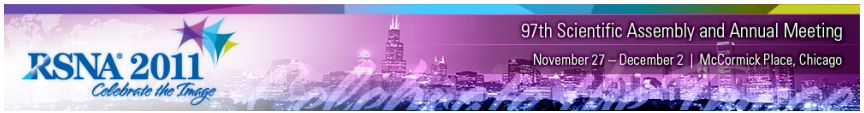
Surgical Planning Laboratory
Brigham and Women's Hospital
Boston, Massachusetts USA

a teaching affiliate of
Harvard Medical School

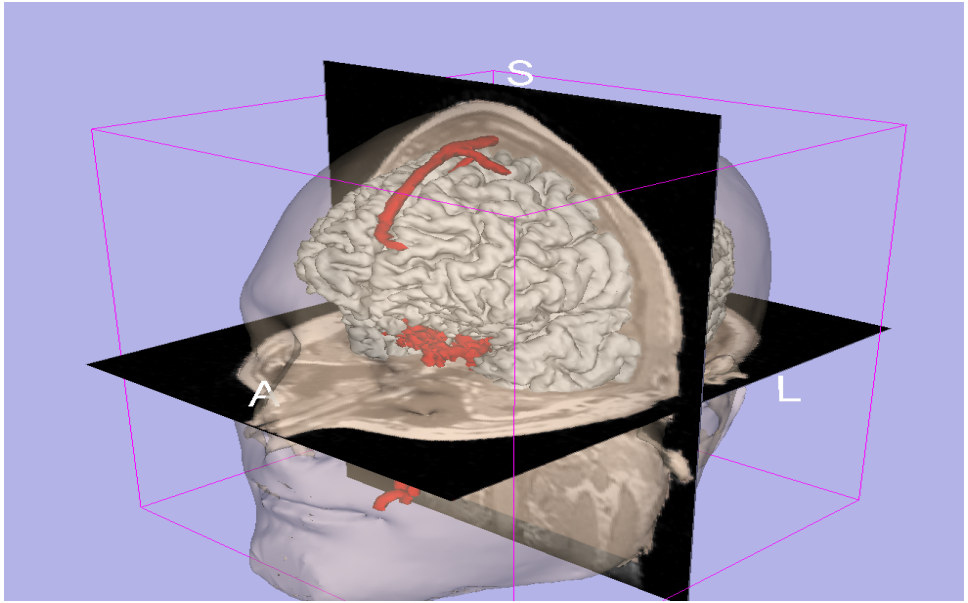
3D VISUALIZATION OF DICOM IMAGES FOR RADIOLOGICAL APPLICATIONS

Sonia Pujol, Ph.D., Harvard Medical School
Director of Training, National Alliance for Medical Image Computing

Kitt Shaffer, M.D., Boston University
Vice-Chairman for Education, Boston University School of Medicine



Goal



- The Goal of this tutorial is to guide you through the process of 3D data loading and visualization of DICOM data and surface-models

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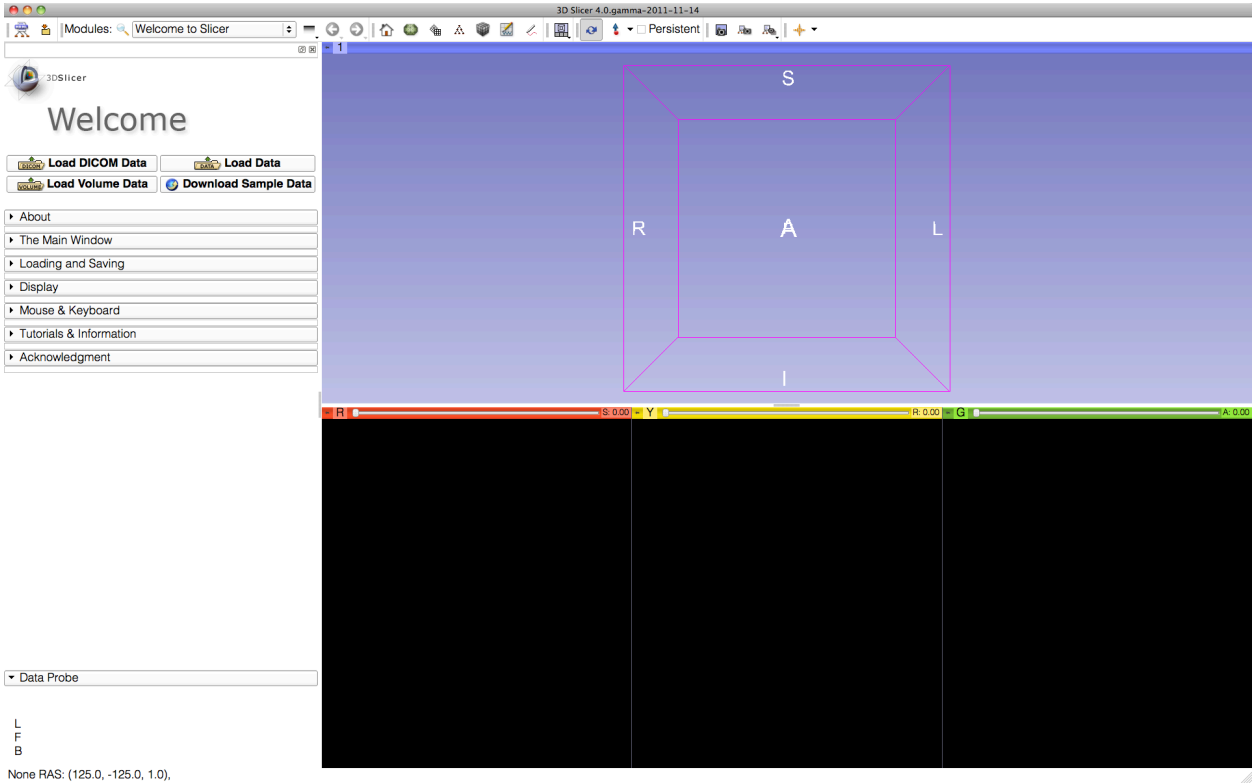
Slicer4



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PART 1: LOADING A DICOM VOLUME

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The DICOM 3.0 File Format

Radiological imaging equipment produce images in DICOM file format (‘.dcm files’)

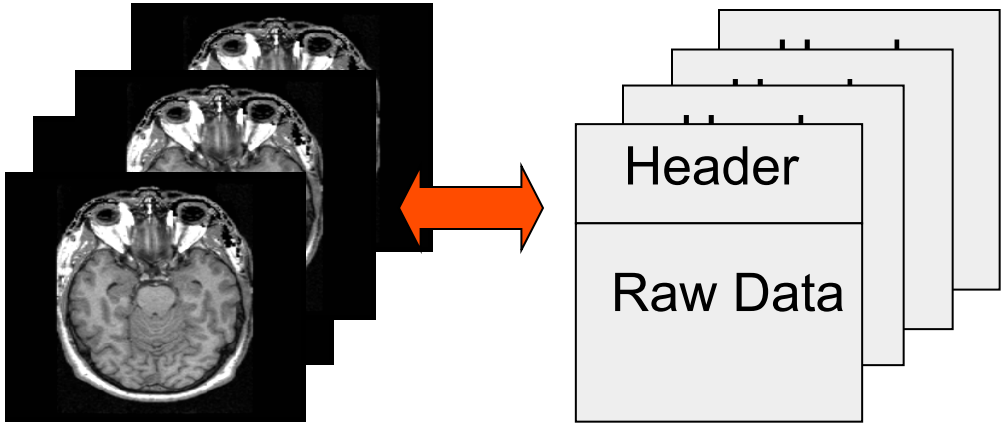

Image001.dcm

Image002.dcm

Image003.dcm

….

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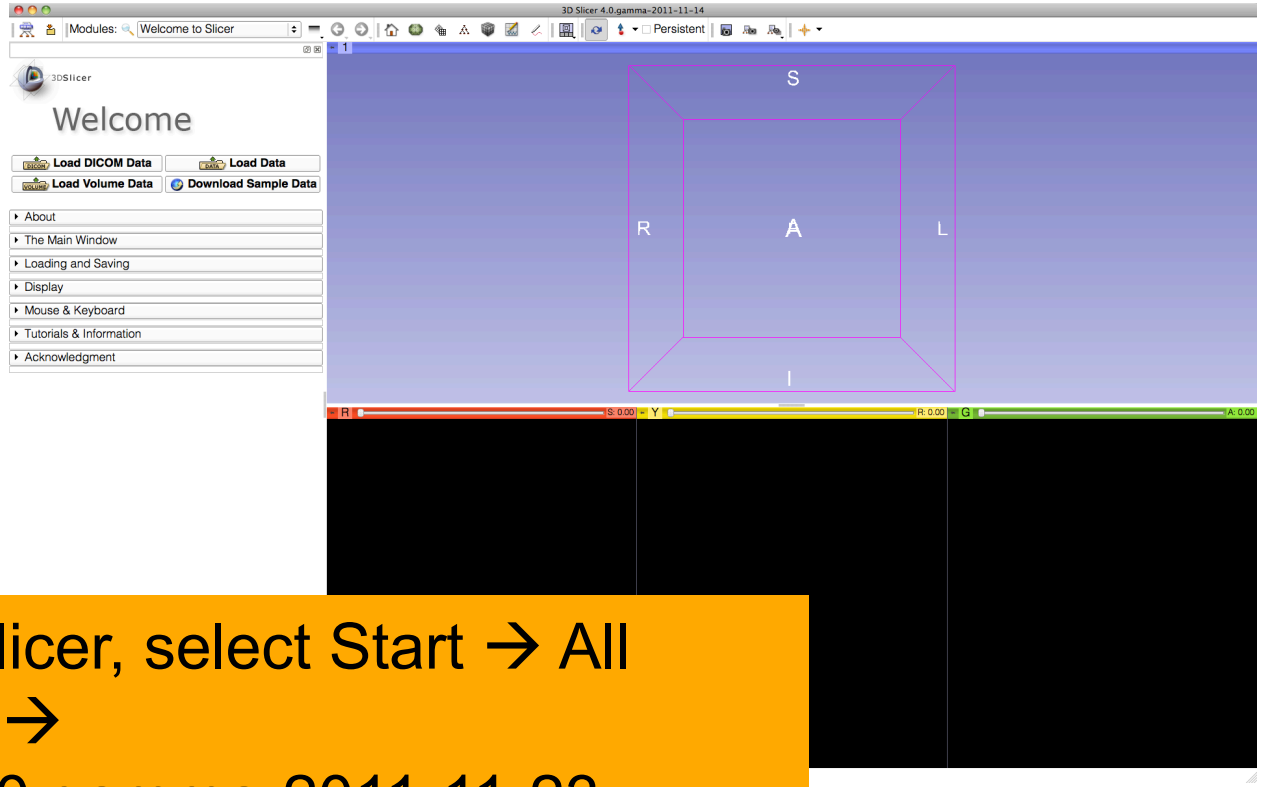
Slicer4



To start Slicer, select Start → All Programs→ Slicer4-4.0.gamma-2011-11-23

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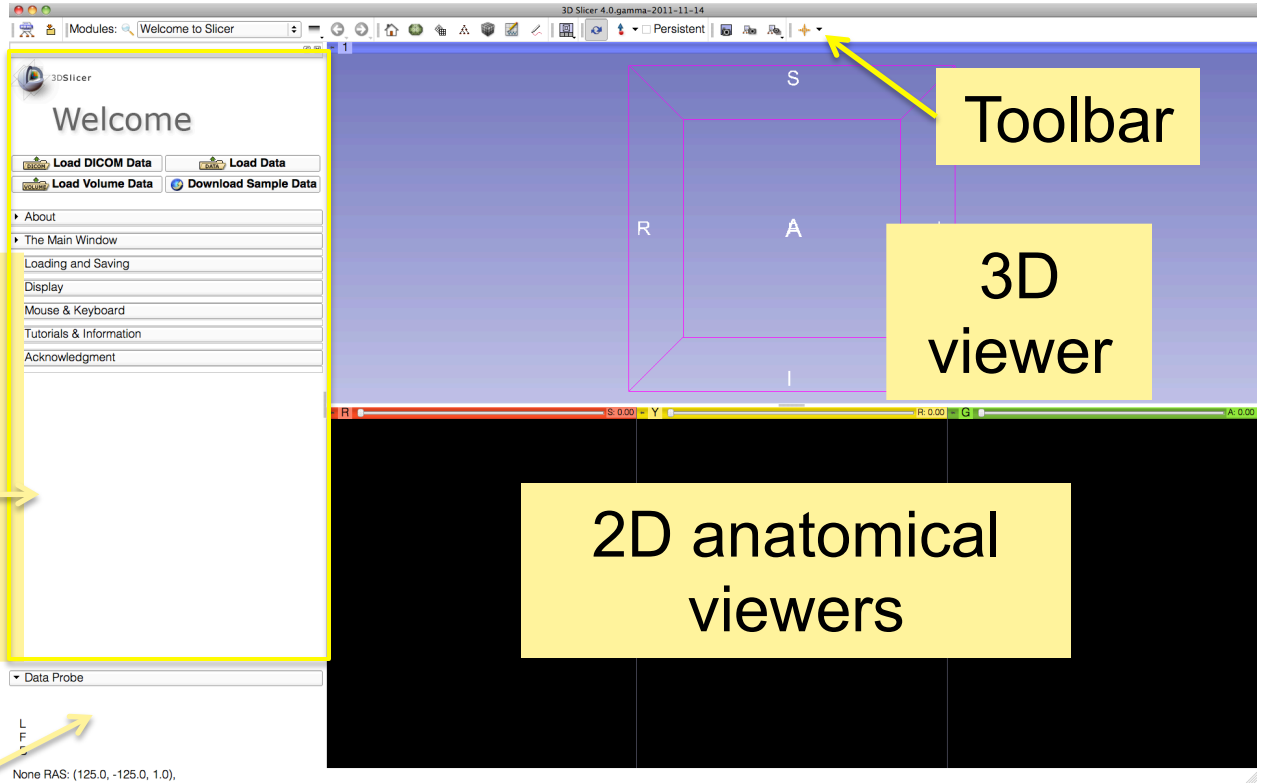
Slicer User Interface

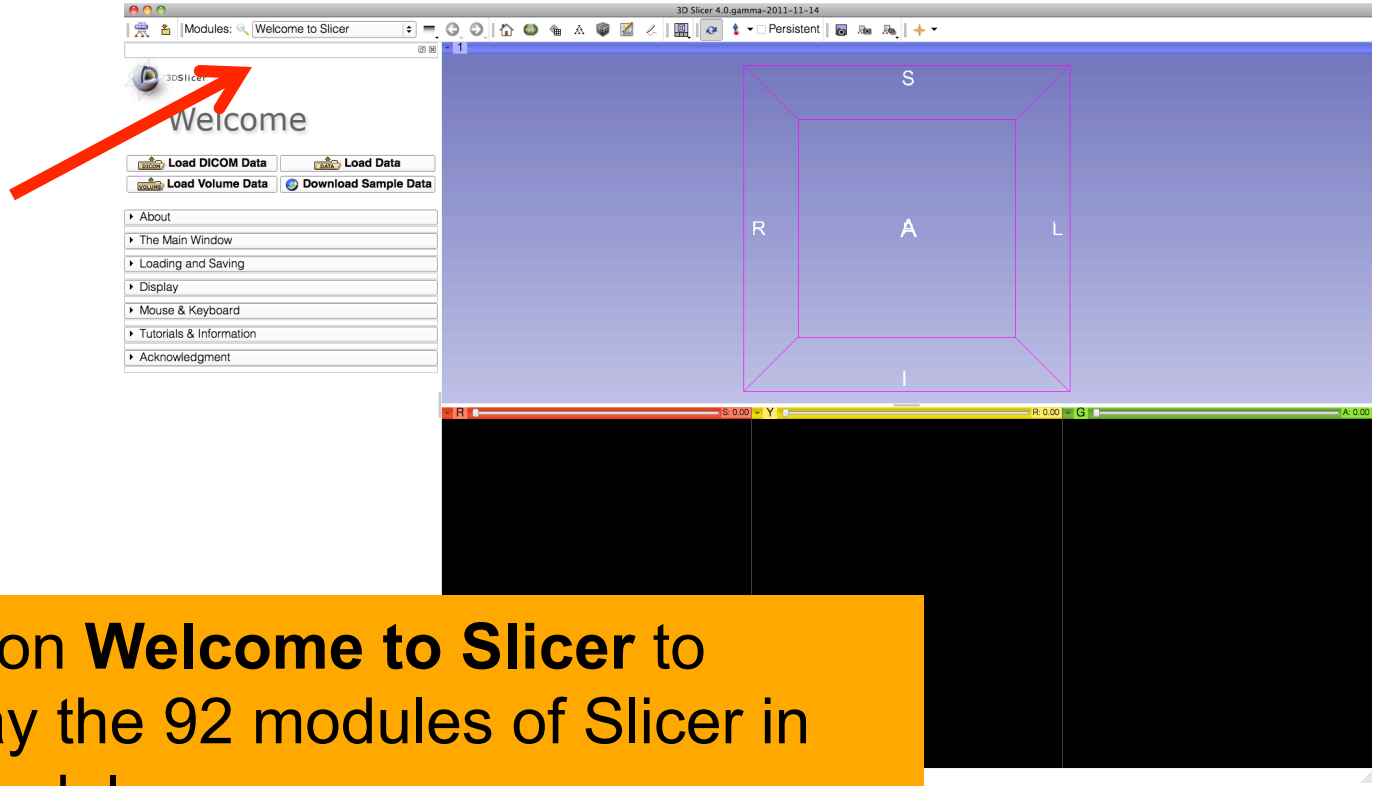
Main Menu

GUI panel of the Slicer Welcome Module



Data Probe

Start Slicer



Click on **Welcome to Slicer** to display the 92 modules of Slicer in the Modules menu

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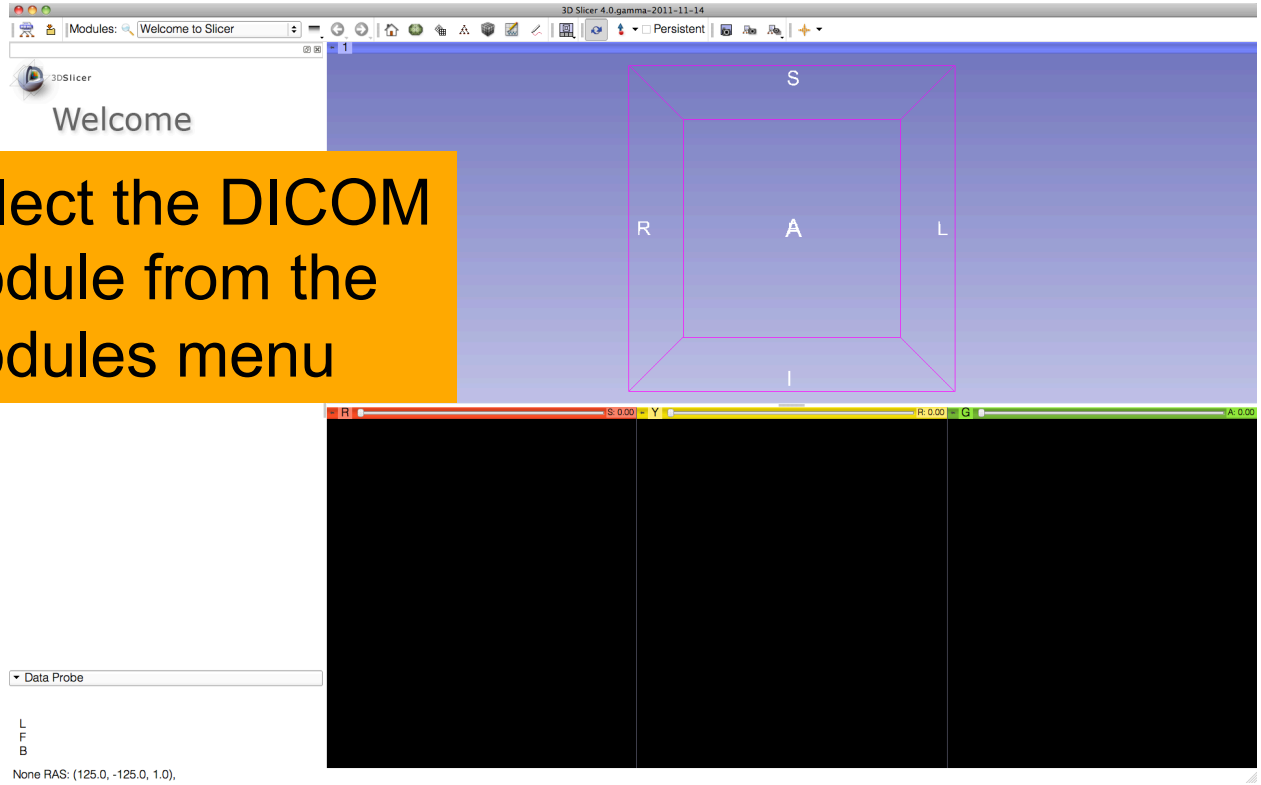
DICOM Module



Select the DICOM module from the Modules menu

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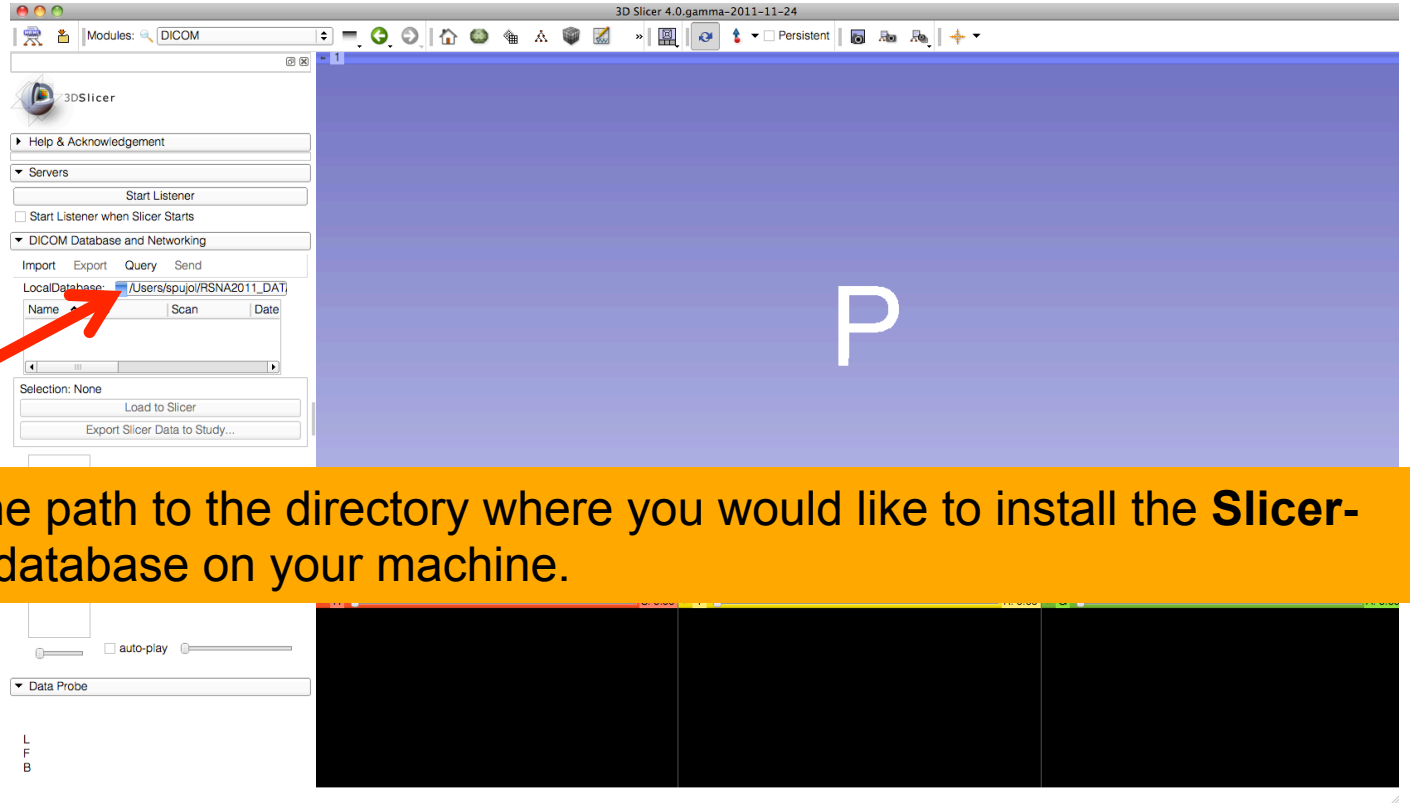
DICOM module



Enter the path to the directory where you would like to install the **Slicer-dicom** database on your machine.

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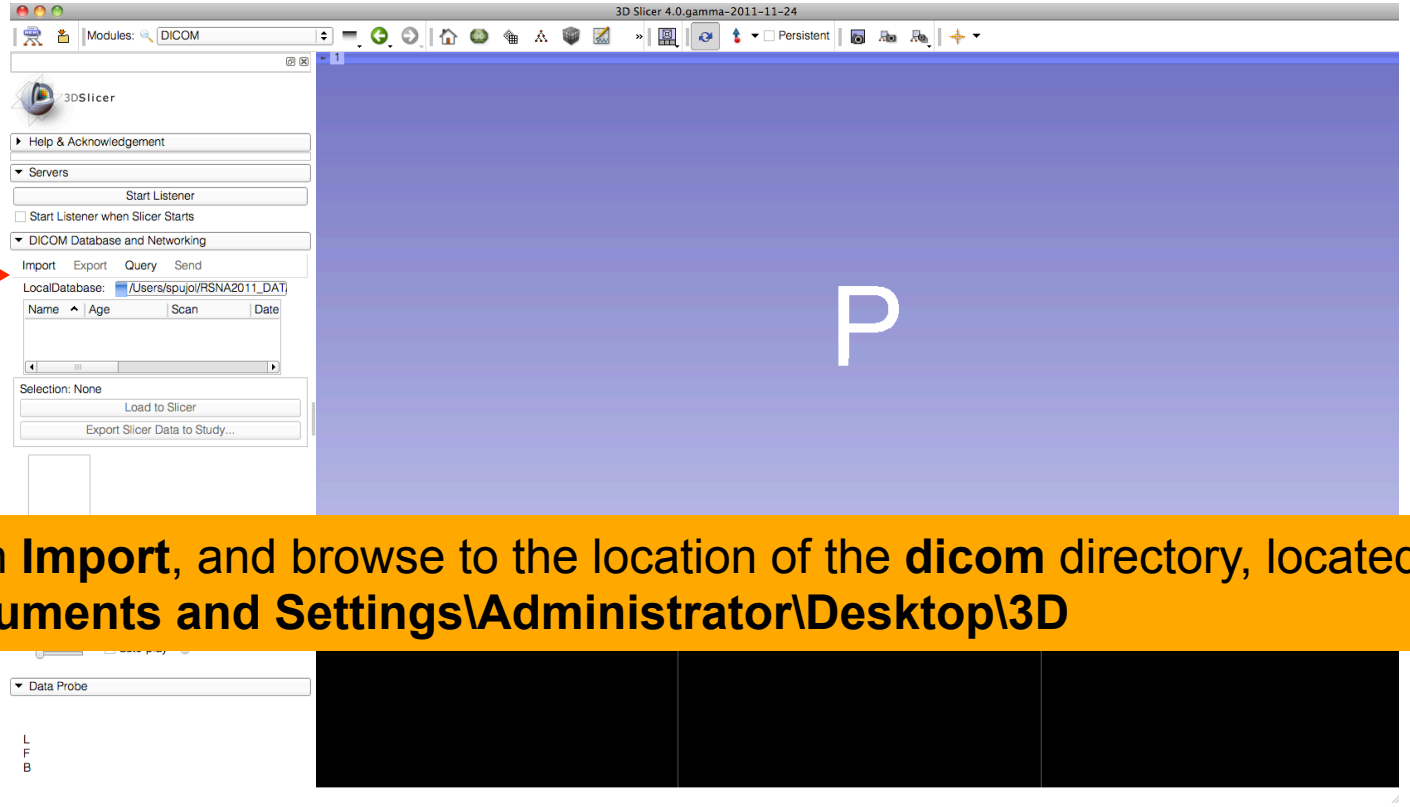
DICOM module



Click on **Import**, and browse to the location of the **dicom** directory, located in **C:\Documents and Settings\Administrator\Desktop\3D**

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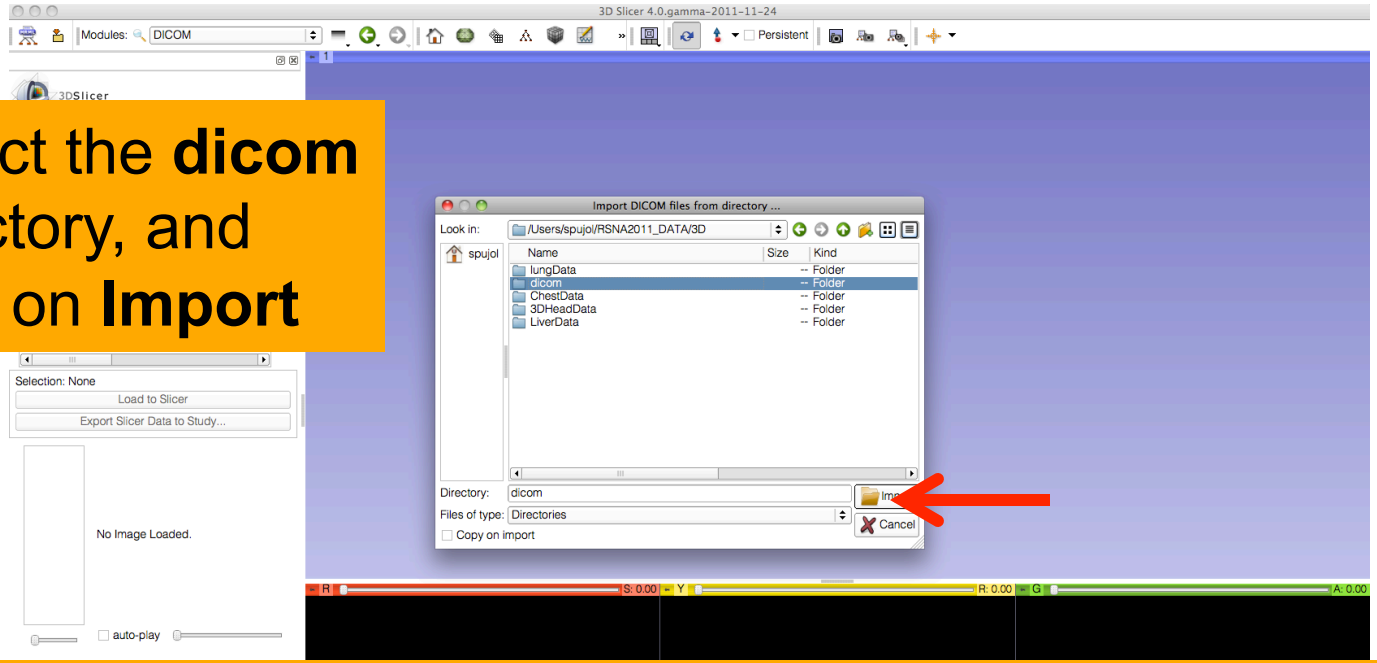
DICOM module



Select the **dicom** directory, and click on **Import**

Note: Loading the dicom dataset in the database may take a few minutes.

