## UNIT- V
## NEW IT INITIATIVES
### 5.1 Introduction to Deep Learning

Deep learning is a branch of machine learning which is based on artificial neural networks. It is capable of learning complex patterns and relationships within data. In deep learning, we don't need to explicitly program everything. It has become increasingly popular in recent years due to the advances in processing power and the availability of large datasets. Because it is based on artificial neural networks (ANNs) also known as deep neural networks (DNNs). These neural networks are inspired by the structure and function of the human brain's biological neurons, and they are designed to learn from large amounts of data.

Deep Learning is a subfield of Machine Learning that involves the use of neural networks to model and solve complex problems. Neural networks are modeled after the structure and function of the human brain and consist of layers of interconnected nodes that process and transform data.

The key characteristic of Deep Learning is the use of deep neural networks, which have multiple layers of interconnected nodes. These networks can learn complex representations of data by discovering hierarchical patterns and features in the data. Deep Learning algorithms can automatically learn and improve from data without the need for manual feature engineering.

Deep Learning has achieved significant success in various fields, including image recognition, natural language processing, speech recognition, and recommendation systems. Some of the popular Deep Learning architectures include Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Deep Belief Networks (DBNs).

Training deep neural networks typically requires a large amount of data and computational resources. However, the availability of cloud computing and the

development of specialized hardware, such as Graphics Processing Units (GPUs), has made it easier to train deep neural networks.

In summary, Deep Learning is a subfield of Machine Learning that involves the use of deep neural networks to model and solve complex problems. Deep Learning has achieved significant success in various fields, and its use is expected to continue to grow as more data becomes available, and more powerful computing resources become available.
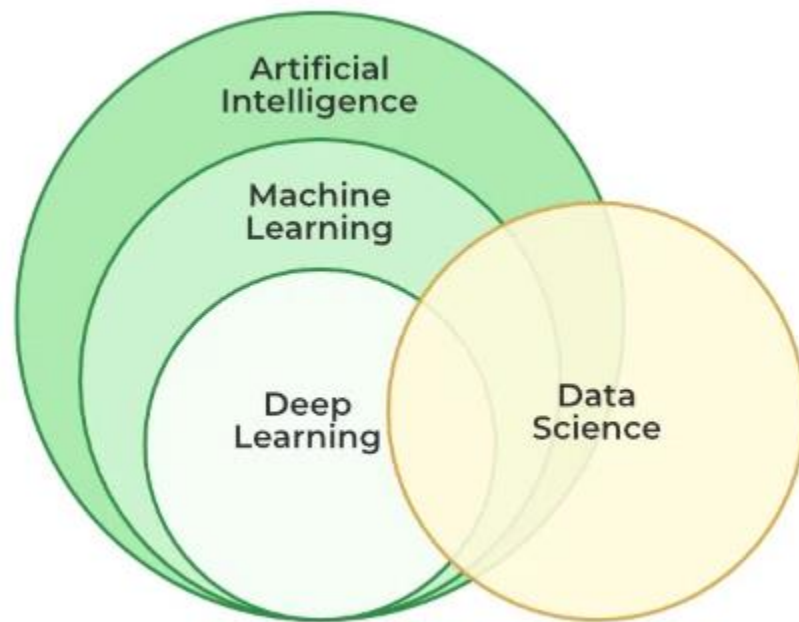
Today Deep learning has become one of the most popular and visible areas of machine learning, due to its success in a variety of applications, such as computer vision, natural language processing, and Reinforcement learning.

Deep learning can be used for supervised, unsupervised as well as reinforcement machine learning. it uses a variety of ways to process these.

- **Supervised Machine Learning:** Supervised machine learning is the machine learning technique in which the neural network learns to make predictions or classify data based on the labeled datasets. Here we input both input features along with the target variables. the neural network learns to make predictions based on the cost or error that comes from the difference between the predicted and the actual target, this process is known as backpropagation. Deep learning algorithms like

Convolutional neural networks, Recurrent neural networks are used for many supervised tasks like image classifications and recognization, sentiment analysis, language translations, etc.

