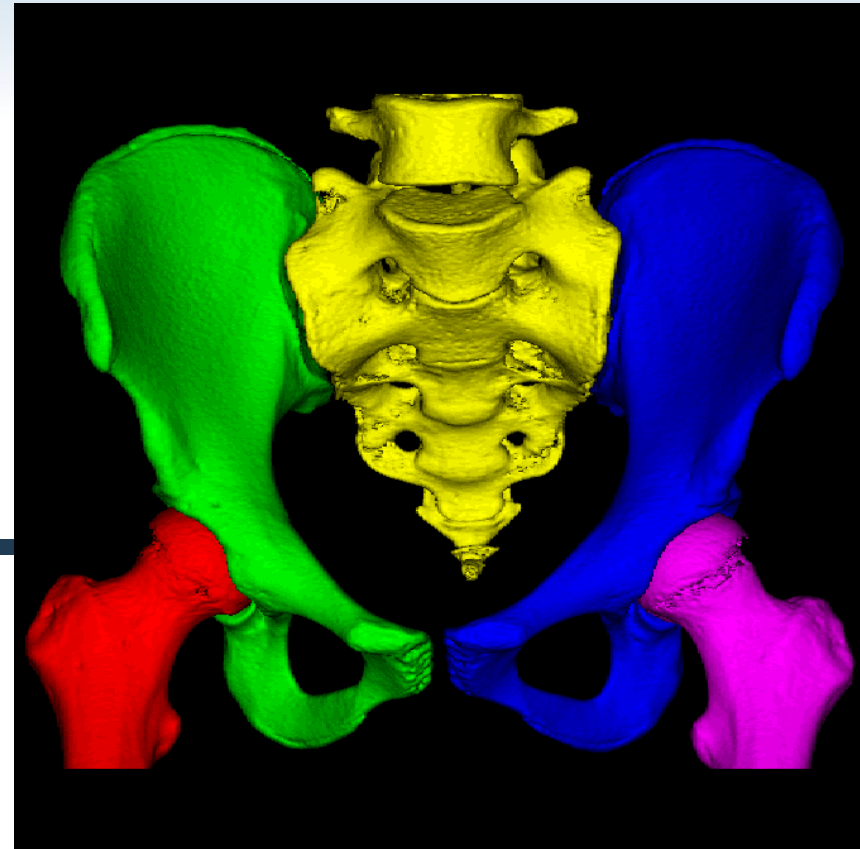


Analyze Webinar – September 29, 2011

Bone Segmentation and Surface Generation

Michael Philcock
Application Specialist
AnalyzeDirect

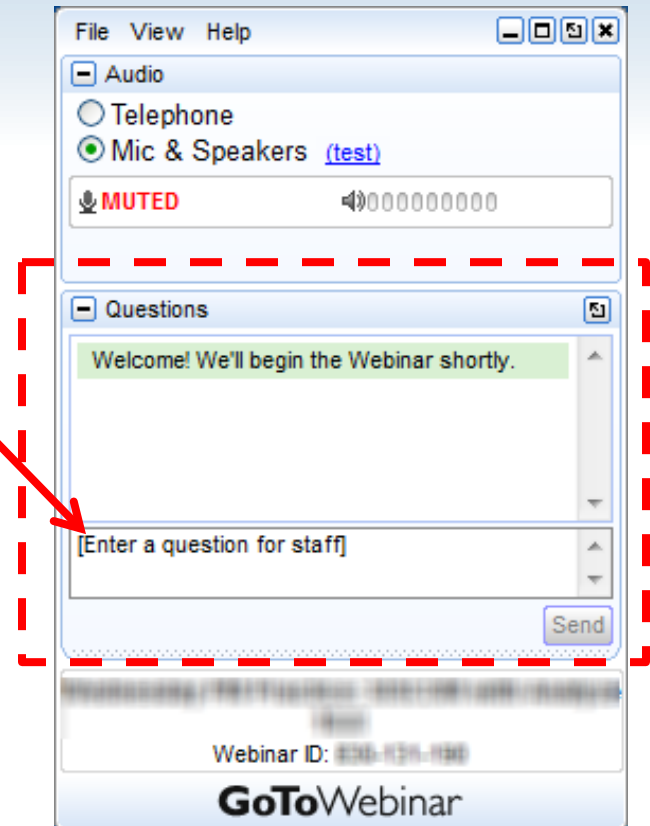


Webinar Agenda

- ◆ Estimated Duration: 40 minutes
- ◆ Webinar Agenda:
 - Demonstrate how to use Analyze to transform data from the voxel-based volume image domain to the geometric surface-based domain
 - Questions & Answers
- ◆ Webinar Objectives:
 - Introduction to bone segmentation techniques for CT and MRI
 - Demonstrate how Surface Extractor can be used for surface generation and export

