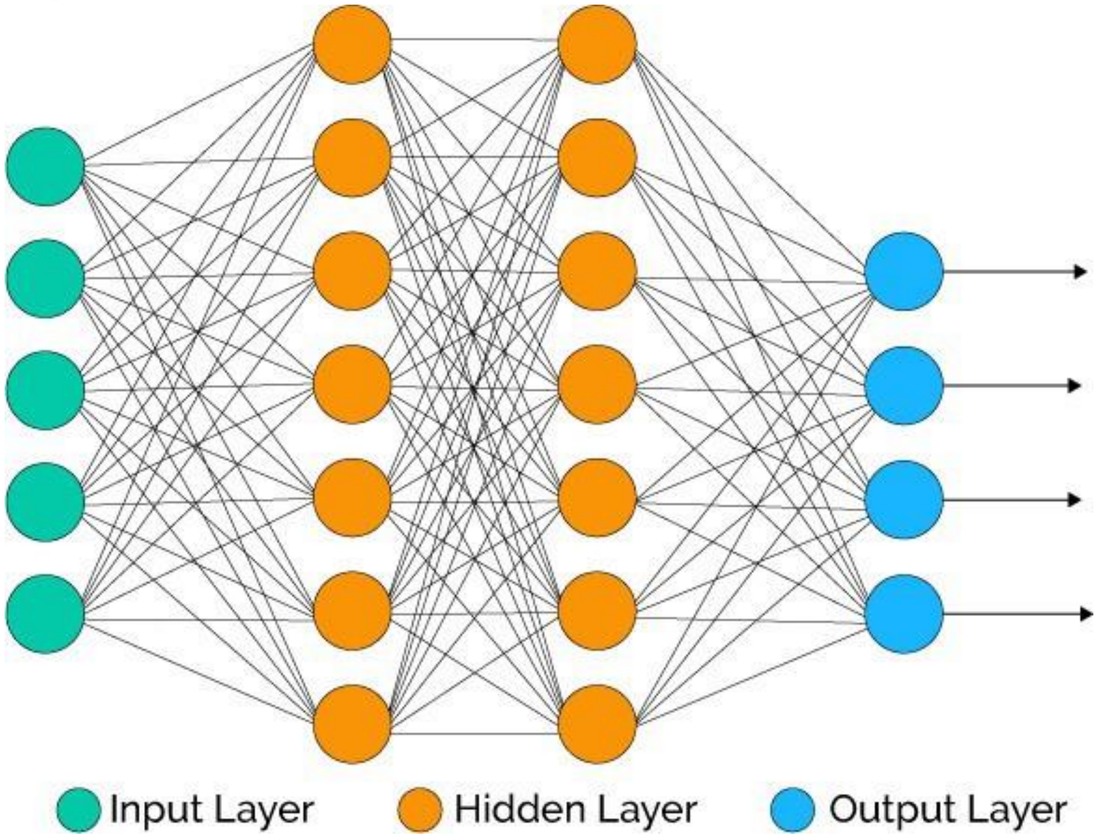


“Don’t you dare call yourself ML Engineer if you can’t understand Neural Networks.”

