

ENSC 894, 462: Computational Anatomy and Medical Image Analysis

Medical Image Analysis deals with 1) Segmentation, 2) Registration and 3) Shape Analysis. The applications of shape analysis to studying different pathologies and how they affect the shape of organs such as the heart or brain regions falls under the rubric of Computational Anatomy. A practitioner in the field must be acquainted with concepts from several areas such as linear systems, probability, random processes, statistics, pdes, calculus of variations, differential and Riemannian geometry, tensors to name a few. In this course, we will explore some of the current topics in these areas via combinations of lectures, paper readings and student presentations.

Topics:

- Overview of concepts in linear systems theory, vector spaces, normed spaces, inner product spaces, operators, and formulation of linear least squares problems
- Overview of concepts in calculus of variations and optimization in functional spaces
- Overview of concepts in differential and Riemannian geometry
- Segmentation of medical images (paper reading)
- Registration techniques for medical images using landmarks, surfaces, images (paper reading)
- Statistical shape analysis of medical images and applications (paper reading)

Textbook: No single book will adequately cover all the topics. References will be provided as the class progresses. Handouts will be provided where possible.

Prerequisites:

ENSC 801 and 802 are required. Familiarity with variational calculus and concepts from differential geometry are also an asset. This course will be heavy on mathematics, so mathematical inclination and motivation to learn the basic concepts will be essential.

Grading:

There is no exam in the course. The main deliverable in this course will be a review paper that is written in the style of IEEE-Transactions in Medical Imaging paper. There will be several stages of this paper due over the course of the semester. Timely deliverable of these will constitute 20% weight. There will be a final student presentation on their chosen topic. This presentation will count for 30%. The remaining 50% will be on the quality of the written paper.