Deep Learning Curriculum

Module 1: Introduction to Deep Learning

- AI vs ML vs DL
- Applications of Deep Learning
- Deep Learning Workflow

Module 2: Artificial Neural Networks (ANN)

- Biological Neuron vs Artificial Neuron
- Perceptron and MLP
- Activation Functions
- Loss Functions
- Backpropagation
- Optimizers (SGD, Adam, RMSProp)
- Regularization Techniques
- ANN Projects

Module 3: Deep Neural Networks

- Deep Architectures
- Vanishing/Exploding Gradients
- Weight Initialization
- Hyperparameter Tuning
- Transfer Learning Basics

Module 4: Convolutional Neural Networks (CNN)

- Image Fundamentals
- Convolution and Pooling
- CNN Architectures (LeNet, AlexNet, VGG, ResNet, EfficientNet)
- Image Classification
- Data Augmentation
- Transfer Learning
- CNN Projects

Module 5: Advanced Computer Vision

- Object Detection
- YOLO, Faster R-CNN

- Image Segmentation
- U-Net and Mask R-CNN
- Vision Transformers (ViT)
- CV Project

Module 6: Sequence Modeling

- Sequential Data
- RNN
- LSTM
- GRU
- Seq2Seq Models

Module 7: Natural Language Processing (NLP)

- Text Preprocessing
- Bag of Words, TF-IDF
- Word2Vec, GloVe, FastText
- Text Classification
- NER
- Neural Machine Translation (NMT)
- NLP Projects

Module 8: Transformers and LLMs

- Attention Mechanism
- Transformer Architecture
- BERT
- GPT
- Modern LLMs
- Prompt Engineering
- RAG
- LoRA and Fine-Tuning
- AI Agents

Module 9: Generative AI

- Autoencoders
- Variational Autoencoders
- GANs
- Diffusion Models
- Multimodal AI

Module 10: Capstone Projects

- Medical Image Diagnosis
- Face Recognition System
- Question Answering System
- RAG Chatbot
- Sentiment Analysis
- Vision-Language Applications

Module 11: Time Series Analysis

- Time Series Fundamentals
- Trend, Seasonality & Cyclic Patterns
- Stationarity
- ARIMA & SARIMA
- Forecasting Techniques
- Machine Learning for Time Series
- LSTM & GRU
- Forecast Evaluation
- Time Series Projects

CampusX-এর 100 Days of Deep Learning playlistটা মোটামুটি Deep Learning-এর পুরো journey cover করে–Basic ANN থেকে Transformer পর্যন্ত।

- তোমার সুবিধার জন্য topic-wise ভাগ করে বলছি:
- **1. Deep Learning Fundamentals**
  - What is Deep Learning?
  - Deep Learning vs Machine Learning
  - Perceptron
  - Neural Networks
  - Forward Propagation
  - Activation Functions
  - Loss Functions
  - Backpropagation (What, How, Why)
- **2. ANN (Artificial Neural Networks)**
  - MLP (Multi Layer Perceptron)
  - Classification using ANN

    - Regression using ANN
    - Customer Churn Prediction
    - MNIST Digit Classification
    - Admission Prediction
- **3. Training Deep Neural Networks**
    - Gradient Descent
    - Batch / Stochastic / Mini-Batch GD
    - Vanishing Gradient
    - Exploding Gradient
    - Early Stopping
    - Data Scaling
    - Dropout
    - Hyperparameter Tuning (Keras Tuner)
- **4. Optimizers**
    - Momentum
    - NAG (Nesterov Accelerated Gradient)
    - AdaGrad
    - RMSProp
    - Adam Optimizer
- **5. CNN (Computer Vision)**
    - CNN Intuition
    - History of CNN
    - Convolution Operation
    - Padding
    - Stride
    - Pooling
    - LeNet Architecture
    - CNN vs ANN
    - CNN Backpropagation
- **6. RNN Family**
    - Recurrent Neural Networks
    - LSTM
    - GRU
    - Stacked RNN
    - Stacked LSTM
    - Bidirectional RNN
    - BiLSTM
    - Bidirectional GRU
- **7. NLP & LLM Foundations**
    - History of LLMs
    - Seq2Seq
    - Encoder-Decoder Architecture
    - Attention Mechanism

