Statistics on Anatomic Objects
Reflecting Inter-Object Relations

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Goal: p(Multi-Object Complexes) Probabilistic Representation

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- Mixed model: for each object, $\Delta M = \Delta M_{\text{self}} + \Delta M_{\text{ngbr}}$
  
- $\Delta M_{\text{self}}$ and $\Delta M_{\text{ngbr}}$ probabilistically independent

- Neighbor effect divided into neighbor prediction & deviation from prediction
  
- The effect of neighboring objects is local
  
- Prediction from nearby medial atoms in neighboring objects

Estimation of self and neighbor effects through iterative steps

1) Compute difference $\Delta M$ from a base model

2) Self Step:
   
   In each training model, remove estimate of effects of neighboring objects from $\Delta M$
   
   Estimate variation modes and thus shape space of the residues (by Principal Geodesic Analysis (PGA))

3) Neighbor Step:
   
   In each training model, remove estimates of effects of neighbor-independent changes of objects from $\Delta M$
   
   Estimate predicting probability distribution
   
   In each training model, remove prediction
   
   Estimate probability distribution on deviations from prediction

Iterate self and neighbor steps over all objects until convergence

Prediction:

a) Combine object medial atoms with independent changes in nearby predicting-atoms
b) Find the probability distribution and shape space of that set (via PGA)
c) Prediction = conditional mean, within the shape space, of object atoms given the predicting atoms

Effectiveness of the Method

- Estimation of self and neighbor effect shown in eigenmodes and their variances:
  
  1) Biologically Realistic:
     
     bladder: large variation independent from changes of its neighboring object prostate
     
     prostate: small self variation in its own shape compared to the effect from its neighboring object bladder
  
  2) Convergence

- Preliminary segmentation results are encouraging

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