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Department of Biomedical Engineering

Course Name: 19AMT301 & DEEP LEARNING

III Year : V Semester

Unit I– INTRODUCTION TO NEURAL NETWORKS

Topic : Intro to Neural Networks- What Shallow Network compute?

What is Neural Networks?

• A Neural Network is a computing system that is based on the biological neural network that makes up the human brain.

•Neural networks are not based on any specific computer program written for it, but it can progressively learn and improve its performance over time.

• A neural network is made up of a collection of units or nodes called neurons.
• These neurons are associated with methods for an association called a synapse.
• Using the synapse, a neuron can transmit signals or information to another neuron nearby.
• The receiving neuron can receive the signal, process it, and signal the next one. The process continues until an output signal is produced.

Application of Neural Networks

- Computer Vision
- Pattern Recognition/Matching
- Natural Language Processing

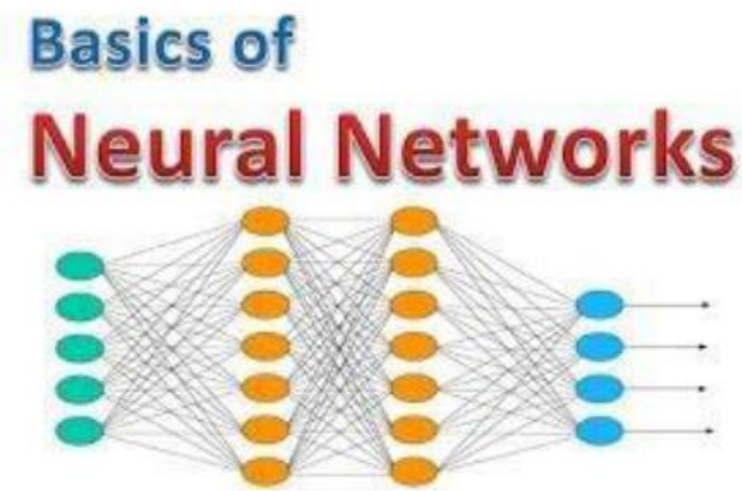
Neural Network implementation

- Nodes represents Neurons
- Output of each Neuron is a non linear function
- The non linear function takes sum of all inputs of Neurons
- Neuron and Synapses have weights

•This weight controls the strength of the signal the neuron sends out across the synapse to the next neuron.

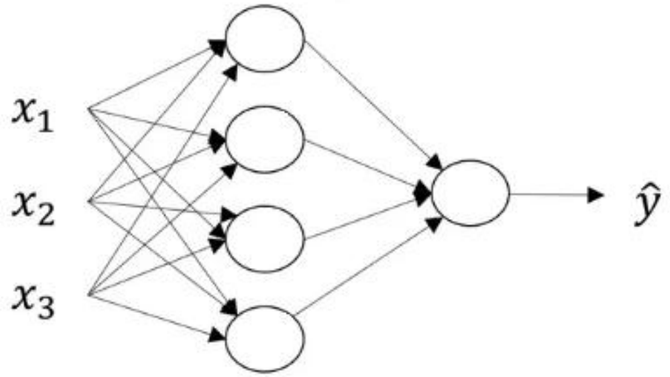
•Neurons are normally arranged in layers.

What are Hidden layers?



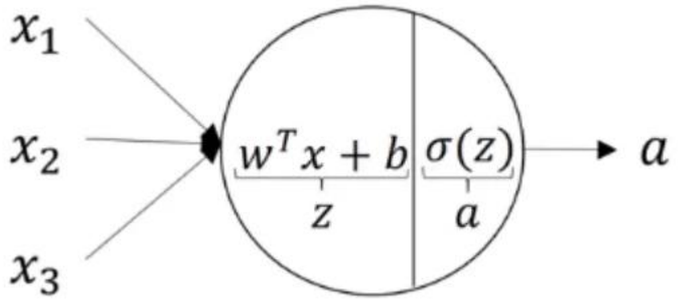
The layers between input and output layers are called hidden layers. There can be many layers until we get an output. Neurons are normally arranged in layers. Different layers may perform different kinds of transformation on its input, or it can adjust as per output result. Signals move through different layers including hidden layers to the outputs.

What a Shallow network computes?