Webinar Notes

- ◆ Questions during the Webinar
 - Use “Questions” pane of your GoToWebinar control panel
- ◆ After the Webinar
 - Webinar registrants will receive an email from Analyze Webinars that contains a link to the recording tomorrow



Surface Generation

- ◆ Uses for surface generation
 - Finite Element Analysis (FEA)
 - Computational Fluid Dynamics (CFD)
 - Surgical Simulation
 - Rapid prototyping
 - Plus many more!

Surface Generation Process

1. Segmentation and/or region labeling of voxel data

- Explicit Segmentation (outside Surface Extractor)
 - Object Maps
 - Binary Images
- Thresholding (within Surface Extractor)

2. Determination of object surface in voxel space

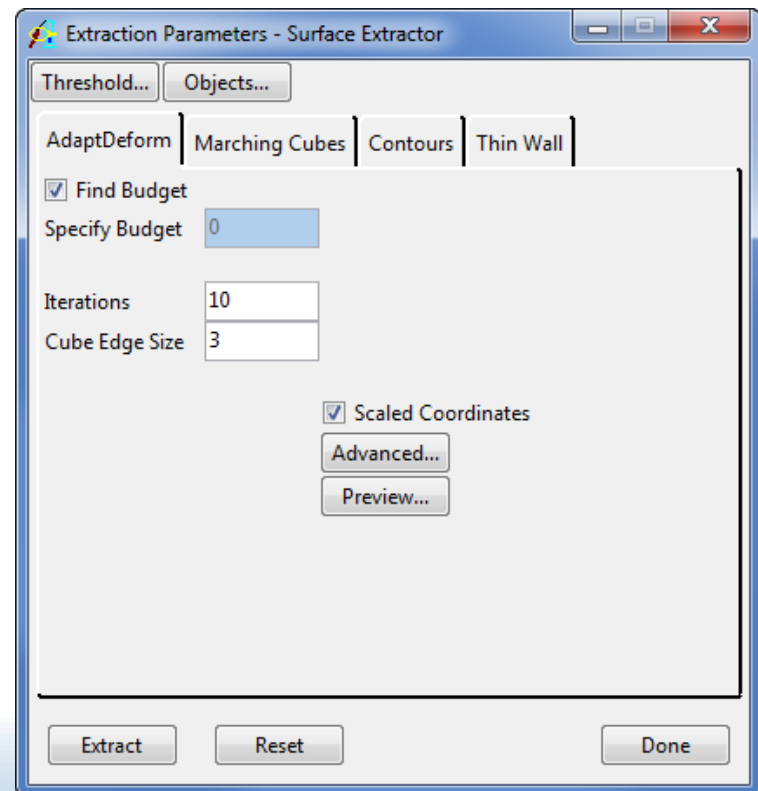
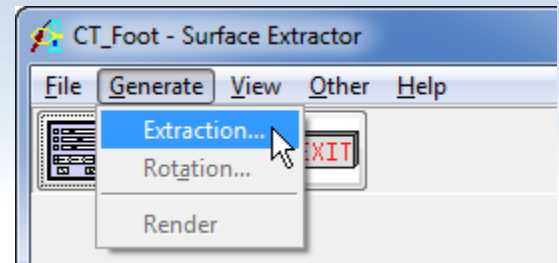
3. Feature/topology extraction

4. Surface Generation

- Polygons
- Contours

Extraction Algorithms

- ◆ **Generate > Extract**
- ◆ Available extraction algorithms:
 - Adapt/Deform
 - Marching Cubes
 - Contours
 - Thin Wall



Extraction Algorithms

- ◆ **Adaptive Deformation algorithm**

- Developed by BIR at Mayo Clinic
- Based on work of Algorri and Schmitt¹
- Generates a set of polygons for surface using deformable modeling process

¹ M. Algorri and F. Schmitt, "Reconstructing the surface of unstructured 3D data," SPIE Proceedings Vol. 2431, Medical Imaging 1995: Image Display.