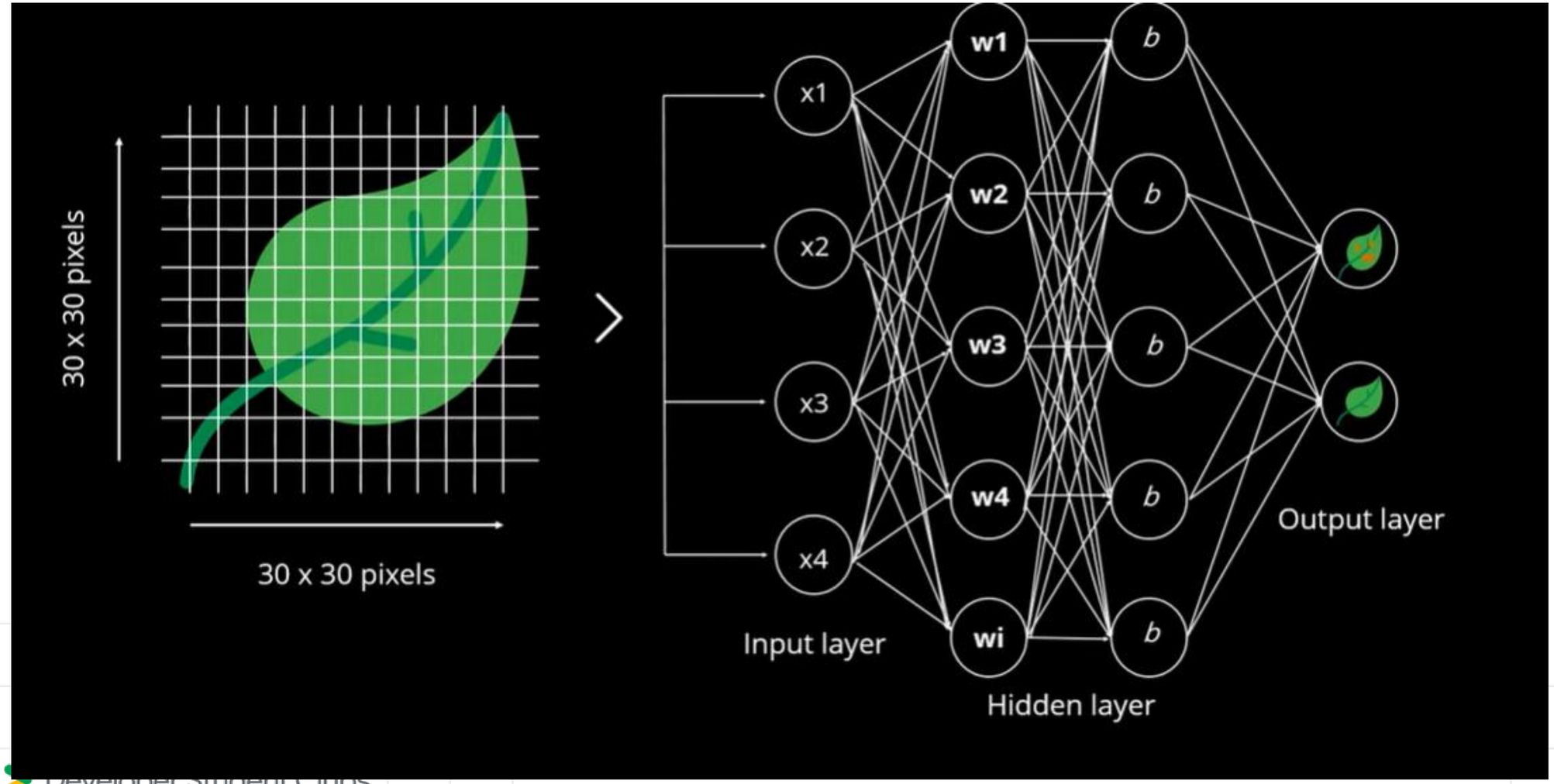
Muhammad Huzaifa Shahbaz

Neural Network

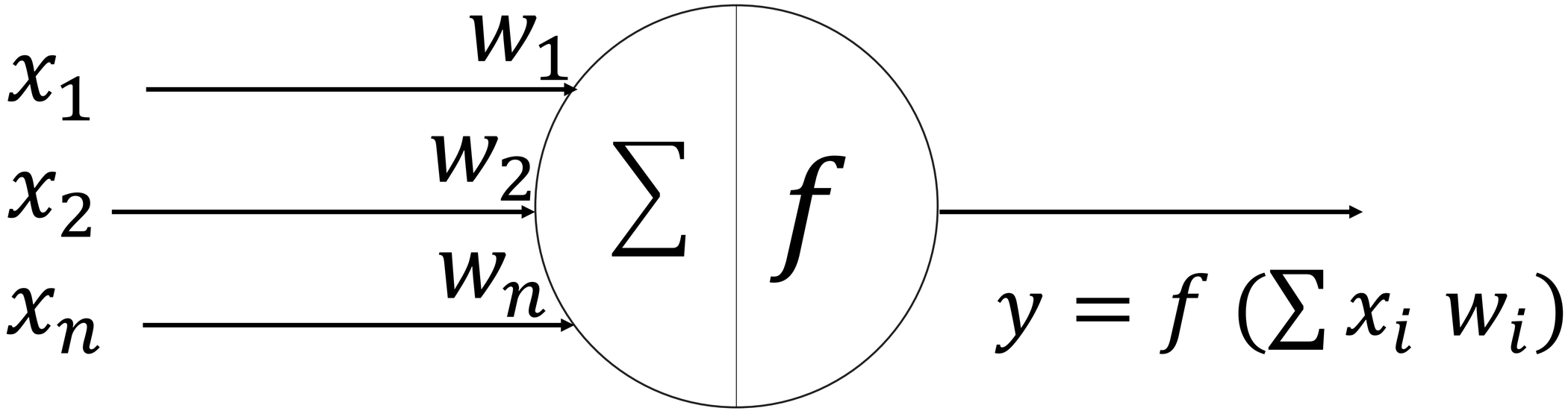
Let’s Understand It



How they works



Artificial Neural Network



$$x_1.w_1 + x_2.w_2 + \cdots + x_n.w_n$$

Activation Functions

Activation function decides, whether a neuron should be activated or not by calculating weighted sum and further adding bias with it. The purpose of the activation function is to **introduce non-linearity** into the output of a neuron.

Explanation :-

We know, neural network has neurons that work in correspondence of *weight, bias* and their