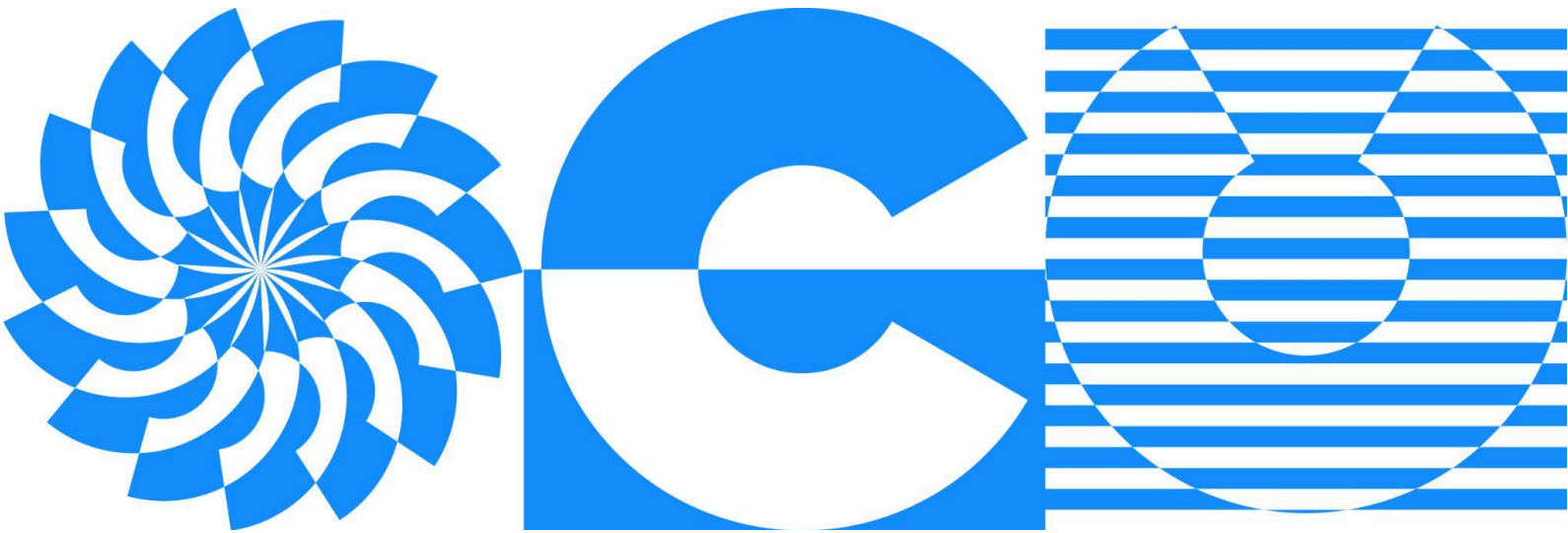


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TxAP

Advanced Vision Applications with Deep Learning & Transformers

Detailed Curriculum



Index

1. **Introduction**
 2. **Module 1: Neural Networks and Classification**
 3. **Module 2: Object Detection**
 4. **Module 3: Text Detection & Recognition (OCR)**
 5. **Module 4: Segmentation**
 6. **Module 5: Tracking**
 7. **Module 6: Keypoint Estimation**
 8. **Module 7: Face Recognition and Applications**
 9. **Bonus Module: Vision-Language Models (CLIP, Moondream2)**
-

Introduction

Welcome

Course Logistics

- How is the Course Organized?
- Grading Policy and Certification
- How to Use Online Labs
- Where can I Download Code?
- Quiz Instructions

Setting Up Deep Learning Tools

- Introduction to Colab
 - Introduction to Kaggle Kernel
-

Module 1: Neural Networks and Classification

Introduction to Neural Networks

- What is a Neural Network?
- Deep Learning Frameworks
- How Does a Neural Network Learn?

