If you have any questions, please contact louisevanderwerff@gmail.com or JasamineCB@gmail.com

An Introduction to 3D Slicer

Version 4.8

Research Platforms, Melbourne University

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THE UNIVERSITY OF MELBOURNE

ResBaz RESEARCH BAZAAR

Workshop Slides

http://go.unimelb.edu.au/jom6

Workshop datasets

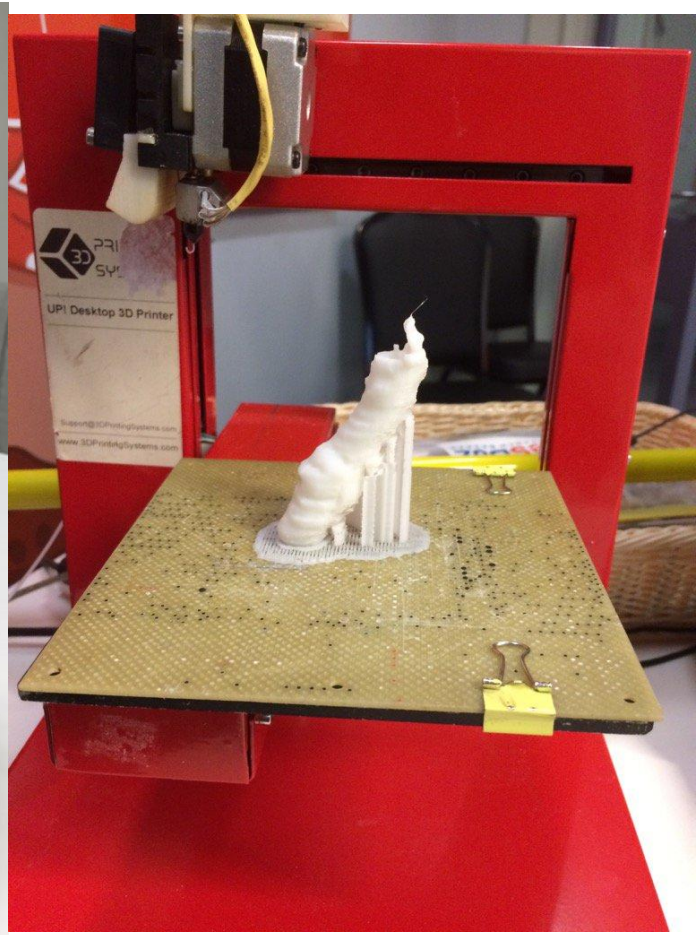
http://go.unimelb.edu.au/9kma

http://go.unimelb.edu.au/m6ur

Email: gordon.chen@unimelb.edu.au

This workshop will cover:

- What are medical image datasets? (DICOMS)
- Volume rendering of datasets to create visually attractive 3D representations of the data (CT, MRI scans etc)
- Automatic and manual Segmentation techniques to define tissue types in DICOM datasets
- Image Registration techniques
- A 3D Printing overview
- ...and more


UP! Desktop 3D Printer

Introduction to 3D Slicer

Introduction to 3D Slicer

3D Slicer is Free and Open Source!

Available on:

- Windows
- Linux
- Mac Os X

3D Slicer version 4.8 can be downloaded at
http://download.slicer.org/

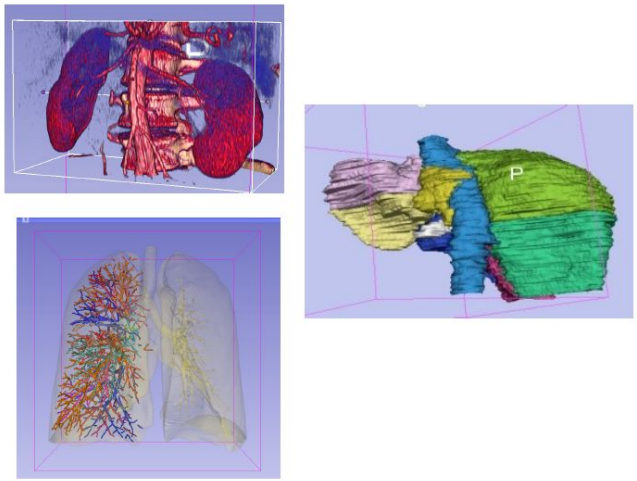


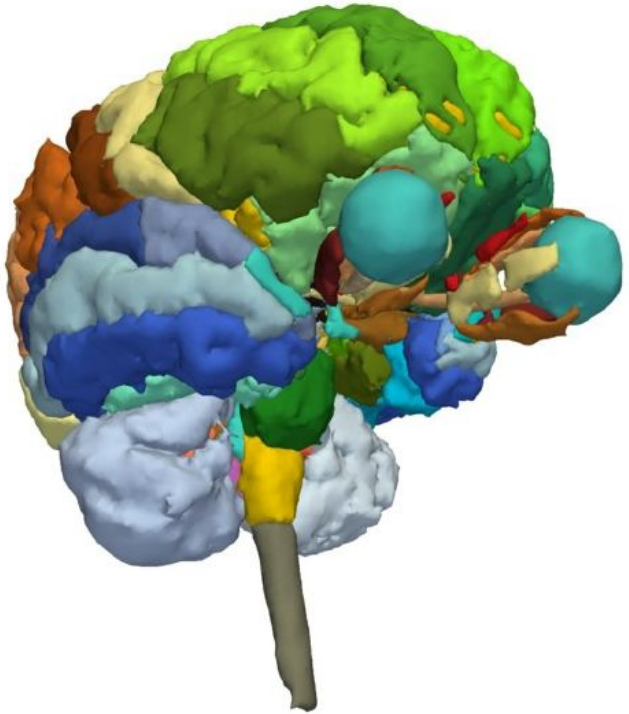
Image credits: ©2012-2014 Surgical Planning Laboratory, ARR

Introduction to 3D Slicer

3D Slicer started as a Masters thesis project between the Surgical Planning Laboratory at the Brigham and Women's Hospital and the MIT Artificial Intelligence Laboratory in 1998.

3D Slicer is distributed under a BSD-style license (open source).

3D Slicer is not FDA approved for clinical use. It is ultimately the user's responsibility to ensure compliance with applicable laws, rules and regulations in regards to 3D Slicers use.



Introduction to 3D Slicer

3D Slicer is a community platform with a flexible, modular interface for image analysis, segmentation, registration and 3D visualisation (volume rendering) of multi-modal medical image data and for image guided therapy research.

3D Slicer contains over 120 inbuilt modules. Additional modules and extensions can be installed into the software package and new modules are continually being developed.

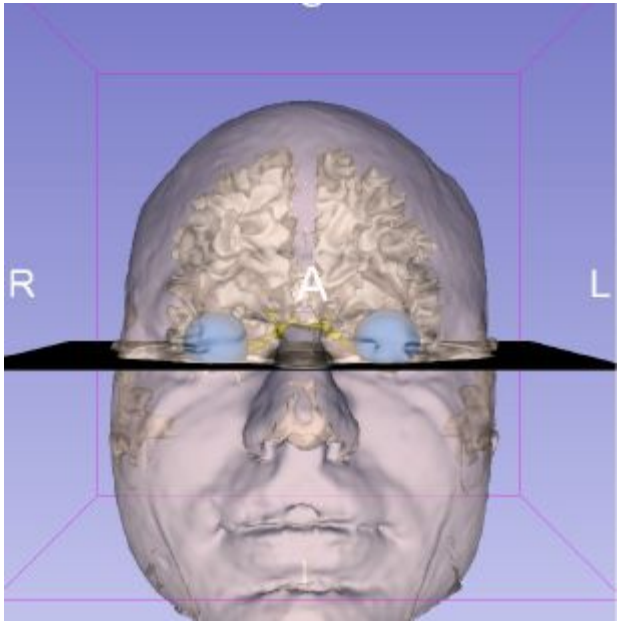


Image credits: ©2012-2014 Surgical Planning Laboratory, ARR

Useful Online Resources

3D Slicer Home Page

3D Slicer Wiki Pages

3D Slicer NEW online help documentation

3D Slicer Visual Blog

3D Slicer forum

3D Slicer YouTube channel

3D Slicer on Twitter @3dslicerapp

Medical Imaging and DICOMS

Medical imaging is the process of creating a visual representation of the interior of the body for analysis, diagnosis and medical treatments. Eg: MRI, CT, Ultrasound, PET, X-Ray etc

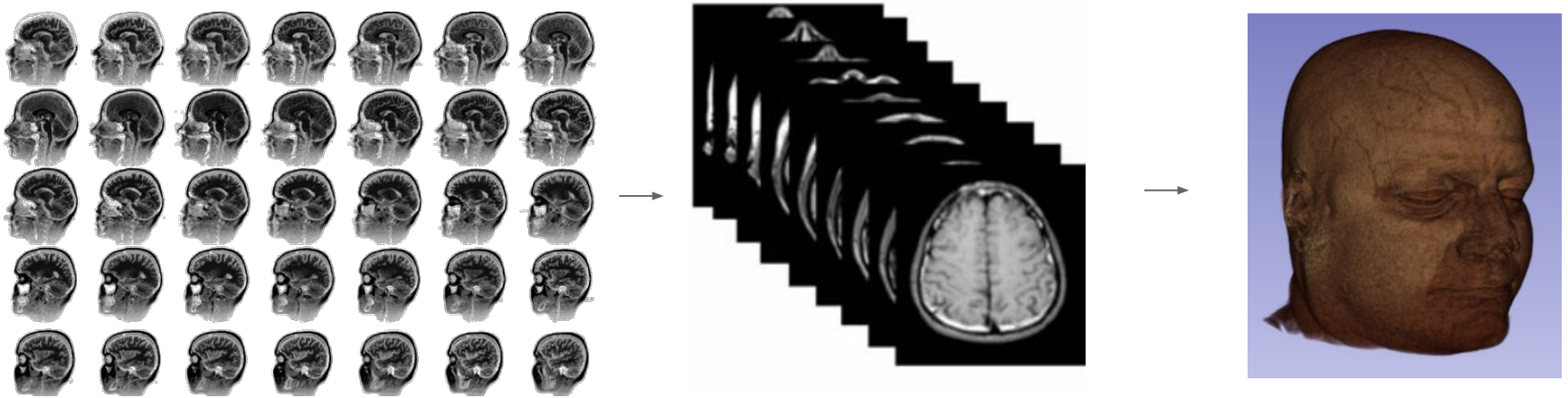
This image data is saved as a DICOM (Digital Imaging and Communications in Medicine standard) file, which is a sophisticated set of standards for digital radiology.

DICOM datasets also contain patient and scan metadata.

Photo credit: Jan Ainali, 2008, Philips MRI in Sahlgrenska University Hospital, Gothenburg, Sweden.

Medical Imaging and DICOMS

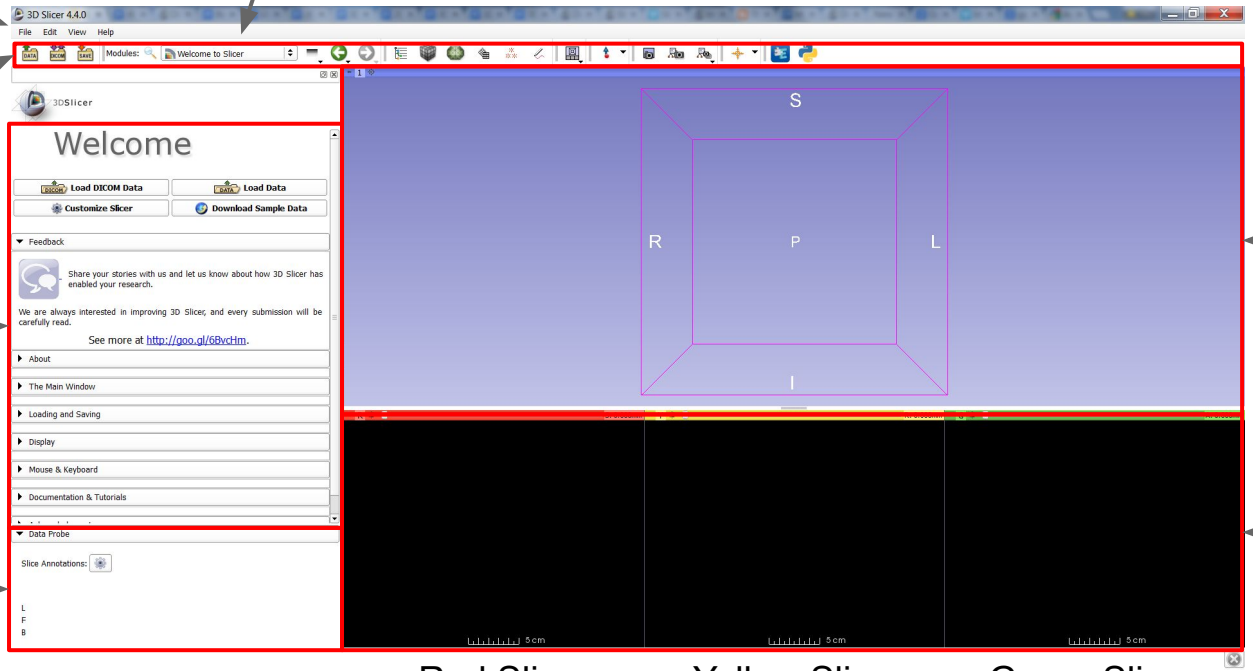
CT scans and MRI scans yield many cross-sectional slices of the body



Many thin slices stack together like pancakes to create a 3 dimensional representation or ‘volume’.

3D Slicer Interface

3D Slicer Layout

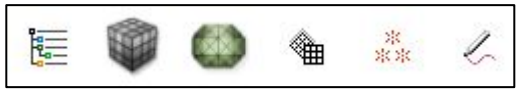


3D Slicer (Default) Toolbar

Import Data and DICOMs, save Data and Scenes

Select from list of available modules, by category, alphabetically, or via search.

View or navigate through history of modules used

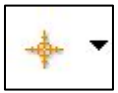


Selection of core 3D Slicer modules. Left to right: Subject Hierarchy, Volumes, Models, Transforms, Markups, Editor

Change layout of 2D and 3D viewers

Toggle on or off ability of mouse to insert fiducials, rulers, or ROIs

Capture screenshots and scene views



Customise appearance of mouse cross-hairs

Launch Extensions Manager wizard and Python Interactor

3D Slicer Modules

3D Slicer is modular in nature, and contains over 120 inbuilt modules. Additional modules can also be installed and new modules are continually being developed. You can find the 3D Slicer modules Wiki page here.

Helpful Tip: Help and acknowledgements for each module can be found at the top of that module's user interface.

3D Slicer will always start up in the 'Welcome to Slicer' Module.

'Welcome to Slicer' module user interface

What does a DICOM dataset look like

A DICOM dataset is typically comprised of a collection of many small .dcm files

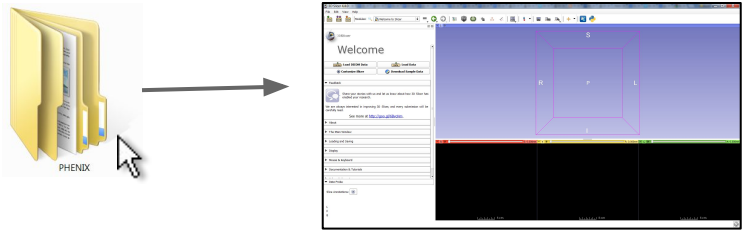
=126MB total size

MRIHead001.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead002.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead003.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead004.dcm	15/05/2015 2:03 PM	DCM File	516 KB
MRIHead005.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead006.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead007.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead008.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead009.dcm	15/05/2015 2:04 PM	DCM File	516 KB
MRIHead010.dcm	15/05/2015 2:04 PM	DCM File	516 KB
⋮			
MRIHead327.dcm	15/05/2015 2:04 PM	DCM File	516 KB

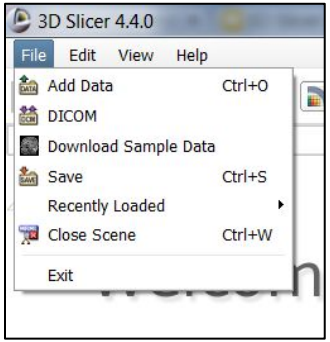
Importing a DICOM File

Multiple Approaches:

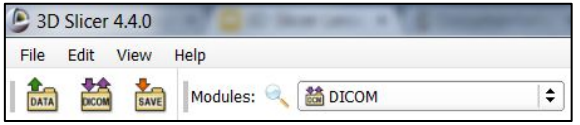
- Drag and drop DICOM data set (directory folder) into 3D Slicer window



- File -> DICOM



or

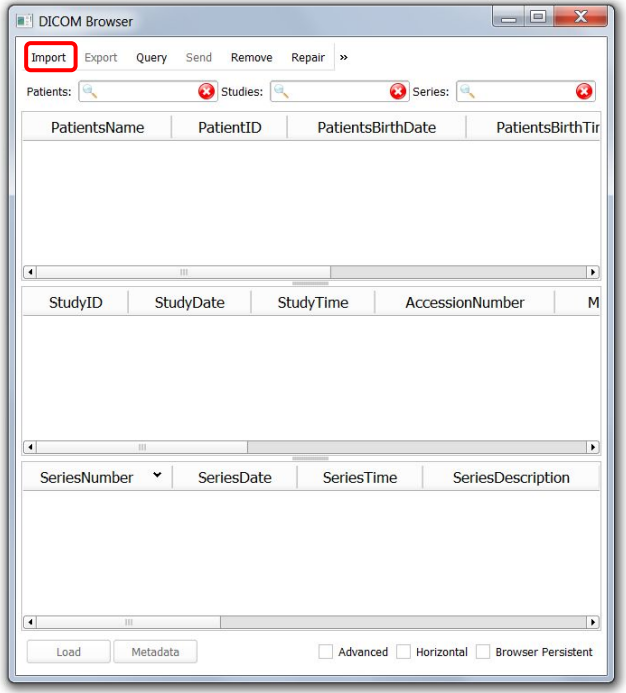


- Find DICOM icon in toolbar or select DICOM Module

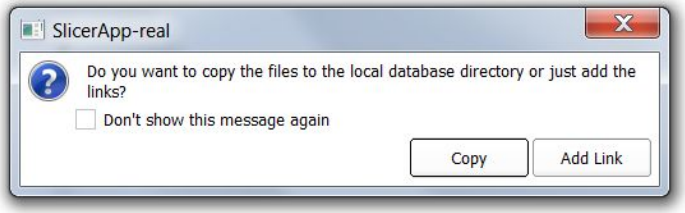
- Welcome Module -> Load DICOM Data

Importing a DICOM File

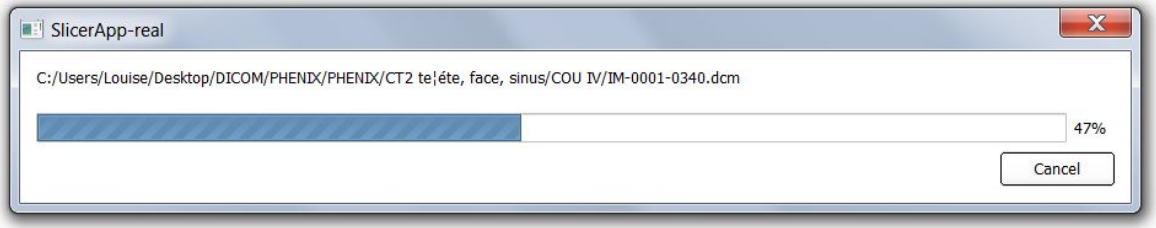
All methods bar ‘drag and drop’ will open the DICOM Browser.

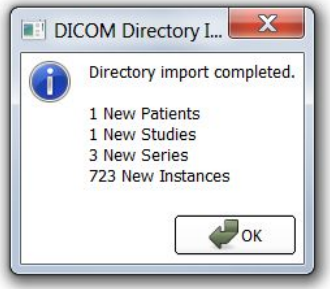


Select ‘Import’. Find data set and open.



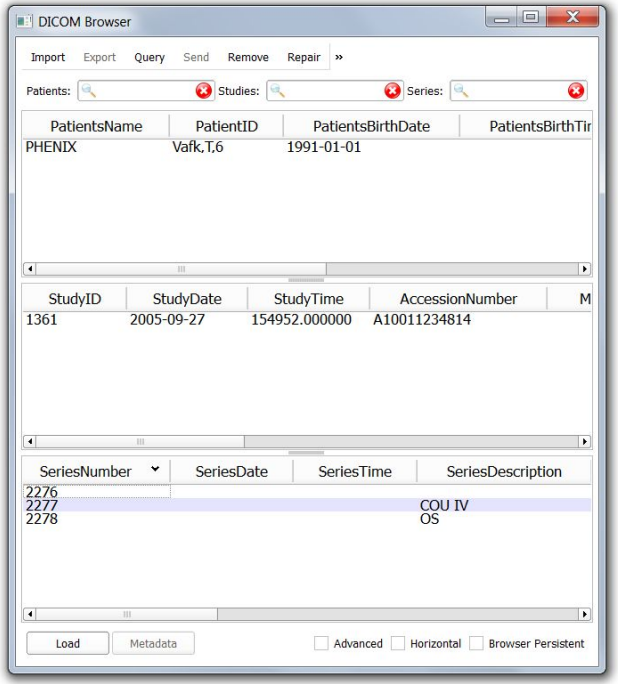
Select ‘Copy’

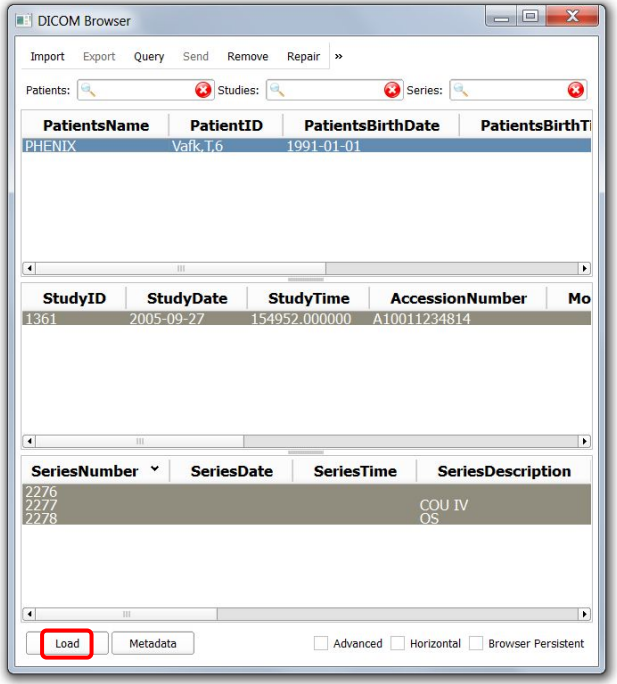




Importing a DICOM File

Select data sets and ‘Load’

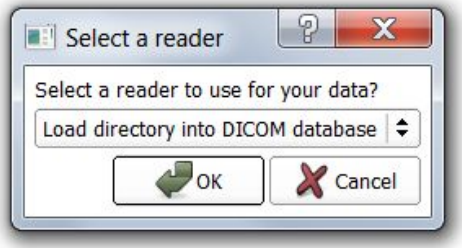


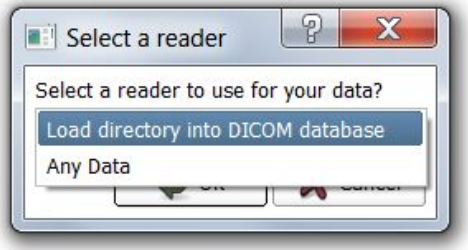


Importing a DICOM File

For ‘drag and drop’, a different window appears.

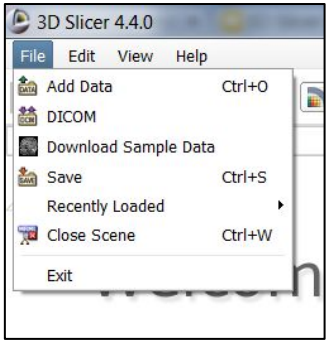
Select ‘Load directory into DICOM database’

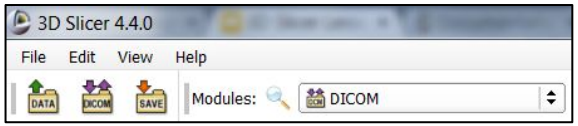




Importing other Data or a Scene

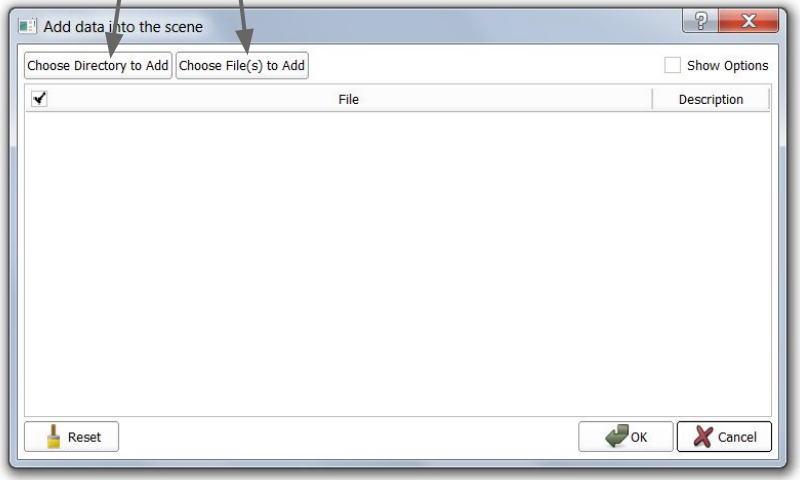
- Select File -> Add Data
- Welcome to Slicer module -> Load Data
- Find DATA icon in toolbar





Select folder

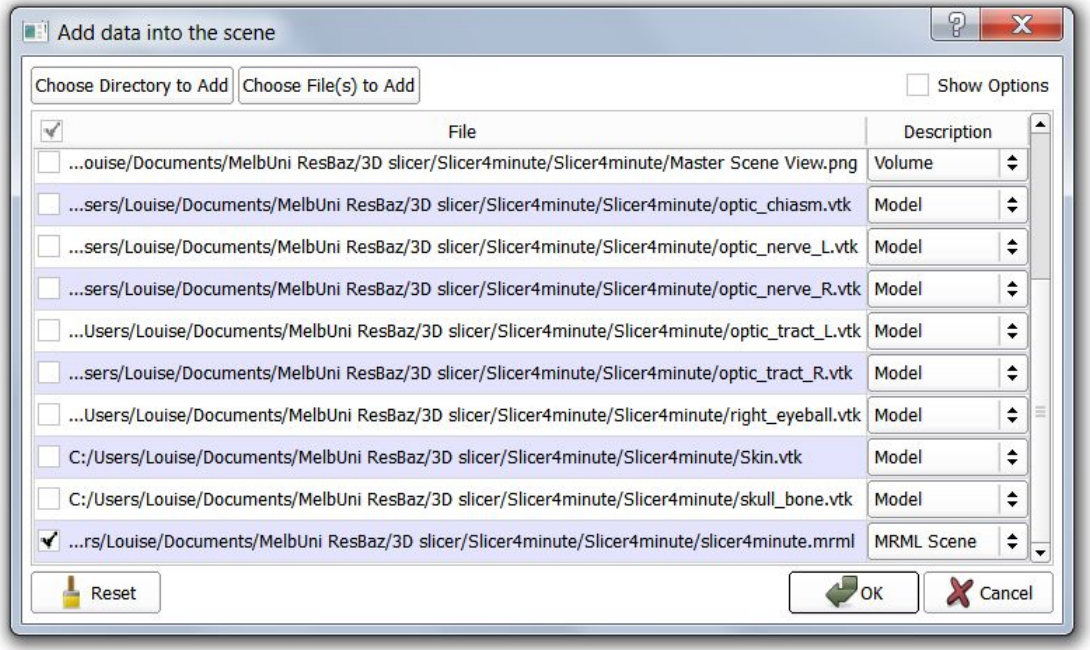
Select file(s)



Importing other Data or a Scene

E.g. Choose directory to add -> **Slicer4minute** (online tutorial)

In this instance we only need to select .mrml (scene) file



Introduction to 3D Slicer

Module: Welcome to Slicer

The Welcome to Slicer module is provided to introduce new users to Slicer's basic functionality, and to provide pointers to additional useful resources, such as downloadable sample data, support material, and acknowledgements etc.

Welcome to Slicer is the default module when 3D Slicer is launched.

[Wiki Help Link]

Basic Navigation

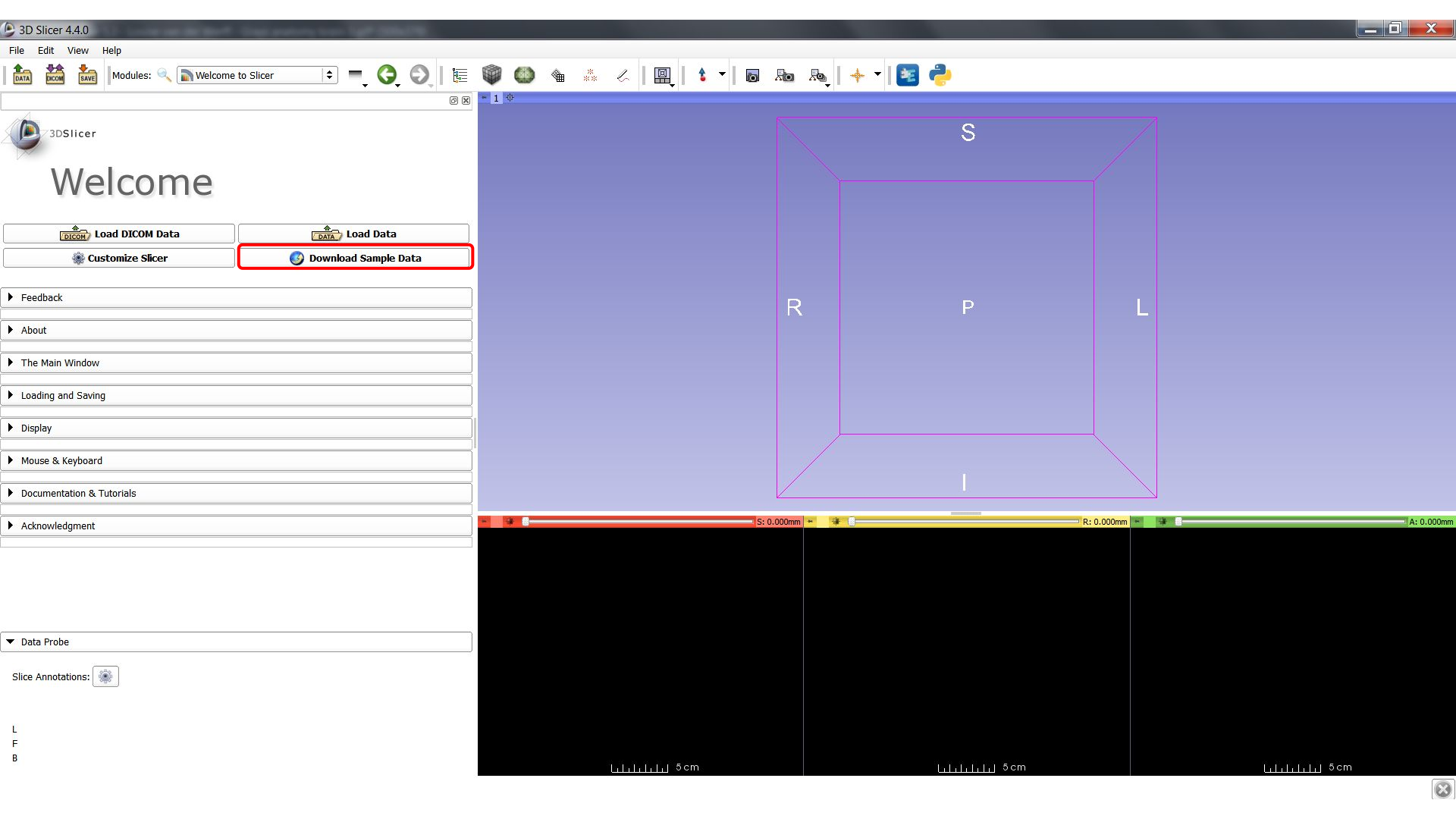
Let’s open some sample data to learn navigation basics.

‘Welcome to Slicer’ module ->

‘Download Sample Data’ ->

‘Download MRHead’

The sample data will download and appear within the 2D anatomical viewers.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Welcome to Slicer
3DSlicer
Welcome
Load DICOM Data
Load Data
Customize Slicer
Download Sample Data
Feedback
About
The Main Window
Loading and Saving
Display
Mouse & Keyboard
Documentation & Tutorials
Acknowledgment
Data Probe
Slice Annotations:
L
F
B
S
R
P
L
I
S: 0.000mm
R: 0.000mm
A: 0.000mm
5 cm
5 cm
5 cm

3D Slicer 4.4.0

File Edit View Help

Modules: Sample Data

3DSlicer

Help & Acknowledgement

BuiltIn

Download MRHead

Download CTChest

Download CTACardio

Download DTIBrain

Download MRBrainTumor1

Download MRBrainTumor2

Download BaselineVolume

Download DTIVolume

Download DWIVolume

Download Panoramix

Download CBCTDentalSurgery

Download MR-US Prostate

Load finished

File already exists in cache - reusing it.

