1. What is Deep Learning (DL)?

Deep Learning is a subset of machine learning that uses artificial neural networks (ANNs) with multiple layers (deep networks) to learn from data. It is particularly effective for tasks involving large datasets and complex patterns, such as image recognition, natural language processing, and speech recognition.

2. Difference Between Deep Learning (DL) and Machine Learning (ML)?

- **ML**: In traditional machine learning, algorithms learn from data using features that are manually defined. It often requires feature extraction and selection.
- **DL**: Deep learning automatically extracts features from raw data using neural networks. It works well for unstructured data (e.g., images, text) and can handle much larger datasets.

3. Applications of Deep Learning

- Image recognition (e.g., facial recognition, object detection)
- Natural Language Processing (e.g., translation, chatbots)
- Speech recognition (e.g., virtual assistants)
- Self-driving cars (e.g., path planning, object detection)
- Healthcare (e.g., medical diagnosis, drug discovery)
- Gaming (e.g., AI opponents)
- Finance (e.g., fraud detection, algorithmic trading)

4. Challenges of Deep Learning

- Requires large datasets
- High computational power (often needs GPUs)
- Long training times
- Complex model interpretability (black-box nature)
- Susceptibility to overfitting
- Hyperparameter tuning is complex and time-consuming

5. What is a Neuron, Learning, Activation?

- **Neuron**: A fundamental unit in a neural network that takes inputs, applies weights and bias, and passes the result through an activation function.
- **Learning**: The process by which a model adjusts its parameters (weights and biases) to minimize the error (loss) during training.
- **Activation**: An activation function introduces non-linearity to the model, enabling the network to learn complex patterns. Examples include Sigmoid, ReLU, and Softmax.

6. Define Supervised Machine Learning, Unsupervised Machine Learning, Reinforcement Learning

- **Supervised ML**: The model learns from labeled data where both input and output are provided. The goal is to predict outputs for unseen data.
- **Unsupervised ML**: The model learns from unlabeled data, identifying patterns and structures like clusters and associations without explicit labels.
- **Reinforcement Learning**: The model learns by interacting with an environment, receiving feedback in terms of rewards or penalties, and adjusting its actions accordingly.

7. What is Perceptron?

A perceptron is the simplest type of artificial neural network with one layer, consisting of input nodes and an output node. It is used for binary classification tasks.

8. What is Multilayer Perceptron (MLP)?

An MLP is a type of feedforward neural network with multiple layers (input, hidden, and output layers). Each neuron in one layer is connected to every neuron in the next layer. It can learn more complex patterns than a single perceptron.

9. Types of Feedforward Neural Networks

- **Single-layer Perceptron (SLP)**
- **Multilayer Perceptron (MLP)**
- **Convolutional Neural Networks (CNN)**
- **Recurrent Neural Networks (RNN)**

10. What is GPU?

GPU (Graphics Processing Unit) is a specialized processor designed to accelerate computations, particularly useful for deep learning tasks that involve massive matrix operations. GPUs provide parallel processing, making DL training faster.

11. Different Layers in an Artificial Neural Network (ANN)

- **Input Layer**: Receives the input data.
- **Hidden Layer(s)**: Intermediate layers where computations occur using weights and activations.
- **Output Layer**: Produces the final output or prediction.

12. What is Backpropagation?

Backpropagation is a training algorithm used in neural networks to adjust weights by minimizing the error (cost) function. It involves computing the gradient of the loss function and propagating it backward through the network to update weights using techniques like gradient descent.

13. What is a Cost Function?

A cost function measures the error between the predicted output and the actual output. Common cost functions include Mean Squared Error (MSE) for regression and Cross-Entropy Loss for classification.

14. Common Activation Functions

- **Sigmoid**: Produces output between 0 and 1. Used in binary classification.
- **ReLU (Rectified Linear Unit)**: Outputs the input if positive, 0 otherwise. It helps mitigate the vanishing gradient problem.
- **Leaky ReLU**: Allows a small negative slope for negative input values, avoiding dead neurons.
- **Softmax**: Converts logits into probabilities for multi-class classification problems.

15. What is Data Augmentation and Edge Detection?

- **Data Augmentation**: Techniques used to artificially increase the size of a training dataset by applying transformations like rotation, flipping, zooming, etc., to the images.
- **Edge Detection**: A process used in image processing to identify boundaries or edges within an image by detecting rapid changes in brightness.

16. How to Avoid Overfitting?

- Use regularization techniques (e.g., L2, Dropout)
- Early stopping during training
- Cross-validation
- Use data augmentation (for image data)
- Increase the training dataset size

17. Define Epochs, Iterations, and Batches

- **Epoch**: One full pass through the entire training dataset.
- **Iteration**: One update of the model's weights after processing a batch of data.
- **Batch**: A subset of the training dataset used in one iteration.

18. Define Learning Rate

Learning rate is a hyperparameter that controls the size of the steps the optimizer takes during gradient descent to update the model weights.

19. Define Gradient Descent

Gradient descent is an optimization algorithm used to minimize the cost function by iteratively adjusting the model's weights in the direction of the steepest descent of the gradient.

20. Define Optimization

Optimization in machine learning refers to adjusting model parameters (weights and biases) to minimize the error. Techniques like Gradient Descent, Adam, and RMSProp are used for optimization.

21. Types of Neural Networks

- **Feedforward Neural Networks (FNN)**
- **Convolutional Neural Networks (CNN)**
- **Recurrent Neural Networks (RNN)**
- **Long Short-Term Memory (LSTM) Networks**
- **Generative Adversarial Networks (GANs)**