    - Bahdanau Attention
    - Luong Attention
- **8. Transformers**
    - Introduction to Transformers
    - Self Attention
    - Multi-Head Attention
    - Positional Encoding
    - Encoder Architecture
    - Decoder Architecture
    - Cross Attention
    - Transformer Inference
- ---
- তুমি যেহেতু ML already শিখেছ এবং এখন 3rd year-এ আছ, আমার মতে এই playlist-এর সবচেয়ে valuable অংশ হলো:
    1. Backpropagation
    2. Gradient Descent & Optimizers
    3. CNN
    4. LSTM/GRU
    5. Attention Mechanism
    6. Transformers
- অনেকেই CNN পর্যন্ত শিখে থেমে যায়, কিন্তু CampusX-এর এই playlist-এর বড় শক্তি হলো যে এটা **Transformer architecture পর্যন্ত conceptually deep** যায়। Reddit-এও অনেক learner বলেছে যে CampusX theory এবং implementation দুটোই ভালোভাবে explain করে।
- তুমি যদি CampusX-এর 100 Days of Deep Learning শেষ করো, তাহলে Deep Learning-এর foundation বেশ ভালো হয়ে যাবে। কিন্তু AI Engineer বা ML Engineer হওয়ার জন্য শুধু Deep Learning জানলেই হয় না।
- তোমার বর্তমান অবস্থা (Python + OOP + ML + DL শিখছ) অনুযায়ী আমি এই roadmap সাজাতাম:
- **1. Mathematics (সবসময় চলবে)**
    - Linear Algebra
    - Calculus (Gradient, Partial Derivative)
    - Probability
    - Statistics
- Deep Learning-এর অনেক concept (Backpropagation, Attention, Optimization) এগুলো ছাড়া পুরোপুরি clear হয় না।
- ---
- **2. MLOps (অনেকেই এটা শেখে না)**
- Model train করা এক জিনিস, production-এ deploy করা আরেক জিনিস।
- শিখবে:
    - Docker
    - FastAPI

    - Model Deployment
    - MLflow
    - DVC
    - CI/CD basics
- ---
- **3. Data Engineering Basics**
- AI project-এর 70-80% সময় data নিয়ে কাজ হয়।
- শিখবে:
    - Advanced SQL
    - Pandas
    - Data Cleaning
    - Feature Engineering
    - ETL concepts
- ---
- **4. Generative AI & LLM**
- বর্তমান AI industry-এর সবচেয়ে hot field।
- শিখবে:
    - Transformer
    - BERT
    - GPT
    - Tokenization
    - Embeddings
    - Vector Database
    - RAG (Retrieval Augmented Generation)
    - Fine Tuning
    - Agents
- ---
- **5. Deep Learning Framework Internals**
- শুধু Keras ব্যবহার না করে:
    - PyTorch (খুব গুরুত্বপূর্ণ)
    - Tensor operations
    - Autograd
    - Custom Layers
    - Custom Loss Functions
- ---
- **6. Specialization (একটা বেছে নাও)**
- **Computer Vision**
    - Object Detection
    - YOLO
    - Segmentation
    - Vision Transformers
- **NLP**

    - Transformers
    - LLM
    - RAG
    - Fine-tuning
- **Recommendation Systems**
    - Collaborative Filtering
    - Ranking Models
- **Time Series**
    - Forecasting
    - LSTM
    - Transformers for Time Series
- ---
- **7. Research Reading**
- এখানেই beginner আর advanced learner-এর পার্থক্য।
- পড়তে শিখবে:
    - Research Paper
    - arXiv papers
    - Model Architecture Diagrams
- যেমন:
    - Attention Is All You Need
    - BERT
    - GPT-3
- ---
- **আমি হলে তোমার জন্য priority দিতাম**
    1. CampusX 100 Days DL শেষ
    2. PyTorch
    3. Advanced SQL + Pandas
    4. FastAPI
    5. Docker
    6. Transformers
    7. RAG
    8. LLM Applications
    9. MLOps
    10. Research Papers
- তোমার যেহেতু business করার ইচ্ছাও আছে, শুধু model training শিখে থেমো না। এমন skill শিখো যাতে **একটা AI idea থেকে data collection → model training → API → web app → deployment** পুরো pipeline নিজে বানাতে পারো। তখন চাকরি, freelancing, startup—তিন দিকেই সুবিধা হবে। 🚀