Requesting load *MRHead* from C:/Users/Louise/AppData/Local/Temp/Slicer/RemoteIO/MR-head.nrrd...

Load finished

Data Probe

Slice Annotations:

L
F
B

S
R P L
I

R: S: -10.214mm

Y: R: -2.145mm

G: A: 6.929mm

B: MRHead_1 10 cm

B: MRHead_1 10 cm

B: MRHead_1 10 cm

2D Viewer Coordinate System

3D Slicer implements the following nomenclature to define the directional views in DICOM images.

The text colours correspond to the viewing windows in 3D Slicer.

- Axial plane: Separates the head (**S**uperior) from the feet (**I**nferior)
- *Coronal plane*: Separates the Front (**A**nterior) from the Back (**P**osterior)
- *Sagittal plane*: Separates the **L**eft from the **R**ight

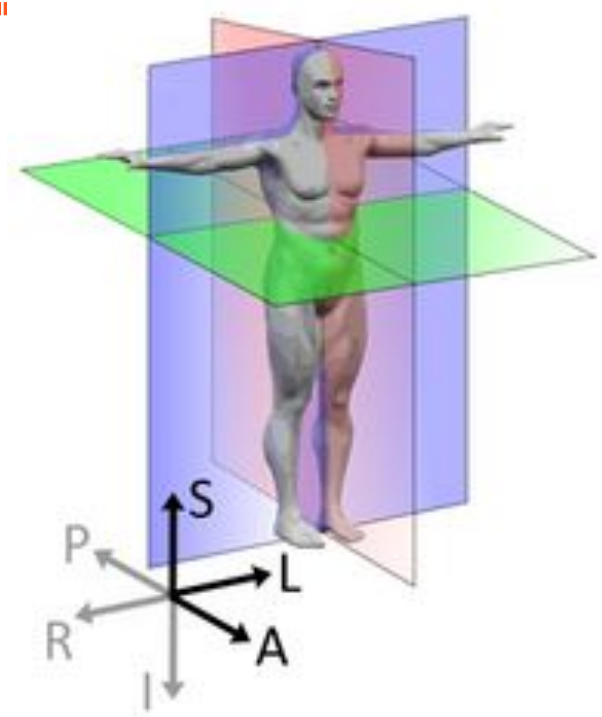


Image from 3D Slicer wiki

2D Anatomical Viewers

The three 2D anatomical viewers in 3D Slicer are defined by Red, Yellow and Green windows.

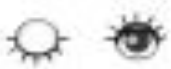
Axial Sagittal Coronal

Basic tips and tricks in 2D Viewers

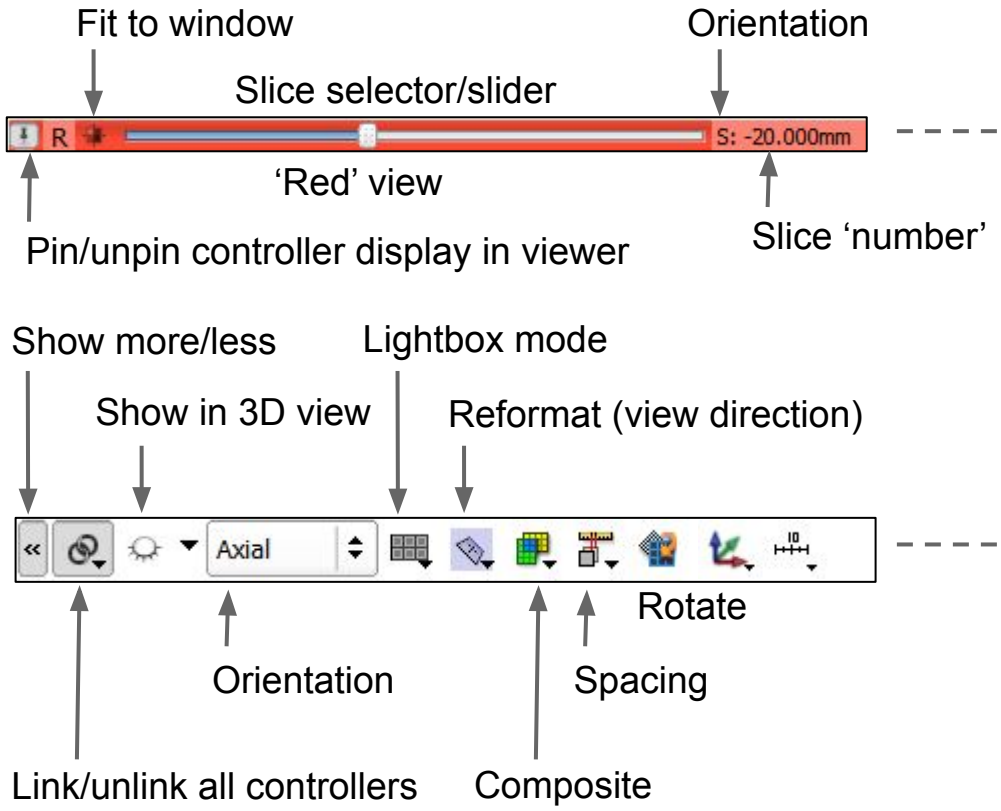
- Left clicking and dragging mouse up or down will change the **brightness** of scan data down and up respectively. *(brightness = level)*
- Left clicking and dragging mouse right and left will change the **contrast** of scan data down and up respectively. *(contrast = window)*
- Right clicking and dragging mouse up and down will **zoom** image out and in respectively.
- Middle clicking and dragging mouse around will **pan/translate** the image.
- Holding ‘shift’ & hovering the mouse over an area in one view plane will cause the other two views to scroll to the same position (using cross-hairs button in toolbar may be useful here).

Mouse and Keyboard Shortcuts Wiki Help Link.

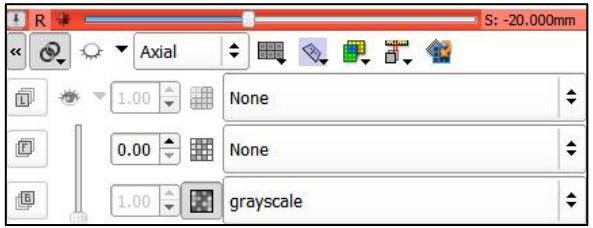
2D View Controllers



The eye icon appears throughout 3D Slicer and can be toggled open and closed by the user via a mouse click. It is used to toggle views on and off.



Slice Viewer Controller

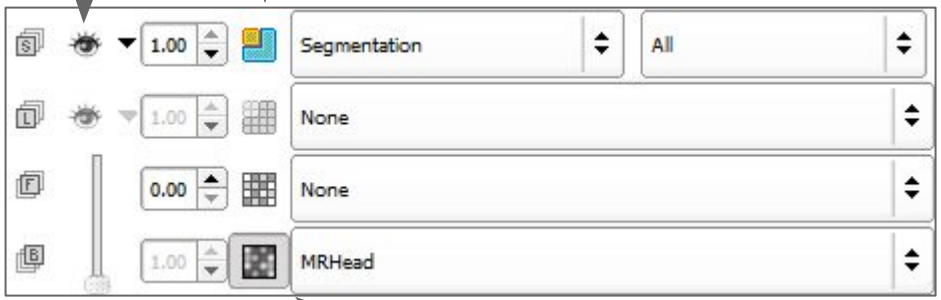


2D View Controllers

Segmentation (S) Label (L),
Foreground (F) and Background (B)
layers and layer specific options

Show/
hide

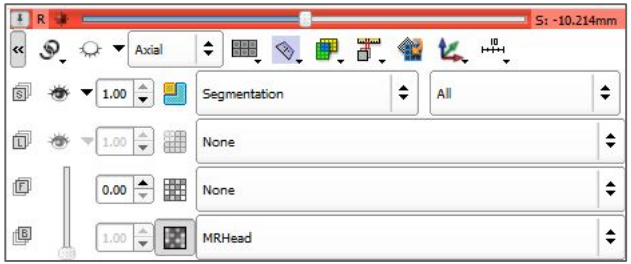
Toggle segmentation
filled or contour



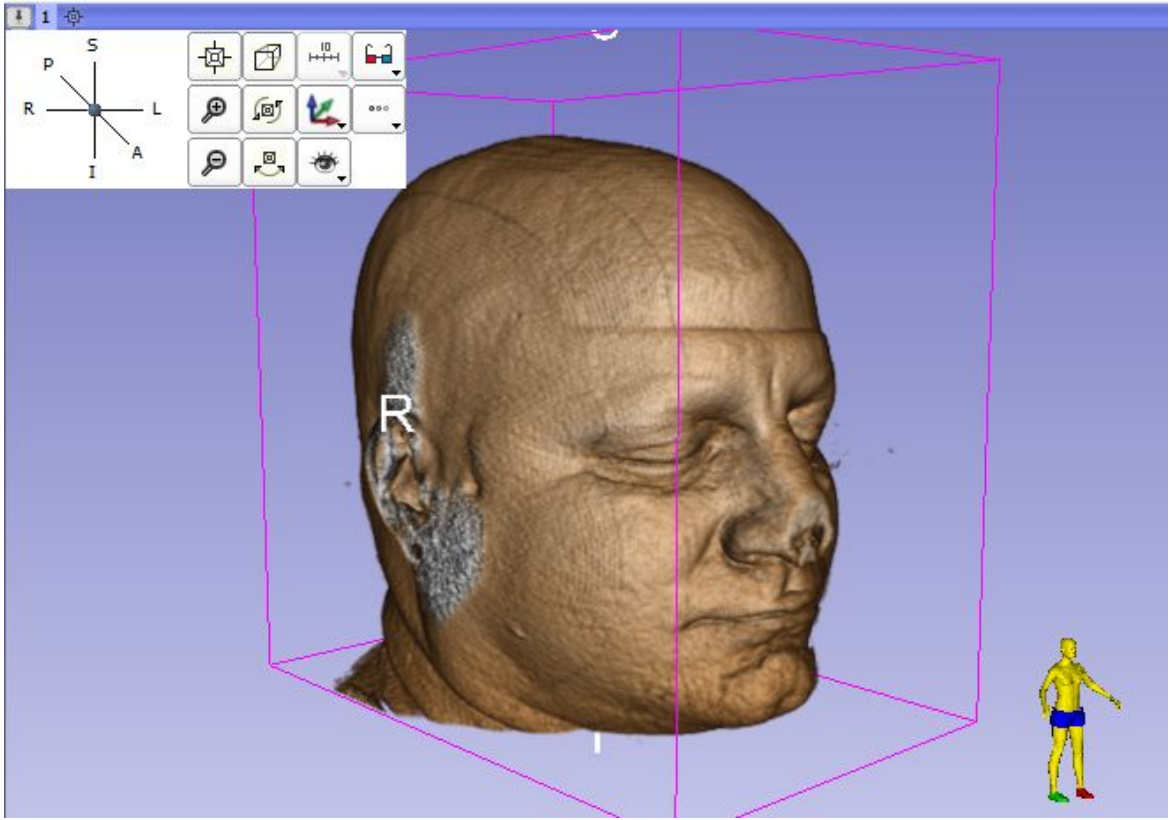
Opacity slider and
layer specific values

Interpolation (switch
between pixelated and
smoothed images

Slice Viewer Controller



3D View Controllers

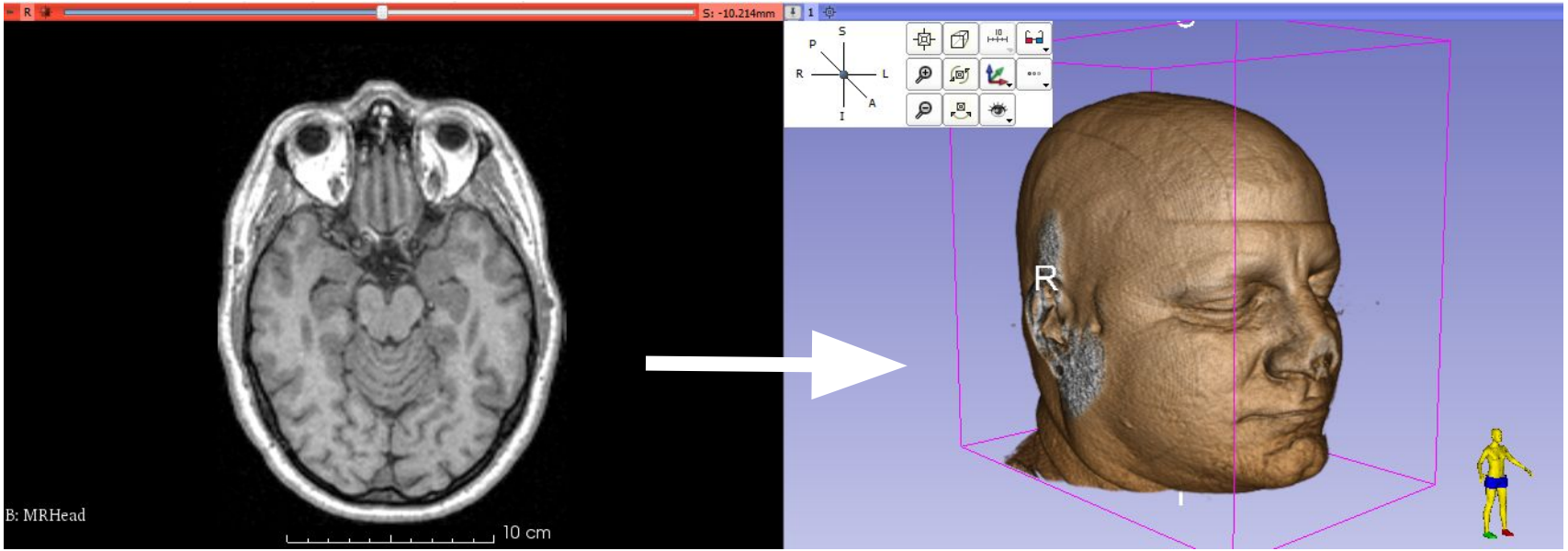


Challenge

Volume Rendering

Module: Volume Rendering

This module provides a method to quickly and interactively visualise 3D image data.



Volume Rendering Module

Use the volume rendering tool to visualise the ‘CTChest’ dataset in 3D space.

Download ‘CTChest’ Sample Data from ‘Welcome to Slicer’ module.

Select **‘Volume Rendering’** module.

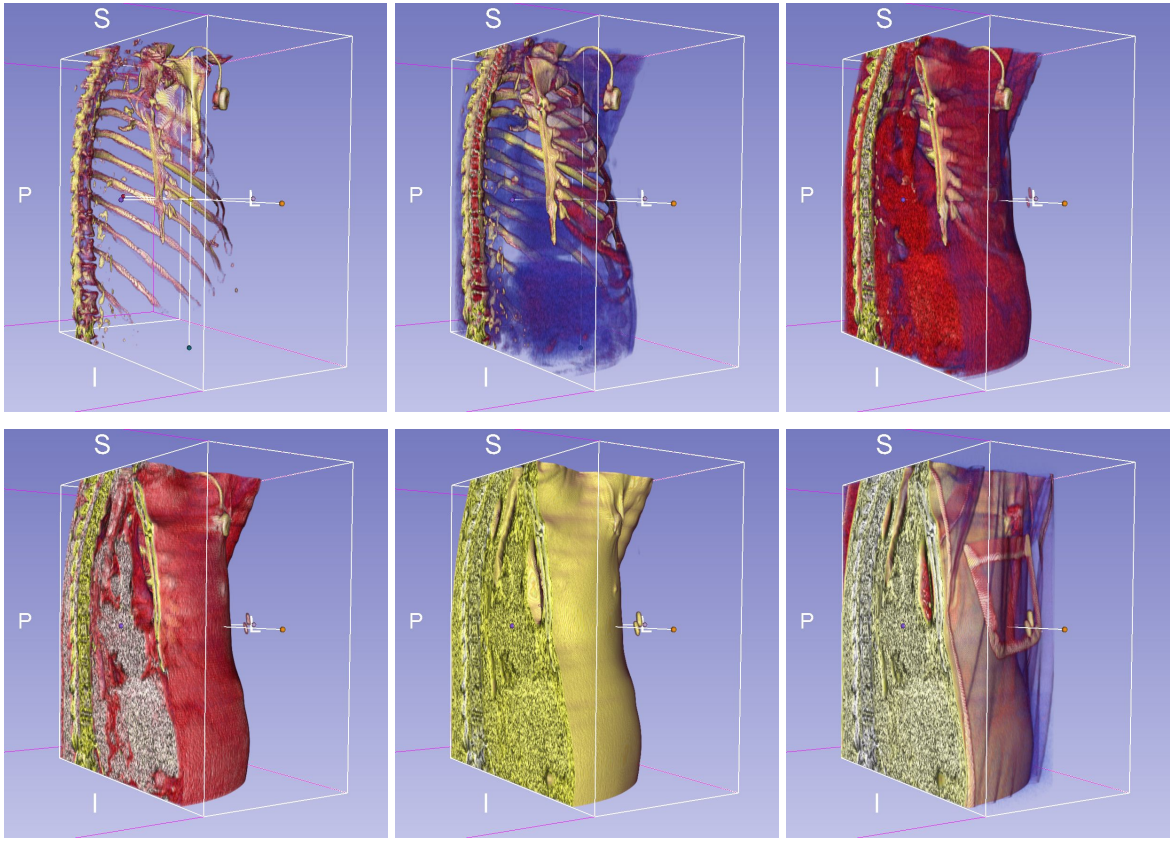
Open eye icon next to ‘Volume’ to generate 3D rendering of DICOM volume. Adjust view as required.

Under ‘Display’ menu, adjust ‘Shift’ slider to remove noise.

Tick box ‘Crop: Enable’ and select ‘Display ROI’. An adjustable window will appear in the 2D and 3D viewers. Adjust to crop out half of the volume in the Sagittal plane.

Volume Rendering

Preset: CTCardiac3

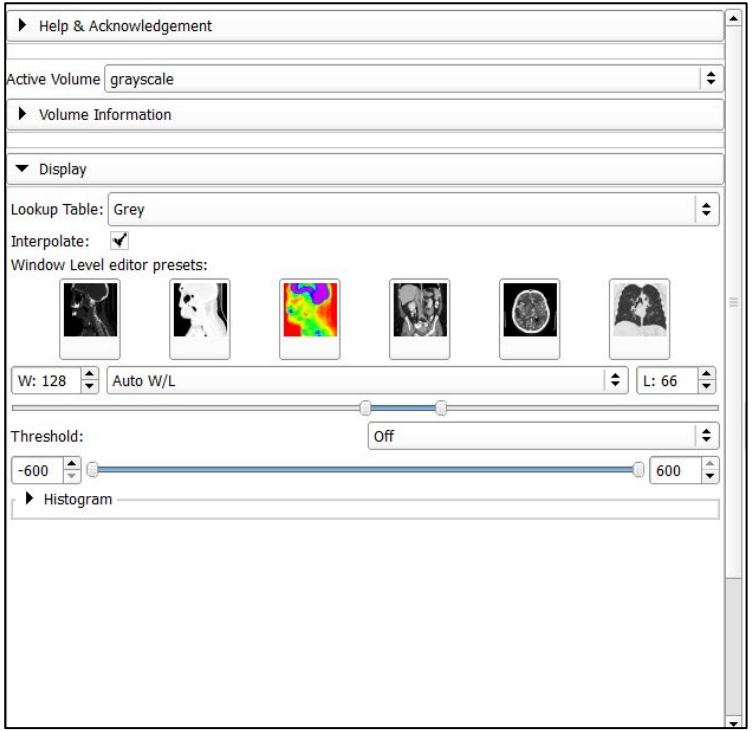


Change in rendering by adjusting ‘Shift’ slider

Module: Volumes

This module loads and adjusts display parameters of volume data. It is used for changing the appearance of various volume types.

[Wiki Help Link]



Volumes Module

The volumes module can be used to change the appearance of volume data. Unlike the **Volume Rendering** module, a 3D representation of the data is not rendered. Rather, the visual appearance in the 2D slice views changes.

Can be used to make areas of a slice layer differently coloured or even transparent.

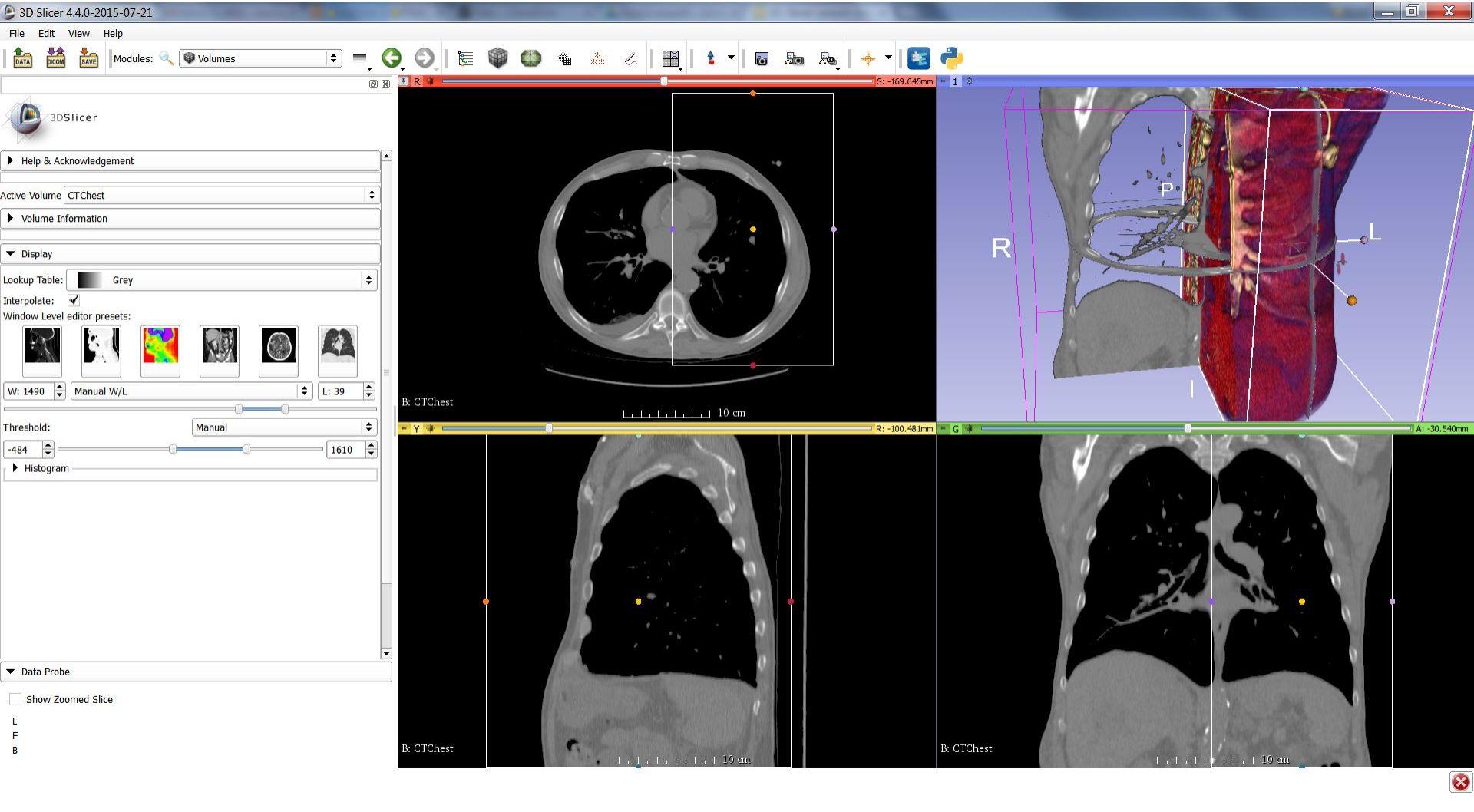
Turn on visibility of slices in 3D viewing window.

Go to ‘Volumes’ module.

Select last preset (CT lung).

Adjust the threshold slider to change the visual representation of the 2D slices.


3D Slicer 4.4.0-2015-07-21
File
Edit
View
Help
Modules:
Volumes
3DSlicer
Help & Acknowledgement
Active Volume
CTChest
Volume Information
Display
Lookup Table:
Grey
Interpolate:
Window Level editor presets:
W: 1490
Manual W/L
L: 39
Threshold:
Manual
-914
1610
Histogram
Data Probe
Show Zoomed Slice
L
F
B
R
S: -169.645mm
B: CTChest
10 cm
1
R
L
Y
R: -100.481mm
B: CTChest
10 cm
G
A: -30.540mm
B: CTChest
10 cm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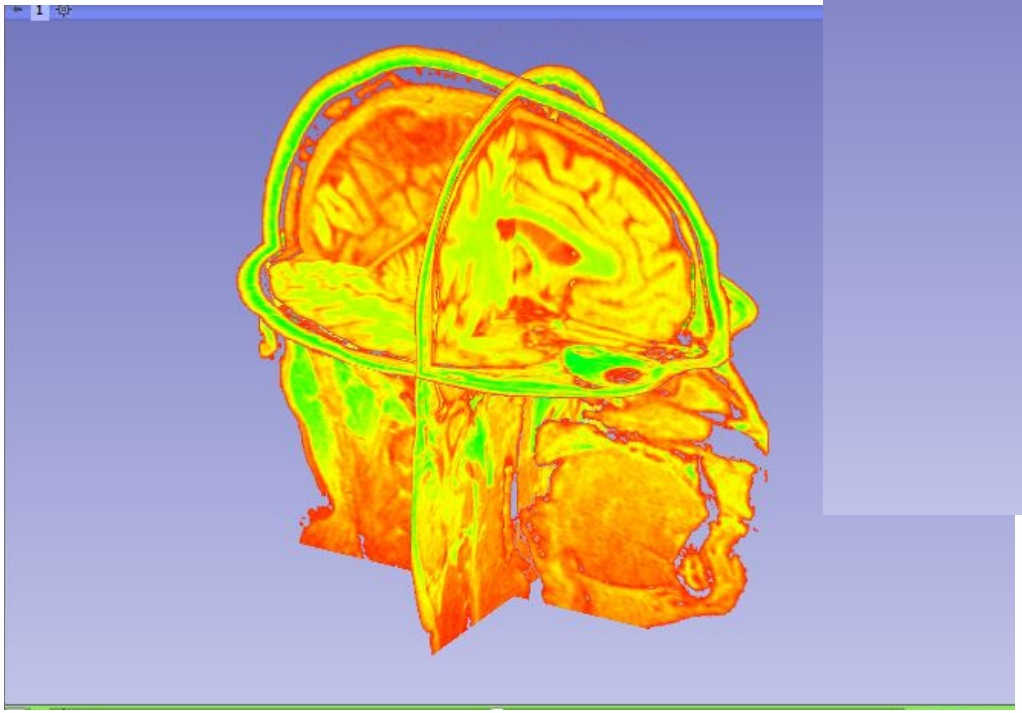
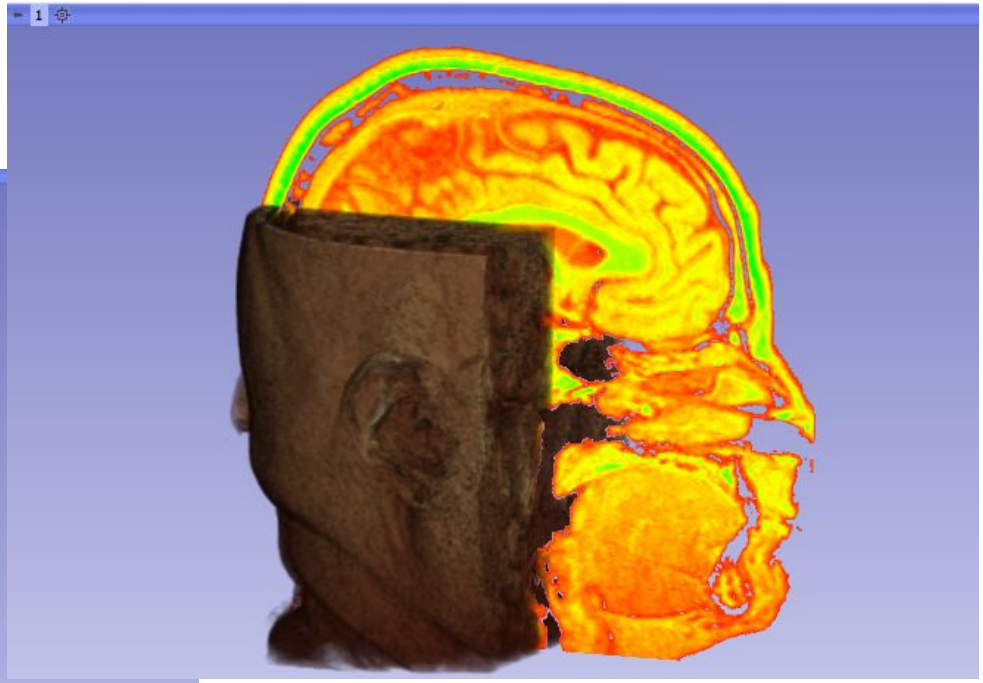
W: 1490
Manual W/L
L: 39
Threshold:
Manual
-484
1610
Histogram
Data Probe
Show Zoomed Slice
L
F
B
R
S: -169.645mm
B: CTChest
10 cm
1
P
R
L
I
Y
R: -100.481mm
G
A: -30.540mm





Challenge

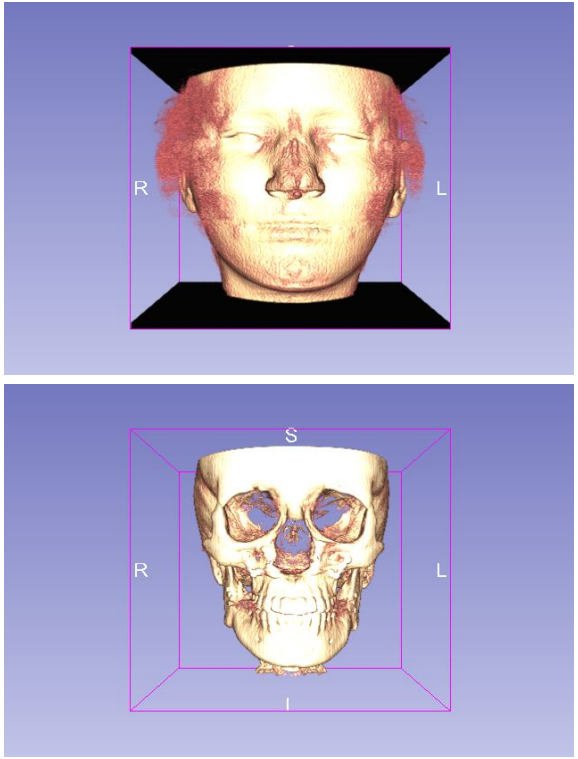
Segmentation of bone

Automatic Segmentation: Thresholding

We will now use a thresholding effect for simple automatic segmentation. This is appropriate for datasets with well defined boundaries between tissue of interest. E.g. bone in a CT scan.
Load sample dataset CBCTDentalSurgery.

Firstly have a look at the data using the Volume Rendering tool. E.g. use CT-bone preset

This dataset was selected for thresholding because of the well defined bone-soft tissue interface.



