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

Ans: a) In the summation junction, all features are multiplied by their weights and bias are summed up. (Y=W1X1+W2X2+b). This summed function is applied over an Activation function.

b) Threshold activation function compares the input value to a threshold value. If the input value is greater than the threshold value, then only the neuron is activated otherwise it gets disabled if the input value is less than the threshold value, which means its output isn't sent on to the next or hidden layer.

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

Ans: Step Function:   
A step function is a function that takes on a single value, either 0 or 1, depending on whether the input is less than or equal to a threshold value. The threshold value is usually denoted by theta. The step function can be defined mathematically as follows:

f(x) = 1 if x >= theta

f(x) = 0 if x < theta

The main difference between a step function and a threshold function is the threshold value. A step function can have any threshold value, while a threshold function always has a threshold value of 0.

1. **Explain the McCulloch–Pitts model of neuron.**

Ans: McCulloch-PittsNeuronModel:

Proposed by Warren McCulloch and Walter Pitts in 1943, this model imitates the functionality of a biological neuron, thus is also called an Artificial Neuron. An artificial neuron accepts binary inputs and produces a binary output based on a certain threshold value which can be adjusted. This can be mainly used for classification problems. It is first mathematical model of biological neuron

1. **Explain the ADALINE network model.**

Ans: Adaptive Linear Neuron, is a single-layer neural network that was first proposed by Bernard Widrow and Marcian E. Hoff in 1960. ADALINE is a supervised learning algorithm, which means that it requires labeled training data to learn.

The ADALINE model has the following components:

Inputs: The inputs to an ADALINE network are real-valued numbers.

Weights: The weights are associated with each input, and they represent the strength of the connection between the neuron and the input.

Bias: The bias is a constant value that is added to the weighted sum of the inputs.

Output: The output of an ADALINE network is also a real-valued number. The output is determined by the following equation:

output = sign(weighted sum + bias)

where sign() is the sign function, which returns 1 if the input is positive and -1 if the input is negative.

The ADALINE model is trained using the delta rule, which is a gradient descent algorithm. The delta rule updates the weights and bias of the network in the direction of the steepest descent of the error function. The error function is the difference between the desired output and the actual output of the network.

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

Ans :

* The output of a perceptron can only be a binary number (0 or 1) due to the hard limit transfer function.
* Perceptron can only be used to classify the linearly separable sets of input vectors. If input vectors are non-linear, it is not easy to classify them properly and in real-world scenarios data may be non-linear therefore perceptron may be fail to perform task.

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

Ans: In a linearly inseparable problem data cannot be separated into two classes by a linear decision boundary. A simple perceptron may fail to solve inseparable problems in this case we can add a hidden layer, hidden layer is located between the input and output of algorithm. Hidden layer learns more complex relationship between the inputs and outputs and founds non-linear decision boundary that can separate the two classes of data .

1. **Explain XOR problem in case of a simple perceptron.**

Ans: The XOR problem is a classic problem in machine learning that cannot be solved by a simple perceptron. The XOR problem is defined as follows:

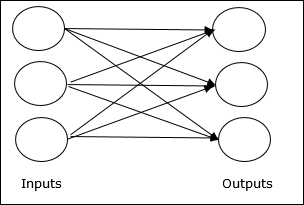
Given two binary inputs, x1 and x2, the XOR problem is to determine whether the output is 1 or 0. The output is 1 if and only if one of the inputs is 1 and the other input is 0.

A simple perceptron can only learn to classify data that is linearly separable. The XOR problem is not linearly separable, so a simple perceptron cannot learn to solve it.

To solve XOR problem we can use neural network with non-linear activation function OR

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

Ans:

Single layer Feedforward Neural Networks: This is the simplest type of ANN architecture, where the information flows in one direction from input to output. The layers are fully connected, meaning each neuron in a layer is connected to all the neurons in the next layer. Single layer FFNN is ANN having only one weighted layer i.e. input layer is fully connected to output layer

1. **Explain the competitive network architecture of ANN.**

Ans:

Competitive learning is an artificial neural network learning process where different neurons or processing elements compete on who is allowed to learn to represent the current input. The competitive network is trained using a process called winner-take-all. Winner-take-all is an algorithm that selects the neuron with the highest output as the winner. The winner neuron then outputs the correct label for the input data.

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

Ans: The steps in the backpropagation algorithm can be described as follows,

Forward pass: The forward pass is the process of calculating the output of the network. The input data is fed into the network, and the output of each neuron is calculated as a weighted sum of the inputs from the previous layer, plus a bias term. The output of the final layer is the network's prediction.

Error calculation: The error between the network's output and the desired output is calculated. The error is typically calculated using a loss function, such as the mean squared error. The loss function measures the difference between the network's output and the desired output.

Backward pass: The error is propagated back through the network, and the weights and biases of the network are updated. The backward pass is the process of calculating how much each weight and bias contributed to the error. The weights and biases are then updated using a learning rule, such as the gradient descent algorithm. The learning rule updates the weights and biases in the direction that will reduce the error.

Repeat: Steps 1-3 are repeated until the error is minimized. The error is minimized when the network's output is as close to the desired output as possible.

The backpropagation algorithm is a powerful tool for training artificial neural networks. It is a relatively simple algorithm, but it can be very effective in training networks to solve a wide variety of problems

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

Ans:

The advantages of neural networks are,

i) They can learn complex relationships between input and output data

ii) They are Robust to noisy data.

iii) Can be used to solve a wide variety of problems: Neural networks can be used to solve a wide variety of problems, including classification, regression, prediction, and natural language processing. This makes them a versatile tool for machine learning.

And disadvantages are,

i) Computation cost can be high: As the neural networks are trained on different combinations of input layers and weights , it can take huge amount of storage and more time during training

ii) Sometimes Neural Networks suffer from Overfitting

1. **Write short notes on any two of the following:**

a) Biological neuron:

A biological neuron is a nerve cell that is the basic unit of the nervous system. Neurons are responsible for sending and receiving signals throughout the body, and they play a vital role in everything from movement to thought.

There are three main parts to a biological neuron:

The cell body is the main part of the neuron. It contains the nucleus, which is the control center of the cell.

The dendrites are the branches that extend from the cell body. They receive signals from other neurons.

The axon is a long, thin fibre that extends from the cell body. It carries signals to other neurons. When a neuron receives a signal from another neuron, it creates an electrical impulse. This impulse travels down the axon to the end of the neuron, where it is released as a chemical signal. The chemical signal then binds to receptors on the dendrites of other neurons, which causes them to create their own electrical impulses.

artificial neurons are inspired by biological neurons and can be used to model some of their functions.

b) Recurrent networks:

A recurrent neural network (RNN) is a type of artificial neural network that is able to process sequential data. RNNs are made up of a series of interconnected neurons, and the output of each neuron is fed back into the network as an input. This allows the network to learn long-term dependencies in the data, which makes it well-suited for tasks such as natural language processing and speech recognition.

RNNs are typically used to solve problems where the output depends on the input sequence. For example, an RNN could be used to translate a sentence from one language to another or to predict the next word in a sentence.

RNNs have been used to achieve impressive results in a variety of tasks, including:

* Natural language processing: RNNs have been used to achieve state-of-the-art results in natural language processing tasks such as machine translation, text summarization, and question answering.
* Speech recognition: RNNs have been used to achieve state-of-the-art results in speech recognition tasks such as automatic speech recognition and speaker identification.
* Time series forecasting: RNNs have been used to achieve state-of-the-art results in time series forecasting tasks such as stock market prediction and weather forecasting.