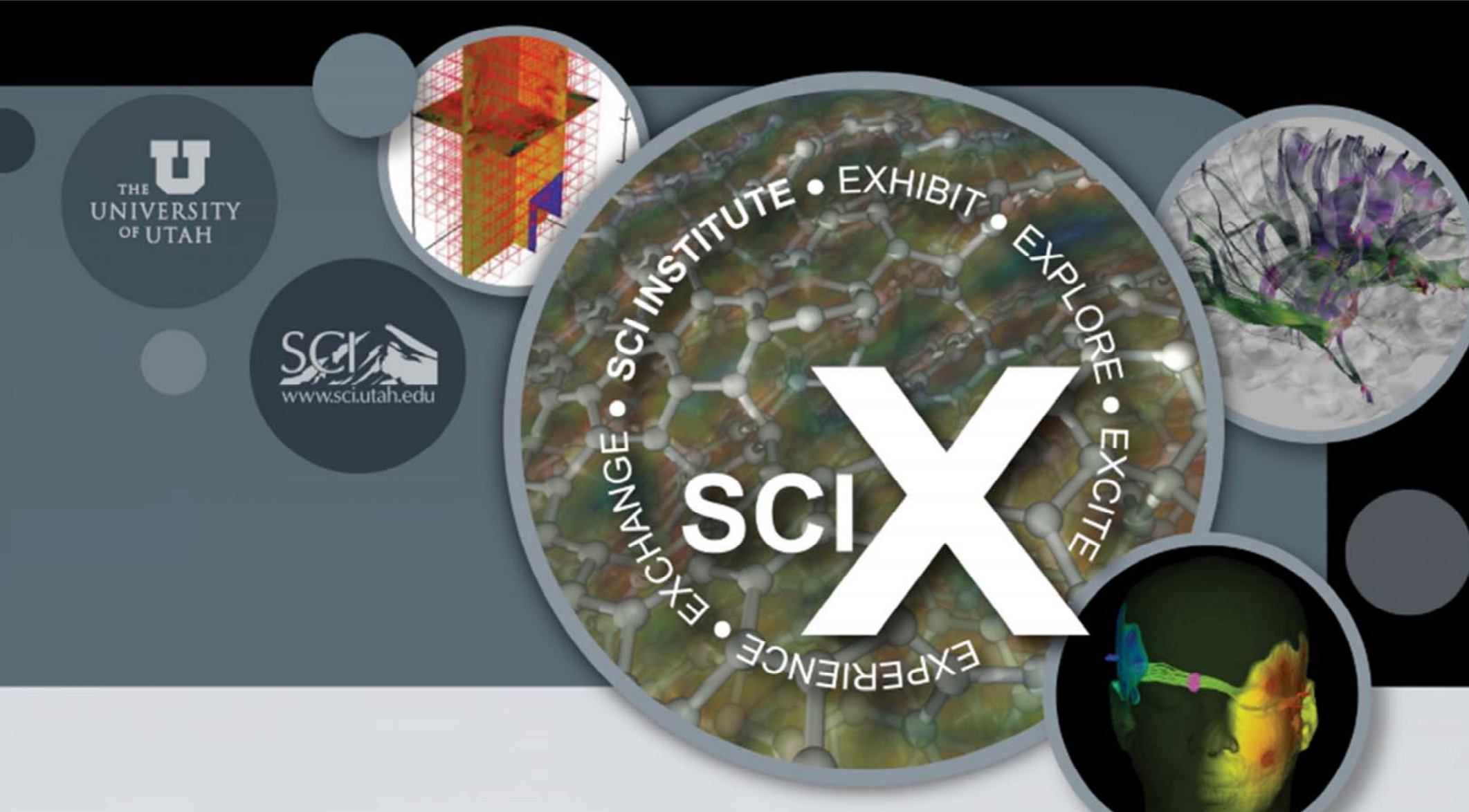# Objective Severity Metric for Craniosynostosis