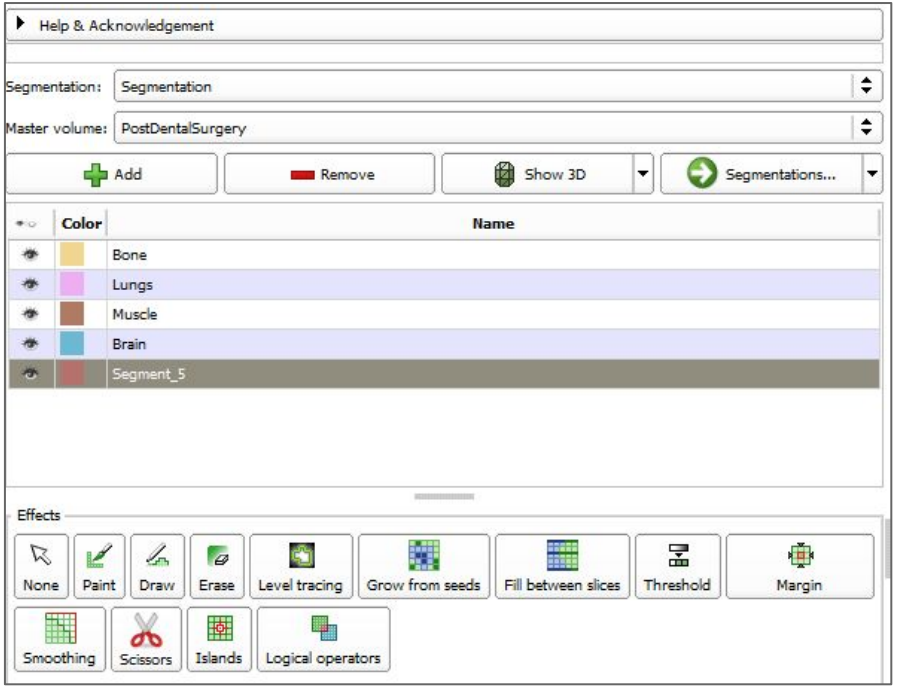
Volume Rendering of dataset

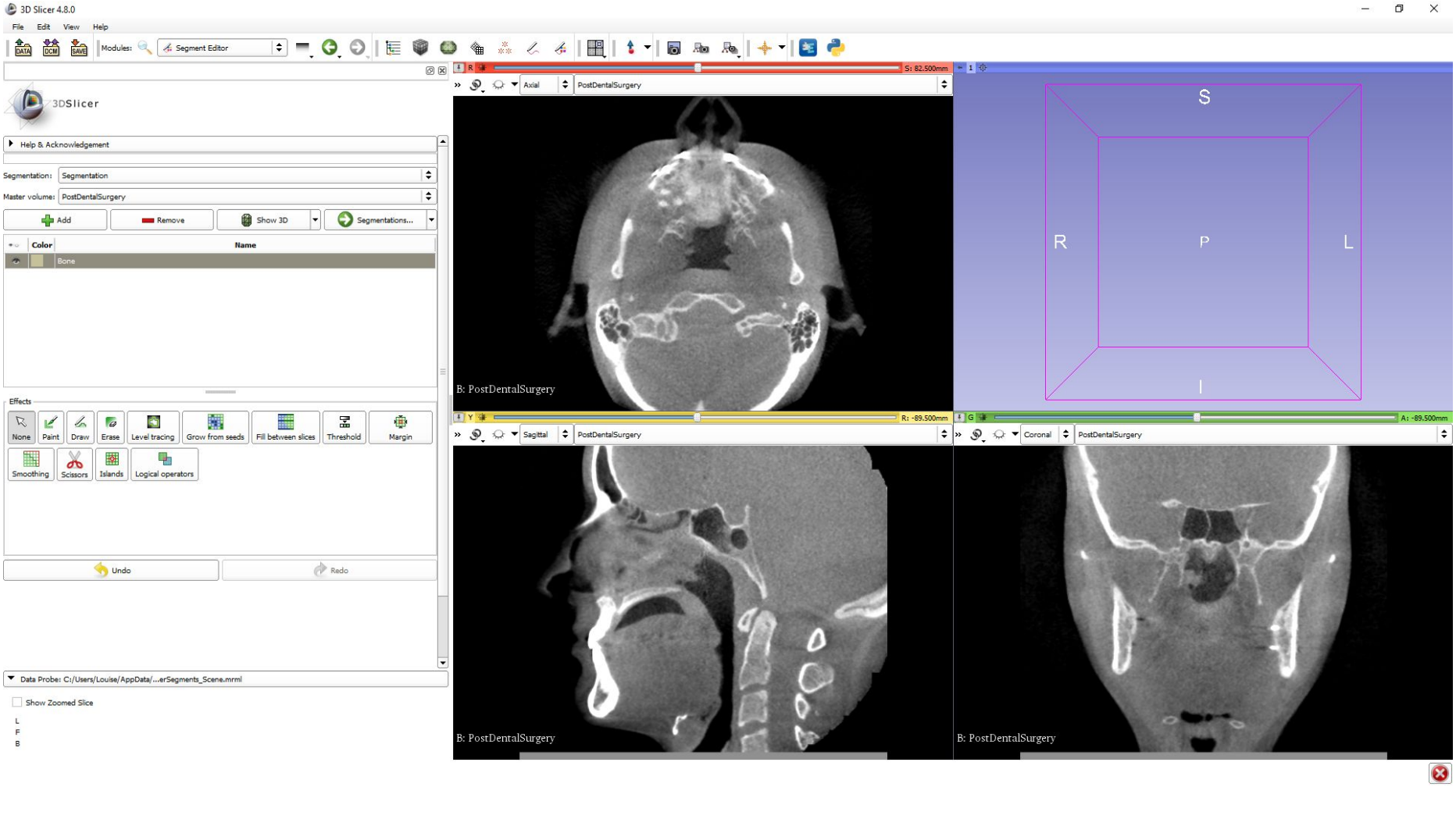
Module: Segmentation Editor

This module can be used for automatic and manual segmentation.

This is a new and powerful feature of 3D Slicer v 4.8. Previous versions relied on creating ‘labelmaps’ in the ‘Editor’ module, a similar but distinct tool.

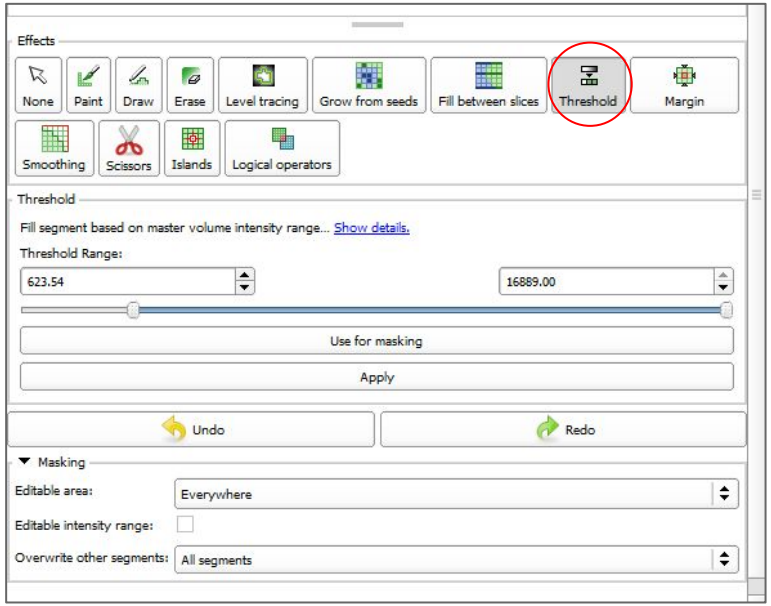
Challenge dataset: CBCTdentalsurgery

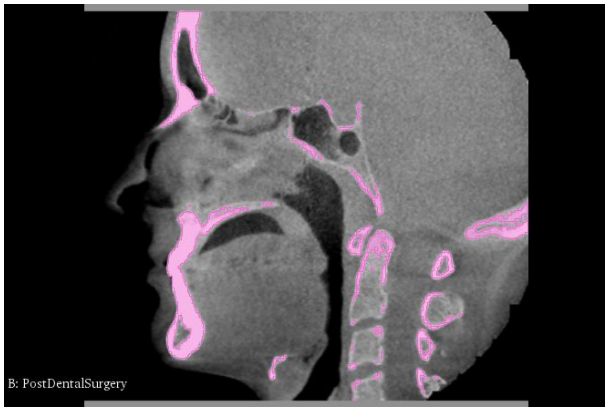



3D Slicer 4.8.0
File
Edit
View
Help
Modules:
Segment Editor
3DSlicer
Help & Acknowledgement
Segmentation:
Segmentation
Master volume:
PostDentalSurgery
Add
Remove
Show 3D
Segmentations...
Color
Name
Bone
Effects
None
Paint
Draw
Erase
Level tracing
Grow from seeds
Fill between slices
Threshold
Margin
Smoothing
Scissors
Islands
Logical operators
Undo
Redo
Data Probe: C:/Users/Louise/AppData/...erSegments_Scene.mrml
Show Zoomed Slice
L
F
B
Axial
PostDentalSurgery
B: PostDentalSurgery
S
R
P
L
I
Sagittal
PostDentalSurgery
B: PostDentalSurgery
Coronal
PostDentalSurgery
B: PostDentalSurgery

Challenge: Thresholding Segmentation

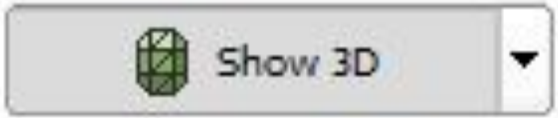
Segment bone using the Thresholding tool. Adjust thresholding range until all bone is selected.



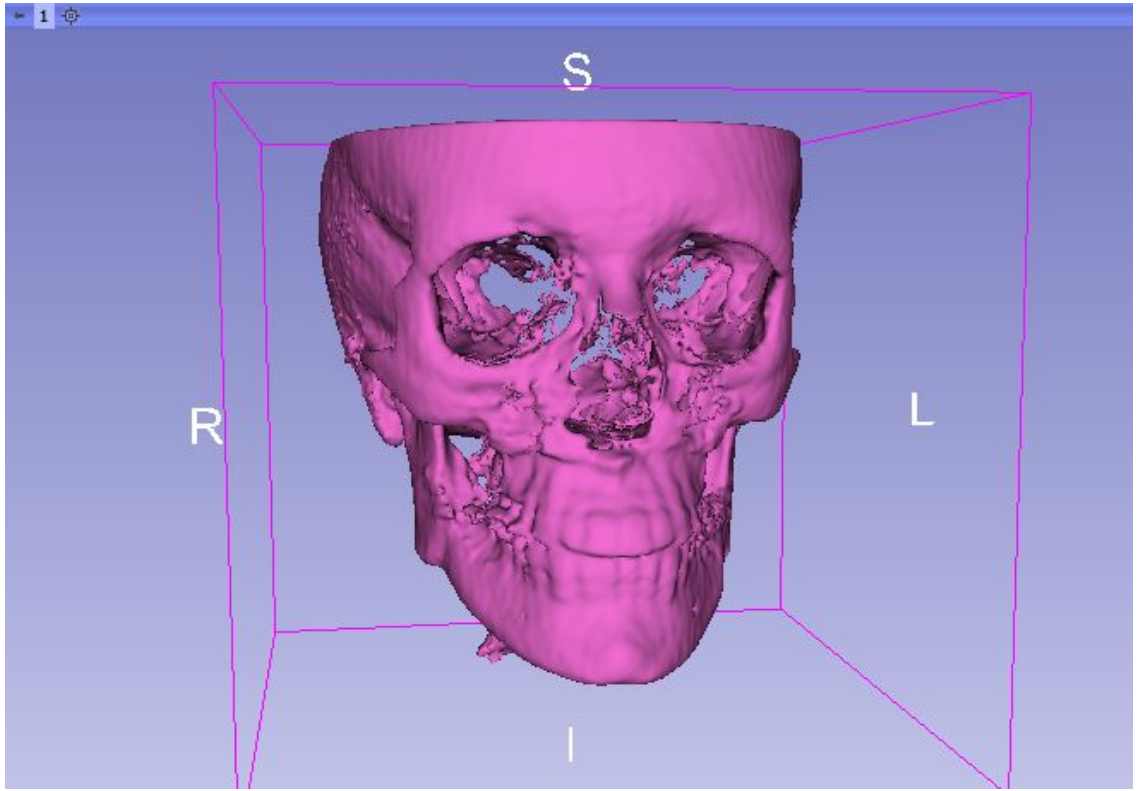


View the model in 3D

View the resultant segmentation in 3D.



(We will cover how to export these models in 3D printable formats a bit later.)

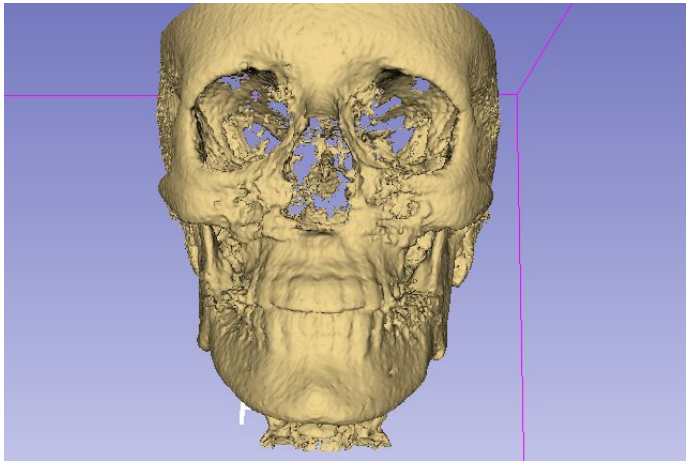


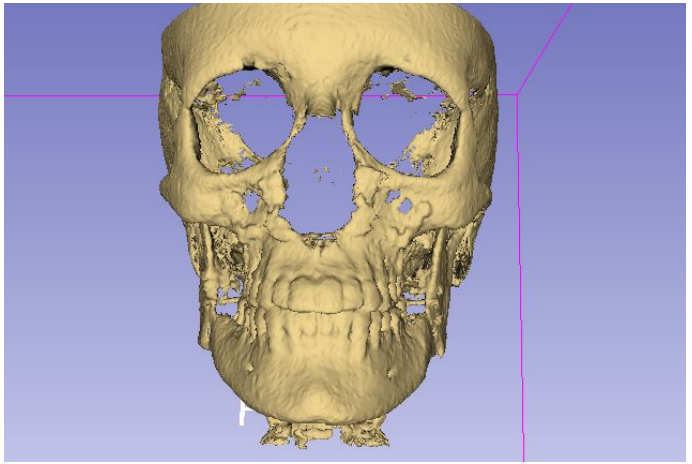
Improving Model

So we have generated a 3D model fairly quickly, but it is probably not perfect. Depending on your threshold range selection, you may have some or lots of scattered ‘island’ regions, and regions other than bone may have been selected.

Challenge: Clean up the data.

Hint: Check out the ‘Islands’ tool.





Background Information

Image Processing Fundamentals

Image Processing Fundamentals

A digital image is a numerical representation of a two-dimensional image. Digital images can be *raster*, or *vector* images.

Vector images are defined by mathematical relationships between points. Can be scaled up without loss of quality.

Raster images are composed of a grid of discrete pixels, each with their own co-ordinate and colour/intensity values. Loses quality when scaled up (becomes ‘pixelated’).

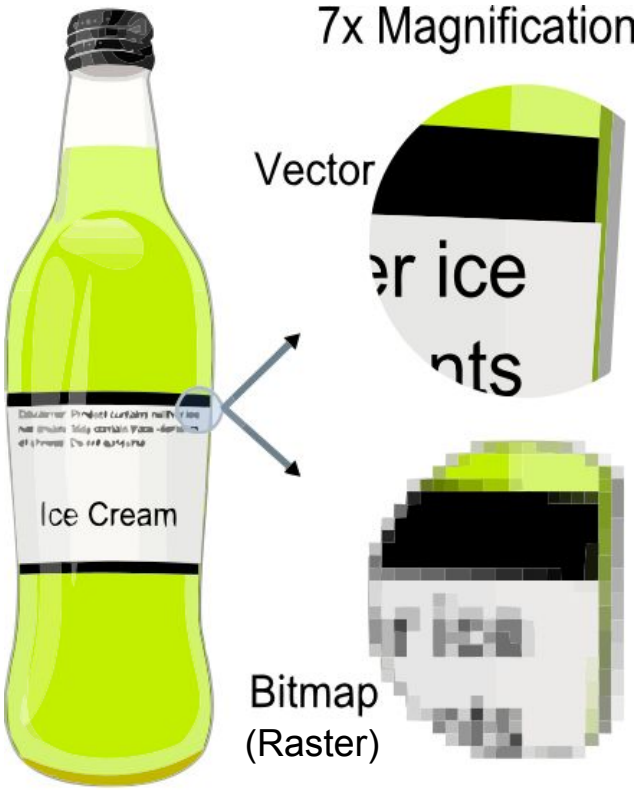


Image Processing Fundamentals

Resolution in raster images refers to the pixel count of an image.

Resolution affects image quality and the level of detail that can be extracted from an image.

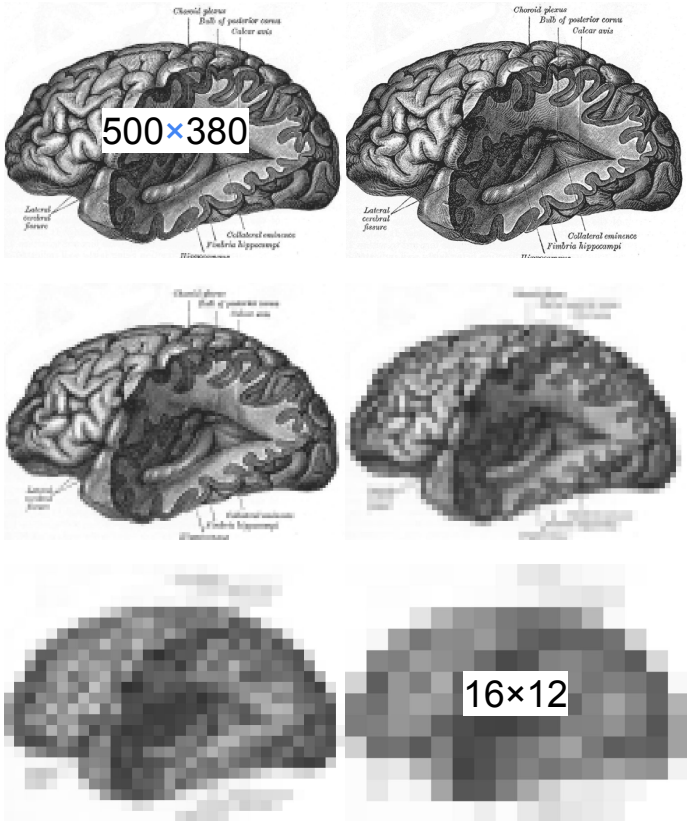
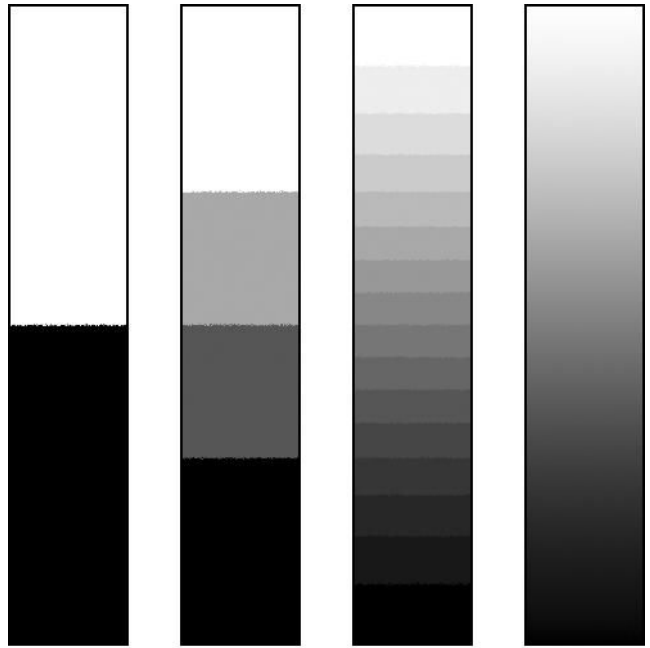


Image Processing Fundamentals

Grey scale images are digital images with a single intensity value (or grey level).

The no. of intensity or grey level values depends on the *bit-depth* of the image.



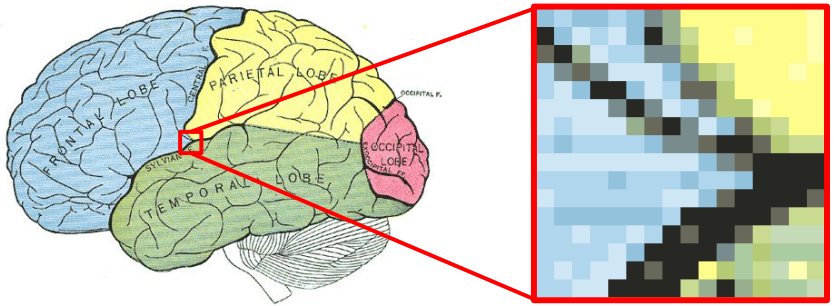
2^(bit depth) = grey levels

1bit	2bit	4bit	8bit
2 grey levels	4 grey levels	16 grey levels	256 grey levels

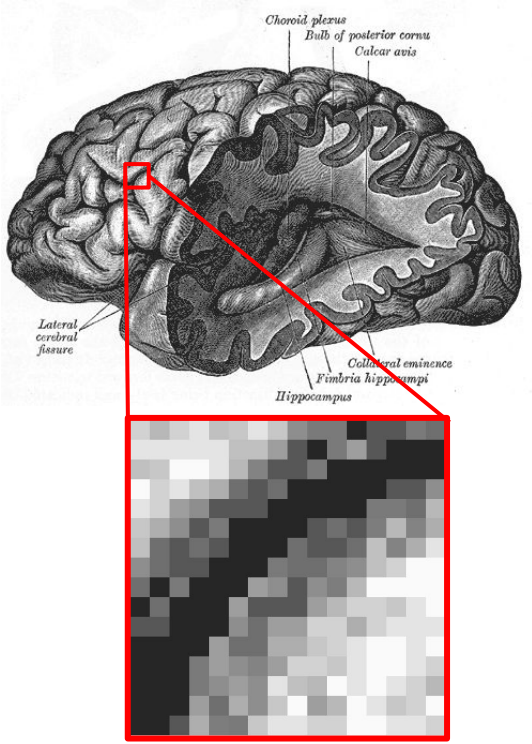
Image Processing Fundamentals

2D raster image are composed of individual pixels each with their own RGB values.

In grayscale images, each pixel is denoted by a single intensity value.



Colour (RGB)



Grayscale

Image Processing Fundamentals

Image **segmentation** involves partitioning an image into multiple segments (i.e. groups of pixels or masks).

Segmentation is used to simplify and/or change the representation of an image into something that is more meaningful for analysis.

Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

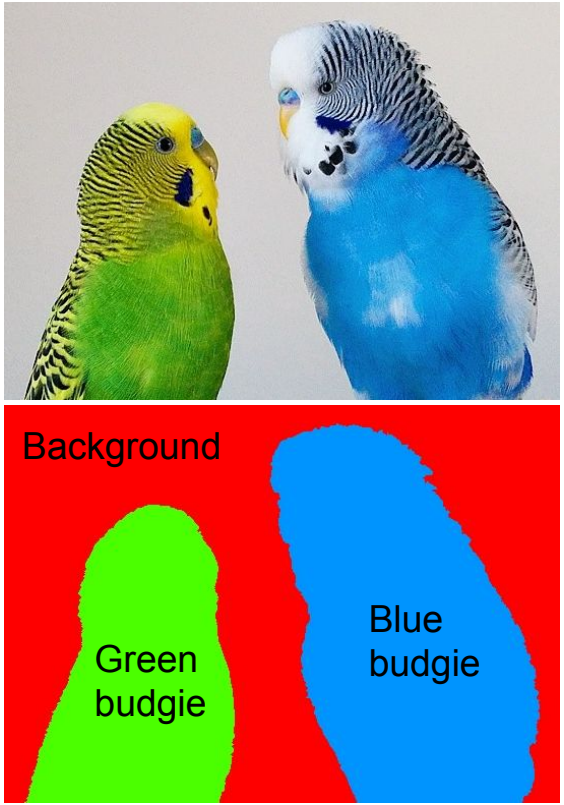
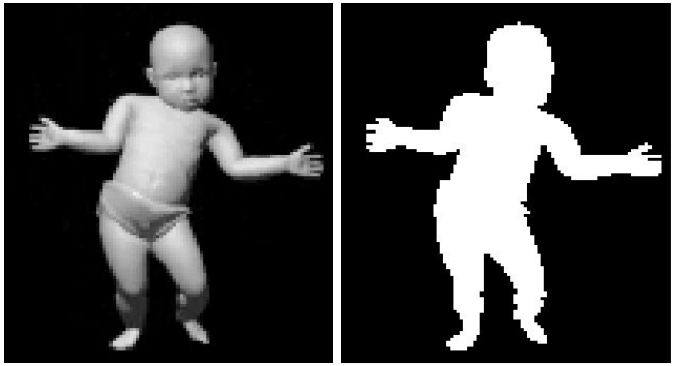


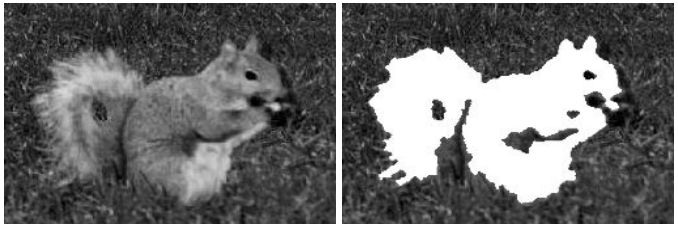
Image Processing Fundamentals

Image thresholding is the simplest segmentation method. The user defines an intensity range of pixels to separate an object from its surroundings. All pixels within that intensity range become the segmented object, the remaining area is defined as ‘negative space.’

Thresholding can be easy when there is a well defined boundary between objects in an image. It becomes more difficult when the boundary between objects is not clear.



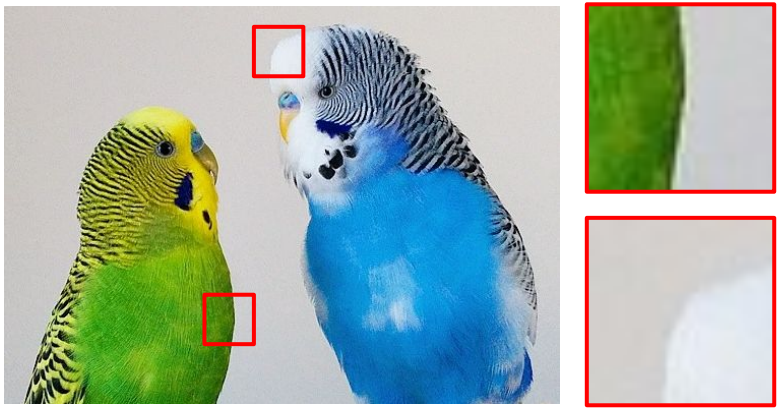
Easy



Difficult

Image Processing Fundamentals

Poor boundary definition means that manual segmentation, or more advanced segmentation techniques may be required instead of (or in addition to) the simple thresholding technique.



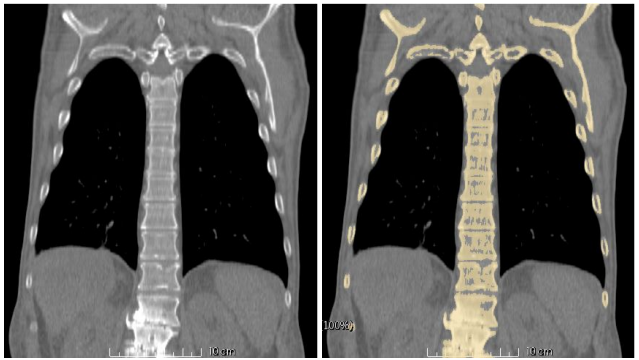
Good boundary definition

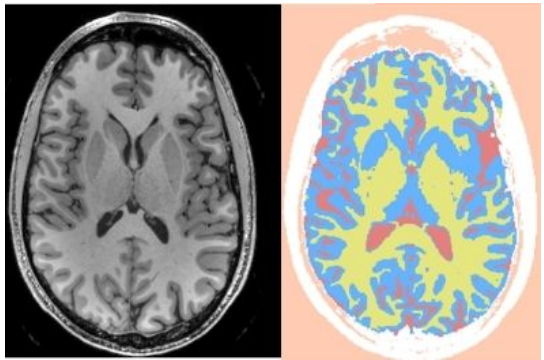
Poor boundary definition

Image Processing Fundamentals

In 3D Slicer, segmentations can define specific types of tissue or anatomical features.

Since a DICOM dataset defines a 3D volume, voxels, rather than pixels, are segmented. Thus segmentations occur in 3D space.





Challenge

Segmentation of Lungs

Automatic Segmentation of Lungs

Challenge dataset: CTChest

Tools: Paint/Erase/Draw, then Grow from Seeds

Automatic Segmentation of Lungs

Steps: Create ‘seed’ regions using Paint/Erase/Draw tools.

Hint: Define both ‘Lung’ and ‘Not-Lung’.

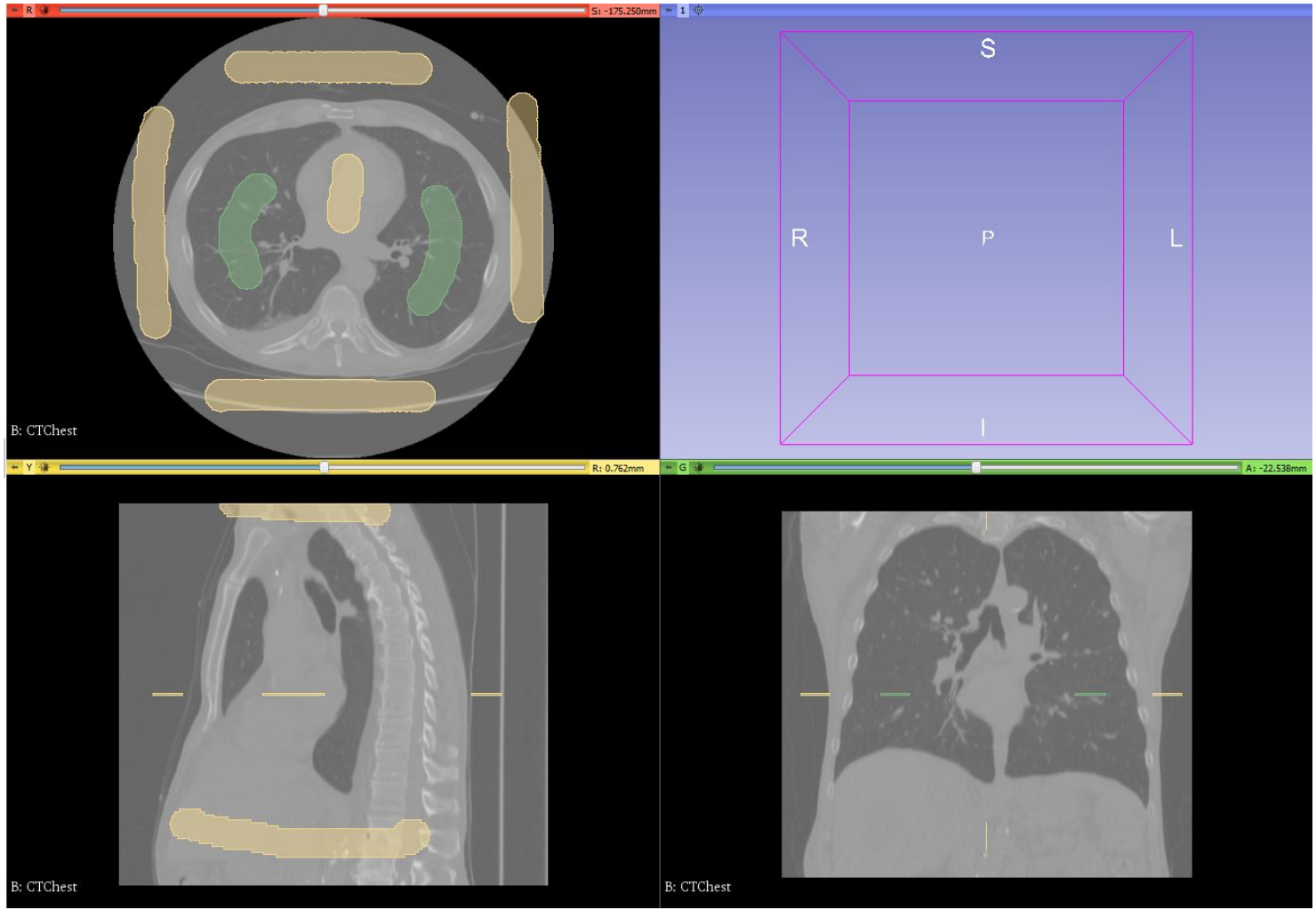
Select ‘Grow from Seeds’. -> Initialise.