respective activation function. In a neural network, we would update the weights and biases of the neurons based on the error at the output. This process is known as *back-propagation*. Activation functions make the back-propagation possible since the gradients are supplied along with the error to update the weights and biases.

Activation Functions

The **activation function** of a node defines the output of that node given an input or set of inputs.

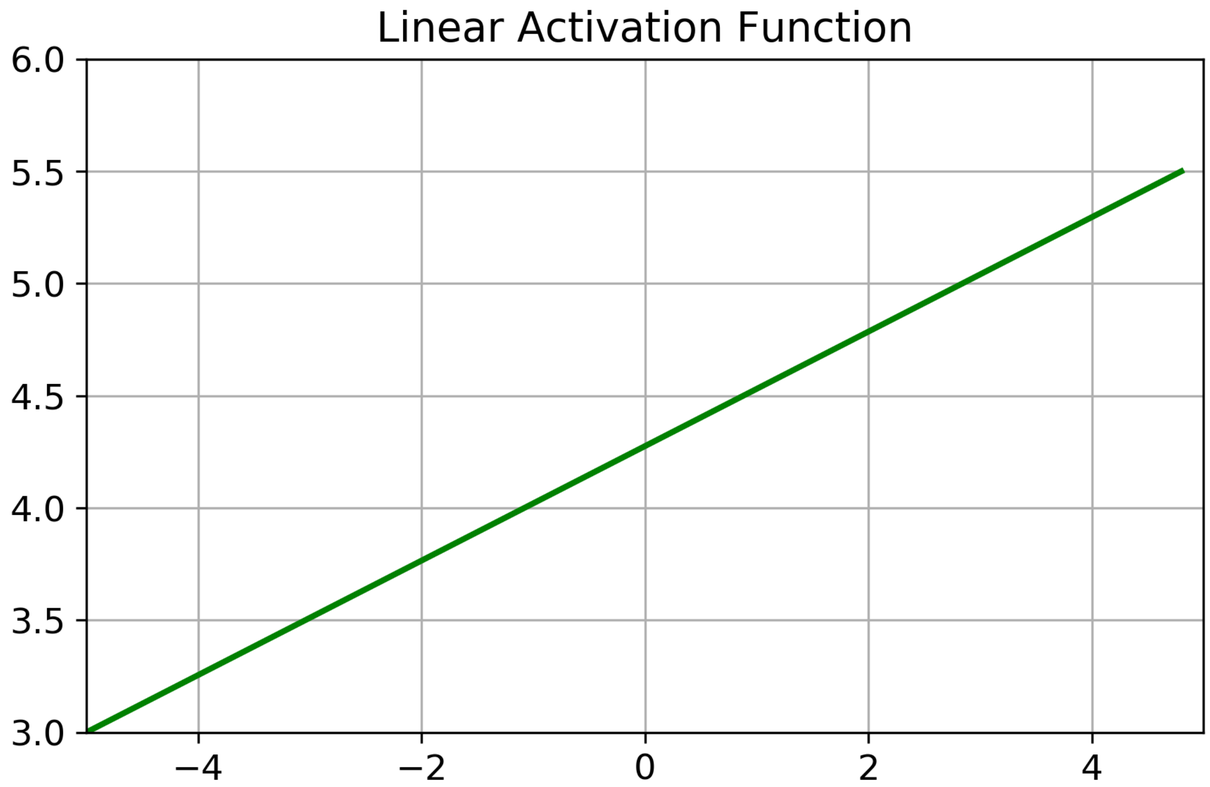
- Linear Function
- Heaviside Step Function
- Sigmoid Function
- Tanh Function
- ReLU
- SoftMax Function

