Image-Based Anatomical Modeling

Part I

Summary

Part I – Fundamentals on IBAM

- ❑ Definition of Image-Based Modeling
- ❑ Applications
- ❑ Types of volume data sets.
- ❑ 3D medical image visualization
- ❑ Image segmentation
- ❑ Mesh processing and adjustment techniques

Part II – Tutorial on IBAM

- ❑ Software Pipeline
- ❑ 3D Modeling class

Objectives

A – Understand what IBAM really is

B – Why 3D anatomical models are important

C – Reveal the stages of 3D modeling from images

D – Able to use a freeware/opensource pipeline

Image-Based Modeling

Creating a 3D model from a set of views

Why is a view so important?

Image-Based Modeling

GEOMETRY

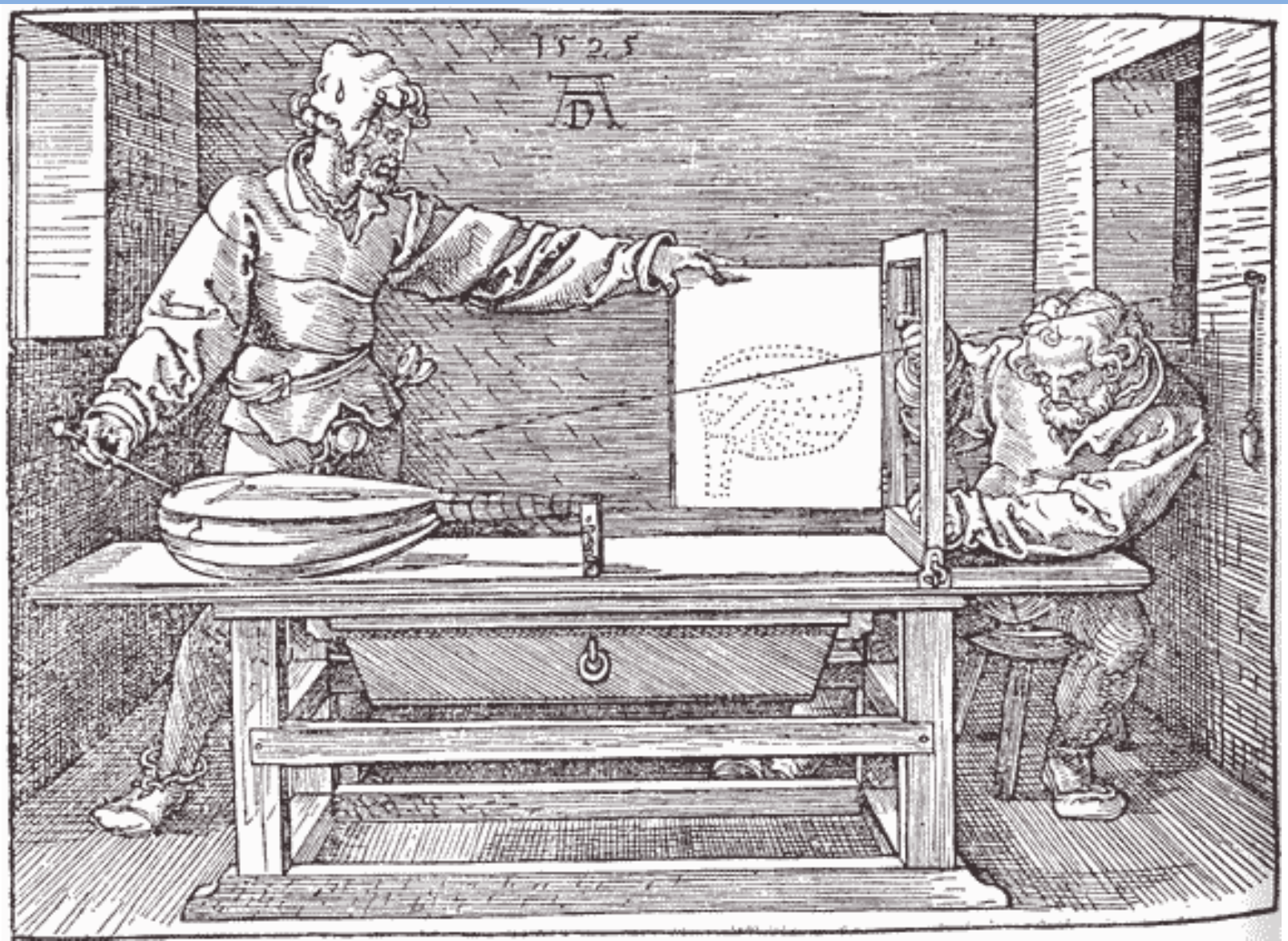


Image-Based Modeling

TOPOLOGY

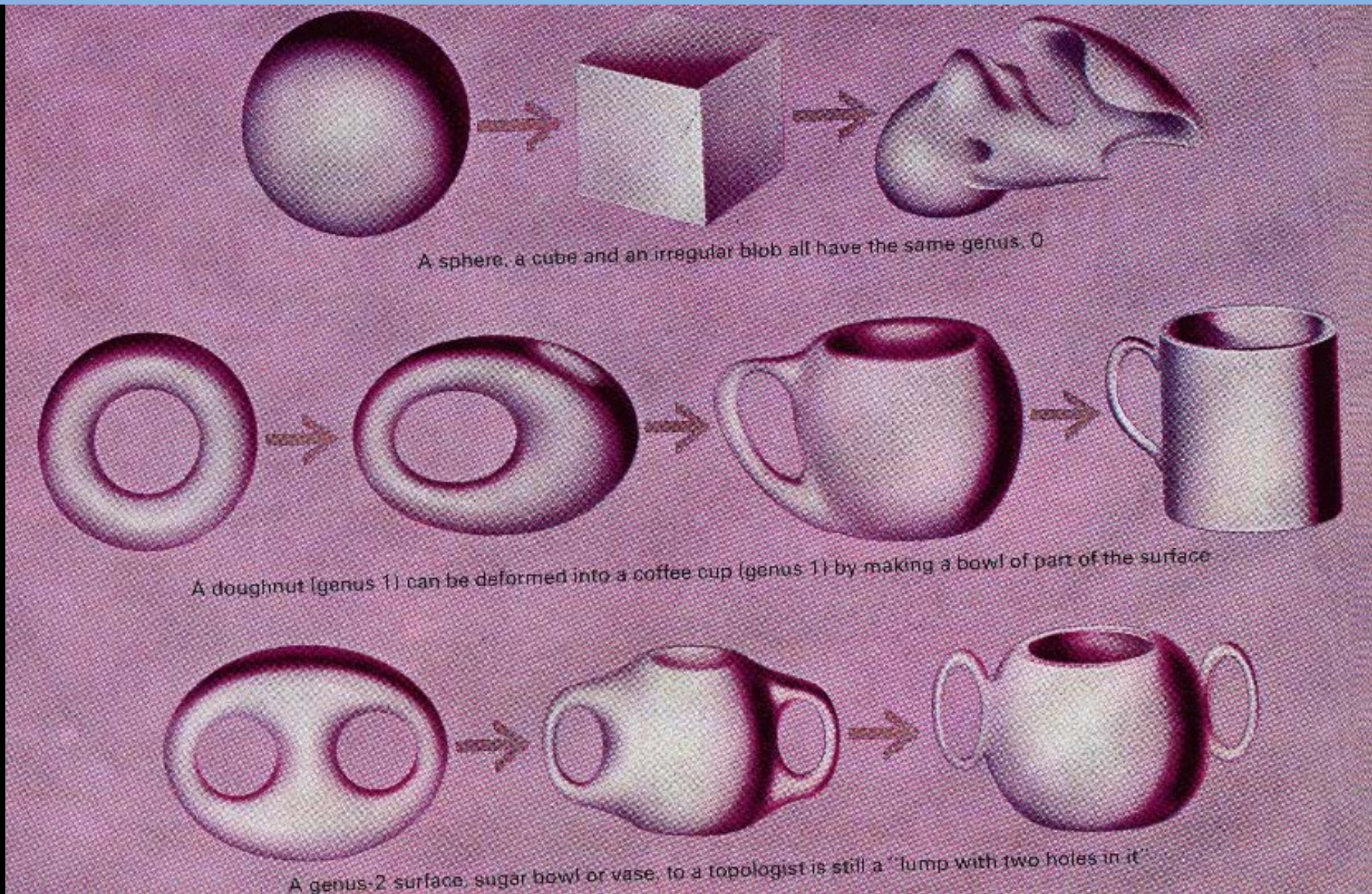


Image-Based Modeling

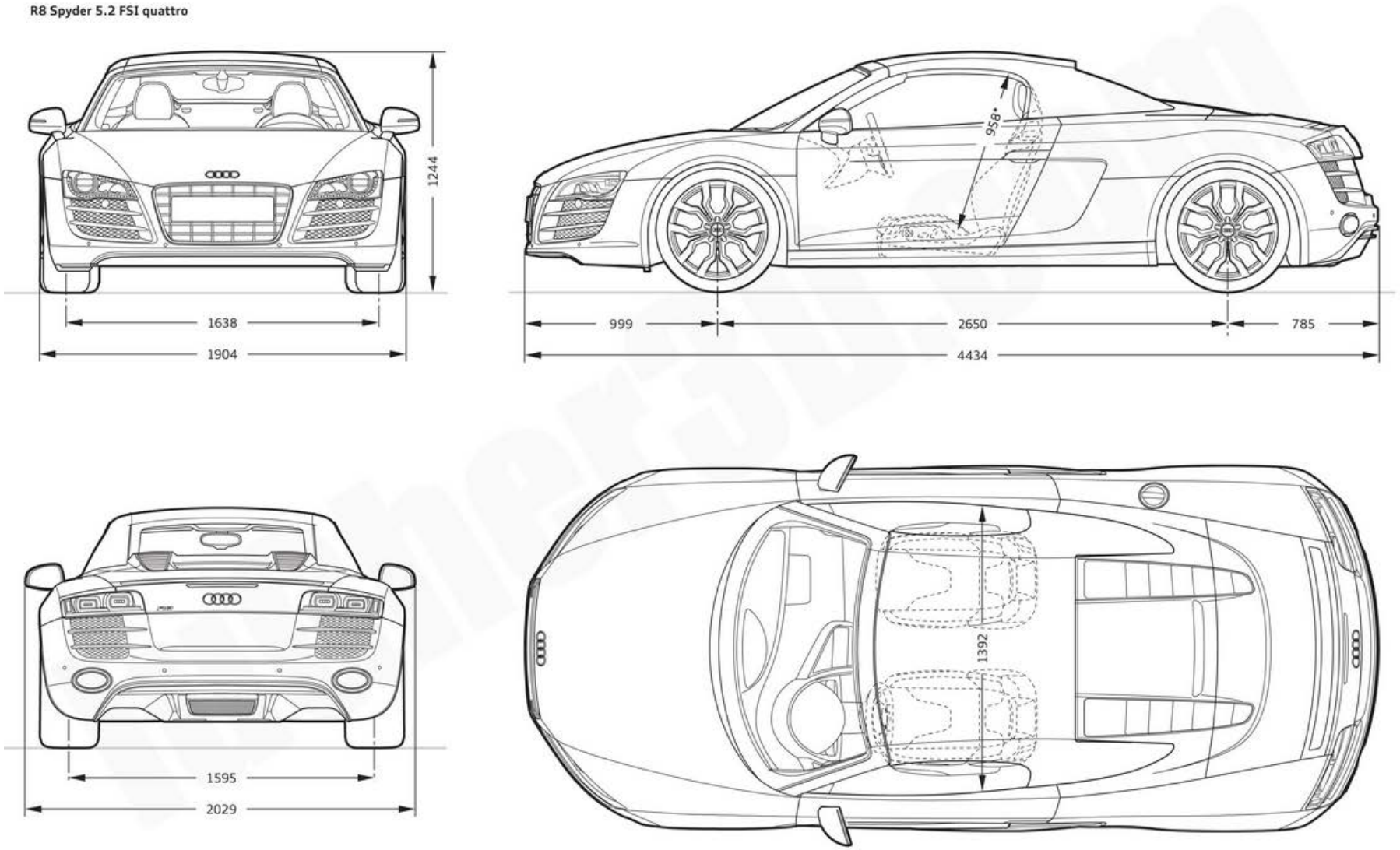
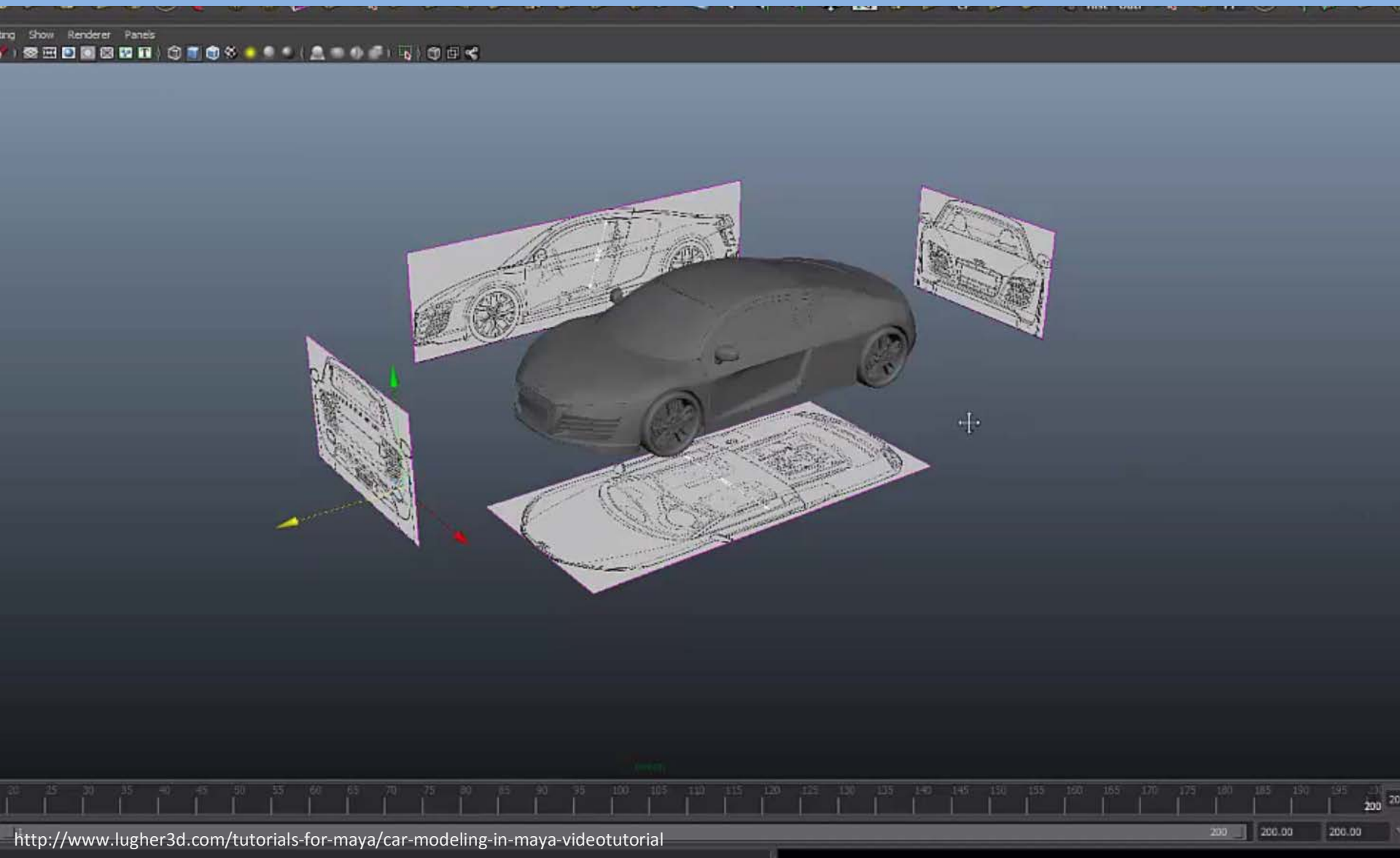
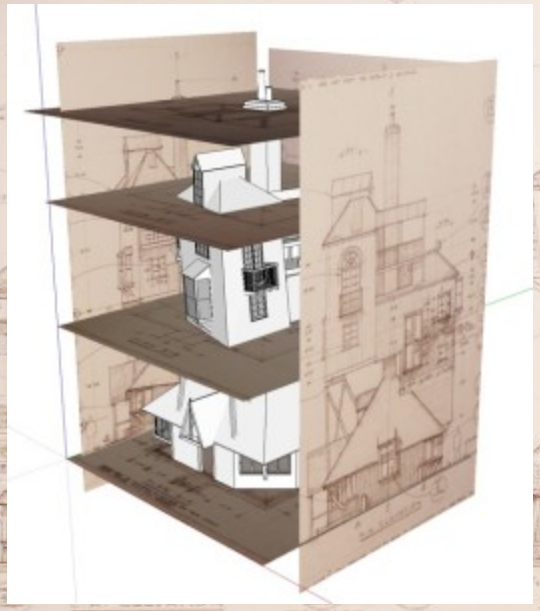