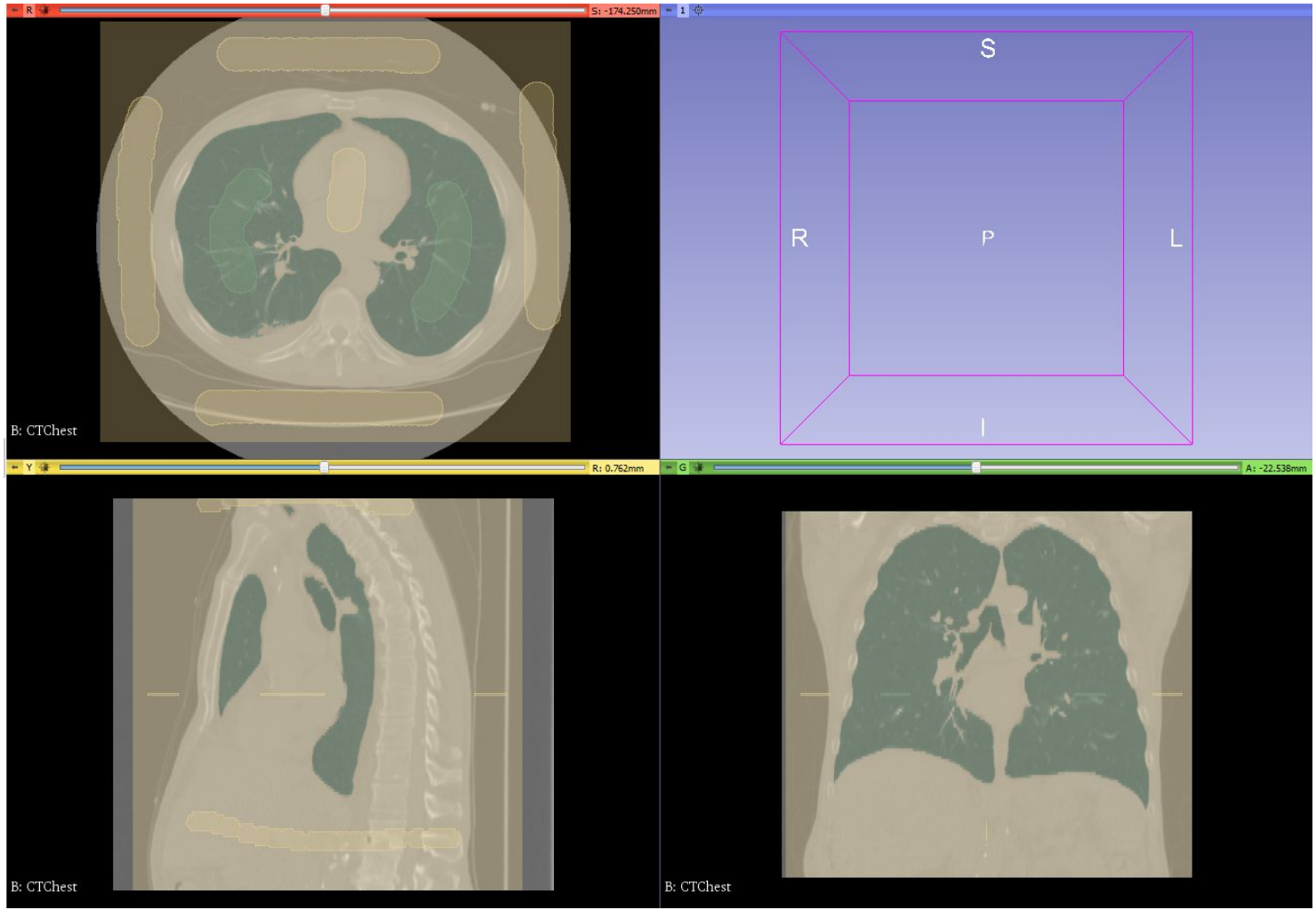
Adjust seeds as necessary if you aren’t happy with the segmentation. Grow from Seeds will remain ‘live’ until completed.

Click ‘Apply’.

Delete segmentation surrounding lung.

Show in 3D… Voila!


S: -175.250mm
B: CTChest
S
R
P
L
I
R: 0.762mm
B: CTChest
A: -22.538mm
B: CTChest


S: -174.250mm
B: CTChest
S
R
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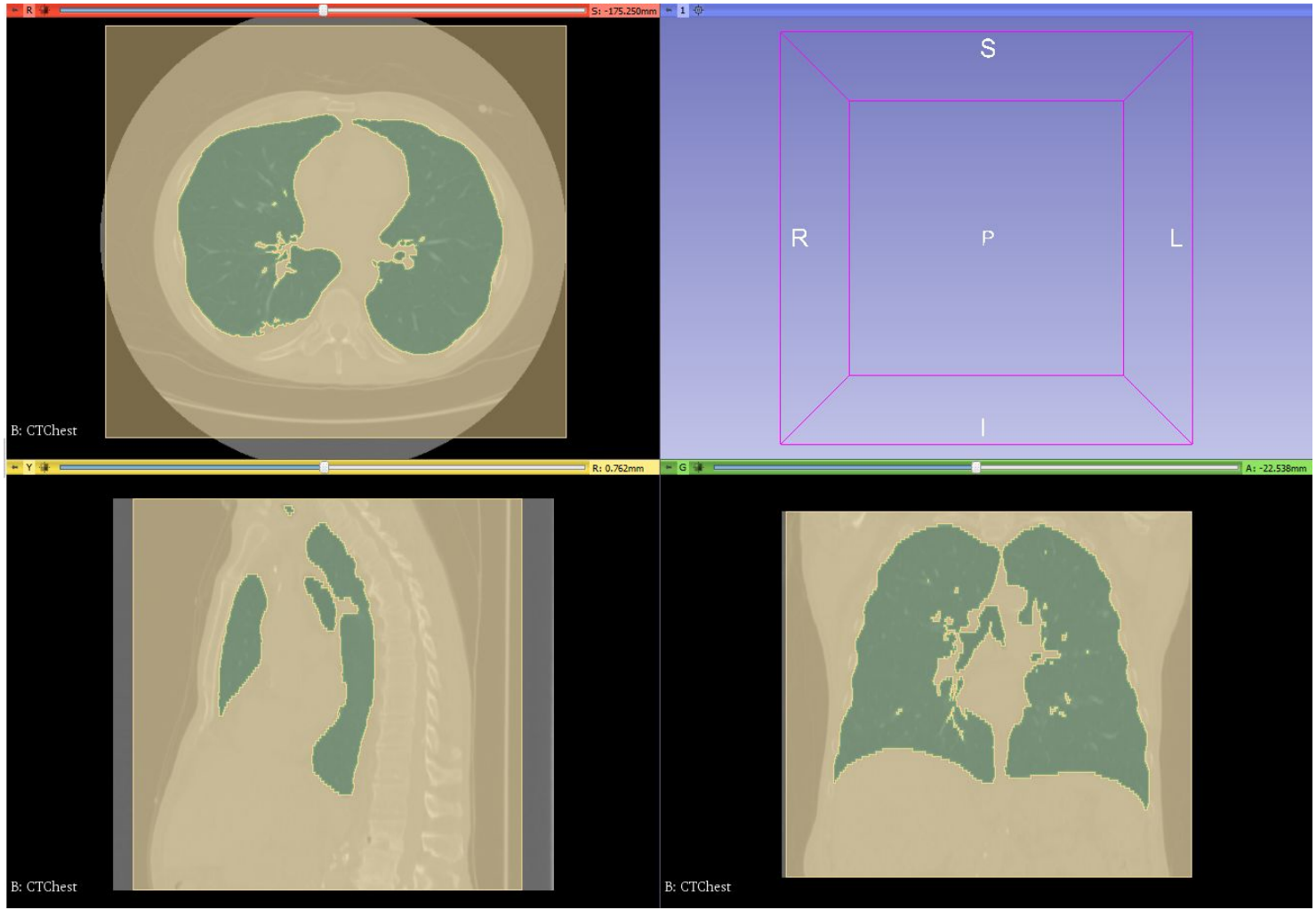
R: 0.762mm
B: CTChest
A: -22.538mm
B: CTChest


S: -175.250mm
B: CTChest
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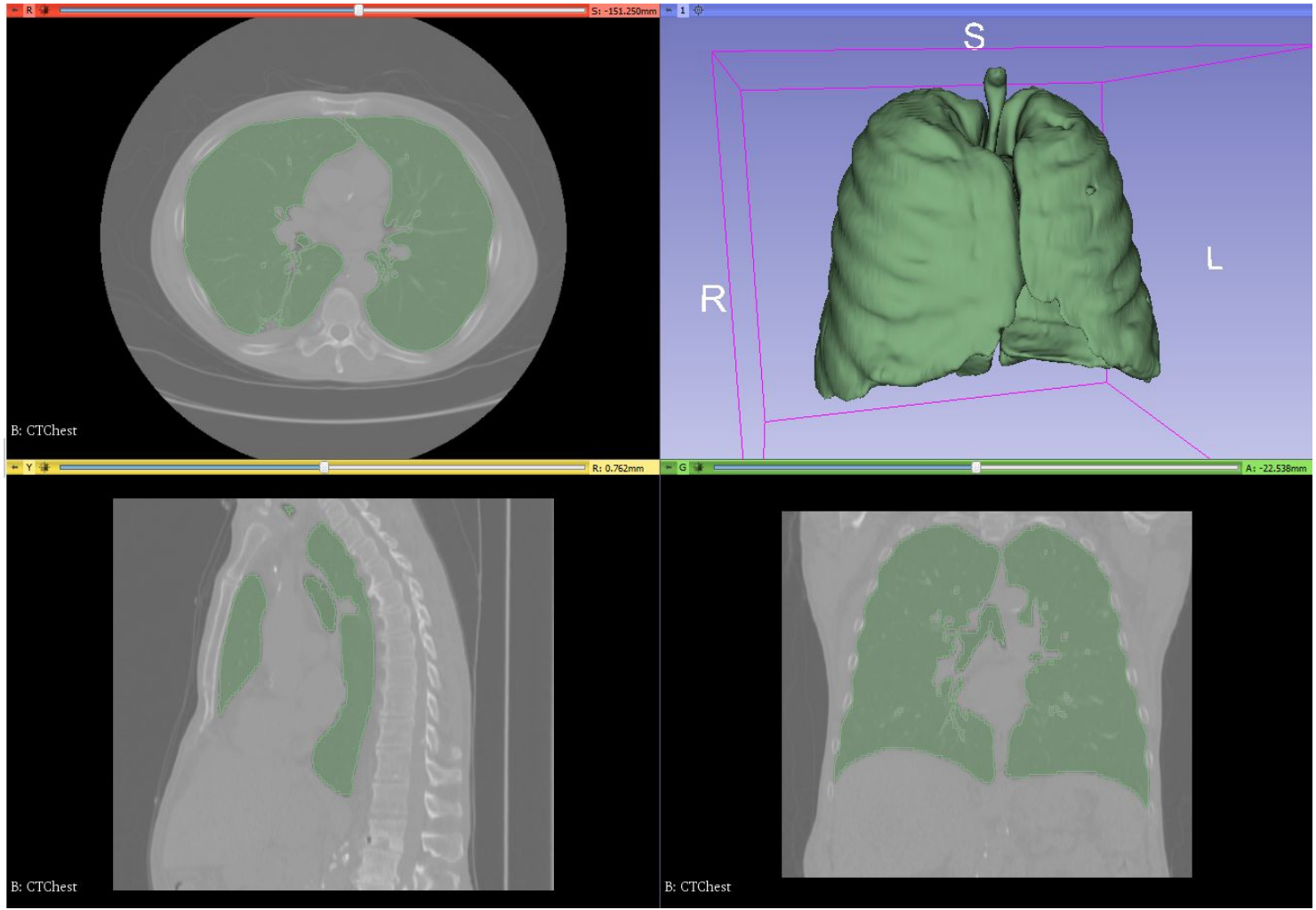
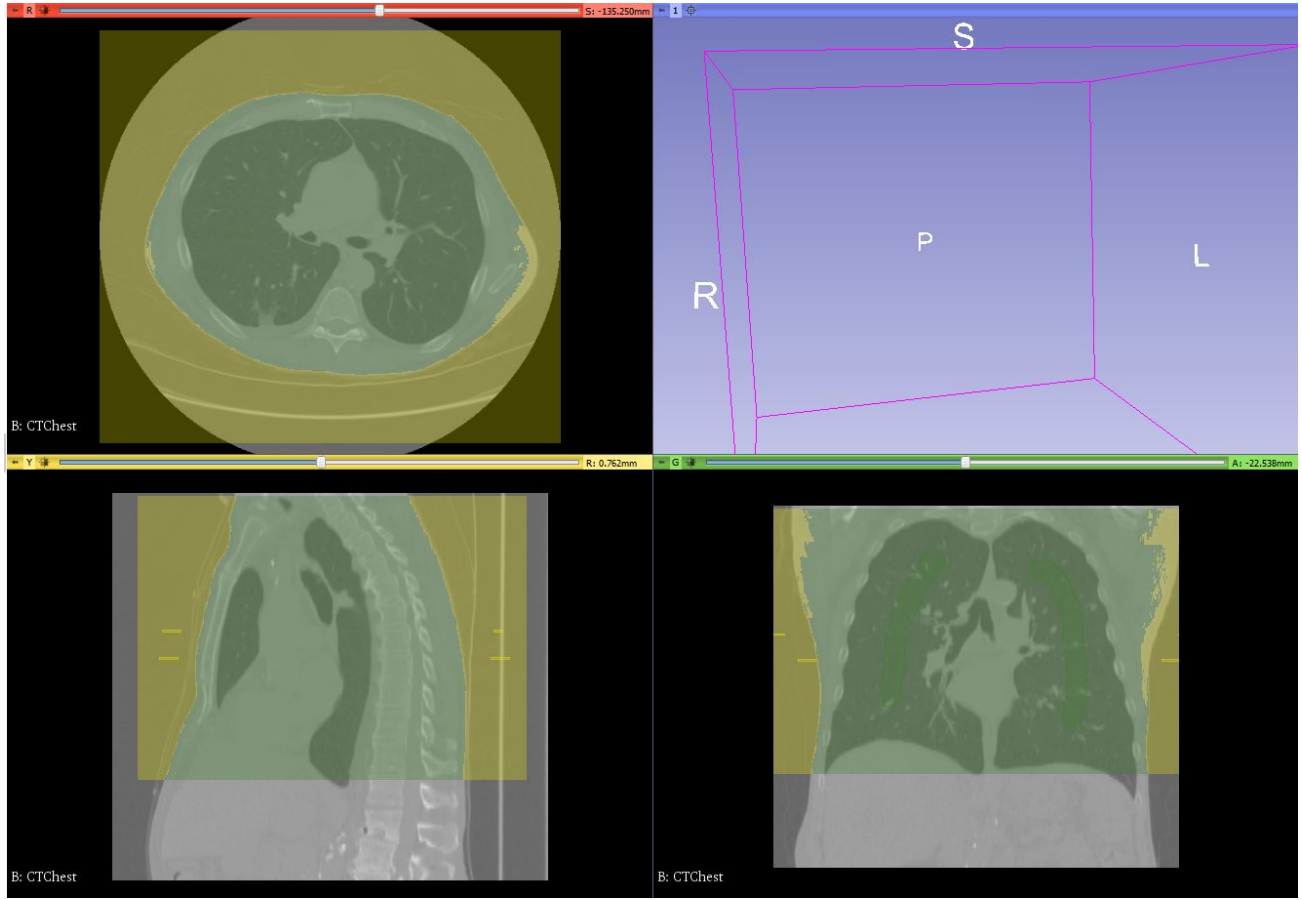
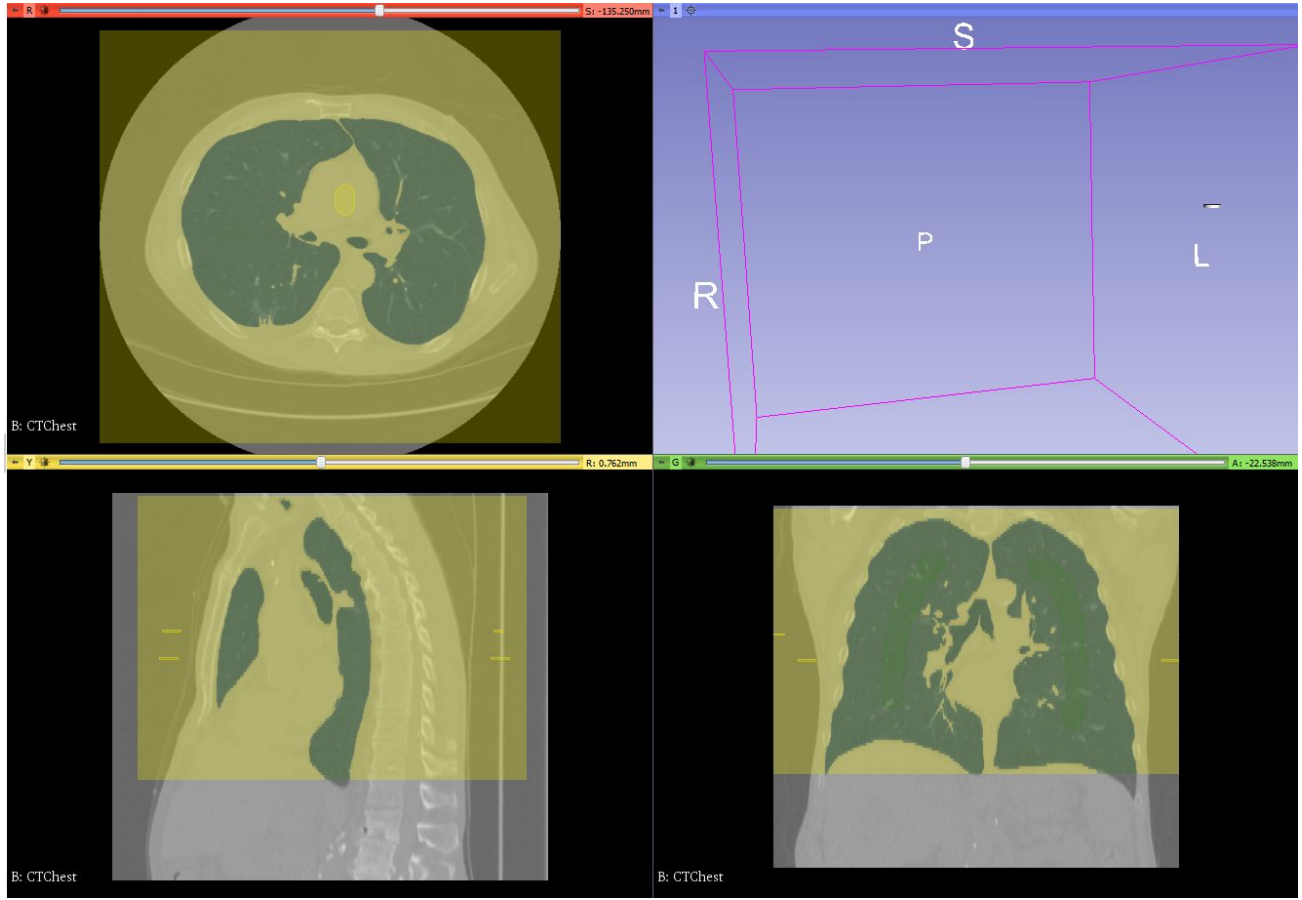
R: 0.762mm
B: CTChest
A: -22.538mm
B: CTChest


S: -151.250mm
B: CTChest
S
R
L
R: 0.762mm
B: CTChest
A: -22.538mm
B: CTChest

Ooops… (segmentation didn't end up where I wanted…)



Fixed! (by painting a new seed in the problem area)



Challenge

Segmentation of Lung Nodules

Automatic Segmentation of Lungs

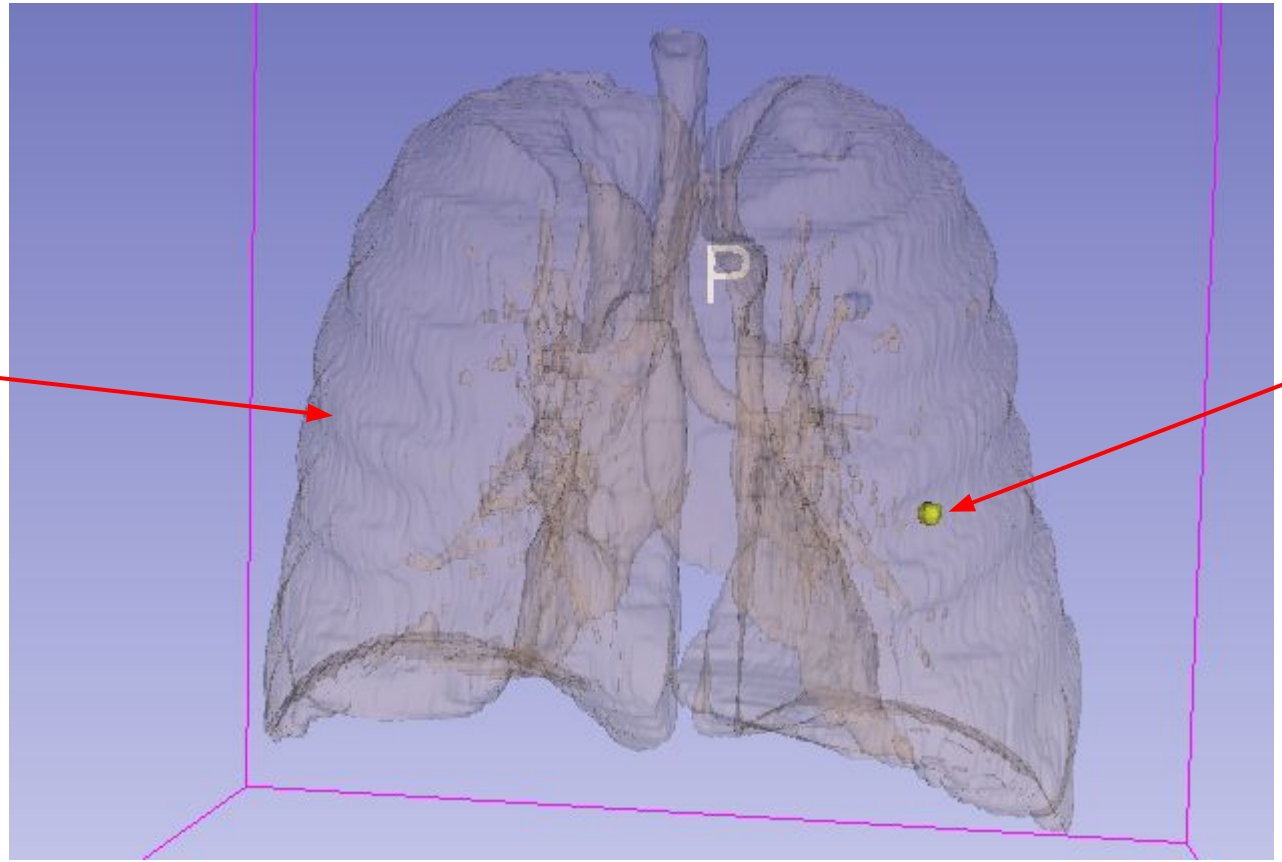
Find a prominent lung nodule to segment.

Explore ‘Level Tracing’ tool as a way to segment this nodule.

Once segmented, view both ‘Lung’ and ‘Lung nodule’ segmentations in the ‘Segmentation’ module.

Reduce the opacity of the ‘lungs’ model to see where the ‘lung nodule’ is located.

lungs at 30% opacity

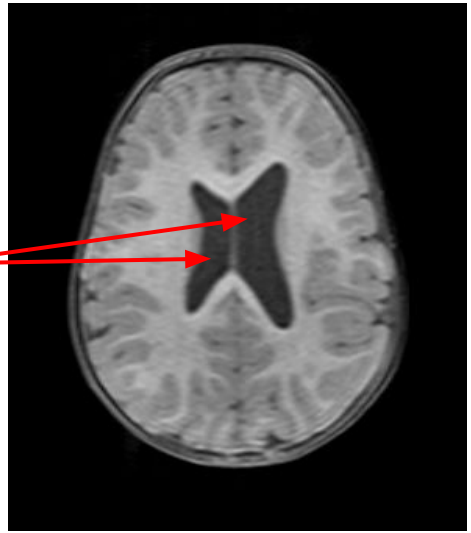


foreign object

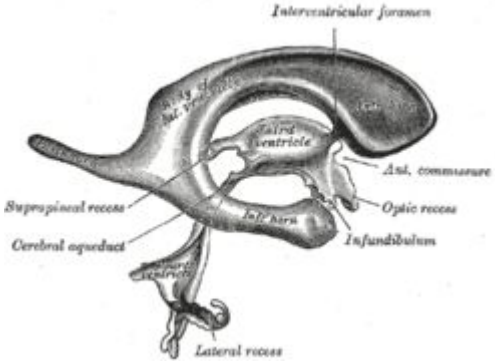
Challenge

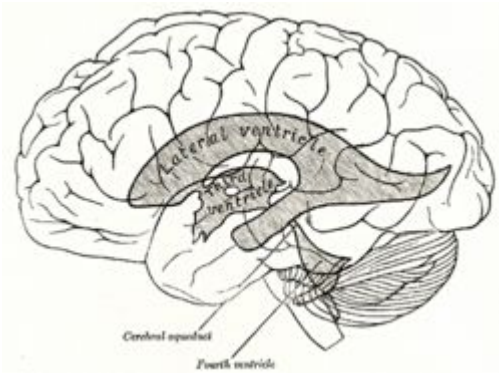
Segmentation of Lateral Ventricles

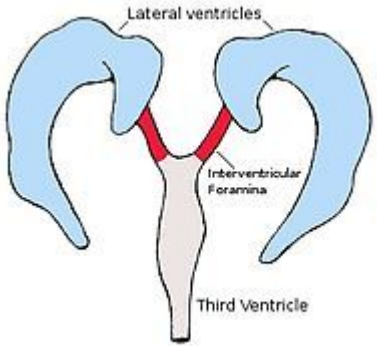
Lateral Ventricles



Here we will explore two different approaches to segment the lateral ventricles.





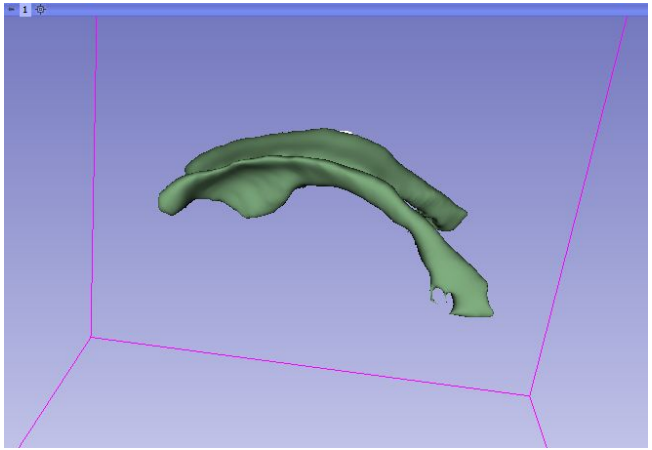


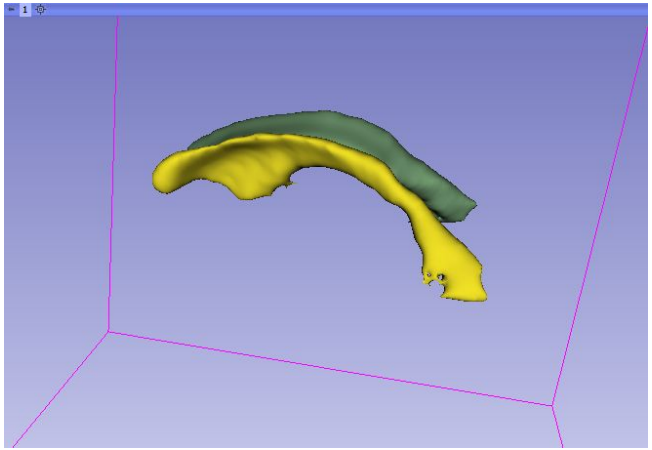
Ventricles Segmentation #1

Challenge dataset: MR Head

Option 1: Thresholding + Islands tools

Option 2: Grow from seeds to define both left and right ventricles.





Experimentation

Experiment with these tools:

-Smoothing

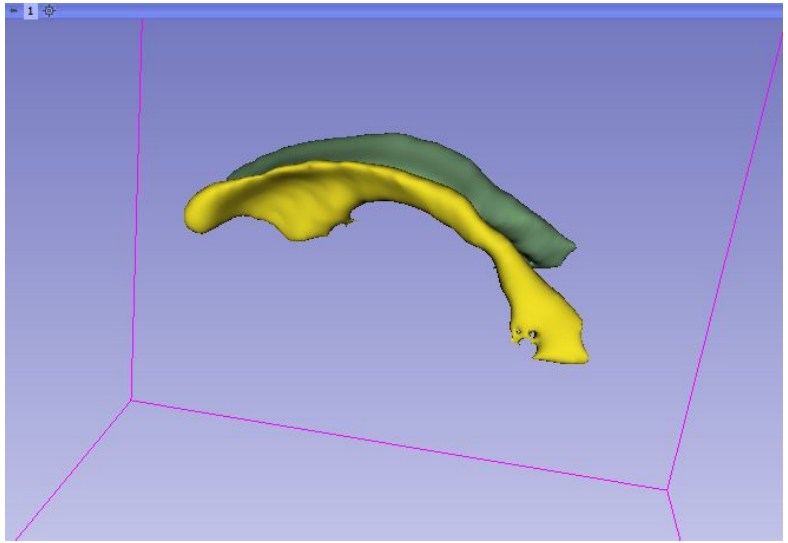
-Margins

-Scissors

-Logical operators

Module: Segment Statistics

Use this module to calculate counts and volumes for segments plus statistics on the grayscale background volume.



E.g.

Left ventricle = 9.47cm^3

Right ventricle = 6.04cm^3

Challenge

Manual Segmentation of Trachea

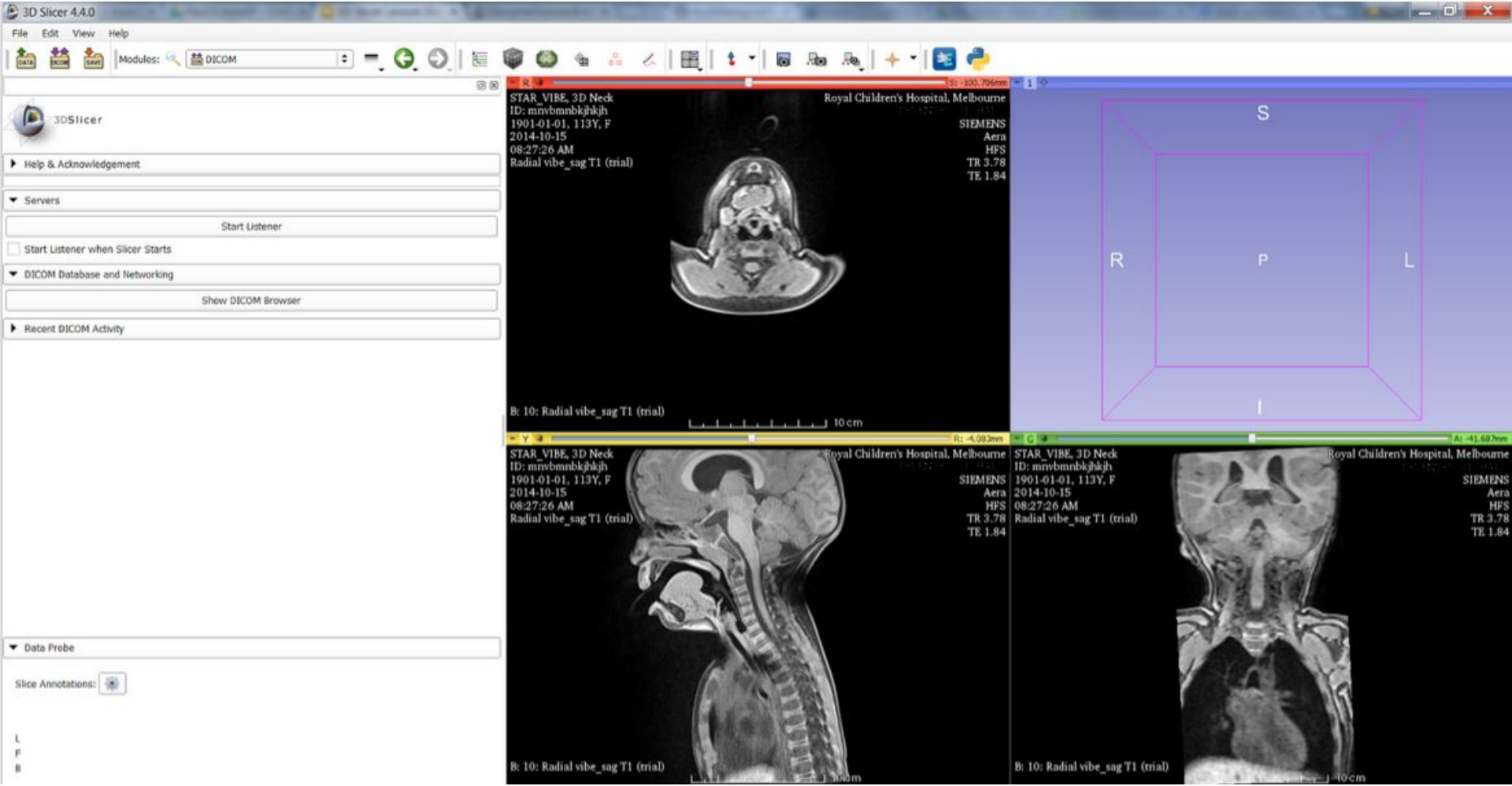
Manual segmentation of trachea

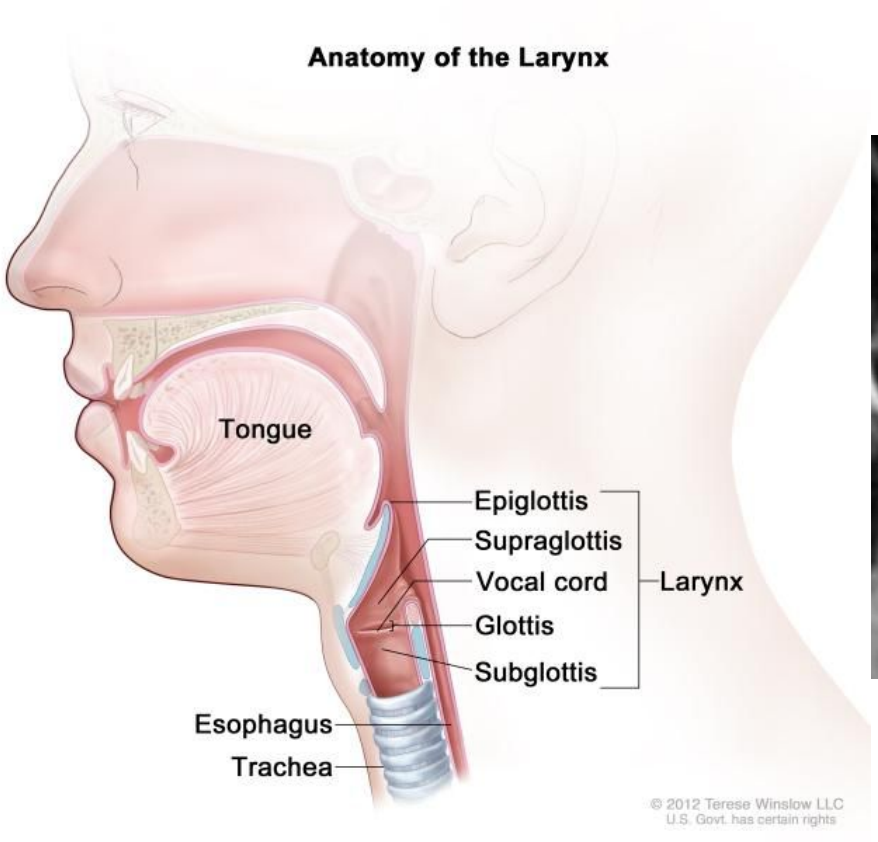
We want to segment a child's trachea from an MRI scan to create a 3D model for 3D printing and training purposes.