Shallow Network- one or two hidden layers

The Neuron



TWO PARTS:

- The first part computes the output ***Z***, using the inputs and the weights.
- The second part performs the activation on **Z** to give out the final output **A** of the neuron.

The Hidden Layer

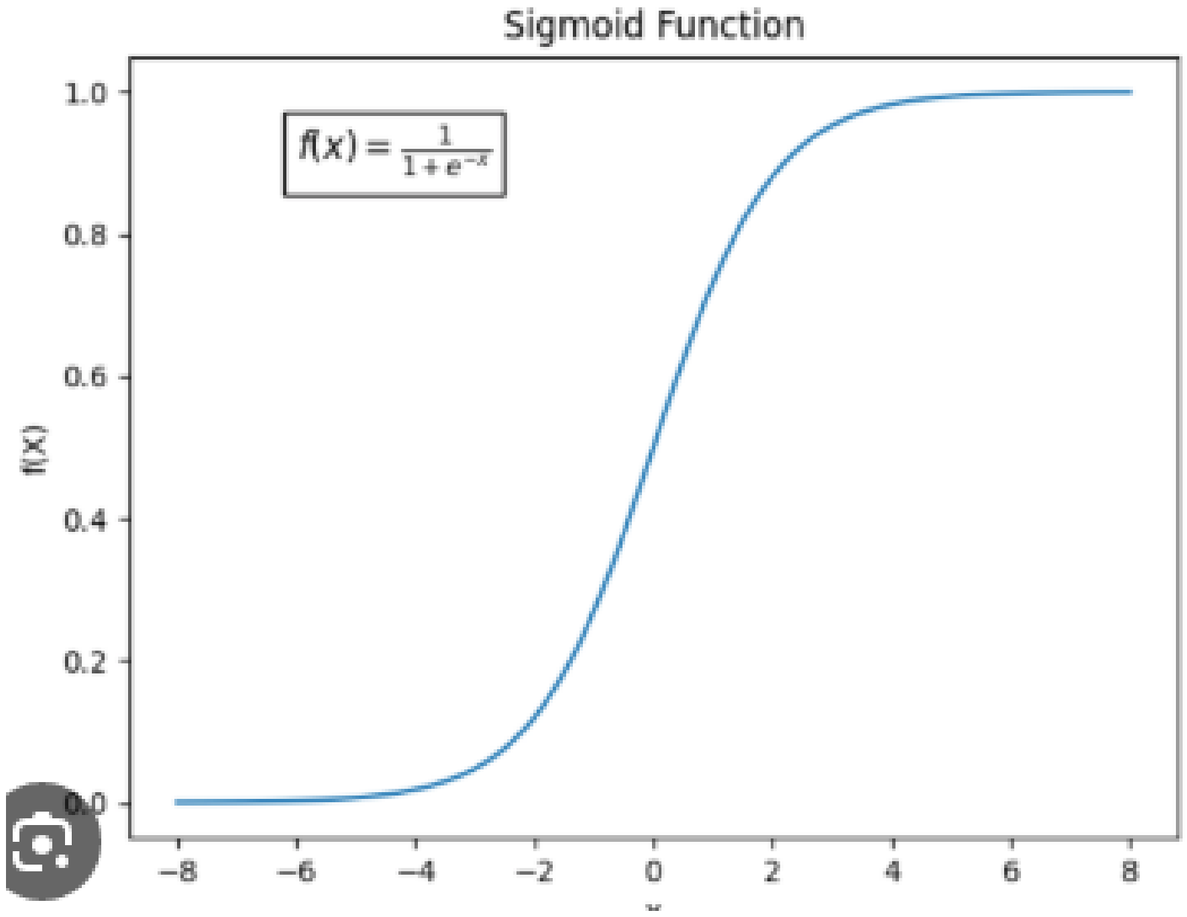
The hidden layer comprises of various neurons, each of which performs the 2 calculations. The 4 neurons present in the hidden layer of our shallow neural network compute the following:

$$z_1^{[1]} = w_1^{[1]T} x + b_1^{[1]}, a_1^{[1]} = \sigma\left(z_1^{[1]}\right)$$
$$z_2^{[1]} = w_2^{[1]T} x + b_2^{[1]}, a_2^{[1]} = \sigma\left(z_2^{[1]}\right)$$
$$z_3^{[1]} = w_3^{[1]T} x + b_3^{[1]}, a_3^{[1]} = \sigma\left(z_3^{[1]}\right)$$
$$z_4^{[1]} = w_4^{[1]T} x + b_4^{[1]}, a_4^{[1]} = \sigma\left(z_4^{[1]}\right)$$