Linear Function

$$f(x) = a + x$$
$$f(x) = a + \sum x_i \, w_i$$

Where

$$a \rightarrow bias$$



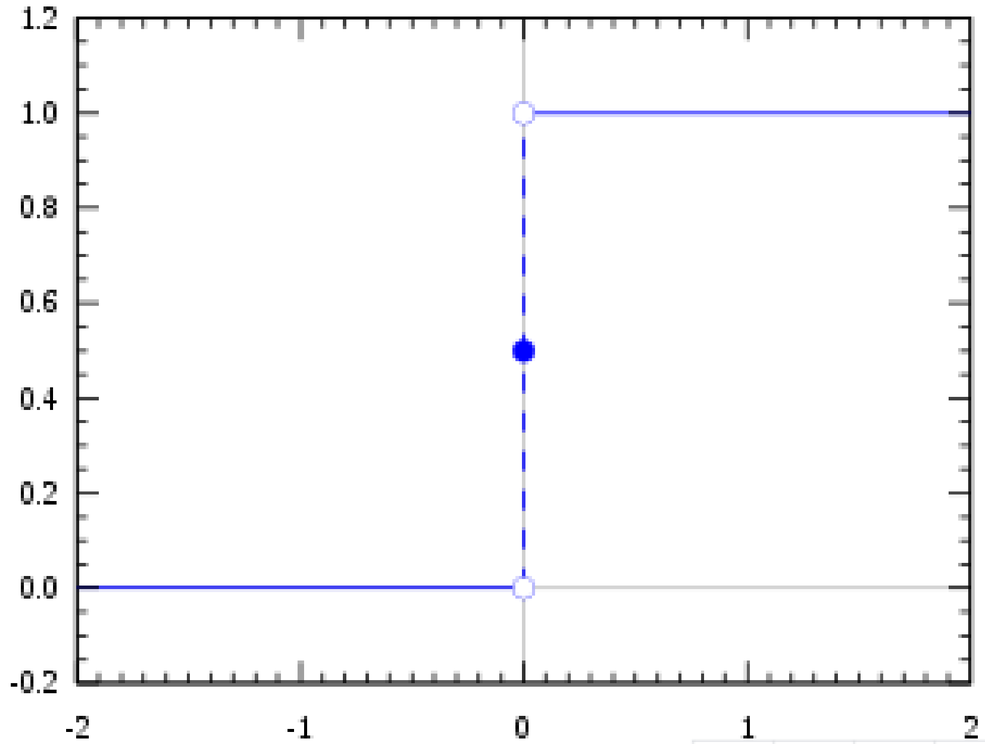
When? Usually used at Output Layer
Regression Problems, if all layers are linear in nature the final will absolutely be Linear one