Please download the dataset via this link

Import Data -> ‘ChildMRI’*

*Dataset kindly supplied by Stefan Sabato and Mitchell Finlayson at the Royal Childrens Hospital.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
DICOM
3DSlicer
Help & Acknowledgement
Servers
Start Listener
Start Listener when Slicer Starts
DICOM Database and Networking
Show DICOM Browser
Recent DICOM Activity
Data Probe
Slice Annotations:
STAR_VIBE, 3D Neck
ID: mnvbmnbkjhkjh
1901-01-01, 113Y, F
2014-10-15
08:27:26 AM
Radial vibe_sag T1 (trial)
Royal Children's Hospital, Melbourne
SIEMENS
Aera
HFS
TR 3.78
TE 1.84
B: 10: Radial vibe_sag T1 (trial)
10 cm
S
R
P
L
I


Anatomy of the Larynx
Tongue
Epiglottis
Supraglottis
Vocal cord
Glottis
Subglottis
Larynx
Esophagus
Trachea
© 2012 Terese Winslow LLC
U.S. Govt. has certain rights

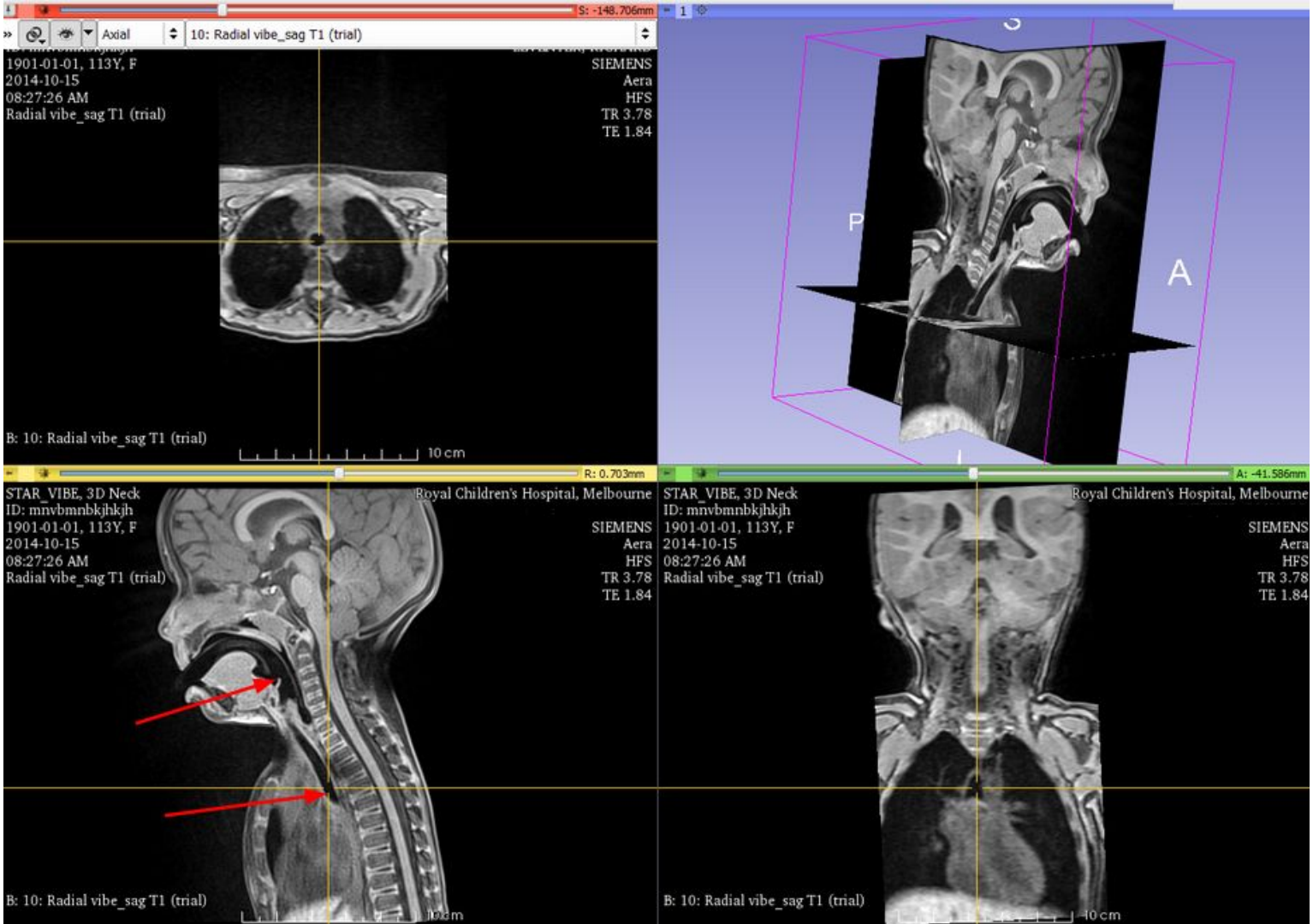

Epiglottis
Applied labelmap

Manual segmentation of trachea

We want to segment from just a small area of the total scan volume.

Tip: Use shift button + mouse and crosshair function (toolbar) to navigate the same feature across different slices.

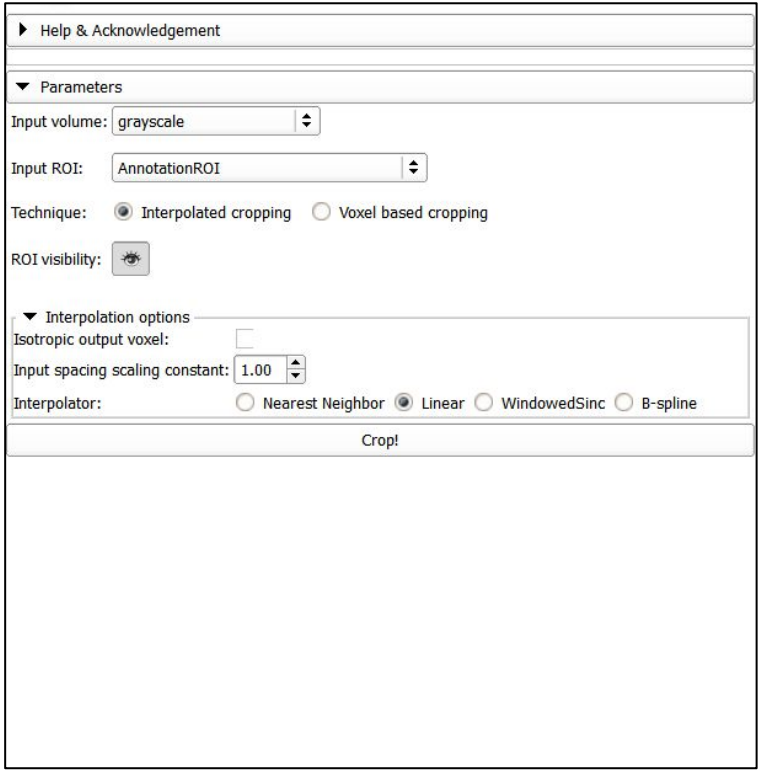
We will crop out a ROI using the ‘Crop Volume’ module.


Axial
10: Radial vibe_sag T1 (trial)
1901-01-01, 113Y, F
2014-10-15
08:27:26 AM
Radial vibe_sag T1 (trial)
SIEMENS
Aera
HFS
TR 3.78
TE 1.84
B: 10: Radial vibe_sag T1 (trial)
10 cm
P
A
STAR_VIBE, 3D Neck
ID: mnvbmnbkjhkjh
Royal Children's Hospital, Melbourne

Module: Crop Volume

This module allows the user to crop a volume down to a specific region of interest (ROI).

[Wiki Help Link]



Manual segmentation of trachea

Go to ‘Crop Volume’ module.

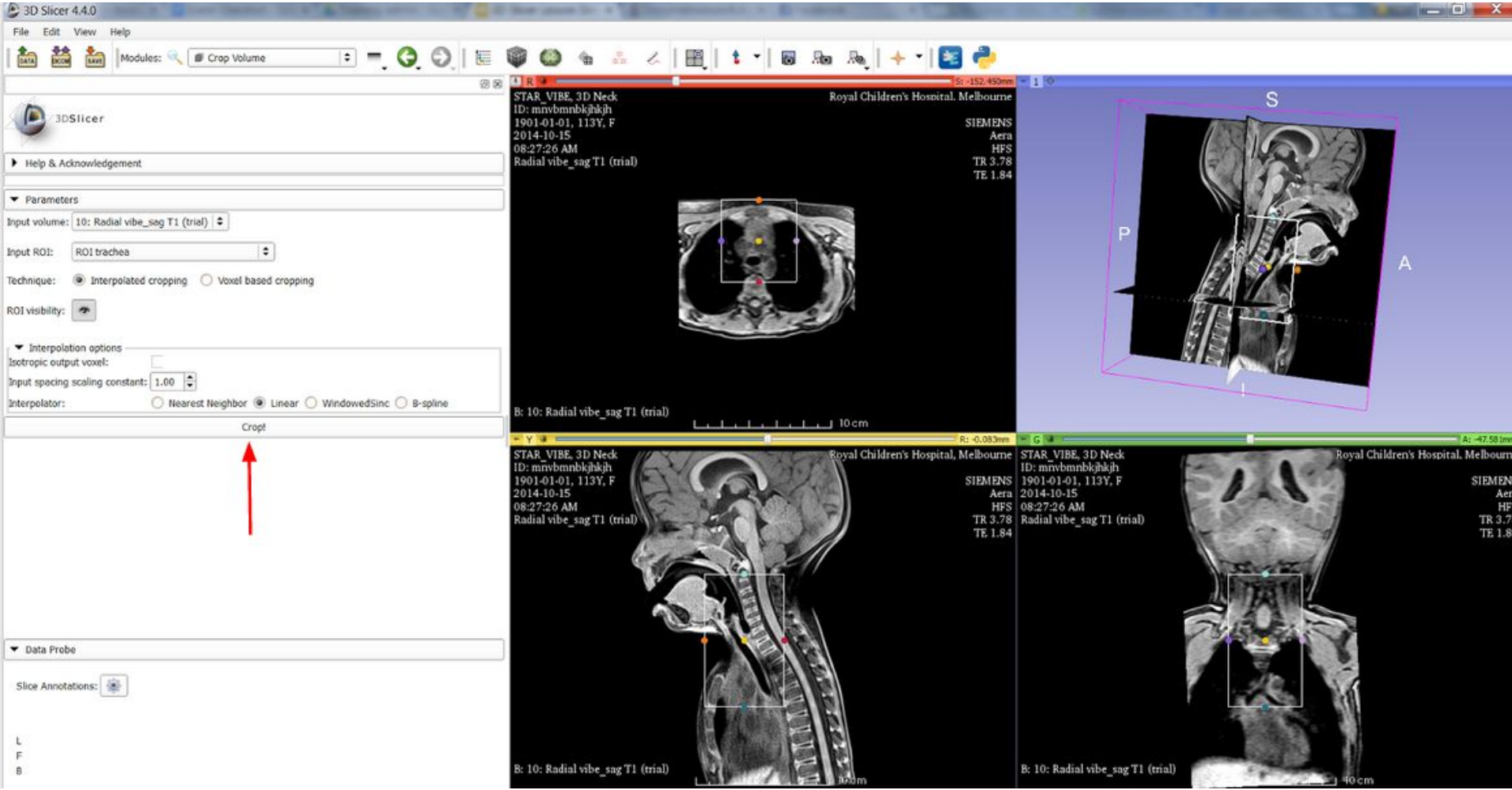
Input ROI: Create New AnnotationROI

Input ROI: Rename Current AnnotationROI (your choice)

ROI visibility: Turn on (open eye)

A small box will appear in the 3D viewing window. It’s dimensions are also visible and adjustable in the three 2D viewing windows.

Adjust the ROI to encompass just the trachea (keep a bit of room on each side) -> Crop!


3D Slicer 4.4.0
File Edit View Help
Modules: Crop Volume
3DSlicer
Help & Acknowledgement
Parameters
Input volume: 10: Radial vibe_sag T1 (trial)
Input ROI: ROI trachea
Technique: Interpolated cropping Voxel based cropping
ROI visibility:
Interpolation options
Isotropic output voxel:
Input spacing scaling constant: 1.00
Interpolator: Nearest Neighbor Linear WindowedSinc B-spline
Crop!
Data Probe
Slice Annotations:
L
F
B
STAR_VIBE, 3D Neck
ID: mnvbmnbkjhkjh
1901-01-01, 113Y, F
2014-10-15
08:27:26 AM
Radial vibe_sag T1 (trial)
Royal Children's Hospital, Melbourne
SIEMENS
Aera
HFS
TR 3.78
TE 1.84
B: 10: Radial vibe_sag T1 (trial)
10 cm
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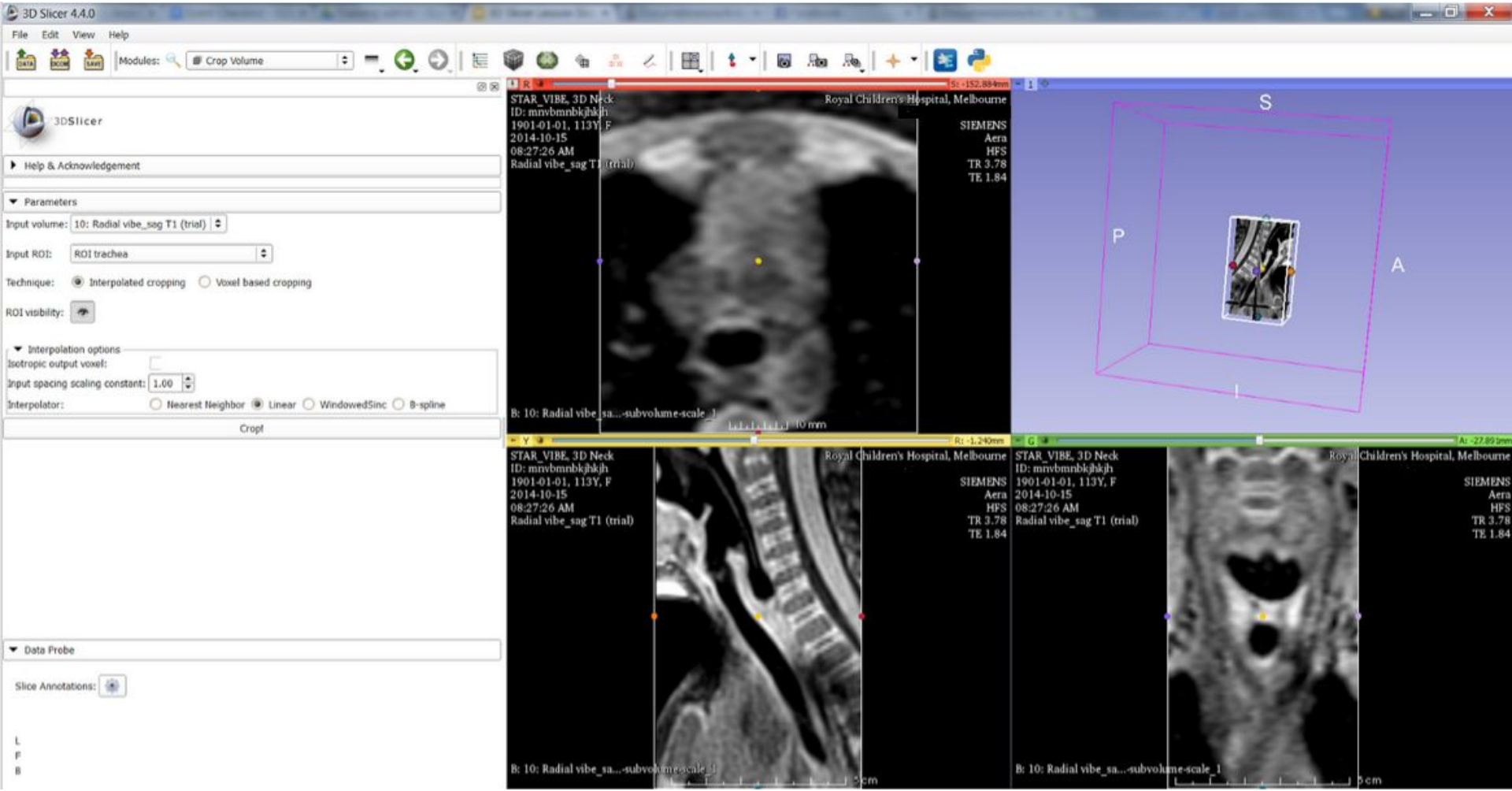
3D Slicer 4.4.0
File
Edit
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Modules:
Crop Volume
3DSlicer
Help & Acknowledgement
Parameters
Input volume:
10: Radial vibe_sag T1 (trial)
Input ROI:
ROI trachea
Technique:
Interpolated cropping
Voxel based cropping
ROI visibility:
Interpolation options
Isotropic output voxel:
Input spacing scaling constant:
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Interpolator:
Nearest Neighbor
Linear
WindowedSinc
B-spline
Crop
Data Probe
Slice Annotations:
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STAR_VIBE, 3D Neck
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Radial vibe_sag T1 (trial)
Royal Children's Hospital, Melbourne
SIEMENS
Aera
HFS
TR 3.78
TE 1.84
B: 10: Radial vibe_sa...-subvolume-scale_1
10 mm
S
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5 cm

Manual segmentation of trachea

We will be using a combination of ‘Threshold’ and ‘Paint’ tools in the Segmentation Editor Module to manually segment the trachea.

Why manually? The trachea and surrounding tissue is difficult to distinguish, there are no clear boundaries.

We need to rely on human judgement.

Manual segmentation involves ‘painting or ‘drawing’ on the dataset layer-by layer.

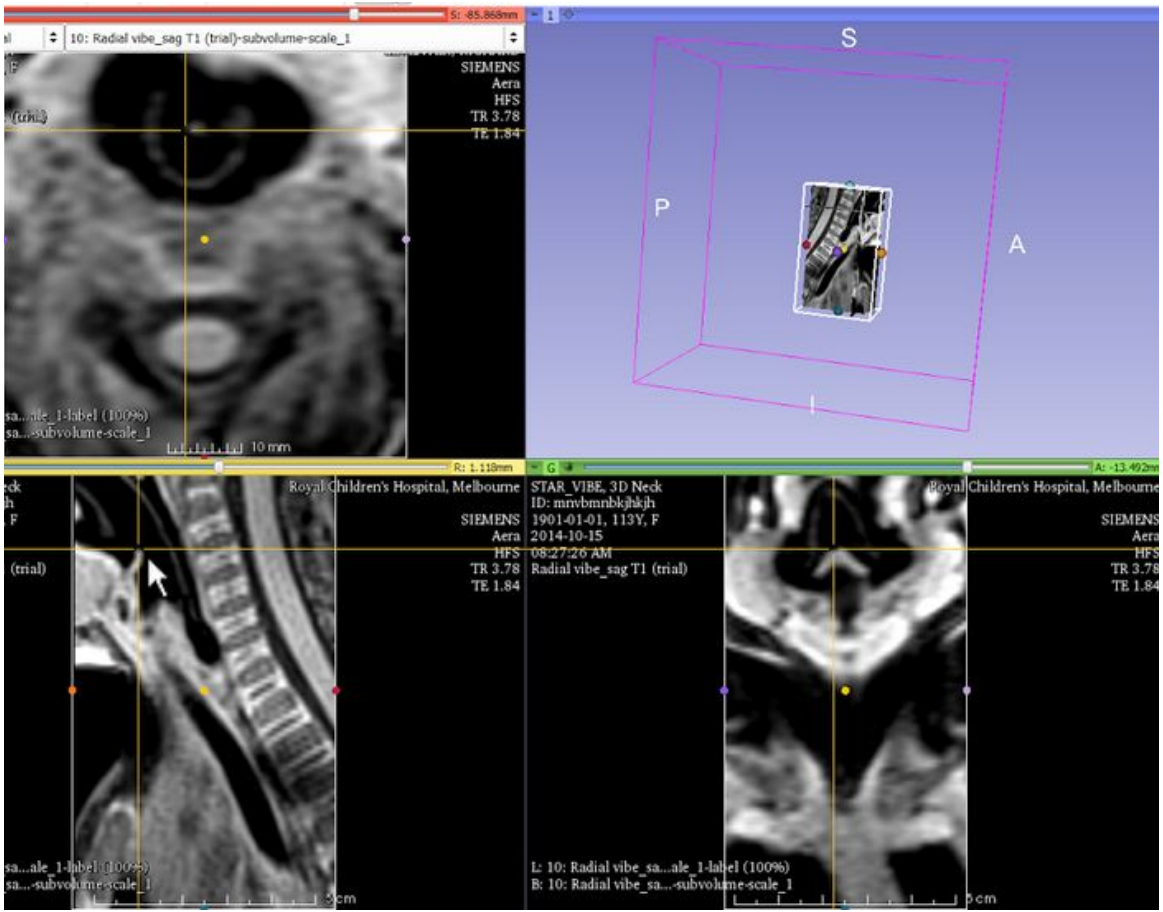
Manual segmentation of trachea

In Segmentation Editor create new ‘Trachea’ segmentation.

Navigate to the tip of the epiglottis on all three views.

Hint: Use ‘shift’ when moving the mouse to track the same feature in all three views, turn on ‘crosshairs’, and navigate via the sagittal plane view.

The segmentation can be painted onto any of the viewpoints, but we will be painting the ‘trachea’ segmentation down through the axial plane. Top-down is the best way to visually distinguish the trachea from surrounding tissue.


10: Radial vibe_sag T1 (trial)-subvolume-scale_1
SIEMENS
Aera
HFS
TR 3.78
TE 1.84
10 mm
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Royal Children's Hospital, Melbourne
STAR_VIBE, 3D Neck
ID: mnvbmnbkjhkjh
1901-01-01, 113Y, F
2014-10-15
08:27:26 AM
Radial vibe_sag T1 (trial)
L: 10: Radial vibe_sa...ale_1-label (100%)
B: 10: Radial vibe_sa...-subvolume-scale_1

Manual segmentation of trachea

Select ‘threshold effect.’ Adjust threshold such that epiglottis is distinguished from surrounding empty airways.

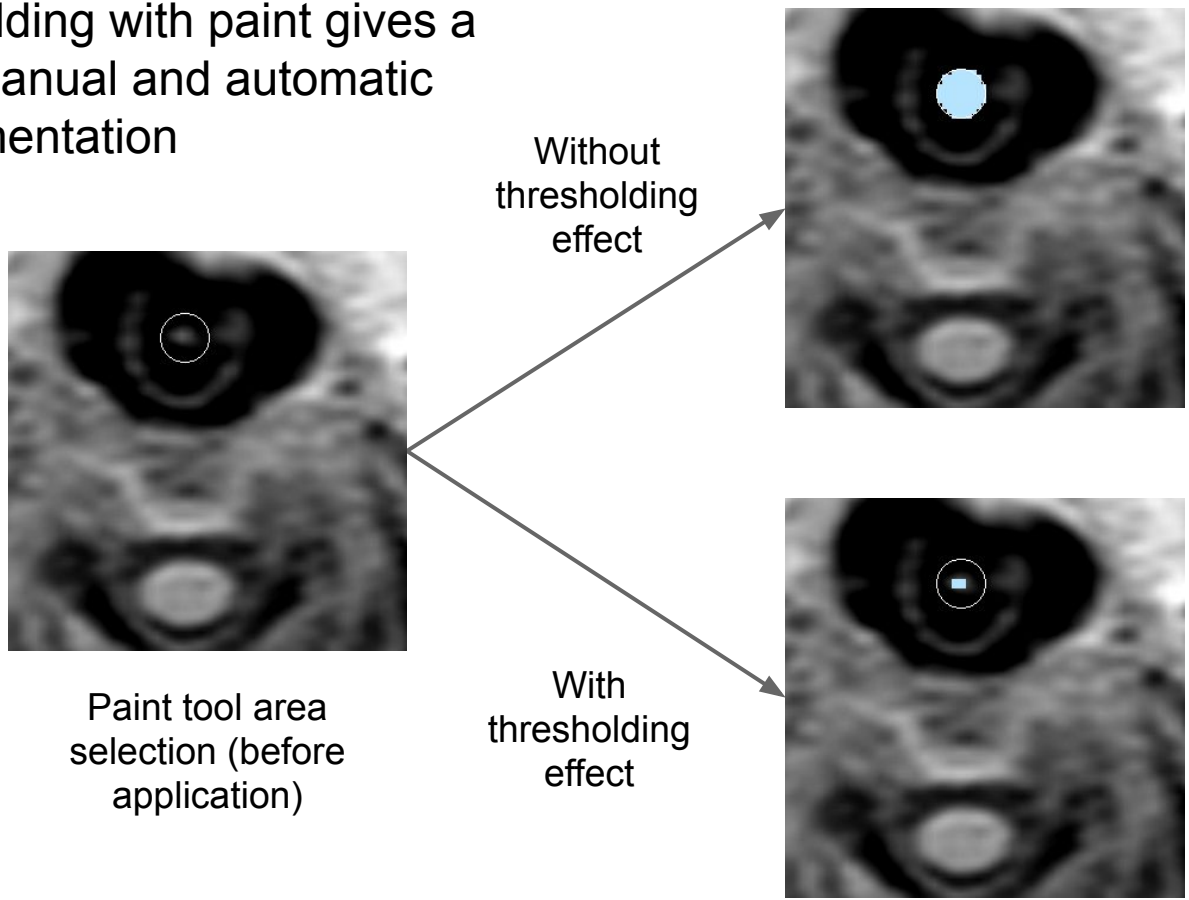
Instead of selecting ‘Apply’, select ‘Use for Masking.’

This will allow us to manually paint the ‘trachea’ segmentation to regions of our choice, while still providing some automation re distinguishing between regions of clear contrast difference.

Select the ‘Paint’ tool. Start applying the segmentation layer by layer downwards in the axial view.

Tip: Use the wheel on your mouse to move through the volume layer-by-layer.

Combining thresholding with paint gives a combination of manual and automatic segmentation



Manual segmentation of trachea

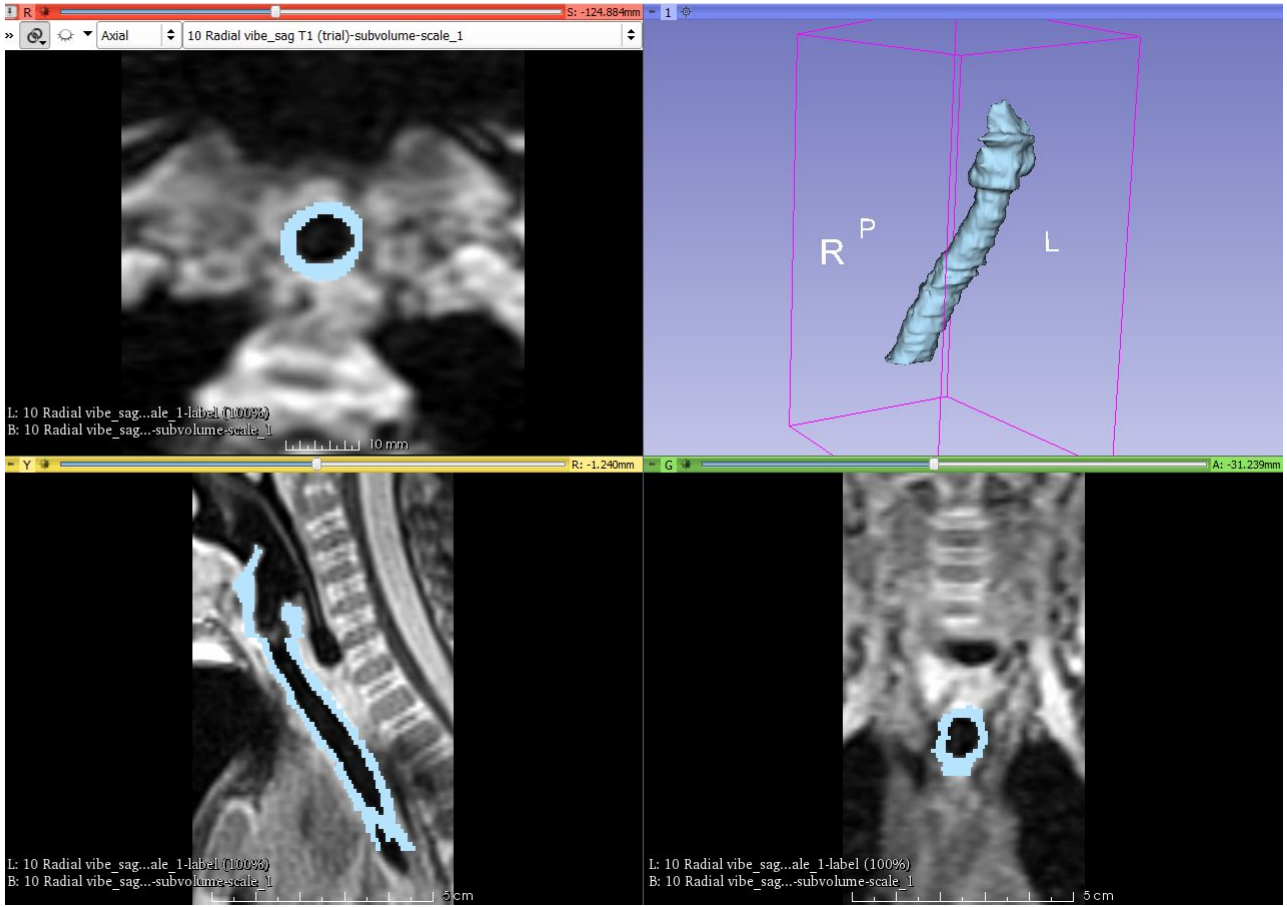
Tips:

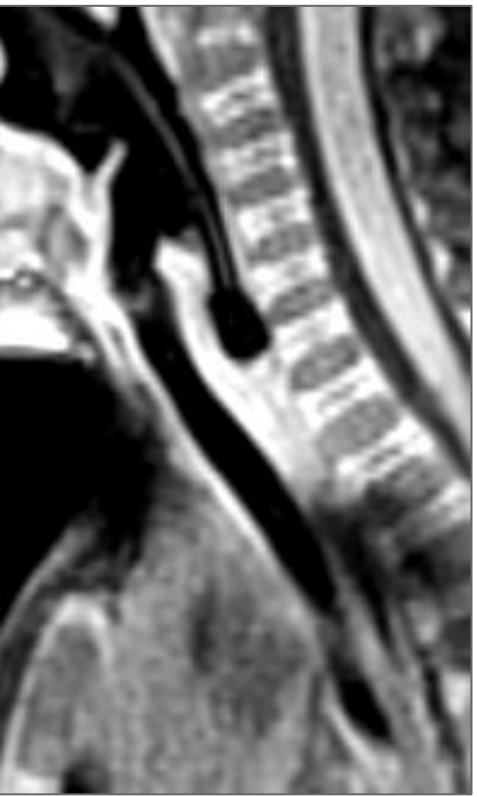
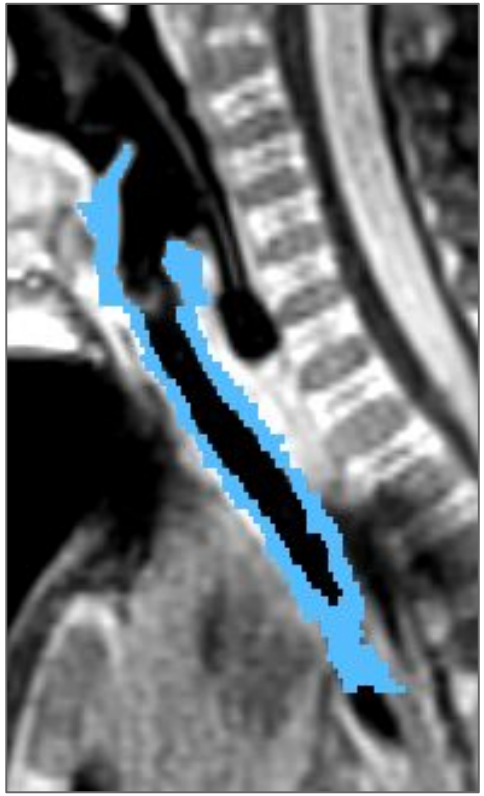
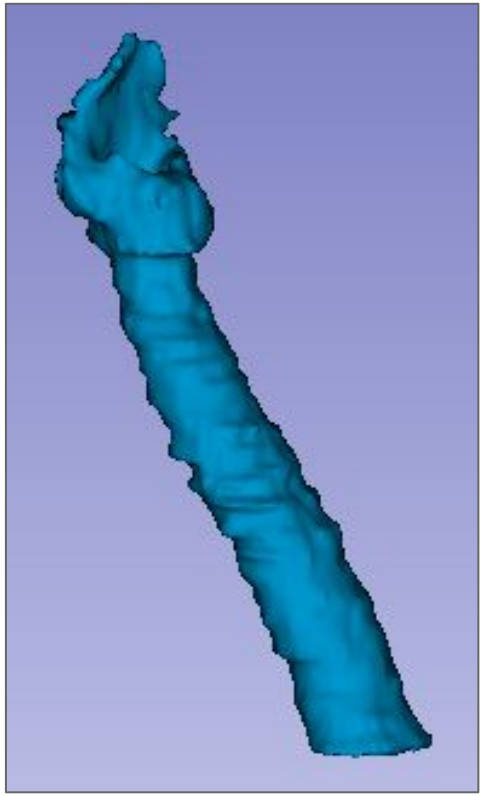
- As you move down layer by layer in the axial viewer, you will see the segmentation appearing in both the sagittal and coronal views. You can use this feedback to help your judgments when applying the paint effect.

