UNIT 1 – Fundamentals of Deep Learning

1. What is Artificial Intelligence? List its main branches.
Answer: Artificial Intelligence (AI) is the simulation of human intelligence in machines. Branches include:

- Machine Learning
- Natural Language Processing
- Computer Vision
- Robotics
- Expert Systems

2. Explain the evolution of Machine Learning.
Answer: ML evolved from:

- **Probabilistic Modeling** (using probabilities),
- **Early Neural Networks** (Perceptrons),
- **Kernel Methods** (SVMs),
- **Ensemble Models** (Random Forests),
- to **Deep Learning** (neural networks with many layers).

3. What is Probabilistic Modeling? Give an example.
Answer: It uses probability to predict outcomes. Example: Naive Bayes for spam email classification.

4. What are Perceptrons?
Answer: Early neural models with a single-layer that adjust weights based on inputs to learn binary classification.

5. What are Kernel Methods?
Answer: They transform data into higher dimensions using kernels (like RBF), useful in SVM for non-linear classification.

6. Compare Decision Trees, Random Forests, and Gradient Boosting.
Answer:

- Decision Tree: single model
- Random Forest: multiple trees (bagging)
- Gradient Boosting: sequential tree learning (boosting)

7. Name four branches of ML with examples.
Answer:

- Supervised (e.g., regression)
- Unsupervised (e.g., clustering)
- Reinforcement (e.g., game AI)
- Semi-supervised (e.g., limited labeled data)

8. Explain Supervised Learning.
Answer: Input-output mapping using labeled data. Example: spam detection. Includes diagram with input → model → output.

9. How do we evaluate ML models?
Answer:

- **Accuracy** = (TP + TN) / Total
- **Precision** = TP / (TP + FP)
- **Recall** = TP / (TP + FN)
- **F1-Score** = 2 * (Precision * Recall) / (Precision + Recall)

10. What is Overfitting and Underfitting?
Answer:

- Overfitting: model memorizes training data (high variance)
- Underfitting: model fails to learn patterns (high bias)
- Solutions: Regularization, cross-validation

🔹 UNIT 2 – Introducing Deep Learning

1. Define Deep Learning.
Answer: A subset of ML that uses deep neural networks to model complex patterns in large datasets.

2. Biological vs Machine Vision?
Answer:

- Biological: Human eye + brain
- Machine: Cameras + neural networks
  Example: Face detection by human vs. using CNN

3. Human vs Machine Language Understanding.
Answer:

- Human: contextual, emotional
- Machine: uses embeddings, RNNs, transformers

4. What is an ANN?
Answer: Artificial Neural Network consists of input, hidden, and output layers. Diagram: nodes with connections.

5. Single vs Multi-layer Neural Network?
Answer:

- Single: learns simple patterns
- Multi-layer (deep): learns complex, hierarchical patterns

6. Explain training of deep neural networks.
Answer:

- Forward pass → loss → backpropagation → weight update via gradient descent

7. Challenges in deep learning training?
Answer: Overfitting, vanishing gradients, computational cost, large data requirements

8. Techniques to improve DL models?
Answer: Dropout, Batch Normalization, Data Augmentation

9. Importance of Activation Functions?
Answer: Adds non-linearity.
Compare:

- ReLU: fast, sparse activation
- Sigmoid: saturates
- Tanh: zero-centered

10. Optimization algorithms in DL?
Answer:

- **SGD:** updates weights using gradients
- **Adam:** combines momentum + RMSprop

🔹 UNIT 3 – Neural Networks and Tools

1. Define Neural Network with diagram.
Answer: Mimics brain neurons. Diagram: input → hidden → output layers

2. Layers in NN?
Answer:

- Input Layer
- Hidden Layer(s)
- Output Layer
  Examples: Dense, Convolution, Recurrent

3. Activation Functions?
Answer: Introduce non-linearity. Examples: ReLU, Sigmoid, Tanh

4. Compare Keras, TensorFlow, Theano, CNTK.
Answer:

- Keras: high-level
- TensorFlow: flexible, Google-backed
- Theano: older, research
- CNTK: Microsoft, less used now

5. Setting up DL workstation?
Answer:

- Install Python, libraries (Keras/TensorFlow)
- Set up GPU drivers
- Use Jupyter or IDE

6. What is binary classification?
Answer: Classify into 2 classes.
Example: Positive/Negative sentiment in IMDB reviews

7. Preprocessing IMDB reviews?
Answer:

- Tokenization
- Padding
- Vectorization
- Label encoding

8. Define multiclass classification.
Answer: More than two classes.
Example: Classifying news articles into topics

9. Classifying newswires using DL?
Answer:

- Dataset: Reuters
- Architecture: Embedding → Dense → Softmax

10. Compiling and training a model in Keras?
Answer:

- model.compile() → define loss, optimizer
- model.fit() → train
- model.evaluate() → test

🔹 UNIT 4 – CNN and RNN

1. What is a CNN? Main components?
Answer:

- Convolution layer
- Pooling layer
- Fully connected layer
  Used in image classification.

2. Representation learning in CNN?
Answer: CNNs automatically learn filters to extract meaningful features.

3. Convolution layer working?
Answer: Applies filters across image patches to detect patterns. Diagram: sliding filter.

4. Multichannel convolution?
Answer: Applies filters across all color channels (RGB). Each filter spans all channels.

5. Define RNN. Difference from FFNN?
Answer:

- RNN: has memory via feedback loops
- FFNN: no memory, input → output directly

6. RNN working step-by-step?
Answer:

- Inputs processed sequentially
- Hidden state updated at each step

7. Simple RNN in Python?

```
import torch.nn as nn

model = nn.RNN(input_size=10, hidden_size=20, num_layers=1)
```

8. What are PyTorch Tensors?
Answer: Multi-dimensional arrays for GPU/CPU. Operations: reshape, add, matmul.

9. Building CNN in PyTorch?
Answer:

- Define model
- Use loss = nn.CrossEntropyLoss()
- Optimizer: torch.optim.Adam()

10. NumPy vs PyTorch Tensors?
Answer:

- NumPy: CPU only
- PyTorch: GPU support, auto-diff

🔹 UNIT 5 – Applications and Research Models

1. What is Machine Vision? Example?
Answer: Ability of machines to see and interpret visual data. Example: Object detection in self-driving cars.

2. NLP Workflow in DL?
Answer:

- Tokenization → Embedding → RNN/Transformer → Output (e.g., sentiment)

3. What is GAN? Architecture?
Answer:

- Generator creates fake data
- Discriminator checks real vs fake

- Trained together in a loop
  Diagram: Generator → Fake data → Discriminator

4. Types of Deep Reinforcement Learning?
Answer:

- DQN
- Policy Gradient
- Actor-Critic
  Difference: learns through environment feedback

5. Agent-Environment interaction?
Answer: Agent takes action → Environment gives reward → Agent updates strategy

6. What is an Autoencoder?
Answer: Neural network for unsupervised learning. Encoder compresses → Decoder reconstructs

7. How do Boltzmann Machines work?
Answer:

- Models energy of system
- Learns by lowering energy of data-like configurations

8. What is RBM?
Answer: A type of Boltzmann Machine with restricted connections. Faster and easier to train.

9. Structure of DBN?
Answer: Stack of RBMs. Each layer learns features and passes them up.

10. Compare Autoencoders, RBMs, and DBNs.

Model	Structure	Learning	Use Case
Autoencoder	Encoder–Decoder	Backpropagation	Dimensionality Reduction
RBM	Bipartite graph	Energy Minimization	Feature learning
DBN	Stack of RBMs	Layer-wise training	Pre-training deep nets