Heaviside Step Function

$$f(x) = \begin{cases} 1, & if\ x \geq a \\ 0, & Else \end{cases}$$

Where

$$a \rightarrow bias \mid threshold$$



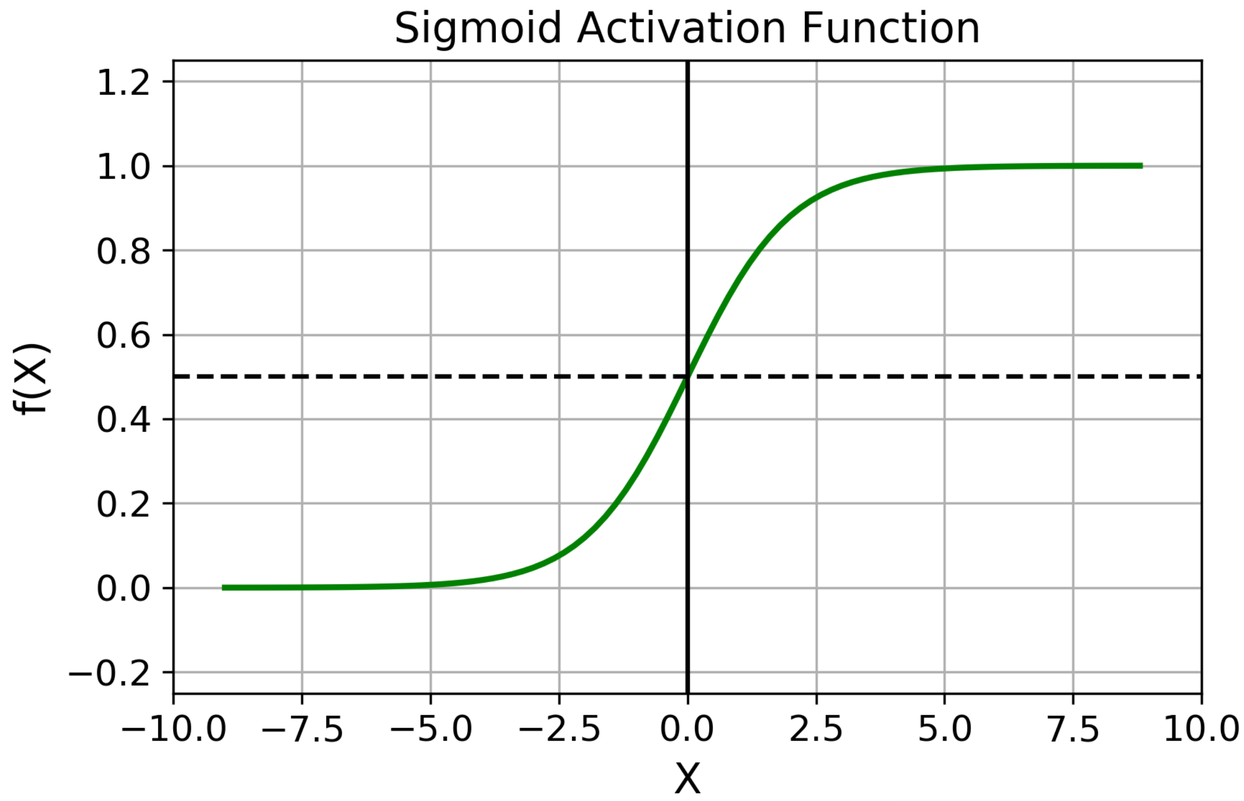
When? Usually used for Binary Classification
If threshold is passed, it is 1.

Sigmoid Function (Also knowns as Logistic Function)