- If you select some tissue you didn't want selected, you can use the 'Erase' tool to remove the segmentation voxels.

- You may need to change the thresholding settings as you move through the volume. You can do this by switching back and forth between 'Threshold Effect' and 'Paint', or by adjusting the threshold slider in the 'Paint' tool window (no feedback mechanism with second approach.)

- You can turn on 'Sphere Brush', which lets you paint through multiple layers at once (requires more care.))

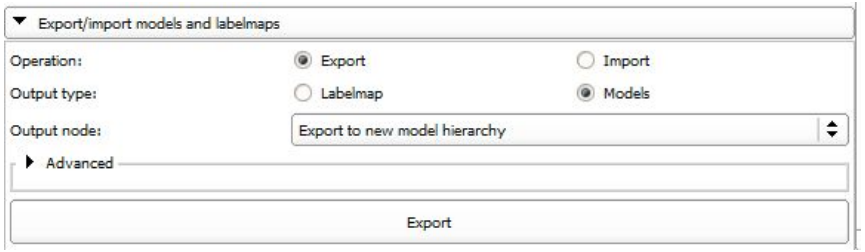

R
S: -124.884mm
Axial
10 Radial vibe_sag T1 (trial)-subvolume-scale_1
L: 10 Radial vibe_sag...ale_1-label (100%)
B: 10 Radial vibe_sag...-subvolume-scale_1
10 mm
1
R
P
L
Y
R: -1.240mm
L: 10 Radial vibe_sag...ale_1-label (100%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm
G
A: -31.239mm
L: 10 Radial vibe_sag...ale_1-label (100%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm


Exporting model for 3D Printing

Step 1: Generate a surface model.

Go to ‘Segmentations’ -> ‘Export/Import models and labelmaps’.



A surface model has now been generated. You can view this in the ‘Models’ module.

File -> Save. Find Surface model (Default file format ‘vtk’.) Change file format to .stl and save.

Adding annotations to model

What if we want to add annotations to the trachea model we have just generated?

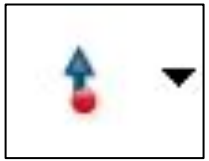
We can use the **‘Markups’** module for adding *fiducials* and the **‘Annotations’** module for adding *rulers* and *ROIs (Regions of Interest)*.

Adding annotations to model

Go to ‘Markups’ module.

-> List: Select ‘Create new MarkupsFiducial’

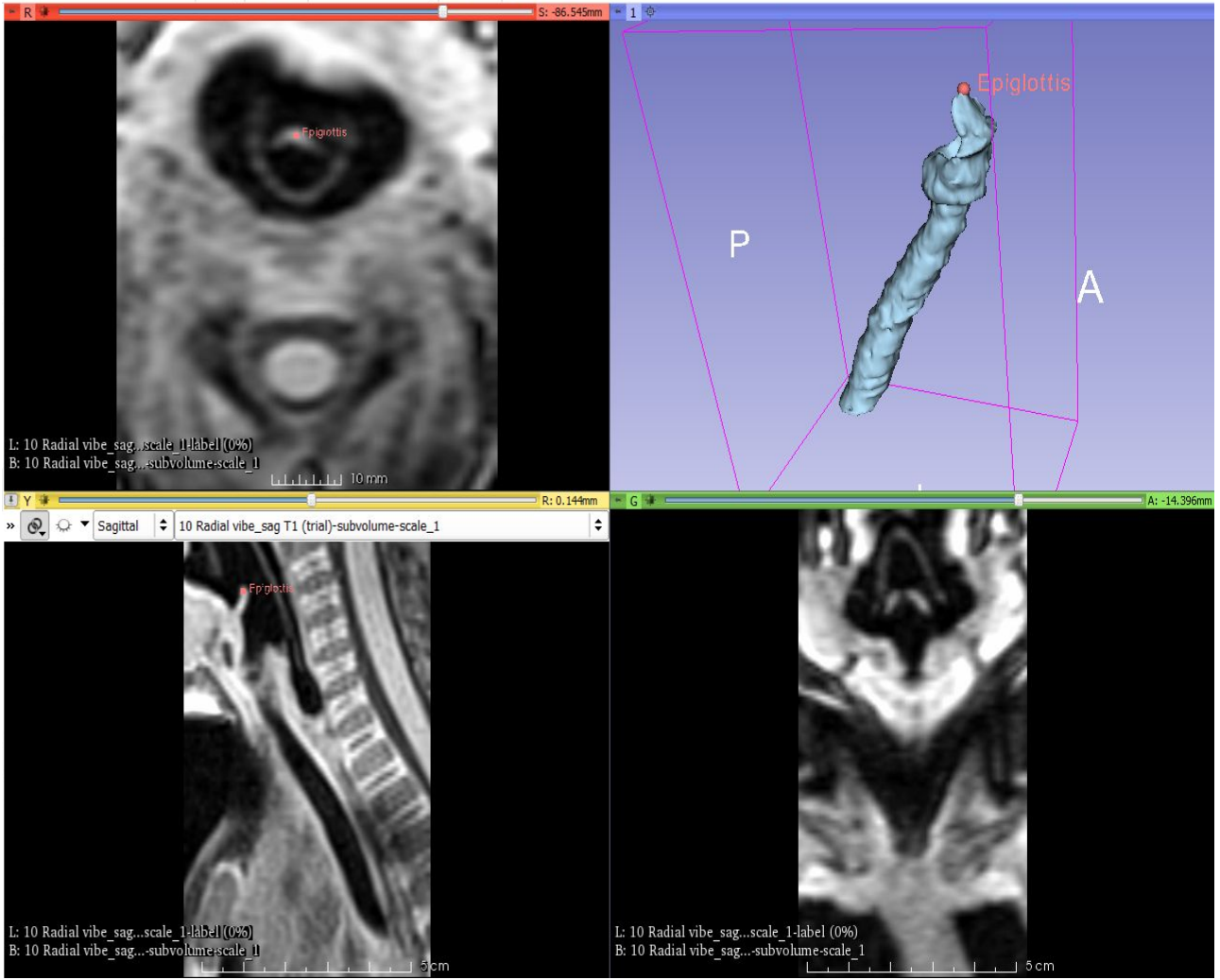
Place Fiducials in 2D planes by using Fiducial tool in toolbar.



In the toolbar, select the fiducials tool, and place a fiducial at the epiglottis.

Rename the fidicual in the module UI.

Fiducials can be scaled larger and smaller, and their visibility toggled on and off.


R
S: -86.545mm
Epiglottis
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
10 mm
1
Epiglottis
P
A
Y
R: 0.144mm
G
A: -14.396mm
Sagittal
10 Radial vibe_sag T1 (trial)-subvolume-scale_1
Epiglottis
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm

Adding annotations to model

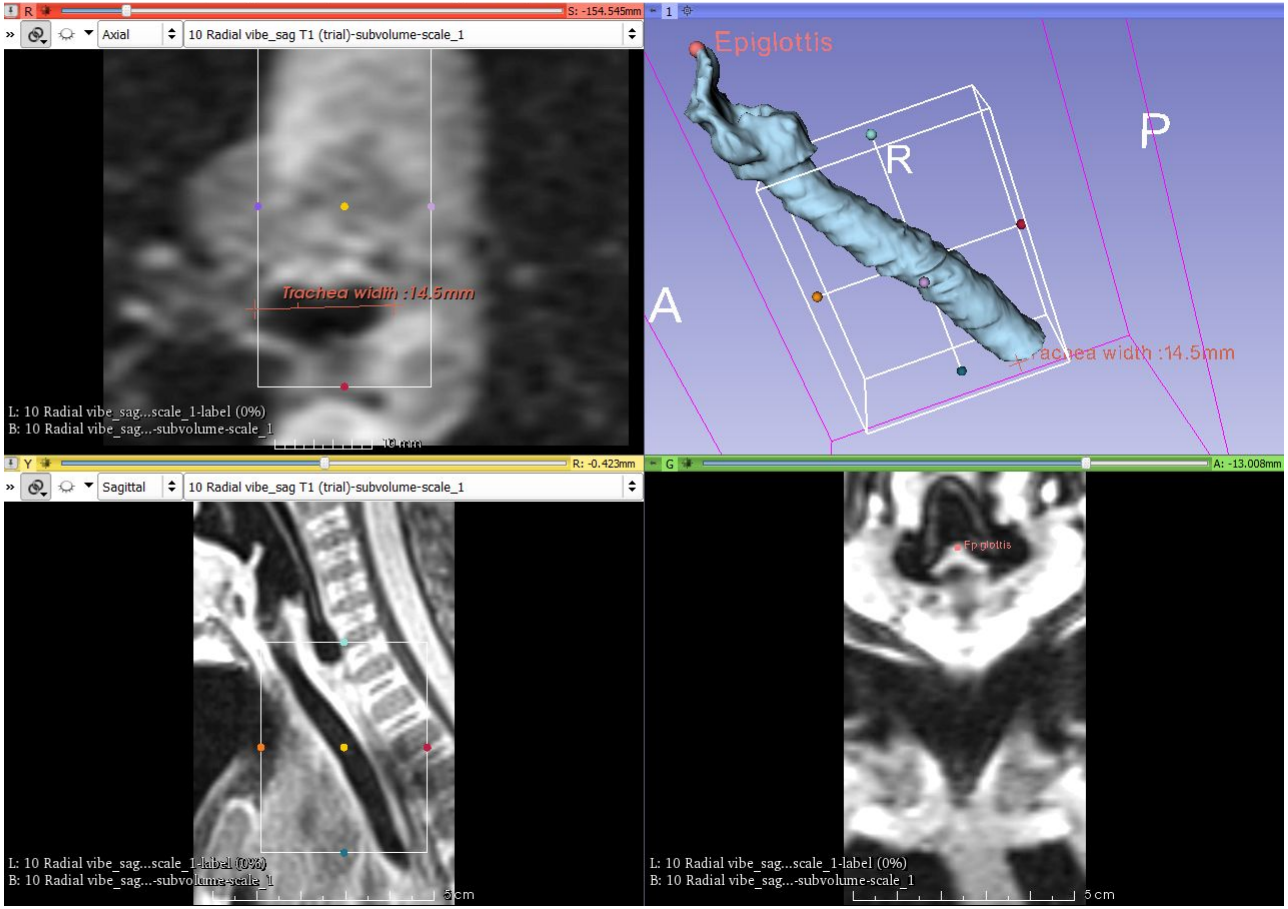
Go to ‘Annotations’ module.

In the toolbar, select the ruler tool.

Navigate to the base of the model in the axial plane view, and place a ruler across the width of the trachea. (left-click to define start of ruler, and again to define end-point.

In the toolbar, select to ROI tool.

Place a ROI box in the 3D window, and adjust it to define just the trachea.


Axial
10 Radial vibe_sag T1 (trial)-subvolume-scale_1
Trachea width :14.5mm
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
Epiglottis
R
P
A
Trachea width :14.5mm
Sagittal
10 Radial vibe_sag T1 (trial)-subvolume-scale_1
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm
Epiglottis
L: 10 Radial vibe_sag...scale_1-label (0%)
B: 10 Radial vibe_sag...-subvolume-scale_1
5 cm

Overview of Segmentation Methods

Models will probably not come out perfectly the first time, practice makes perfect.

The user will often have to make their own judgements if a feature is not very distinct.

More than one segmentation method may be usable for any given task.

The user can usually clean up any defects arising from an automated segmentation process using the paint, draw and erase effects.

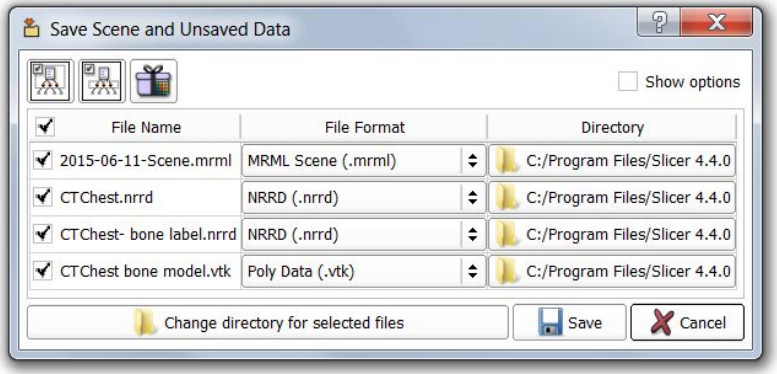
There are other segmentation methods available, including automatic segmentation add ons available via the Extensions Manager (e.g. like the AirwaySegmentation module.)

Saving Data and Scene

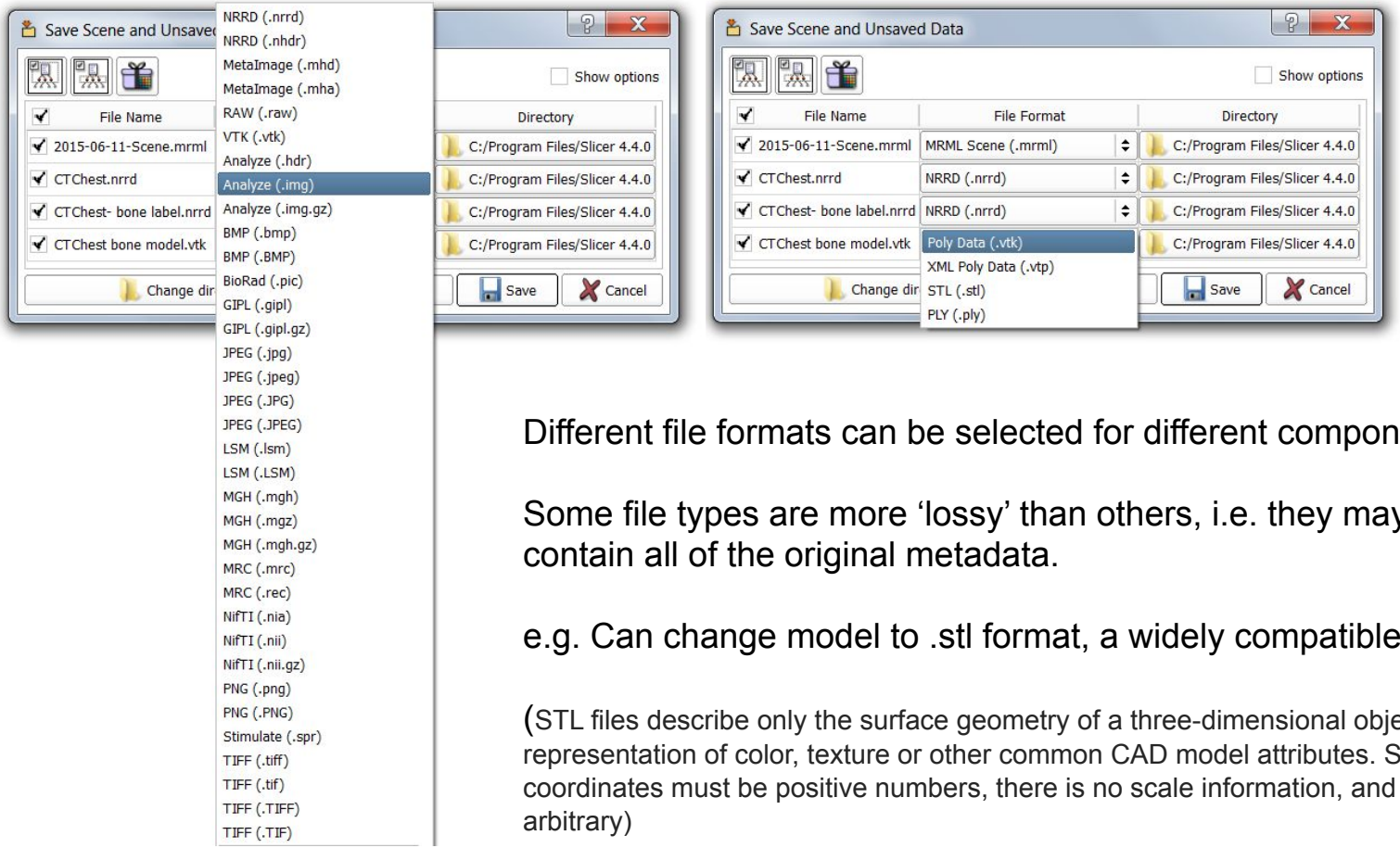
3D Slicer provides a rich set of options for saving data. The "Save Data" panel is accessed through the File menu using **File->Save.**

The user is given options to save the overall state of the program at a given time (MRML scene), as well as any other components, such as label maps, 3D models etc

Users can select which components to save (checkboxes), the file format for each, and the directory in which it is saved.



[Wiki Help Link]



Different file formats can be selected for different components.

Some file types are more ‘lossy’ than others, i.e. they may not contain all of the original metadata.

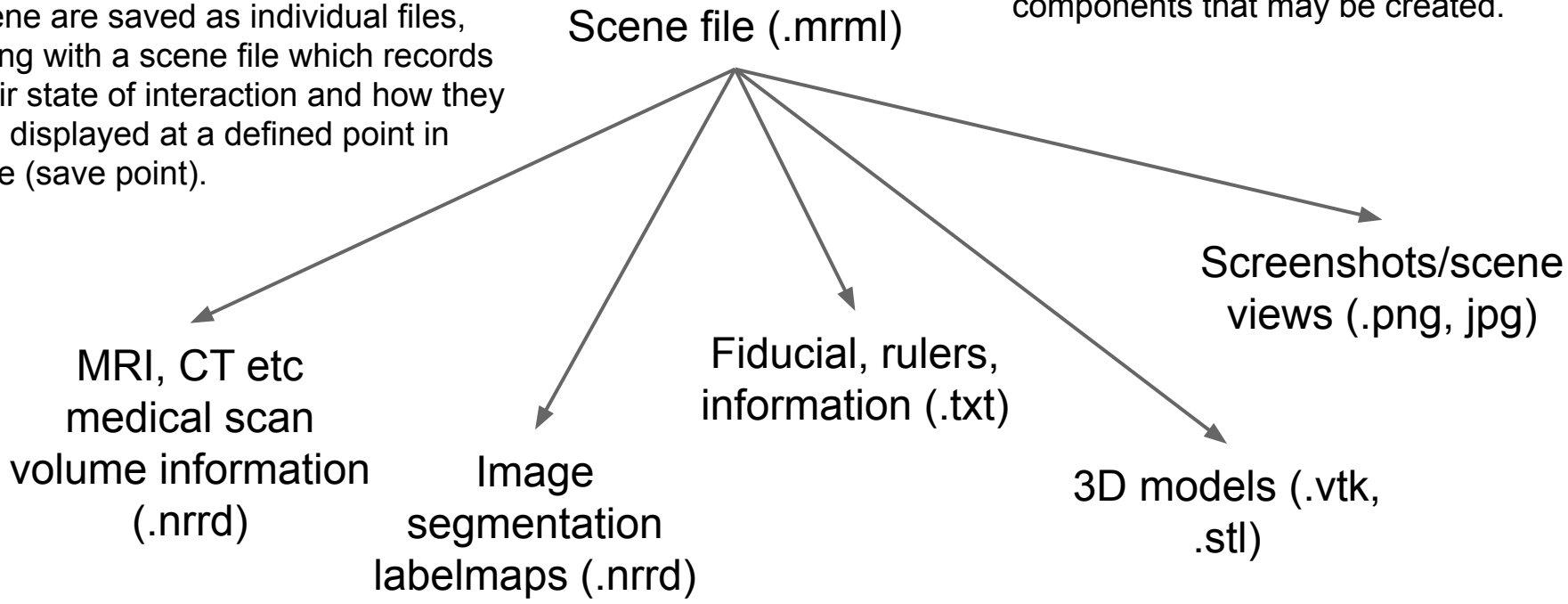
e.g. Can change model to .stl format, a widely compatible file type.

(STL files describe only the surface geometry of a three-dimensional object without any representation of color, texture or other common CAD model attributes. STL coordinates must be positive numbers, there is no scale information, and the units are arbitrary)

Typical file organisation structure

Different components of a created scene are saved as individual files, along with a scene file which records their state of interaction and how they are displayed at a defined point in time (save point).

These are some typical scene components that may be created.



Overview of Key File Formats

.mrml - *Medical Reality Markup Language.* A 3D Slicer scene description file. Contains scene metadata and stores references to 3D datasets and scene properties to reconstruct a 3D scene.

.dcm - *DICOM.* A standardised file format for the storage of medical scan data such as MRIs, CTs etc. DICOM files contain medical scan data as well as patient identification information.

.stl - *STereoLithography.* Describes the surface geometry of a 3D object with no information regarding colour, texture etc. A standard file type used by most additive manufacturing systems including 3D printing. The model surface is triangulated.

.vtk - *Visualisation ToolKit.* Binary 3D data format used by a software system for image processing, 3D graphics, volume rendering and visualization.

.nrrd - *Nearly Raw Raster Data.* Encodes n-dimensional raster data. Supports scientific visualization and image processing applications.

.txt - *Plain Text File.* Comprised of plain text that is human-readable as well as software readable.

All Supported File Types

3D Slicer reads and writes to a wide range of file formats, a list of which can be found here.

Scenes: .mrml, .mrb, .zip, .xml, xcat, .xar

Rastor Images (2D and 3D): .dcm, .nrrd, .nhdr, .mhd, .mha, .vtk, .hdr, .img, .img.gz, .nia, .nii, .nii.gz, .bmp, .pic, .mask, .gipl .gipl.gz, .jpg, .jpeg, .lsm, .png, .spr, .tif, .tiff, .mgz, .mrc, .rec

Models: .vtk, .vtp, .stl, .obj, .orig, .inflated, .sphere, .white, .smoothwm, .pial, .g, .byu

Fiducials: .fcsv, .txt

Rulers: .acsv, .txt

Transforms: .tfm, .txt, .mat, .nrrd, .nhdr, .mha, .mhd, .nii, .nii.gz

Transfer Functions: .vp, .txt

Lookup tables: .txt, .ctbl

Saving Data and Scene

“Many file formats are 'lossy' when it comes to saving and restoring image orientation metadata. For example, Analyze format cannot store all image orientations and .vtk format for images does not store orientation information at all. When exporting data to a new format, please reload the data to ensure the correct data has been saved. In general, NRRD, NIfTI, and Meta formats preserve exported information. All meta-information other than image content and image orientation (such as patient name, acquisition-related details) is lost when the image loaded from DICOM is saved into any of the non-DICOM formats!”

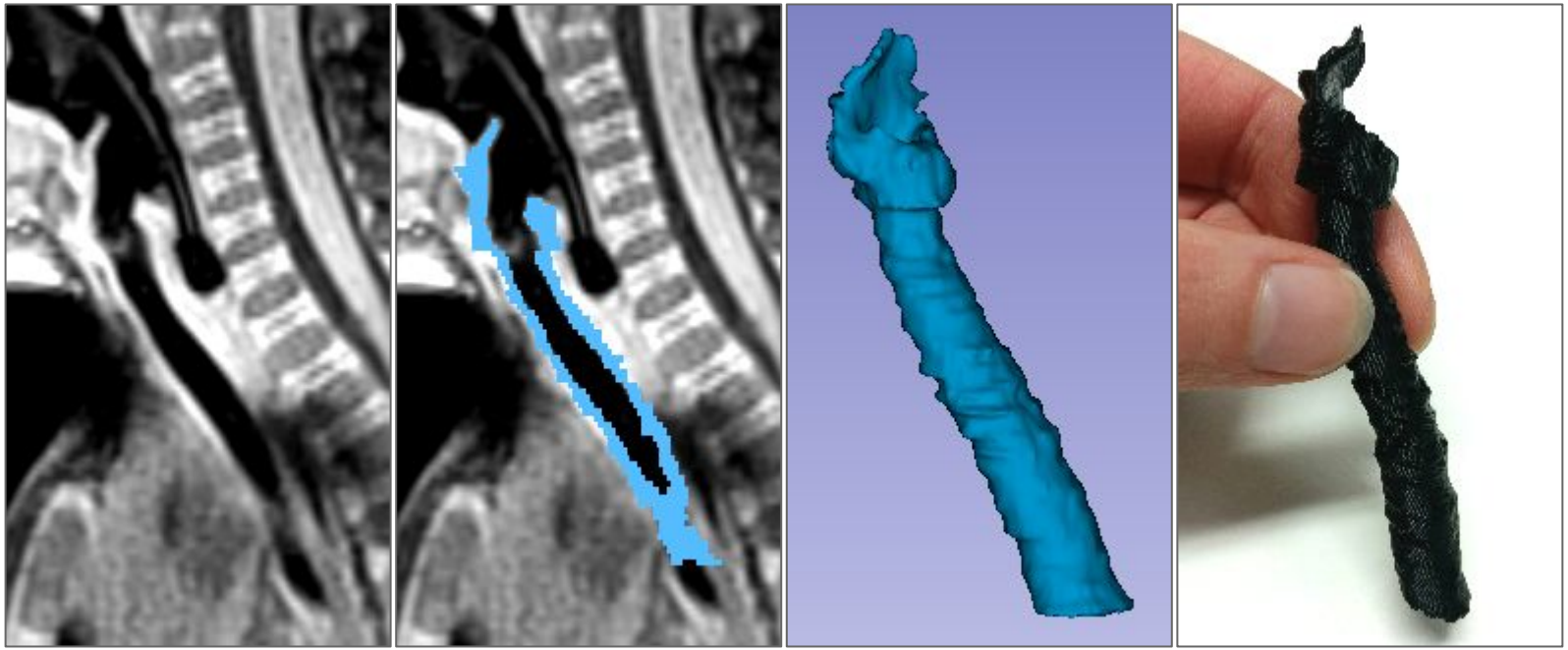
- SavingData Wiki Page

Learning objectives: Achieved?

- Understanding 3D medical imaging datasets
- Familiarity with 3D Slicer interface
  - Loading datasets, viewing 2D slices, navigation through modules, exporting models
- Volume rendering
  - 3D cross sections
  - 2D planes
- Segmentation skills
  - Thresholding
  - Grow from seeds
  - Thresholding masking for manual segmentation
- Clean up tools
  - Island
  - Erase
  - Scissors
- Annotations
  - Labeling
  - Measuring

3D Slicer and 3D Printing

Surface models in 3D Slicer can be 3D printed into a physical object



3D Printing Overview

Export any 3D surface models generated in 3D Slicer as .stl files.

.stl files are widely used for 3D printing and computer-aided manufacturing.

.stl files describe the surface geometry of an object and can be imported into 3D printer software, such as Makerbot Desktop, UP, ReplicatorG, Ultimaker Cura, etc.

3D Printing software generates G-code, which describes the path information the 3D printer has to follow to print out the object described in the .stl file.

3D Printing Overview

Types of 3D Printing:

- **Fused Deposition Modelling (FDM)**
  - plastic is extruded layer by layer
- **Selective Laser Sintering/Melting (SLS)**
  - plastic, ceramic or metal powder is laser sintered layer by layer
- **Stereolithography (SLA)**
  - Ultraviolet curable photopolymer is cured via UV layer by layer
- etc...