- **Unsupervised Machine Learning:** Unsupervised machine learning is the machine learning technique in which the neural network learns to discover the patterns or to cluster the dataset based on unlabeled datasets. Here there are no target variables. while the machine has to self-determined the hidden patterns or relationships within the datasets. Deep learning algorithms like autoencoders and generative models are used for unsupervised tasks like clustering, dimensionality reduction, and anomaly detection.

- **Reinforcement Machine Learning**: Reinforcement Machine Learning is the machine learning technique in which an agent learns to make decisions in an environment to maximize a reward signal. The agent interacts with the environment by taking action and observing the resulting rewards. Deep learning can be used to learn policies, or a set of actions, that maximizes the cumulative reward over time. Deep reinforcement learning algorithms like Deep Q networks and Deep Deterministic Policy Gradient (DDPG) are used to reinforce tasks like robotics and game playing etc.

### 5.1.1 Importance of Deep Learning

- Machine learning works only with sets of structured and semi-structured data, while deep learning works with both structured and unstructured data

- Deep learning algorithms can perform complex operations efficiently, while machine learning algorithms cannot

- Machine learning algorithms use labeled sample data to extract patterns, while deep learning accepts large volumes of data as input and analyzes the input data to extract features out of an object

- The performance of machine learning algorithms decreases as the number of data increases; so to maintain the performance of the model, we need a deep learning.

### 5.1.2 What are Neural Networks?

Now that you know what exactly is deep learning, it's application and importance, next up in this introduction to deep learning tutorial, let us look at neural networks and its operations. A neural network is a system modeled on the human brain, consisting of an input layer, multiple hidden layers, and an output layer. Data is fed as input to the neurons. The information is transferred to the next layer using appropriate weights and biases. The output is the final value predicted by the artificial neuron.

Each neuron in a neural network performs the following operations:

- The product of each input and the weight of the channel it is passed over is found

- The sum of the weighted products is computed, which is called the weighted sum

- A bias value of the neuron is added to the weighted sum

- The final sum is then subjected to a particular function known as the activation function
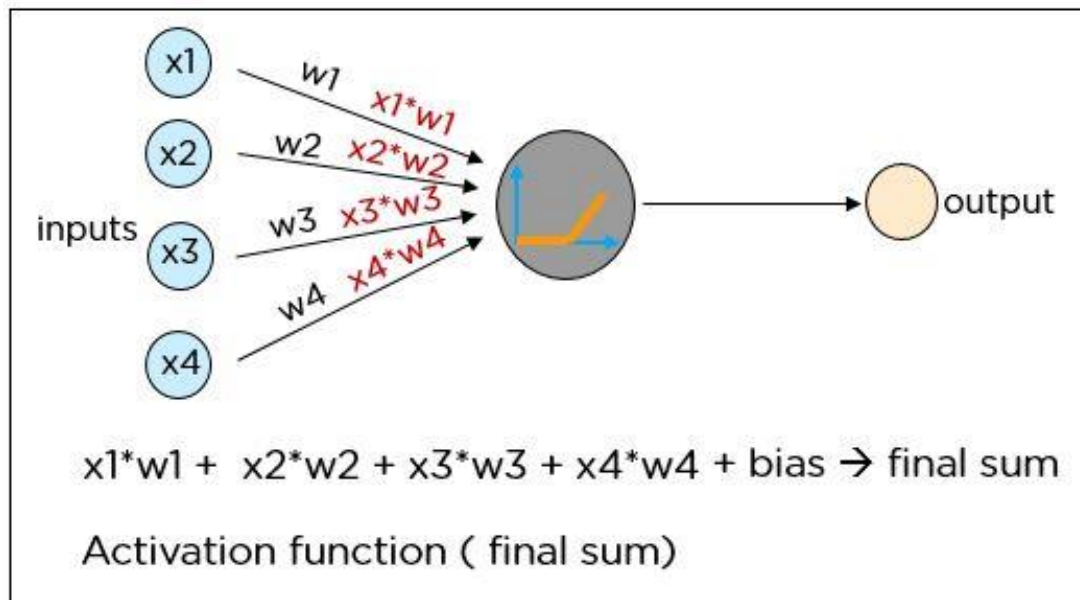


