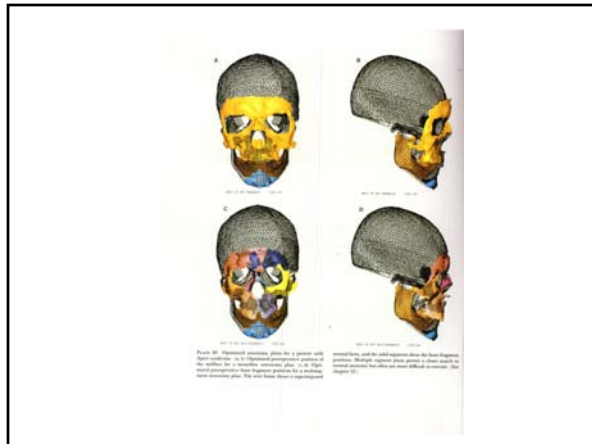


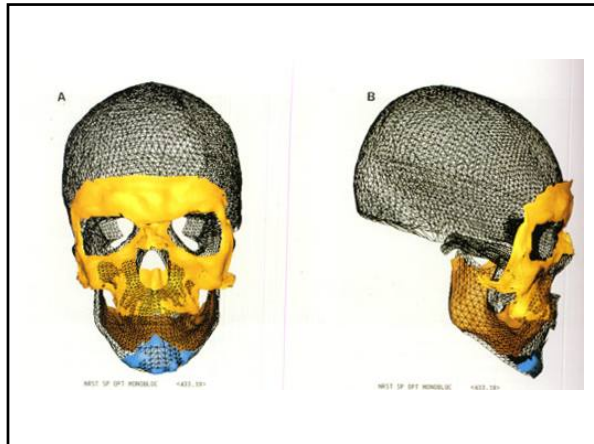
Averaging Skulls

Reference: Cutting, Bookstein, et. al. chapter
in Computer-Integrated Surgery

Skull Model Parameterization

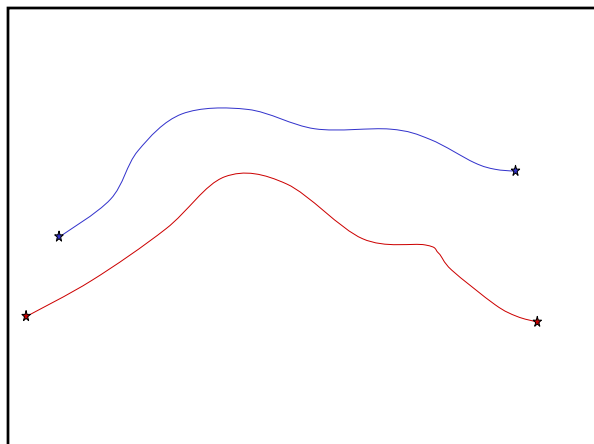
1. Segment CT images to label "bone" pixels
2. Create boundary representation model (typically, polyhedron)
3. Scale model and perform some very approximate registration
4. Compute curvatures and locate ridge curves & landmark points
5. (Refine ridge curves)
6. Augment ridge curves with geodesic lines connecting landmarks
7. "Patch out" regions
8. Combine ridges, landmarks, and patches into "average" model





Deficient Coordinates

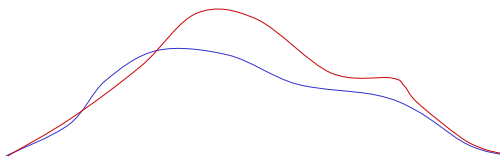
- Point landmarks - use all 3 coordinates
- Ridge features - deficient 1 coordinate
- Surface features - deficient 2 coordinates



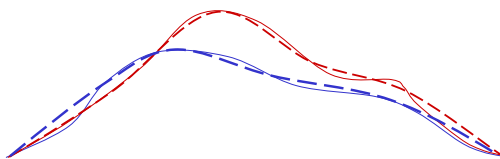
Averaging Ridges (Naive Way)

1. Scale so that landmarks superimpose
2. Compute piecewise cubic splines for each sample
3. Recut each sample into equal number of equal length pieces
4. Average the sample points
5. Fit spline curve thru sample points