Riddhish Bhalodia, Ladislav Kavan, Ross Whitaker

INTRODUCTION

Craniosynostosis is a medical condition caused by premature fusion of individual bone plates in the skull, resulting in deformed head shapes in children.
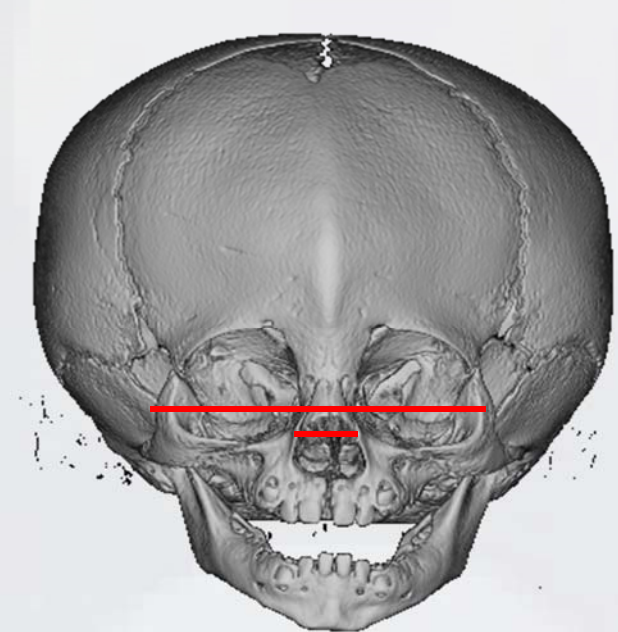

- Affects 1 in 2000 newborns
- Patients face social difficulties and increased brain pressure may cause neuro-psychiatric disorders and vision loss
- Final aim is to define a severity scale, to aid in decision for surgery which tends to be a risky procedure
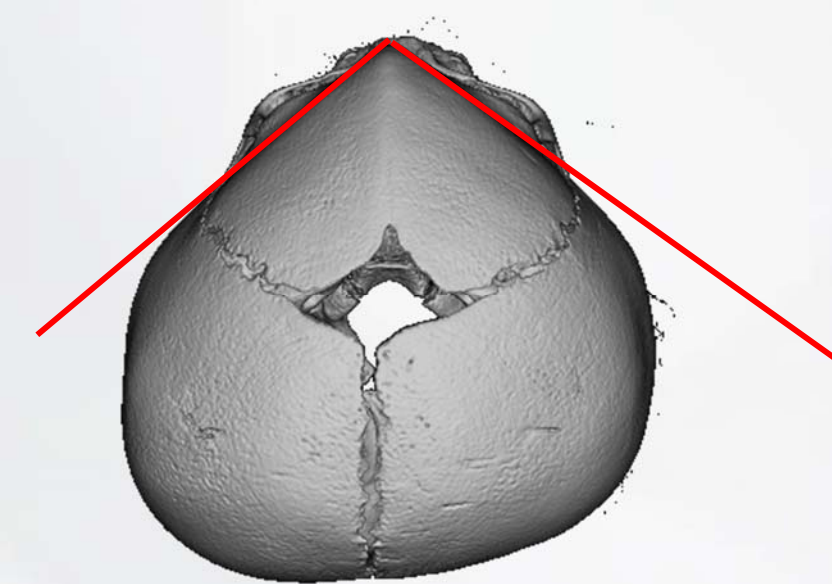
Severity Scale =   0 1 2 3 4 5

RELATED WORK

- Some geometric metrics like

(a) Bitemporal dist./ intercantal dist.   (b) Frontal angle

- Shape analysis on other applications using [1]

