Segmentation

- Process of identifying structure in 2D & 3D images
- Output may be
  - Labeled pixels or voxels
  - Boundary representation of organs
- Many different techniques and methods
  - Manual (still very common)
  - Automated (much research, some practice)
- We don’t have time to cover this in any detail
Automated Methods

- Pixel-based
  - Thresholding
  - Region growing
- Edge/Boundary based
  - Deformable surfaces
  - Implicit surfaces / level sets
- Emerging themes
  - Incorporation of prior knowledge of anatomy
  - Statistical learning methods
  - Validation still difficult
Segment statistically

- Measure distribution of intensities at known tissue locations
- Use nearest neighbor style classifiers for all other voxels

Standard Scans
Statistical segmentation

EM-Segmentation [Wells 1994]

E-Step
Compute tissue posteriors using current intensity correction.

M-Step
Estimate intensity correction using residuals based on current posteriors.
Contour method example: Bone Modeling from CT

Contours → Tetrahedral Mesh → Density Model

Density Function $f_n$

Tetrahedral Mesh Simplification

Multiple Resolution Model

CT Slices
Level Set Methods

Basic idea: "insideness" function $f(\mathbf{x})$ such that

- $f(\mathbf{x}) > 0$ if $\mathbf{x}$ is outside structure
- $f(\mathbf{x}) = 0$ if $\mathbf{x}$ is on surface of structure
- $f(\mathbf{x}) < 0$ if $\mathbf{x}$ is inside structure

Assign values for $f(\mathbf{x})$ to points $\mathbf{x}$ near possible surface and iteratively adjust the values so that "inside" and "outside" correspond more closely with the image data.

Many detailed variations on this basic idea

Deformable Surfaces & Level Sets

Example of current research:
- New data structure ("Springls") and associated algorithmic formulation combining aspects of level sets and meshes
- Blake Lucas, October 2010
Pelvis

Other examples

Video: Blake Lucas