Image-Based Modeling



http://www.lugher3d.com/tutorials-for-maya/car-modeling-in-maya-videotutorial

Image-Based Modeling



http://mastersketchup.com/sketchup-modeling-from-plans-and-elevations/

Image-Based Modeling

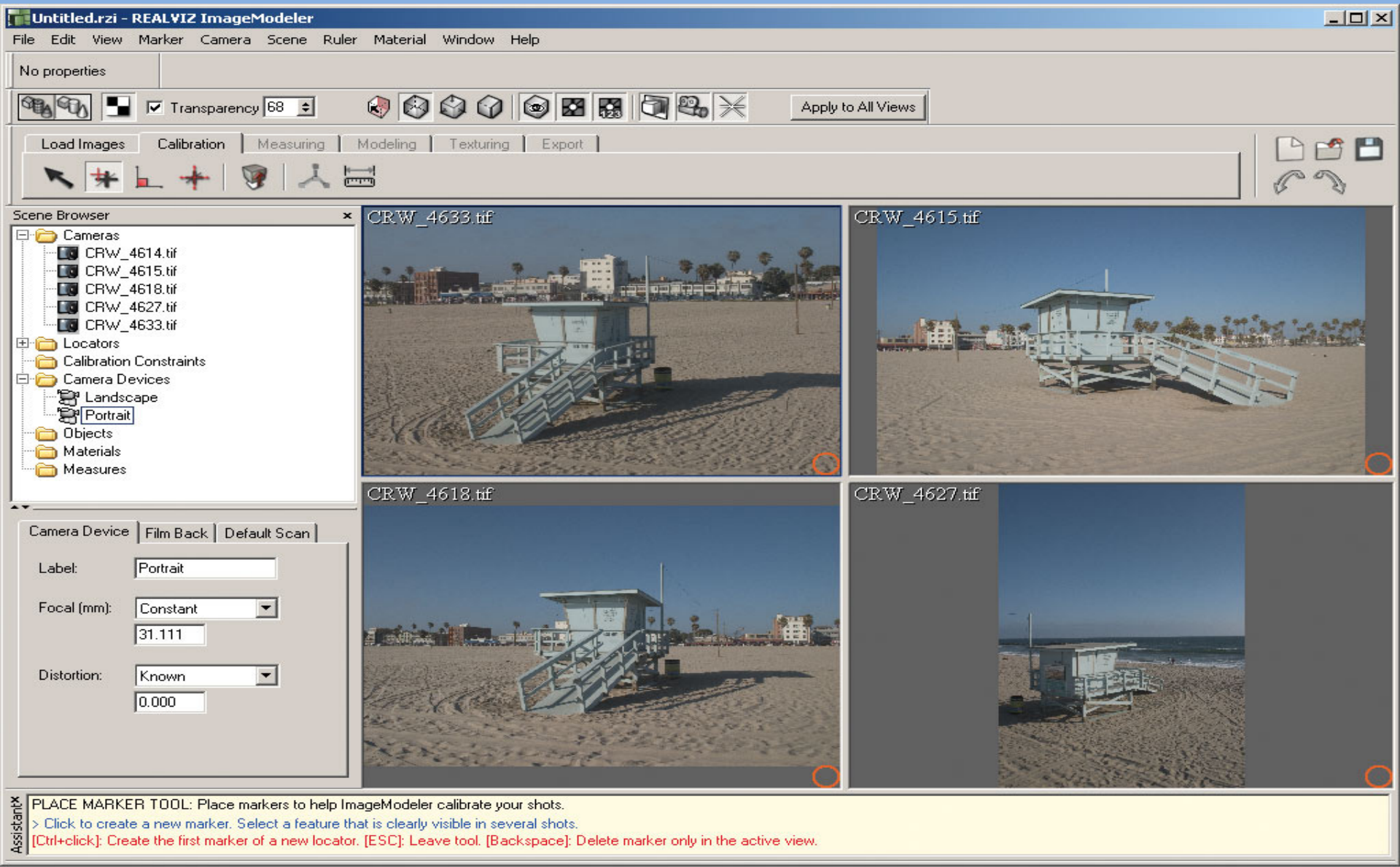
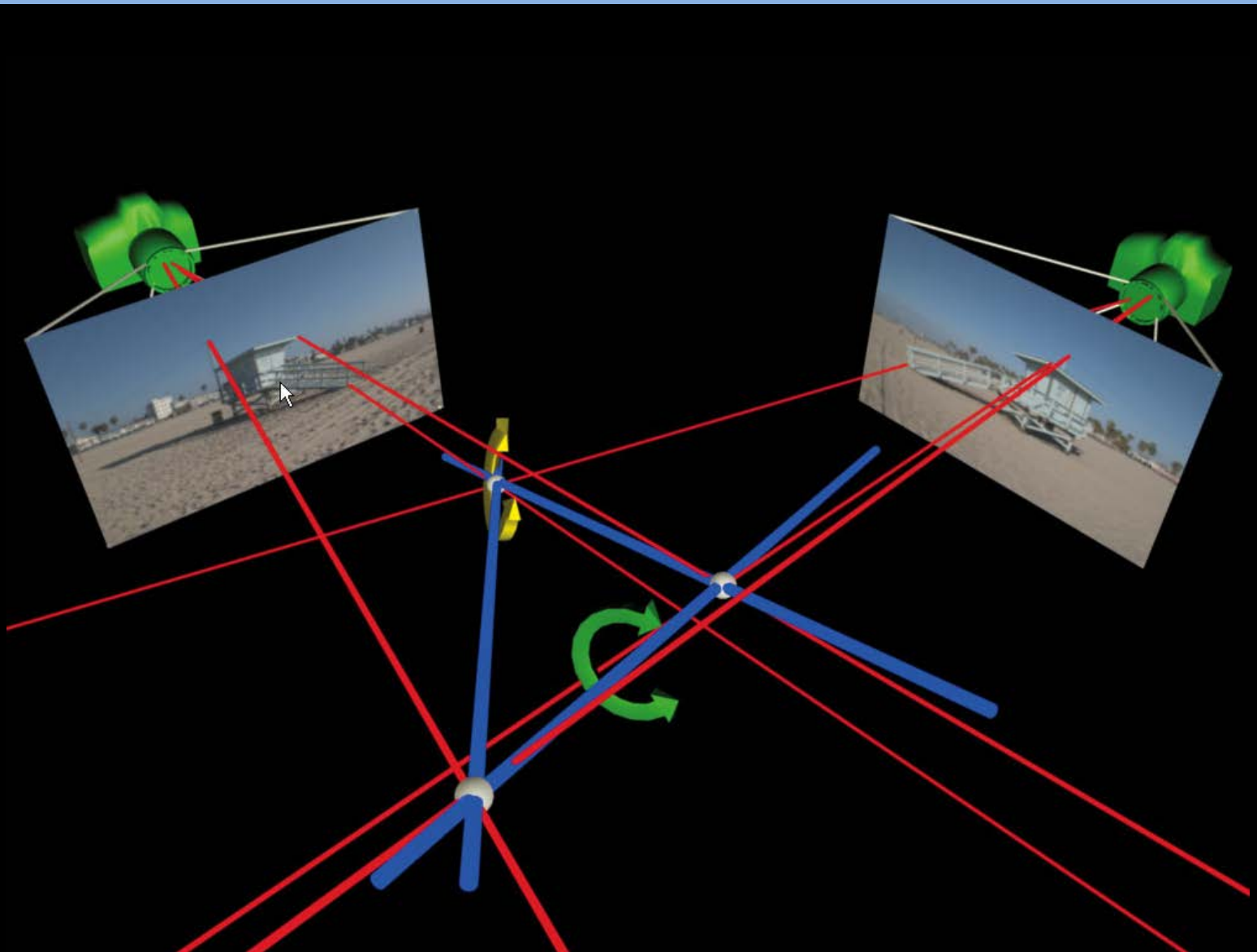


