

# Deep Learning for Big Visual Data

**Prerequisite:** graduate standing, prefer with background on image processing, computer vision and linear algebra, statistical data analysis

**Grading:** 5 biweekly Deep Learning Projects 20%/each

- **Introduction and Lab Tutorial (1 week)**
  - Machine Learning Paradigms
  - Visual Data and Features
  - Distance Measure of Visual Features
  - Machine Learning Performance Metrics
  - Tutorial Use of GPU and the Deep Learning Language and Platforms (Python, Scikit-Learn, Colab, Pytorch)
- **Traditional Machine Learning Techniques (1 week)**
  - **Unsupervised Learning**
    - K-Mean Clustering
    - Gaussian Mixture Model
    - Mean Shift Segmentation
    - Normalized Cut Segmentation
  - **Supervised Learning**
    - Classification Trees and Random Forest
    - Support Vector Machine
    - Distance Metric Learning
- **From Multilayer Perceptron (MLP) to Convolution Neural Network (CNN) (1 week)**
  - Multilayer Perceptron and Backpropagation Learning
  - From LeNet to AlexNet: the Use of convolution kernels
  - CNN Supervised Classification for Image Recognition
  - CNN Supervised Regression for Autonomous Driving

- CNN Reinforcement Learning for AlphaGo Game
- **CNN for Generative Adversarial Network (GAN) (0.5 week)**
  - Unsupervised Data Generation
  - Training of GANs
  - Conditional GANs
  - Style Mixing GANs
  - Cycle Consistent GANs
- **Few Shot Learning and Open-Set Long-Tailed Recognition (0.5 week)**
  - Long-Tailed Recognition and Open-Set Recognition
  - Few Shot Learning for Rare Data Classes
  - Long-Tailed Recognition for Imbalanced Data
  - Open-Set and Long-Tailed Recognition (OLTR)
- **Deep Learning for Detection and Segmentation (1.5 week)**
  - Traditional Face Detection and Human/Object Detection
  - Two-Stage CNN Detectors: R-CNN, Fast R-CNN, Faster R-CNN, Cascade R-CNN
  - One-Stage CNN Detectors: SSD, Yolo, RetinaNet
  - CNN for Semantic and Instance Segmentation
- **Transfer Learning and Domain Adaptation (DA) in Deep Learning (0.5 week)**
  - DA via Subspace Alignment and Backpropagation
  - Deep Domain Adaptation
  - Adversarial based DA for Classification and Segmentation
  - DA for Object Detection
- **Deep Learning for Image Related Applications (1 week)**
  - CNN-based Face detection
  - Eigenface/Fisherface and LBP based Traditional Face Recognition
  - CNNs for Face Identification and Verification
  - Query Learning for Fine Grained Fish Species Identification

- Image based Depth Estimation
- 2D Human Pose Estimation
- Medical Image Applications
- **Deep Learning for Radar Related Applications (0.5 week)**
  - Radar Signals and Characteristics
  - Radar Object Classification
  - Radar Object Detection
  - Radar Object Annotations and Cross-Modality Training
- **Deep Learning for Point Cloud Related Applications (0.5 week)**
  - Rich 3D Representations
  - Feature Extraction from Point Clouds
  - 3D Object Classifications
  - 3D Object Detection from Point Clouds
- **Deep Learning for Video Related Applications (1 week)**
  - Multiple Object Tracking (MOT)
  - Multiple Object Tracking and Segmentation
  - Ego-Motion Estimation of Moving Cameras
  - 3D Human Pose Estimation
- **Recurrent and Graph Neural Networks (1 week)**
  - Recurrent Neural Networks (RNNs) and Image Captioning
  - Hidden Markov Models (HMMs) and Action Recognition
  - Long Short Term Memory (LSTM) and Gated Recurrent Unit (GRU)
  - LSTM for MOT
  - Graph Convolution Networks (GNNs) and Applications