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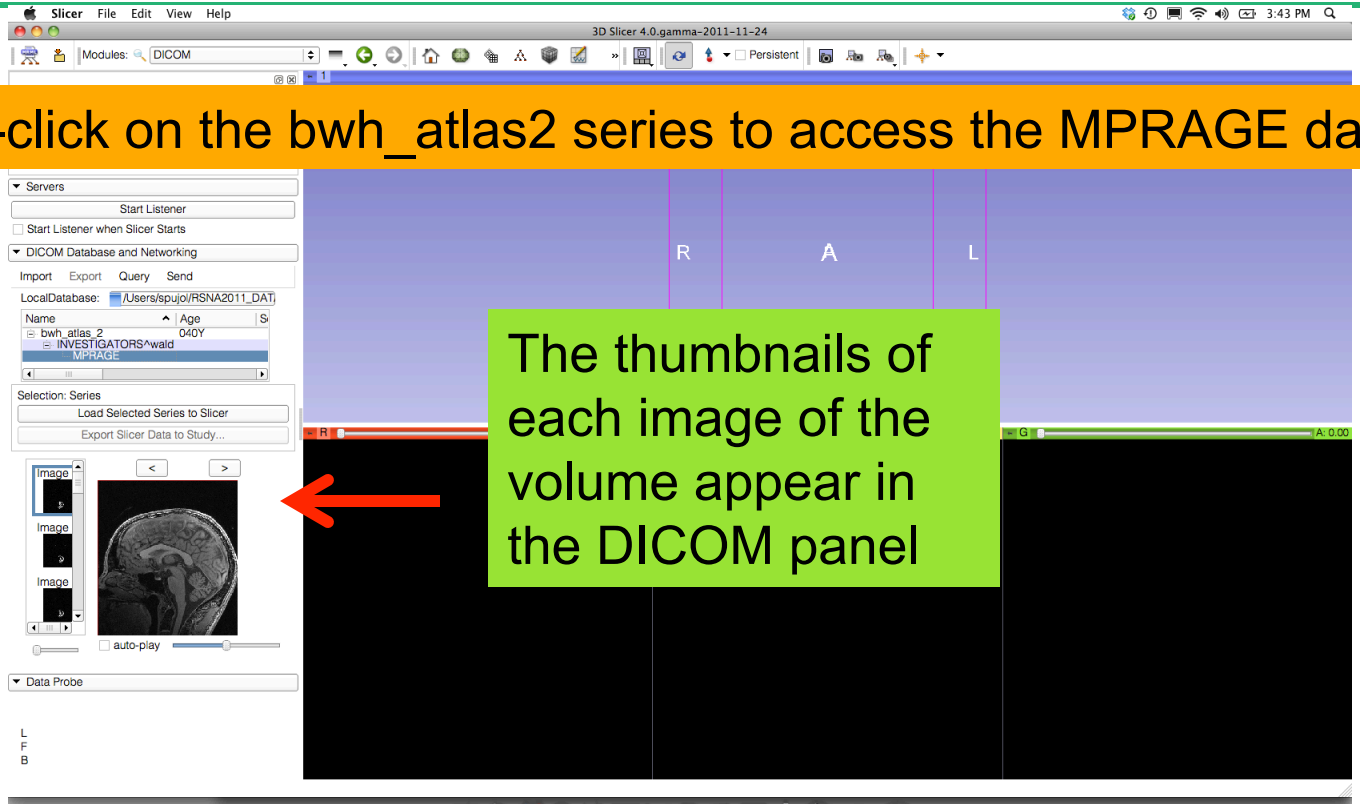
DICOM module

Double-click on the bwh_atlas2 series to access the MPRAGE dataset.



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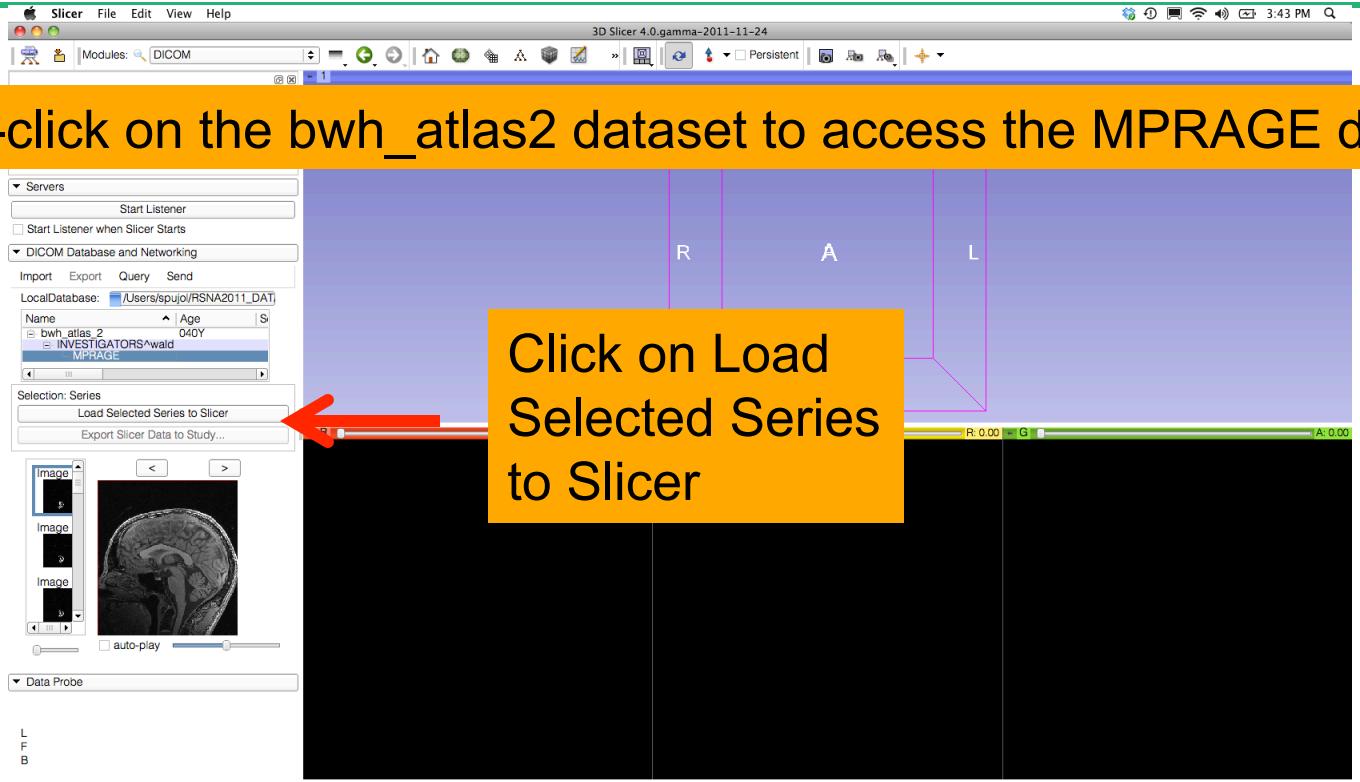
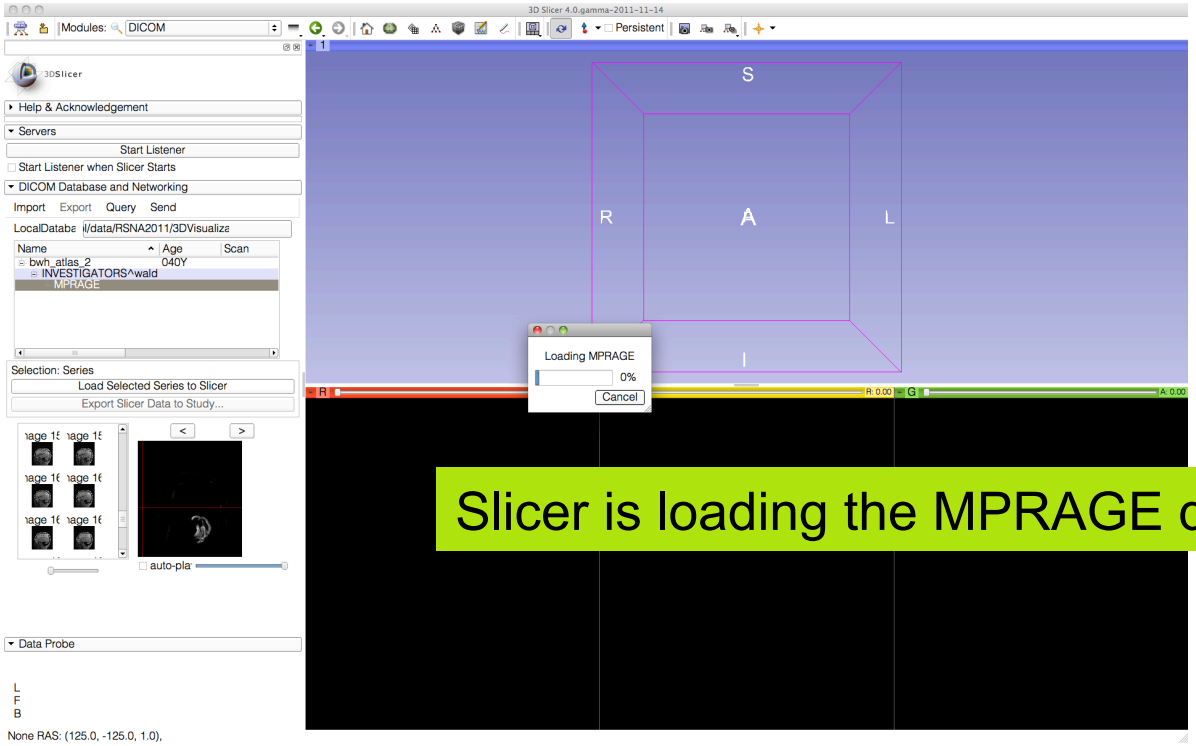
DICOM module

Double-click on the bwh_atlas2 dataset to access the MPRAGE dataset.



DICOM module



Slicer is loading the MPRAGE dataset

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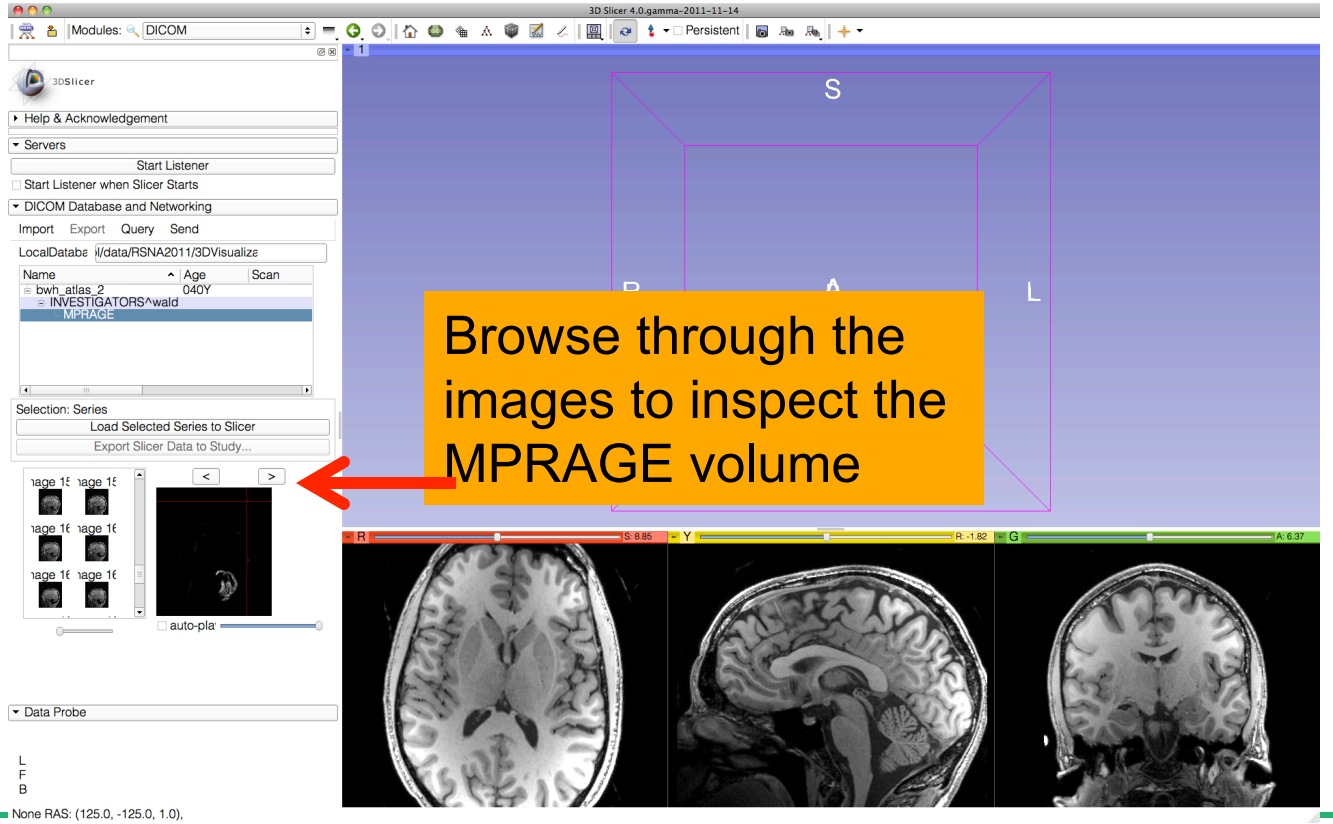
DICOM module



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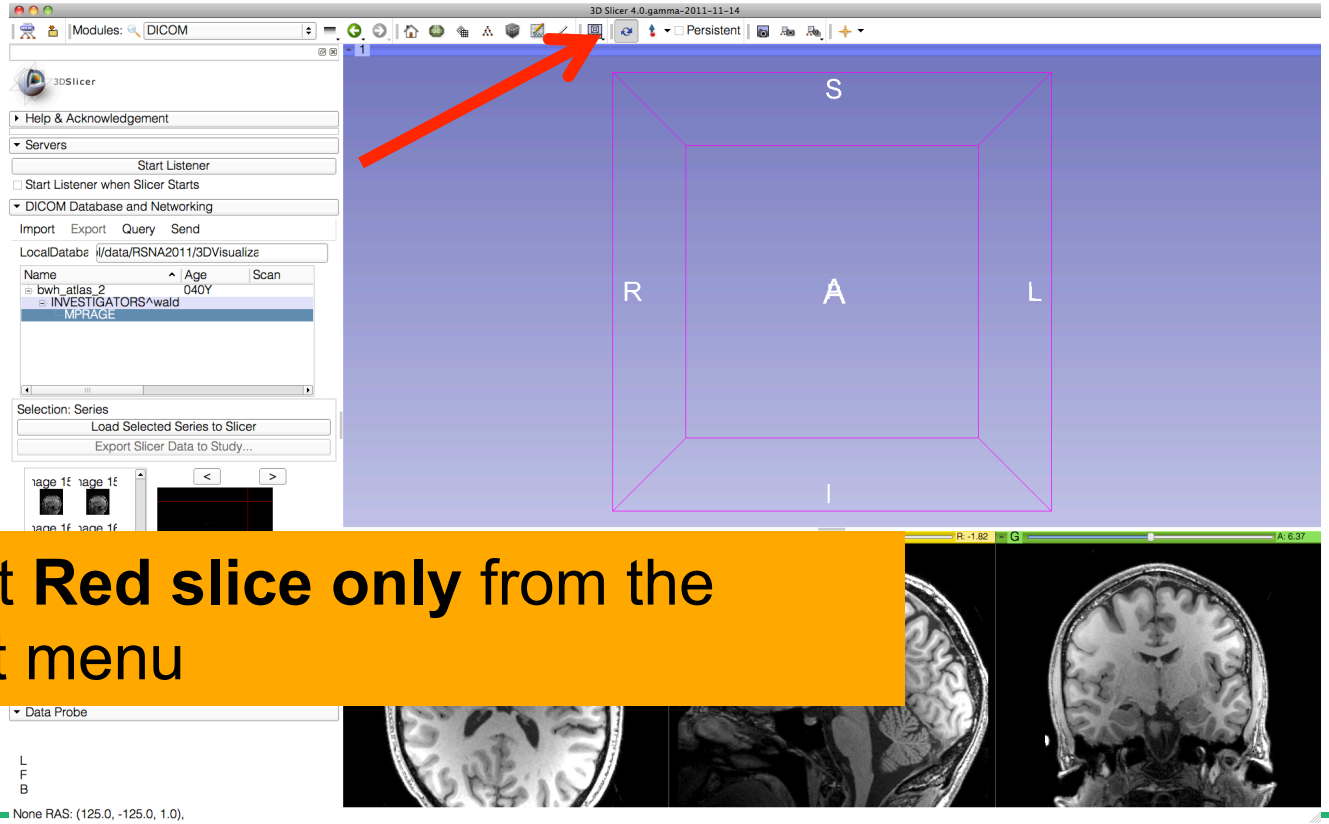
DICOM module



Select **Red slice only** from the layout menu

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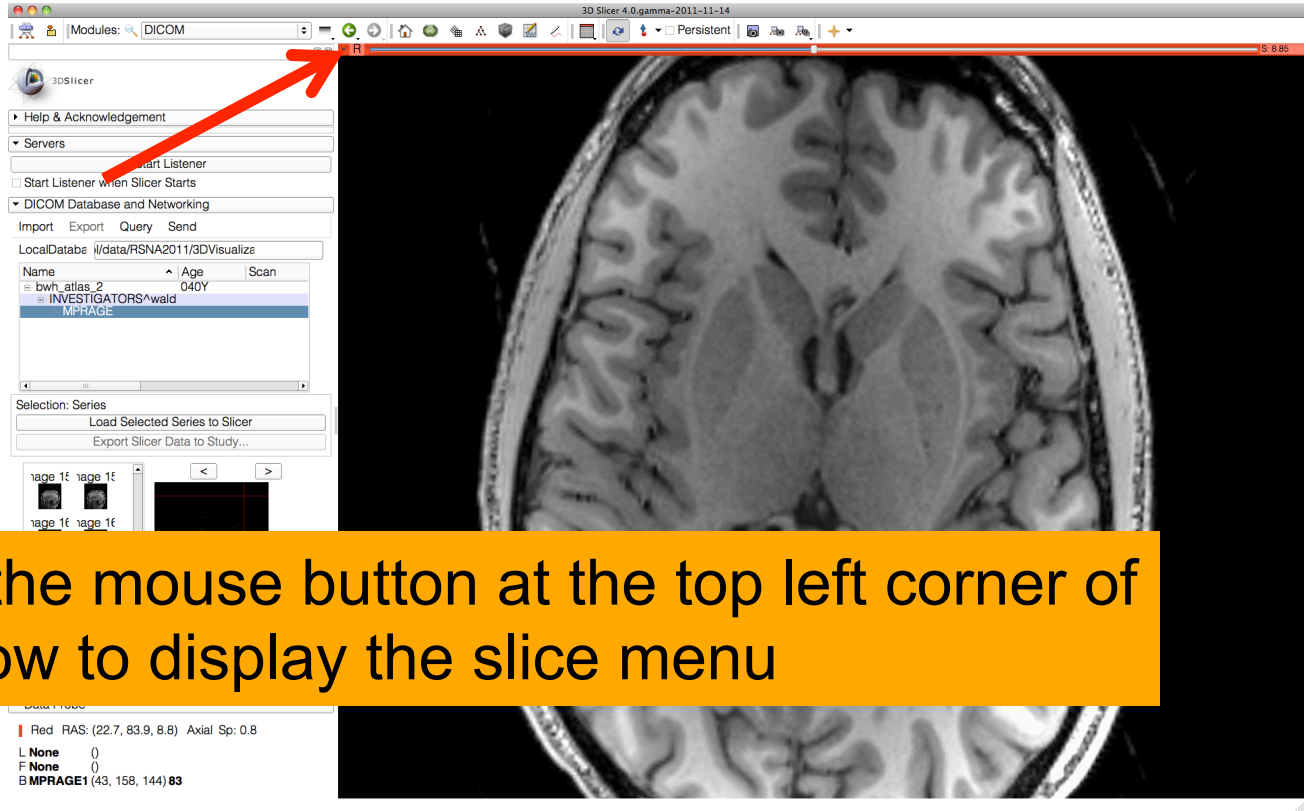
DICOM module



Position the mouse button at the top left corner of the window to display the slice menu

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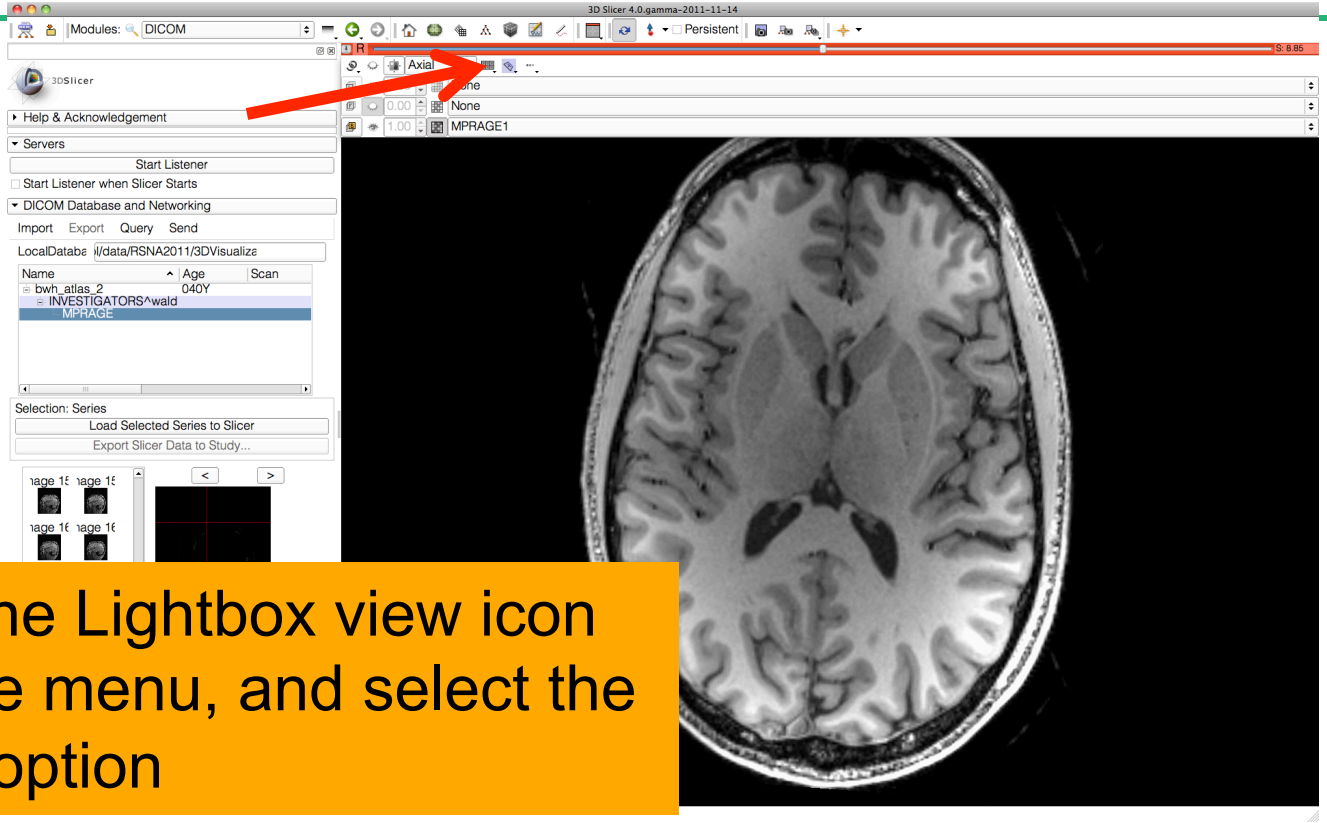
DICOM module



Click on the Lightbox view icon in the slice menu, and select the 6x6 view option

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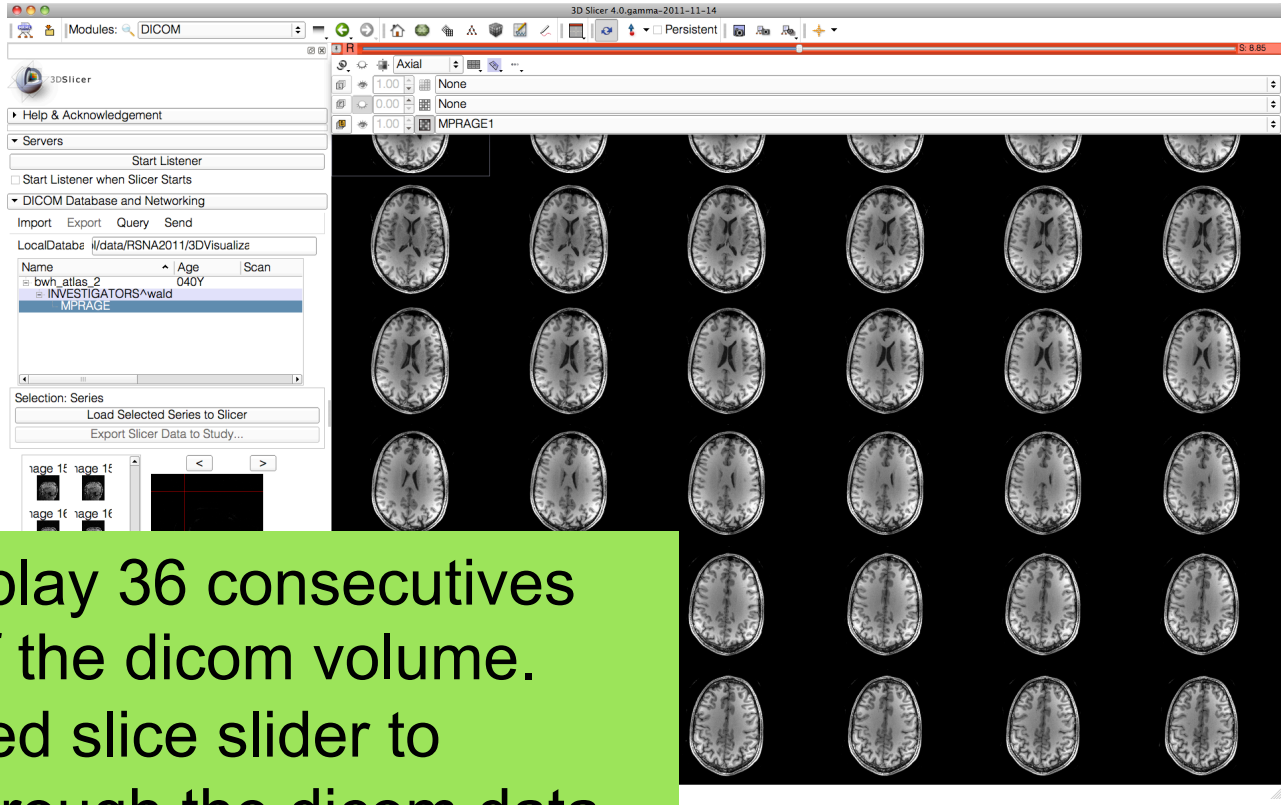
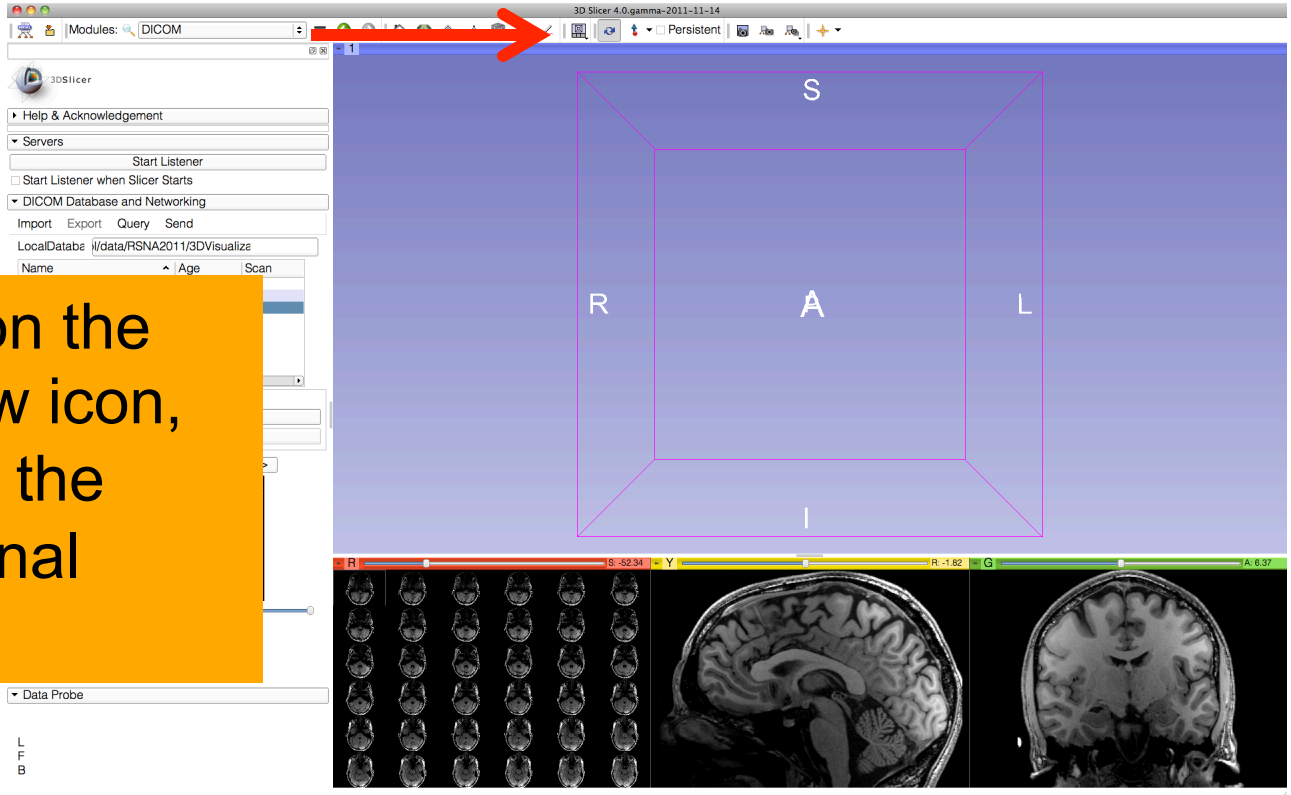
DICOM module



Slicer display 36 consecutives images of the dicom volume. Use the red slice slider to browse through the dicom data