Image-Based Modeling



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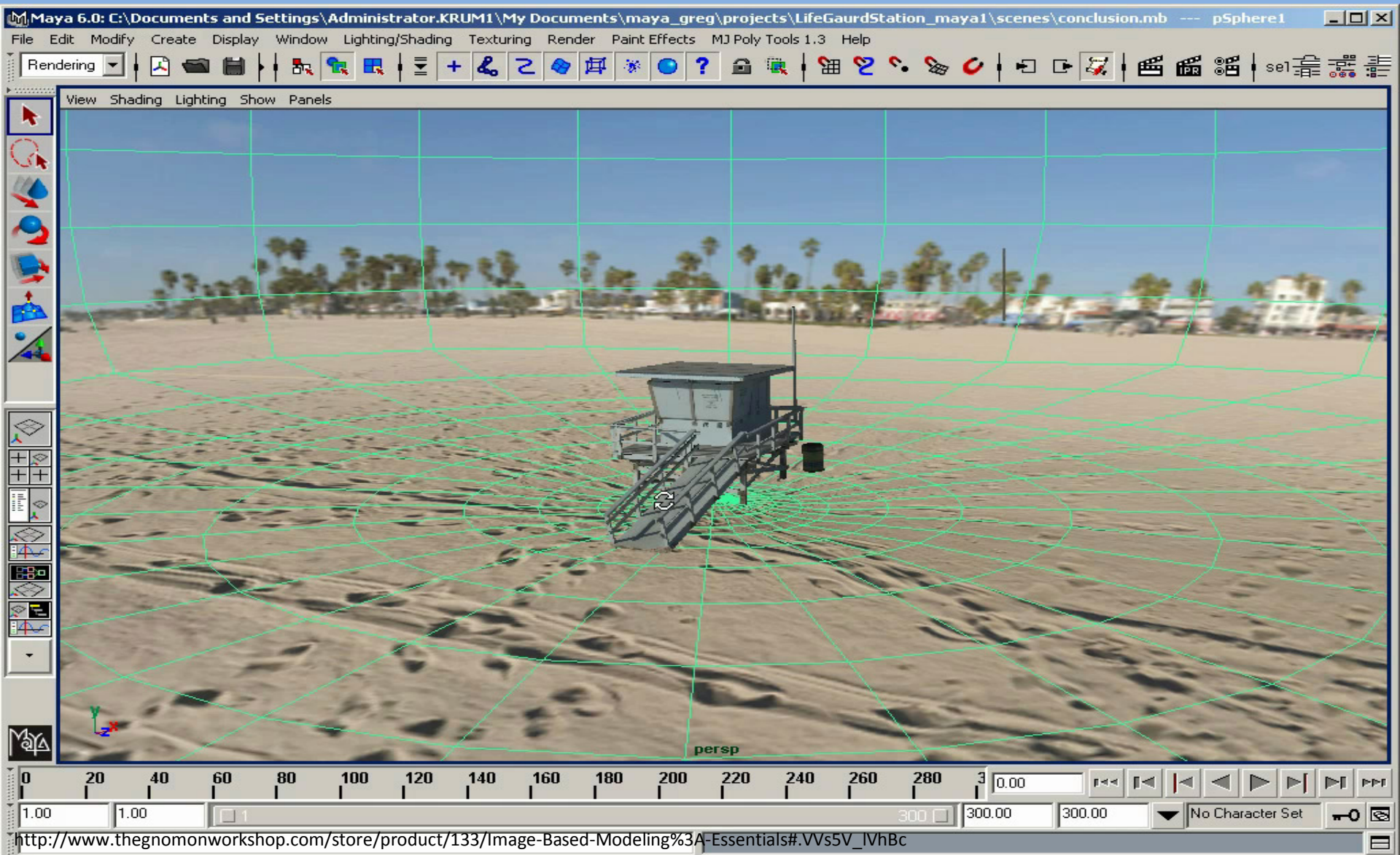
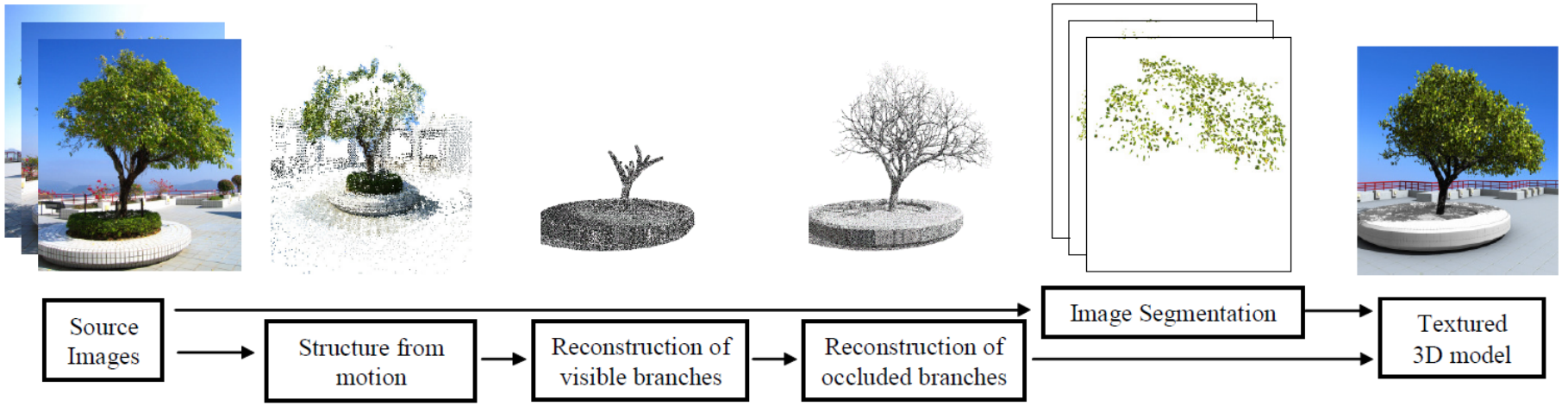


http://www.thegnomonworkshop.com/store/product/133/Image-Based-Modeling%3A-Essentials#.VVs5V_lVhBc

Image-Based Modeling

Image-Based Modeling



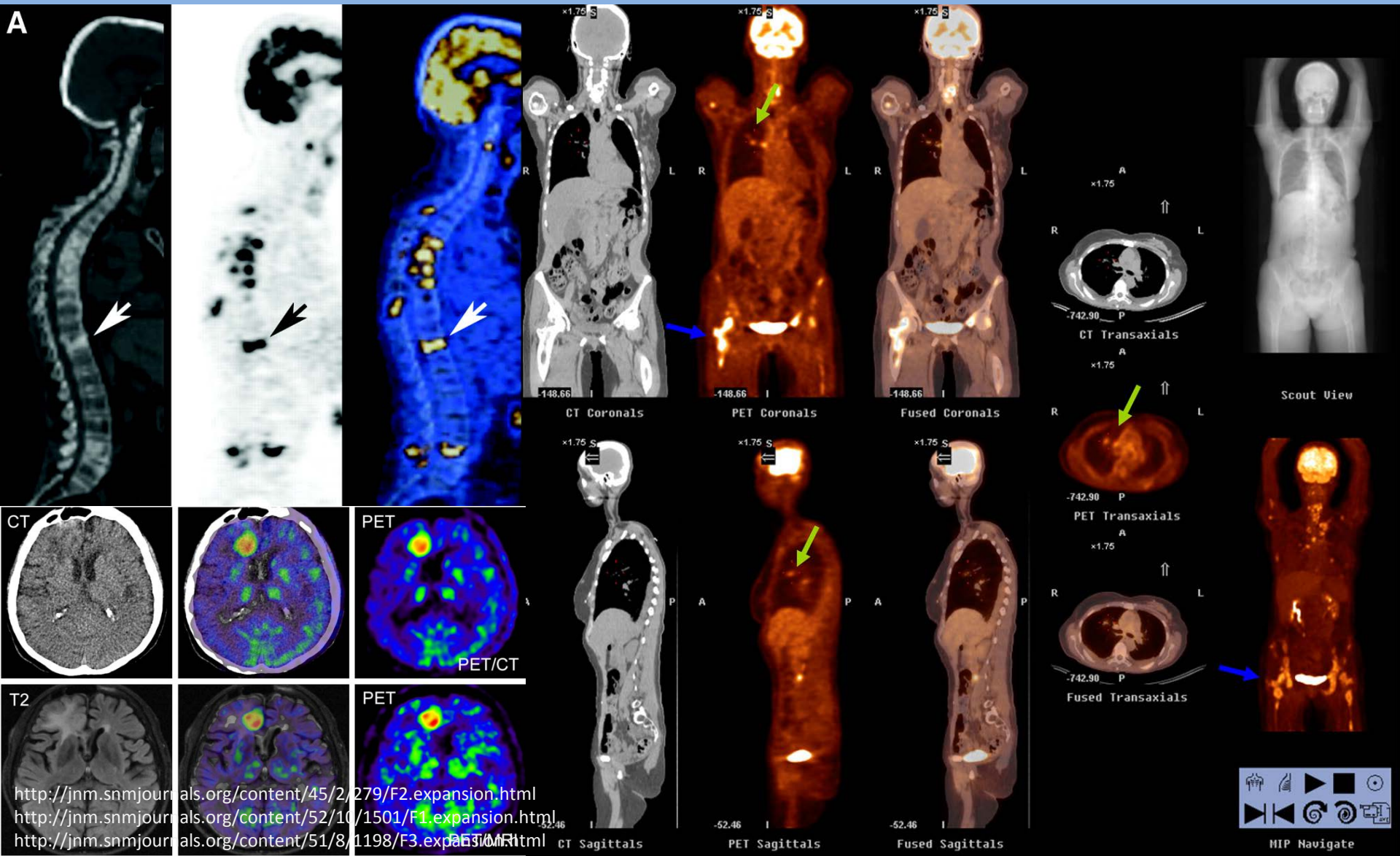
"Image-based Tree Modeling, " Ping Tan, Gang Zeng, Jingdong Wang, Sing Bing Kang, Long Quan, ACM Transactions on Graphics 26(3) (Proc. SIGGRAPH 2007)

Image-Based Anatomical Modeling

Creating anatomical models from a stack of medical images

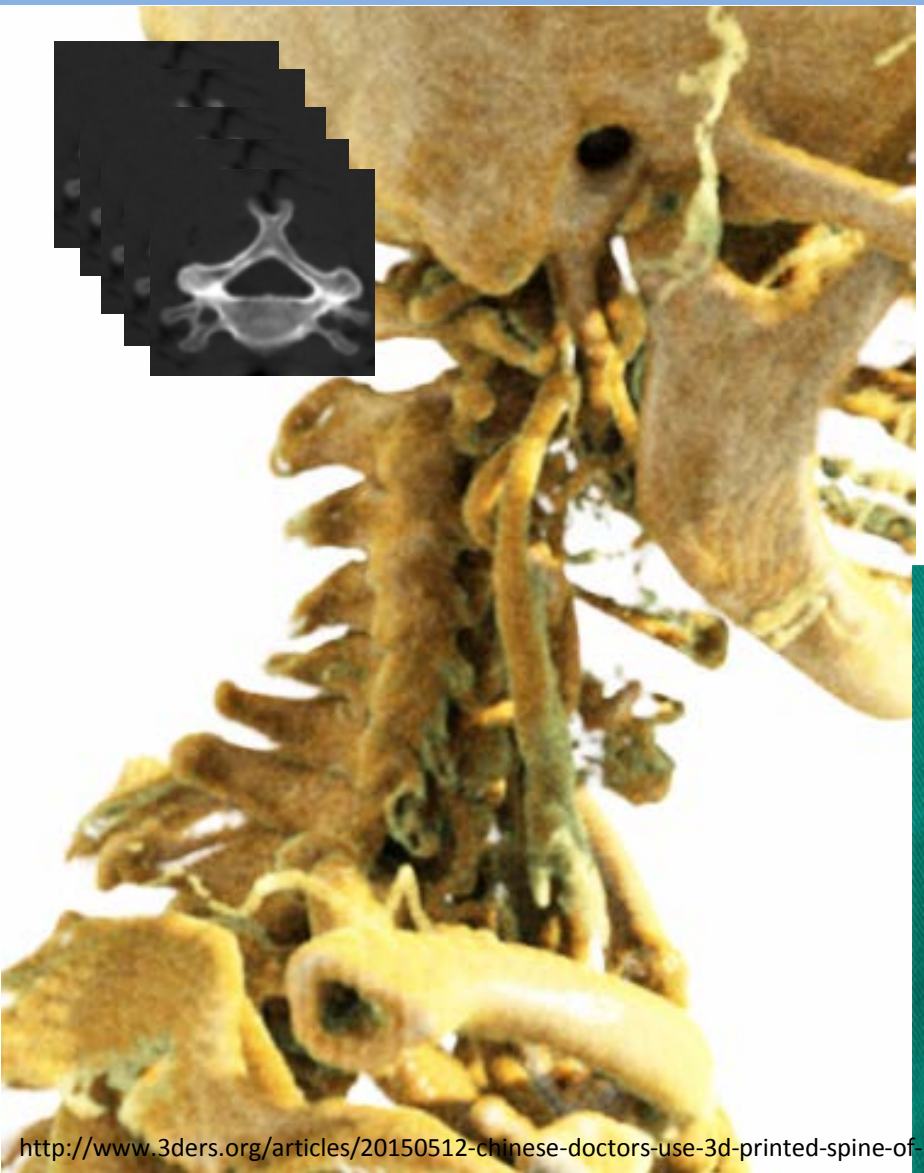
Why is a medical image so important?