NORMATIVE HEAD MODEL

- To model deformities we need to understand and model normal head variation
- Hard to get CT data for normal kids, so have to work with MRI scans from PedsMRI dataset at NIH [4], with age less than a year
- Using ShapeWorks [1] to find the normative statistical skull model
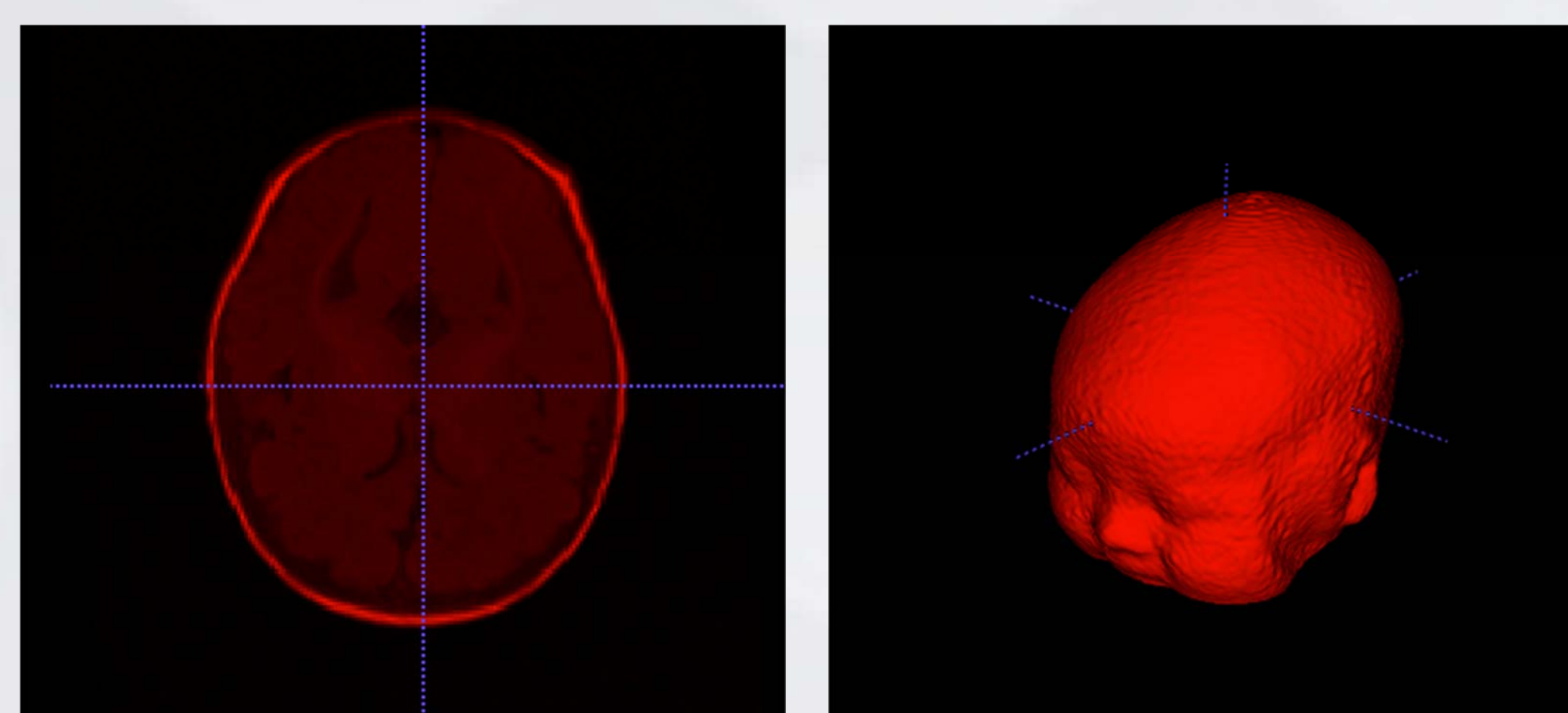
Segmented head from the MRI scan, using [3]

- Statistical analysis on the correspondence points to find normal "modes of variation"
- Capturing global and local shape variation