DICOM module



Left click on the red window icon, and select the Conventional layout

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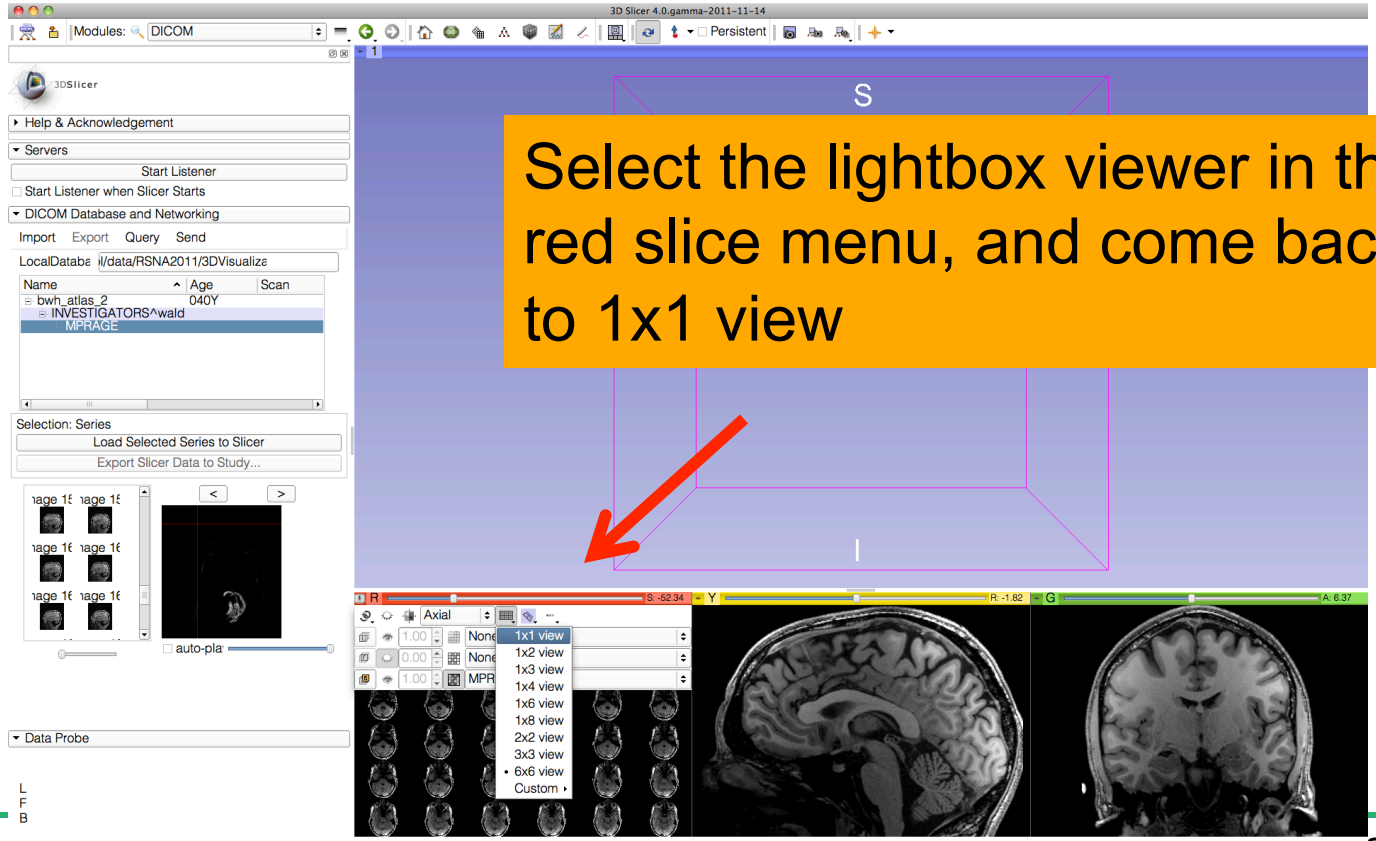
DICOM module



Select the lightbox viewer in the red slice menu, and come back to 1x1 view

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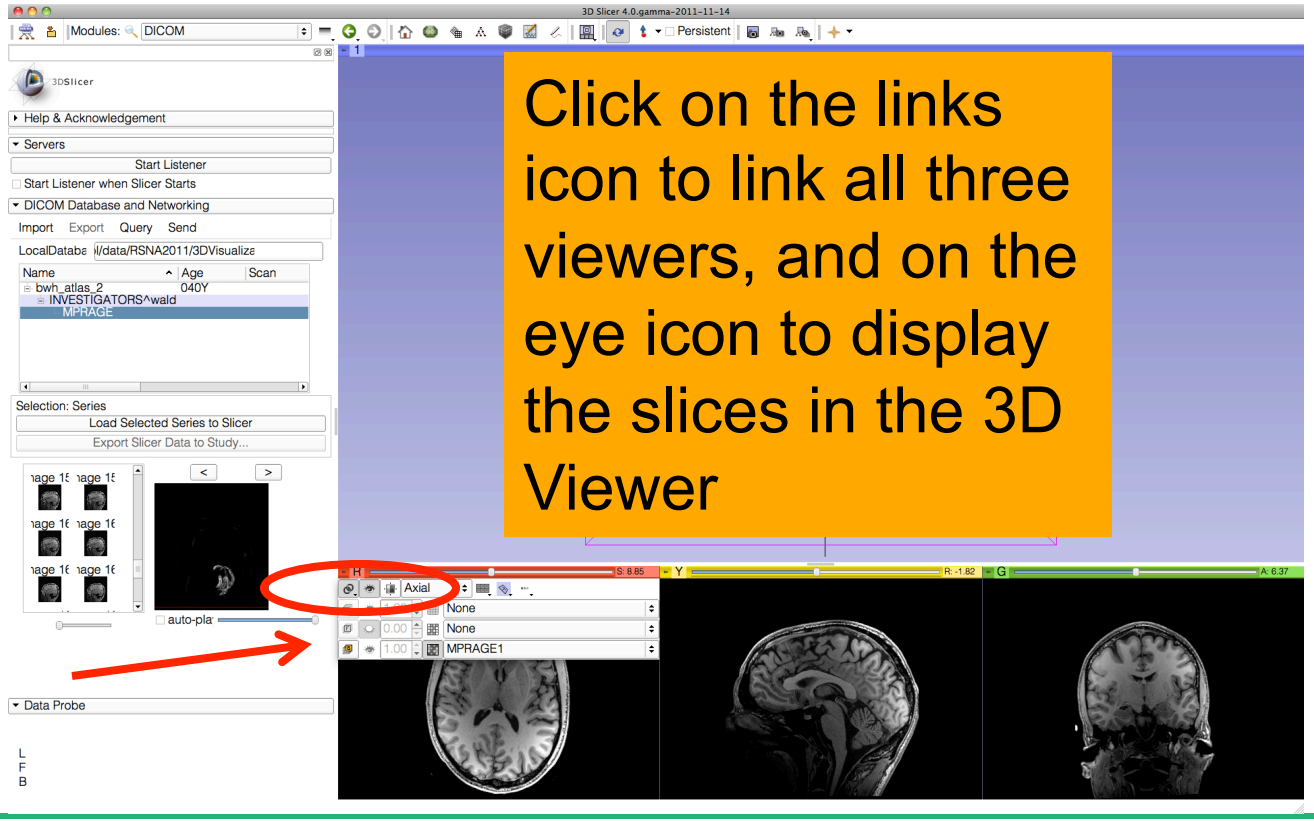
DICOM module



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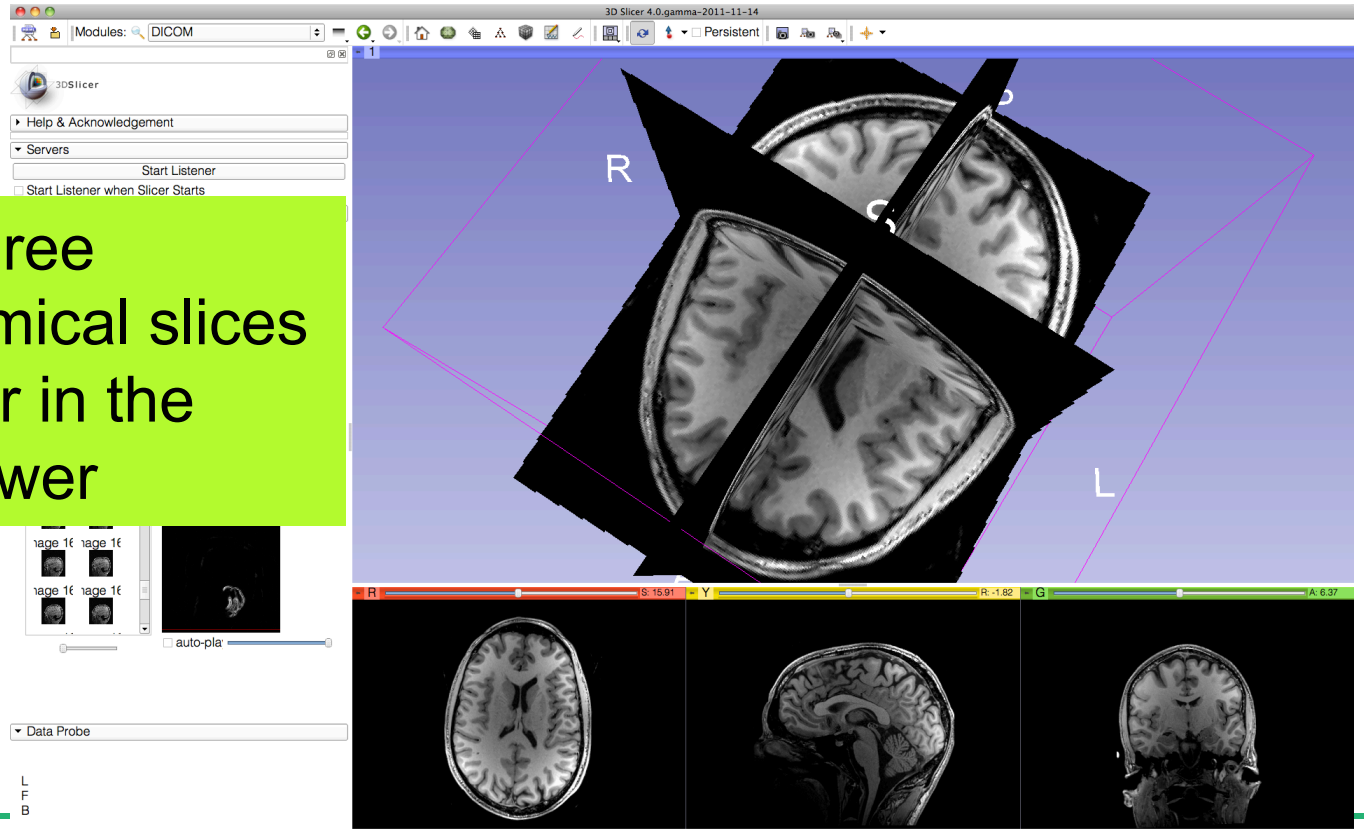
DICOM module



The three anatomical slices appear in the 3DViewer

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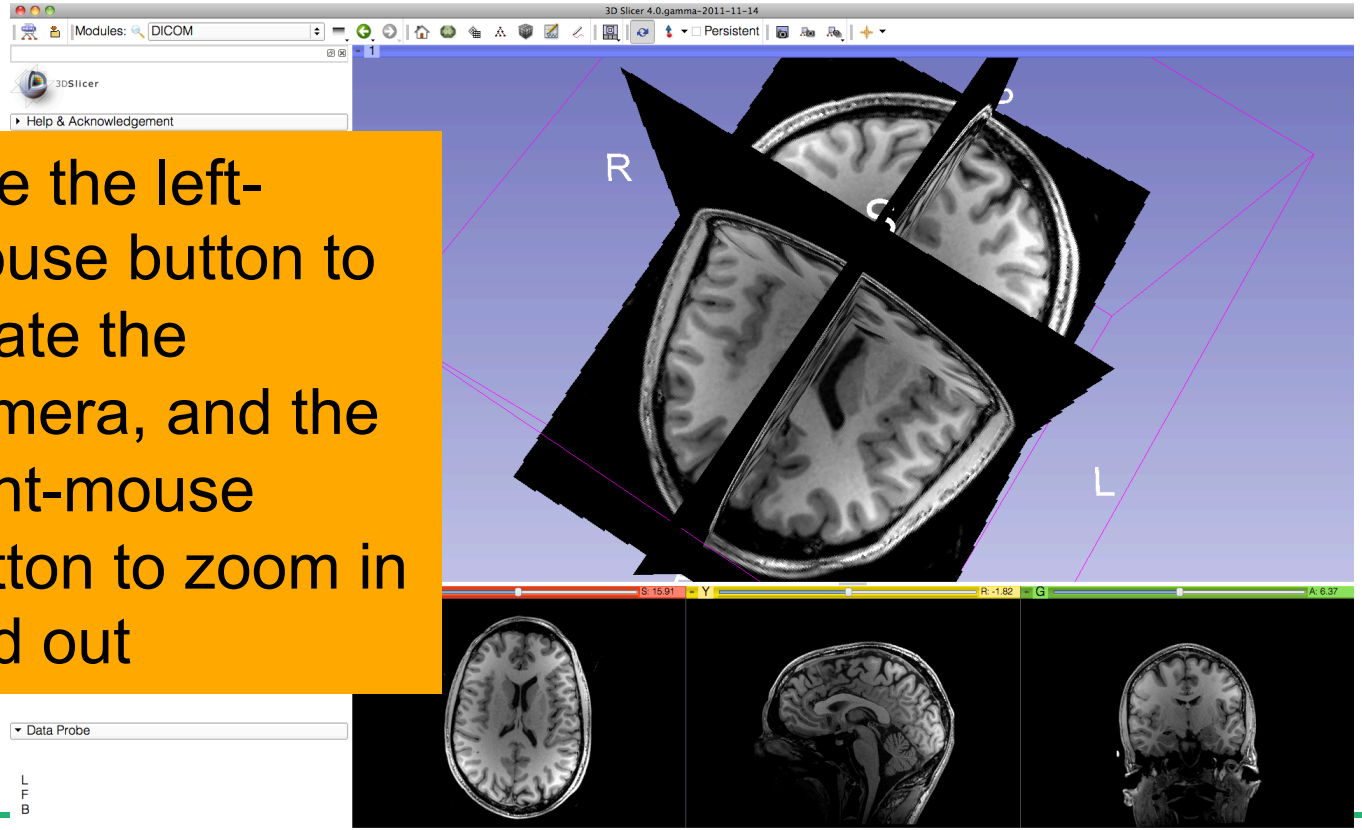
DICOM module



Use the left-mouse button to rotate the camera, and the right-mouse button to zoom in and out

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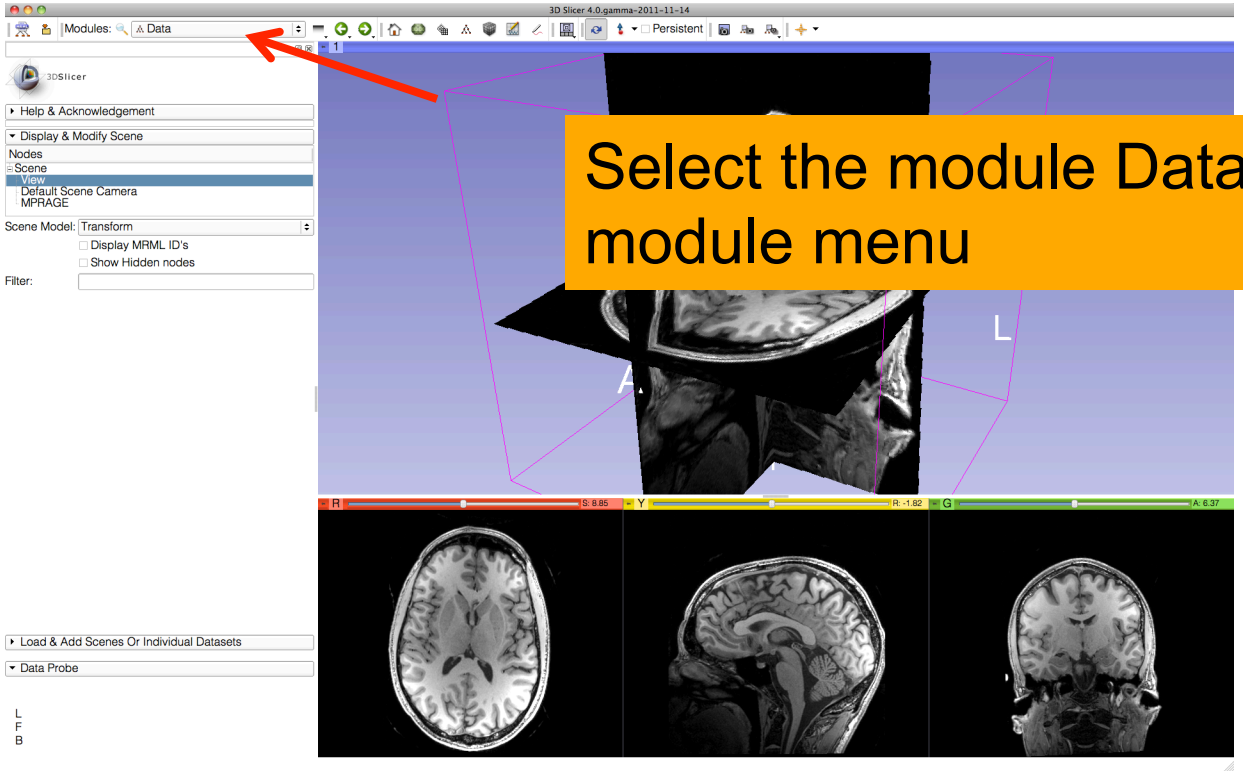
DICOM module



Select the module Data from the module menu

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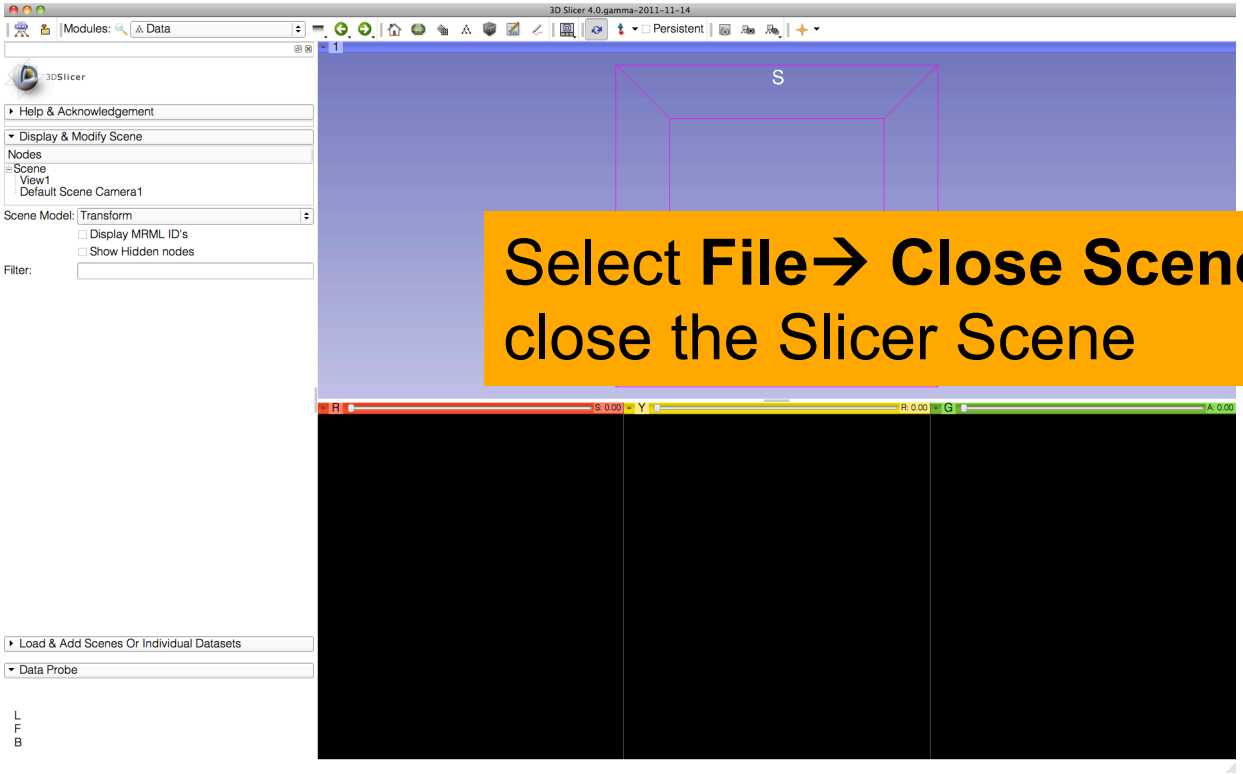
Close the Scene



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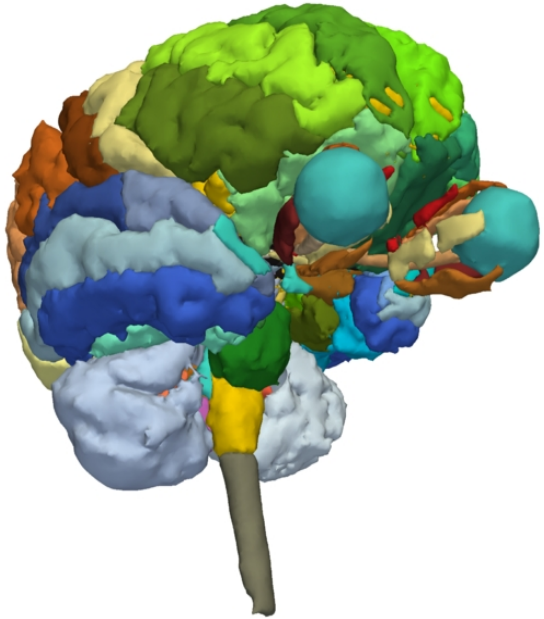

Part 2:

3D visualization of surface models of the brain

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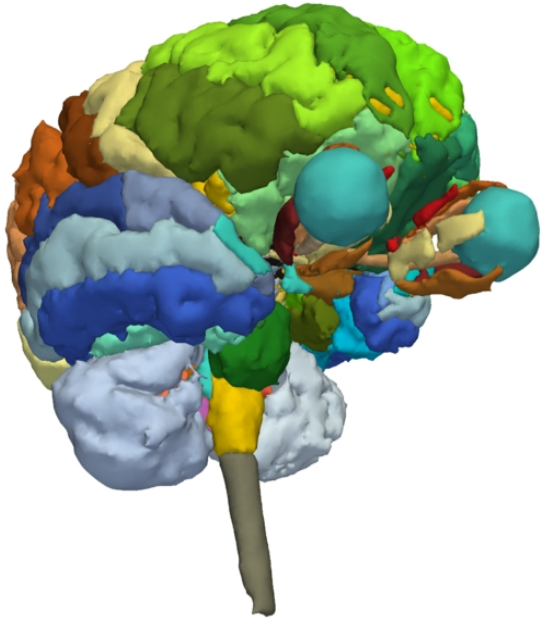
3D Slicer Scene



- A Slicer scene is a MRML file which contains a list of elements loaded into Slicer (volumes, models, fiducials…)
- The tutorial scene contains an MR scan of the brain and 3D surface models of anatomical structures.

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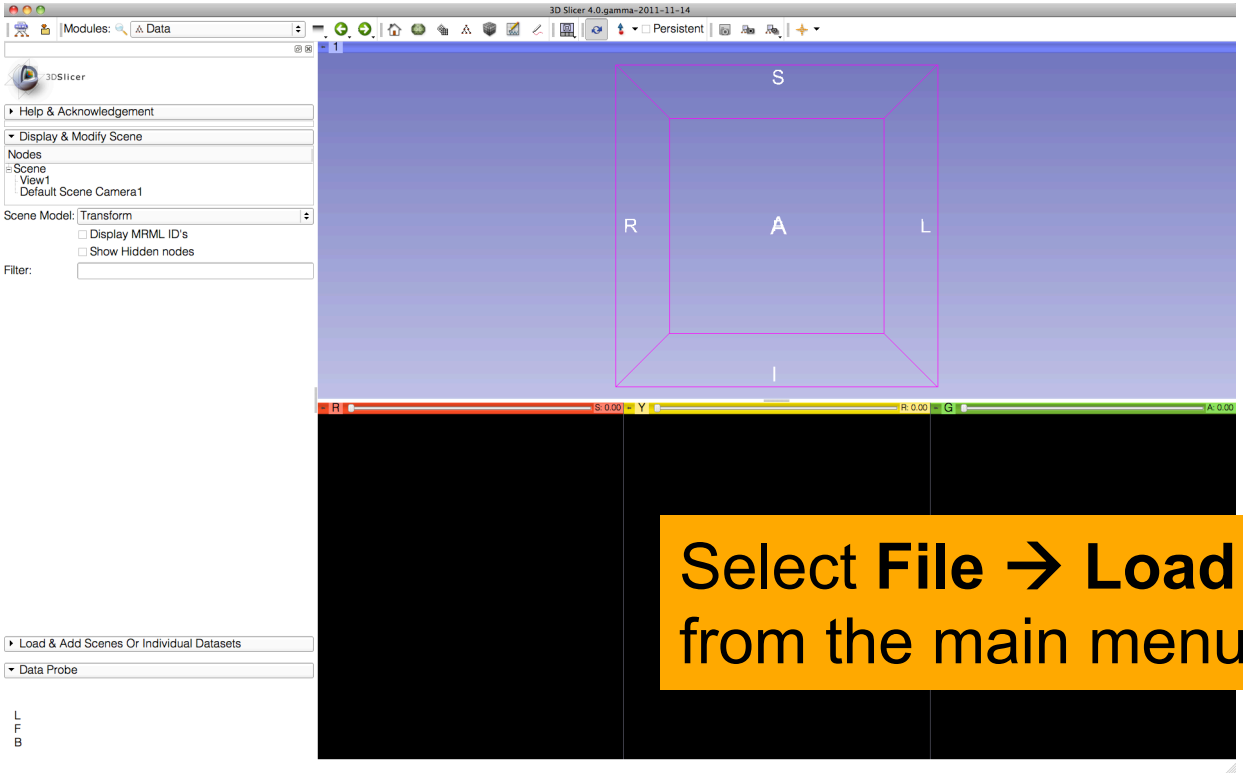
Loading a Scene



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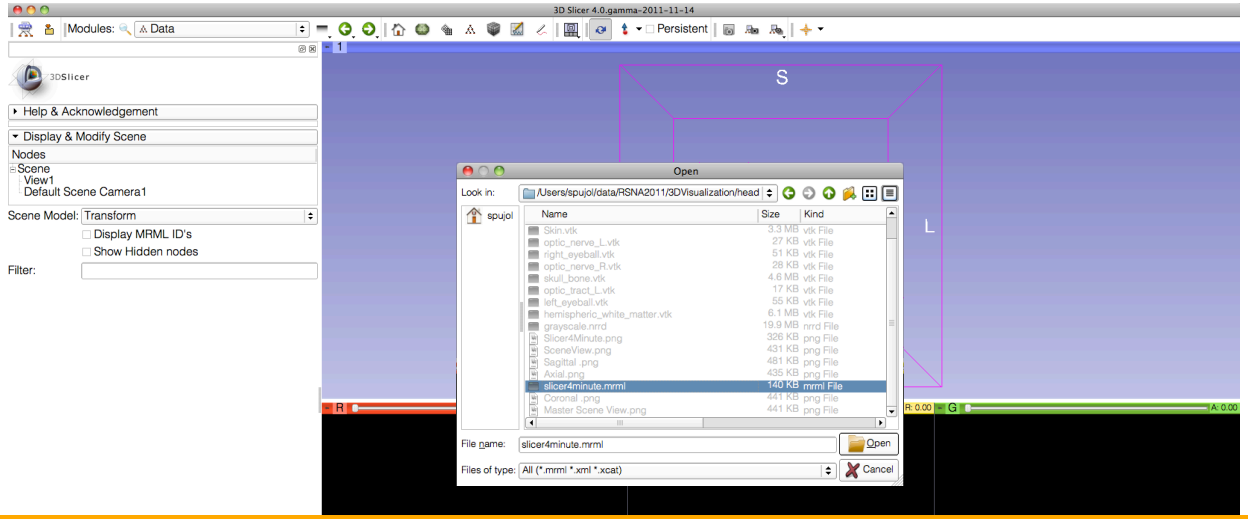
Loading a Scene



Browse to the directory **3D**, located on the Desktop:

C:\Documents and Settings\Administrator\Desktop\3D

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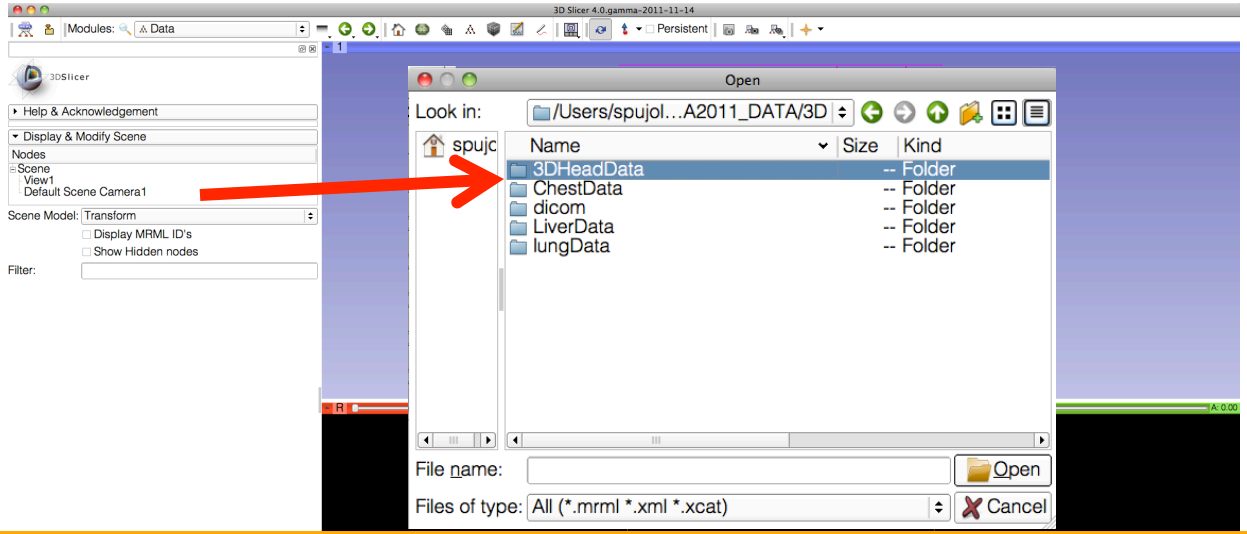
Loading a Scene



