**1. Explain the architecture of Spark**

Ans: Spark works on **DAG** i.e directed acyclic graph. This insures fault tolerance

The data is stored in RDDs which is Resilient redistributed Datasets. This ensures that the data is redundant stored in multiple nodes which are stored in-memory on worker nodes

Whenever an action is performed, it gets converted into a **spark context** which stays inside a driver.

The **driver** assigns this context to the **cluster manager**

The cluster manager distributes the task to **slave nodes**, which contain the task manager and cache to complete the tasks.

**2. Explain activation function**

Ans: An activation function is a mathematical function/ model which is used in neural networks. An activation function decides whether a single node will be activated or not, based on its output of the activation function.

An activated node contributes to the output of the neural network, whereas an unactivated node does not.

These activation functions introduce non-linearity to the neural network,

There are several activation functions (given in the next answer)

**3. List different types of activation function with their formula**

**Ans:** Here are some commonly used activation functions in neural networks along with their formulas:

1. Sigmoid Activation Function (Logistic Function)

\[ f(x) = 1/{1 + e^(-x)}

2. Hyperbolic Tangent Activation Function (Tanh)

tanh(x) = {e^{x} - e^{-x}}/{e^{x} + e^{-x}}

3. Rectified Linear Unit (ReLU)

[ f(x) = \max(0, x) ]

4. Leaky ReLU

F(X) =

x & if x > 0

A x & otherwise

Here, A is a small constant (e.g., 0.01).

5. Exponential Linear Unit (ELU

\[ f(x) =

x if x > 0

alpha (e^{x} - 1) otherwise

Here, alpha is a hyperparameter usually set to 1.0.

**5. Explain Neural Networks**

Neural networks are a set of algorithms, inspired by the human brain, that are designed to recognize patterns. They interpret sensory data through a kind of machine perception, labeling, or clustering of raw input. These algorithms consist of various layers of interconnected nodes (or "neurons") that contain parameters (or "weights") which are adjusted during the learning process.

Basic Components of a Neural Network:

1. Neurons (Nodes): The basic unit of computation in a neural network. Neurons receive input, apply a transformation, and produce an output.

2. Weights: Every input to a neuron has an associated weight that is adjusted during training. These weights determine the strength of the connection between neurons.

3. Bias: A bias is an additional parameter that allows the neuron to shift the activation function to the left or right, which may be critical for successful learning.

4. Activation Function: Determines the output of a neuron given an input or set of inputs. Common activation functions include sigmoid, ReLU (Rectified Linear Unit), and tanh.

5. Layers: A neural network consists of layers of interconnected neurons. The input and output layers are called input and output layers, respectively, while the layers in between are called hidden layers.

Types of Neural Networks:

1. Feedforward Neural Networks (FNN): In this type of network, information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any), and to the output nodes.

2. Recurrent Neural Networks (RNN): Unlike feedforward networks, RNNs have connections that form directed cycles. This allows them to retain information over time and are commonly used for sequence data like time series or natural language.

3. Convolutional Neural Networks (CNN): Primarily used in image processing, CNNs use a specialized layer called a convolutional layer that can scan an image with a filter to detect features like edges and textures.

4. Generative Adversarial Networks (GANs): Consist of two networks, a generator and a discriminator, which are trained together in a competitive manner. GANs are widely used for image generation.

5. Long Short-Term Memory (LSTM): A type of recurrent neural network that is capable of learning long-term dependencies. LSTMs are often used for sequence prediction tasks.

Training a Neural Network:

Training a neural network involves adjusting the weights and biases to minimize the difference between the predicted output and the actual output for a given input. This is typically done using optimization algorithms like Gradient Descent and backpropagation, which calculate the gradients of the loss function with respect to each weight and bias.

Applications of Neural Networks:

Neural networks have a wide range of applications, including but not limited to:

- Image and video recognition

- Natural language processing

- Speech recognition

- Autonomous vehicles

- Financial forecasting

- Healthcare diagnostics

Conclusion:

Neural networks are a powerful class of machine learning models capable of learning complex patterns from data. With the advancements in hardware and algorithms, neural networks have become increasingly popular and are used extensively across various industries to solve a wide range of problems.