Vision Title 3

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

Sigmoid Function



Vectorization

$$Z^{[1]} = X^{[1]T} X + b^{[1]}$$

$$A^{[1]} = \sigma\left(Z^{[1]}\right)$$

1. The first equation computes all the intermediate outputs Z in single matrix multiplication.
2. The second equation computes all the activations $\mathbf{A}$ in single matrix multiplication.

Shallow network forward propagation equations

$$Z^{[1]} = W^{[1]T} X + b^{[1]}$$

$$A^{[1]} = \sigma\left(Z^{[1]}\right)$$

$$Z^{[2]} = W^{[2]T} A^{[1]} + b^{[2]}$$

$$\hat{y} = A^{[2]} = \sigma\left(Z^{[2]}\right)$$

1. The first equation calculates the intermediate output *Z[1]* of the first hidden layer.
2. The second equation calculates the final output *A[1]* of the first hidden layer.
3. The third equation calculates the intermediate output *Z[2]* of the output layer.
4. The fourth equation calculates the final output *A[2]* of the output layer which is also the final output of the whole neural network.

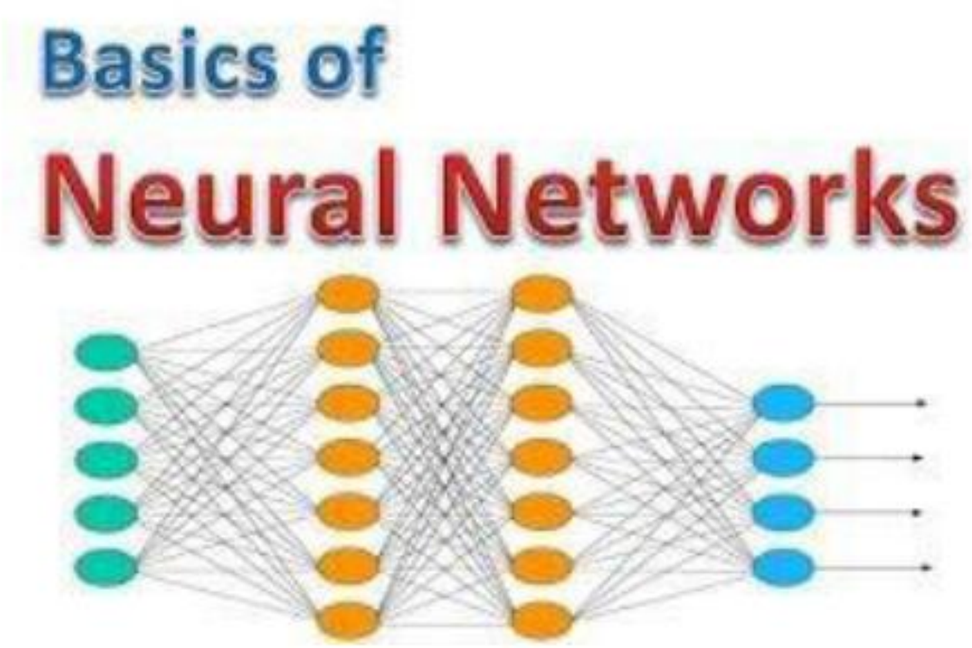
Quiz

Neuron is equivalent to

a) Node
b) Weight
c) Bias
d) Activation function

Quiz

Identify the hidden layer in below diagram



Quiz

What function represents below equation:

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

Quiz

What happens when Activation function is not used?

Quiz

What is the Layer number and Neuron number in below equations,

$$z_1^{[1]} = w_1^{[1]T} x + b_1^{[1]}, a_1^{[1]} = \sigma\left(z_1^{[1]}\right)$$

$$z_3^{[1]} = w_3^{[1]T} x + b_3^{[1]}, a_3^{[1]} = \sigma\left(z_3^{[1]}\right)$$

THANK YOU !!!