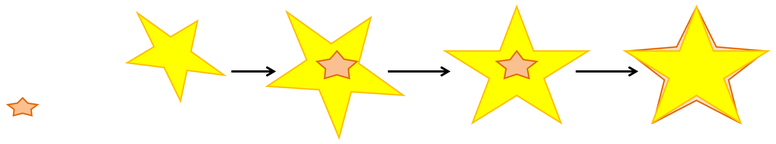
Shape Analysis for Orthopedics

Manasi Datar, Elizabeth Jurrus, Ross Whitaker

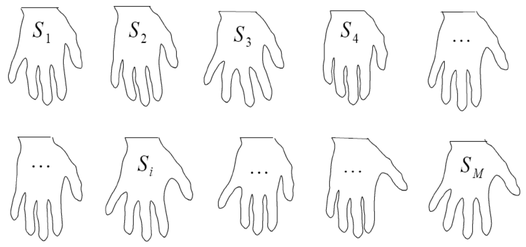
Shape Analysis

What is shape ?

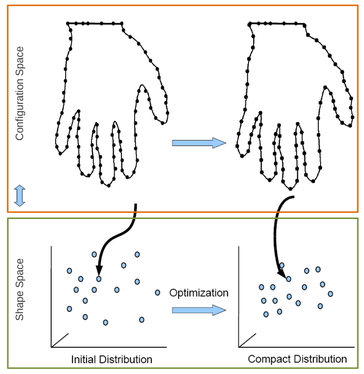


Shape = Object – Location – Orientation - Scale

Now, given a set of shapes…



How do we model them ?

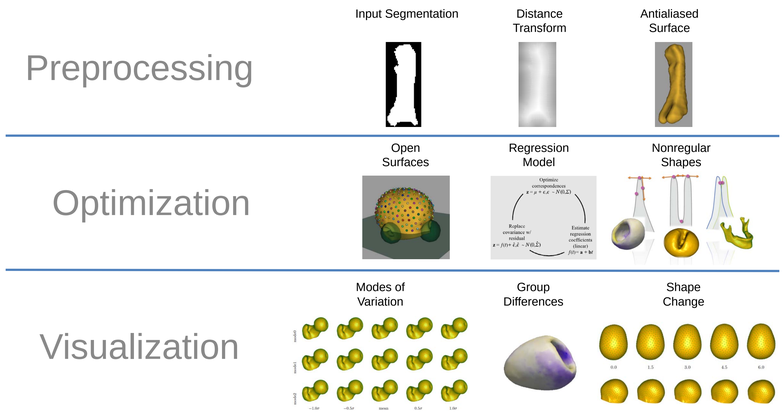


Compact Model
(in Shape Space)
vs.
Accurate Representation
(in Configuration Space)

$$Q = H(\mathbf{S}) - \sum_k H(P^k)$$

Particle Correspondence Model

How do we use this model ?



ShapeWorks Pipeline

Application to Orthopedics

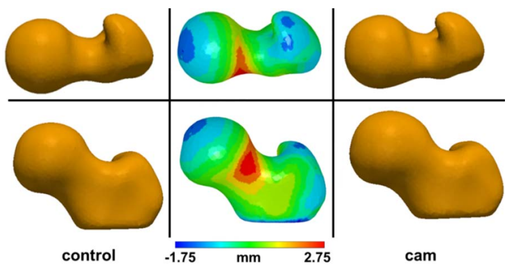
CAM-FAI Characterization w/ Michael Harris, Andrew Anderson

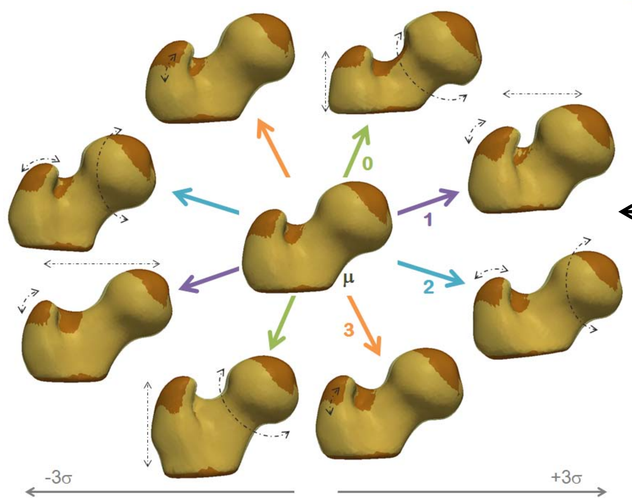
CAM-FAI = ‘cam’ type Femoro Acetabular Impingement
Treatment: surgical debridement

Data:
Segmented femurs – controls (33), CAM-FAI patients (15)

Q: How much to ‘shave off’ ? And from where ?

Average shape differences
(treatment planning)





Shape variability
(understand morphological variability and improve mechanical models of CAM-FAI)

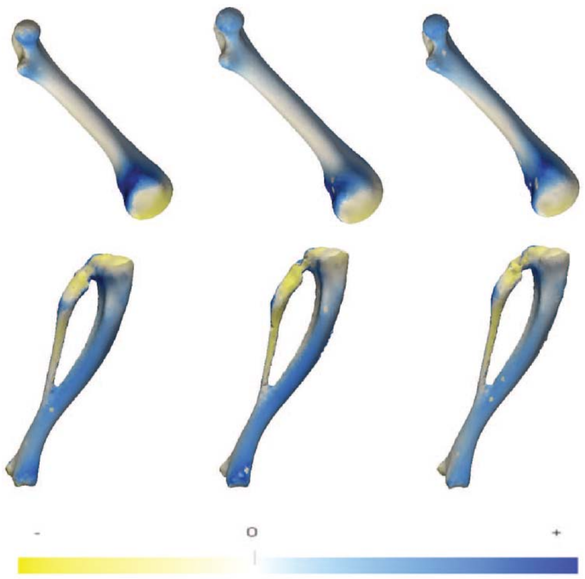
Mouse model of osteochondroma w/ Dr. Kevin Jones

Multiple osteochondroma: Causes shortening of bones in humans
Studied using mice models

Data:
Segmented femurs – controls (12), young-dox (14), mid-dox (14), old-dox (10)
Segmented tibiae – controls (8), young-dox (12), mid-dox (10), old-dox (6)

Q: Can we characterize the effects of disease progression ?

Group mean differences
(indicate shortening of bone)



z-scores to correlate volume and length
(indicate clear separation between control and disease groups)