Select the directory **3DHeadData**, and open the file **slicer4minute.mrml**

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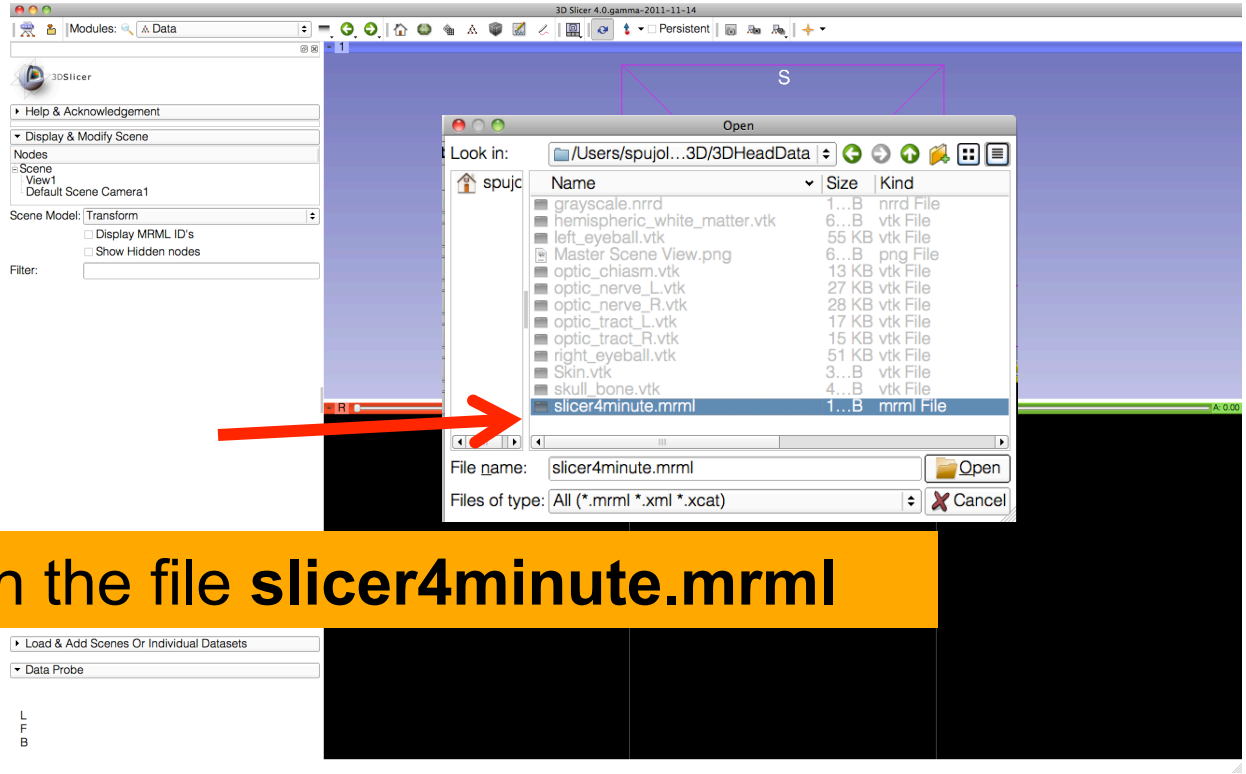
Loading a Scene



Open the file **slicer4minute.mrml**

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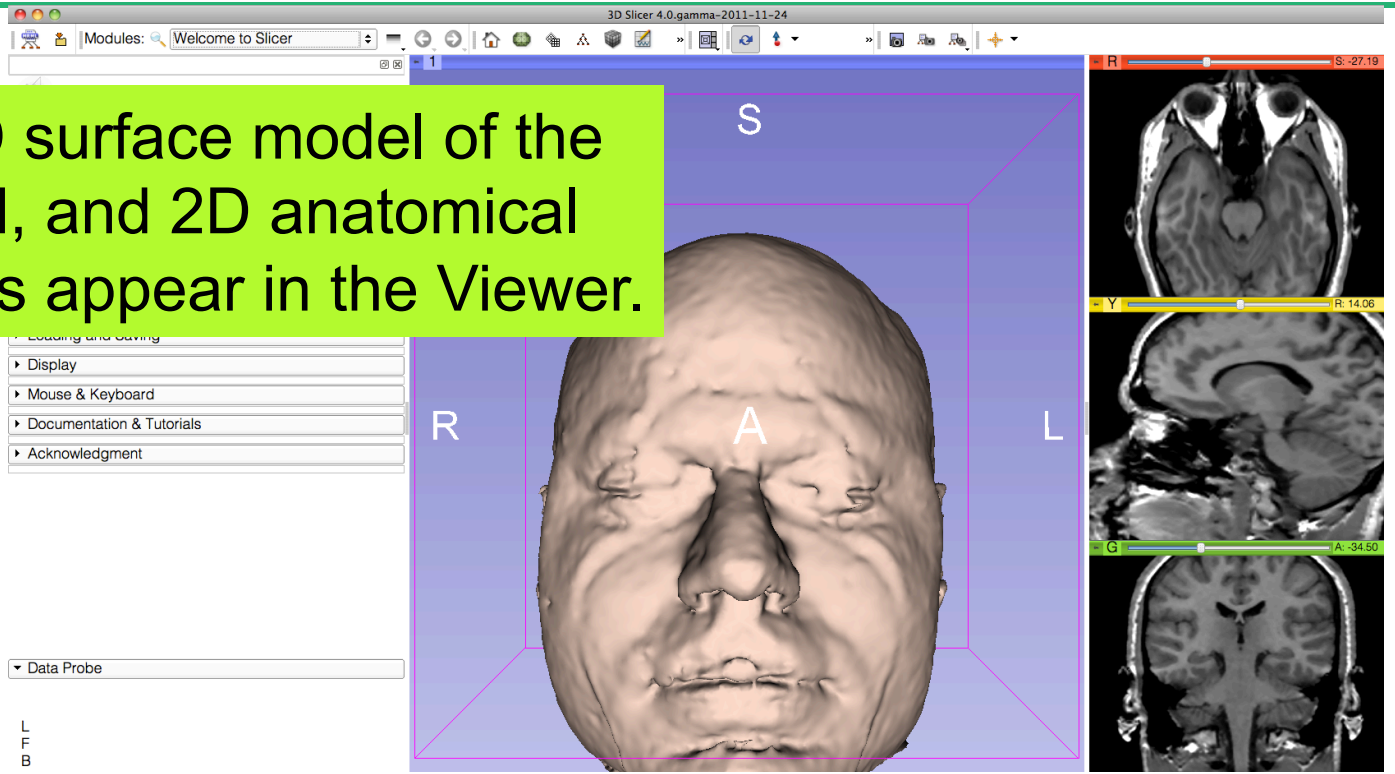
Loading the Slicer Scene

A 3D surface model of the head, and 2D anatomical slices appear in the Viewer.



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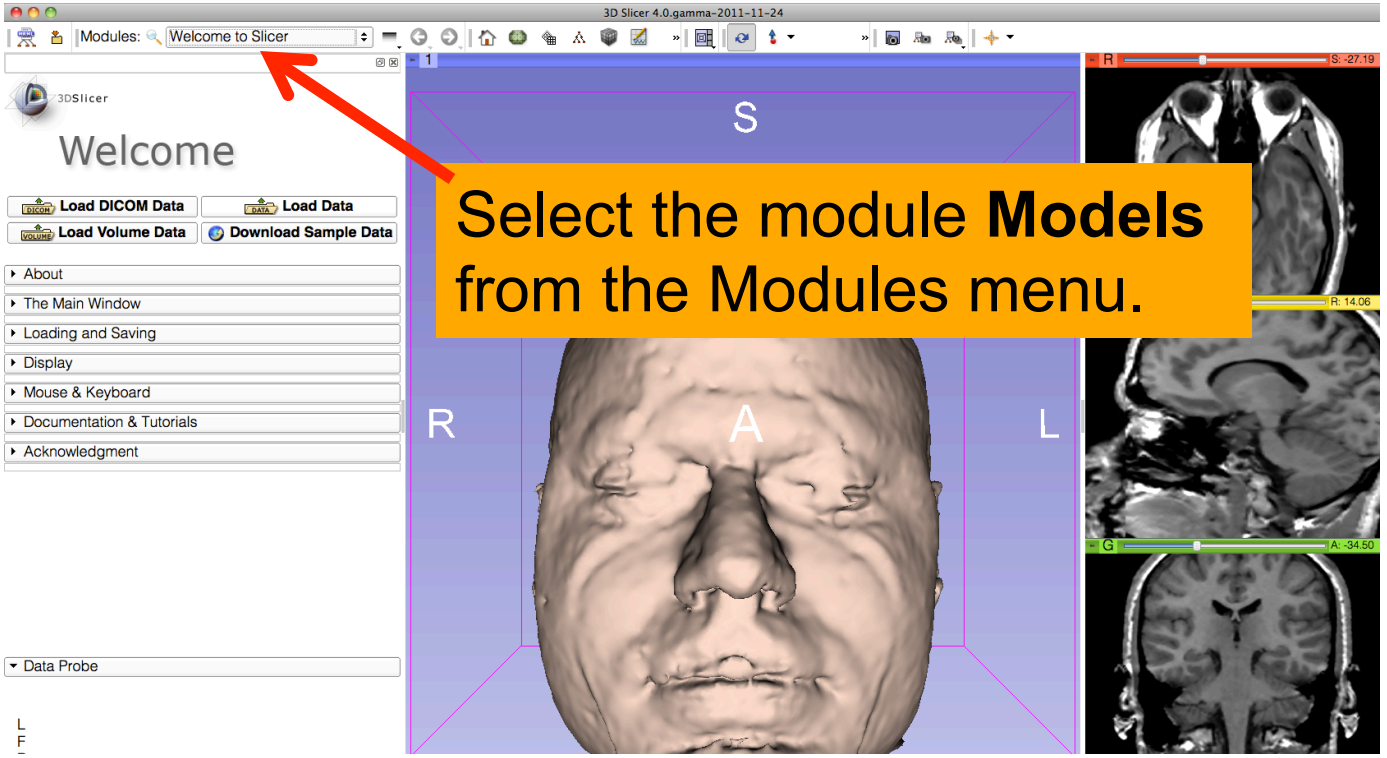
Loading the Slicer Scene



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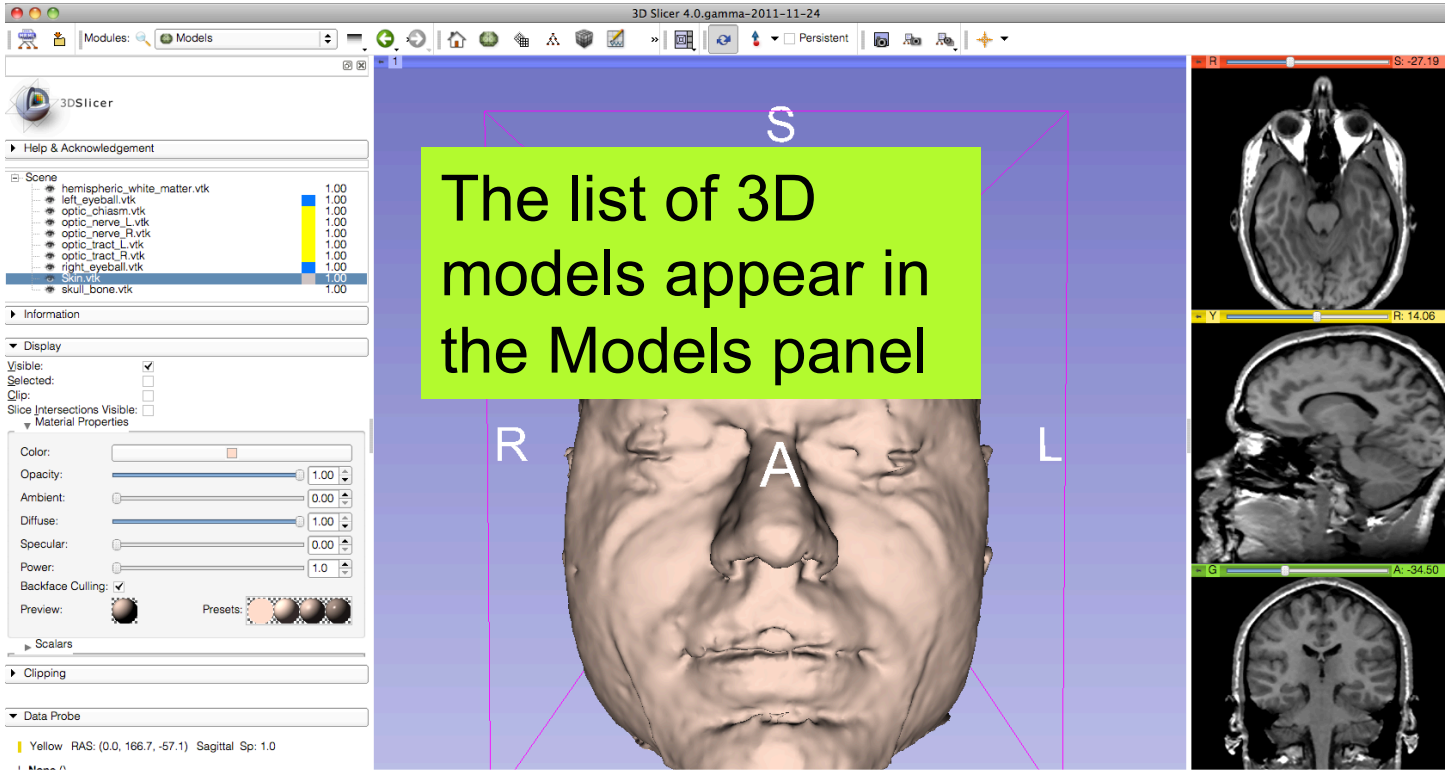
Models module



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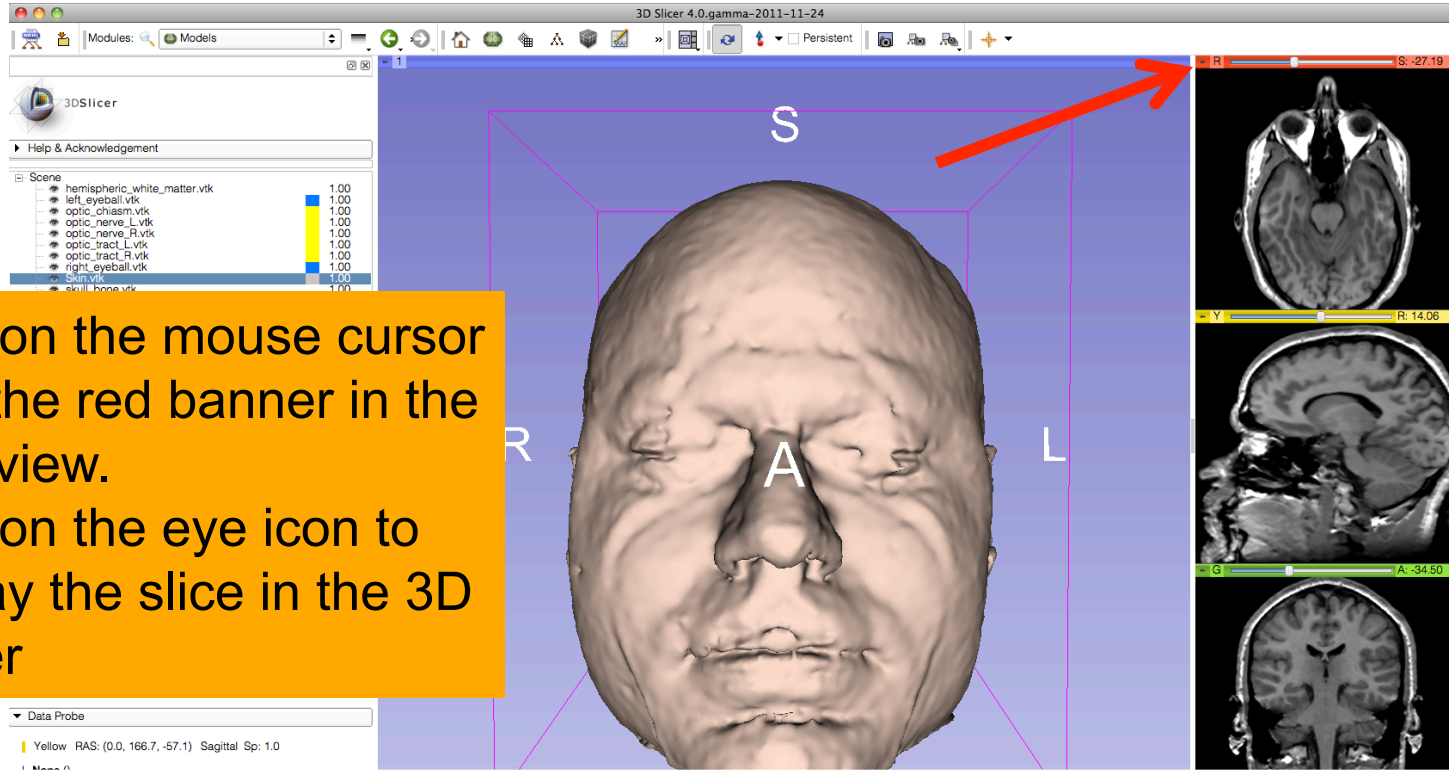
3D Visualization



Position the mouse cursor over the red banner in the axial view.
Click on the eye icon to display the slice in the 3D viewer

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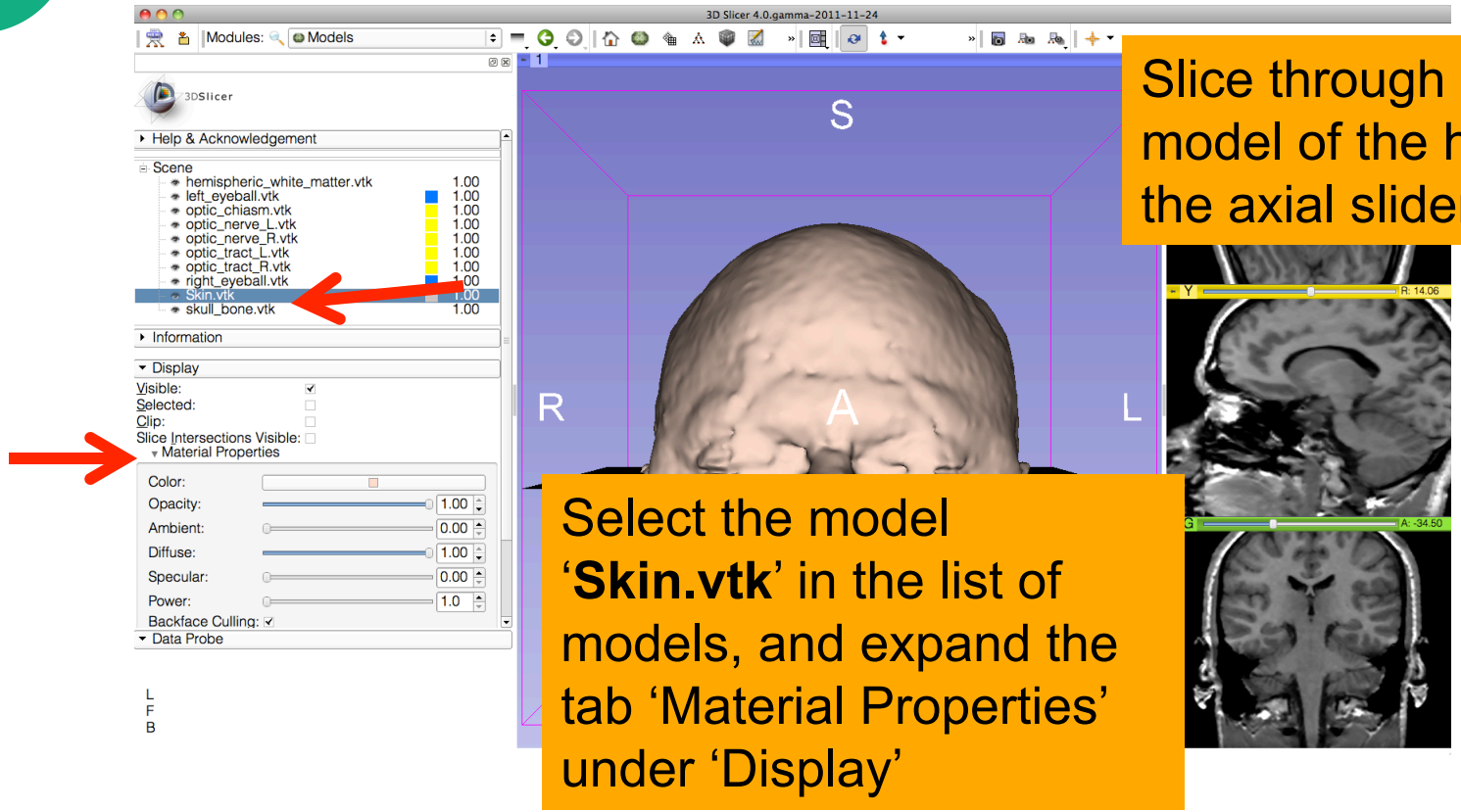
3D Visualization



Slice through the 3D model of the head using the axial slider

Select the model '**Skin.vtk**' in the list of models, and expand the tab 'Material Properties' under 'Display'

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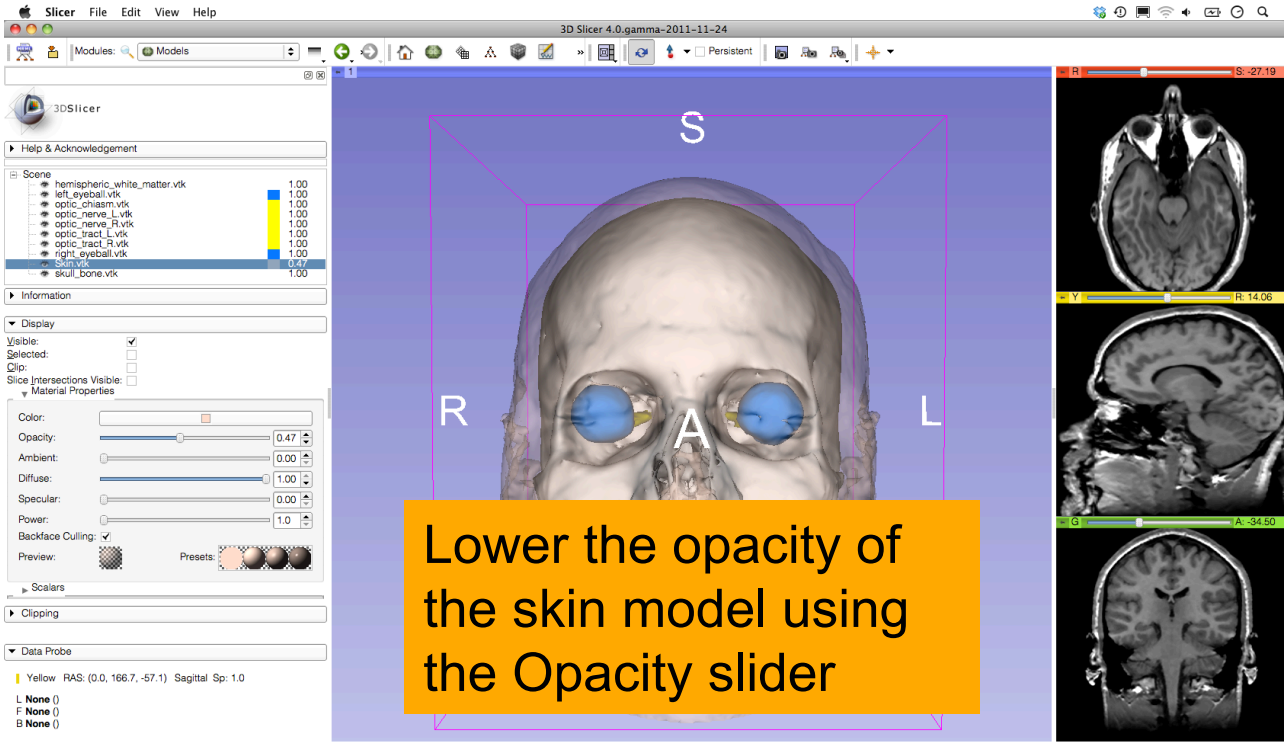
3D Visualization



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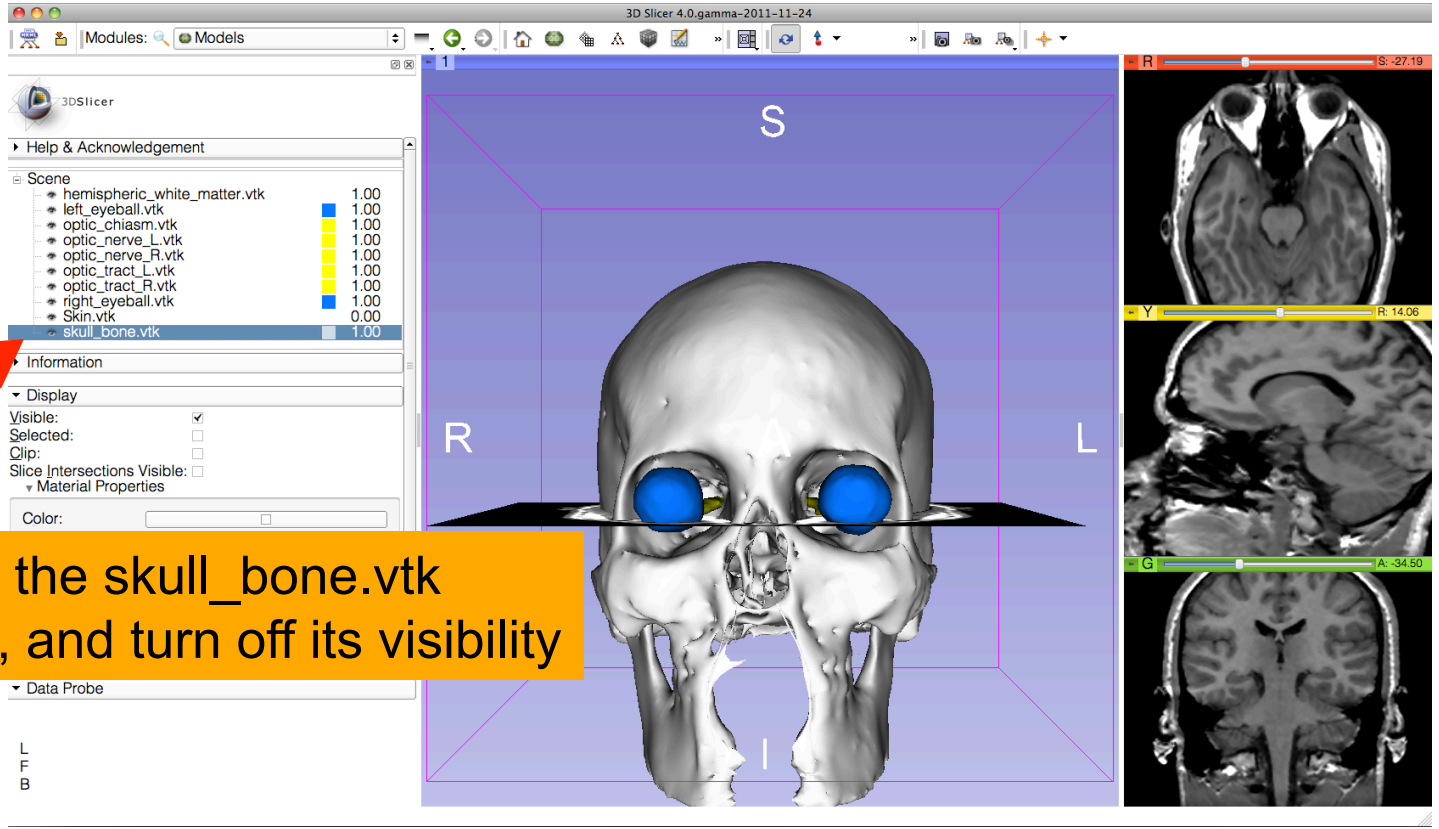
3D Visualization



Select the skull_bone.vtk model, and turn off its visibility

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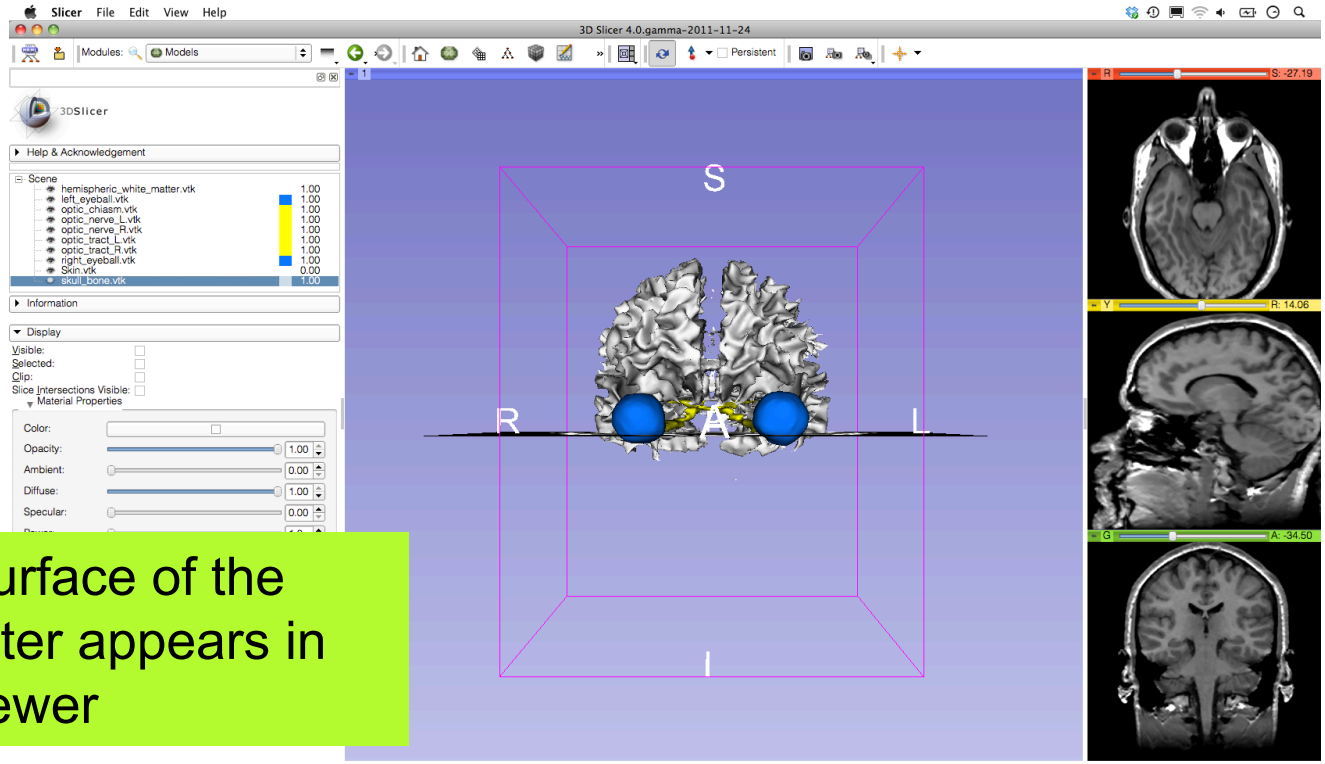
3D Visualization



