Image Analysis - Segmentation: Theory
Syllabus ISMRM 2011

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This lecture provides an overview of current state-of-the art techniques in medical image segmentation. I will introduce the main approaches currently used, highlight the pros and cons of different approaches, and present examples of practical applications.

We will cover the following topics:

Voxel based methods

The best known segmentation techniques are those that label each image voxel individually. Implementations range from thresholding and region growing - which are available in any image analysis workstation - to highly specialized, application specific techniques that incorporate prior knowledge on the segmentation problem at hand.

- the classics: thresholding and region growing
- combining information from different sequences
- dealing with intensity inhomogeneity
- pattern recognition techniques: learning from examples
- image features - beyond intensity
- regularization - to smooth or not to smooth?

Deformable models

In contrast to the local decisions of voxel based approaches, which can lead to "grainy" segmentations, deformable models aim to find complete contours or surfaces directly. Techniques range from methods to extract smooth contours based on image edges to fitting statistical models that describe the expected shape and appearance of a complete object based on training data.

Atlas based segmentation

This relatively new class of image segmentation techniques uses *image registration* to deform an example image so that all image structures overlap as much as possible with the structures in the image to segment. When the example image is segmented by hand, the label image can be deformed in the same way to match the target image. It then becomes possible to segment a large number of similar images automatically.