Fused Deposition Modelling is the most common type of consumer printer. Prints plastics such as ABS and PLA. Makerbots, UP!, Ultimaker, RepRap etc are FDM printers

Fused Deposition Modelling (FDM)

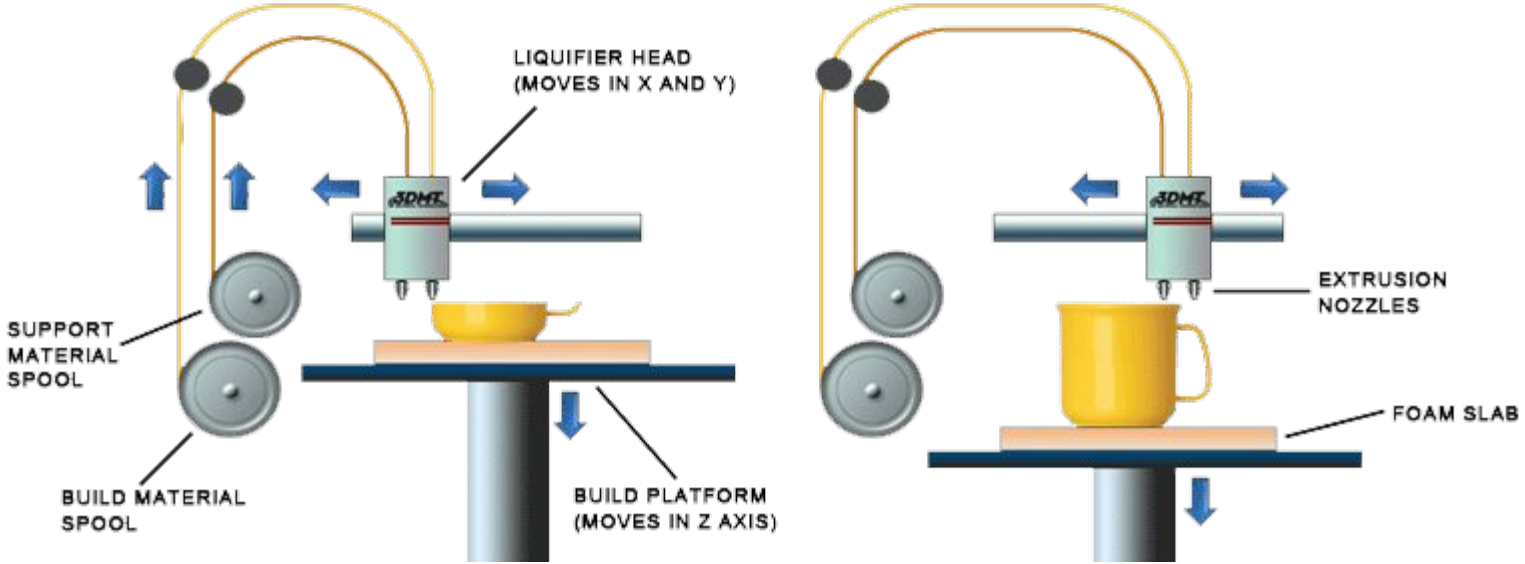
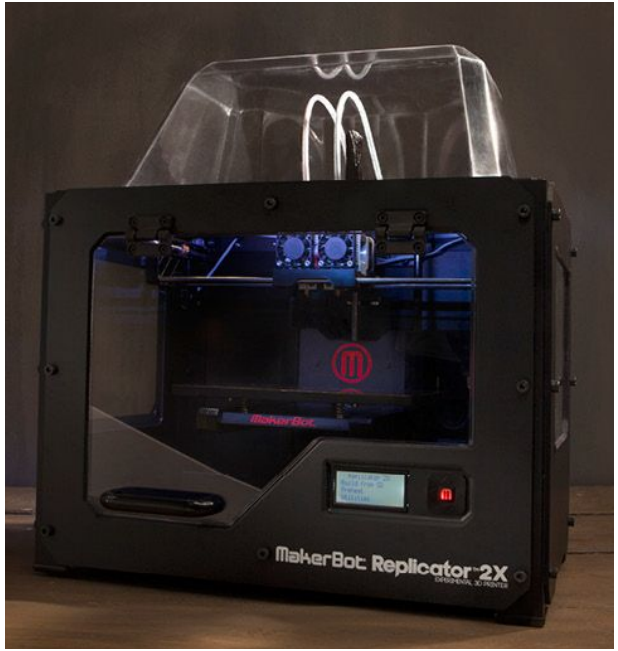


Image source: [3D Material Technologies]

Makerbot 3D Printer and Software



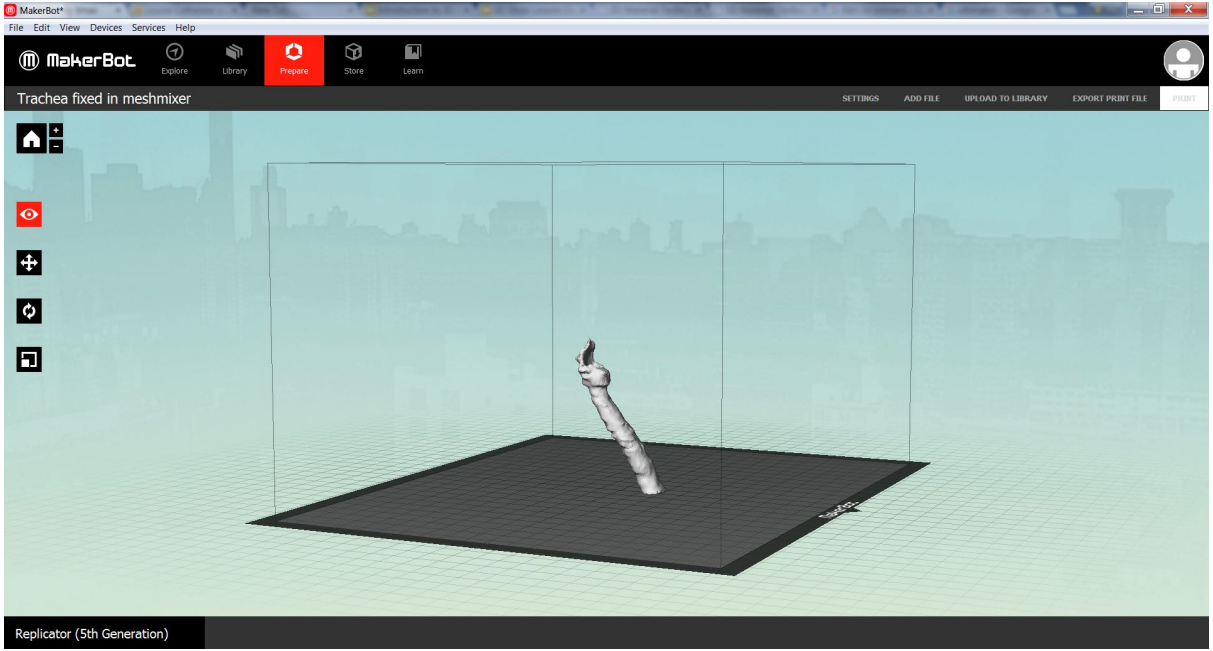
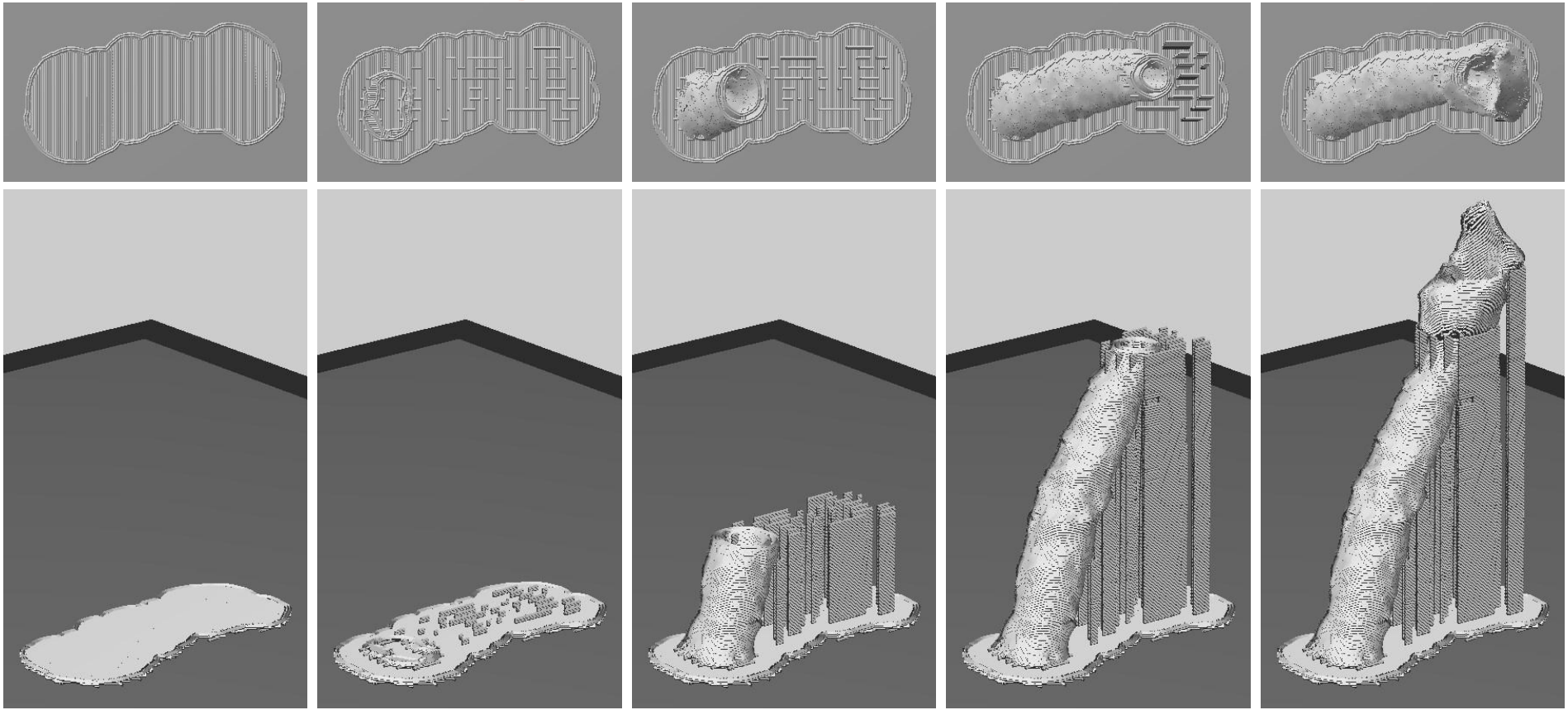


Image source: Makerbot.com

3D Printing Variables

- Choice of plastic (e.g. ABS or PLA etc for FDM modelling)
- Extrusion temperature
- Print bed surface
- Layer height, or print resolution (e.g. 0.1 - 0.3mm)
- Infill density and pattern
- Number of shells (wall thickness)
- Raft or no raft
- Supports and support settings

FDM Printing with Raft and Supports



3D Slicer and 3D Printing

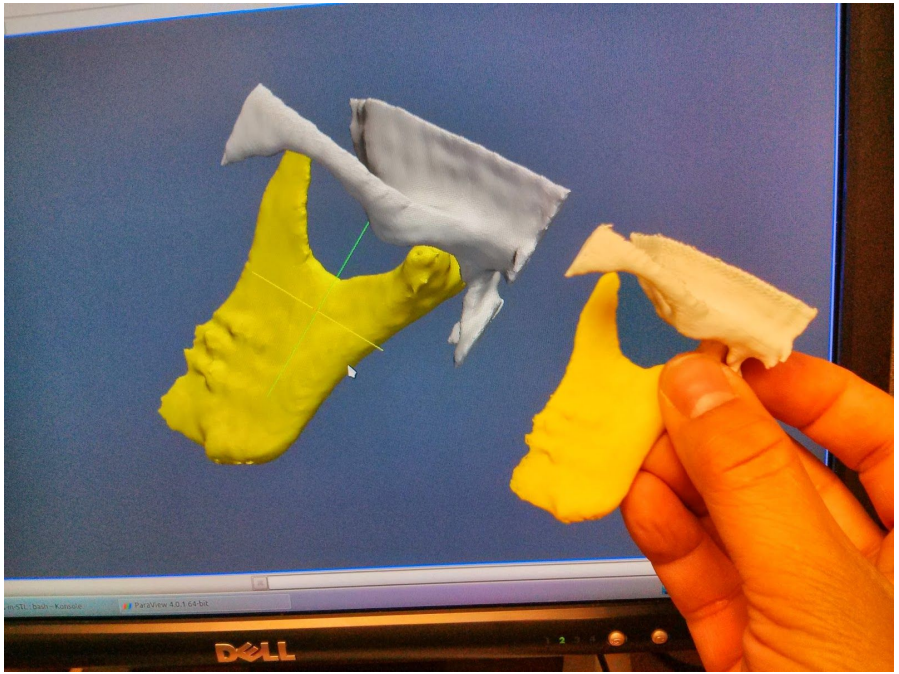


Image Source: DIY 3D Printing

Image taken from a very informative YouTube video:

Tutorial: Preparing Data for 3D Printing Using 3D Slicer

*NOTE: THIS TUTORIAL IS FROM THE NOW OUTDATED v4.4.

Considerations before 3D Printing

Is your generated surface model clean and free of ‘mess’?

Additional (free) software packages such as Meshmixer, MeshLab and NetFabb etc. may be used to post-process .stl files generated in 3D Slicer to improve their quality (which will make them easier to print!)

3D Printing Facilities at UniMelb

- The School of Engineering workshop:
- ~15 Makerbot (FDM) Printers:
- 2 x UP Mini's (FDM) Offers larger print volume.
- Objet Eden 260V: Polyjet technology. Higher quality, more expensive.

3D Printing Facilities at the Austin

- 3D Med Lab (Department of Vascular Surgery):
- 2 x Makerbot Replicator 2X (FDM)
- Form 2 (SLA)
- Objet30 Scholar (Polyjet technology)
- Mimics Materialise and InPrint segmentation software

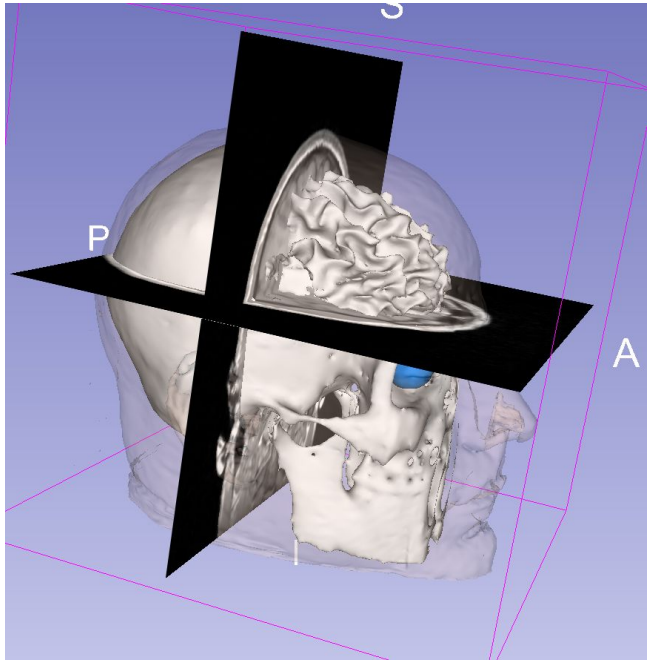
Interacting with 3D surface models

Slicer4Minute Tutorial Dataset

This dataset is available on the 3D Slicer wiki tutorial pages here.

The dataset consists of a pre-segmented cranial dataset useful for illustrating some of the basic navigation techniques used in 3D Slicer, as well as a number of useful modules.

3D surface models of a number of features, including skin, the skull, hemispheric white matter, optic nerves and tracts, and eyeballs.



Slicer4Minute Tutorial Dataset

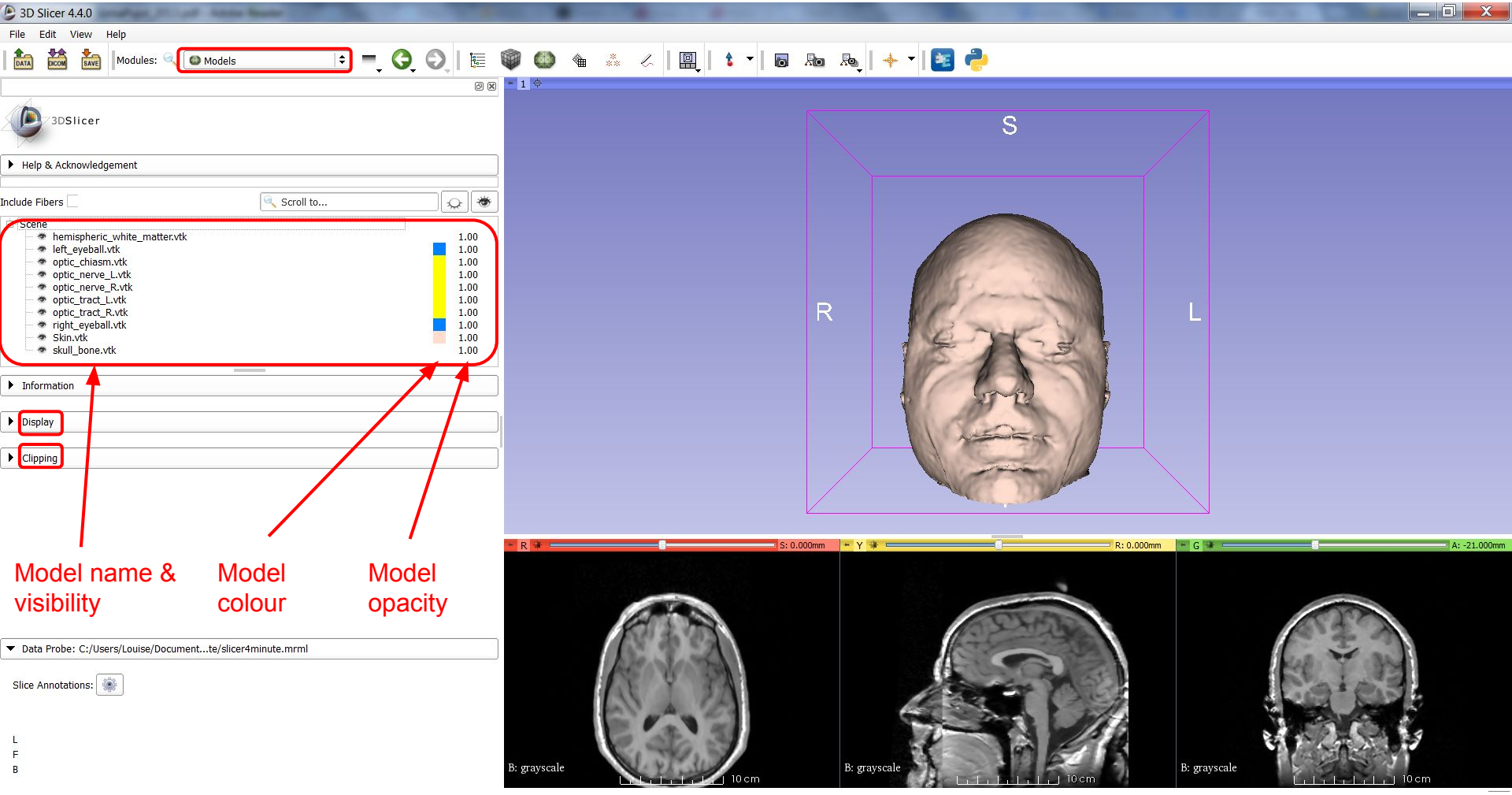
The Slicer4Minute Tutorial dataset is a great introduction to interacting with 3D surface models in 3D Slicer.

Load Data -> Choose File to add -> ‘Slicer4Minute’ folder ➔ select scene file

‘slicer4minute.mrml’ -> Open

Open ‘Models’ module.

All 3D surface models are listed in the ‘Models’ module UI.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Models
3DSlicer
Help & Acknowledgement
Include Fibers
Scroll to...
Scene
hemispheric_white_matter.vtk 1.00
left_eyeball.vtk 1.00
optic_chiasm.vtk 1.00
optic_nerve_L.vtk 1.00
optic_nerve_R.vtk 1.00
optic_tract_L.vtk 1.00
optic_tract_R.vtk 1.00
right_eyeball.vtk 1.00
Skin.vtk 1.00
skull_bone.vtk 1.00
Information
Display
Clipping
Model name & visibility
Model colour
Model opacity
Data Probe: C:/Users/Louise/Document...te/slicer4minute.mrml
Slice Annotations:
L
F
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S: 0.000mm
R: 0.000mm
A: -21.000mm
B: grayscale
10 cm
B: grayscale
10 cm
B: grayscale
10 cm

Slicer4Minute Tutorial Dataset

Work through these steps in the Models module to change the appearance of the surface model data to match the instances shown on the upcoming slide.

1. Highlight ‘skin’ model. Under ‘Slice Display’ ‘Visibility’ tabs, uncheck ‘Visible’. (Alternatively close ‘eye’ in models list).

2. Use ‘eye’ icon in 2D viewing windows to insert the axial and coronal 2D anatomical planes into the 3D visualisation window.

3. Highlight ‘skull_bone’ model. Under ‘Slice Display: Visibility’ tabs, tick ‘Clip’. Under ‘Clipping Planes’ tab, select ‘clipping type’: ‘Intersection’, and select red (axial) and green (coronal). Select ‘Negative’ clipping for both. Move coronal plane back and forth to see adaptive clipping.

4. Turn the visibility of the ‘skin’ model back on but make it’s opacity 0.3 under ‘Slice Display: Colour’ tabs (Alternatively double click ‘opacity’ values in models list.)

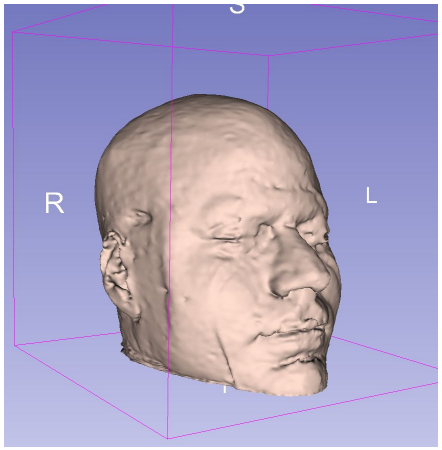
Slicer4Minute Tutorial Dataset

5. Turn visibility of ‘skull_bone’ model off and slide axial plane down to reveal full ‘hemispheric_white_matter’. Clip as per the ‘skull_bone’ model in Step 3 to reveal the optic nerves.

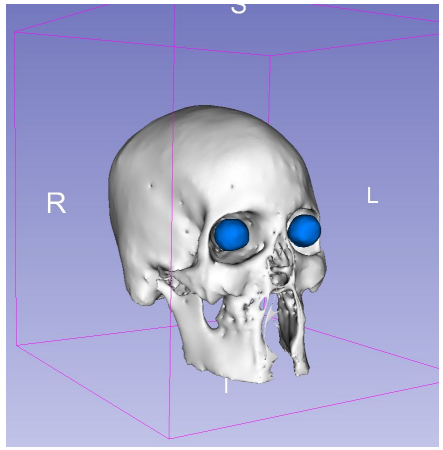
6. Invert clipping of ‘hemispheric_white_matter’ along the coronal plane by changing clipping from negative to positive.

7. Turn off clipping for all models and change the colour of ‘hemispheric_white_matter’ under the ‘Slice Display: Colour’ tabs. Hide axial and coronal planes in the 3D viewer.

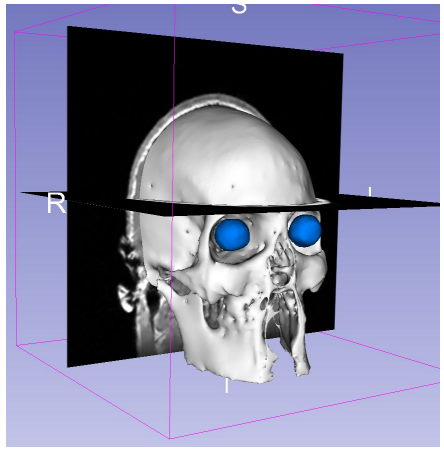
Take a screenshot of the 3D viewing window using the screenshot button in the toolbar. Use ‘save’ to export the screenshots (tip: uncheck all other boxes in save window.)



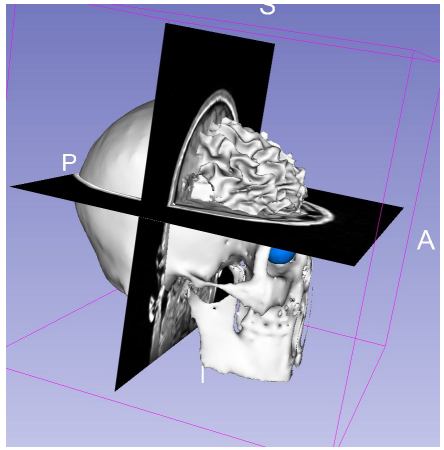
1.



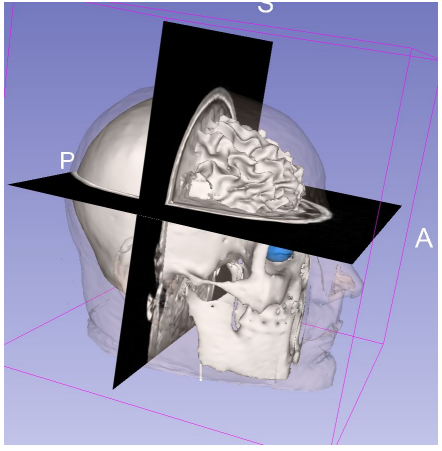
2.



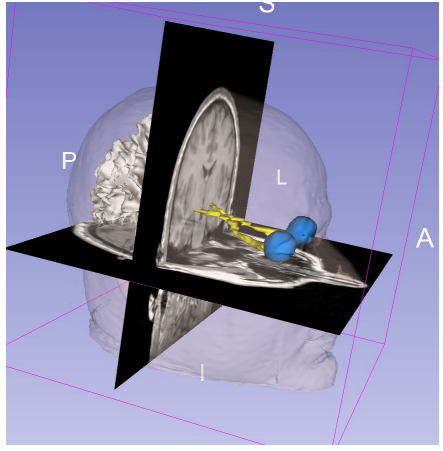
3.



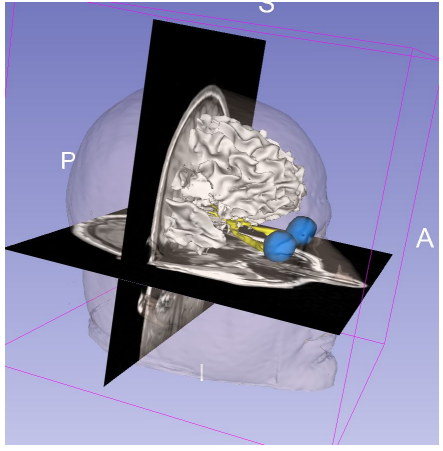
4.



5.



6.



7.

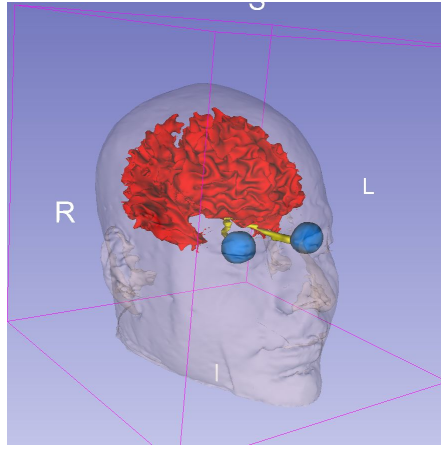


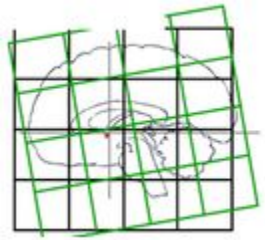
Image Registration

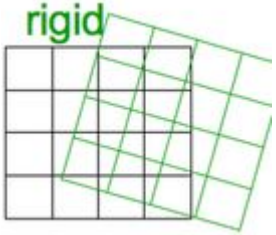
Image Registration

Image registration is the process of transforming different sets of data into one coordinate system. Can be affine, rigid or non-linear (warp).

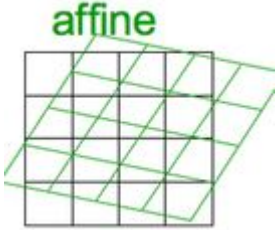
Can be used to overlay different datasets, such as brain MRIs taken at different points in time.

There are three major types of transformations.

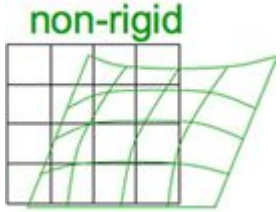




e.g. Rotation and Translation



e.g. Shearing and Scaling



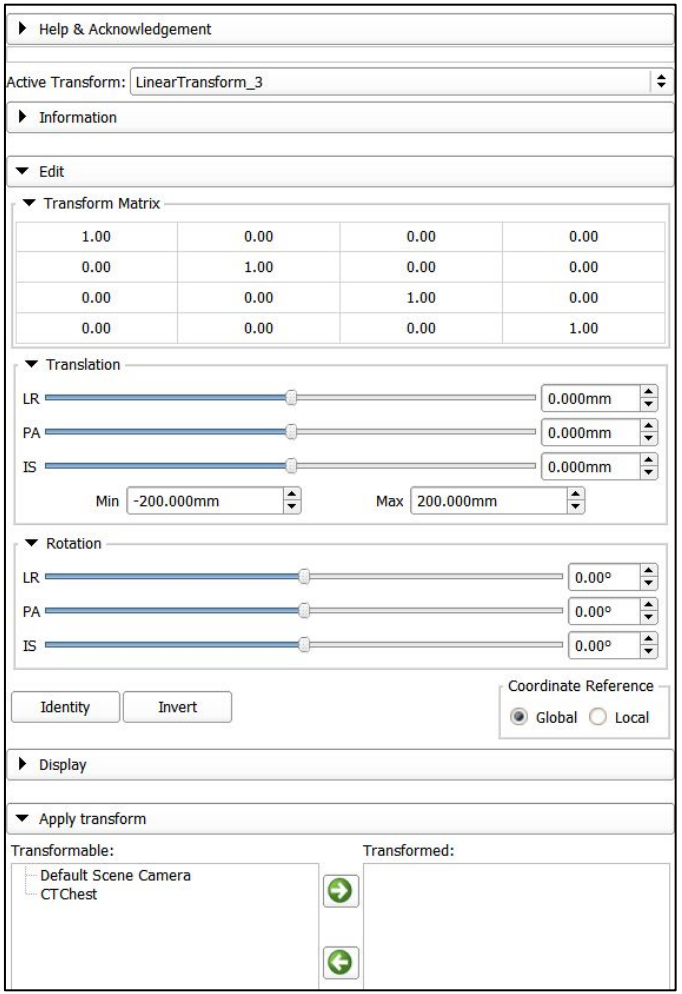
e.g. Local warping of one image to align with another.

Module: Transforms

This module is used for creating and editing transform matrices.

Useful for manual image registration.

[Wiki Help Link]



Simple Image Registration

In ‘Welcome to Slicer’ module -> load sample datasets MRBrainTumor1 and MRBrainTumor2.

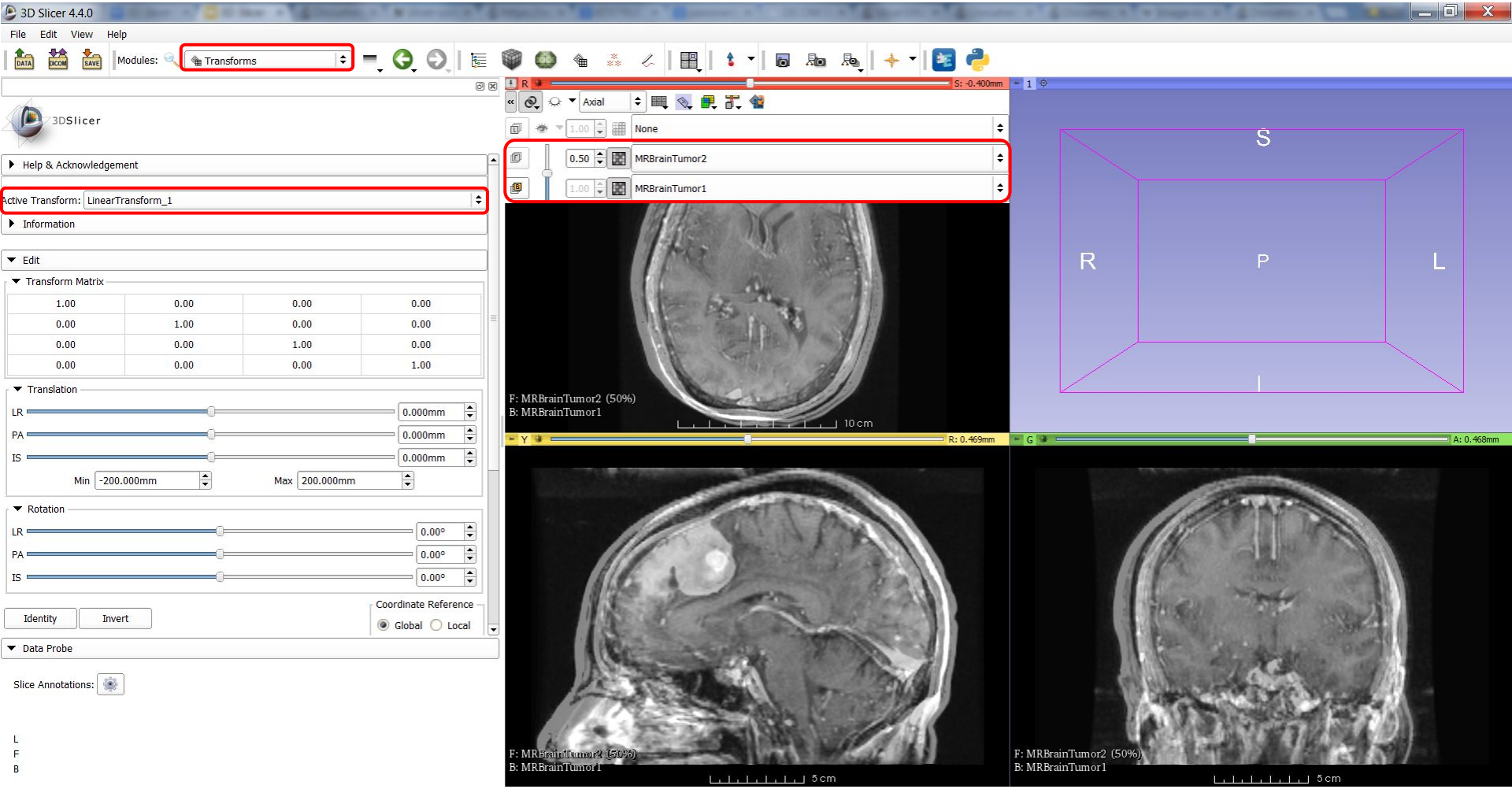
Switch between the two volumes using the 2D Slice Controllers (hint: link them first). Adjust the brightness/contrast of the images until they look comparable.

In the 2D Slice Controllers, set MRBrainTumor1 as the background and MRBrainTumor2 as the foreground.

Set the Opacity of the foreground to 50% (0.5).

The two datasets should appear overlayed.

