Module 1: Introduction to Neural Networks

1. History of Artificial Intelligence
   - Turing Test
   - Perceptron
   - First AI Winter
   - Backpropagation Algorithm
   - Second AI Winter
   - Post AI Winter
   - AI Spring

2. Applications of Deep Learning
   - Speech Recognition
   - Natural Language Processing
   - Automation
   - Medical Diagnostics
   - Facial Analysis
   - Content Creation

Module 2: Image Classification

1. Image Classification Overview
   - Introduction to Image Classification
   - ImageNet
• LeNet and LeNet-5
• Types of layers
  1. Convolutional Layer
  2. Activation Layer
  3. Pooling Layer
  4. Fully Connected Layer

2. Evaluation Metrics

• Confusion Matrix
• Accuracy
• Precision
• Recall
• Specificity
• F1 Score
• ROC Curve, AUC ROC

3. Image Classification Architecture

• AlexNet
• VGG-16
• GoogleNet
• Resnet
• Comparison of methods
• Creating your own architecture

4. Mathematics of Neural Networks

• Mathematical definition of Classifier, Training and Iteration
• Forward Pass
• Loss Function
• Backpropagation
• Deep Learning as Optimization Problem
• Gradient Descent and Weights Update
• Stochastic GD and Mini-Batch GD
• ADAM

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5. Good Practice + Bias, Batchnorm, Dropout

- Data Shuffling
- Dataset Splits
- Fitting the training set
- Overfitting
- Bias and Variance
- Regularization
- Data Augmentations

Module 3: Image Segmentation

1. Semantic Segmentation

- Problem Formulation
- Histogram Based Methods
- Conditional Random Fields
- Datasets – PASCAL VOC 2012, CAMVID, CITYSCAPES, FASSEG
- Evaluation Metrics

2. Architecture of Semantic Segmentation

- Fully Convolutional Network
- U-Net
- SegNet
- DeepLab v1, v2
- DeepLab v3
- DeepLab v3+

3. Loss Function and Blocks

- Commonly used Loss Functions
- Mathematical Formulation
- Implementation

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Module 4: Object Detection

1. Introduction of Object Detection
   - Problem Formulation
   - Challenges
   - Accuracy Improvement
   - Datasets – VOC PASCAL, MS COCO, ImageNet

2. Traditional Approach to Object Detection
   - Background Subtraction
   - Sliding Window
   - Selective Approach
   - Traditional ML
   - Hand-crafted Features

3. Evaluation Metrics
   - Problem Formulation
   - Popular Competitions
   - IoU
   - Confidence Score
   - TP, FP, TN, FN
   - Recall & Precision
   - Non-maximum Suppression

4. Single stage Object Detection
   - Main pipeline
   - YOLO
   - SSD
   - RetinaNet

5. Two Stage Object Detection
   - Main Pipeline
• R-CNN
• Fast-RCNN
• Faster-RCNN
• Comparison between Fast-RCNN and Faster-RCNN

Module 5 : Deploying Applications

1. PyTorch C++ API and LibTorch

• Learn LibTorch for using in deployment
• How to convert models to be used in C++ API
• How to train models in C++ API

2. Cloud Deployment

• Learn about Azure Machine Learning
• Deploy Deep Learning models on the cloud