Segmentation → Semi-Automated grooming → Finding correspondences → Statistical analysis → Visualization
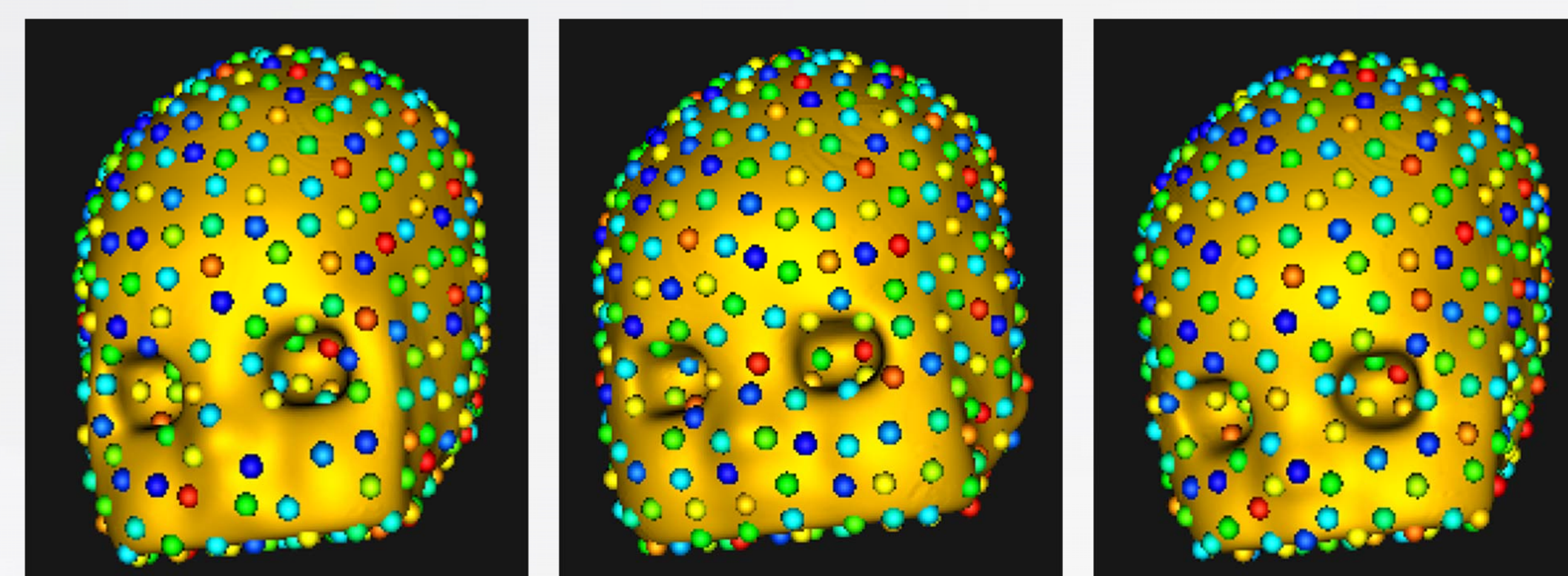