Open ‘Transforms’ module and Create new LinearTransform.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Transforms
3DSlicer
Help & Acknowledgement
Active Transform:
LinearTransform_1
Information
Edit
Transform Matrix
1.00 0.00 0.00 0.00
0.00 1.00 0.00 0.00
0.00 0.00 1.00 0.00
0.00 0.00 0.00 1.00
Translation
LR 0.000mm
PA 0.000mm
IS 0.000mm
Min -200.000mm
Max 200.000mm
Rotation
LR 0.00°
PA 0.00°
IS 0.00°
Identity
Invert
Coordinate Reference
Global
Local
Data Probe
Slice Annotations:
L
F
B
Axial
None
0.50
MRBrainTumor2
1.00
MRBrainTumor1
S
R
P
L
F: MRBrainTumor2 (50%)
B: MRBrainTumor1
10 cm
5 cm

Simple Image Registration

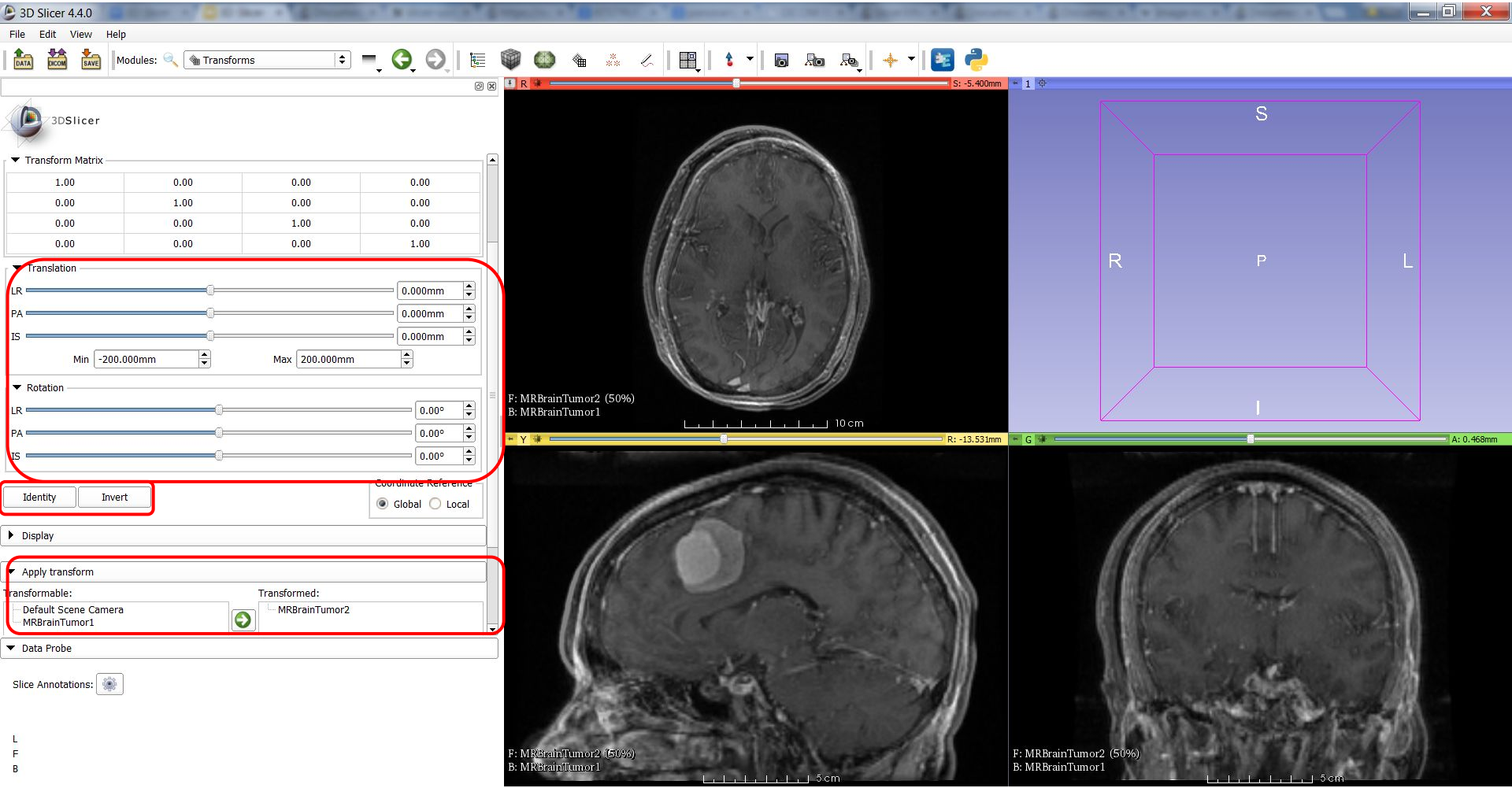
Scroll down to ‘Apply transform’ tab. Highlight MRBrainTumor2 and click arrow to move selection from ‘Transformable’ to ‘Transformed’ window.

We can now actively transform the MRBrainTumor2 foreground layer using the ‘Translation’ and ‘Rotation’ sliders under the ‘Edit’ tab.

Adjust until the two datasets are properly overlayed. Hint: Find common features to align. Adjust the foreground opacity slider to see more or less of each layer.

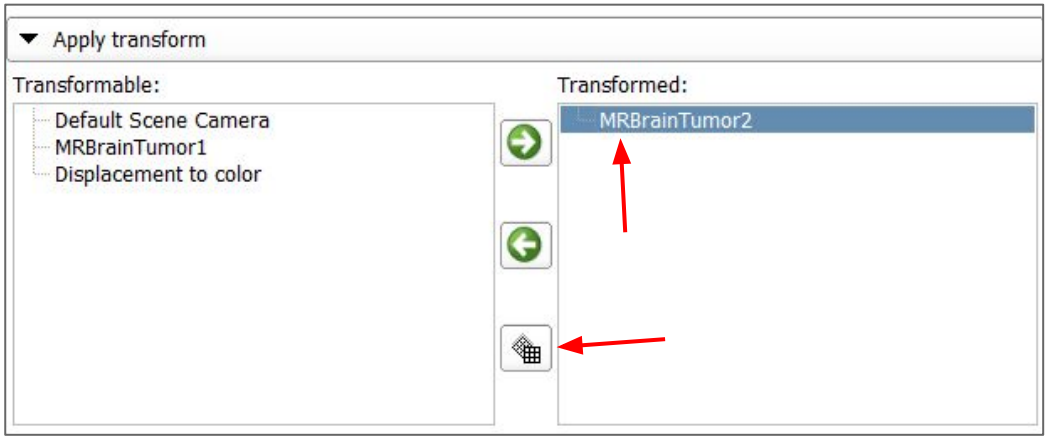
The ‘Identity’ button can be used to reset any changes made.

The ‘Invert’ button can be used to invert (mirror) any applied transformations.


3D Slicer 4.4.0
File
Edit
View
Help
Modules:
Transforms
3DSlicer
Transform Matrix
1.00 0.00 0.00 0.00
0.00 1.00 0.00 0.00
0.00 0.00 1.00 0.00
0.00 0.00 0.00 1.00
Translation
LR 0.000mm
PA 0.000mm
IS 0.000mm
Min -200.000mm
Max 200.000mm
Rotation
LR 0.00°
PA 0.00°
IS 0.00°
Identity
Invert
Coordinate Reference
Global
Local
Display
Apply transform
Transformable:
Default Scene Camera
MRBrainTumor1
Transformed:
MRBrainTumor2
Data Probe
Slice Annotations:
L
F
B
R
S: -5.400mm
F: MRBrainTumor2 (50%)
B: MRBrainTumor1
10 cm
1
S
R
P
L
I
Y
R: -13.531mm
5 cm
G
A: 0.468mm

Simple Image Registration

Once you are happy with your transform, scroll down to the apply transform tab, highlight the transformed volume, and click on the ‘Harden transform’ button.



Landmark Registration

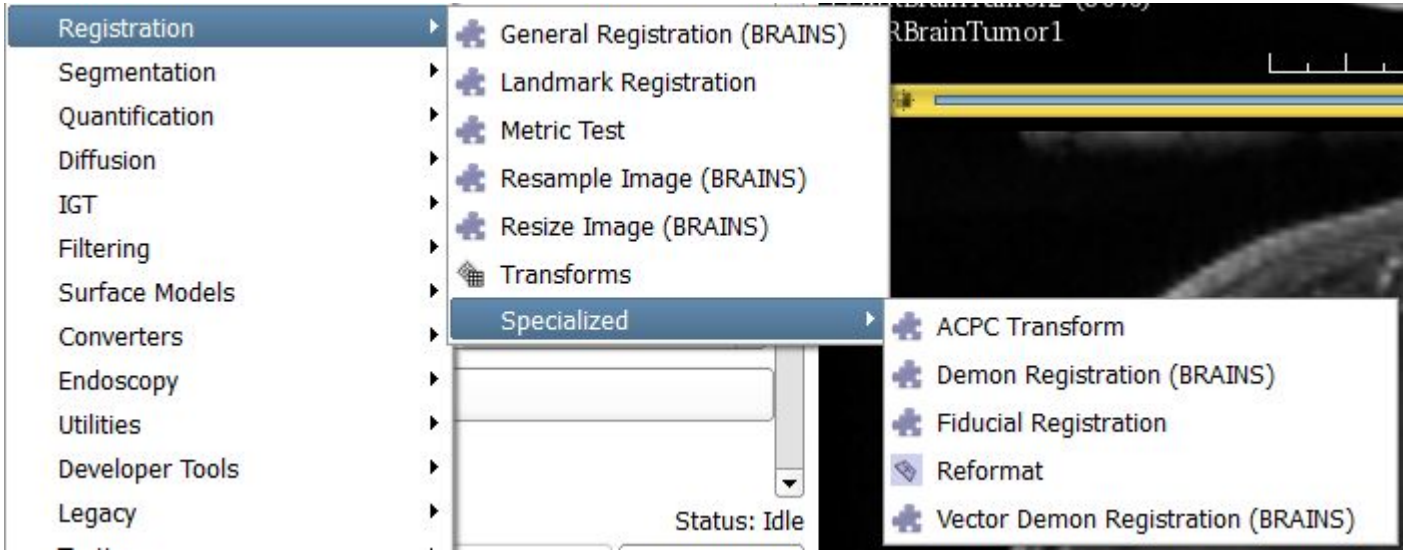
Use the Landmark Registration module for a semi-automated registration method.

Fixed Image Volume: MRBrainTumor1

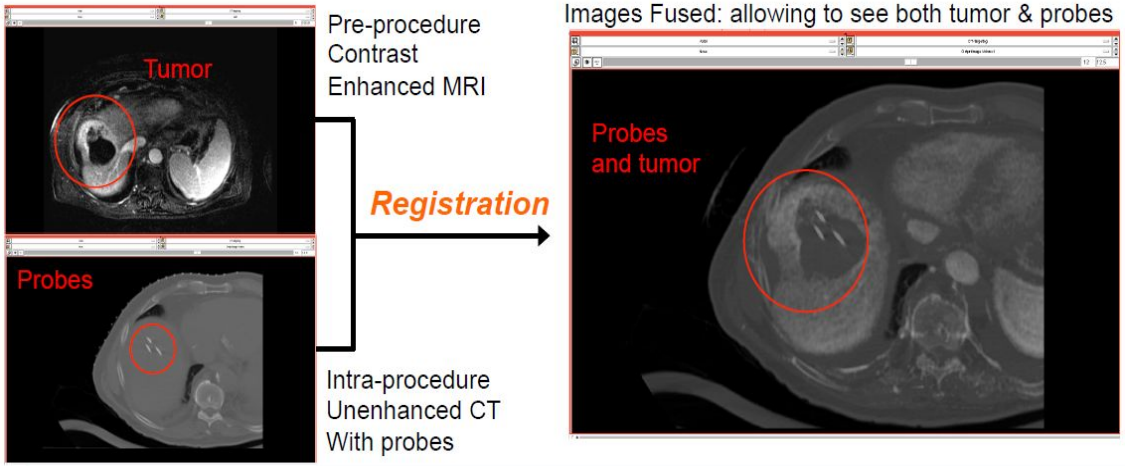
Moving Image Volume: MRBrainTumor2

Other Image Registration Methods

There are a wide range of different manual and automated registration modules available in 3D Slicer. (Not to be covered in this workshop)



Other Image Registration Methods



3D Slicer online tutorials like this one exist for more complex registration cases.

A library of registration case studies exists here

Video tutorials can be found here

...and explore the 3D Slicer registration FAQs here.

3D Slicer Extensions

Extensions Manager

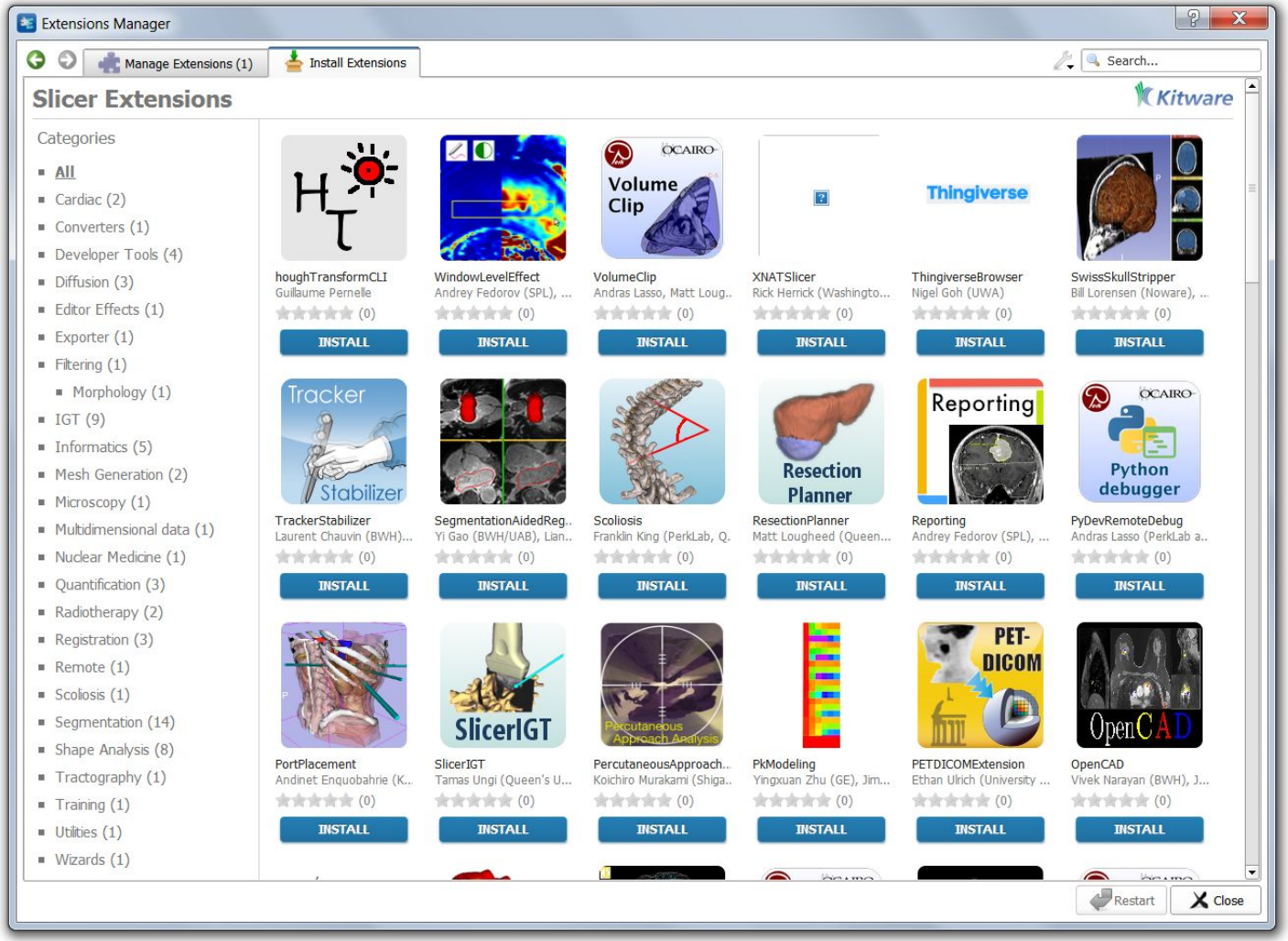
Alongside the core inbuilt modules, Slicer has an Extensions Manager which allows users to selectively install features that are useful for them.

There are currently 80+ extensions available for Slicer 4.8 which can be found via the Extensions Manager. Extensions are sorted into categories such as Segmentation, Registration, Quantification etc.

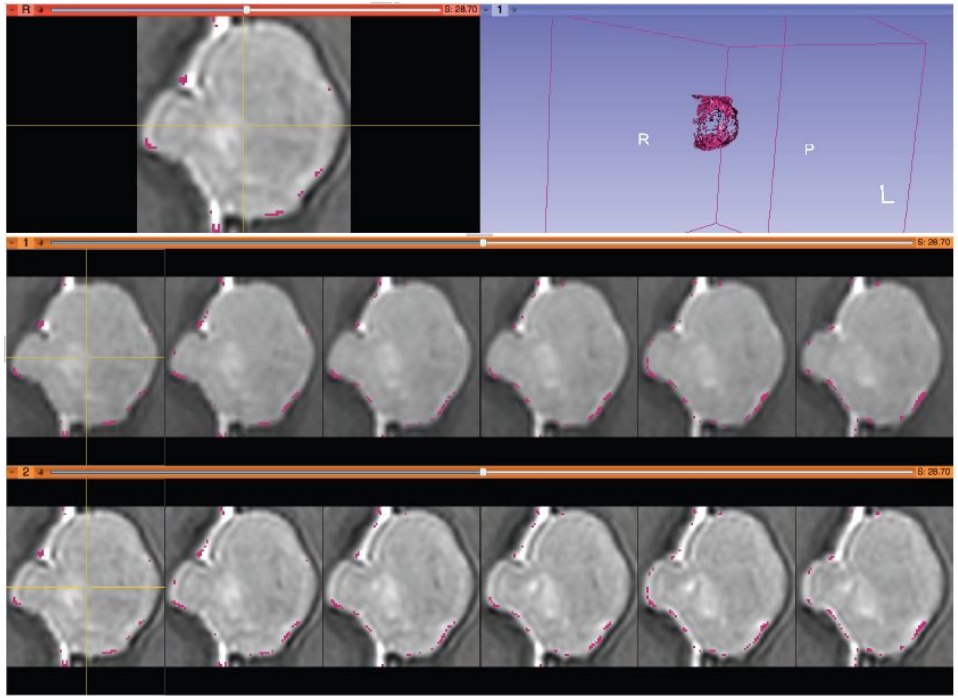
To open the Extensions Manager, go to View -> Extensions Manager, or click the Extensions Manager icon in the toolbar. 

Extensions may contain one or more modules.

[Wiki help link]


Extensions Manager
Manage Extensions (1)
Install Extensions
Search...
Slicer Extensions
Kitware
Categories
All
Cardiac (2)
Converters (1)
Developer Tools (4)
Diffusion (3)
Editor Effects (1)
Exporter (1)
Filtering (1)
Morphology (1)
IGT (9)
Informatics (5)
Mesh Generation (2)
Microscopy (1)
Multidimensional data (1)
Nuclear Medicine (1)
Quantification (3)
Radiotherapy (2)
Registration (3)
Remote (1)
Scoliosis (1)
Segmentation (14)
Shape Analysis (8)
Tractography (1)
Training (1)
Utilities (1)
Wizards (1)
houghTransformCLI
Guillaume Pernelle
WindowLevelEffect
Andrey Fedorov (SPL), ...
VolumeClip
Andras Lasso, Matt Loug..
XNATSlicer
Rick Herrick (Washingto...
ThingiverseBrowser
Nigel Goh (UWA)
SwissSkullStripper
Bill Lorensen (Noware), ...
TrackerStabilizer
Laurent Chauvin (BWH)...
SegmentationAidedReg..
Yi Gao (BWH/UAB), Lian..
Scoliosis
Franklin King (PerkLab, Q.
ResectionPlanner
Matt Lougheed (Queen...
Reporting
Andrey Fedorov (SPL), ...
PyDevRemoteDebug
Andras Lasso (PerkLab a...
PortPlacement
Andinet Enquobahrie (K...
SlicerIGT
Tamas Ungi (Queen's U...
PercutaneousApproach..
Koichiro Murakami (Shiga..
PkModeling
Yingxuan Zhu (GE), Jim...
PETDICOMExtension
Ethan Ulrich (University ...
OpenCAD
Vivek Narayan (BWH), J...
INSTALL
Restart
Close

Tracking changes in a tumour over time.



Images from Quantitative Imaging Tutorial, Sonia Pujol, 2013

3D Slicer Extensions: SlicerRT

Slicer RT is one of many extensions to 3D Slicer, with the goal of making 3D Slicer a powerful radiotherapy research platform.It adds a number of additional modules.

Modules

- DICOM-RT import
- DICOM-RT export
- Contours
- Dose volume histogram
- Dose accumulation
- Dose comparison
- Isodose line and surface display
- Contour comparison
- Contour morphology
- Batch processing scripts (currently only one is available for command-line conversion of RTSS to volume nodes)
- Modules from Plastimatch (Greg Sharp)
  - Plastimatch Automatic deformable image registration (Greg Sharp)
  - Plastimatch LANDWARP Landmark (Greg Sharp)
  - Plastimatch XFORMWARP (Greg Sharp)
- Former SlicerRT modules integrated to Slicer core
  - Subject hierarchy
  - Transform visualizer

Use Cases

- Comparison of dose maps and dose volume histograms from various treatment planning systems
- Evaluation of the effect of image-based non-rigid patient motion compensation
- Dose accumulation with motion compensation
- Evaluation of gel dosimetry
- Testing of treatment planning algorithms

3D Slicer Extensions: SlicerIGT

SlicerIGT is an extension kit aimed at Image Guided Therapy applications. Slicer IGT has been configured SlicerIGT to support procedures including brain surgery, urology, regional anesthesia etc.

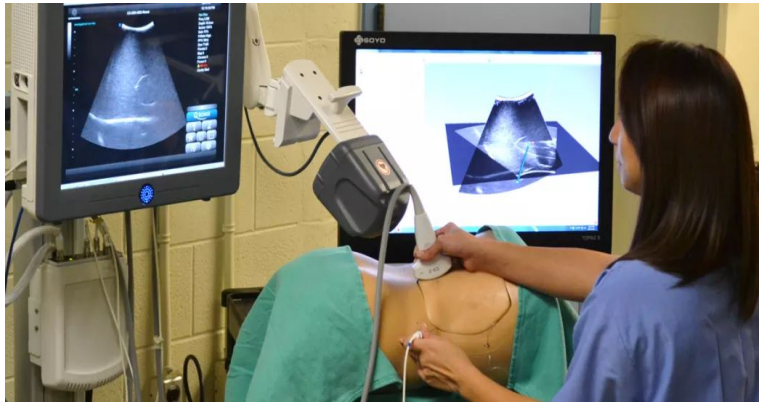
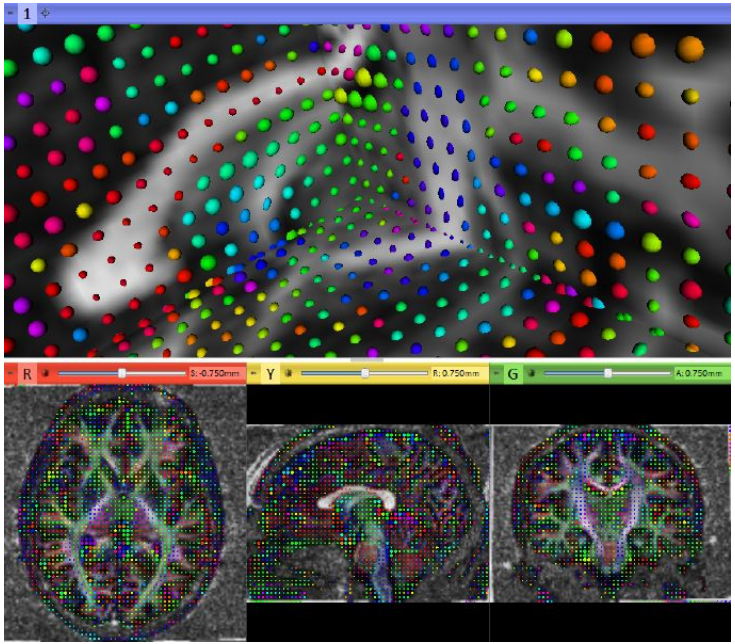
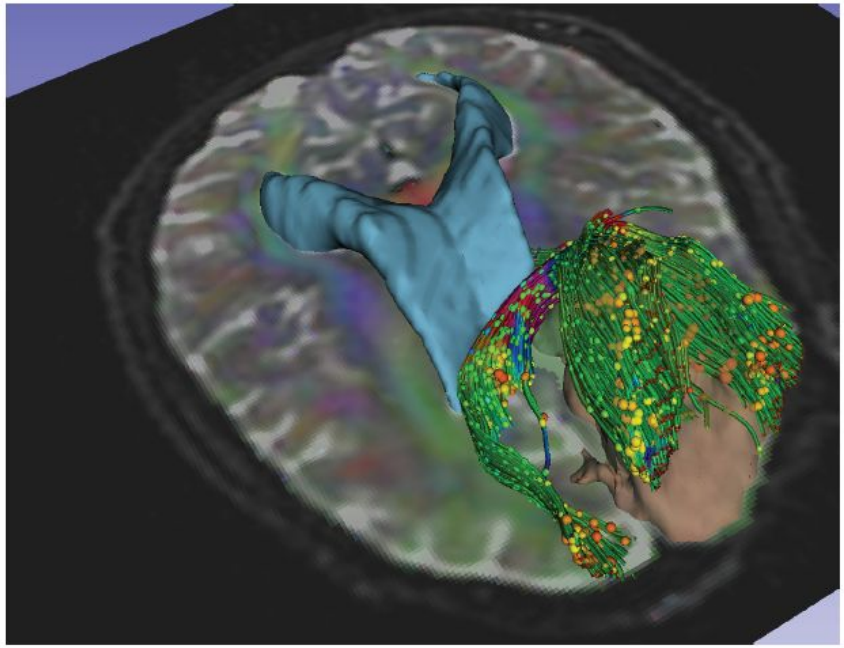


Image from SlicerIGT.org

Analysis and visualization of diffusion tensor imaging (DTI) data.





Images from Diffusion MRI Analysis Tutorial, Sonia Pujol, 2013

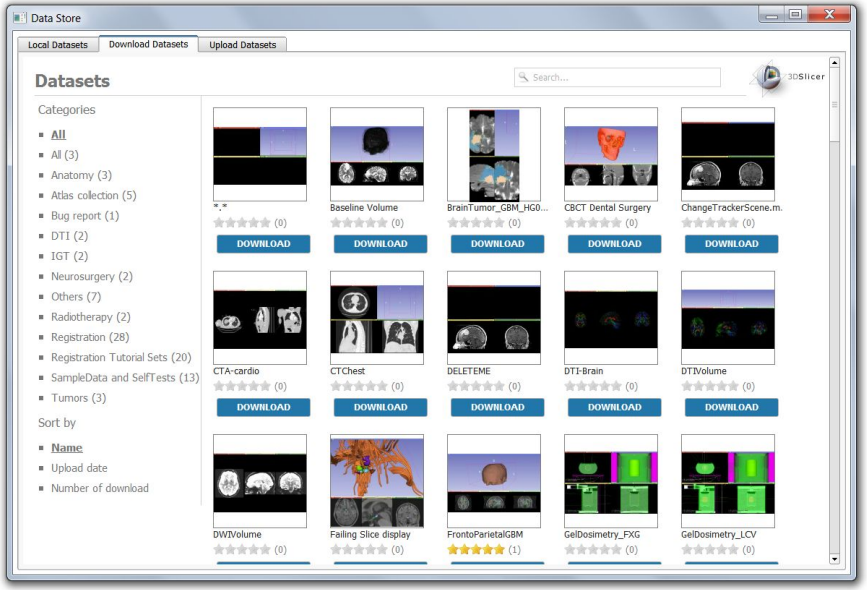
Challenge

Creating and Navigating Scene Views

Module: Data Store

This module allows users to download and upload datasets and scenes.

[Wiki Help Link]



Scene Views

Scene views are manually acquired snapshots of a 3D Slicer scene.

Scene views are like screenshots but contain the metadata required to rebuild a ‘live view’ of the scene which the user can interact with, rather than a 2D image.

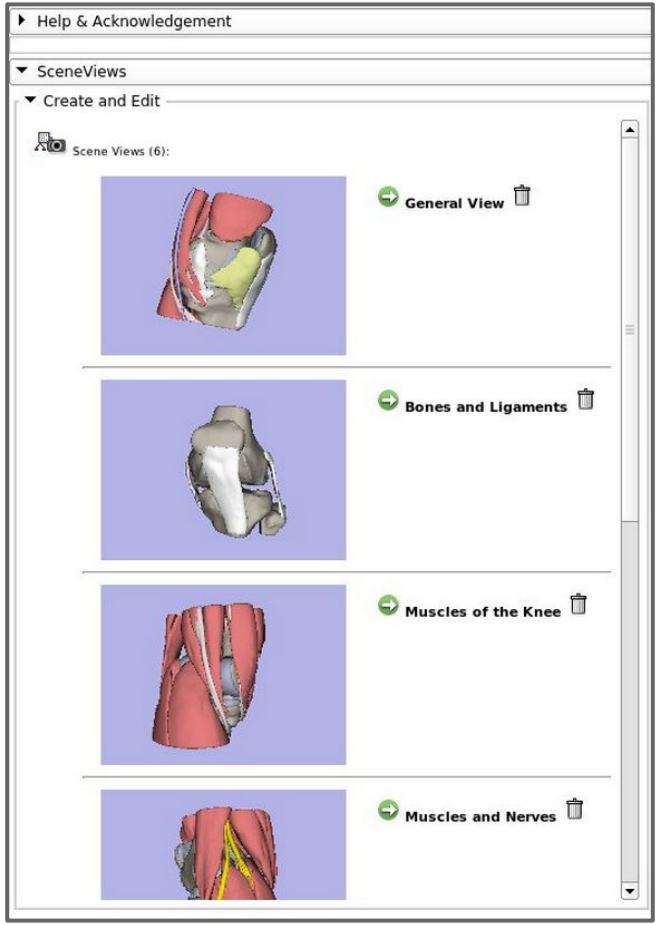
We will take a look at the SPL Knee Atlas, developed by the Surgical Planning Laboratory at Brigham and Women's Hospital, Harvard Medical School.

Load File -> KneeAtlas2012-Slicer4Version.mrb (this can also be found in the datastore

Module: Scene Views

The Scene View module is used to Create, edit, restore and delete scene views. Scene views capture the state of the MRML scene at a given point. Parameters such as the 3D view, model opacity/visibility and windows layout can be defined for a given scene view. Useful for pre-defining different viewpoints of the one data set.

[Wiki Help Link]



Knee Atlas Scene Views

Open the ‘Scene View’ module. The saved scene views will appear in the module user interface.

Browse through the saved scene views. Go to ‘Models’ module and have a look at how the settings for the different models differ.

Make your own unique scene by changing the configuration of the models in the Models module. You could change the colour, opacity, or visibility of any of the models listed.

Capture your new scene using the button in the toolbar.

Thank you for attending!

Please fill out this brief survey to tell us about your experience in the 3D Slicer workshop.

http://melbourne.resbaz.edu.au/feedback

This feedback is invaluable to us and allows us to continue offering these free trainings :)

For any further questions or comments about the workshop, please contact Jas:

jasaminecb@gmail.com

louisevanderwerff@gmail.com or via twitter @JasamineCB.

We're Hiring!

We are looking for a new Research Community Coordinator for 3D Slicer

View the Position Description here:

http://go.unimelb.edu.au/2st6

Supplementary Information

3D Slicer Core Modules

These are the major modules that we have explored at during this workshop:

- Welcome to Slicer
- Sample Data
- DICOM
- Data
- Data Store
- Volume Rendering
- Volumes
- Segmentation Editor
- Segmentations
- Markups
- Annotations
- Scene Views
- Crop Volume
- Models
- Label Statistics
- Transforms
- Landmark Registration

Online DICOM datasets, 3D models, image stacks etc

http://3d.si.edu/

http://morphosource.org/

http://morphomuseum.com/links

www.cancerimagingarchives.net

www.mouseatlas.caltech.edu

Attributes

This course material has been put together using content taken from the 3D Slicer wiki pages, along with generous help and guidance from the 3D Slicer development team, including Chief Architect Steve Pieper.

http://slicer.org/slicerWiki/index.php/Main_Page

http://www.slicer.org/

http://www.slicer.org/pages/Acknowledgments

Useful Definitions

DICOM - (Digital Imaging and Communications in Medicine standard) are a widely used and sophisticated set of standards for digital radiology.

Fiducial - A point or line placed in the field of view and used as a fixed point of reference or comparison.

GUI (Graphical User Interface) - An interface that allows users to interact with a computer using graphical icons and visual indicators, as opposed to to text-based interfaces, typed command labels or text navigation.

Module - Modules are feature-complete and distinct functional units, each designed to serve a specific task.

Registration - Image registration is the process of transforming different sets of data into one coordinate system. Can be affine, rigid or non-linear (warp).

Useful Definitions

ROI (Region of Interest) - A sub-volume within the RAS space defined in 3D Slicer by a rectangular box shaped region.

Segmentation - The process of partitioning an image into multiple components. Can be the result of automated segmentation or interactive editing.

Thresholding - The simplest method of segmenting an image by selecting pixels within a defined intensity range.

Voxel - A point on a grid in 3D space. A 3D pixel.

Slice - A 2D cross-sectional slice of the body along any given plane. Slices can be stacked together to form a 3D volume.

Useful Definitions

Volume - A 3 dimensional dataset comprised of a stack of slices. ‘Scalar’ volume refers to pixels with one value per pixel (e.g grayscale), while ‘vector’ volume refers to when there is more than one value per pixel (e.g RGB).

Transformation - Transformation involves changing the position, size, orientation etc of an object. May involve translation, reflection, scaling, rotation, shearing, stretching/compressing. Involved in image registration.

Raster Image - A graphics image composed of a grid of discrete pixels, each with their own co-ordinate and colour values. Loses quality when scaled up (becomes ‘pixelated’).

Surface Model - A representation of a 3 dimensional object. Defines the outer surface of an object by a set of vertices connected to a mesh.