$$f(v) = \frac{1}{1 + e^{-v}}$$

Where

$e \rightarrow$ Euler's Constant



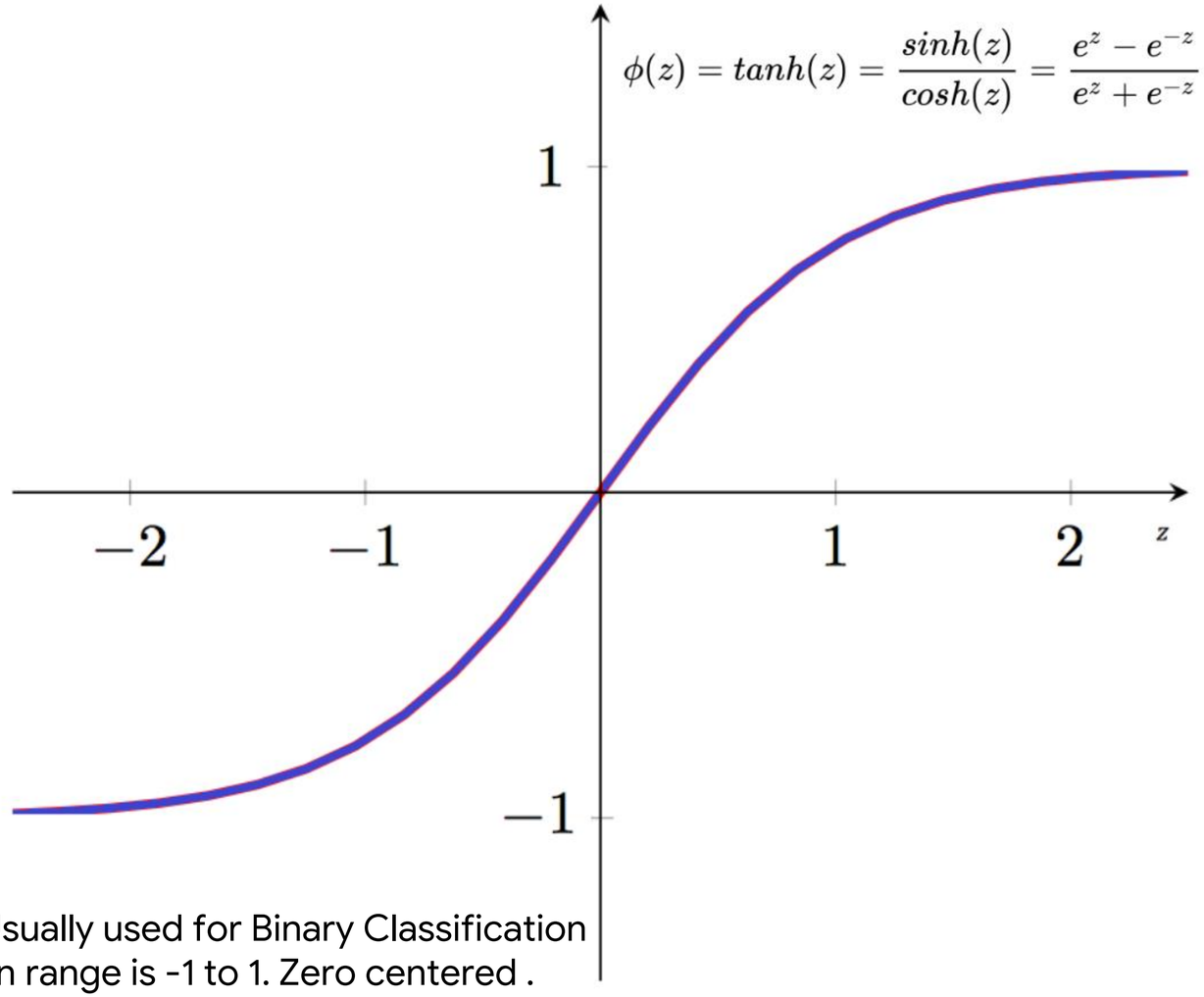
When? Usually used for Binary Classification
Prediction is either 0 or 1. But not Zero Centered

Tanh Function

$$f(x) = \tanh(x)$$

$$f(x) = \frac{\sinh(x)}{\cosh(x)}$$

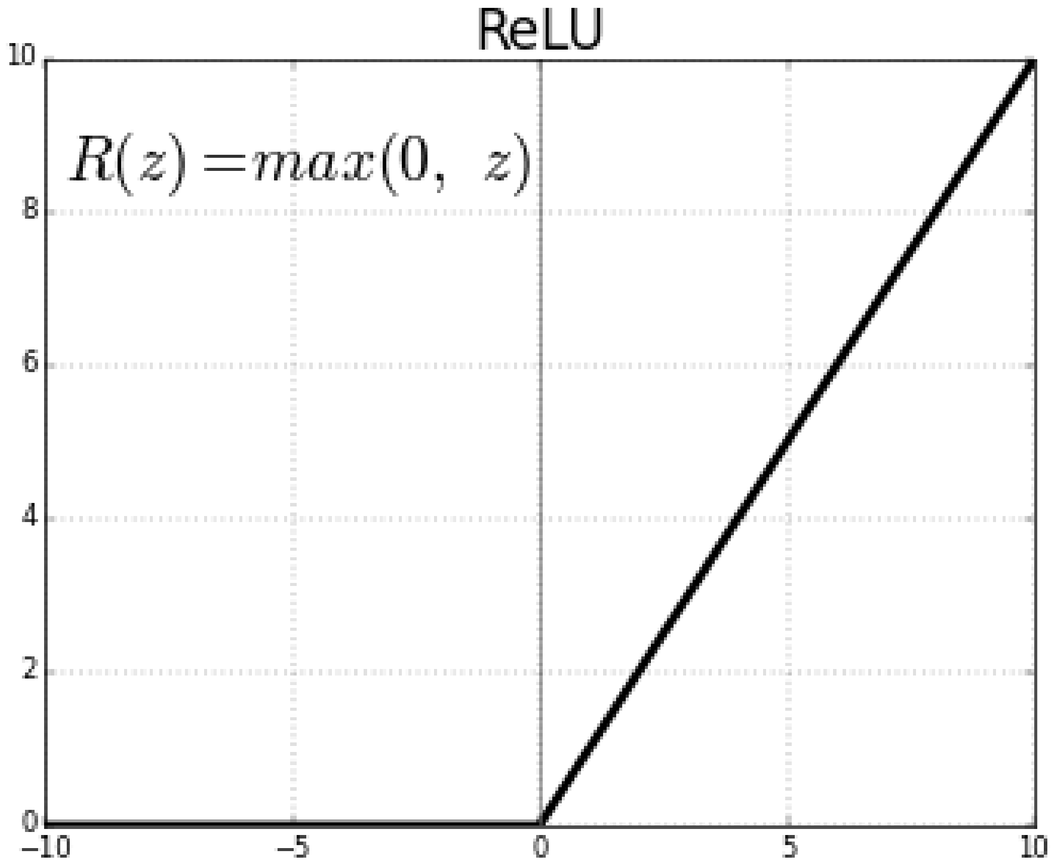
$$f(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$