The 3D surface of the white matter appears in the 3D viewer

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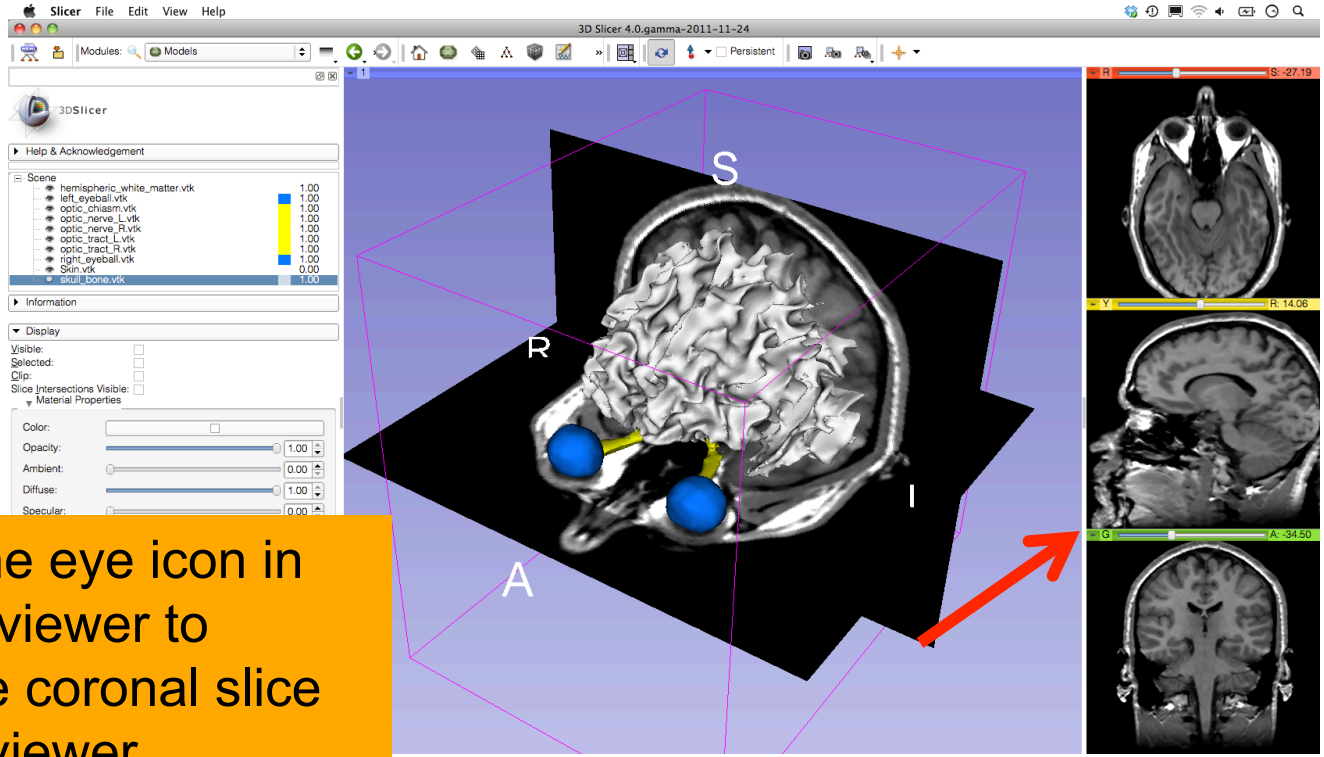
3D Visualization



Click on the eye icon in the green viewer to display the coronal slice in the 3D viewer

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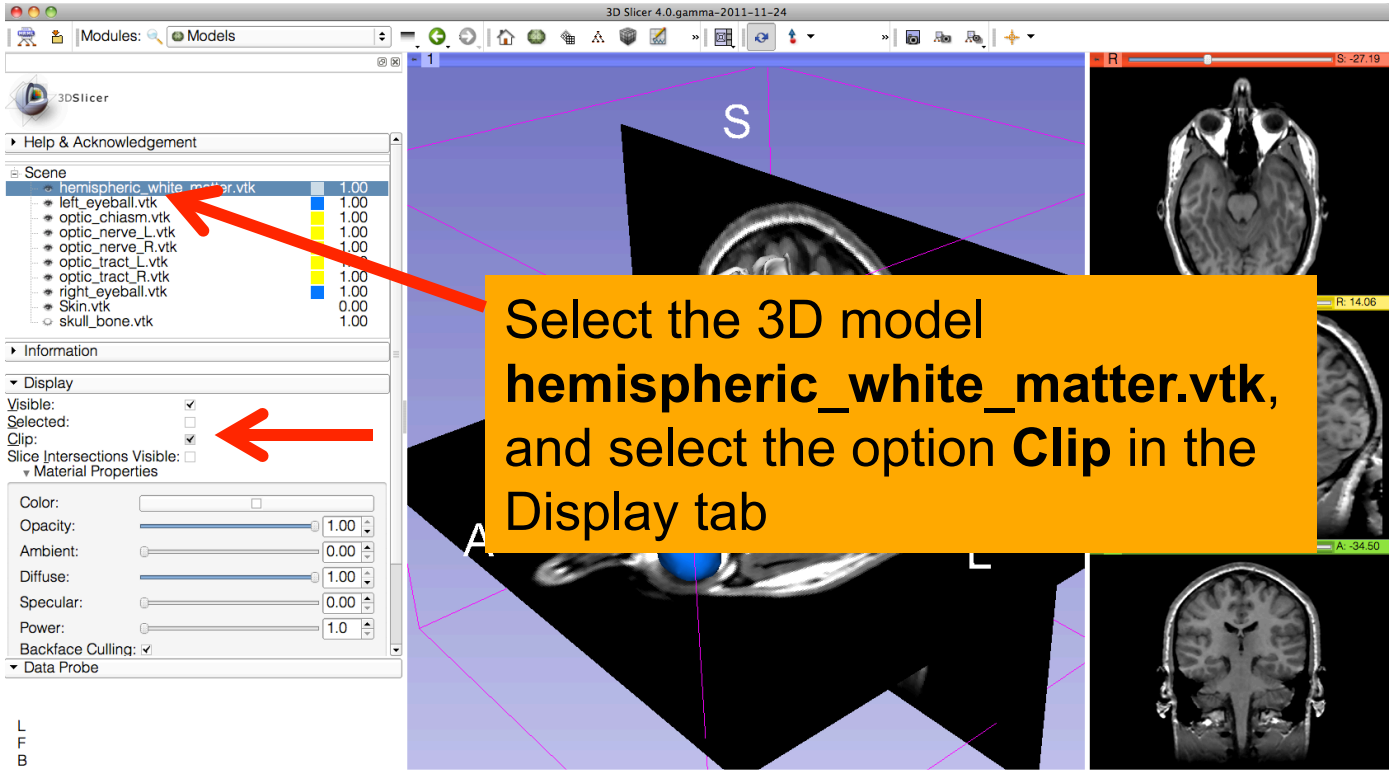
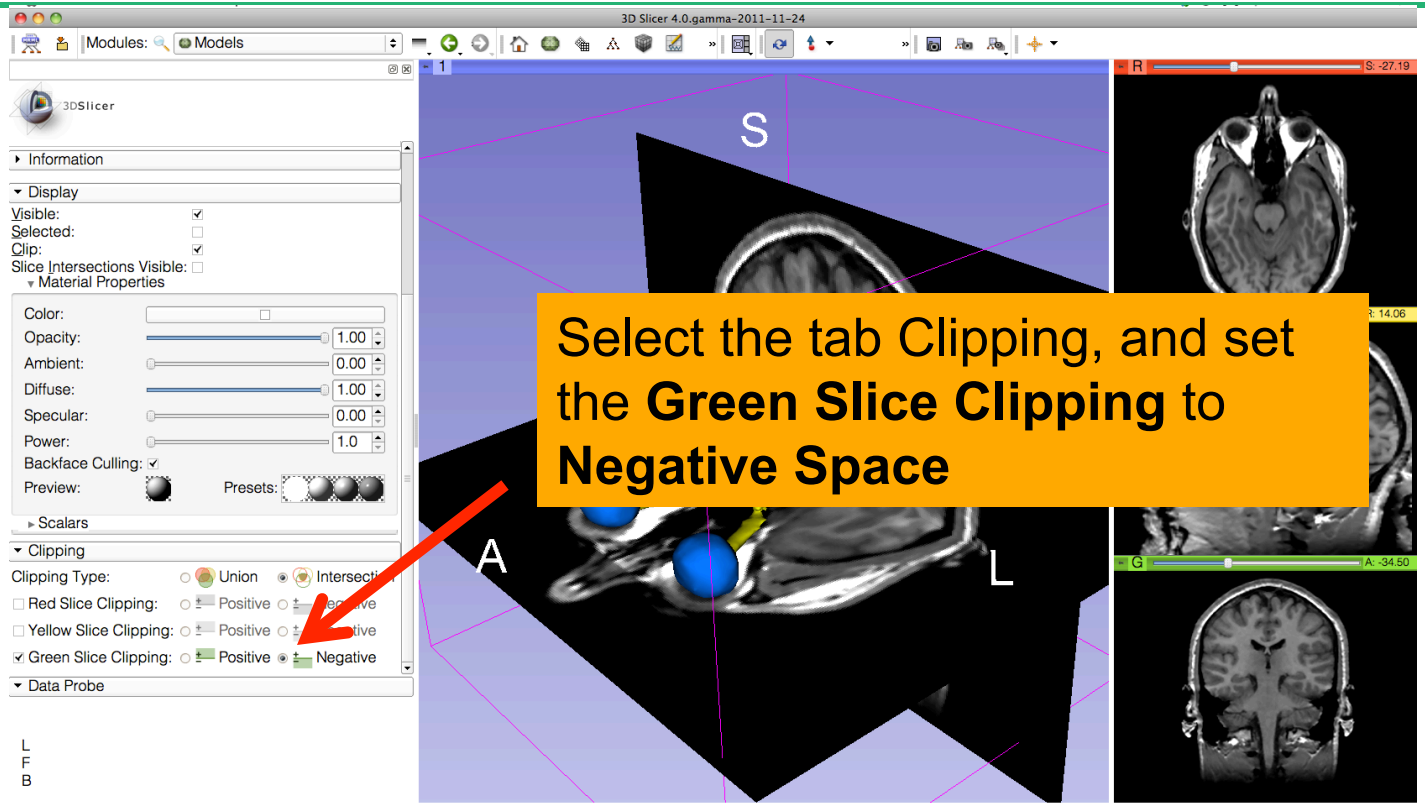
3D Visualization



©2011 Surgical Planning Laboratory, ARR

3D Visualization



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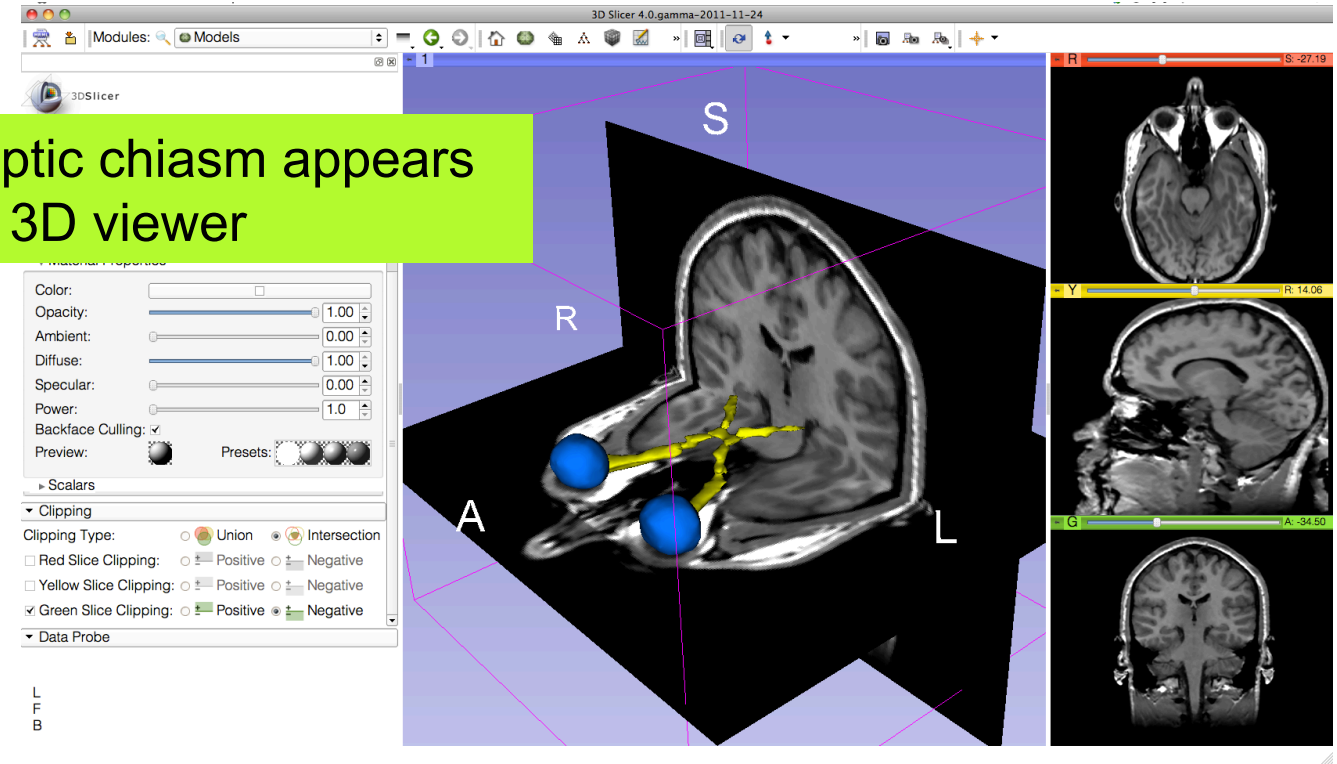
3D Visualization

The optic chiasm appears in the 3D viewer



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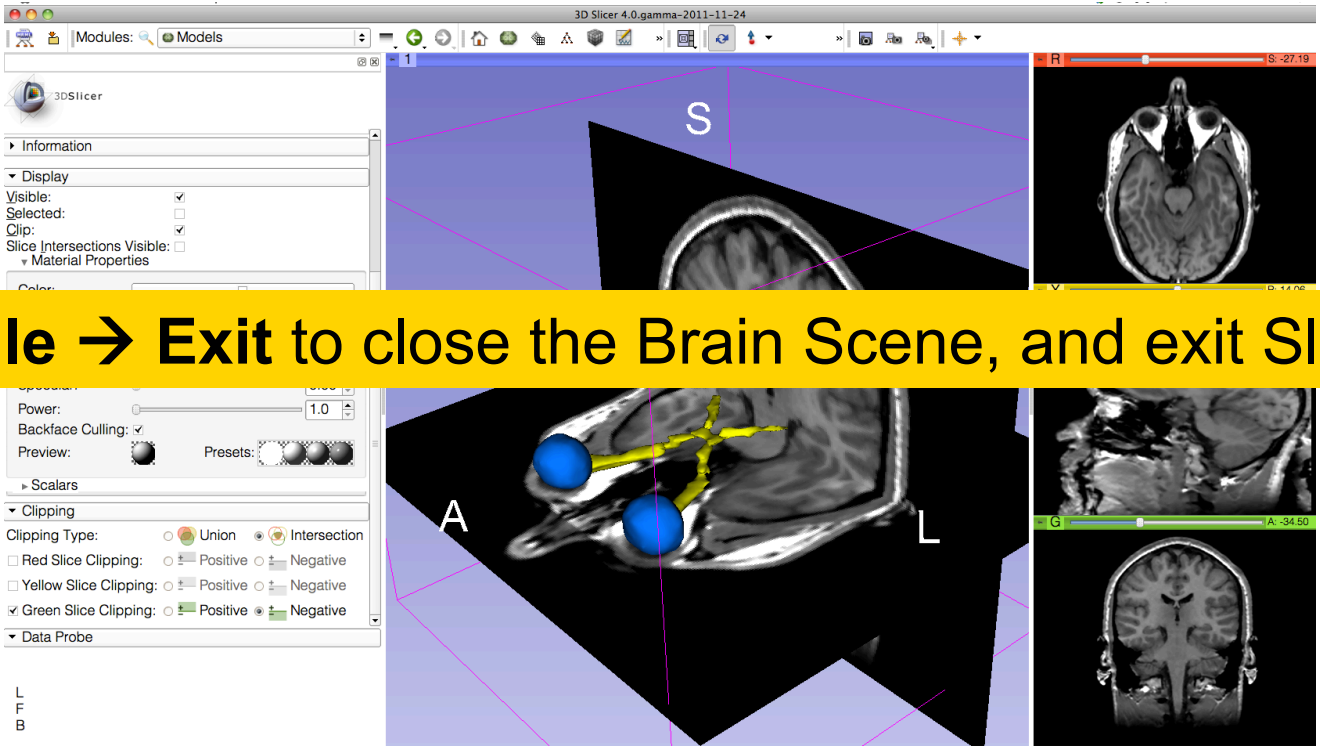
3D Visualization



Select **File → Exit** to close the Brain Scene, and exit Slicer

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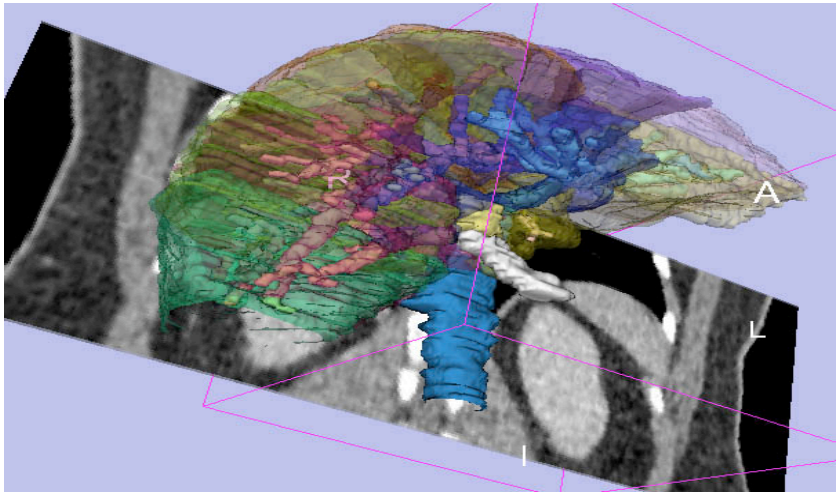

Part 3:

Interactive 3D Visualization of the segments of the liver

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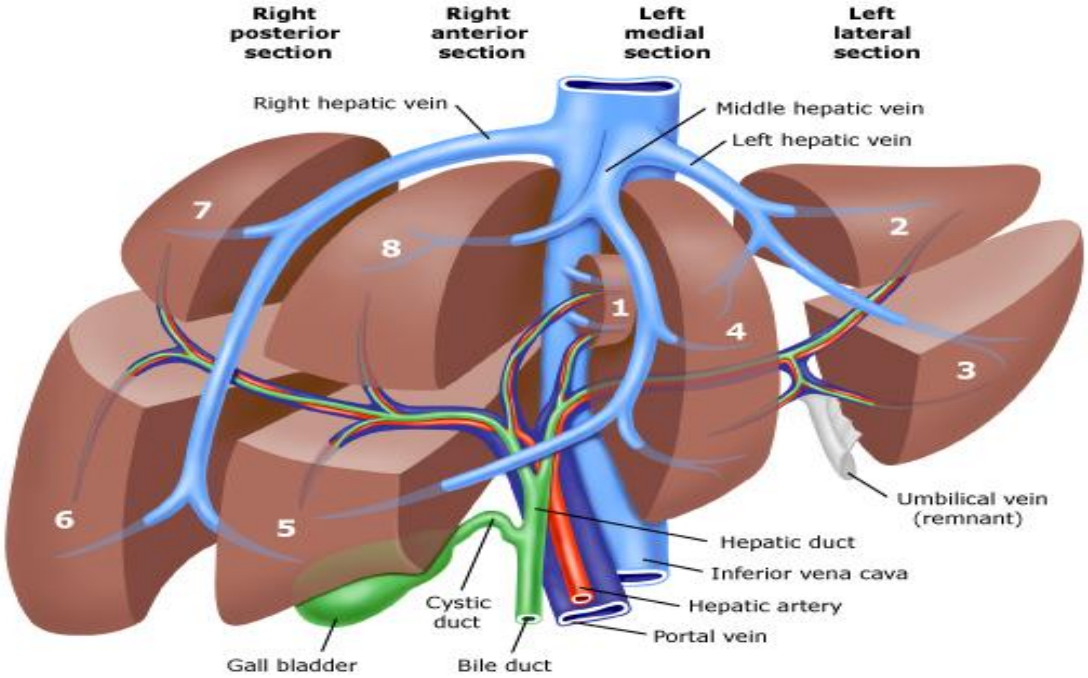
Anatomy of the liver



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Liver dataset

The liver dataset is a contrast-enhanced CT abdominal scan of a healthy 36 year-old male.

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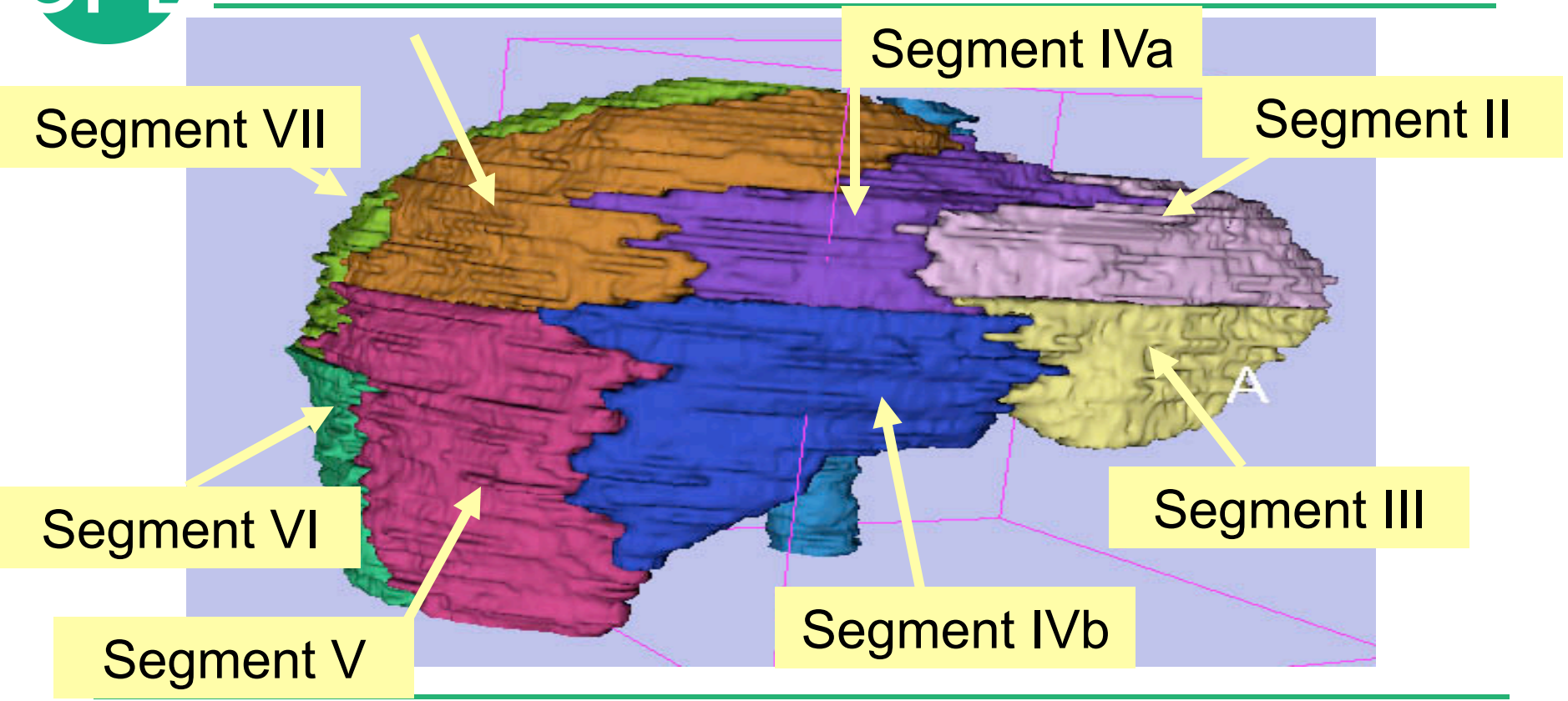
3D segments of the liver



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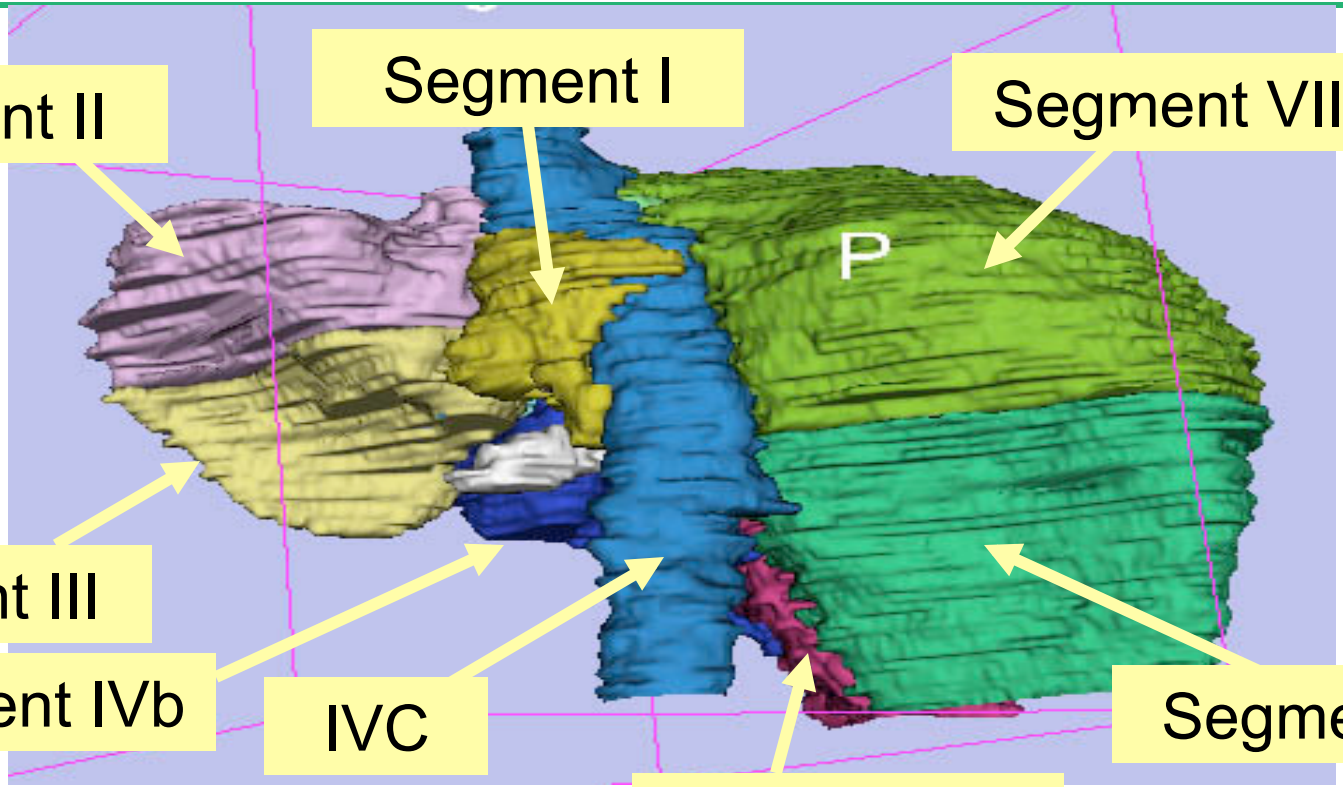
3D segments of the liver



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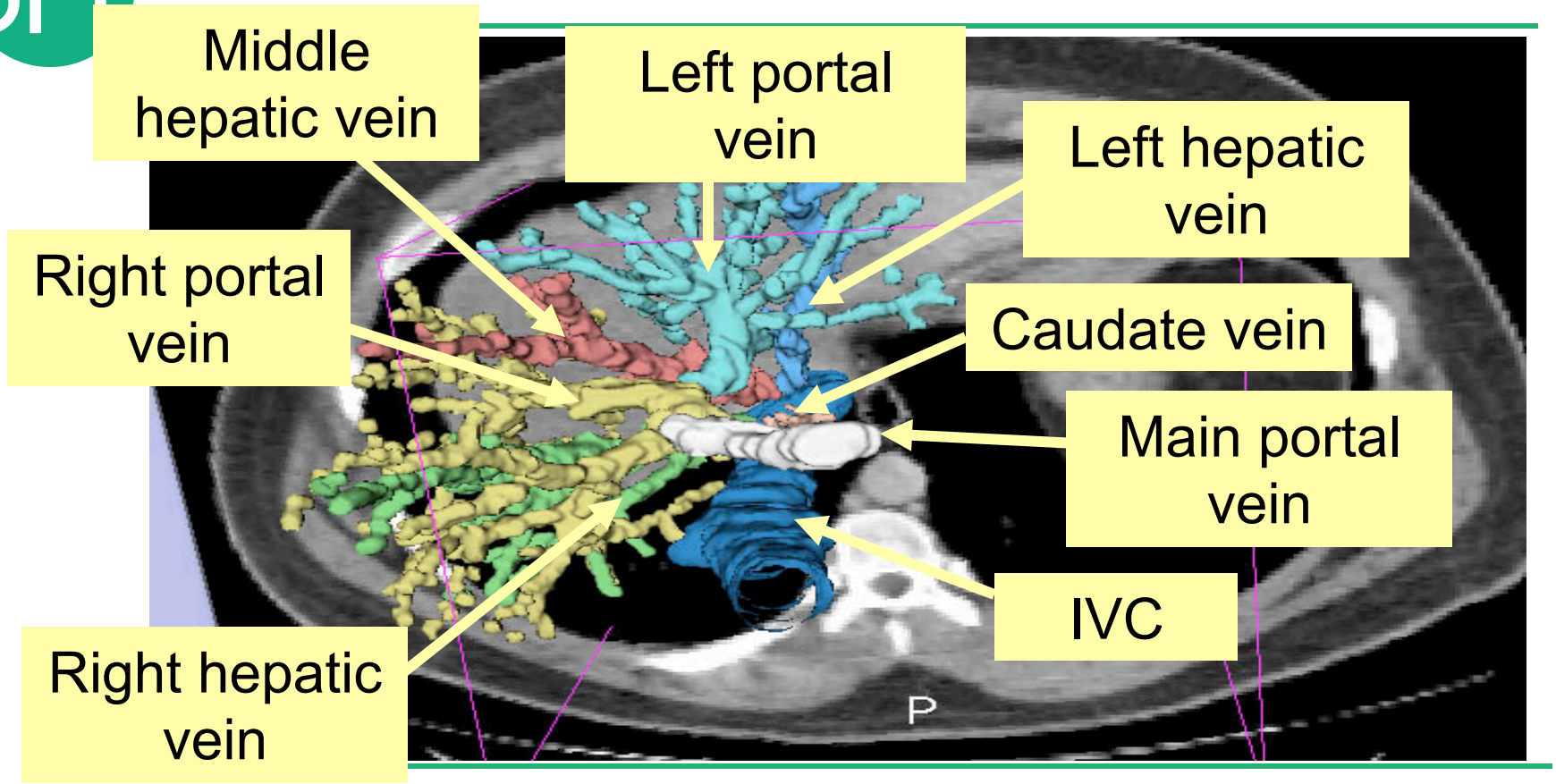
Liver vasculature