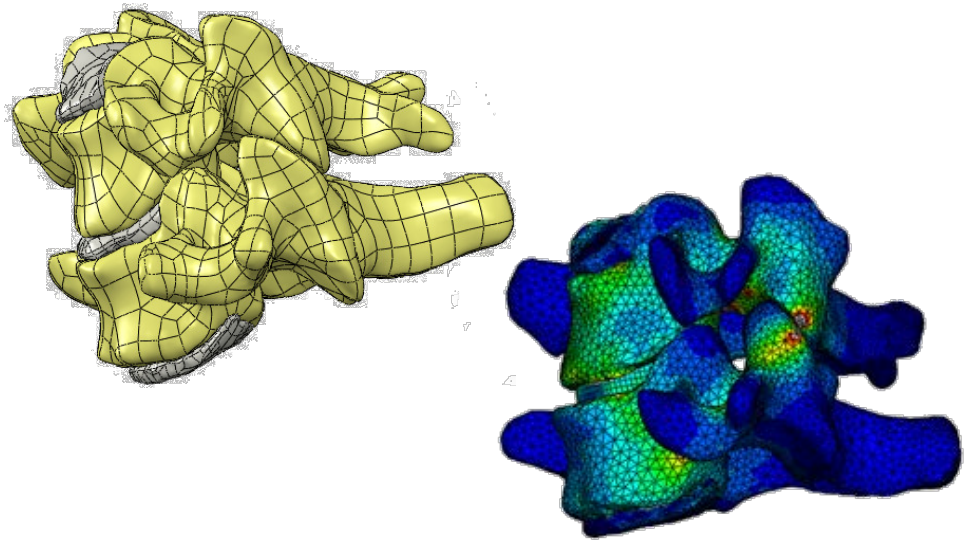
Image-Based Anatomical Modeling



http://jnm.snmjournals.org/content/45/2/279/F2.expansion.html
http://jnm.snmjournals.org/content/52/10/1501/F1.expansion.html
http://jnm.snmjournals.org/content/51/8/1198/F3.expansion.html

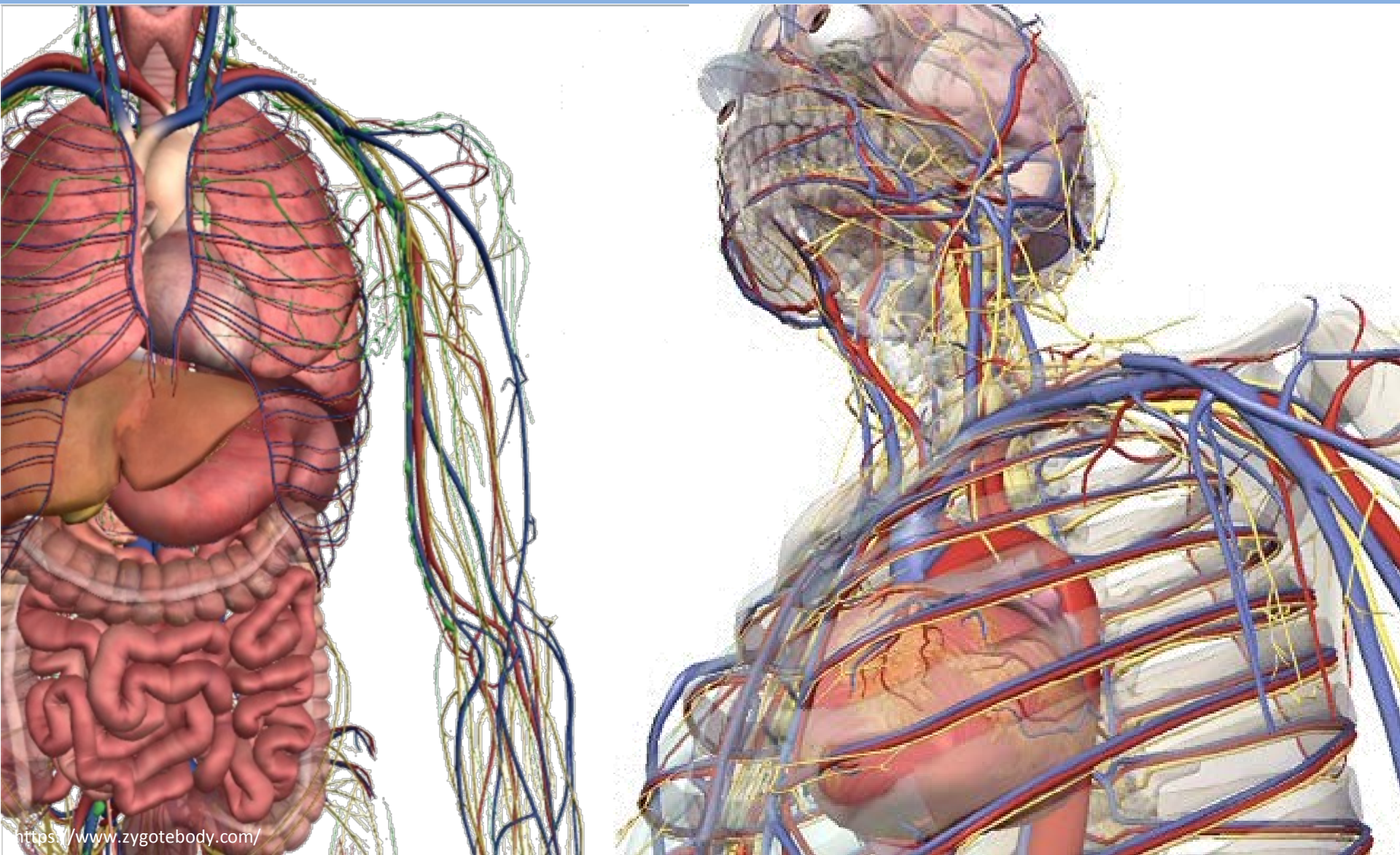
Anatomical Models





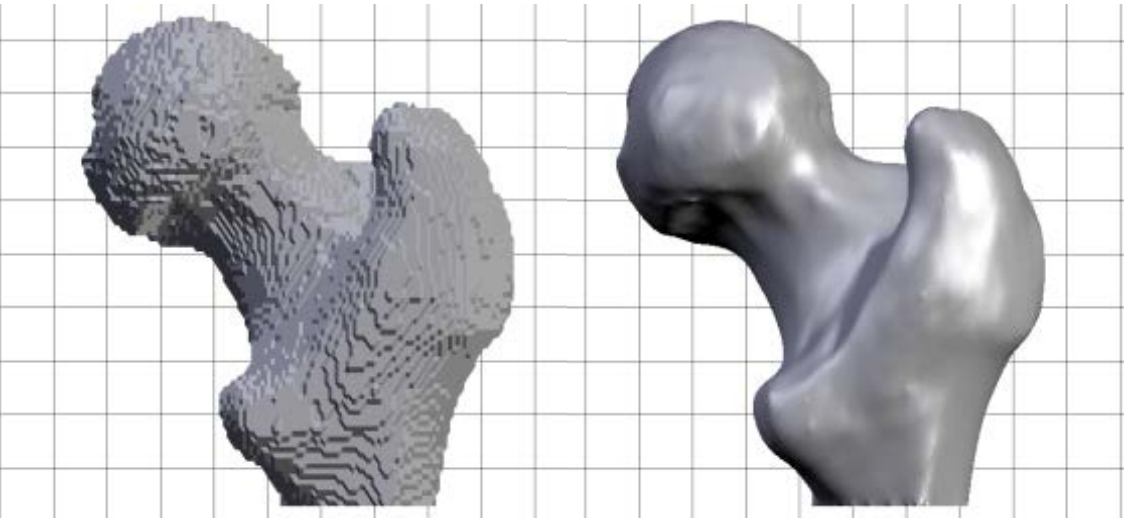
http://www.3ders.org/articles/20150512-chinese-doctors-use-3d-printed-spine-of-patient-to-help-in-delicate-spinal-surgery.html

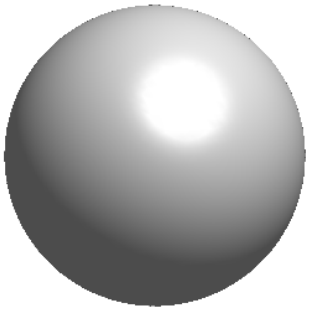
Applications



https://www.zygotebody.com/

Applications





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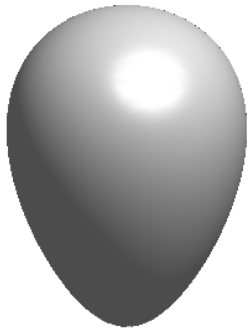


