Merged Deep Learning Roadmap (CampusX + Krish Naik)

Foundations

- Introduction to Deep Learning
- Deep Learning vs Machine Learning
- History & Applications of Deep Learning
- Biological Neuron vs Perceptron vs Artificial Neuron
- Perceptron Intuition & Geometric View
- Training a Perceptron (Perceptron Trick)
- Advantages & Disadvantages of Perceptron
- Problem with Perceptron (Linear Separability)

Artificial Neural Networks (ANN / MLP)

- MLP Notation & Intuition
- Forward Propagation in Neural Networks
- Backpropagation Algorithm (What, How, Why)
- Chain Rule of Derivatives
- Vanishing & Exploding Gradient Problem
- Activation Functions:
    - Sigmoid (versions 1 & 2)
    - Tanh
    - ReLU
    - Leaky ReLU, Parametric ReLU
    - ELU, SELU
    - Softmax (for multi-class)
    - Which Activation Function to use When?
- Loss Functions vs Cost Functions
- Regression Loss Functions (MSE, MAE, etc.)
- Classification Loss Functions (Cross Entropy, Hinge Loss, etc.)
- Which Loss Function to use When?

- Gradient Descent Variants:
  - Batch GD, Stochastic GD, Mini-Batch GD
  - SGD with Momentum
  - Nesterov Accelerated Gradient (NAG)
  - AdaGrad
  - RMSProp
  - Adam Optimizer
  - Exploding Gradient Fixes
- Weight Initialization Techniques:
  - Xavier, He Initialization
  - What not to do?
- Regularization:
  - L1, L2, Weight Decay
  - Dropout Layers
  - Early Stopping
  - Batch Normalization / Layer Normalization
- How to Improve Neural Network Performance
- Hyperparameter Tuning (Keras Tuner, Optuna basics)

ANN Projects (Basic Hands-On)

- Customer Churn Prediction (Classification)
- Handwritten Digit Recognition (MNIST)
- Graduate Admission Prediction (Regression)
- Finding Optimal Hidden Layers & Neurons
- ANN Training End-to-End (with Optimizer + Loss)
- ANN Deployment with Streamlit

Convolutional Neural Networks (CNN – Computer Vision Basics)

- CNN Intuition & Biological Analogy (Visual Cortex)
- Understanding Images (RGB, Channels, etc.)
- Convolution Operation

- Padding & Strides

- Pooling (Max, Min, Average)

- Flattening & Fully Connected Layers

- CNN vs ANN

- CNN Architectures: LeNet-5, AlexNet (intro)

- Backpropagation in CNN (Convolution + Pooling layers)

- CNN Practical Project: Cat vs Dog Classification

- Data Augmentation in CNN

- Pretrained Models (VGG, ResNet, Inception basics)

- Transfer Learning vs Fine Tuning

- Visualizing CNN Filters & Feature Maps

- What does a CNN see?

Recurrent Neural Networks (RNN – Sequential Data)

- Why RNN? RNN vs ANN

- RNN Architecture & Intuition

- Forward Propagation Through Time

- Backpropagation Through Time

- Problems with RNN (Vanishing Gradients, Long Dependencies)

- Simple RNN with Keras (IMDB Sentiment Dataset)

- Prediction from RNN Model

LSTMs & GRUs

- Why LSTM?

- LSTM Architecture:

    - Forget Gate

    - Input Gate & Candidate Memory

    - Output Gate

- Training Process in LSTM

- Variants of LSTM (Peephole, Stacked, BiLSTM, etc.)

- GRU Architecture & Intuition

- GRU vs LSTM

- Bidirectional RNN/LSTM/GRU

- Practical Projects:

    - Next Word Prediction with LSTM

    - Sentiment Analysis with RNN/LSTM

    - Streamlit Integration with RNN/LSTM

Sequence-to-Sequence Models & Attention

- Encoder-Decoder Architecture (Seq2Seq)

- Problems with Seq2Seq (long dependencies)

- Attention Mechanism:

    - Bahdanau Attention

    - Luong Attention

    - Self Attention

    - Scaled Dot Product Attention

    - Multi-Head Attention

    - Positional Encoding

- Layer Normalization (vs BatchNorm)

- Complete Encoder Architecture

- Complete Decoder Architecture

- Cross Attention

- Masked Multi-Head Attention

- Final Linear + Softmax Layer

Transformers (Modern Deep Learning)

- Why Transformers?