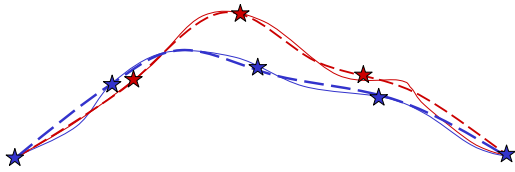
Step 1: Scale Ridges & Align Landmarks



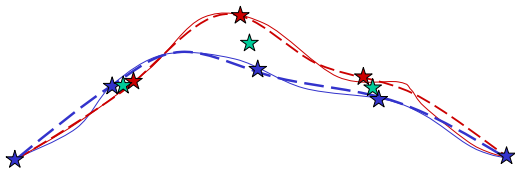
Step 2: Piecewise Splines



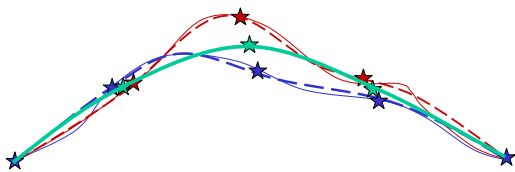
Step 3: Cut into equal length pieces



Step 4: Average the cut points



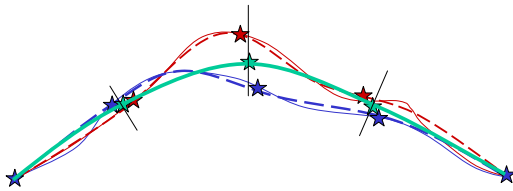
Step 5: Fit a spline



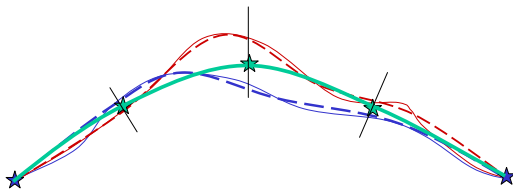
Averaging Ridges (better way)

- 1-5. As before
6. Generate planes perpendicular to the curve
7. Intersect the planes with the original sample curves
8. Average those points
9. Fit spline curve through those points

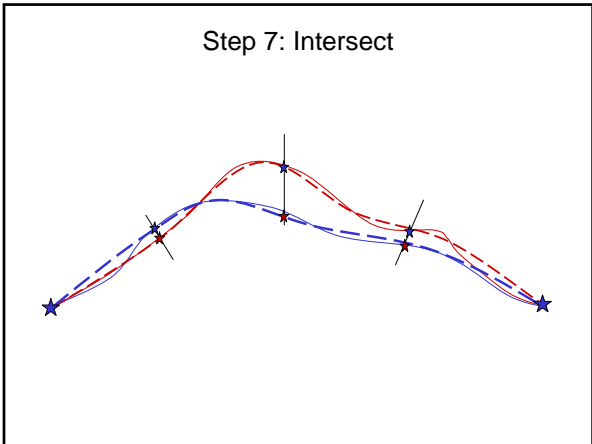
Step 6: Perpendiculars



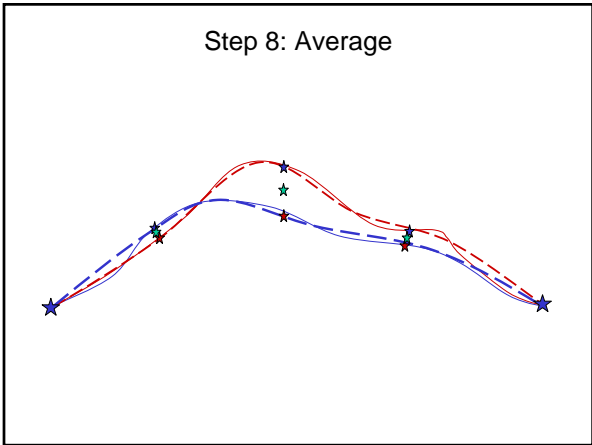
Step 6: Perpendiculars



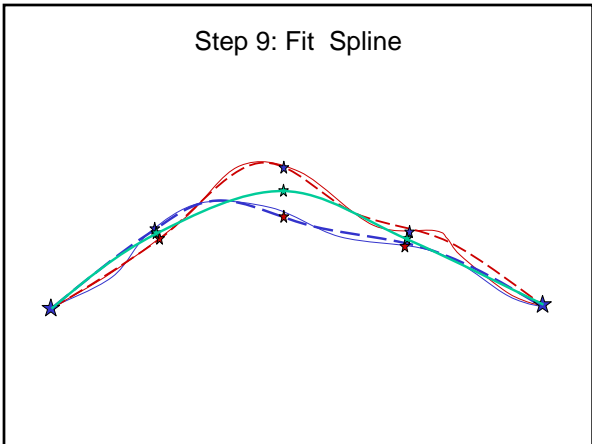
Step 7: Intersect



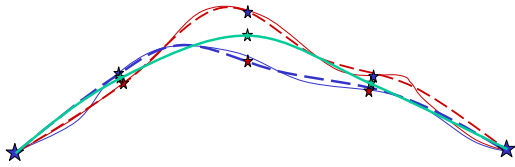
Step 8: Average



Step 9: Fit Spline



Step 9: Fit Spline



Averaging surfaces

1. Construct bilinearly blended Coon's surface from region border curves, with roughly equally spaced subdivisions, for each sample surface region.
2. Construct normal vectors to Coons surfaces for each subdivision.
3. For each sample surface, select sample points at intersections of normal vectors with sample surface.
4. Average the points from different sample sets.
5. Fit surface through these averaged points.
6. Compute surface normals and reintersect with original sample surfaces
7. Compute averages of these points
8. Use these points to regenerate surface