- ◆ **Marching Cubes algorithm**

- Taken from Lorensen and Cline²
- General purpose
- Generates a set of polygons for surface
- Can generate unlimited number of polygons (not necessarily optimal)

² Lorensen, W. E. and Cline, H. E., "Marching cubes: a high resolution 3D surface construction algorithm", Computer Graphics, 21(4), 1987.

Extraction Algorithms

- ◆ **Contours algorithm**

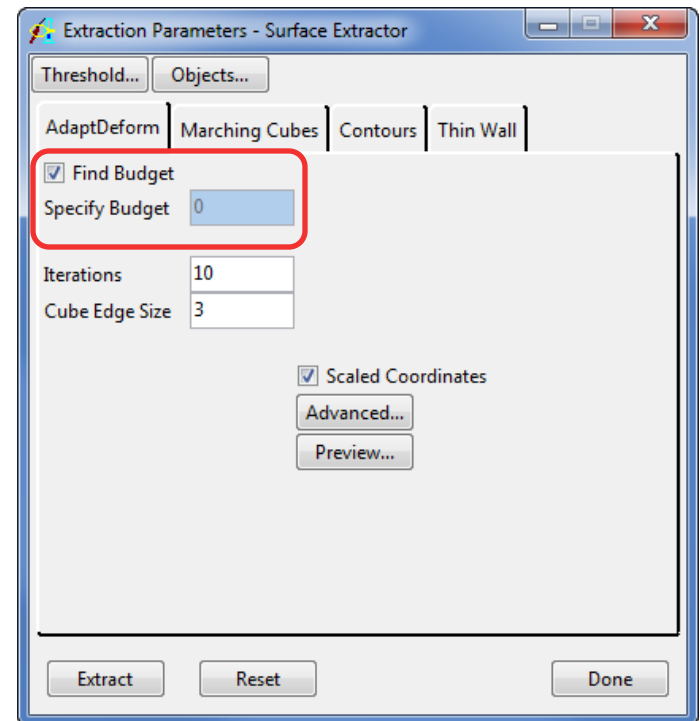
- Generates a stack of planar contours for surface
- Useful for rapid prototyping

- ◆ **Thin wall algorithm**

- Generates a set of polygons for surface
- Generates an inner surface and an estimate of the outer surface
- Useful for generating surfaces for use in CFD

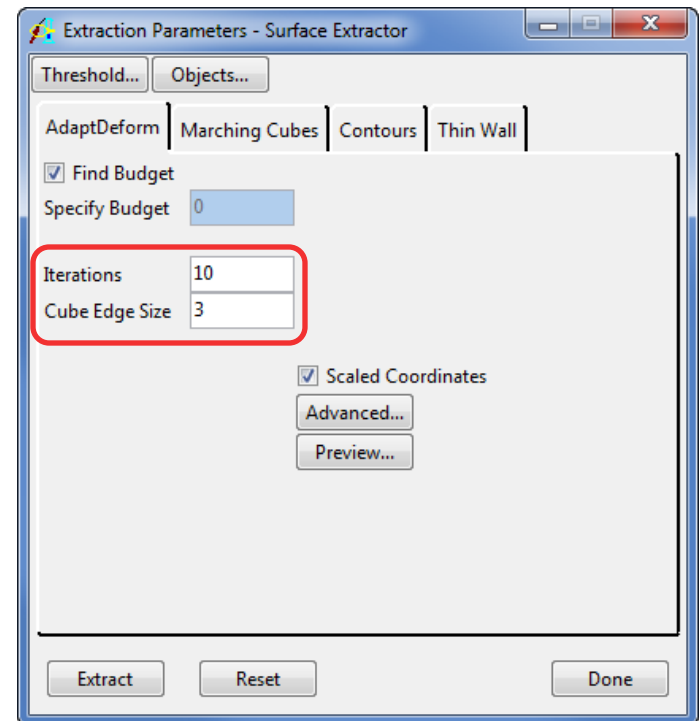
Surface Extractor: Adapt/Deform

- ◆ **Adapt/Deform parameters:**
 - Polygonal Budget
 - Find Budget: Algorithm determines optimal number of polygons for surface (default)
 - Specify Budget: Algorithm generates surface using no more than this number of polygons