Simple Neural Network

## Cost Function:

The cost function is one of the significant components of a neural network. The cost value is the difference between the neural nets predicted output and the actual output from a set of labeled training data. The least-cost value is obtained by making adjustments to the weights and biases iteratively throughout the training process.
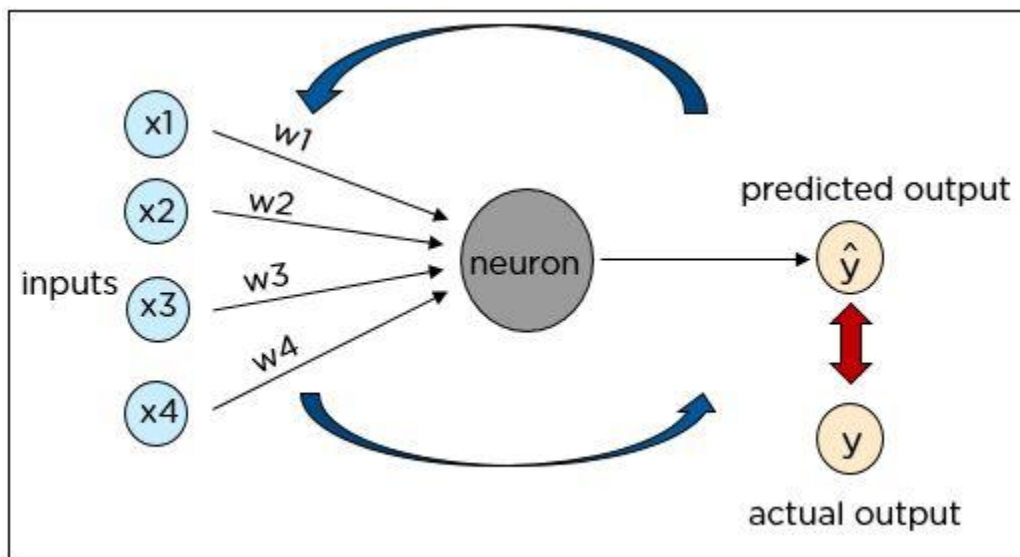


## How Do Neural Networks Work?

In the next section of this introduction to deep learning the neural network will be trained to identify shapes. The shapes are images of 28*28 pixels.
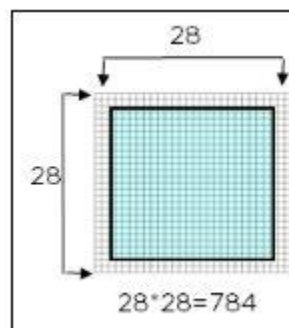
Each pixel is fed as input to the neurons in the first layer. Hidden layers improve the accuracy of the output. Data is passed on from layer to layer overweight channels. Each neuron in one layer is weighted to each of the neurons in the next layer.
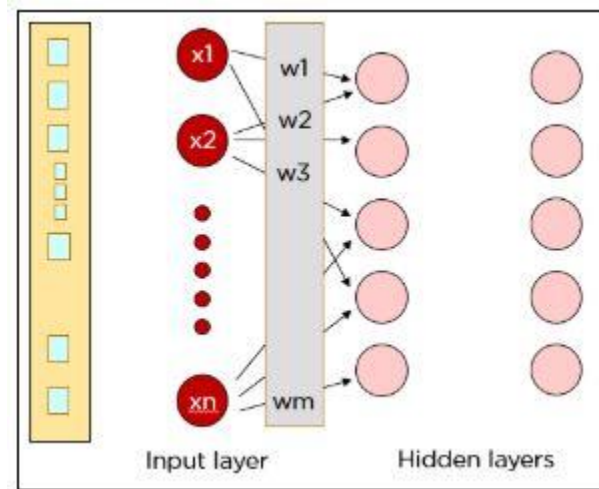