Introduction to PyTorch

- What is PyTorch and Why Choose PyTorch?
- PyTorch Basics and Tensor Operators
- Training Neural Networks: Overview
- Binary Classification with PyTorch
- Dataloaders in PyTorch: Classification

Feedforward Neural Networks

- Why do we need hidden layers?
- Training a Neural Network using Backpropagation
- Image Classification using MLP
- Example: Image Classification using MLP

Convolutional Neural Networks

- The Convolution Operation
- Example: Image Classification using CNNs

Logging using MLOps Tools

- Introduction to Weights & Biases

Transfer Learning and Fine-Tuning using Pre-Trained Models

- Transfer Learning Notebook
- Train Image Classifier to Fine-Tune on a Difficult Dataset

Vision Transformers

- Introduction to ViT
- ViT Attention Map
- Fine-Tuning ViT for Birds Classification

Assignment 1

- Assignment 1: Binary Classification with CNN

Quiz 1

- Quiz 1
-

Module 2: Object Detection

Introduction

- Object Detection Overview
- Traditional Object Detection Pipeline

Single Stage Detectors

- SSD
- RetinaNet

Object Detection using YOLO

- Introduction to YOLO
- Object Detection Inference
- Fine-Tuning for Aerial Images
- Tiled Object Detection using YOLOv8

Detection Transformers

- Object Detection using RTDETR

Case Study – Global Wheat Challenge

- Global Wheat Detection Part 1 – Training
- Global Wheat Detection Part 2 – Practical Improvements

Assignment 2

- Assignment 2: Annotation Conversion

Quiz 2

- Quiz 2

Project 1

- Object Detection
-

Module 3: Text Detection & Recognition (OCR)

Graphic Text Recognition using Tesseract

- What is Tesseract?
- Notebook: Introduction to OCR using Tesseract
- Notebook: Tesseract OCR Failure Cases
- Notebook: Improving Tesseract OCR Failures

Transformer OCR (TrOCR)

- Introduction to TrOCR
- TrOCR Inference with Cropped Image
- TrOCR Inference with Text Detection
- Fine-Tuning using TrOCR on Captcha

Application – ALPR

- Introduction to ALPR
- YOLOv10 License Plate Detection Training
- Fine-Tuning TrOCR on License Plate Text
- ALPR Inference – Combined Detection + OCR

Assignment 3

- Assignment 3: TrOCR Invoice

Quiz 3

- Quiz 3

Project 2

- TrOCR
-

Module 4: Segmentation

Introduction

- Introduction to Segmentation

Deep Learning based Segmentation Models

- Introduction to Segmentation using Torchvision Models

Transformer Based Segmentation Models

- Aerial View Segmentation using SegFormer

SAM (Segment Anything Model)

- Introduction to SAM
- Automatic Person Segmentation with YOLOv11 + SAM2
- Advanced Segmentation Techniques with SAM2

Segmentation using Custom Backbone

- DINO UNet Road Segmentation

Quiz 4

- Quiz 4

Project 3

- Segmentation
-

Module 5: Tracking

Introduction

- Overview
- Object Tracking Algorithms

Ultralytics Tracking

- Tracking using Ultralytics YOLOv8
- SeaDrone Dataset Detection Fine-Tuning and Tracking
- YOLO11 Grocery Cart Tracking and Counting

Multi-Camera Tracking

- Multi-Camera Tracking using OpenVINO

Re-Identification

- Person ReID Fine-Tuning

Transformer-Based Tracker

- Introduction to Point Tracking using CoTracker3

Quiz

- Quiz 5
-

Module 6: Keypoint Estimation

Introduction

- Introduction to Pose Estimation and Landmark Detection

Exercise Analysis using Keypoints

- Squats Analysis Pipeline Overview
- Squats Analysis Code Explanation

Keypoint Fine Tuning using YOLOv8

- Facial Keypoint Fine Tuning using YOLOv8

Applications of Keypoint

- Warping a Triangle
- Delaunay Triangulation
- Face Alignment
- Face Averaging
- Face Morphing
- Bug Eyes
- Face Swap
- Beard Filter
- Aging Filter

Assignment & Quiz

- Assignment 4: Smile Detection
 - Quiz 6
-

Module 7: Face Recognition and Applications

Creating an Automated Attendance System using AWS

- Introduction to Automated Attendance System
- Introduction to AWS Rekognition
- How to Setup AWS with AWS Rekognition
- Registration using AWS Rekognition
- Deregistration using AWS Rekognition
- Attendance Using AWS Rekognition

- Gradio App Setup Instruction

Assignment & Quiz

- Assignment 5: Doppelganger
 - Quiz 7
-

Bonus Module

CLIP

- Zero Shot Image Classification with CLIP

Vision Language Models (VLM)

- Image Captioning and VQA with Moondream2
-

Summary of Assessments

- Total Projects: 3
- Total Assignments: 5
- Total Quizzes: 7

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