Module 1: Introduction to Deep Learning and AI (4 Classes)

Class 1: Introduction to AI and Machine Learning

- Overview of AI, ML, and DL
- Key Concepts and Terminologies
- Historical Context and Evolution
- Key Concepts:
  - Generative AI
  - LLM
  - Vector Database
  - Hugging Face
  - LangChain
- Importance of Kaggle profile.
  - Kaggle Competition
- The job of DL, LLM, Generative AI

Class 2: Basics of Neural Networks

- Artificial Neurons
- Activation Functions
    - Linear, Sigmoid, Softmax, Tanh
    - ReLu, Leaky ReLu,
- Dying Relu Problem
- ANN Architecture
- Forward and Backward Propagation
- Training Neural Networks with Python

Class 3: Deep Learning Frameworks and Tools

- Introduction to Popular Frameworks
    - Keras
    - TensorFlow
    - PyTorch
- Setting up the Environment
- Basic Operations
- Model Creation with Python

Class 4: Training Deep Learning Models

- Data Import, Preparation, and Preprocessing
- Loss Functions and Optimization Algorithms
    - Gradient Descent Optimizer
    - Variants of Gradient Descents (Momentum, Nesterov Momentum, AdaGrad, RMSProp, Adam and Nadam)
- Gradient Problems (Vanishing & Exploding)
- Key Concepts of-
    - Overfitting, Underfitting, and Bestfitting
    - Regularization Techniques

Module 2: Computer Vision (8 classes)

Class 5: Introduction to Computer Vision

- Overview of Computer Vision Tasks
- Image data Handling
- Data Augmentation

Class 6: Convolutional Neural Networks (CNNs)

- CNN architecture and components
- Convolution and pooling layers
- Fully connected layer

Class 7: Advanced CNN Architectures

- Popular CNN models (LeNet, AlexNet, VGG, ResNet, Inception)

- Transfer learning
- Fine-tuning

Class 8: Object Detection and Localization

- Techniques (R-CNN, Fast R-CNN, Faster R-CNN, YOLO)
- Implementation and applications

Class 9: Semantic Segmentation and Image Segmentation

- Techniques (U-Net, Fully Convolutional Networks)
- Practical examples and use cases
- Implementation with Python

Class 10: Generative Adversarial Networks (GANs) in Computer Vision

- Introduction to GANs
- Architecture
- Training of GANs with Python

Class 11: Applications for GANs in Computer Vision

- Variants of GANs (DCGAN, CycleGAN, StyleGAN) & Image generation and transformation
- Style transfer and super-resolution
- Training stability and challenges
- Implementation with Python

Class 12: Computer Vision Projects

- Implementing a real-world project
- Best practice and troubleshooting (**Modular Code**)
- Project Name: Automatic Dhaka traffic detection using the YOLO model.

Module 3: Natural Language Processing (NLP) (7 classes)

Class 13: Introduction to NLP

- Overview of NLP tasks
- Text preprocessing techniques
- Regex
- Implementation with Python

Class 14: Word Embeddings and Representations

- Tf-idf, Word2Vec, GloVe, FastText
- Contextual embeddings (ELMo, BERT)
- Implementation with Python

Class 15: Recurrent Neural Networks (RNNs) and Variants

- Basic RNN architecture
- Long Short-Term Memory (LSTM)
- Gated Recurrent Unit (GRU)
- Implementation with Python

Class 16: Seq2Seq Modeling, Attention Mechanisms, and Contextual Embeddings
Attention Mechanisms and Transformers

- Sequence-to-Sequence Models for Neural Machine Translation (NMT)
- Attention mechanism
- Deep Dive into Contextual Embeddings
- Implementation with Python

Class 17: Advanced Transformer Models & Extended Contextual Embeddings

- Transformers in depth
  - Input Embeddings
  - Positional Encodings
  - Self-Attention, Multi-Head Attention
  - Encoder
  - Decoder
  - Output Layer
- Transformer Variations: Encoder only, Decoder only, Encoder-Decoder, and their applications
- Extended Contextual Embedding Techniques with Transformer Model
- Evaluate NLP models

Class 18: Transformer Model Pretraining, Fine-Tuning, and GPT Decoding

- Pretraining Transformer Models
- Fine-tuning techniques
- GPT Decoding Strategies (Greedy, Beam Search, Sampling)
- Implementation with Python

Class 19: End-to-End NLP Project

- Implementing a real-world project
- Best practice and troubleshooting (**Modular Code**)
- Project Name: Word Spelling Correction

Module 4: Generative AI (7 classes)

Class 20: Introduction to Generative AI

- Overview of generative models
- Instruction Tuning (Basic & Advanced Prompt Engineering)
- Evaluation of LLMs (Metrics and Benchmarks)
- Applications and cases

Class 21: Multimodality - Variational Autoencoders (VAEs) and Multimodal LLMs

- Understanding Multimodal Inputs (Text, Image)
- VAE Architecture demonstrates Multimodal Data
- Integrating Multiple Modalities into LLMs
- Applications for Multimodal LLM-powered chat assistant

Class 22: Model Optimization Techniques for Deep Learning & LLM Model

- Quantization (Linear Quantization, Quantization Aware Training (QAT) , Post Training Quantization (PTQ) , 1.58-Bit LLMs)
- Knowledge Distillation (Teacher-Student Training)
- Parameter-Efficient Fine-Tuning (PEFT): LoRA(Low-Rank Adaptation), QLoRA (Quantized LoRA)
- Implementation with Python

Class 23: Reinforcement Learning Intro & LLM Improvement with RAG & RL

- Introduction to Reinforcement Learning (Agent, Environment, Reward)
- LLM Improvement with RAG
- Preference Alignment of LLMs (Reinforcement Learning from Human Feedback using PPO (Proximal Policy Optimization), Direct Preference Optimization, Offline RL with Preference Optimization)
- Implementation with Python

Class 24: End-to-End Chatbot Development (Generative AI Project)

- Project Name: End-to-End LLM powered Chatbot with Ollama, Langchain, Vector Database with ChatUI

Class 25: Advanced GRPO and DeepSeek LLM Underlying Technology

- GRPO: Extending PPO for LLM Training and Optimization
- DeepSeek Architecture and Coder Capabilities
- Efficient Fine-tuning with Unsloth:
    - FlashAttention, Quantization, Memory Optimization
    - Speed Improvements and Benchmarks
- Domain Applications with Implementation Examples

Class 26: AI Agent Workflows with LangChain and CrewAI

- Agent Components: Memory, Planning, ReAct Framework, Tool Use
- LangChain Implementation: Tools, Chains, Memory Systems
- CrewAI for Multi-Agent Systems: Roles, Task Delegation, Communication
- Project: Collaborative Research System Implementation

Class 27: Job & Final Project Guidelines

- Resume Building and Portfolio Development (Showcasing Projects and Skills & Final Project Guidelines)
- ML Industry Interview Guidelines.

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