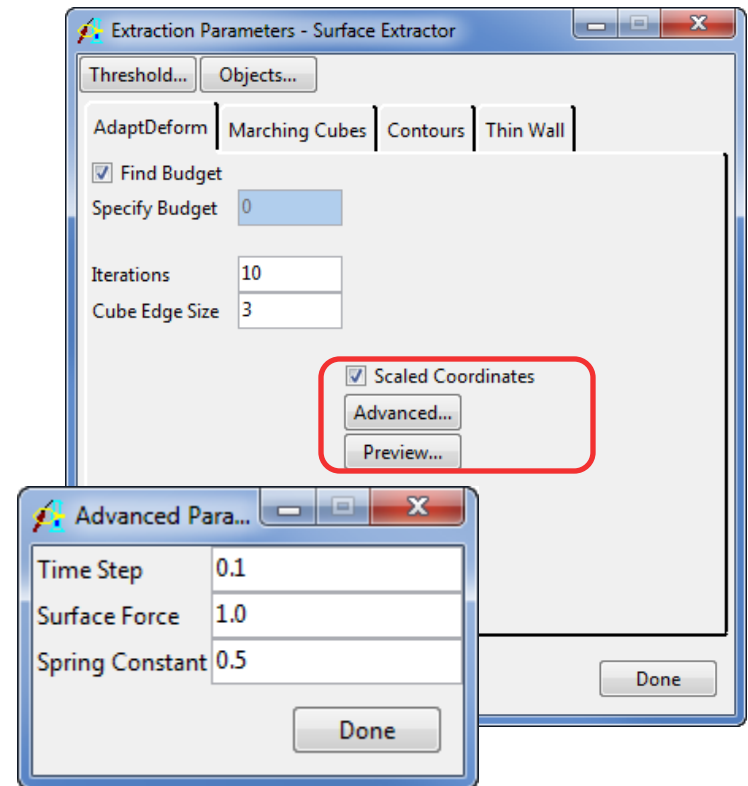
Surface Extractor: Adapt/Deform

- ◆ **Adapt/Deform parameters:**
 - Iterations
 - Number of iterations in deformation process
 - If ratio of object voxels to volume voxels is small, number of iterations should be greater than 10
 - Cube Edge Size
 - Determines resolution of resultant surface
 - A smaller Cube Edge Size will generate a higher resolution surface (more polygons)
 - If data is noisy, or has a large number of thin protuberances, increase Cube Edge Size