- Transformer Basic Architecture

- Encoder-Decoder Attention Working

- Transformer Inference Process

- Applications of Transformers (BERT, GPT intro)

- Epic History of LLMs (CampusX extra)

Final Outcome

By completing all these topics, you will have:

- **Core DL foundations** (ANN, CNN, RNN, LSTM, GRU, Transformers).
- **Hands-on projects** (Churn, MNIST, Cat vs Dog, IMDB Sentiment, Next Word Predictor, etc.).
- **Advanced topics** (Attention, Transformers).
- **Deployment basics** (Streamlit from Krish Naik).

This merged roadmap is **all of Deep Learning** (foundation + CV basics + NLP basics). After this, you'll be ready to move into **specialized tracks**:

- **Computer Vision advanced** (Object Detection, Segmentation, GANs).
- **NLP advanced** (Transformers, BERT, GPT, etc.).
- **Practical DL frameworks** (PyTorch/TensorFlow).

Deep Learning Master Roadmap (with Best Video per Topic)

Foundations

- Introduction to DL → **CampusX** (Day 1–2, deeper explanation).
- Perceptron & MLP basics → **CampusX** (Day 5–7, with intuition & math).
- Forward Propagation → **CampusX**.
- Backpropagation → **CampusX** (detailed derivation).
- Why Perceptron fails? Linear separability → **Krish Naik** (short, crisp).

Activation Functions & Losses

- Sigmoid, Tanh, ReLU family → **CampusX** (deep intuition).
- Softmax (multi-class) → **Krish Naik** (quick + coding).

- Loss Functions (MSE, Cross-Entropy, etc.) → **CampusX** (theory) + **Krish Naik** (hands-on).

Optimization & Training Tricks

- Gradient Descent variants (SGD, Momentum, RMSProp, Adam) → **CampusX** (full theory + math).

- Weight Initialization (Xavier, He) → **CampusX**.

- Regularization (Dropout, BatchNorm, Early Stopping) → **CampusX** (concepts) + **Krish Naik** (practical demo).

- Hyperparameter Tuning → **Krish Naik** (he shows Keras Tuner).

ANN Projects

- Churn Prediction (Classification) → **Krish Naik** (Udemy hands-on).

- MNIST Handwritten Digit Recognition → **CampusX** (step-by-step).

- Graduate Admission (Regression) → **Krish Naik**.

- ANN Deployment with Streamlit → **Krish Naik**.

CNN (Computer Vision Basics)

- CNN Intuition + Convolution/Pooling → **CampusX** (deep math explanation).

- CNN Architectures (LeNet-5, AlexNet) → **CampusX**.

- Backprop in CNN → **CampusX**.

- Cat vs Dog Classification Project → **Krish Naik** (practical + easy to code).

- Data Augmentation, Transfer Learning → **CampusX**.

- Visualizing CNN filters & feature maps → **CampusX**.

RNN (Sequential Data)

- RNN Intuition + Architecture → **CampusX** (Day 40+).

- Vanishing Gradients in RNN → **CampusX**.

- Simple RNN Project (IMDB Sentiment) → **Krish Naik** (short demo).

LSTM & GRU

- LSTM Intuition + Gates (Forget/Input/Output) → **CampusX** (best for math + animation).

- Variants of LSTM → **CampusX**.

- GRU Intuition & Comparison → **CampusX**.

- Next Word Prediction with LSTM → **Krish Naik** (he codes this simply).

- Sentiment Analysis with LSTM/GRU → **Krish Naik**.

Attention & Seq2Seq

- Encoder-Decoder Seq2Seq → **CampusX**.

- Bahdanau Attention → **CampusX**.

- Luong Attention → **CampusX**.

- Self-Attention & Scaled Dot-Product Attention → **CampusX**.

- Multi-Head Attention → **CampusX**.

- Positional Encoding → **CampusX**.

Transformers

- Transformer Architecture (Encoder + Decoder) → **CampusX** (multiple lectures).

- Masked Multi-Head Attention → **CampusX**.

- Applications (BERT, GPT intro) → **CampusX** (Epic history of LLMs).

Final Formula

- **CampusX for concepts, math-heavy parts, attention/transformers.**

- **Krish Naik for quick coding projects + deployment.**