$y_{in}(2) = -1 = t = -1$ { $-1 \; y_{in} \geq 1$ }.

$1.-1+1=0$

$y_{in}(0) = 1 = t = 1$.

1) write the purpose of weights in the artificial neural network models.

A) weights play a crucial role in determining the network's ability to learn and make accurate predictions

i) control the strength of connections.

ii) facilitate learning.

iii) enable generalizations.

iv) control Activation of neurons.

v) help with Nonlinearity.

vi) contribute to model flexibility.

2) Illustrate the uses of different activation functions for artificial neural networks.

1) sigmoid. → Binary classification output layer.

$$\sigma = \frac{1}{1+e^{-x}}$$

- smooth output probabilistic output
- vanishing gradient non zero centered

2) tanh. → Hidden layers for data between -1 and 1

- $\tanh(x) = \frac{2}{1+e^{-2x}} = -1$
- zero-centered better gradients.
- vanishing gradient for large values.

3) Relu → Hidden layers for dnn networks.

$$\text{Relu}(x) = \max(0, x)$$

- Efficient; simple sparse activations.
- Dying Relu problem (inactive neurons).

4) Leaky Relu → Deep networks to prevent dying Relu

$$\text{Leaky Relu}(x) = \max(\alpha x, x)$$

- mitigates dying Relu problem.
- slower convergence in some cases.

5) softmax → multi class classification output.

$$\text{softmax}(z_i) = \frac{e^{z_i}}{\sum_j e^{z_j}}$$

- Converts to probability distribution
- computationally expensive.

3) write the algorithm used in a single layer perceptron model for learning.

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The s.l.p model is a type of artificial neural networks used for binary classification tasks.

$$\hat{y}in = w_1x_1 + w_2x_2 + \cdots + w_nx_n + b.$$

$$w_1new = w_1old + \alpha t \, x_1.$$

$$w_2new = w_2old + \alpha t \, x_2$$

$$b_{new} = b_{old} + \alpha t.$$

$$\begin{cases} 1 & yin \geq \theta \\ -1 & yin < \theta \end{cases}$$

4) Distinguish the following.

1) Threshold:

Def = A value used to determine when a neuron activates

Role: determines the decision boundary for neuron activation.

Usage: used in step functions to decide if the neuron should activate

Impact: Directly impacts when a neuron fires, making the model binary in simpler cases.

2) Learning rate: A hyperparameter that controls the step size in weight updates

Role: control how much the weights are updated during training.

Usage: used during training to adjust weights according to the error gradient.

Impact: Impact the speed and stability of training.

3) Activation: A func applied to the weighted sum of inputs to determine neuron output.

Role: Introduces non-linearity, allowing the network to learn complex functions

Impact: the ability of the model to learn complex patterns & representations