Each neuron in the first hidden layer takes a subset of the inputs and processes it. All the inputs are multiplied by their respective weights and a bias is added. The output of the weighted sum is applied to an activation function. The results of the activation function determine which neurons will be activated in the following layer.
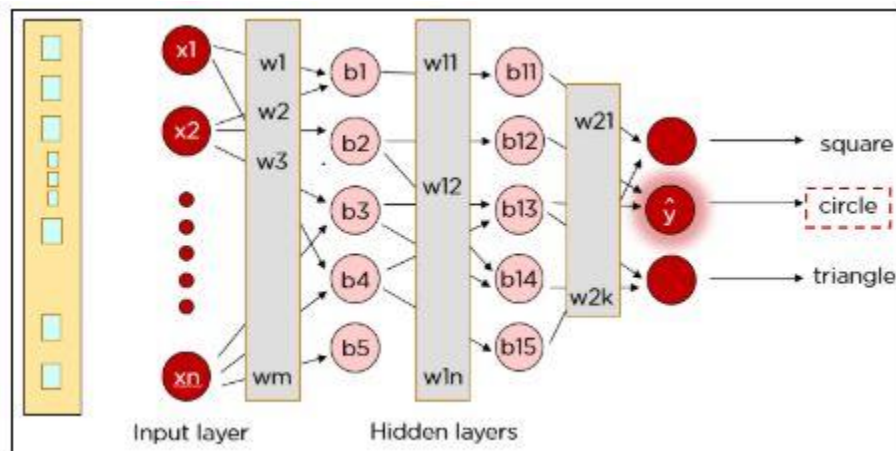
Step 1: x1*w1 + x2*w2 + b1

Step 2: Φ(x1* w1 + x2*w2 + b1)

where Φ is an activation function
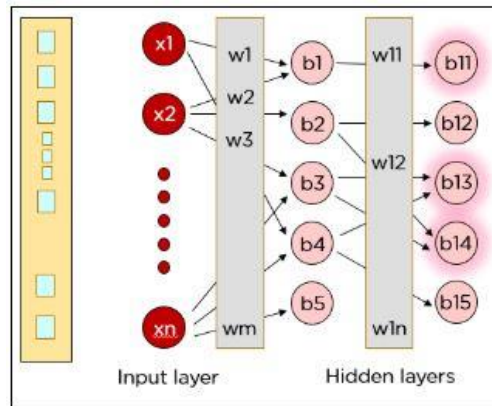
The above steps are performed again to ensure the information reaches the output layer, after which a single neuron in the output layer gets activated based on the activation function's value.



As you can see, our actual input was a square, but the neural network predicted the output as a circle. So, what went wrong? The neural network has to be trained until the predicted output is correct and the predicted output is compared to the actual output by calculating the cost function.  The cost function is calculated using the formula where Y is the actual value and Y hat is the predicted value. The cost function determines the error in the prediction and reports it back to the neural network. This is called backpropagation.

➢ The weights are adjusted to reduce the error. The network is trained with the new weights.

➢ Once again, the cost is determined and the backpropagation procedure is continued until the cost cannot be reduced any further.

➢ Similarly, our network can be trained to predict circles and triangles too.

➢ Now that you have a good understanding of how neural networks work, let's look at some of the important deep learning platforms.

## **Applications of Deep Learning:**

1. Computer Vision
2. Natural Language Processing (NLP):
3. Speech Recognition
4. Healthcare:
5. Finance: Fraud detection., Algorithmic trading, Credit scoring, Customer service chatbots.
6. Autonomous Systems
7. Gaming:
8. Cybersecurity
9. Education
10. Environmental Monitoring
11. Retail
12. Social Media

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