Data Loading & 3D Visualization

Sonia Pujol, Ph.D.
Surgical Planning Laboratory
Harvard Medical School
• 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
Slicer3

• Slicer3 is a multi-platform software that is developed and maintained on:

  – Windows XP
  – Linux x86_64
  – Linux x86
  – Mac OS X – Darwin x86-Intel
  – Mac OS X – Darwin Power PC
3D Visualization dataset

- This course is built upon three datasets of a single healthy subject brain:

  - MR DICOM GRASS
  - MR Nrrd SPGR
  - Pre-computed Label Map
Learning objective

Following this tutorial, you’ll be able to load and visualize volumes within Slicer3, and to interact in 3D with structural images and models.
Start Slicer3

Linux/Mac users
Launch the Slicer3 executable located in the Slicer3.6 directory

Windows users
Select Start → All Programs → Slicer3-3.6-2010-08-23 → Slicer3
The **SlicerWelcome** module is the module displayed by default.

This module gives an overview of the GUI of Slicer3, and data loading & saving functionalities.
The Graphical User Interface (GUI) of Slicer3.6 integrates 8 main components:

- the File Menu
- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice Controller
- the 3D View Controller
- Progress and Error Log
Overview

Part 1. Loading and visualizing multiple volumes simultaneously

Part 2. Loading and visualizing segmented structures overlaid on grayscale images

Part 3. Visualizing 3D reconstructions of anatomical surfaces

Part 4. The lightbox viewer

Part 5. Saving data
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**.
Part 1: Loading and visualizing multiple volumes simultaneously
Select **File** → **Add Volume** from the file menu.
Loading Volumes

Browse to the location of the Slicer3VisualizationDataset directory
Loading Volumes

Select the file **001.dcm** in the */dicom* directory
Loading Volumes

Slicer displays the **Dicom header information** of the images. Browse through the Dicom information panel to display the dimensions of the images.
Loading Volumes

Image dimensions: Rows = 256, Columns = 256
Click on Apply to load the Dicom volume in Slicer.
Loading Volumes

The Dicom images appear in the Background display of the 2DViewer.
Left click on the menu **Modules** and select **All Modules** to display the list of **95 modules** available for image analysis and 3D visualization. Select the module **Volumes**.
Loading Volumes

The panel of the module **Volumes** appears in the interface.

Click on the panel **Display**
Loading Volumes

Use the Window/Level slider to adjust the display of the MR images.
Loading Volumes

Click on Select Volume File
Loading Volumes

Browse to find the header file of the spgr volume `spgr.nhdr` located in the directory `Slicer3VisualizationDataset/nrrd` and click on **Open**.
Loading Volumes

Select Image Origin Centered and click on Apply to load the volume `spgr.nhdr`
The spgr volume appears in the Background display of the 2D Viewer.
Exploring the data

Click on the choose view icon
Select the **red slice only layout** from the menu.

Exploring the data
The axial slices of the spgr volume appear in the 3D viewer. Click on the icon *slices fit to window* to adjust the dimensions of the image to the size of the window.
Exploring the data

To simultaneously view the dicom and the nrrd volumes, left click on the drop-down menu to the right of the Foreground icon and select the image 001.dcm.
Exploring the data

Click on the Background icon or the Foreground icon to display the spgr or the DICOM volumes in the Viewer.
Exploring the data

Browse the images using the slider to display the ventricles (~slice 38)
Exploring the data

Click on the **conventional layout** icon to come back to the standard view.
Click on the icon *slices fit to window* to adjust the dimensions of the image to the size of the window.
Part 2: Loading and visualizing segmented structures overlaid on grayscale images
Image segmentation is the extraction of structural information of particular interest from surrounding image.

Each pixel is assigned a specific label value which corresponds to the anatomical structure that it belongs to.

The three-dimensional result of the segmentation is a binary array called a label map.
Loading a label map

Click on **Select Volume File**
Loading a label map

Browse to find the header file `all.nhdr` of the label map dataset located in the directory `Slicer3VisualizationDataset/nrrd` and click on Open
Visualizing a label map

Set Image Origin to **Centered** Check the **Label Map** box and click on **Apply**
Visualizing a label map

Slicer displays the label map **all** in the **Label layer**

Click on the **links** icon.
Label Viewer

Left click the drop-down menu to the right of the L icon and select None.
Visualizing Multiple Volumes

Foreground Viewer

Left click on the drop-down menu to the right of the F icon and select the volume all
Visualizing Multiple Volumes

Select **Manipulate**

**Slice Views**

Use the slider to fade between the labelmap *all* (Foreground) and the *spgr* volume (Background).
Select the module **Data** in the module menu.
3D Visualization

The Data module displays the volumes loaded in the current Slicer Scene.
The Load & Add Scene tab displays the different data types that can be added to the scene.
Click on the **links** icon.

Click on the **Slice Visibility** icon to display the slices in the 3D Viewer.
Slicer displays 2D anatomical slices in the 3D viewer
Position the mouse in the 3D Viewer, hold down the left mouse button and drag to rotate the volumes.
Part 3: Loading and visualizing 3D models of the anatomy
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.
3D Visualization

Click on the left icon in **Add data or data directory**
A small window displays information on how to use the function **Add data**

**or data directory**

Click on the **icon**
Click on Add Directory to select the directory Slicer3VisualizationDataset
Loading 3D models

Select the directory `Slicer3VisualizationDataset/models` and click on OK.
The list of elements present in the models directory appears in the Add Data window.