traditional model

alternative model

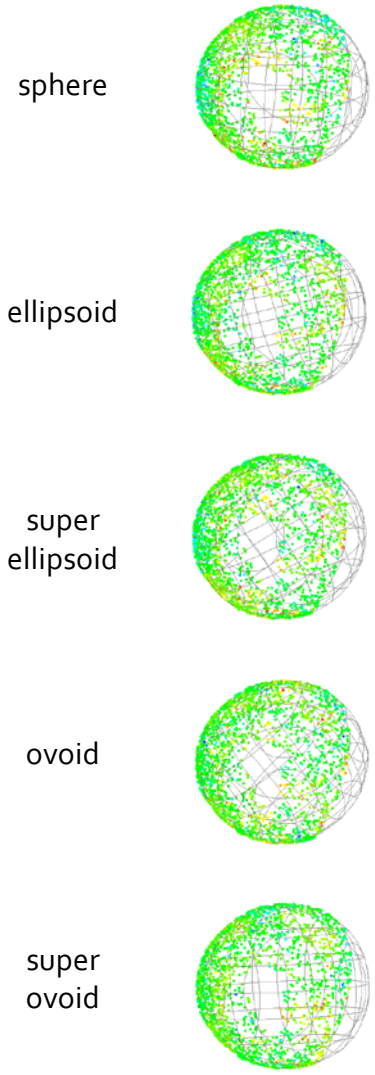
sphere

ellipsoid

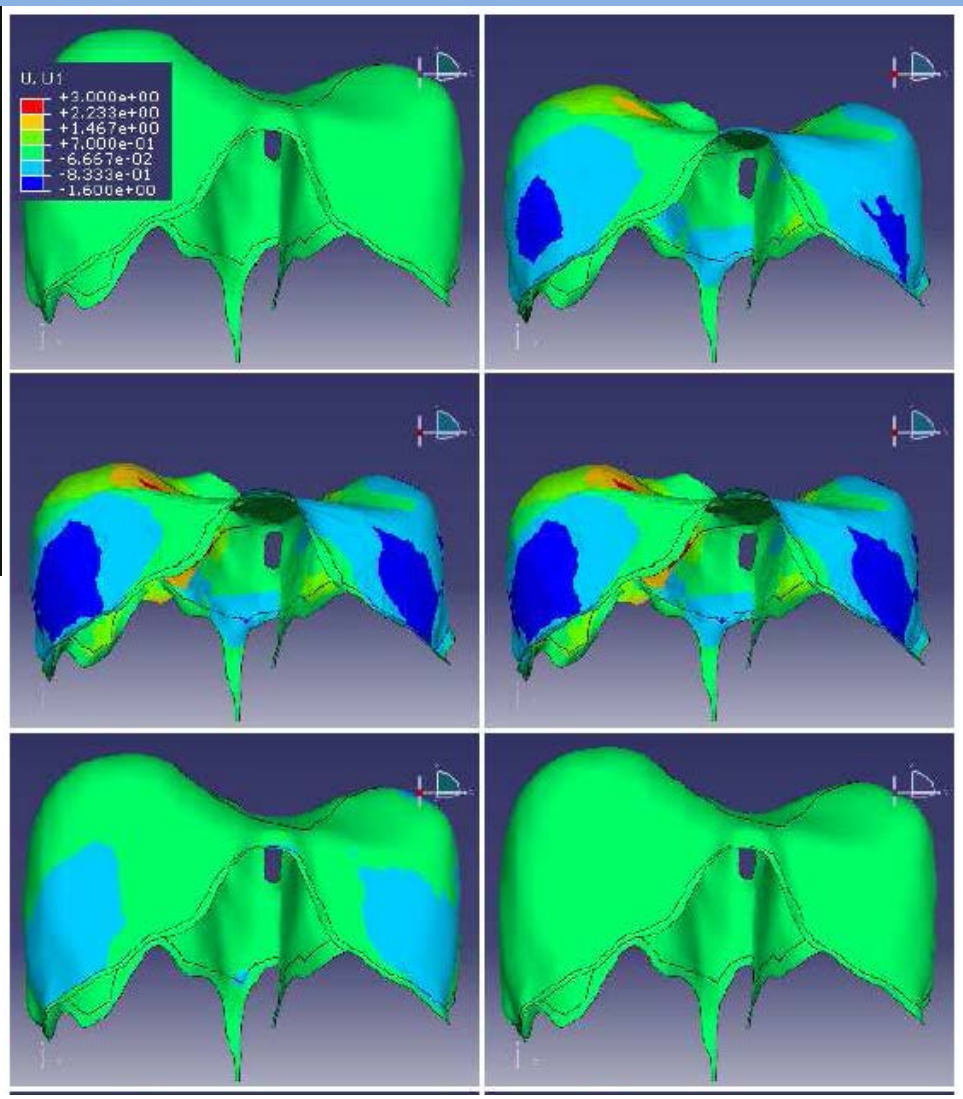
super ellipsoid

ovoid

super ovoid



Applications

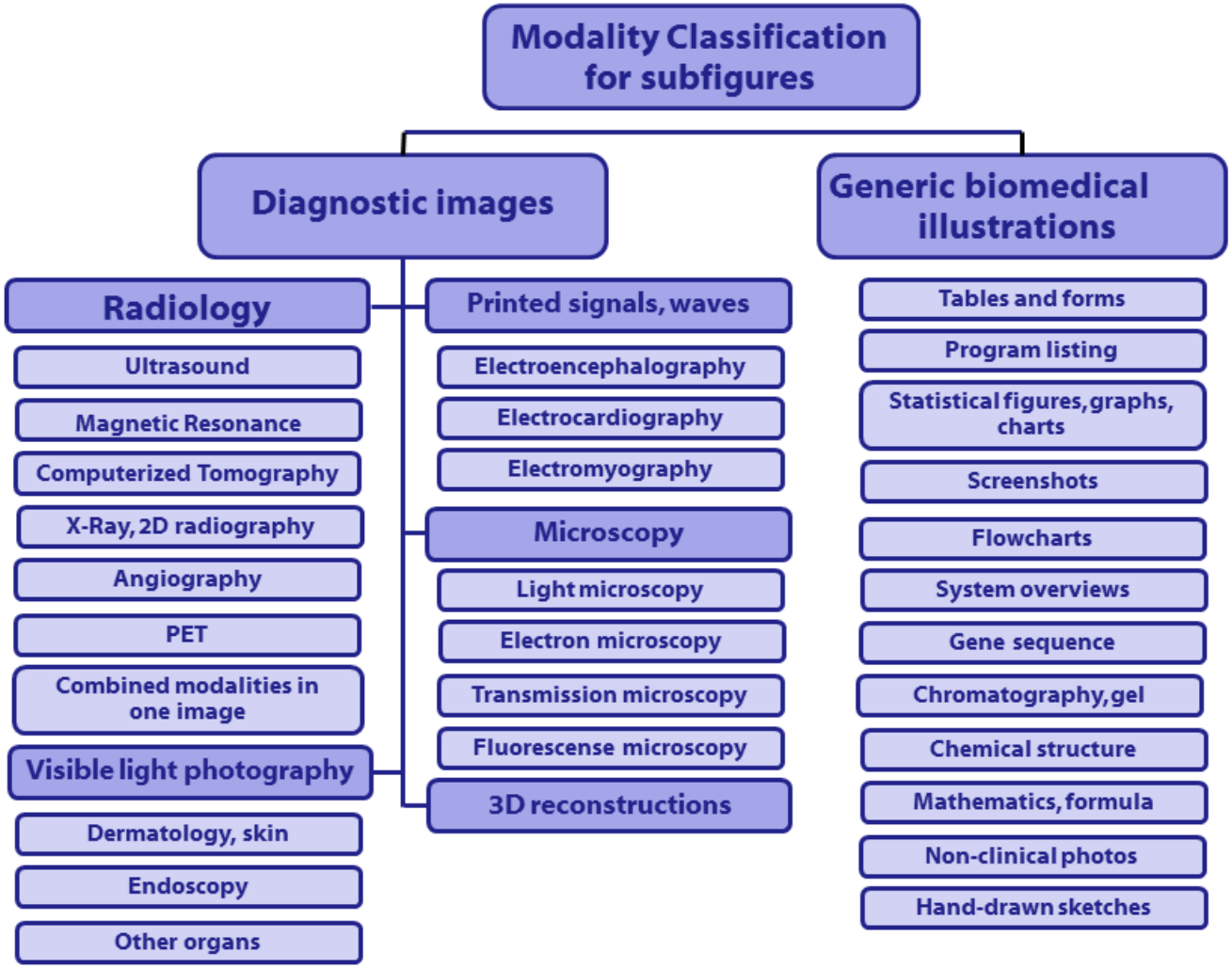


Nuno J.G. dos Santos, Preliminary Biomechanical Studies on the Diaphragmatic Function in Control and Patients with Loss of Motor Units, M.Sc. Thesis, Instituto Superior Técnico, Universidade Técnica de Lisboa, 2009

Applications

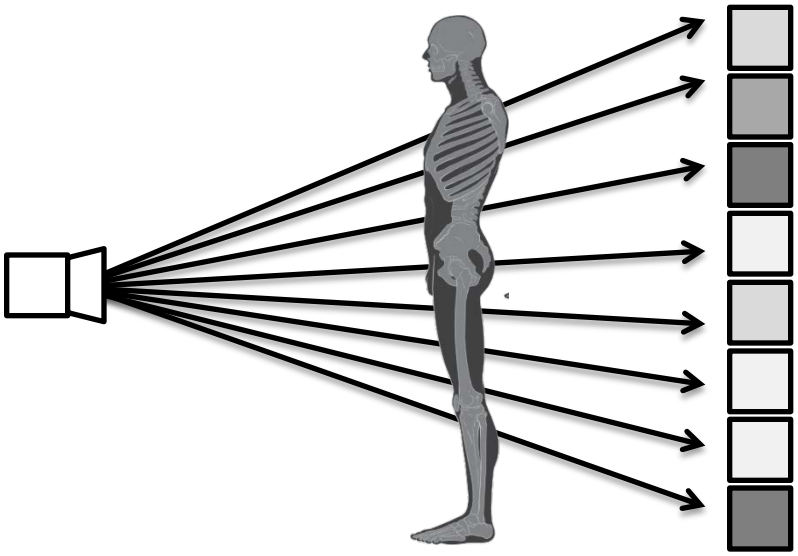
http://thehigherlearning.com/2014/08/25/a-chinese-boy-receives-first-3-d-printed-vertebra-implant-video/
http://www.hallpress.com/index.php/3d-printing-surgical-planning/

Medical Data Types



http://www.imageclef.org/2015/medical

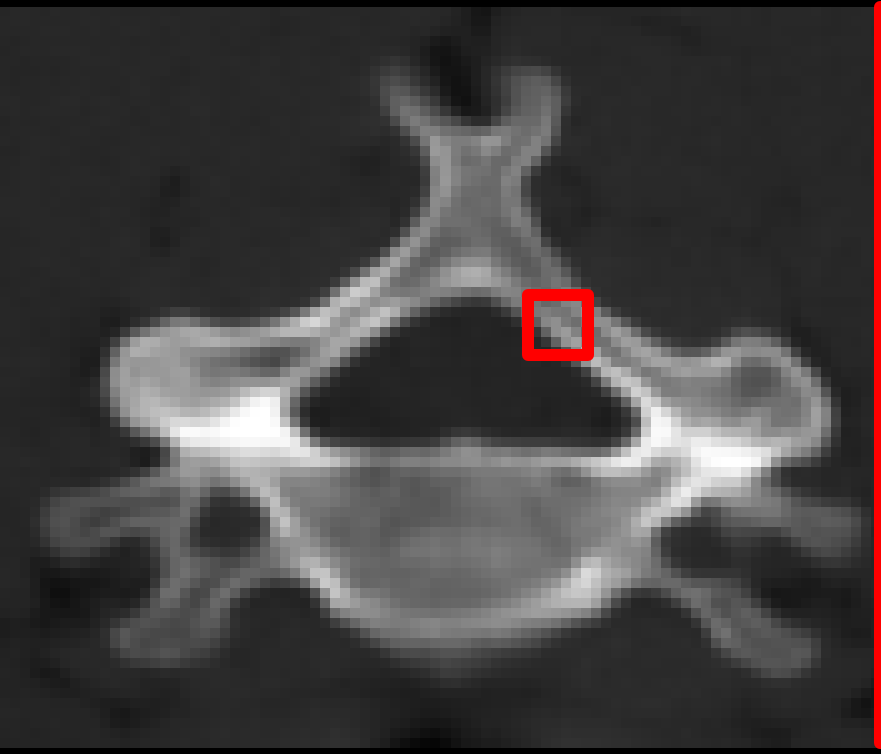
Imaging



Radiation Source | Sample | Sensor

CT	X-Ray	Tissue density (attenuation coefficient)
MRI	Magnetic Field	Proton density

Medical Image



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1800	1803	1944	2134	2317	2518	2476	2034	1
1787	1702	1790	1964	2132	2375	2578	2496	2
1775	1635	1630	1757	1964	2183	2400	2587	2

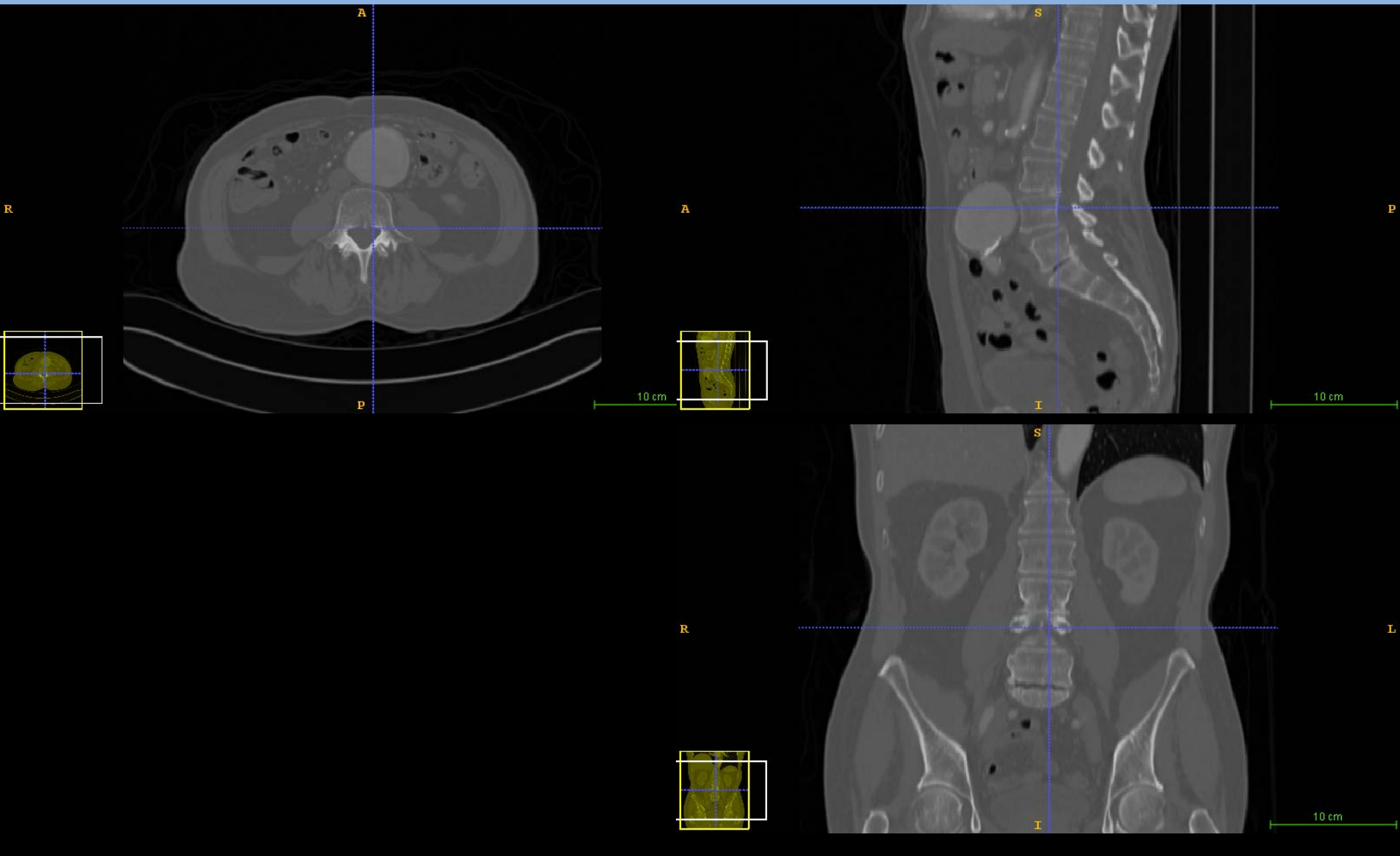
Medical Image File Format

(Digital Imaging and Communications in Medicine)

