"INTRO TO NEURAL NETWORKS" REPORT :

›DonalLoitam

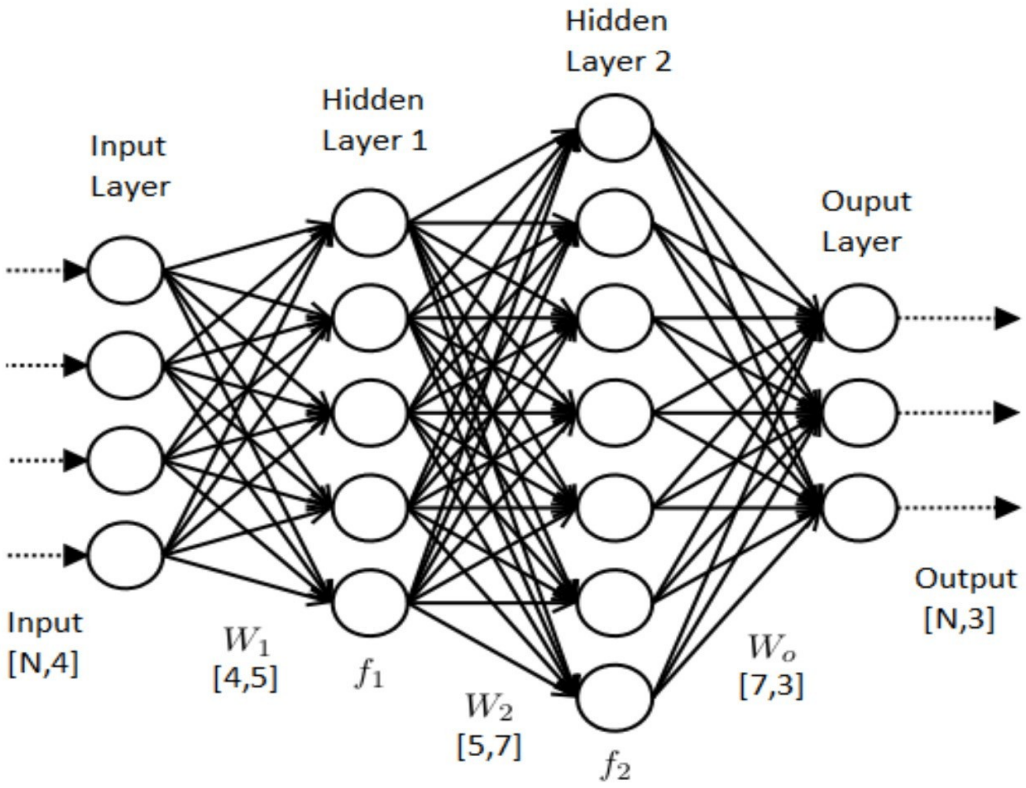
What are Neural Networks?

- Neural networks are used to mimic the basic functioning of the human brain and are inspired by how the human brain interprets information.
- **Neuron**: A building block of ANN. It is responsible for accepting input data, performing calculations, and producing output.
- **Weights**: The strength of the connection between two neurons. Weights determine what impact the input will have on the output.
- **Bias**: An additional parameter used along with the sum of the product of weights and inputs to produce an output.
- Artificial Neural Network has a huge number of interconnected processing elements, also known as Nodes.
- Some real-life applications of neural networks include Air Traffic Control, Optical Character Recognition as used by some scanning apps like Google Lens, Voice Recognition, etc.

Motivation behind Neural Networks :

Have you ever wondered how your brain recognizes images? No matter what or how the image looks, the brain can tell that this is an image of a cat and not a dog. The brain relates to the best possible pattern and concludes the result. The example below will help you understand neural networks:

Consider a scenario where you have a set of labeled images, and you have to classify the images based on if it is a dog or a cat.
To create a neural network that recognizes images of cats and dogs. The network starts by processing the input. Each image is made of pixels. For example, the image dimensions might be 20 X 20 pixels that make 400 pixels. Those 400 pixels would make the first layer of our neural network.