When? Usually used for Binary Classification
Prediction range is -1 to 1. Zero centered .
Usually used in hidden layers, for bringing mean of the data Close to 0.

ReLU Function

$$f(x) = \begin{cases} x_i, & if\ x \geq 0 \\ 0, Else & |if\ x < 0 \end{cases}$$



Range is 0 to + Inf
Nature :- Non-linear, which means we can easily backpropagate the errors and have multiple layers of neurons being activated by the ReLU function.
Uses ReLu is less computationally expensive than tanh and sigmoid because it involves simpler mathematical operations. At a time only a few neurons are activated making the network sparse making it efficient and easy for computation.

SoftMax Function

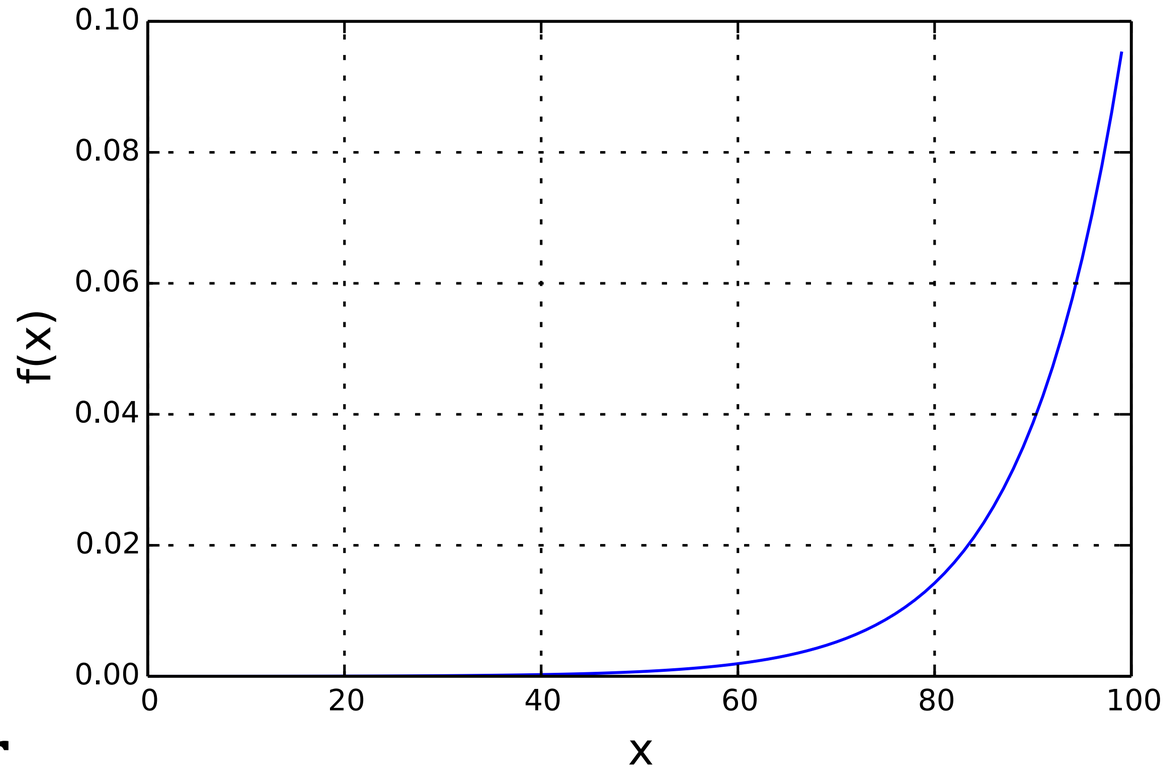
$$f(x) = \frac{e^{x_i}}{\sum_{j=1}^{K} e^{x_j}}$$