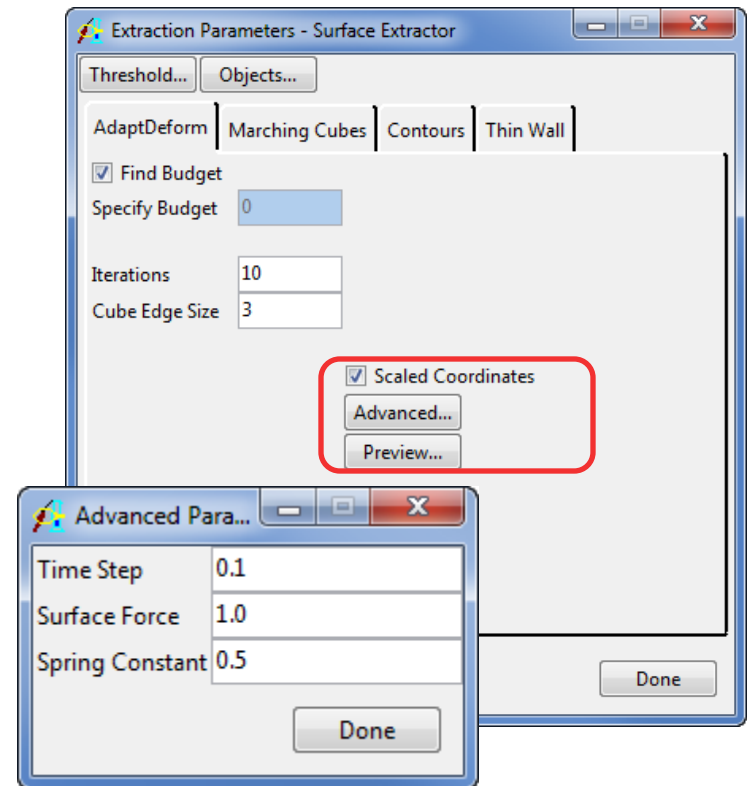
Surface Extractor: Adapt/Deform

- ◆ **Adapt/Deform parameters:**
 - Scaled Coordinates
 - If data is anisotropic, this will scale the surface coordinates back into real-world space
 - Advanced parameters
 - Time Step - Controls the speed of the deformation process, impacting the number of iterations required to produce final surface
 - Surface Force - Controls how well the surface conforms to changes in surface curvature
 - Spring Constant - Controls how well the surface lies across flat areas



Surface Extractor: Adapt/Deform

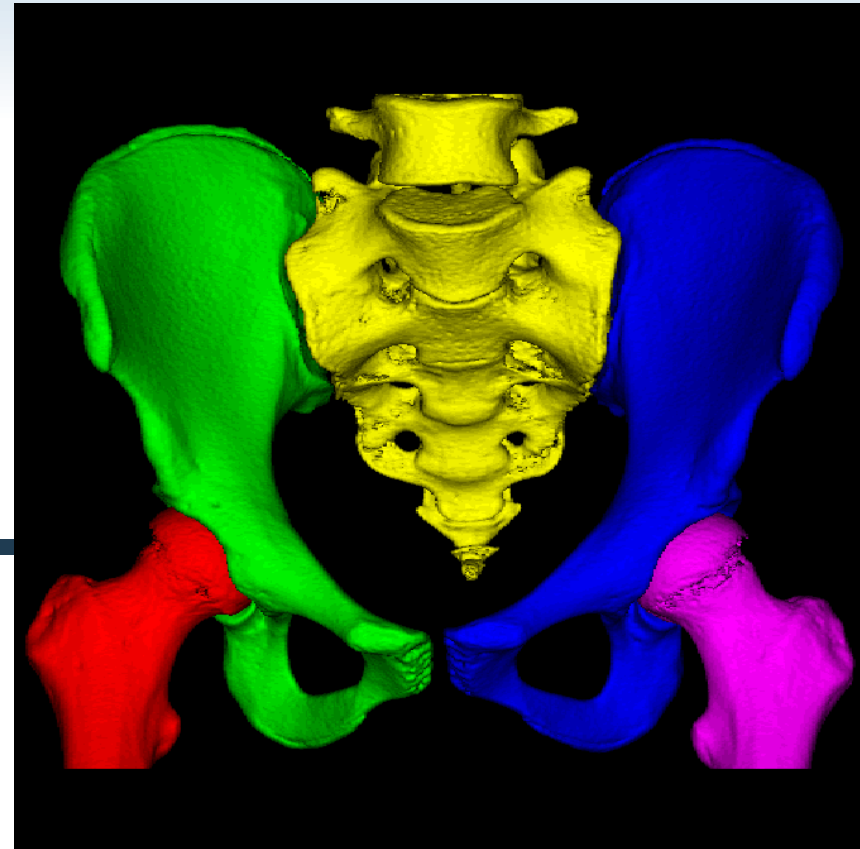
- ◆ **To produce a smoother surface:**
 - Increase Time Step
 - Fewer iterations in deformation process results in less detail
 - Decrease Surface Force
 - Polygons won't be pulled into small crevices
 - Increase Spring Constant
 - Surface will bridge small creases and crevices in surface