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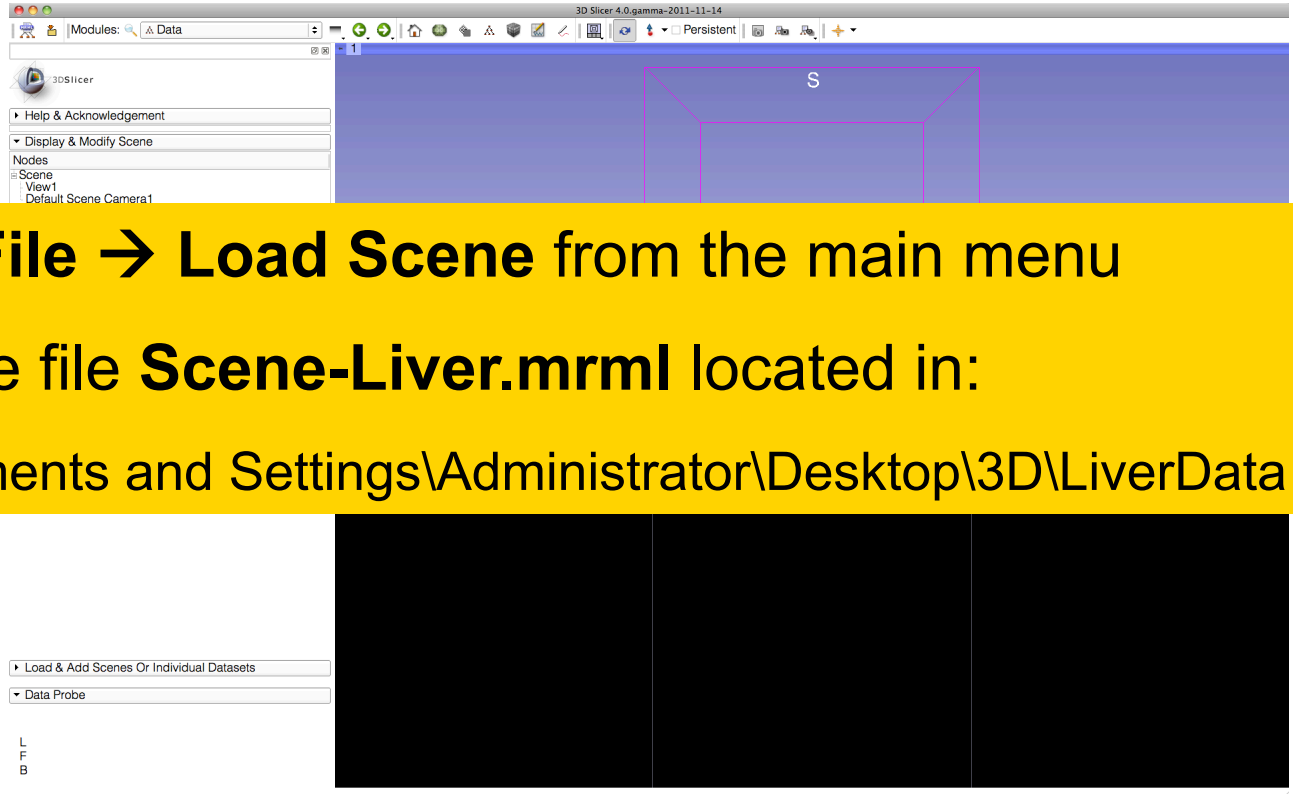
Loading the Liver Scene



Select **File → Load Scene** from the main menu

Load the file **Scene-Liver.mrml** located in:

C:\Documents and Settings\Administrator\Desktop\3D\LiverData

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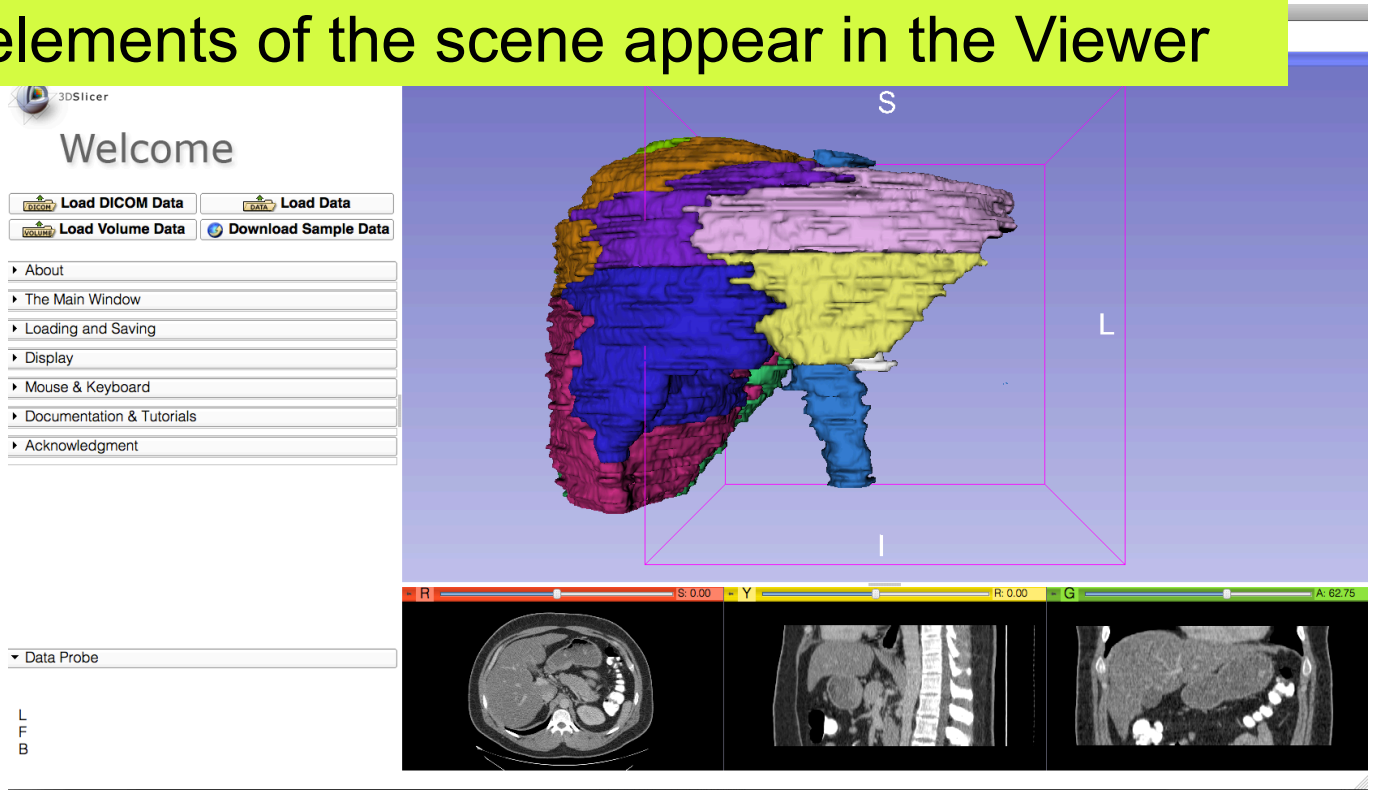
Liver Segments Scene

The elements of the scene appear in the Viewer



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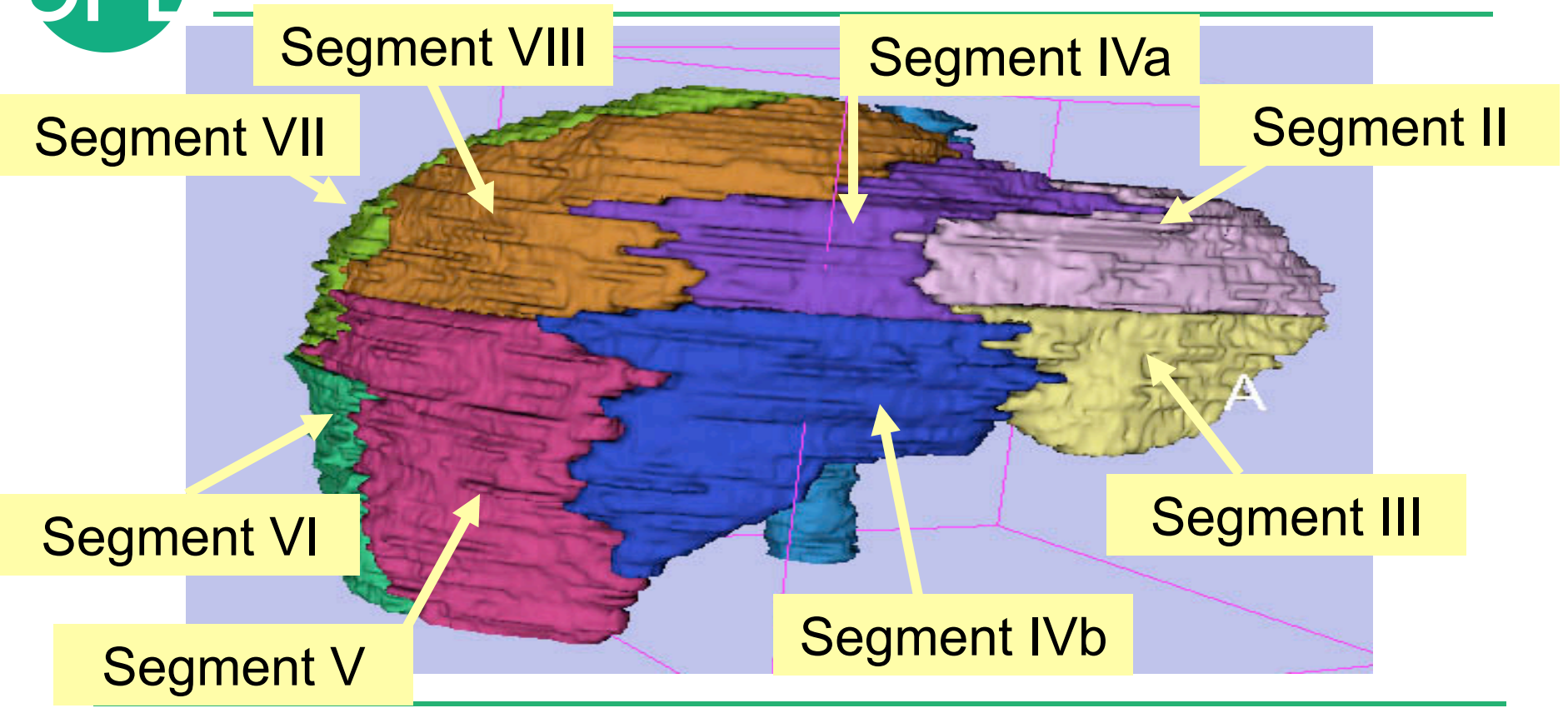
3D models of the liver



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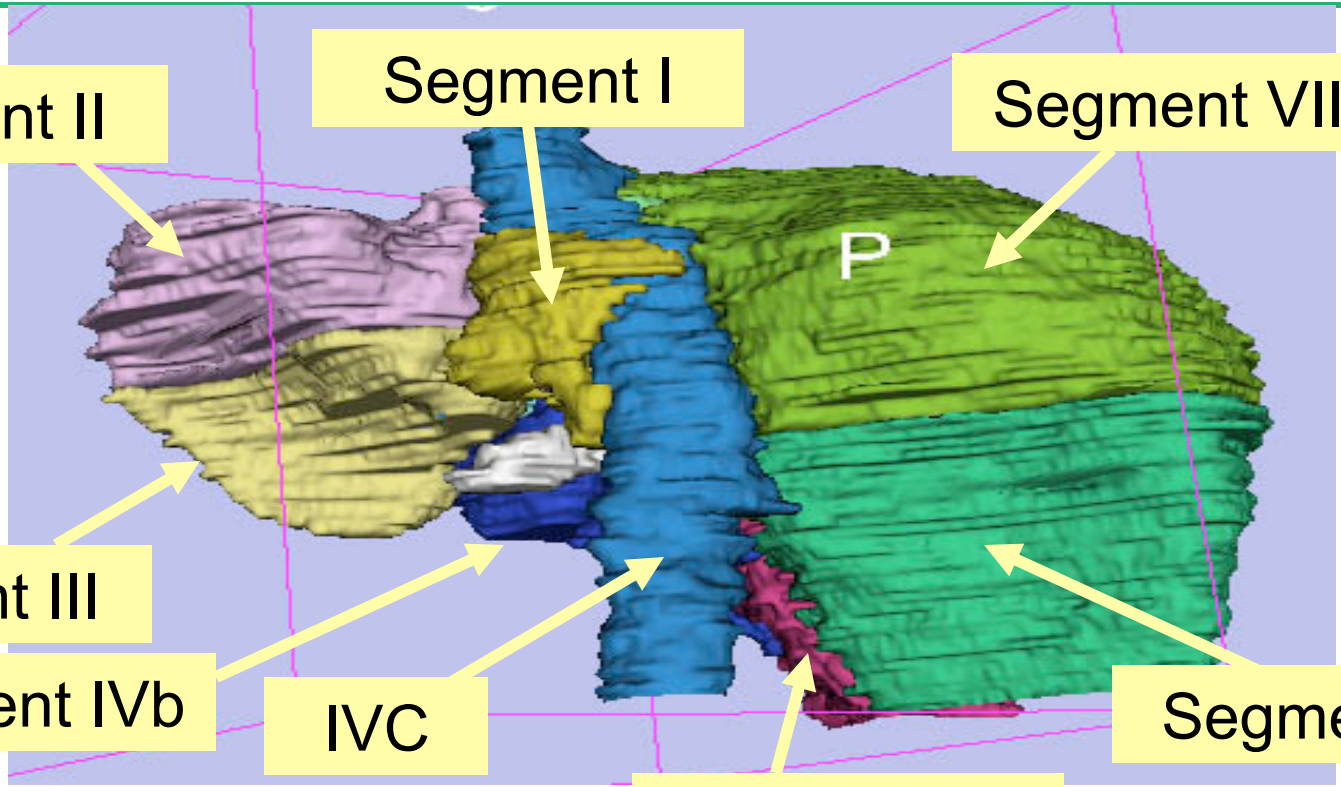
3D models of the liver



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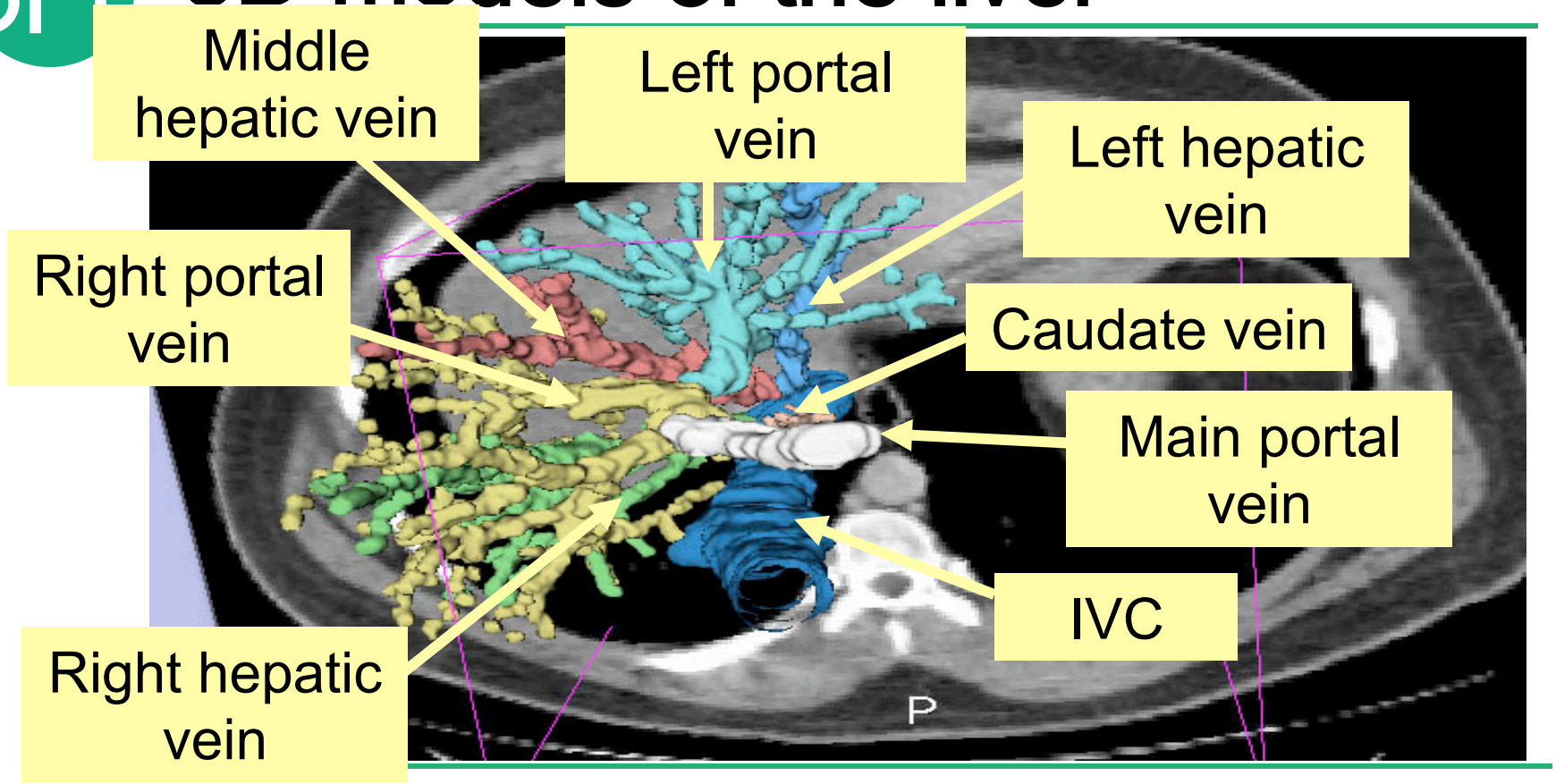
3D models of the liver



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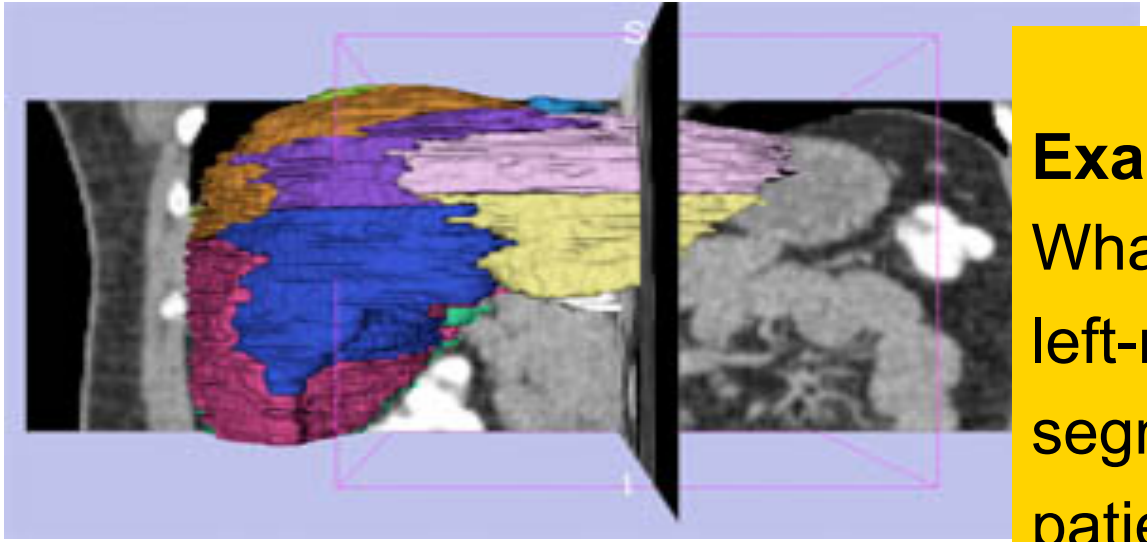
3D Exploration of Liver Segments



Example:

What organ abuts the left-most margin of segment II in this patient ?

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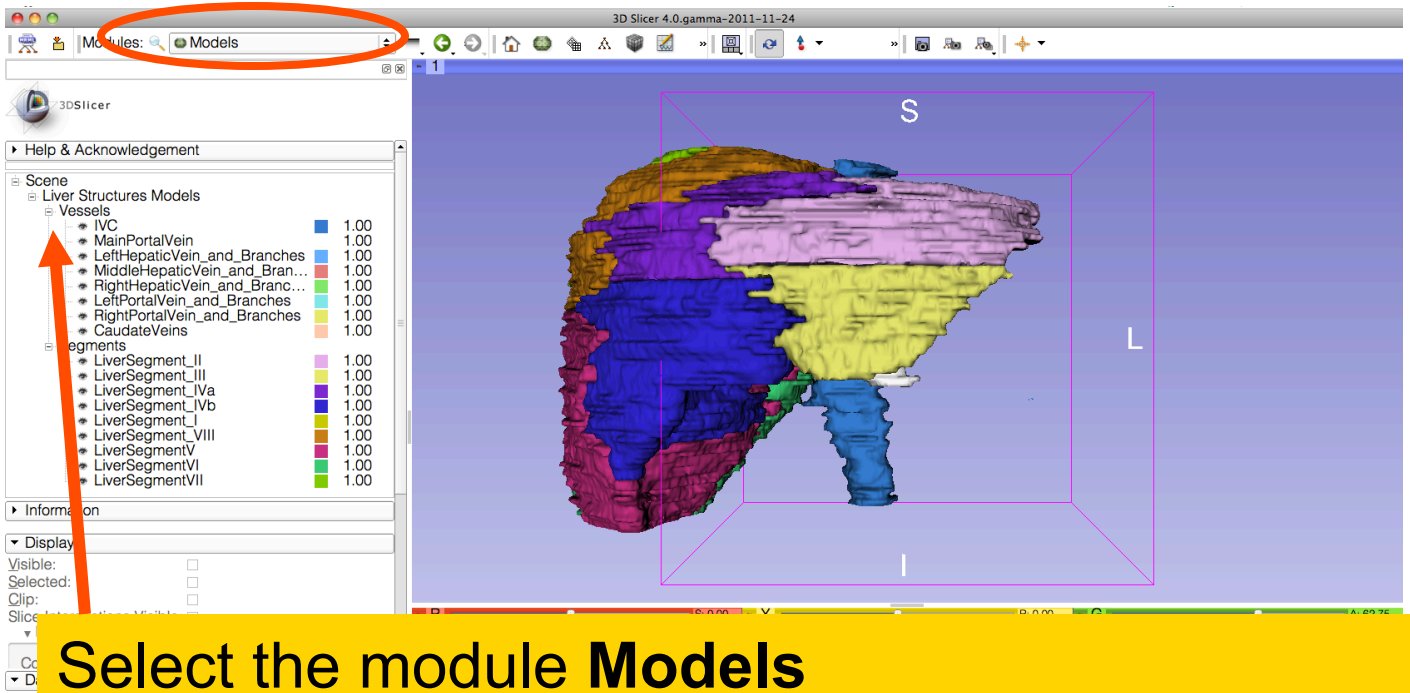
3D Exploration of Liver Segments



Select the module **Models**

Click on the Liver Structures Models Hierarchy

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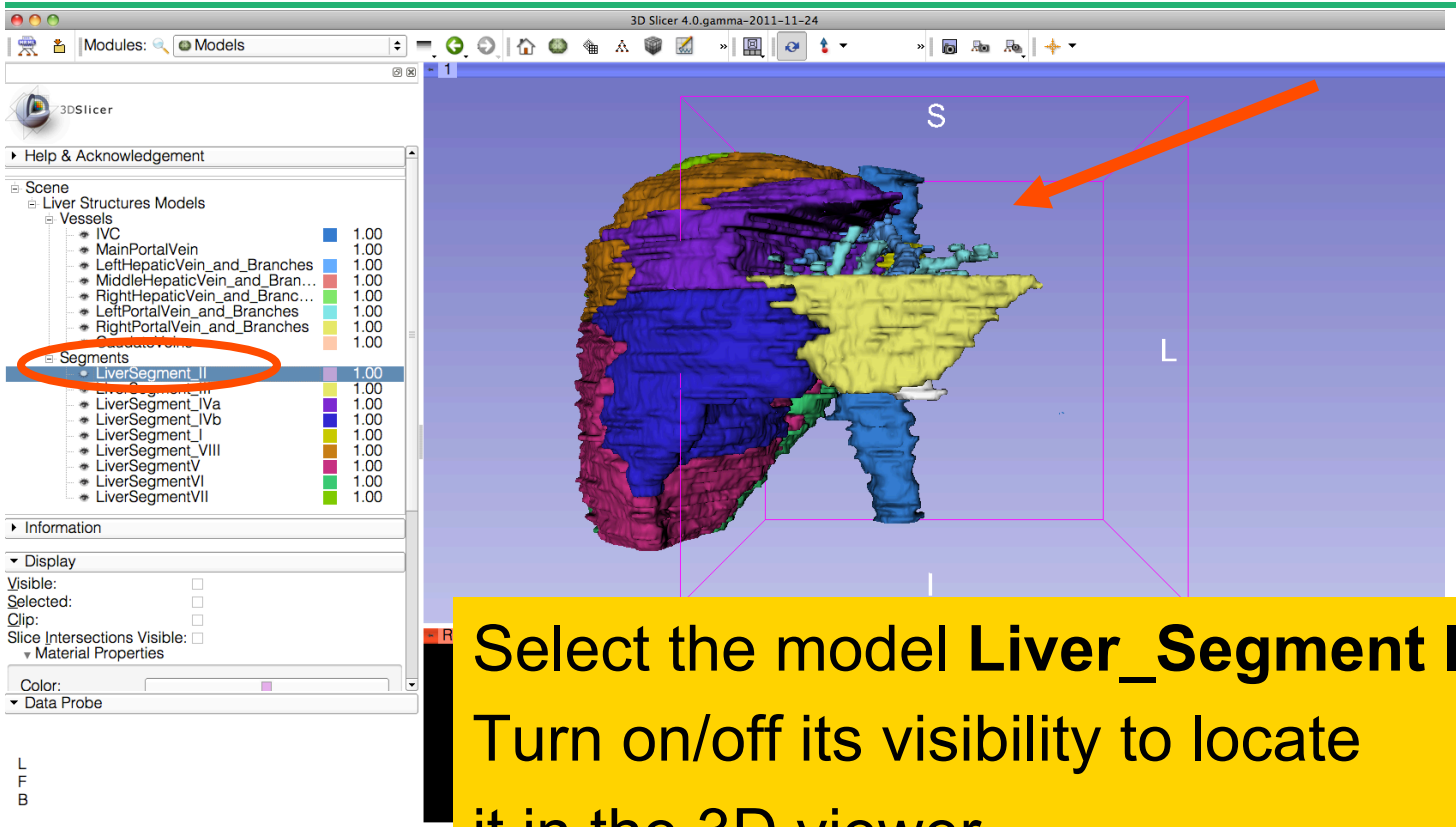
3D Exploration of Liver Segments



Select the model **Liver_Segment II**

Turn on/off its visibility to locate it in the 3D viewer.

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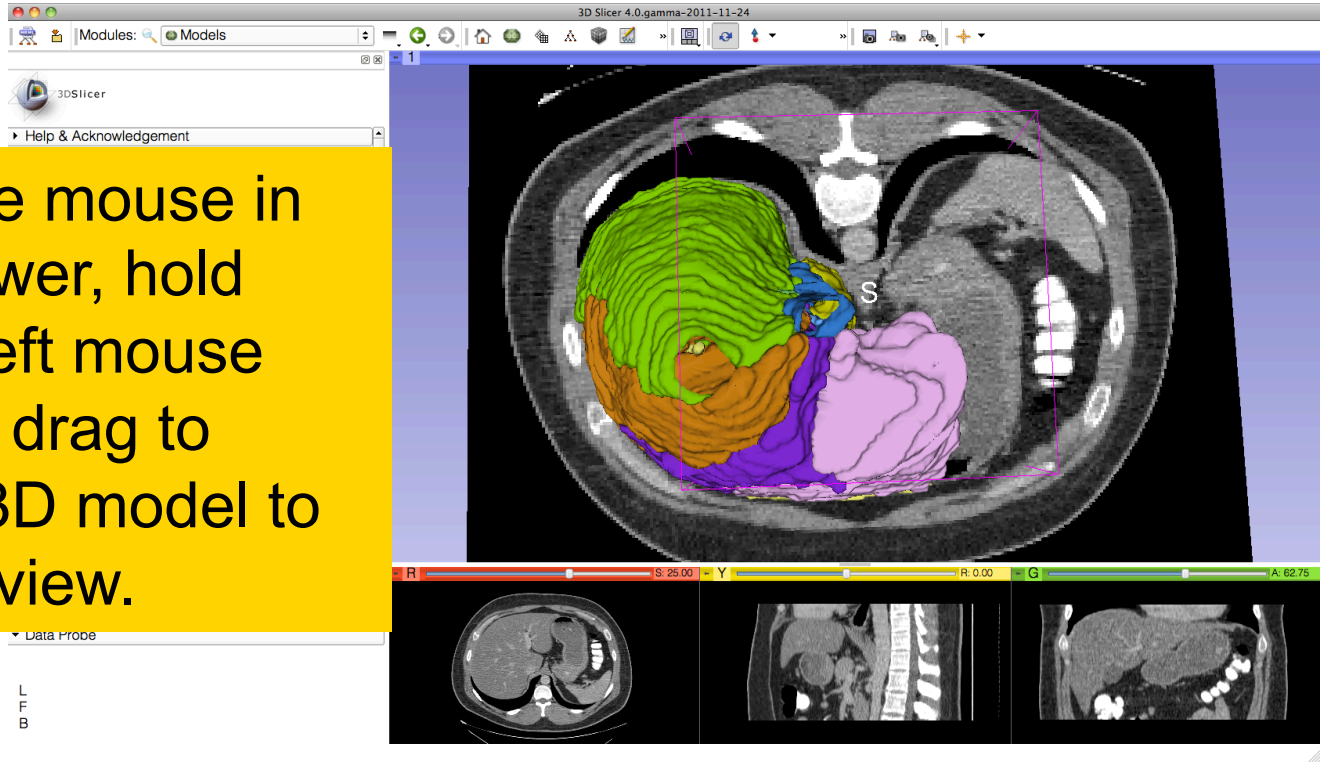
3D Exploration of Liver Segments



Position the mouse in the 3D Viewer, hold down the left mouse button and drag to orient the 3D model to a superior view.