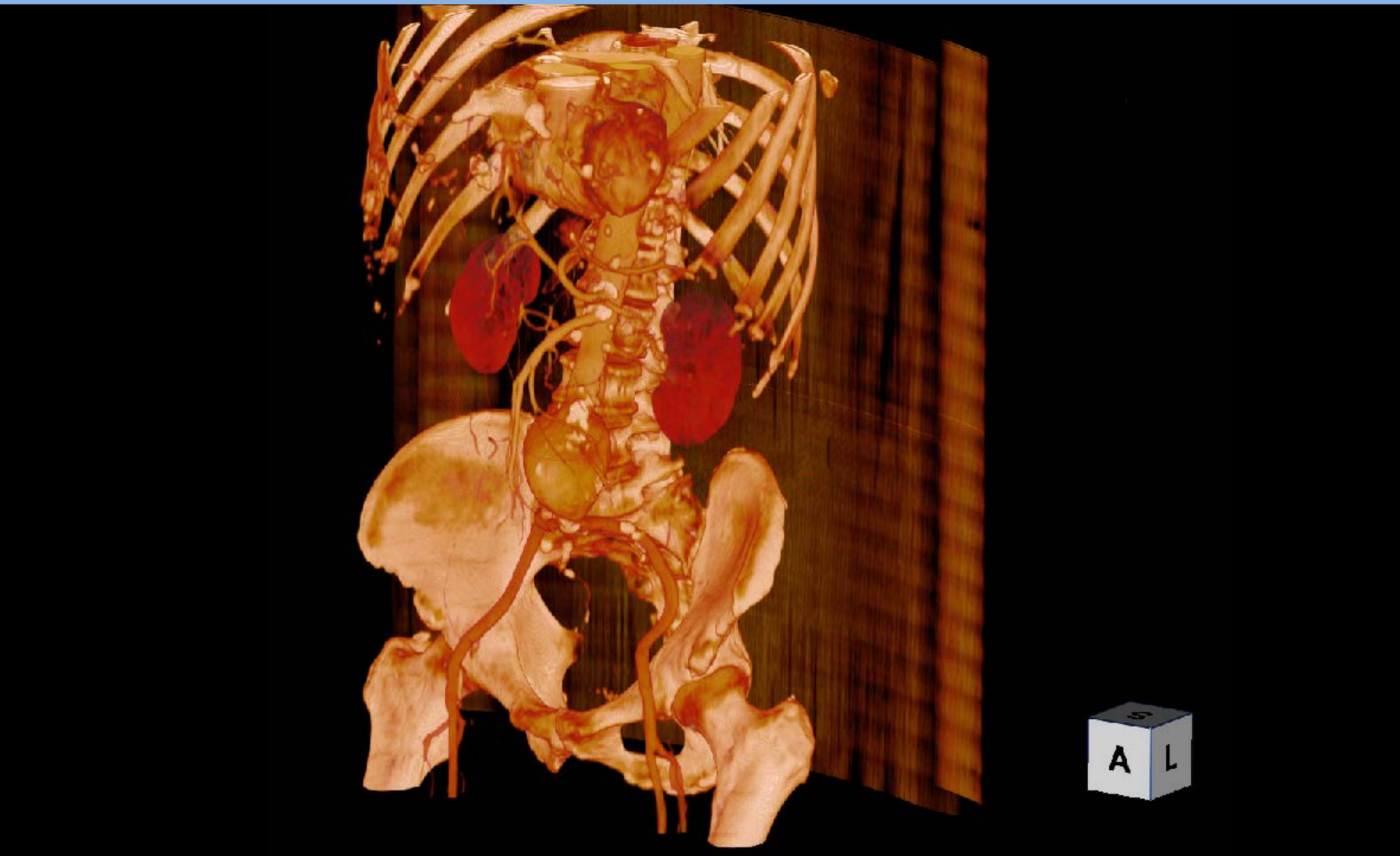
DICOM

*.dcm

Image Navigation



Volume Rendering



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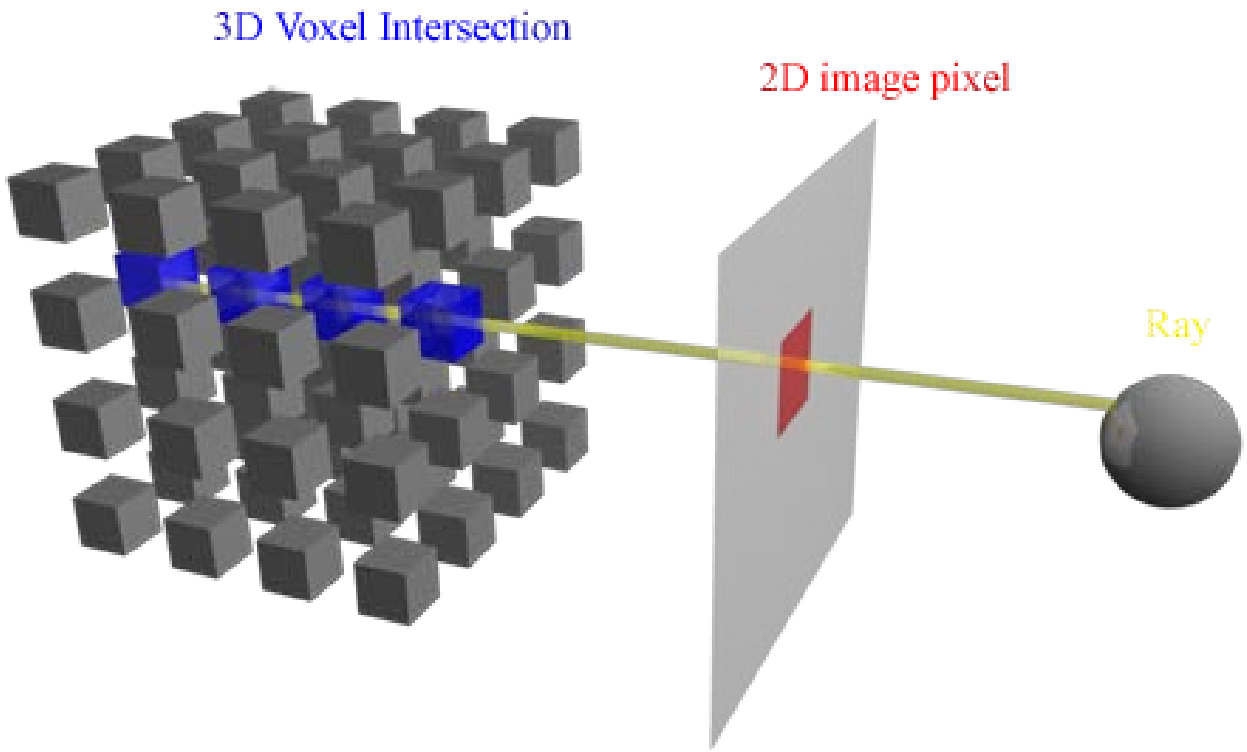
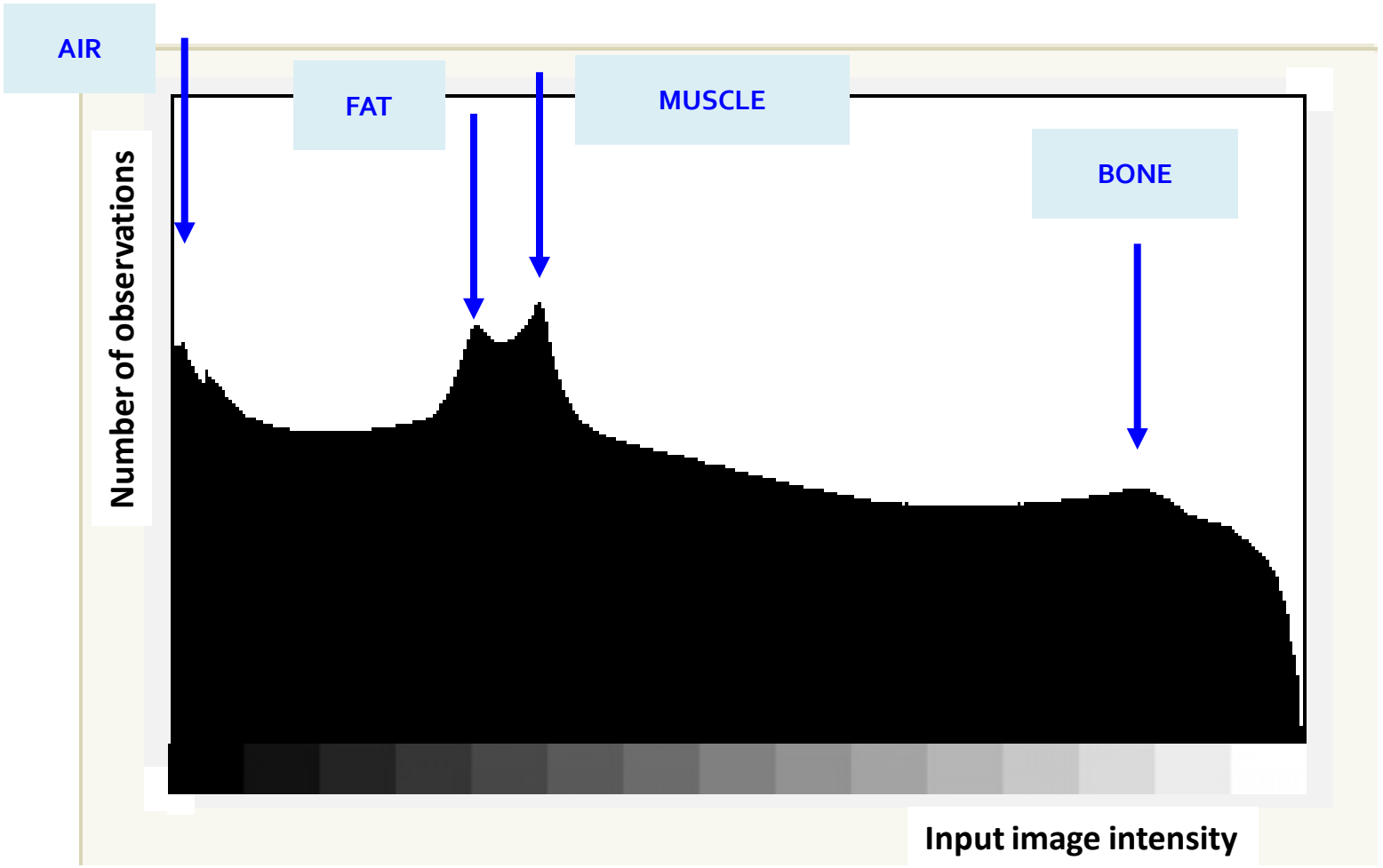


http://www.dca.fee.unicamp.br/courses/IA369E/2s2010/projects/camillo_curado/algoritmos.html

Transfer Function



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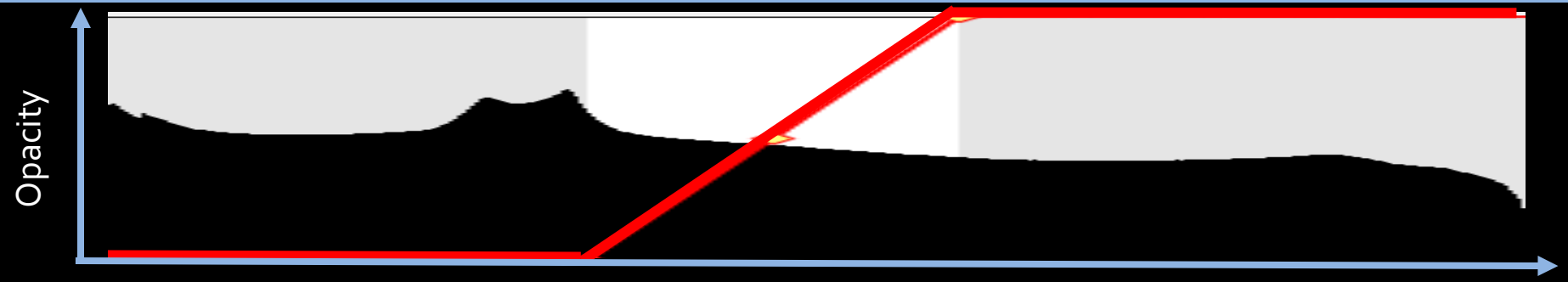
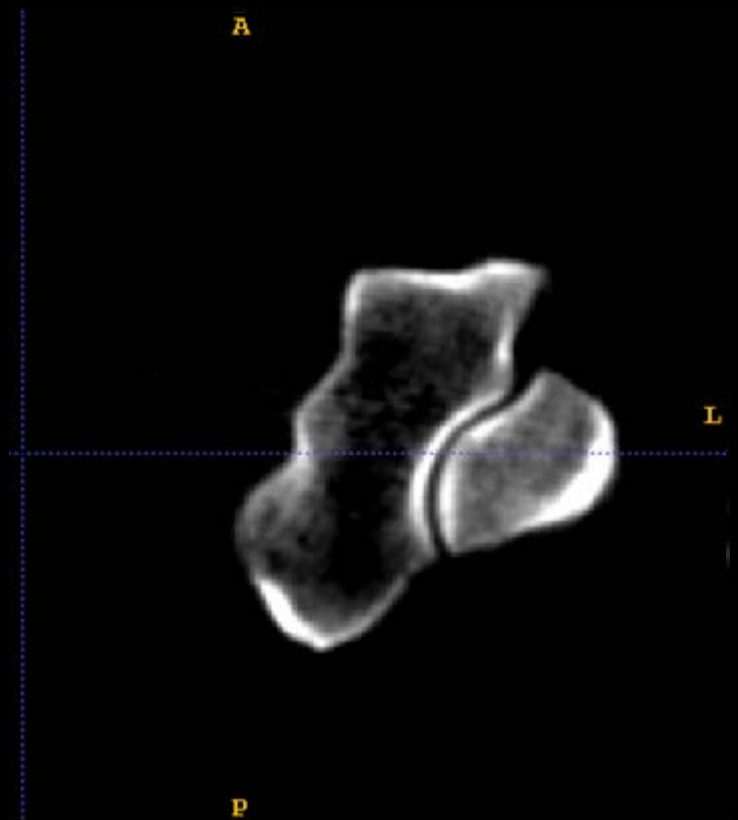