- A neural network is made of artificial neurons that receive and process input data.
- Data is passed through the input layer, the hidden layer, and the output layer.
- Learning taking place within neural networks can be in three different categories:-

1. Supervised Learning - with the help of labeled data, inputs, and outputs are fed to the algorithms. They then predict the desired result after being trained on how to interpret data.

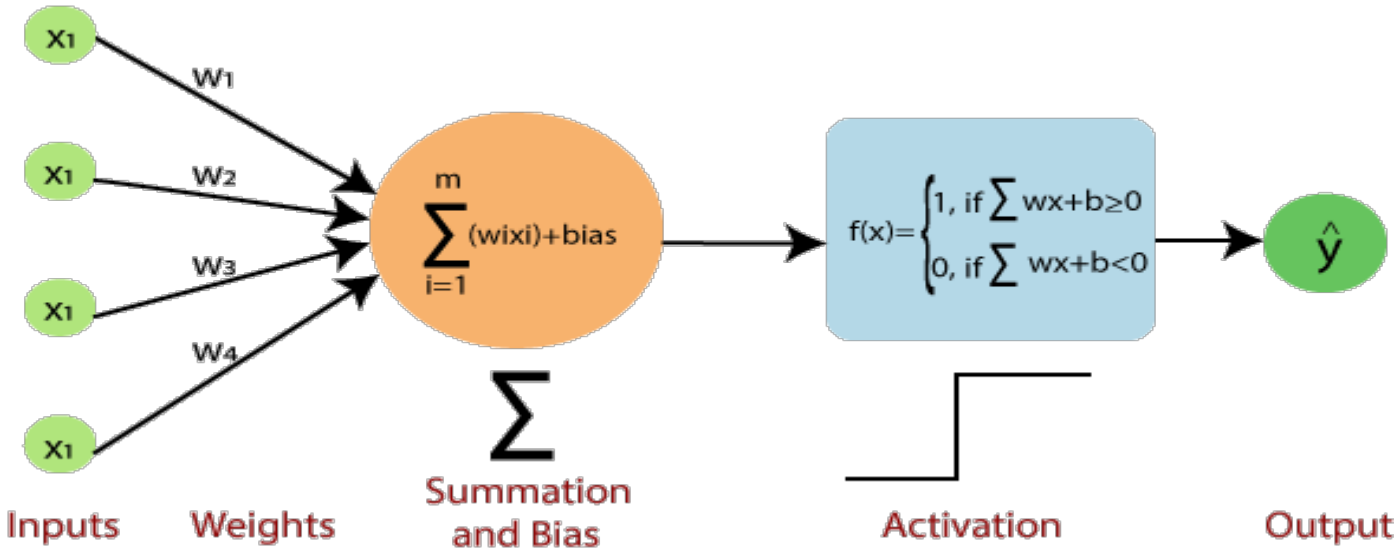
2. Unsupervised Learning - ANN learns with no human intervention. There is no labeled data, and output is determined according to patterns identified within the output data.
3. Reinforcement Learning - the network learns depending on the feedback you give it.

How Neural Networks work ?

Neural Networks are complex systems with artificial neurons.

Artificial neurons or perceptron consist of:

- Input
- Weight
- Bias
- Activation Function
- Output



Neural networks are comprised of layers of neurons.
These layers consist of the following:

- Input layer
- Multiple hidden layers

•Output layer

The input layer receives data represented by a numeric value. Hidden layers perform the most computations required by the network. Finally, the output layer predicts the output.

In a neural network, neurons dominate one another. Each layer is made of neurons. Once the input layer receives data, it is redirected to the hidden layer. Each input is assigned with weights.

The weight is a value in a neural network that converts input data within the network's hidden layers. Weights work by input layer, taking input data, and multiplying it by the weight value.

It then initiates a value for the first hidden layer. The hidden layers transform the input data and pass it to the other layer. The output layer produces the desired output.

The inputs and weights are multiplied, and their sum is sent to neurons in the hidden layer. Bias is applied to each neuron. Each neuron adds the inputs it receives to get the sum. This value then transits through the activation function.

