Data Loading and 3D Visualization

Sonia Pujol, Ph.D., Harvard Medical School
Director of Training, National Alliance for Medical Image Computing
Following this tutorial, you will be able to load and visualize volumes within Slicer4, and to interact in 3D with structural images and models of the anatomy.
Slicer is a freely available open-source platform for segmentation, registration and 3D visualization of medical imaging data.

3DSlicer is a multi-institutional effort supported by the National Institute of Health.
3DSlicer

• An end-user application for image analysis

• An open-source environment for software development

• A software platform that is both easy to use for clinical researchers and easy to extend for programmers
3DSlicer version 4.1 is a multi-platform software running on Windows, Linux, and Mac OSX.

Disclaimer
It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules. Slicer is a tool for research, and is not FDA approved.
3DSlicer History

- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)
3DSlicer History

- 1997: Slicer started as a research project between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)

- 2012: Multi-institution effort to share the latest advances in image analysis with clinicians and scientists
NA-MIC and NAC

NA-MIC Wiki

Center Components
- Algorithms
- Engineering
- Clinical Trials
- Education/Training

Resources
- Publication DB
- Image Gallery
- Downloads
- Training Materials
- Web Archive

About the NAC
- Overview
- Organization
- Research Cores
- Collaborations

The National Alliance for Medical Image Computing (NA-MIC) is a multi-institutional, interdisciplinary team of computer scientists, software engineers, and medical investigators who develop computational tools for the analysis and visualization of medical image data. The purpose of the Center is to provide the infrastructure and environment for the development of computational algorithms and open-source technologies, and then to oversee the training and dissemination of these tools to the medical research community.

Supported by the National Institutes of Health, Roadmap Initiative.

Information about collaborating with NA-MIC is available on our wiki.

The Neuroimage Analysis Center (NAC) develops image processing and analysis techniques for basic and clinical neurosciences. The NAC research approach emphasizes both specific core technologies and collaborative application projects. The activities of the NAC are centered at the Harvard Medical School and the Surgical Planning Laboratory at the Brigham and Women's Hospital in Boston, with collaborations throughout the United States and the rest of the world.

The NAC is a major research center supported by the National Center for Research Resources (NCRR), a component of the National Institutes of Health.
Slicer: Behind the scenes

Slicer is built every night on Windows, Mac and Linux platforms.
Slicer Training

• Hands-on training workshops at national and international venues (MICCAI, SfN, OHBM, RNSA..)

• >2,000 clinicians, clinical researchers and scientists trained since 2005
Welcome to Slicer4

Slicer is built upon a modular architecture. The Welcome to Slicer module is displayed by default at start-up. Click on Welcome to Slicer to display the 103 modules of Slicer in the Modules menu.
Welcome to Slicer4

Slicer4 contains more than 100 modules for image segmentation, registration and 3D visualization of medical imaging data.
PART 1: LOADING AN MR VOLUME
The DICOM 3.0 File Format

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

```
Image001.dcm
Image002.dcm
Image003.dcm
....
```
The result of a volumetric acquisition is a **3D volume of data** related to the patient.

The 3D raster dataset is sampled on a discrete grid with elements called **voxels** which contain the **signal intensity**.
The tutorial dataset is an MR scan of the brain of a healthy subject.

The data in the **Nrrd** file format, part of the NA-MIC open-source toolkit.

DICOM data can be converted in Nrrd using the module ‘**DICOM to NRRD Converter**’ in Slicer.
Click on Load Data in the Slicer Welcome module.
Loading a volume

Click on Choose File(s) to Add
Loading a volume

Browse to the location of the Visualization directory and select the file **MR-head.nrrd**
Click on OK to load the MR dataset into Slicer
Loading a volume

The axial, sagittal and coronal views appear in the 2D viewers.
Loading a volume

Left-click on the Slicer layout icon
Loading a volume

Select **Red slice only layout**
Loading a volume

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

Click on the >> to expand the slice viewer menu
Loading a volume

Click on the Lightbox view icon in the slice menu, and select the 6x6 view option.
Loading a volume

Slicer display 36 consecutives images of the dicom volume. Use the red slice slider to browse through the data.
Left click on the red window icon, and select the Conventional layout
Loading a volume

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

Click on the links icon to link all three viewers, and on the eye icon to display the slices in the 3D Viewer
Loading a volume

The three anatomical slices appear in the 3DViewer.
Loading a DICOM volume

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

Select **File ➔ Close Scene** to close the Slicer Scene
Select **Slicer → Exit** to exit the software.
Part 2:

3D visualization of surface models of the brain
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.

- The tutorial data are part of the SPL-PNL Brain Atlas developed by Thalos et al.
Loading a Scene

Select File → Load Scene from the main menu
Loading a Scene

Browse to the directory **3DHeadData**, located in the 3DVisualizationData directory, select the file **3DHeadScene.mrml** and click on **Open**
Loading the Slicer Scene

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

- A **3D model** is a surface reconstruction of an anatomical structure.

- The model is a **triangular mesh** that approximates a surface from a 3D label map.

- The scalar values for surface models are integers which correspond to the **label** that had been assigned in the segmentation process.
Loading the Slicer Scene

Select the module **Models** from the Modules menu.
Models module

The list of 3D models appear in the Models panel
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.
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’.
3D Visualization

Lower the opacity of the skin model using the Opacity slider
Select the skull_bone.vtk model, and turn off its visibility.
The 3D surface of the white matter appears in the 3D viewer
Click on the eye icon in the green viewer to display the coronal slice in the 3D viewer.
3D Visualization

Select the 3D model `hemispheric_white_matter.vtk`, and select the option **Clip** in the Display tab.
Select the tab Clipping, and set the Green Slice Clipping to Negative Space.
3D Visualization

The optic chiasm appears in the 3D viewer
Uncheck the option clipping and lower the opacity of the White Matter surface.
Uncheck the option clipping and lower the opacity of the White Matter surface.
The intersection of the white matter surface with the 2D anatomical slices appear in the 2D viewers.
Select Conventional Layout from the layout manager, and turn off the visibility of the coronal slice in the green viewer.
3D Visualization

Click on the top left corner of the 3D viewer to display the 3D control windows.

Click on A (Anterior) to display an anterior view of the 3D models.
3D Visualization
Part 3:

Saving a scene
Saving a Scene

Select File → Save from the main menu
Saving a Scene

The **Save Scene and Unsaved Data** lists all the elements of the Slicer Scene.
Saving a Scene

Rename the scene **myNewScene.mrml** and click on **OK**
Saving a Scene

Select **Slicer** → **Exit** to close the scene ‘**myNewScene.mrml**’, and exit Slicer
Scene Restore

Restart Slicer and select File ➔ Load Scene from the main menu.
Scene Restore

Restart Slicer and select **File** → **Load Scene** from the main menu.
Scene Restore

Browse to the directory where you copied the scene, select the file `myNewScene.mrml` and click on Open.
Scene Restore

The scene myNewScene.mrml appears in the viewer
Conclusion

This tutorial guided you through the basics of data loading and interactive 3D visualization of volumes and 3D surface models in Slicer4.

Contact: spujol@bwh.harvard.edu
Slicer Community

- www.slicer.org

- Mailing lists:
  slicer-user@bwh.harvard.edu
  slicer-devel@bwh.harvard.edu
Acknowledgment

National Alliance for Medical Image Computing
NIH U54EB005149

Neuroimage Analysis Center
NIH P41RR013218