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## **Q.1-** Explain artificial neural network & biological neural network. Explain the similarities & dissimilarities between the two.

**Ans- Artificial neural network :-**

The term "Artificial neural network" refers to a biologically inspired sub-field of artificial intelligence modeled after the brain. An Artificial neural network is usually a computational network based on biological neural networks that construct the structure of the human brain. Similar to a human brain has neurons interconnected to each other, artificial neural networks also have neurons that are linked to each other in various layers of the networks. These neurons are known as nodes.

An Artificial Neural Network in the field of Artificial intelligence where it attempts to mimic the network of neurons makes up a human brain so that computers will have an option to understand things and make decisions in a human-like manner. The artificial neural network is designed by programming computers to behave simply like interconnected brain cells.

There are around 1000 billion neurons in the human brain. Each neuron has an association point somewhere in the range of 1,000 and 100,000. In the human brain, data is stored in such a manner as to be distributed, and we can extract more than one piece of this data when necessary from our memory parallelly. We can say that the human brain is made up of incredibly amazing parallel processors.

We can understand the artificial neural network with an example, consider an example of a digital logic gate that takes an input and gives an output. "OR" gate, which takes two inputs. If one or both the inputs are "On," then we get "On" in output. If both the inputs are "Off," then we get "Off" in output. Here the output depends upon input. Our brain does not perform the same task. The outputs to inputs relationship keep changing because of the neurons in our brain, which are "learning."

Artificial Neural Network primarily consists of three layers:

1. Input Layer:

As the name suggests, it accepts inputs in several different formats provided by the

programmer.

1. Hidden Layer:

The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.

1. Output Layer:

The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.

**Some advantages of ANN :**

Ability to learn irrespective of the type of data (Linear or Non-Linear). ANN is highly volatile and serves best in financial time series forecasting. **Some disadvantages of ANN :**

The simplest architecture makes it difficult to explain the behavior of the network. This network is dependent on hardware.

**biological neurol network *:-***

Humans have made several attempts to mimic the biological systems, and one of them is artificial neural networks inspired by the biological neural networks in living organisms.

However, they are very much different in several ways. For example, the birds had inspired humans to create airplanes, and the four-legged animals inspired us to develop cars. The artificial counterparts are definitely more powerful and make our life better. The perceptrons, who are the predecessors of artificial neurons, were created to mimic certain parts of a biological neuron such as dendrite, axon, and cell body using mathematical models, electronics, and whatever limited information we have of biological neural network.

The neuron is the fundamental building block of neural networks. In the biological systems, a neuron is a cell just like any other cell of the body, which has a DNA code and is generated in the same way as the other cells. Though it might have different DNA, the function is similar in all the organisms. A neuron comprises three major parts: the cell body (also called Soma), the dendrites, and the axon. The dendrites are like fibers branched in different directions and are connected to many cells in that cluster.

Dendrites receive the signals from surrounding neurons, and the axon transmits the signal to the other neurons. At the ending terminal of the axon, the contact with the dendrite is made through a synapse. Axon is a long fiber that transports the output signal as electric impulses along its length. Each neuron has one axon. Axons pass impulses from one neuron to another like a domino effect.

**Some advantages a{ BNN***:*

The synapses are the input processing element.

It is able to process highly complex parallel inputs.

#### Some disadvantages of BNN :

There is no controlling mechanism.

Speed of processing is slow being it complex.

**Differences between ANN and BNN :**

1. Information processing in biological neural networks is usually slow; this is because neurons need several milliseconds to react to a stimulus. In artificial neural networks information processing is very fast because electronic gates which they use to operate can achieve switching times of a few nanoseconds.
2. Nevertheless the brain is capable of solving problems which no digital computer can yet efficiently deal with.
3. Biological neural networks are constructed in a three dimensional way from microscopic components which are capable of nearly unrestricted interconnection. Artificial neural networks are the simple clustering of the primitive artificial neurons, this clustering occurs in layers which vary.
4. Biological neural networks connect massive neurons of the order of 1011 neurons while artificial neural networks connect few neurons of the order of 102 to 104 neurons.
5. There is much higher numbers of connections between biological neurons which involves random connectivity with no master blueprint. In artificial neural networks there is less edges and connectivity is precisely specified that there is a blueprint for their connection.
6. Performance tends to degrade gracefully under partial damage in biological neural networks while artificial neural networks has the potential to be fault tolerant, that is capable of robust performance

**Similarities between ANN and BNN :**

1. Biological neural networks process information in parallel; this is also true of artificial neural networks.
2. Learning in biological neural networks is through past experiences which improve their performance level; this is also true of artificial neural networks.
3. Learning in biological neural networks involves adjustment of the synaptic connections; learning in artificial neural networks is also by adjustment of weights. Weight in artificial neural networks is similar to synapse in biological neural networks.
4. Information transmission in biological neural networks involves using electrical signals. In artificial neural networks, electrical signals are also used in information transmission.
5. Information storage in biological neural networks is at the synapses, in artificial neural networks information is also stored in weights matrix.

**Q.2-** ANN can be used for both supervised & unsupervised learning. Explain how they learn in supervised mode & in a unsupervised mode.

**Ans-** Learning is a fundamental component required by every human being in the creation of intelligence. Humans derive their

intelligence from the brain's capacity to learn from experience and utilizing that to adapt when confronted with existing

and new circumstances. Reproduction of human intelligence in machines and computers is the objective of artificial

intelligence techniques, one of which is an Artificial Neural Network. ANNs are models defined to mimic the learning

capability of human brains. Like humans, validation, training, and testing are significant components in making such

computational models. Artificial Neural Networks acquire information by getting some datasets (might be labeled or

unlabeled) and computationally changing the network's free parameters adapted from the environment through simulation.