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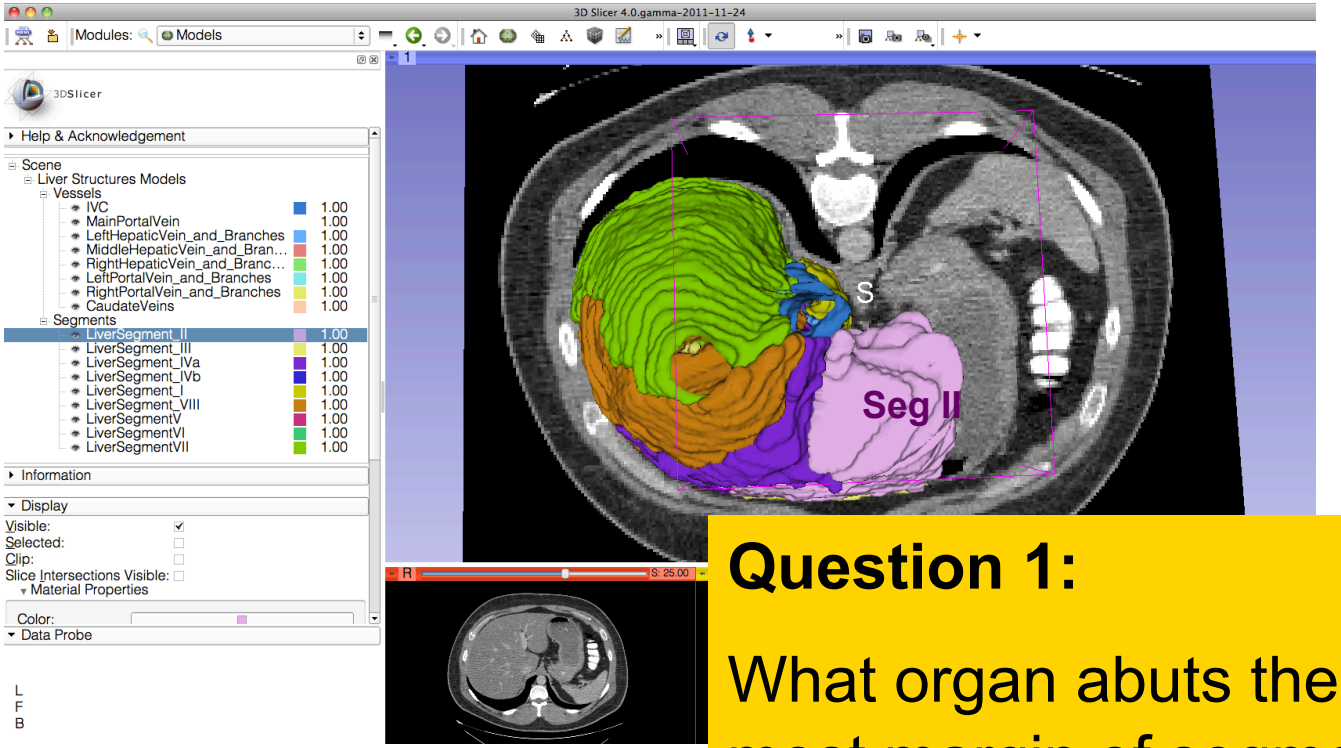
http://na-mic.org © 2010, ARR

3D Exploration of Liver Segments



Question 1:

What organ abuts the left-most margin of segment II in Patient 1?

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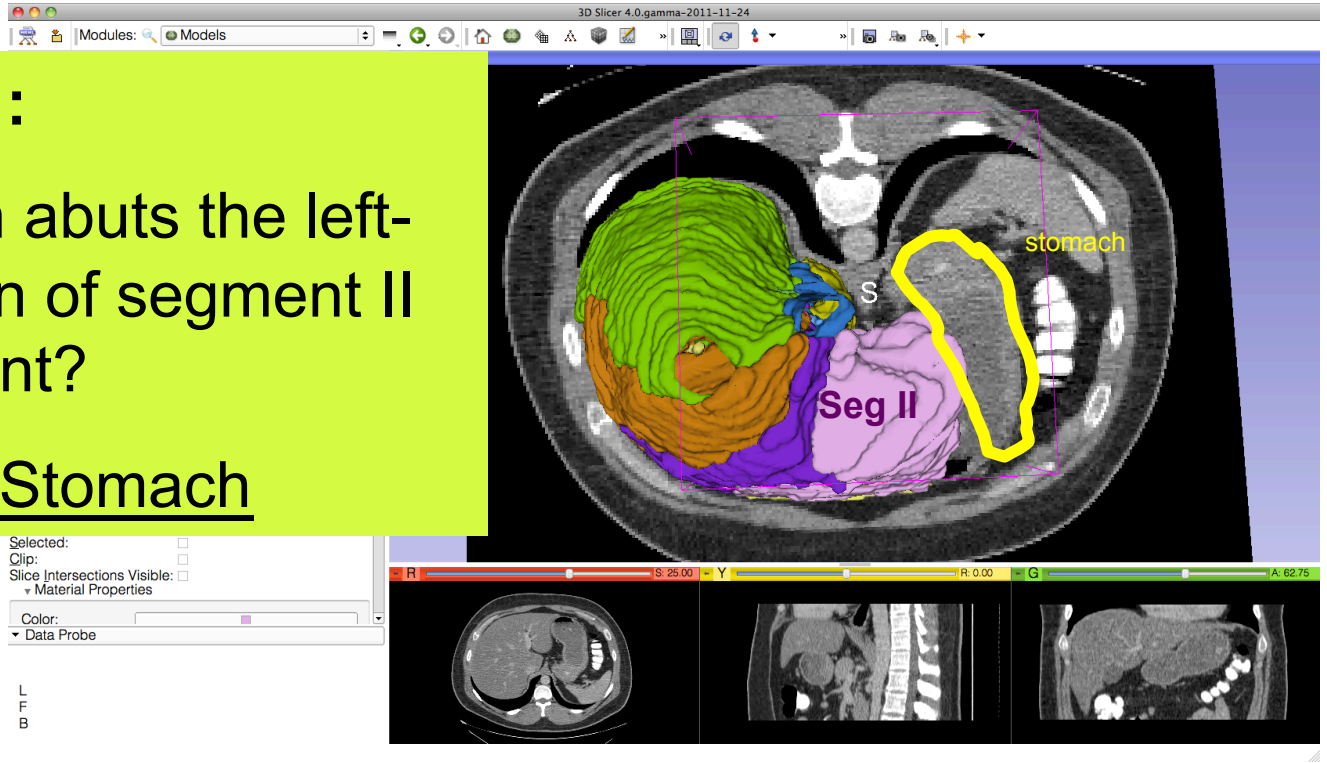
3D Exploration of Liver Segments

Question 1:

What organ abuts the left-most margin of segment II in this patient?

Answer 1: Stomach



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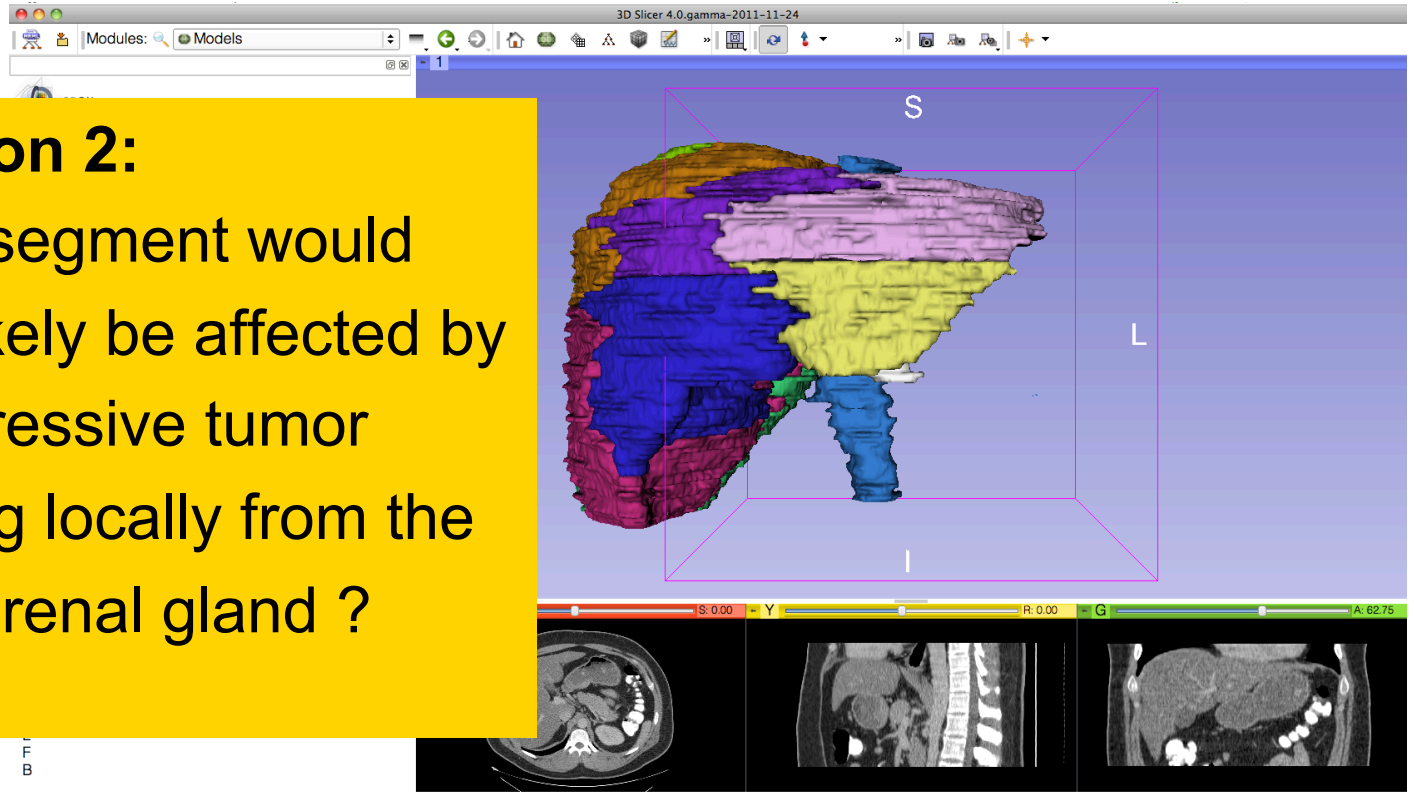
3D Exploration of Liver Segments

Question 2:

Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ?



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3D Exploration of Liver Segments

Question 2:
Which segment would most likely be affected by an aggressive tumor invading locally from the right adrenal gland ?
Answer 2: Segment VII

3D Exploration of Liver Segments

Question 3:

Which vessel separates Segment IVb and Segment V?

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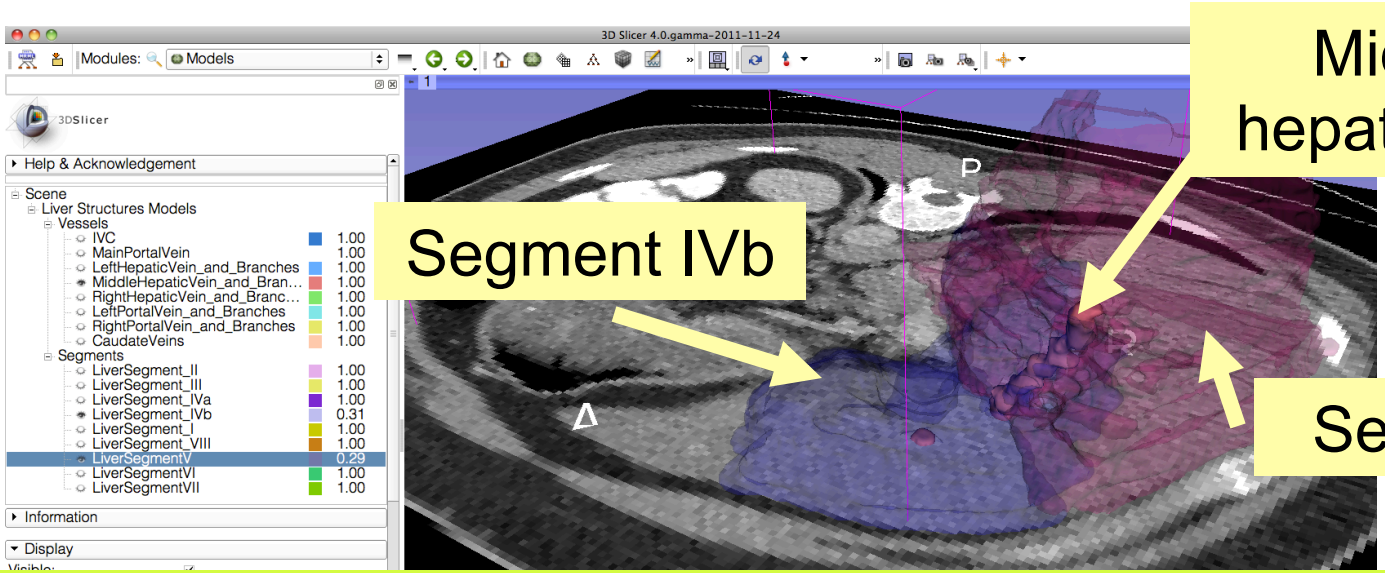
Middle Hepatic Vein



Question 3:

Which vessel separates Segment IVb and Segment V?

Answer 3: The middle hepatic vein

Closing the Liver Scene

Select **File → Exit** to close the Liver Scene and exit Slicer

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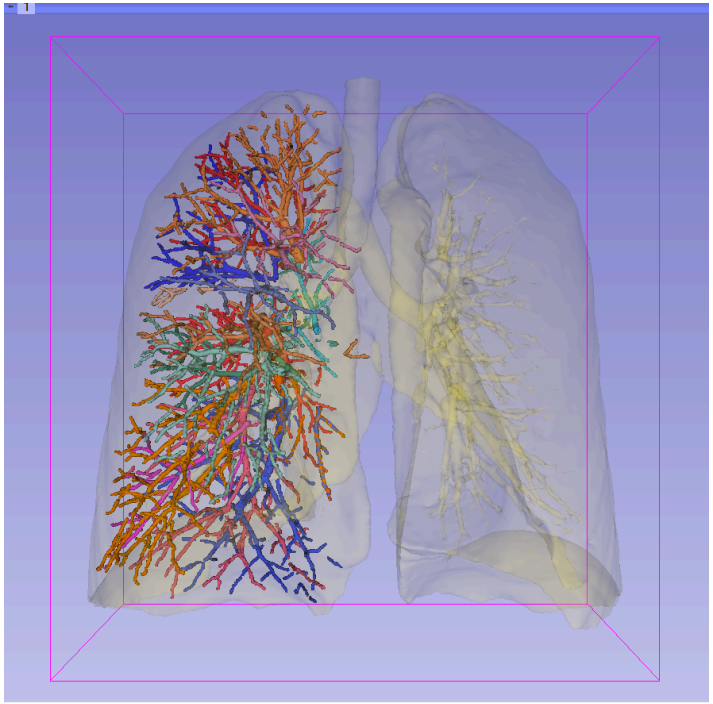

Part 4:

Interactive 3D Visualization of the segments of the lungs

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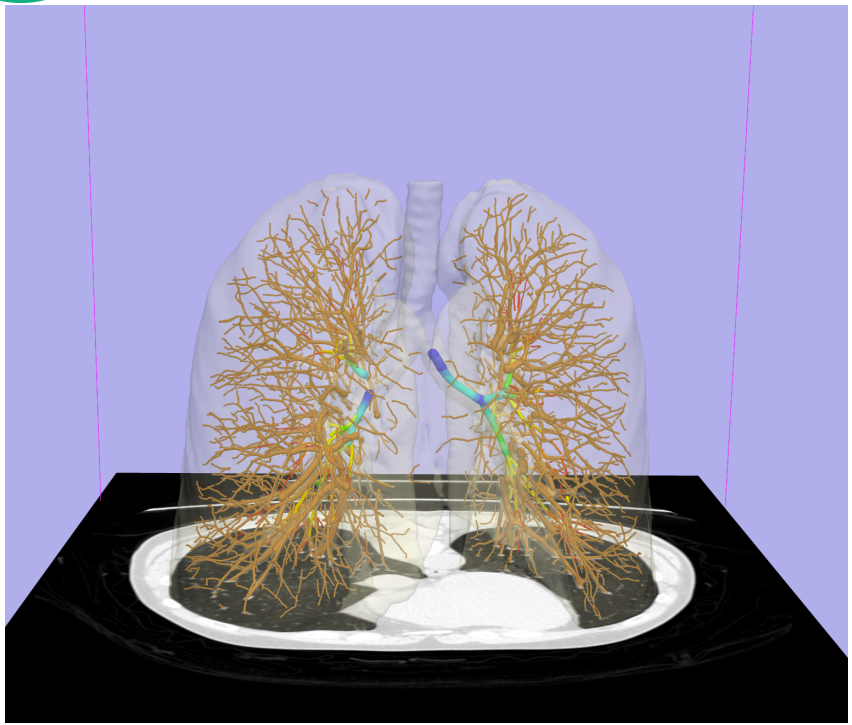
Segments of the lung



Segmentation and 3D surface reconstruction of the lung and pulmonary vessels

Acknowledgment:
Segmentation of the lung surface and vasculature: Raul San Jose Estepar, Ph.D., George Washko, M.D., Ed Silverman, M.D. and James Ross, MSc. Brigham and Women's Hospital, Boston, MA

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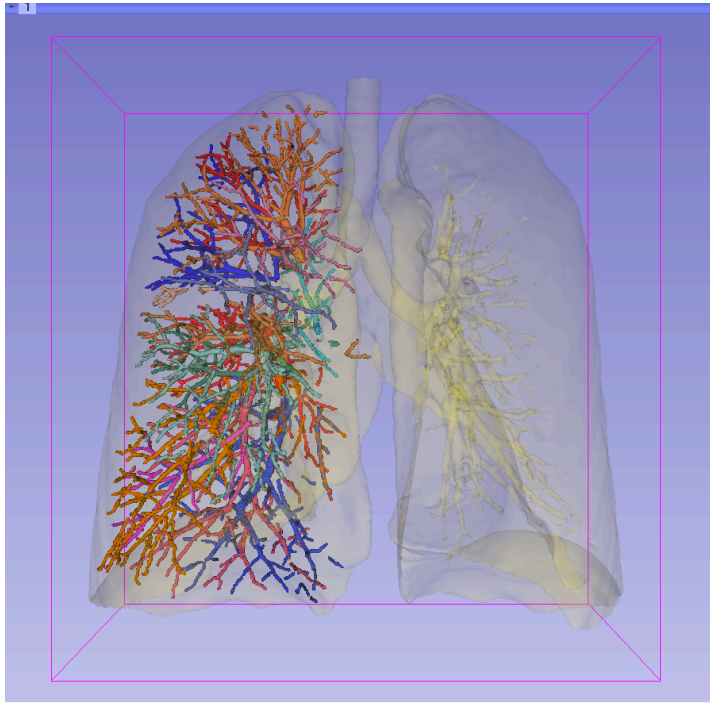
Segments of the lung



3D parcellation of arteries and veins from original model of pulmonary vessels
(Kitt Shaffer, M.D., Ph.D. - Sonia Pujol, Ph.D.)

- Right Upper Lobe (RUL)
  - RUL Pulmonary Vein
  - RUL Anterior Segment
  - RUL Apical Segment
  - RUL Posterior Segment
- Right Middle Lobe (RML)
  - RML Pulmonary Vein 1 & 2
  - RML Lateral Segment
  - RML Medial Segment
- Right Lower Lobe (RLL)
  - RLL Pulmonary Vein 1,2,3
  - RLL Anterior Basal Segment
  - RLL Medial Basal Segment
  - RLL Lateral Basal Segment
  - RLL Posterior Basal Segment

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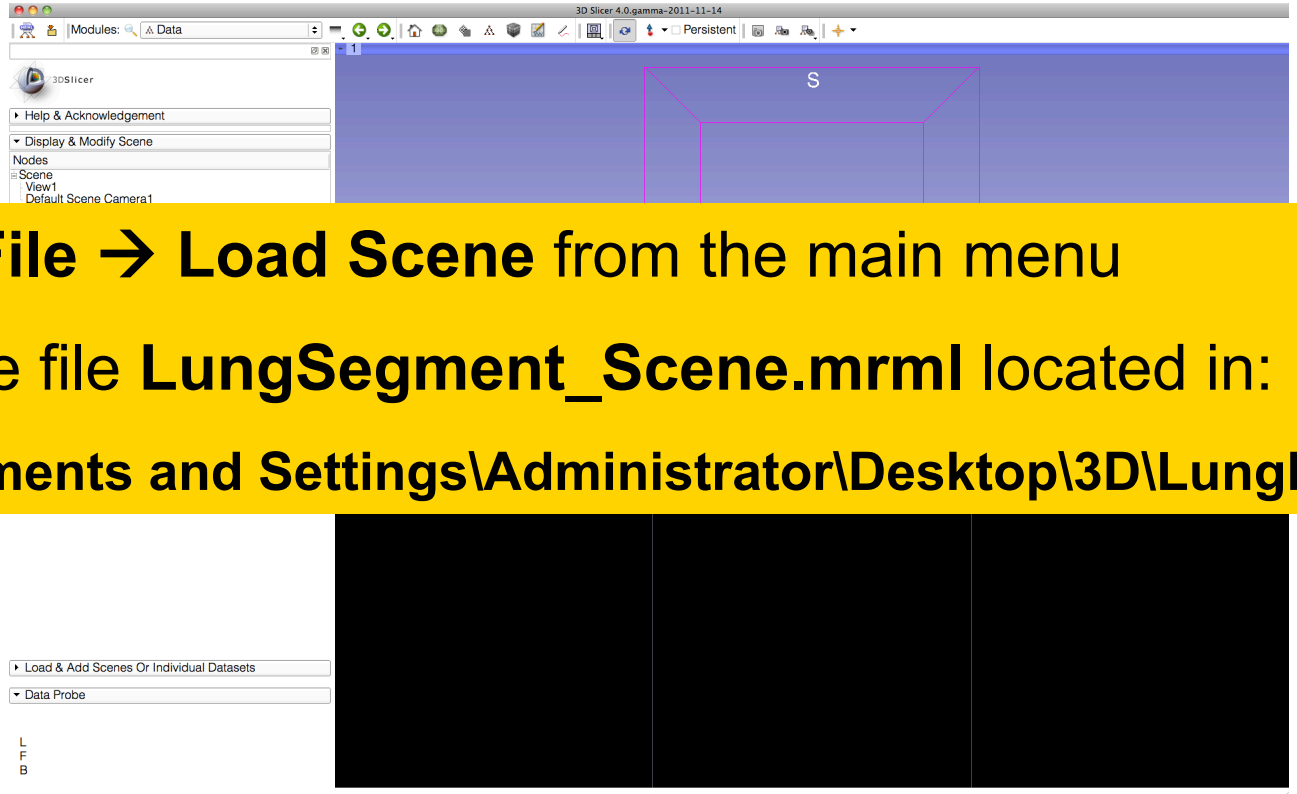
Loading the Lung Scene



Select **File → Load Scene** from the main menu

Load the file **LungSegment_Scene.mrml** located in:

C:\Documents and Settings\Administrator\Desktop\3D\LungData

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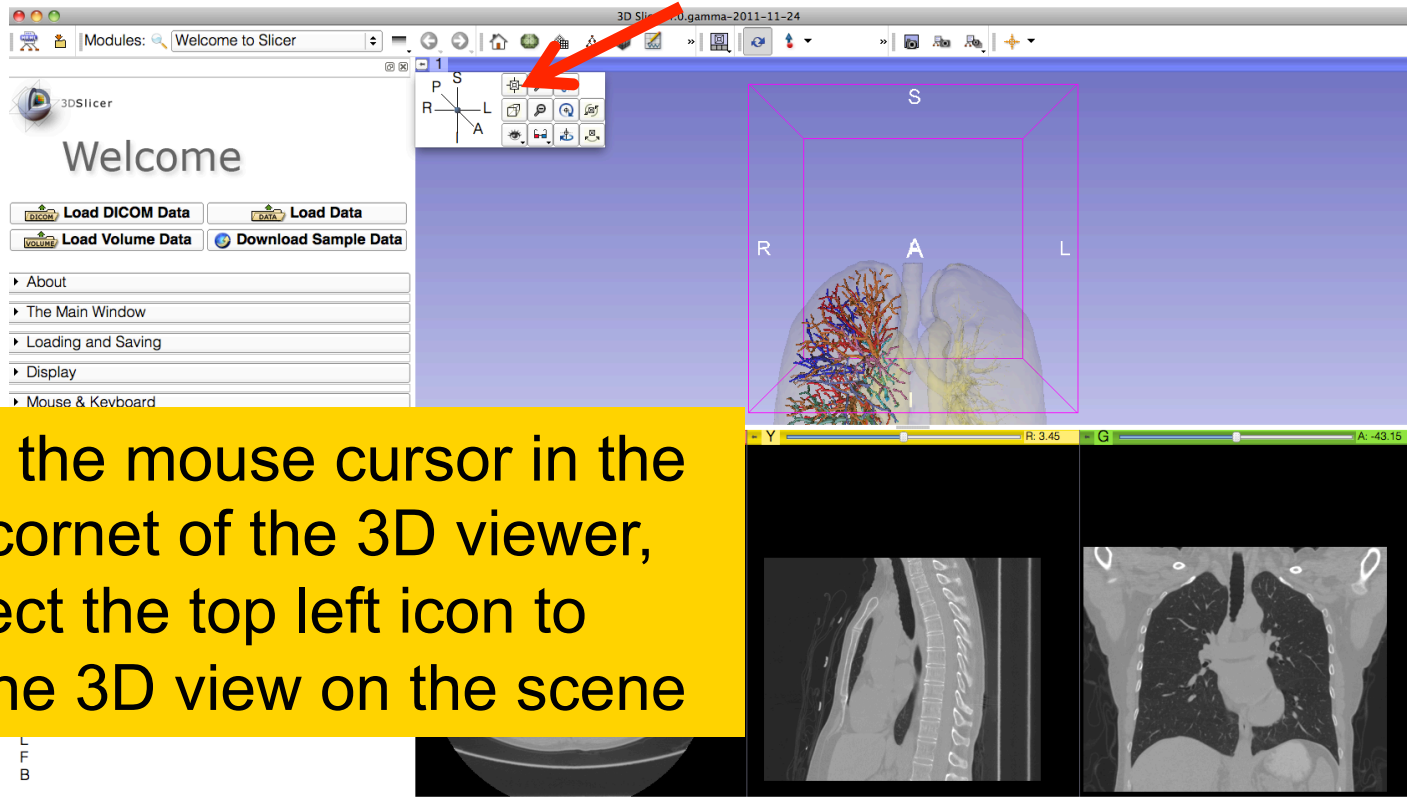
Loading the Lung Scene



Position the mouse cursor in the top left cornet of the 3D viewer, and select the top left icon to center the 3D view on the scene

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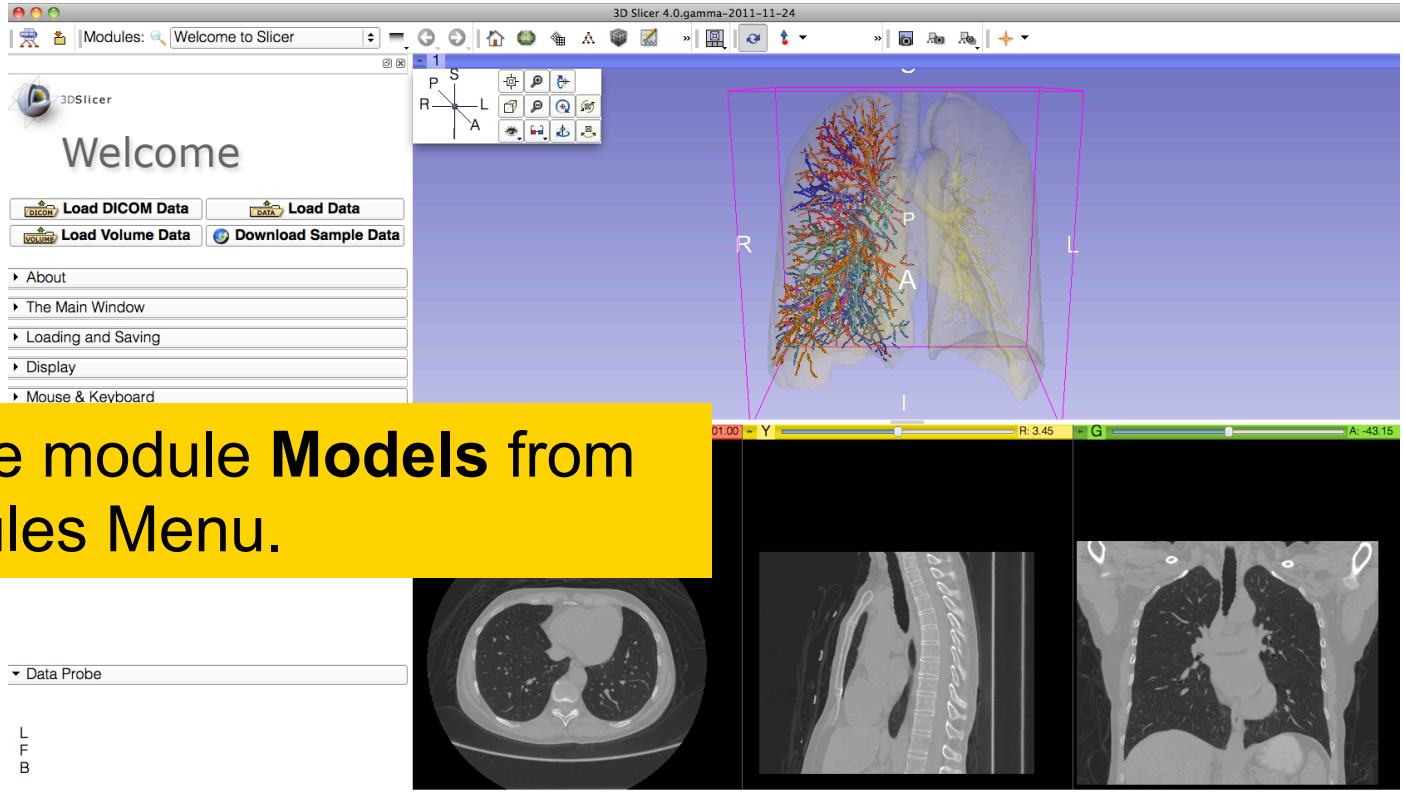
Loading the Lung Scene



Select the module **Models** from the modules Menu.

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Lung Segments

Slicer displays the list of 15 surface models of pulmonary structures.