Where,

$K \rightarrow Number\ of\ Classes$

$e^{x_i} \rightarrow$ Exp fn for input vector

$e^{x_j} \rightarrow$ Exp fn for output vector



The softmax function is also a type of sigmoid function but is handy when we are trying to handle classification problems. The softmax function would squeeze the outputs for each class between 0 and 1 and would also divide by the sum of the outputs.

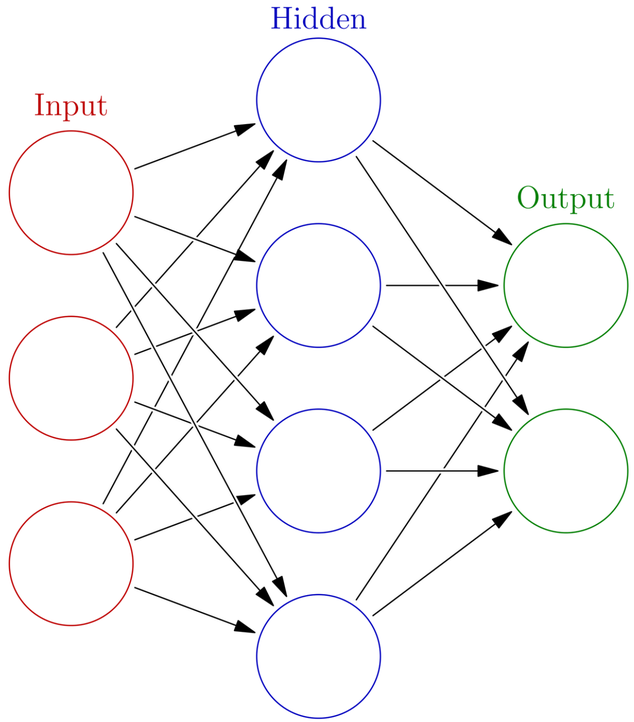
Choosing the right Activation Function

The basic rule of thumb is if you really don't know what activation function to use, then simply use *RELU* as it is a general activation function and is used in most cases these days.
If your output is for binary classification then, *sigmoid function* is very natural choice for output layer.

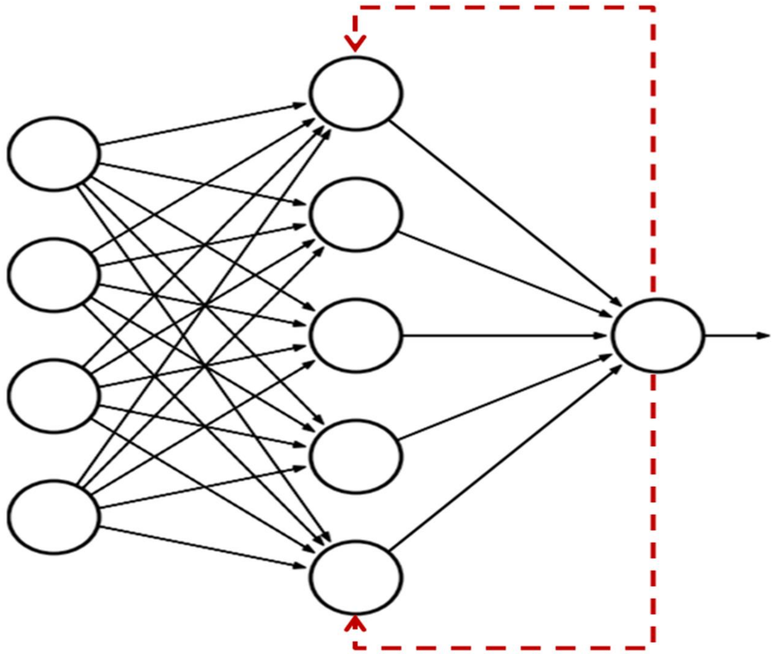
Foot Note :-
The **activation function** does the non-linear transformation to the input making it capable to learn and perform more complex tasks.

Artificial Neural Network

Feed Forward Networks



Feed Back Network



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Thank You!

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