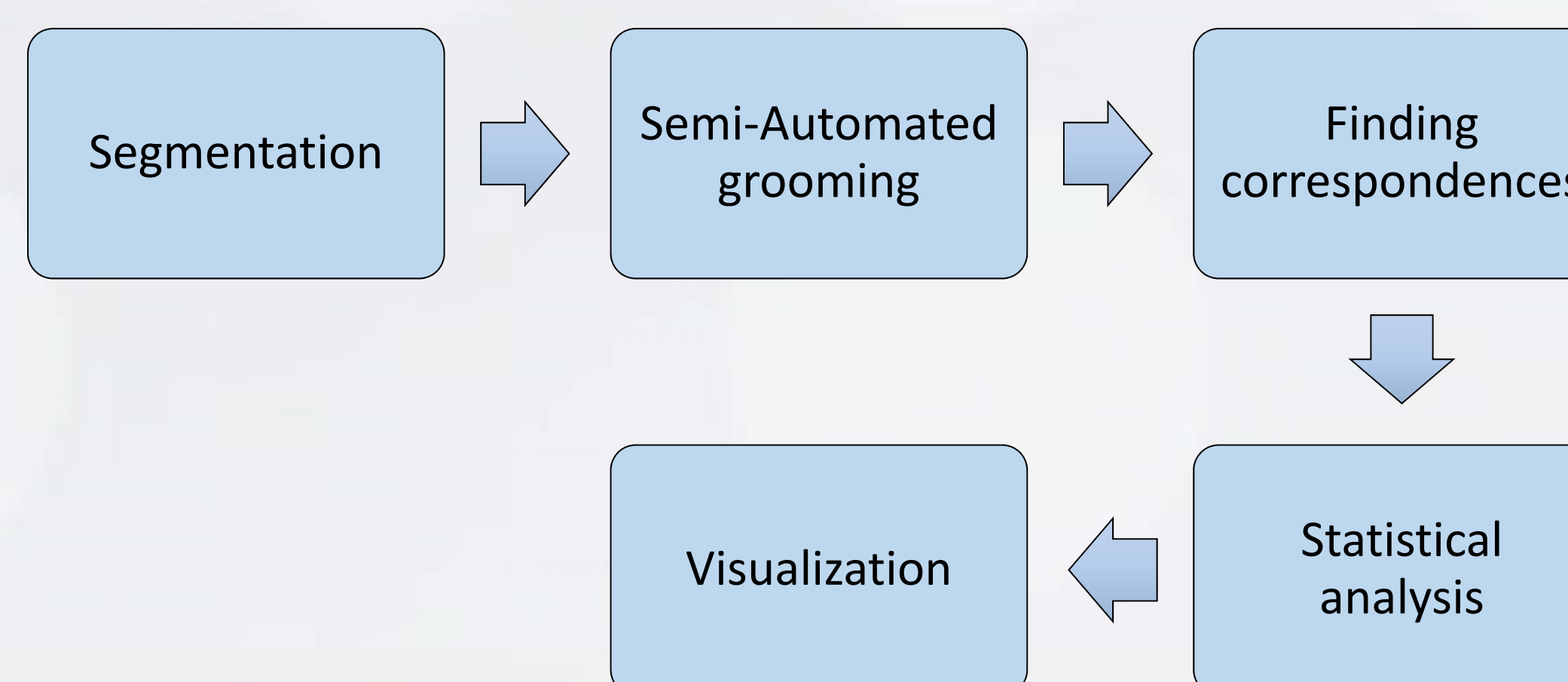
Correspondence points using ShapeWorks [1] on three different normal heads