Click on **Apply** to load all the **3D models**.
Slicer loads the 3D models in the 3D Viewer. The models have been added to the MRML scene.
Loading a 3D model

Select the module **Models**

Click on the panel **Hierarchy & Display** to access the module’s display components
Select the model **Skin.vtk**
Click on the icon **Set Color** and choose a new color for the 3D model of the head.
Visualizing a 3D model

Change the opacity of the skin model from 1.0 to 0.5 using the opacity slider:
Visualizing a 3D model

The 3D models of the brain and vessels appear through the skin.
Visualizing a 3D model

Turn off the visibility of the skin model
Visualizing a 3D model

Select the model **Brain** and change its color to white
Visualizing a 3D model

Select Green Slice Only Layout from the Viewer menu
Visualizing a 3D model

Click on the icon to adjust the size of the image to the size of the window.
Select Slice Intersection Visible to display the model intersection on the slice plane.
Visualizing a 3D model

The intersection of the 3D model of the brain with the 2D image plane appears in the viewer.

Go back to the conventional layout
Visualizing a 3D model

Select the model **Vessels** and change its color to red
Visualizing a 3D model

Select the model **Brain** and select the option **Clipping**
Visualizing a 3D model

Set **Yellow Slice Clipping** to **Positive Space**
Visualizing a 3D model

Click on the letter S in the Control Window to display a superior view of the 3D models
Visualizing a 3D model

Use the yellow slice slider to expose the 3D model of the vasculature
Visualizing a 3D model

Turn off the option clipping for the model Brain and set the Yellow Slice Clipping to Off.

Turn on the visibility of the model Skin.
Slicer displays the 3D models of the Skin, Vessels and Brain.
Part 4: Lightbox viewer
Visualizing a 3D model

Select the option **Compare Layout** in the Viewer menu
Visualizing a 3D model

Set the Number of compare Viewers to 1 and the number of lightbox rows and columns to 2.

Click on Apply
Slicer displays a lightbox view of the Background dataset.
Browse through the spgr volume using the lightbox slider
Slicer displays 4 adjacent axial slices of the spgr volume simultaneously
Left click on the Slice Viewer menu of the Compare Layout viewer
Select the **lightbox view option**
Set the configuration of the light box view to 6x6
Slicer displays a matrix of 36 adjacent axial slices of the spgr volume.
Select the option **Conventional Layout** in the Viewer menu.
Part 5: Loading and saving a Scene
Saving Data

Click on **File** and Select **Save**
Saving Data

The list of elements currently loaded into Slicer3 appears.

<table>
<thead>
<tr>
<th>Select</th>
<th>Node Name</th>
<th>Node Type</th>
<th>Node Status</th>
<th>File Format</th>
<th>File Name</th>
<th>Data Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Scene Des...</td>
<td>(SCENE)</td>
<td>Modified</td>
<td>MRML</td>
<td>SlicerScene1</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>001</td>
<td>Volume</td>
<td>Not Modified</td>
<td>Pick Format for saving</td>
<td>001.dcm</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>spgr.nhdr</td>
<td>Volume</td>
<td>Not Modified</td>
<td>NRRD</td>
<td>spgr.nhdr</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>all.nhdr</td>
<td>Volume</td>
<td>Not Modified</td>
<td>NRRD</td>
<td>all.nhdr</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>Vessels.vtk</td>
<td>Model</td>
<td>Not Modified</td>
<td>Poly Data (vtk)</td>
<td>Vessels.vtk</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>Ventricles.vtk</td>
<td>Model</td>
<td>Not Modified</td>
<td>Poly Data (vtk)</td>
<td>Ventricles.vtk</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>Skin.vtk</td>
<td>Model</td>
<td>Not Modified</td>
<td>Poly Data (vtk)</td>
<td>Skin.vtk</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
<tr>
<td></td>
<td>Brain.vtk</td>
<td>Model</td>
<td>Not Modified</td>
<td>Poly Data (vtk)</td>
<td>Brain.vtk</td>
<td>SliceData/SlicerScene/SlicerScene/...</td>
</tr>
</tbody>
</table>

Make sure only the first check box is selected.
Click on **Change Destination for All Selected** and browse to the location where the scene will be saved.
Saving Data

Browse to the directory where you would like to save your scene and click OK
Double click on the file name **SlicerScene1** and change it to **Slicer3DScene**
Saving Data

Click on **Save Selected**
Creating Scene Snapshots

Choose a 3D view of the scene and click on the capture snapshot icon.
Creating Scene Snapshots

Enter the Snapshot name `MySceneSnapshot1` and click on OK
Creating Scene Snapshots

Select a Superior view of the dataset, and click on the capture snapshot icon.
Creating Scene Snapshots

Enter the name MySceneSnapshot2 and click on OK
Creating Scene Snapshots

Select **File → Save** and click on **Save Selected** to include the two scene snapshots in the saved scene.
Click **Yes** to overwrite the file with a new file that contains the scene snapshots.
Select **File → Close Scene** in the main menu and click on **OK**.
The elements of the previous scene disappear from the Viewer.
Select **File → Load Scene** from the main menu.
Saving Data

Browse to find the file **Slicer3DScene.mrml** and click on **Open**
Slicer loads the elements from the scene `Slicer3DSscene.mrml`
Loading a Scene

Left-click on the **restore snapshot** icon.

Select *MySceneSnapshot2* and click on **restore**
Slicer restores the scene snapshot **MySceneSnapshot2**
Conclusion

- 3D visualization of anatomical surface reconstructions
- 3D interaction with volumes and models
- Open-source platform
Acknowledgments

National Alliance for Medical Image Computing
NIH U54EB005149

Neuroimage Analysis Center
NIH P41RR013218