

**Title:** Parametric and Nonparametric Active contours for Image Segmentation and Registration With Applications in Medical Image Analysis

**Abstract:** This course gives an overview of active contour method for image segmentation and registration as well as their applications in medical image analysis. It provides the basic ideas, techniques, and necessary background of this partial differential equation (PDE)/variational based method integrated with probabilistic estimations. Typical examples and comparisons of various developed models and numerical results are presented through the course to make a better understanding of this method. The main topics covered in this course are as follows:

1. Edge based active contours:  
Basic idea, advantages and drawbacks, level set method;
2. Region-based active contours:
  - (1). Mumford-Shah model for simultaneous image smoothing and segmentation;
  - (2). Region based active contours with parametric density estimations for segmentation: basic idea, advantages and drawbacks, maximum likelihood estimation and maximum a posteriori estimation based approaches, connection between parametric models and Mumford-Shah model;
  - (3). Region-based active contour with nonparametric density estimations for segmentation: basic idea, advantages and drawbacks, kernel method for nonparametric density estimation, global and local nonparametric models for segmentation.
  - (4). Applications in medical image analysis:  
Experimental results in MRI brain image segmentation, cardiac ultrasound image segmentation.
3. Registration:
  - (1). Brief introduction to image registration;
  - (2). Variational method with parametric density estimations for deformable (non-rigid) registration of the same modality images;
  - (3). Variational method with non-parametric density estimations / information theory for deformable registration of multi-modality images.
  - (4). Applications in medical image analysis:  
Significance and applications of deformable image registration techniques in radiation therapy

**Learning Outcomes:** This course will enable you to:

- learn basic ideas, techniques, and some necessary background of active contour method for image segmentation and registration as well as its applications to medical image analysis;
- gain an understanding of how to integrate PDE/ variational method with probabilistic method in modeling image segmentation and registration.
- enhance the ability in modeling and algorithm developing for image analysis.