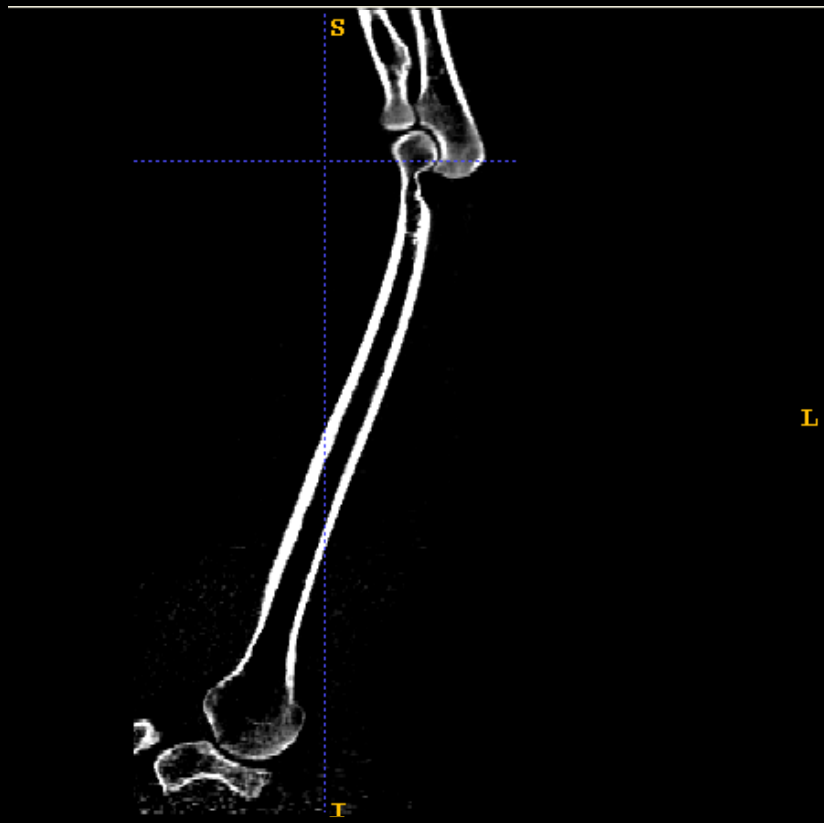
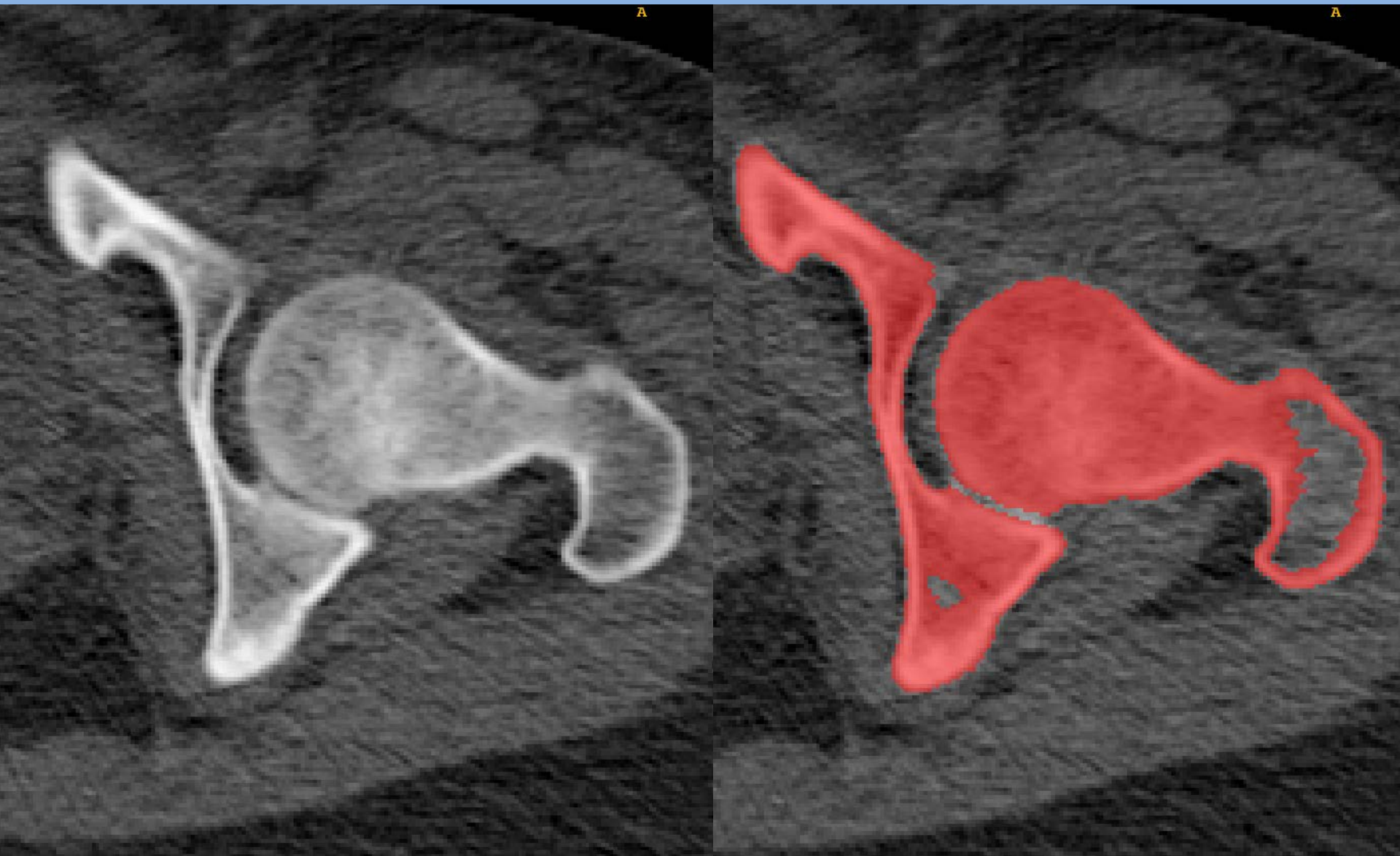


Image Segmentation



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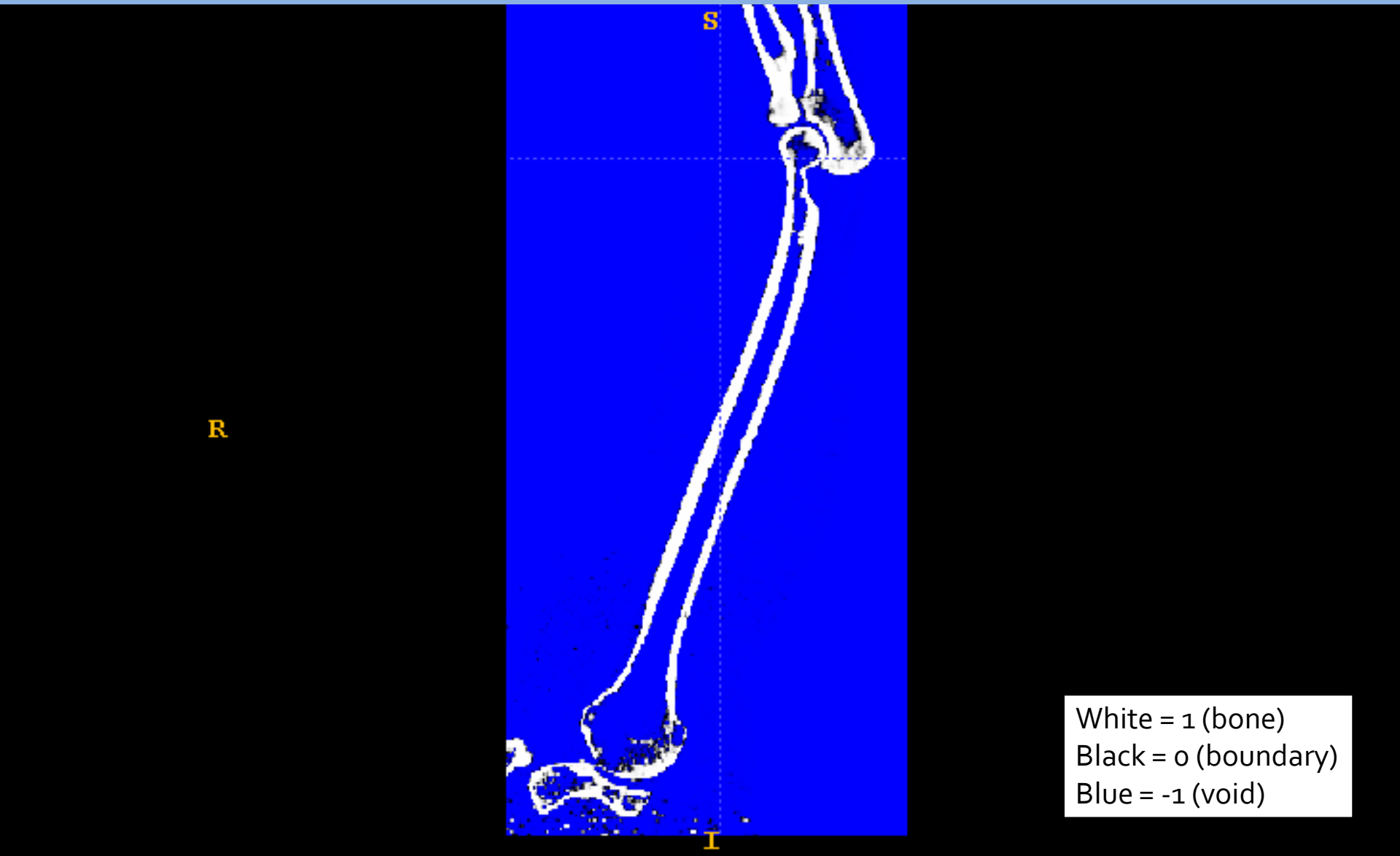

White = 1 (bone)
Black = 0 (boundary)
Blue = -1 (void)

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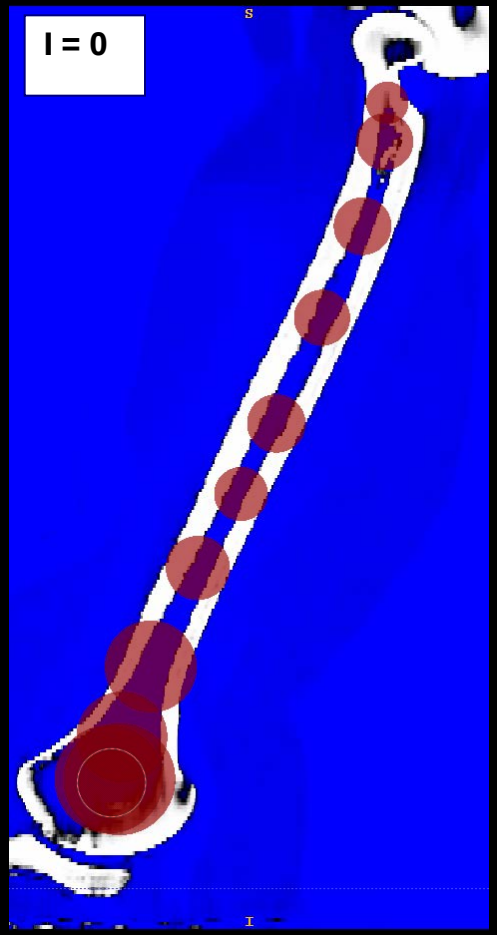

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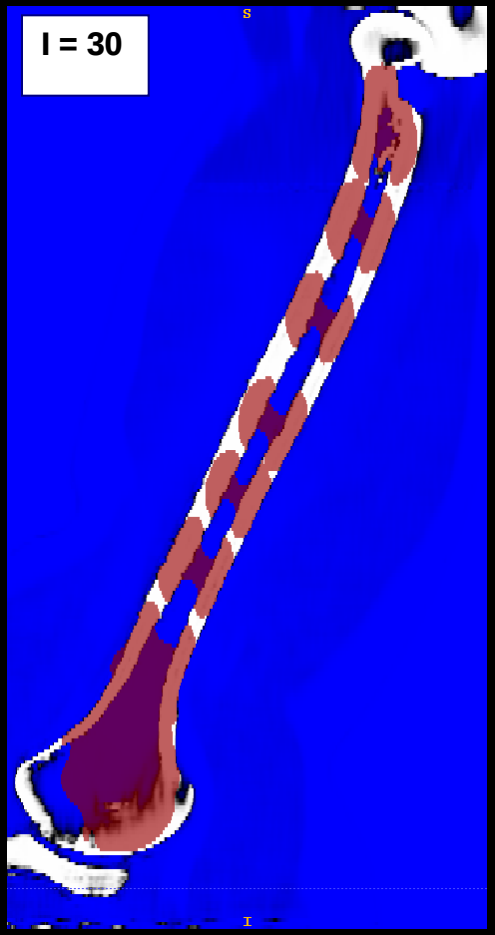

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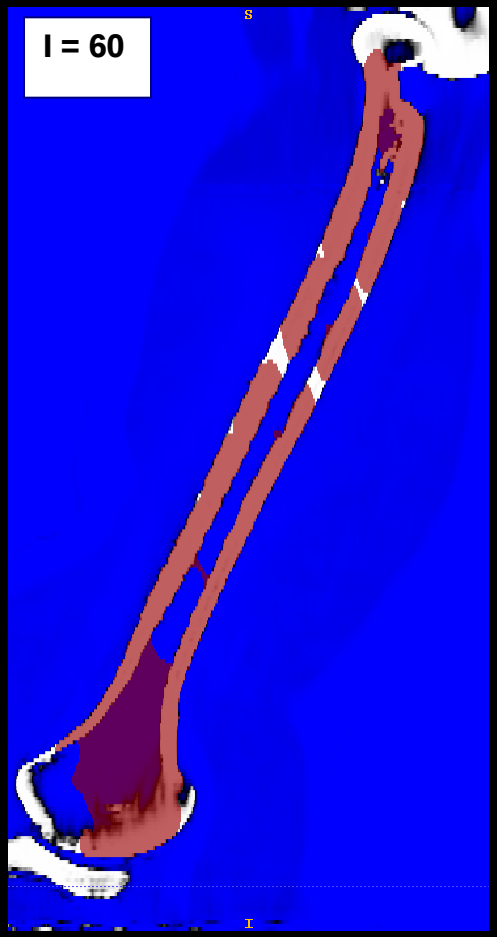

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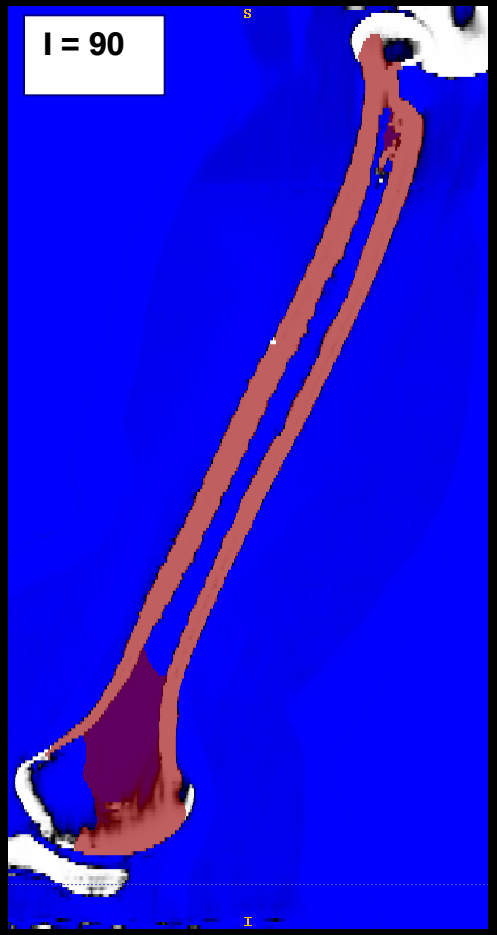

