■ Deep Learning Complete Roadmap (Basic → Advanced)

1. Introduction to Deep Learning

- What is Artificial Intelligence (AI)?
- What is Machine Learning (ML)?
- What is Deep Learning (DL)?
- Difference between AI, ML, and DL
- Applications of Deep Learning (vision, NLP, robotics, etc.)

2. Prerequisites

- Mathematics: Linear Algebra, Calculus, Probability, Optimization
- Programming: Python, NumPy, Pandas, Matplotlib, Jupyter Notebooks

3. Neural Networks Basics

- Perceptron model and neuron structure
- Activation Functions: Sigmoid, Tanh, ReLU, Softmax
- Loss Functions: MSE, Cross-Entropy
- Forward Propagation and Backpropagation
- Gradient Descent Variants: SGD, Adam, RMSProp

4. Building Neural Networks

- Network architecture (input, hidden, output layers)
- Hyperparameters: learning rate, batch size, epochs
- Overfitting & Underfitting, Regularization, Dropout
- Normalization (Batch, Layer), Data Preprocessing

5. Deep Learning Frameworks

- TensorFlow (Keras), PyTorch, JAX, MXNet
- Model training, evaluation, saving

6. Convolutional Neural Networks (CNNs)

- Convolution, Filters, Pooling, Padding, Stride
- Architectures: LeNet, AlexNet, VGG, ResNet, EfficientNet
- Transfer Learning and Image Augmentation
- Object Detection: YOLO, SSD, Faster R-CNN

7. Recurrent Neural Networks (RNNs)

- Sequential data, RNN architecture
- LSTM, GRU, Bidirectional RNNs
- Seq2Seq models, Applications in NLP and Time Series

8. Natural Language Processing (NLP) with DL

- Tokenization, Embeddings (Word2Vec, GloVe, FastText)
- Attention, Transformers, BERT, GPT, T5
- Fine-tuning pre-trained models

9. Generative Models

- Autoencoders, Variational Autoencoders (VAE)
- Generative Adversarial Networks (GANs): DCGAN, CycleGAN, StyleGAN
- Diffusion Models (Stable Diffusion)

10. Advanced Architectures

- Vision Transformers (ViT)
- Graph Neural Networks (GNNs)
- Capsule Networks, Neural Architecture Search (NAS)

11. Optimization & Regularization (Advanced)

- Optimizers: AdamW, Ranger, Adabelief
- Learning Rate Scheduling, Gradient Clipping
- Model Pruning, Quantization, and Distillation

12. Model Deployment

- Model Serialization (SavedModel, TorchScript, ONNX)
- Deployment Platforms: Flask, FastAPI, Streamlit, TensorRT

- Edge Deployment: TensorFlow Lite

13. Deep Learning Projects

- Image Classification, Object Detection, Sentiment Analysis
- Face Recognition, Chatbots, GAN Image Generation, Time Series Forecasting

14. Research and Cutting-edge Topics

- Self-Supervised Learning, Meta Learning, RL (Deep Q-Networks)
- Federated Learning, Multimodal Models (CLIP, DALL·E)
- Explainable AI (XAI)

15. Tools and Ecosystem

- Google Colab, Kaggle, Hugging Face, Weights & Biases
- TensorBoard, OpenAI Gym, Datasets (ImageNet, COCO, MNIST)