

= ECE 4501/6782 - CS 4501/6501: Digital Image Processing

Description: This course focuses on an in-depth study of advanced topics and interests in image data analysis. Students will learn about hardcore imaging techniques and gain mathematical fundamentals needed to build their own models for an effective problem solving. Topics of deformable image registration, numerical analysis, probabilistic modeling, data dimensionality reduction, and convolutional neural networks for image segmentation will be covered. The main focus might change from semester to semester. The graduate students (ECE 6782 / CS 6501) will be given additional programming tasks and more advanced theoretical questions.

Mathematical background in linear algebra, multivariate calculus, probability and statistics, and programming skills are required in this class.

- ***Class Meetings:*** MW 3:30-4:45pm @ Mechanical Engr Bldg 339

- ***Instructor:*** Miaomiao Zhang (mz8rr -at- virginia.edu)

Teaching Assistant: TBD

- ***Office hours:*** TBD

Lecture materials including slides and notes will be posted on UVA Collab

== Grading

- Projects (4 course projects and 1 final project) (80%)

- Presentation (15%)

- Participation (5%)

*No exams are required in this course.

*All programming will be in Matlab, a powerful, free programming tool for UVa students: [<https://data.library.virginia.edu/research-software/matlab-for-students/>].

*All reports must be written in LaTeX and submitted as a PDF.

Homeworks are due by midnight (11:59:59 PM) on the due date. Late assignments will not be accepted.

== Schedule

- Aug 26** Course Introduction
- Aug 31** Introduction to Image Analysis and Basic Variational Methods
- Sep 02** Image Denoising I: Convolution, Fourier Transformation (P1 Release)
- Sep 07** Image Denoising II: Total Variation
- Sep 09** Basics of Image Registration
- Sep 14** Deformable Image Registration
- Sep 16** Diffeomorphisms, Geodesic Shooting (P1 Due)
- Sep 21** Population studies: Fréchet mean, image atlas estimation (P2 Release)
- Sep 23** Data Dimensionality Reduction: Principal Component Analysis (PCA)
- Sep 28** Nonlinear PCA methods, kernel trick
- Sep 30** Regression Methods I
- Oct 05** Regression Methods II
- Oct 07** Bayesian Methods (P2 Due)
- Oct 12** Reading day (P3 Release)
- Oct 14** Maximum a Posteriori (MAP), maximum likelihood (MLE)
- Oct 19** Image Clustering: Gaussian Mixture Model
- Oct 21** Expectation Maximization
- Oct 26** Sampling Methods: Markov Chain Monte Carlo
- Oct 28** Metropolis–Hastings, Hamiltonian Monte Carlo (P3 Due)
- Nov 02** Image Classification / Segmentation I (P4 Release)
- Nov 04** Image Classification / Segmentation II
- Nov 09** Neural Network
- Nov 11** Back propagation

- Nov 16** Variational AutoEncoders
- Nov 18** Deep learning I (P4 Due)
- Nov 23** Deep learning II
- Nov 25** Thanksgiving break
- Nov 30** Final project presentation
- Dec 02** Final project presentation
- Dec 07** Final project presentation (Final Project Due on Dec 18)

== Disclaimer

The instructor reserves the right to make changes to the course schedule, syllabus, and project deadlines. Changes will be announced early in advance.