**Assignment\_2**

1. Describe the structure of an artificial neuron. How is it similar to a biological neuron? What are its main components?

**Ans:** **An artificial neuron is a connection point in an artificial neural network. Artificial neural networks, like the human body's biological neural network,** **have a layered architecture and each network node (connection point) has the capability to process input and forward output to other nodes in the network**.

**Artificial neurons are modeled after the hierarchical arrangement of neurons in biological sensory systems. In the visual system, for example, light input passes through neurons in successive layers of the retina before being passed to neurons in the thalamus of the brain and then on to neurons in the brain's visual cortex. As the neurons pass signals through an increasing number of layers, the brain progressively extracts more information until it is confident it can identify what the person is seeing. In artificial intelligence, this fine tuning process is known as deep learning.**

1. What are the different types of activation functions popularly used? Explain each of them.

**Ans:**

**Binary Step Function.**

**Linear Function.**

**Sigmoid.**

**Tanh.**

**ReLU.**

**Leaky ReLU.**

**Parameterised ReLU.**

**Exponential Linear Unit.**

* 1. Explain, in details, Rosenblatt’s perceptron model. How can a set of data be classified using a simple perceptron?

Ans: **Rosenblatt perceptron is a binary single neuron model. The inputs integration is implemented through the addition of the weighted inputs that have fixed weights obtained during the training stage. If the result of this addition is larger than a given threshold θ the neuron fires.**

* 1. Use a simple perceptron with weights *w*0, *w*1, and *w*2 as −1, 2, and 1, respectively, to classify data points (3, 4); (5, 2); (1, −3); (−8, −3); (−3, 0).

1. Explain the basic structure of a multi-layer perceptron. Explain how it can solve the XOR problem.

**Ans: A multilayer perceptron is a neural network connecting multiple layers in a directed graph, which means that the signal path through the nodes only goes one way. Each node, apart from the input nodes, has a nonlinear activation function. An MLP uses backpropagation as a supervised learning technique.**

**The XOr problem is that we need to build a Neural Network (a perceptron in our case) to produce the truth table related to the XOr logical operator. This is a binary classification problem. Hence, supervised learning is a better way to solve it. In this case, we will be using perceptrons.**

1. What is artificial neural network (ANN)? Explain some of the salient highlights in the different architectural options for ANN.

**Ans: ANN is made of three layers namely input layer, output layer, and hidden layer/s. There must be a connection from the nodes in the input layer with the nodes in the hidden layer and from each hidden layer node with the nodes of the output layer.**

**It is neurally implemented mathematical model. It contains huge number of interconnected processing elements called neurons to do all operations. Information stored in the neurons are basically the weighted linkage of neurons.**

1. Explain the learning process of an ANN. Explain, with example, the challenge in assigning synaptic weights for the interconnection between neurons? How can this challenge be addressed?

**Ans: “Essentially, backpropagation evaluates the expression for the derivative of the cost function as a product of derivatives between each layer from left to right — “backwards” — with the gradient of the weights between each layer being a simple modification of the partial products (the “backwards propagated error).”**

**Disadvantages of Back Propagation Algorithm:**

**It relies on input to perform on a specific problem. Sensitive to complex/noisy data. It needs the derivatives of activation functions for the network design time**

1. Explain, in details, the backpropagation algorithm. What are the limitations of this algorithm?

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1. Describe, in details, the process of adjusting the interconnection weights in a multi-layer neural network.

**Ans: One main part of the algorithm is adjusting the interconnection weights. This is done using a technique termed as Gradient Descent.**

1. What are the steps in the backpropagation algorithm? Why a multi-layer neural network is required?

Ans: **Step — 1: Forward Propagation**. **Step — 2: Backward Propagation**. **Step — 3: Putting all the values together and calculating the updated weight value**.

1. Write short notes on:

1 Artificial neuron : **Artificial neurons (also called Perceptrons, Units or Nodes) are the simplest elements or building blocks in a neural network.**

2. Multi-layer perceptron : Multi layer perceptron (MLP) is **a supplement of feed forward neural network**. It consists of three types of layers—the input layer, output layer and hidden layer. The input layer receives the input signal to be processed.

3 .Deep learning : **Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. Deep learning is an important element of data science, which includes statistics and predictive modelling.**

1. Write the difference between:-

1 Activation function vs threshold function :

Ans: **The threshold could be considered to be the point where the sigmoid function is 0.5**. **Some sigmoid functions will have this at 0, while some will have it set to a different 'threshold'. The step function may be thought of as a version of the sigmoid function that has the steepness set to infinity.**

2. Step function vs sigmoid function

**Ans: Sigmoid Function: A general mathematical function that has an S-shaped curve, or sigmoid curve, which is bounded, differentiable, and real. Logistic Function: A certain sigmoid function that is widely used in binary classification problems using logistic regression.**

3. Single layer vs multi-layer perceptron

**Ans: A Multi-Layer Perceptron (MLP) or Multi-Layer Neural Network contains one or more hidden layers (apart from one input and one output layer)**. **While a single layer perceptron can only learn linear functions, a multi-layer perceptron can also learn non – linear functions**.