VISUALIZATION

- Need fast mesh reconstruction from points to better visualize shape variation
- Use of biharmonic coordinates from [2]
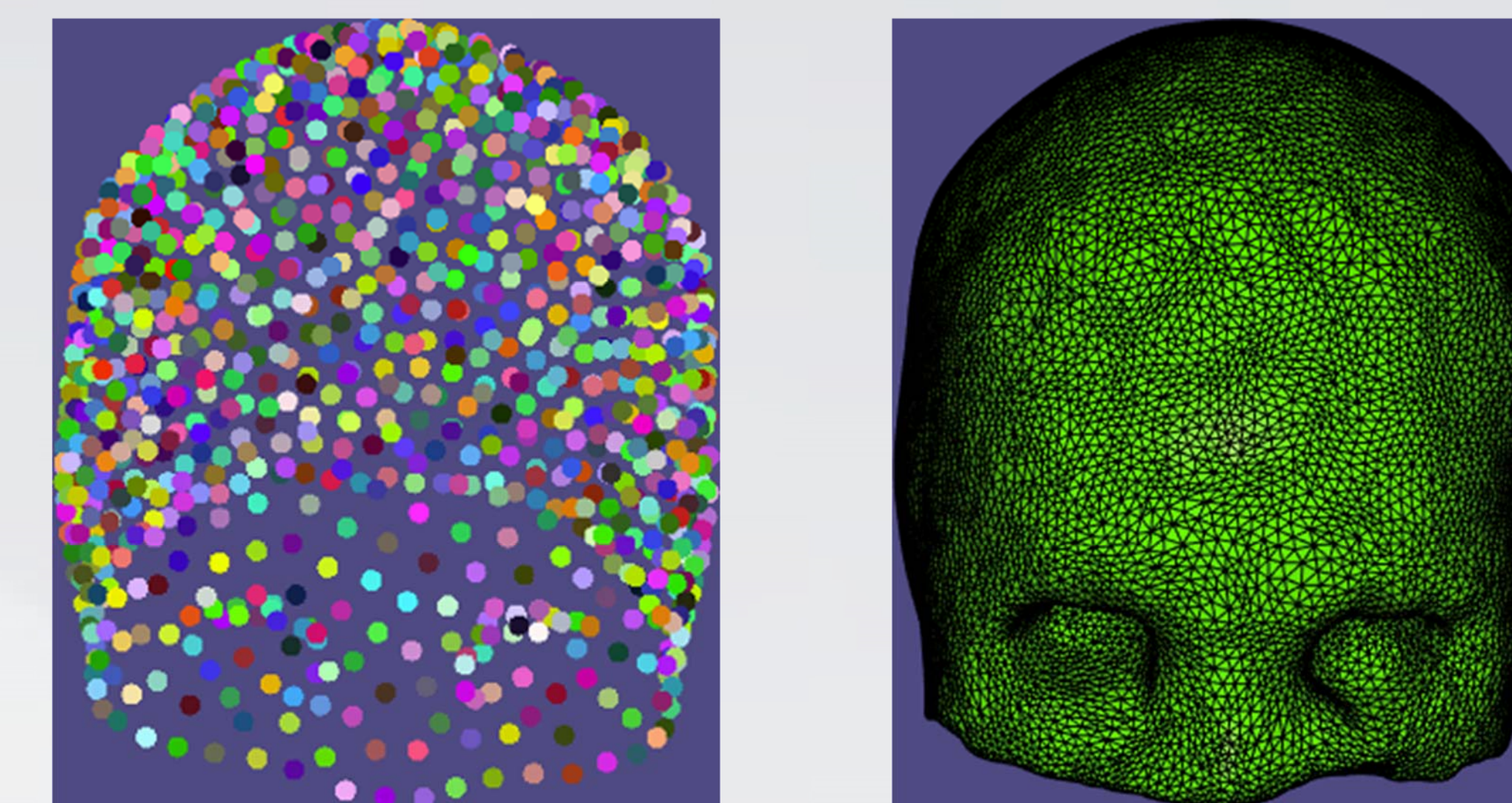
Mesh reconstruction from control points

FUTURE WORK

- Test different statistical models on the normative head model
- Compare the pathological cases with the normative head model and analyze variation
- Form a statistical distance metric of the severity scale for craniosynostosis

COLLOBORATORS

- Jesse Goldstein - Children's hospital of Pittsburgh
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[1]: J. Cates, P.T. Fletcher, M. Styner, H. Hazlett, R.T. Whitaker. **Particle-Based Shape Analysis of Multi-Object Complexes** *MICCAI 2008*
[2]: Yu Wang, Alec Jacobson, Jernej Barbic, Ladislav Kavan. **Linear Subspace Design for Real-Time Shape Deformation**. *SIGGRAPH 2015*
[3]: T. F. Chan, L. A. Vase **Active Contours Without Edges,** *Transactions on Image Processing 2001*
[4]: National Institutes of Health. **The MRI Study of Normal Brain Development**. 2004. http://www.bic.mni.mcgill.ca/nihpd/info.