The activation function outcome then decides if a neuron is activated or not. An activated neuron transfers information into the other layers. With this approach, the data gets generated in the network until the neuron reaches the output layer.

Feed-forward propagation takes place when the hidden layer accepts the input data. Processes it as per the activation function and passes it to the output. The neuron in the output layer with the highest probability then projects the result.

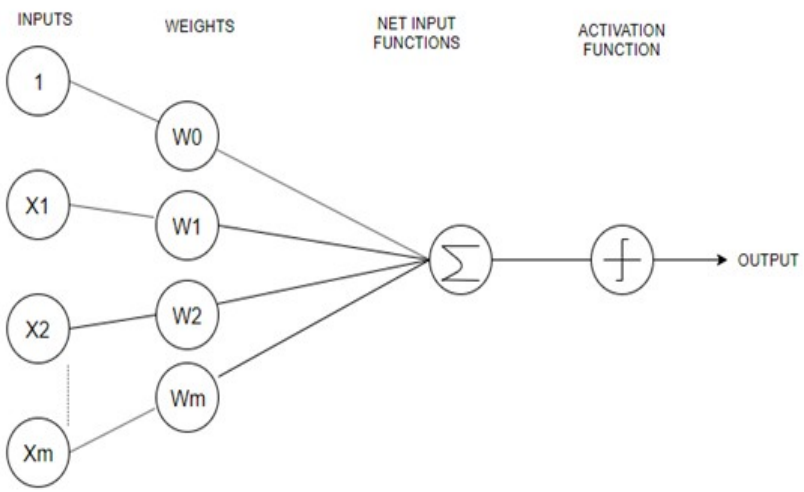
If the output is wrong, backpropagation takes place. While designing a neural network, weights are initialized to each input. Backpropagation means re-adjusting each input's

weights to minimize the errors, thus resulting in a more accurate output.

Questions :

Q1. What do you mean by Perceptron?

Ans. A perceptron also called an **artificial neuron** is a neural network unit that does certain computations to detect features.



It is a single-layer neural network used as a linear classifier while working with a set of input data. Since perceptron uses classified data points which are already labeled, it is a **supervised learning algorithm**. This algorithm is used to enable neurons to learn and process elements in the training set one at a time.

Q2. What is the role of the Activation functions in Neural Networks?

Ans. The reason for using activation functions in Neural Networks are as follows:

1. The idea behind the activation function is to introduce nonlinearity into the neural network so that it can learn more complex functions.

2. Without the Activation function, the neural network behaves as a linear classifier, learning the function which is a linear combination of its input data.

3. The activation function converts the inputs into outputs.

4. The activation function is responsible for deciding whether a neuron should be activated i.e, fired or not.

5. To make the decision, firstly it calculates the weighted sum and further adds bias with it.

Q3. What do you mean by Backpropagation?

Ans. The backpropagation algorithm is used to train multilayer perceptrons. It propagates the error information from the end of the network to all the weights inside the network. It allows the efficient computation of the gradient or derivatives.

Q4. How to initialize Weights and Biases in Neural Networks?

Ans. Neural network initialization means initialized the values of the parameters i.e, weights and biases. Biases can be initialized to zero but we can't initialize weights with zero.

Weight initialization is one of the crucial factors in neural networks since bad weight initialization can prevent a neural network from learning the patterns.

On the contrary, a good weight initialization helps in giving a quicker convergence to the global minimum. As a rule of thumb, the rule for initializing the weights is to be close to zero without being too small.

Q5. Why is ReLU the most commonly used Activation Function?

Ans. **1. No vanishing gradient:** The derivative of the RELU activation function is either 0 or 1, so it could be not in the range of [0,1]. As a result, the product of several derivatives would also be either 0 or 1, because of this property, **the vanishing gradient problem doesn't occur** during backpropagation.

2. Faster training: Networks with RELU tend to show better convergence performance. Therefore, we have a much lower run time.

3. Sparsity: For all negative inputs, a RELU generates an output of 0. This means that fewer neurons of the network are firing. So we have sparse and efficient activations in the neural network.