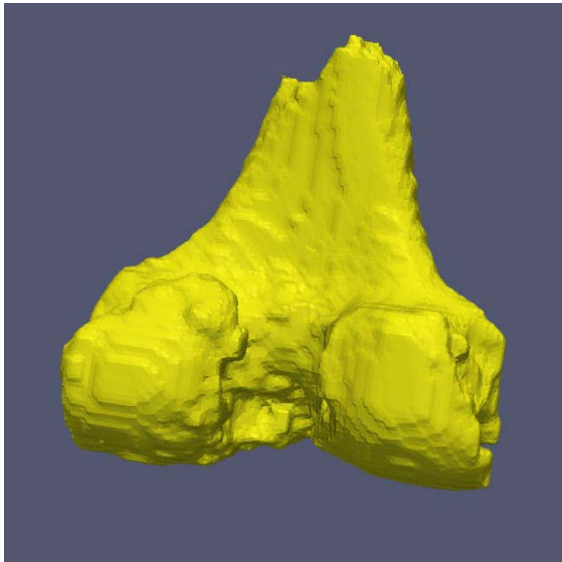
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Bone Segmentation and Surface Generation

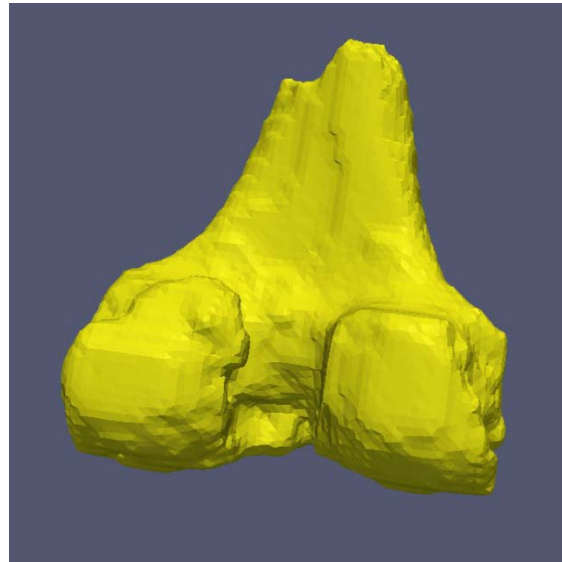
Demonstration



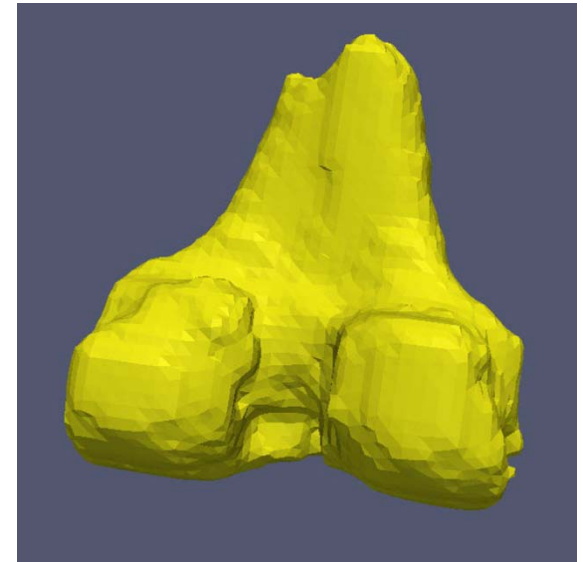
Surface Extractor: Cube Edge Size



Cube Edge Size 3



Cube Edge Size 5



Cube Edge Size 7

→
Smoother Surface

Supported Surfaces

- ◆ Supported file formats for **polygonal** surfaces

File Format	File Extension
Alias Wavefront	.obj
Autocad	.dxf
IGES	.iges
Compressed IGES	.iges
SGI Open Inventor*	.iv
Patran	.out
PLY	.ply
SGI Poly	.poly
3D Systems Stereolithography	.stl
Binary 3D Systems Stereolithography	.stl
VRML*	.wrl

Supported Surfaces

- ◆ Supported file formats for **contour** surfaces

File Format	File Extension
ASCII Columns	.txt
IGES	.iges
Compressed IGES	.iges
HP 3D	.hppl
3D Systems	.pogo
3D Systems	.slc

Questions?

Summary

- ◆ Watch for an email from Analyze Webinars tomorrow
- ◆ Find out about upgrade pricing - sales@analyzedirect.com
- ◆ Evaluate Analyze 10.0 free for 30 days- www.analyzedirect.com/evaluate
- ◆ Suggest a topic for a future Webinar - webinars@analyzedirect.com
- ◆ Contact me: **Michael Philcock**
michael@analyzedirect.com
1 (913) 653-8303