1. What is the function of a summation junction of a neuron? What is threshold activation function?

Function of Summation junction is used to combine the various input activations into single activation

Threshold Activation function results in an output signal only when an input signal exceeding a specific threshold value comes as an input.

1. What is a step function? What is the difference of step function with threshold function?

Step function is kind of activation function and in this input fed to the activation function is compared to a certain threshold and if the input is greater than it, then the neuron is activated.

step function is one of the threshold functions

1. Explain the McCulloch–Pitts model of neuron.

* It is earliest of ANN model and it has two types of inputs excitatory and inhibitory
* Excitatory inputs have weights of positive magnitude and inhibitory weights have weights of negative magnitude. The inputs of Mcculloch-Pitts neuron can be either 0 or 1.
* And the activation function threshold function is used for this model so the o/p is 1 for input which is greater than or equal to threshold or else 0.
* This is used to design logical operations

1. Explain the ADALINE network model.

* This is example of supervised learning which is network with single linear unit
* It receives the input from several units and from one unit called bias
* It consists of trainable weights with input of two values(+1 or -1) and the weights have signs
* Initially random weight is assigned and the net input calculated is applied to quantizer transfer function that restores the output to +1 or -1
* This model compares the actual output with the target output and with bias and adjusts the weights

1. What is the constraint of a simple perceptron? Why it may fail with a real-world data set?

The output of the perceptron can only be a binary number(0 or 1) due to hard edge transfer function, so it can only be used to classify the linearly separable sets of input vectors.

It may fail with real -world data set as it can’t implement XOR and also this network can represent only a limited set of functions, this model only works for the linearly separatable data.

1. What is linearly inseparable problem? What is the role of the hidden layer?

* It is the problem of determining if a pair of sets is linearly separable and finding a separating hyperplane if they are, arises in several areas.
* Hidden layers are used overcome the linearly inseparable problem as they manages to transform the input features into processed features that can then be correctly classified in the output layer.

1. Design a multi-layer perceptron to implement A XOR B.

True table is

|  |  |  |
| --- | --- | --- |
| A | B | Output |
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

Diagram

Description automatically generated

Python Implementation:

Graphical user interface

Description automatically generated with medium confidence

1. Explain the single-layer feed forward architecture of ANN.

* In this we have only two layers input layer and output layer but the input layer doesn’t count because no computation is performed in this layer.
* The output layer is formed when the different weights are applied to the input nodes and the cumulative effect per node is taken.
* Then the neurons collectively give the output layer to compute the output signals.

1. Explain the competitive network architecture of ANN.

* competitive networks are composed of two networks: the Hemming net and the Maxnet
* In a simple competitive network, a Maxnet connects the top nodes of the Hemming net. Whenever an input is presented, the Hemming net finds out the “distance” of the weight vector of each node from the input vector via the dot product, while the Maxnet selects the node with the greatest dot product. In this way, the whole network selects the node with its weight vector closest to the input vector, i.e. the winner.
* The network learns by moving the winning weight vector towards the input vector: while the other weight vectors remain unchanged.

1. Consider a multi-layer feed forward neural network. Enumerate and explain steps in the backpropagation algorithm used to train the network.

* Back- Propagation is the method used during network training for calculating the gradient of the network to reduce the error by changing values of weights and biases
* First we will calculate the rate of change of error wrt outputs
* Then we propagate further backwards and calculate the change in output wrt its total net input
* In the same way we calculate the other weight values as well.
* Then again propagate forward and calculate the output. Again, calculate the error.
* If the error is minimum we wilstop right there, else again propagate backwards and update the weight values.
* This process will keep on repeating until error becomes minimum.

1. What are the advantages and disadvantages of neural networks?

Advantages:

* A neural network can implement tasks that a linear program cannot.
* When an item of the neural network declines, it can continue without some issues by its parallel features.
* A neural network determines and does not require to be reprogrammed.
* It can be executed in any application.

Disadvantages:

* The neural network required training to operate.
* The structure of a neural network is disparate from the structure of microprocessors therefore required to be emulated.
* It needed high processing time for big neural networks.

1. Write short notes on any two of the following:
   * 1. Biological neuron
     2. ReLU function
     3. Single-layer feed forward ANN
     4. Gradient descent
     5. Recurrent networks

Relu Function - It is one of the activation function used in Neural networks for adding non linearity or for normalization or regularization that will output the input directly if it is positive otherwise it will output zero. The equation is f(x) = max(0,x). It acts as linear function for positive values and as non linear function for negative values

Single Layer feed forward ANN – This has only two layers input layer and output layer but the input layer does not count because no computation is performed in this layer. The output layer is formed when different weights are applied to input nodes and the cumulative effect per node is taken. After this, the neurons collectively give the output layer to compute the output signals.