Based on the learning rules and training process, learning in ANNs can be sorted into supervised, reinforcement, and

unsupervised learning.

**Supervised learning:**

In supervised learning, the artificial neural network is under the supervision of an educator (say a system designer) who

utilizes his or her knowledge of the system to prepare the network with labeled data sets.

Thus, the artificial neural

networks learn by receiving input and target the sets of a few observations from the labeled data sets. It is the process

of comparing the input and output with the objective and computing the error between the output and objective. It utilizes

the error signal through the idea of backward propagation to alter the weights that interconnect the network neuron with

the point of limiting the error and optimizing performance. Fine-tuning of the network proceeds until the set of weights

that limit the discrepancy between the output and the targeted output. The supervised learning process is used to solve

classification and regression problems. The output of a supervised learning algorithm can either be a classifier or

predictor. The application of this process is restricted when the supervisor's knowledge of the system is sufficient to

supply the network's input and targeted output pairs for training.

**tfnsupervised learning:**

Unsupervised learning is used when it is absurd to augment the training data sets with class identities(labels). This

difficulty happens in situations where there is no knowledge of the system, or the cost of obtaining such knowledge is too

high. In unsupervised learning, as its name suggests, the ANN is not under the guidance of a "teacher." Instead, it is

provided with unlabelled data sets (contains only the input data) and left to discover the patterns in the data and build a

new model from it. In this situation, ANN figures out how to arrange the data by exploiting the separation between clusters

within it.

**Q.3-**What is a Support Vector Machine and explain the working of the same?

### **Ans-**A support vector machine is a very important and versatile machine learning algorithm, it is capable of doing linear and nonlinear classification, regression and outlier detection.

Support vector machines also known as SVM is another algorithm widely used by machine learning people for both classification as well as regression problems but is widely used for classification tasks. It is preferred over other classification algorithms because it uses less computation and gives notable accuracy. It is pood because it gives reliable results even if there is less data.

A support vector machine is a machine learning model that is able to generalise between two different classes if the set of labelled data is provided in the training set to the algorithm. The main function of the SVM is to check for that hyperplane that is able to distinguish between the two classes.

There can be many hyperplanes that can do this task but the objective is to find that hyperplane that has the highest margin that means maximum distances between the two classes, so that in future if a new data point comes that is two be classified then it can be classified easily.

When data are unlabelled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The support-vector clustering algorithm, created by Hava Siegelmann and Vladimir Vapnik, applies the statistics of support vectors, developed in the support vector machines algorithm, to categorize unlabeled data.

## **Q.4-**What are the different types of SVM?

### **Ans.- Types of SVMs:-**

There are two different types of SVMs, each used for different things:

1. **Simple SVM**: Typically used for linear regression and classification problems.
2. **Kernel SVM:** Has more flexibility for non-linear data because you can add more features to fit a hyperplane instead of a two-dimensional space.
   * **Linear SVM** *:* Linear SVM is used for data that are linearly separable i.e. for a dataset that can be categorized into two categories by

utilizing a single straight line. Such data points are termed as linearly separable data, and the classifier is used

described as a Linear SVM classifier.

* + **Non-linear SVM:**Non-Linear SVM is used for data that are non-linearly separable data

i.e. a straight line cannot be used to classify the

**dataset.** For this, we use something known as a kernel trick that sets data points in a higher dimension where they can be

separated using planes or other mathematical functions. Such data points are termed as non-linear data, and the classifier

used is termed as a Non-linear SVM classifier.

**Q.5-**What are the Advantages & disadvantages of SVM?

## **Ans.- Advantages:**

1. SVM works relatively well when there is a clear margin of separation between classes.

1. SVM is more effective in high dimensional spaces.

1. SVM is effective in cases where the number of dimensions is greater than the number of samples.

1. SVM is relatively memory efficient

1. Regularization capabilities: SVM has L2 Regularization feature. So, it has good

generalization capabilities which prevent it from over-fitting.

1. Handles non-linear data efficiently: SVM can efficiently handle non-linear data using

Kernel trick.

1. Solves both Classification and Regression problems: SVM can be used to solve both classification and regression problems. SVM is used for classification problems while SVR (Support Vector Regression) is used for regression problems.

1. Stability: A small change to the data does not greatly affect the hyperplane and hence the SVM. So the SVM model is stable.

**Disadvantages:**

1. SVM algorithm is not suitable for larpe data sets.

1. SVM does not perform very well when the data set has more noise i.e. target classes are overlapping.

1. In cases where the number of features for each data point exceeds the number of training data samples, the SVM will underperform.

1. As the support vector classifier works by putting data points, above and below the classifying hyperplane there is no probabilistic explanation for the classification.

1. Choosing an appropriate Kernel function is difficult: Choosing an appropriate Kernel function (to handle the non-linear data) is not an easy task. It could be tricky and complex. In case of using a high dimension Kernel, you might generate too many support vectors which reduce the training speed drastically.

1. Extensive memory requirement: Algorithmic complexity and memory requirements of SVM are very high. You need a lot of memory since you have to store all the support vectors in the memory and this number grows abruptly with the training dataset size.

1. Requires Feature Scaling: One must do feature scaling of variables before applying

SVM.

1. Long training time: SVM takes a long training time on large datasets.

1. Difficult to interpret: SVM model is difficult to understand and interpret by human beings unlike Decision Trees.