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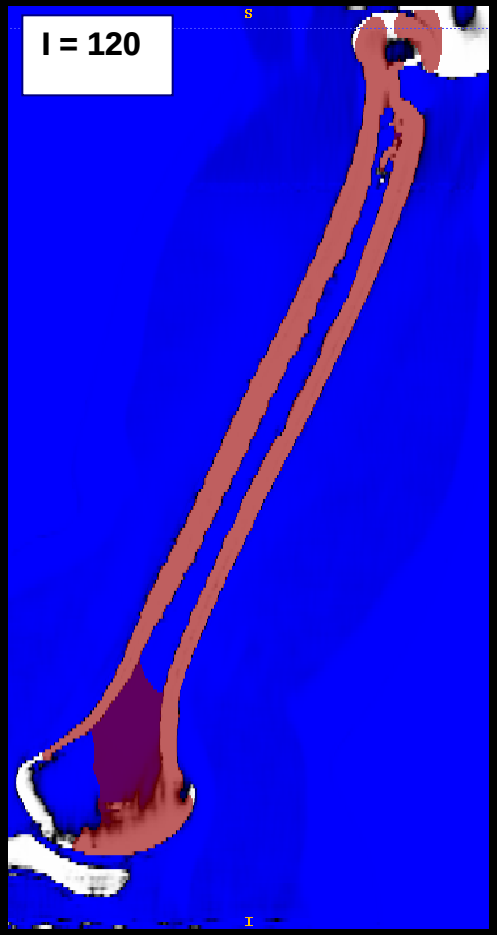

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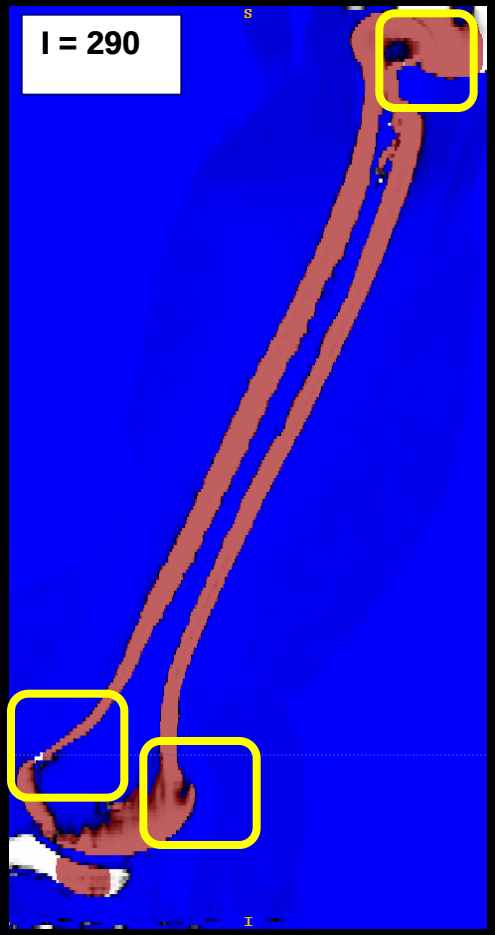
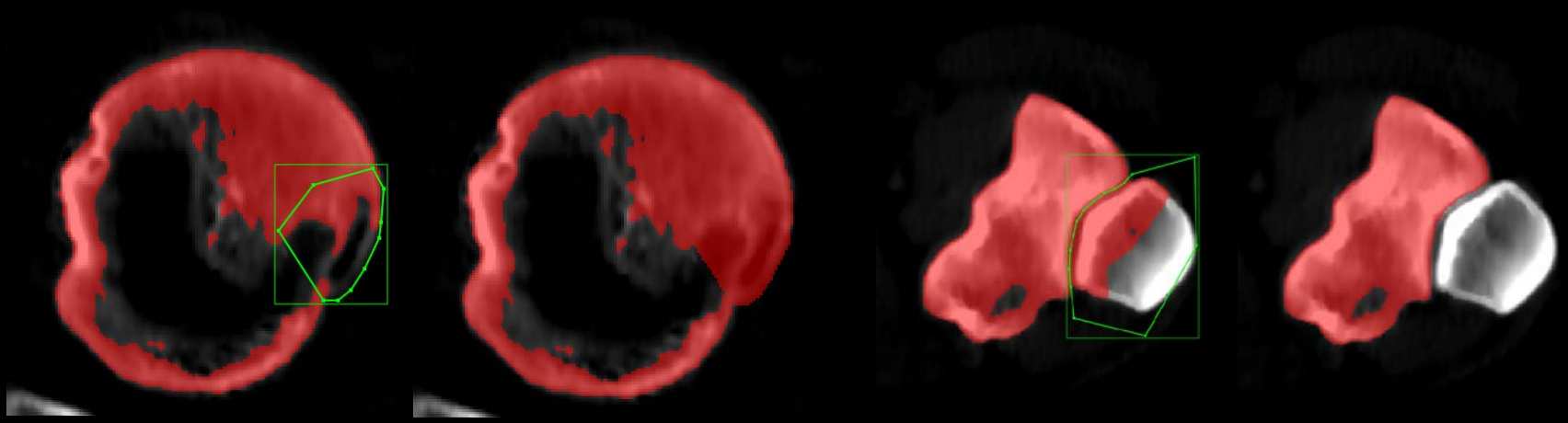


ATTENTION:
Over-Segmentation
Sub-Segmentation

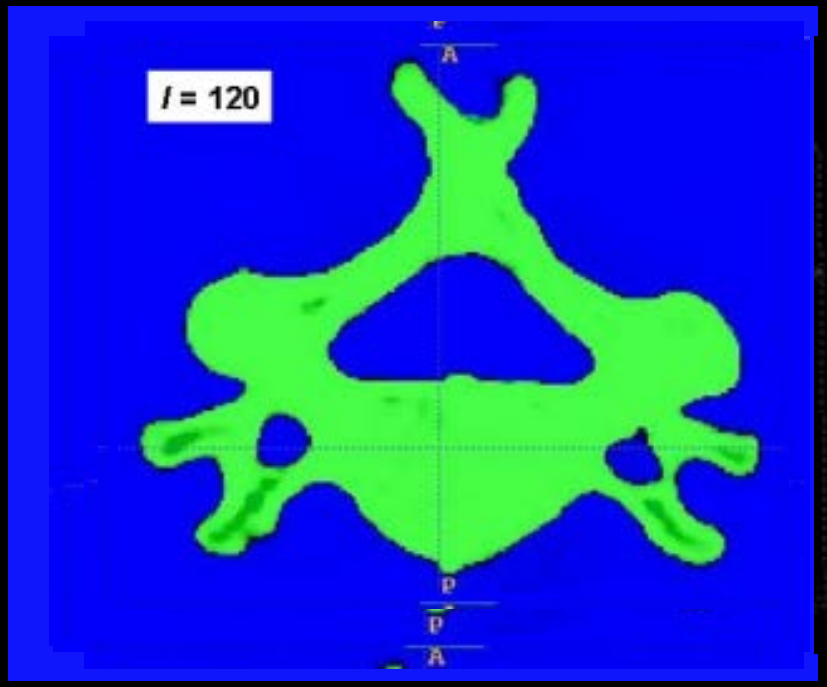
Image Segmentation

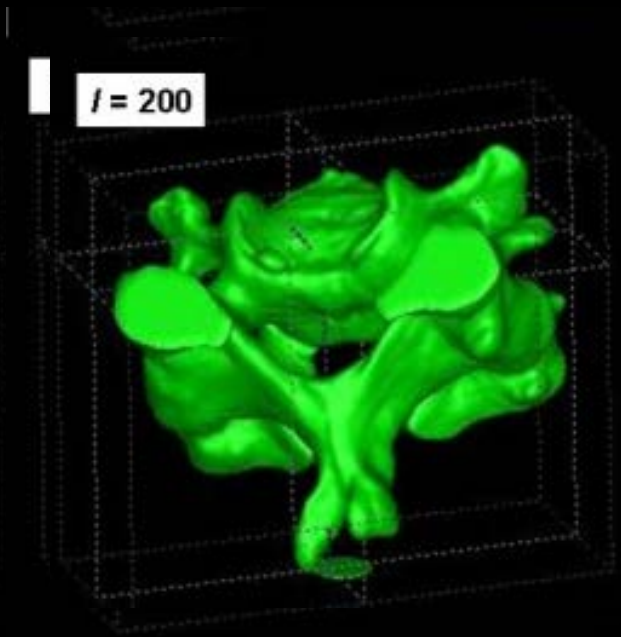


Sub-Segmentation

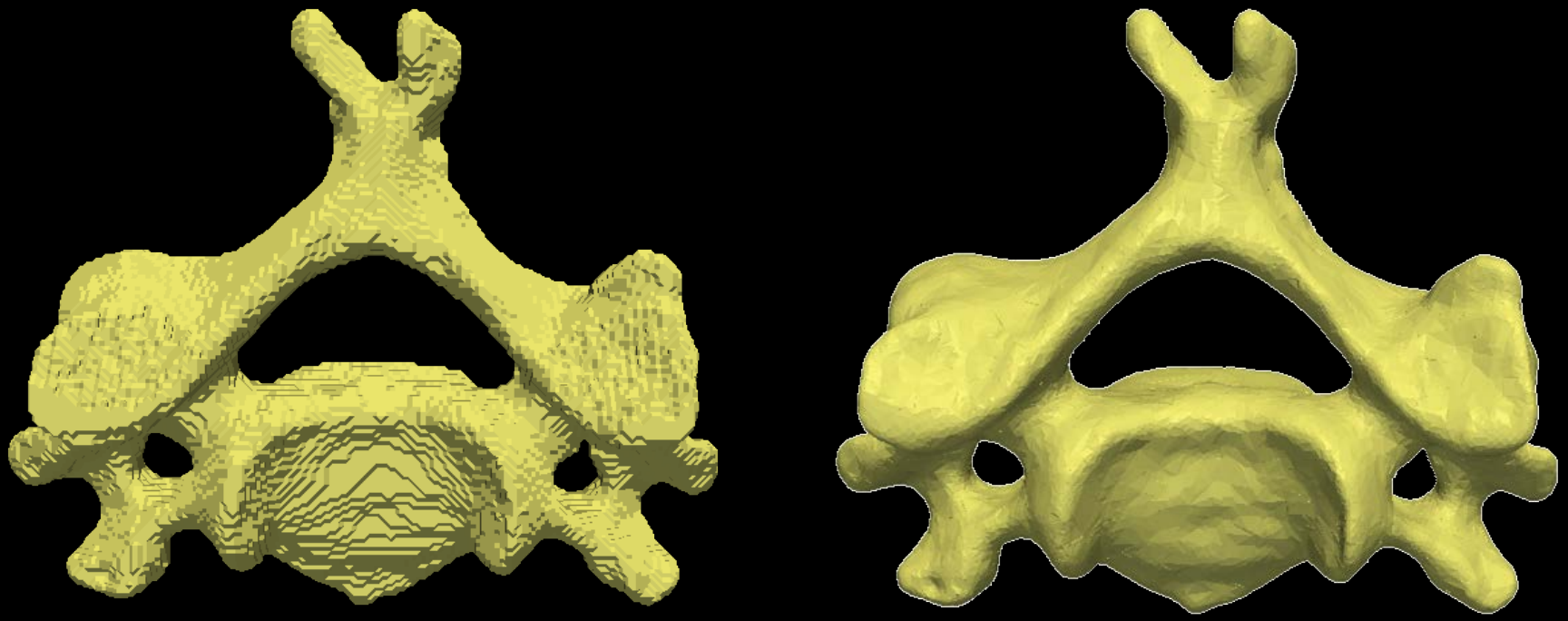
Over-Segmentation

Image Segmentation





Mesh Processing & Adjustments



References

N.S. Ribeiro, P.C.R. Fernandes, D.S. Lopes, J. Folgado and P.R. Fernandes, ***3-D Solid and Finite Element Modeling of Biomechanical Structures – A Software Pipeline.*** ESMC2009 7th Euromech Solid Mechanics Conference, Lisboa, Portugal, September 2009.

P. A. Yushkevich, J. Piven, H. C. Hazlett, R. G. Smith, S. Ho, J. C. Gee and G. Gerig, ***User-guided 3-D active contour segmentation of anatomical structures: significantly improved efficiency and reliability.*** Neuroimage. 31(3): 1116-28, 2006.

W. Lorensen and H. Cline, ***Marching Cubes: A high resolution 3-D surface construction algorithm.*** Computer Graphics. 21(4): 163-169, 1987.

W. J. Schroeder, J. A. Zarge and W. E. Lorensen, ***Decimation of Triangle Meshes.*** Computer Graphics. (SIGGRAPH92 Proceedings): 65-70, 1992.