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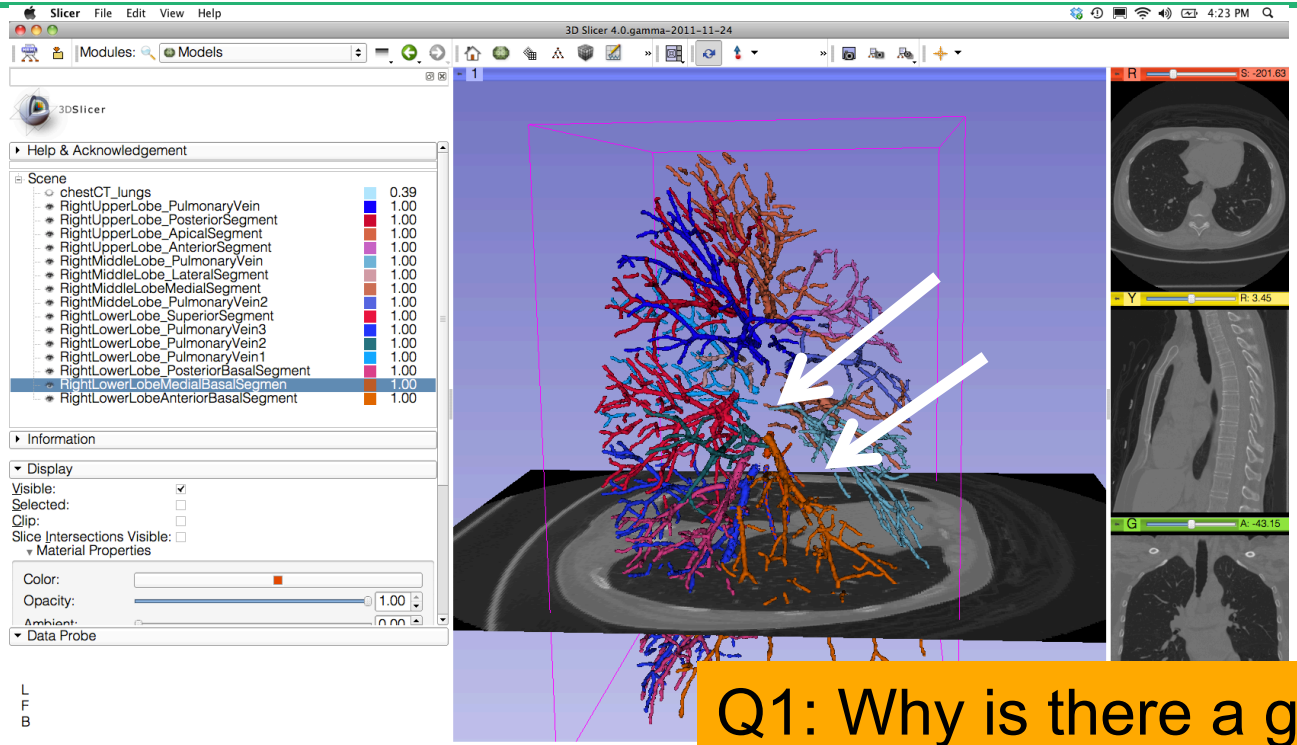
Lung Segments – Question 1



Q1: Why is there a gap in the vessels at the arrows?

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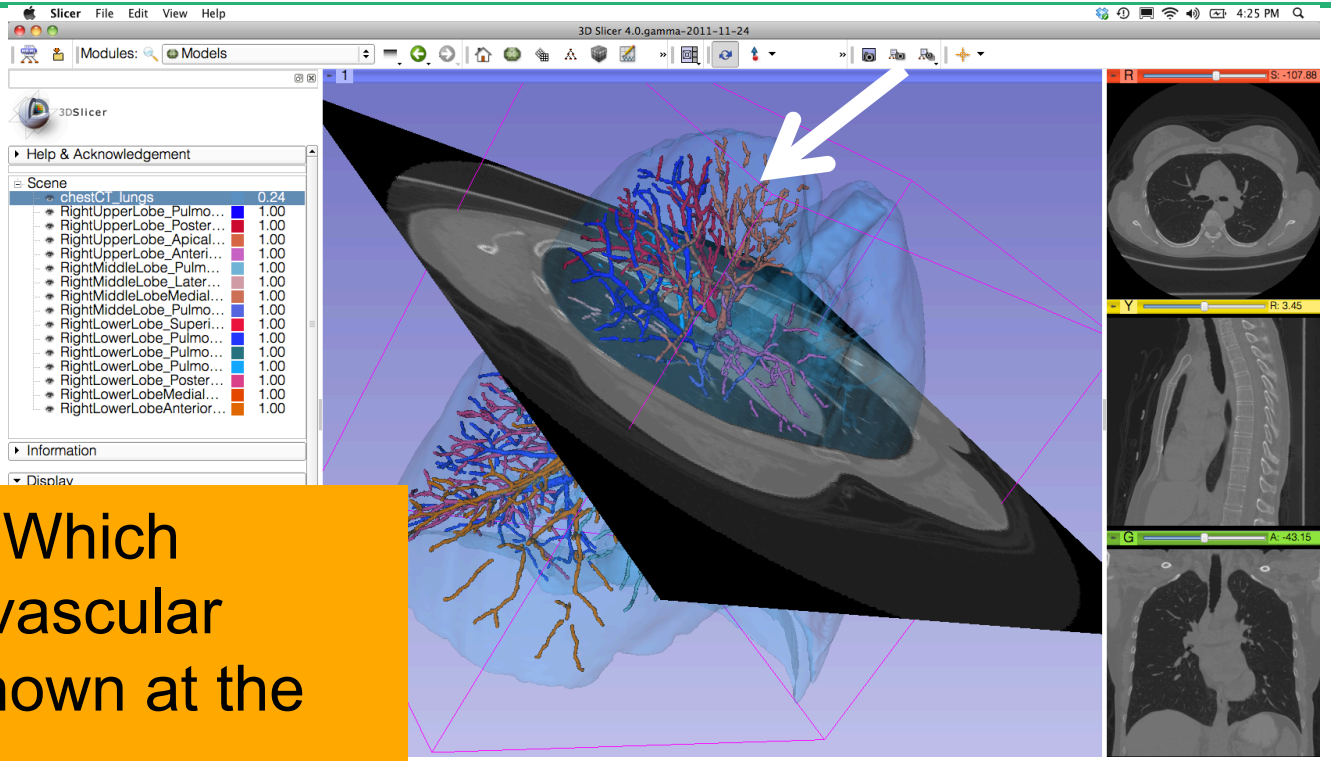
Lung Segments – Question 2



Question 2:Which segment's vascular supply is shown at the arrow?

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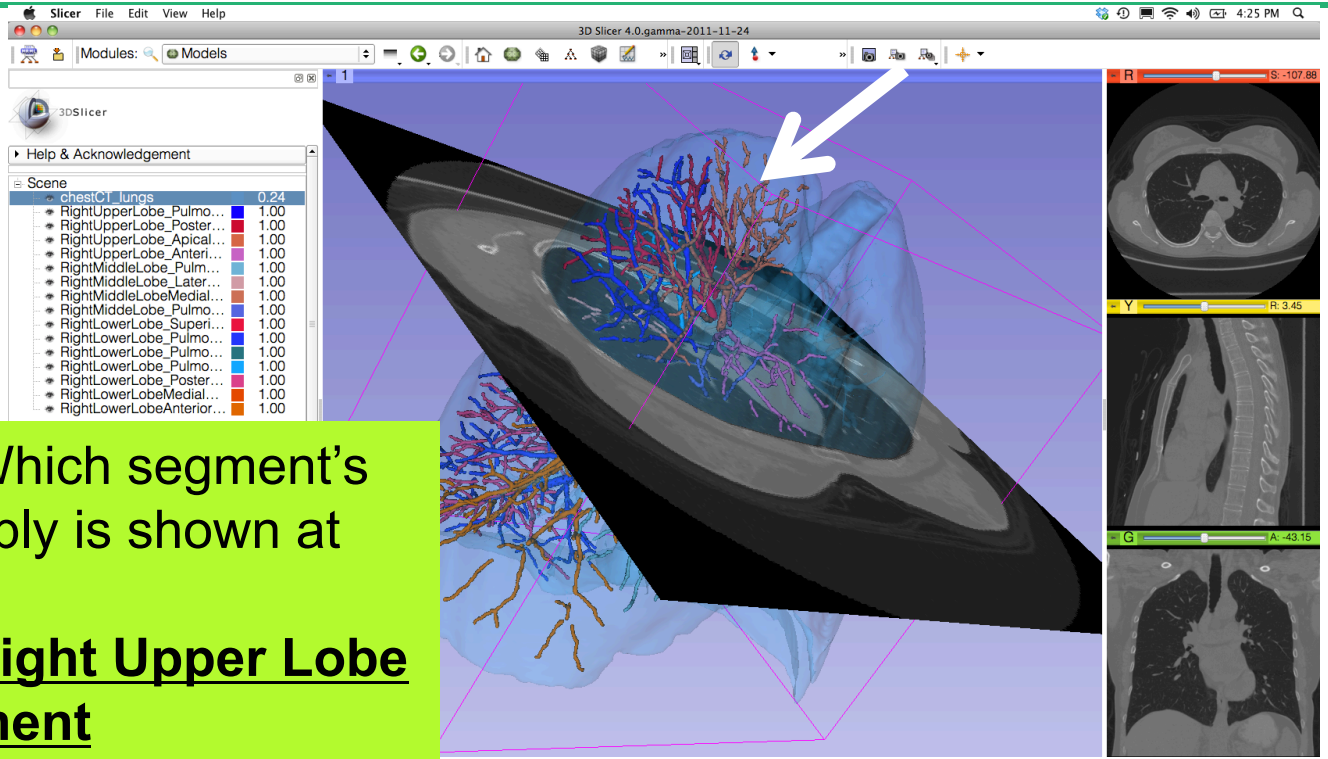
Lung Segments – Question 2



Question 2:Which segment's vascular supply is shown at the arrow?

Answer 2: Right Upper Lobe Apical Segment

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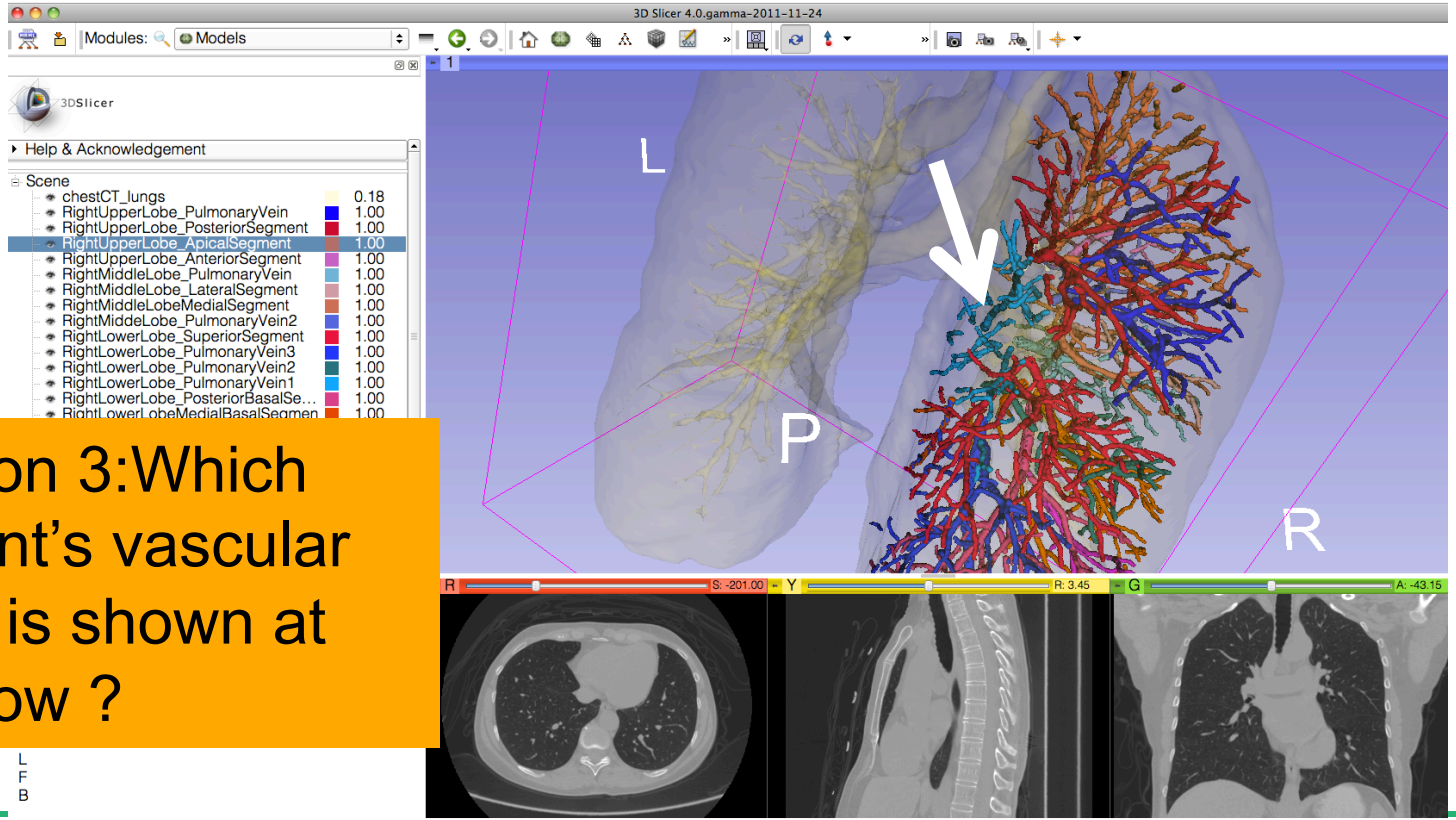
Lung Segments – Question 3



Question 3:Which segment's vascular supply is shown at the arrow ?

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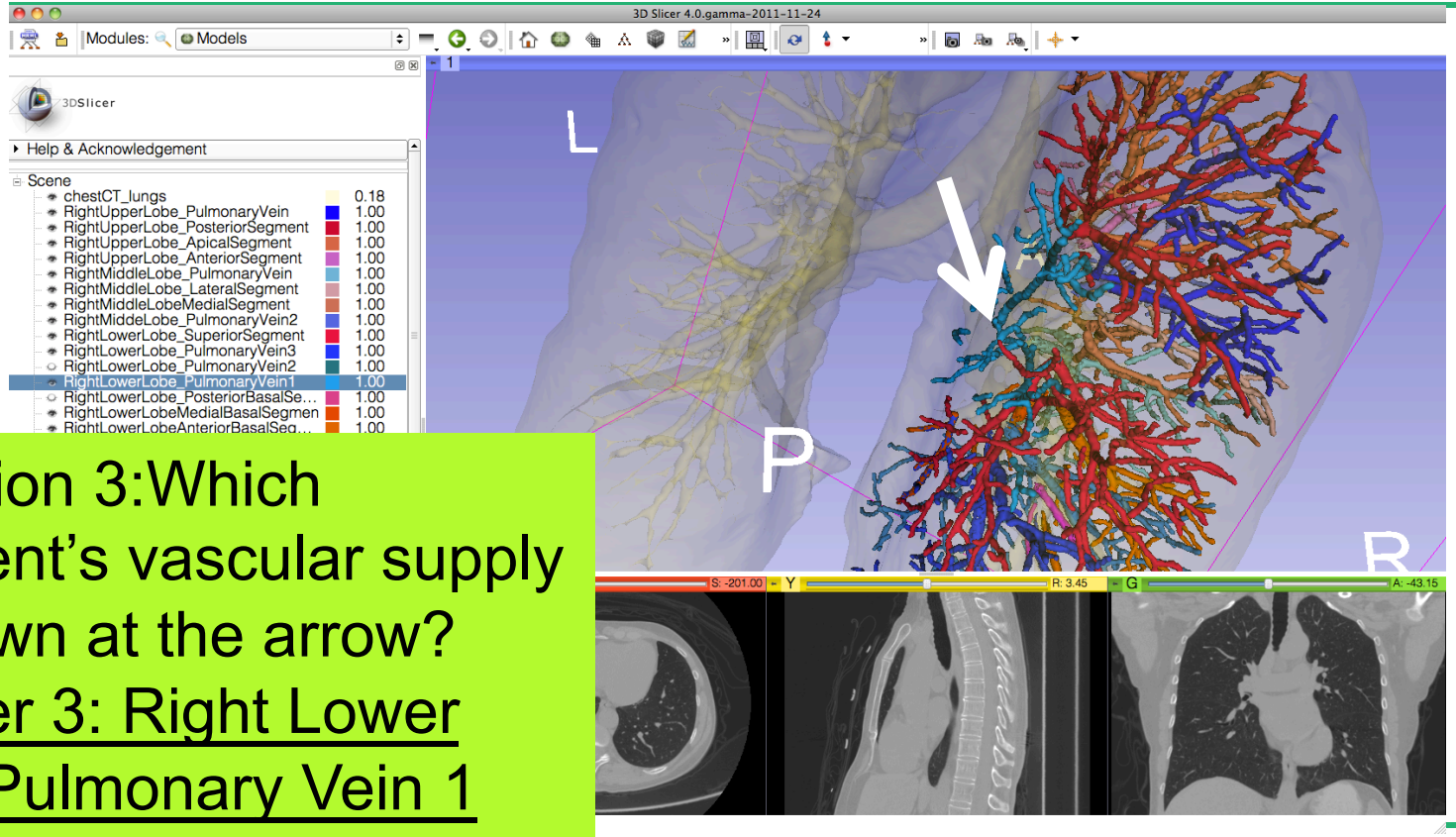
Lung Segments – Question 3



Question 3:Which segment's vascular supply is shown at the arrow?

Answer 3: Right Lower Lobe Pulmonary Vein 1

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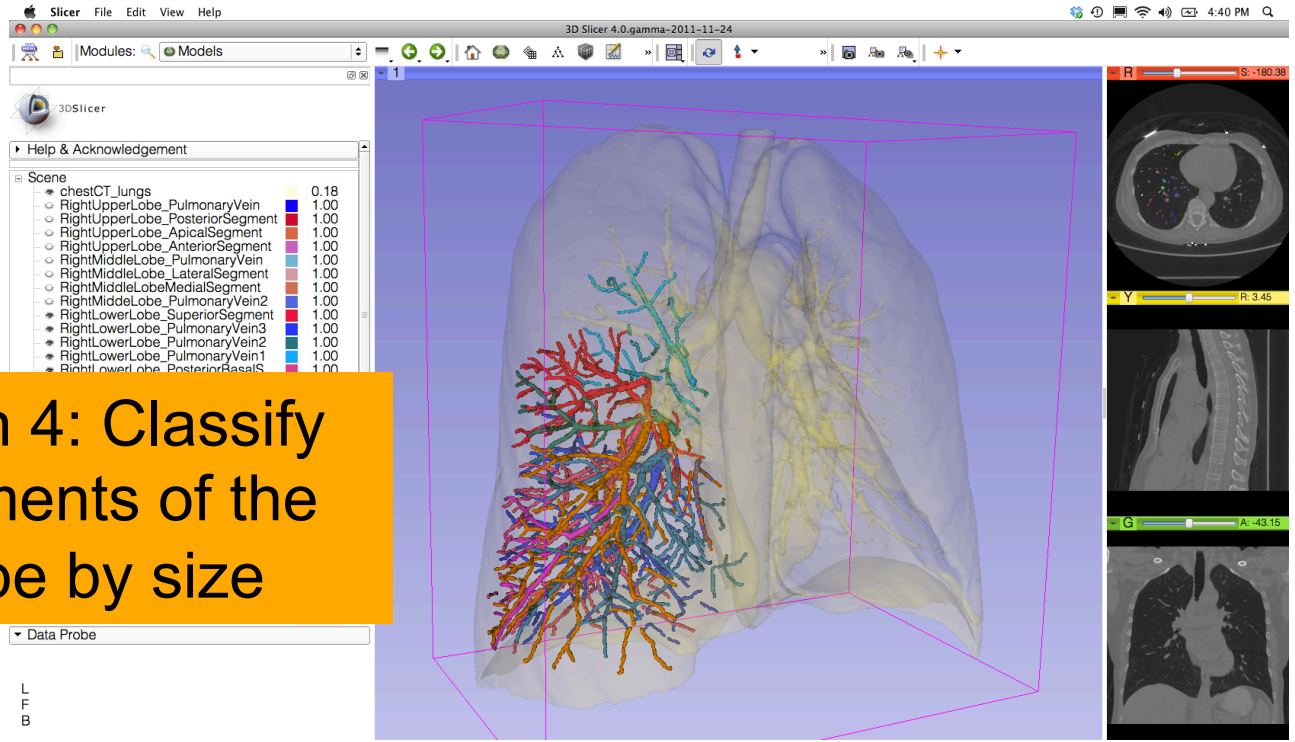
Lung Segments – Question 4



Question 4: Classify the segments of the lower lobe by size

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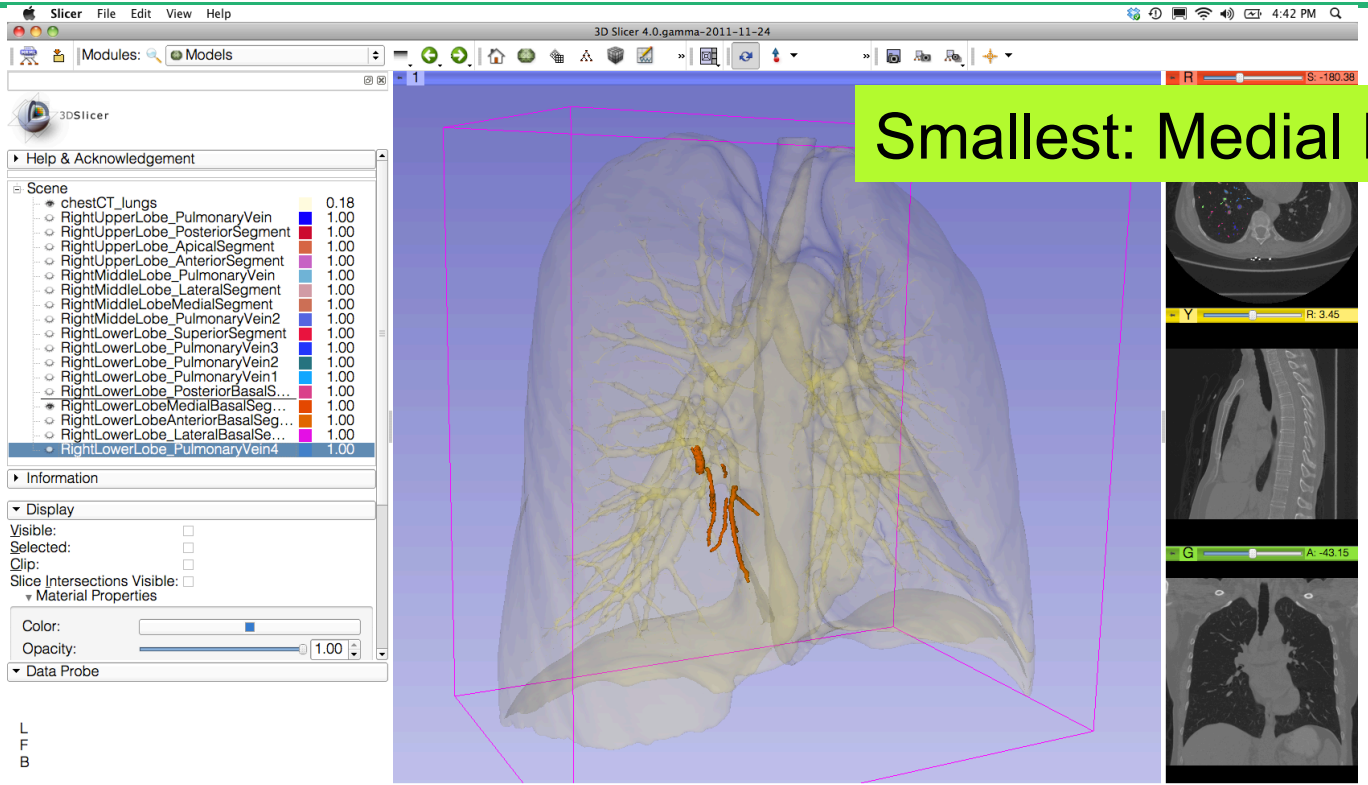
Lung Segments – Question 4



Smallest: Medial Basal

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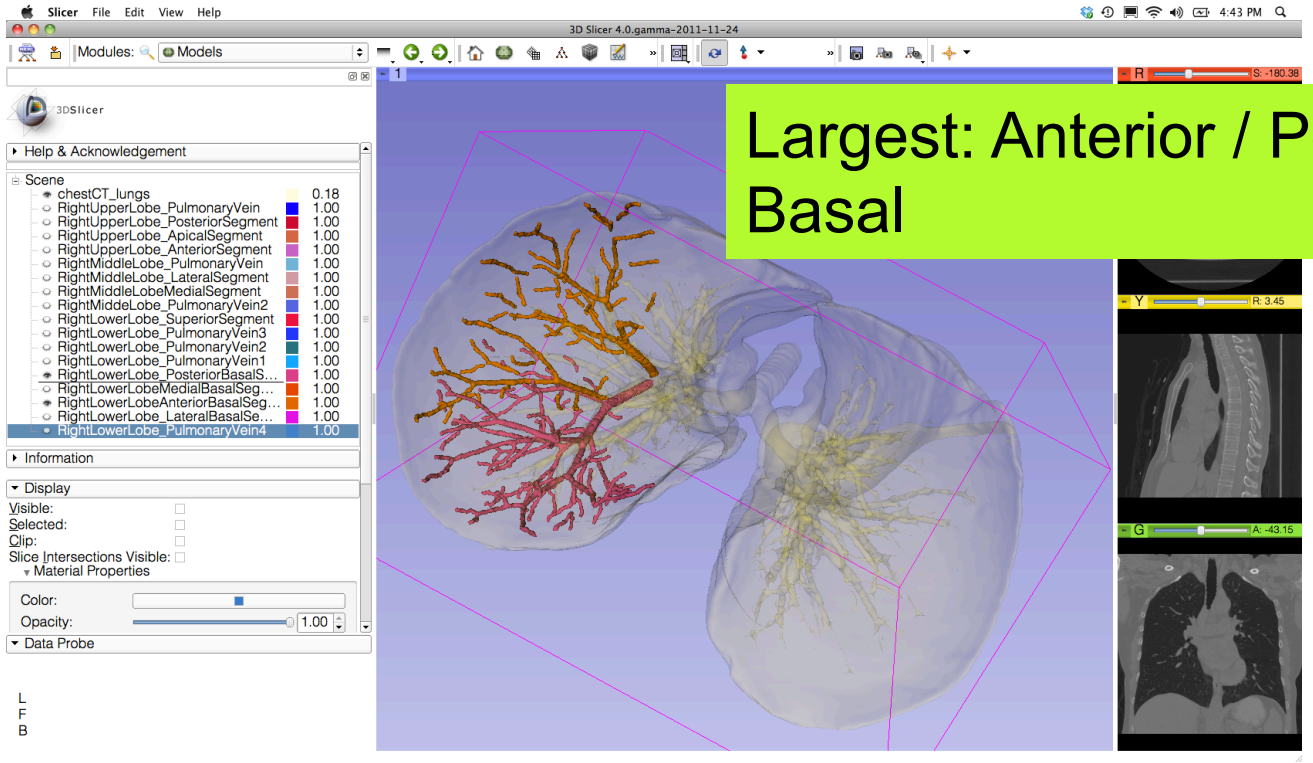
Lung Segments – Question 4



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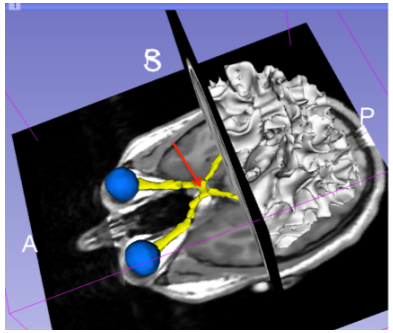
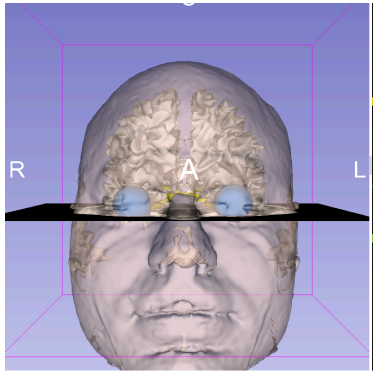
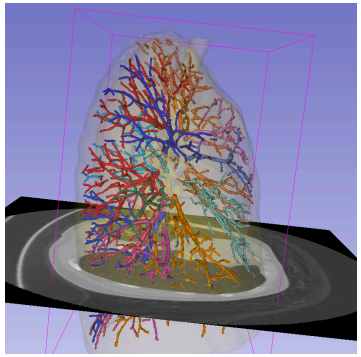
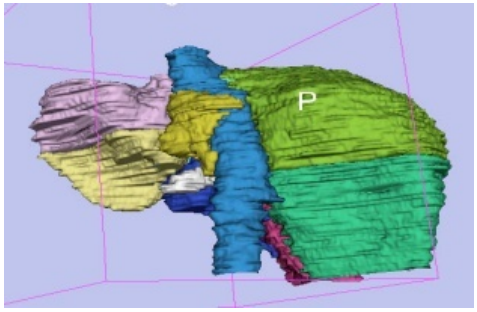
3D Visualization of DICOM images









- Interactive user-interface to load and manipulate greyscale volumes, labelmaps and 3D models.
- User-defined 3D view of the anatomy
- 3D Open-source platform for Linux, Mac and Windows

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Acknowledgments

National Alliance for Medical Image Computing (NA-MIC)
(NIH Grant U54EB005149)

Estepar, Washko, Silverman, Ross - Brigham and Women's Hospital.
K25 HL104085, COPDGene 01 HL089897 and U01 HL089856 (lung)

Neuroimage Analysis Center (NAC)
(NIH Grant P41 RR013218)

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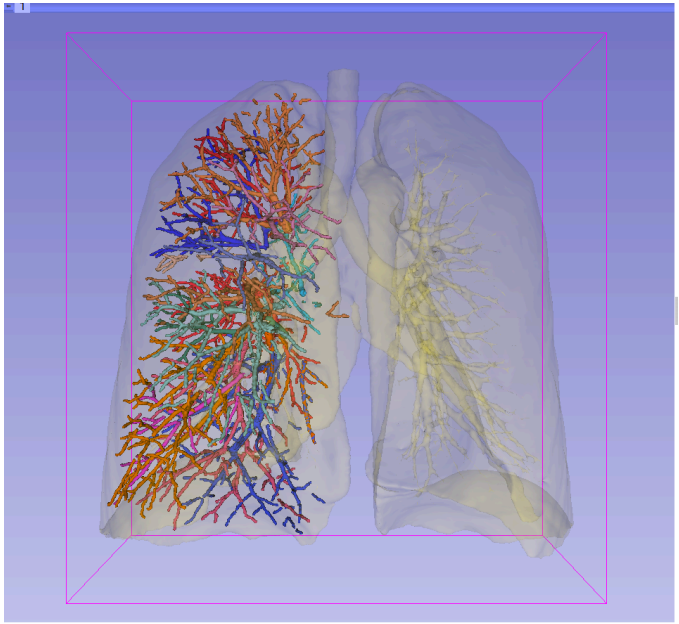

www.slicer.org

www.na-mic.org

Questions and comments: spujol@bwh.harvard.edu

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