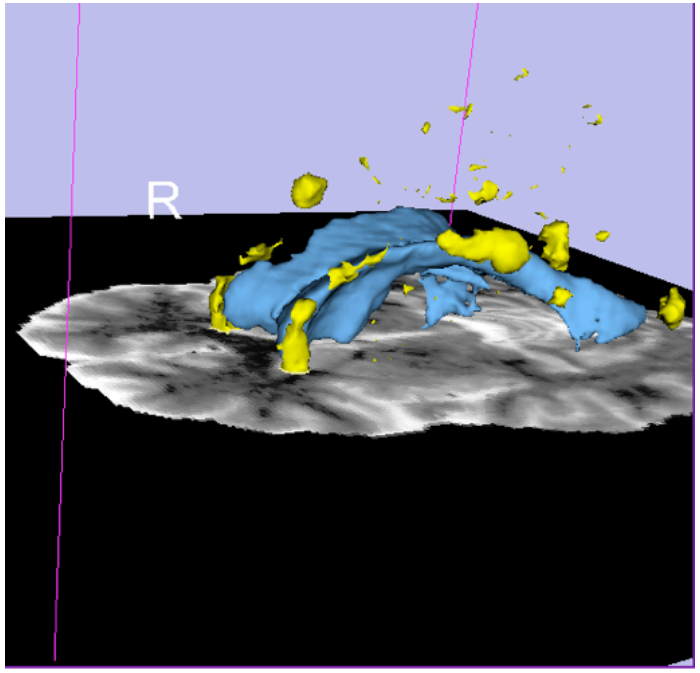
Detecting White Matter Lesions in Lupus



Version 2.1
6/25/2009

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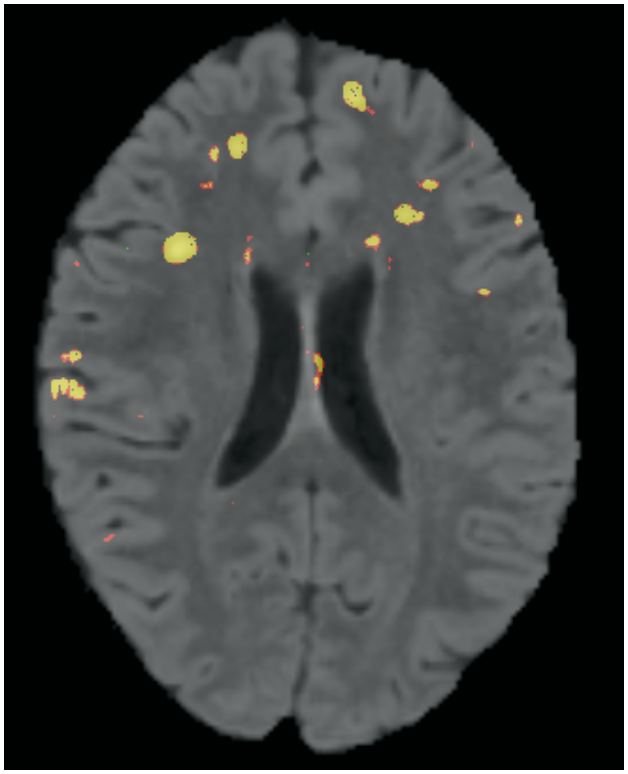
Mark Scully

Learning objective



This tutorial demonstrates an automated, multi-level method to segment white matter brain lesions in lupus.

Following this tutorial, you'll be able to load scans into Slicer3, and segment and measure the volume of white matter lesions on the provided data-set.

Prerequisites

This tutorial assumes that you have already completed the tutorial **Data Loading and Visualization**. Tutorials for **Slicer3** are available at the following location:

- **Slicer3** tutorials
http://www.na-mic.org/Wiki/index.php/Slicer3.2:Training

Material

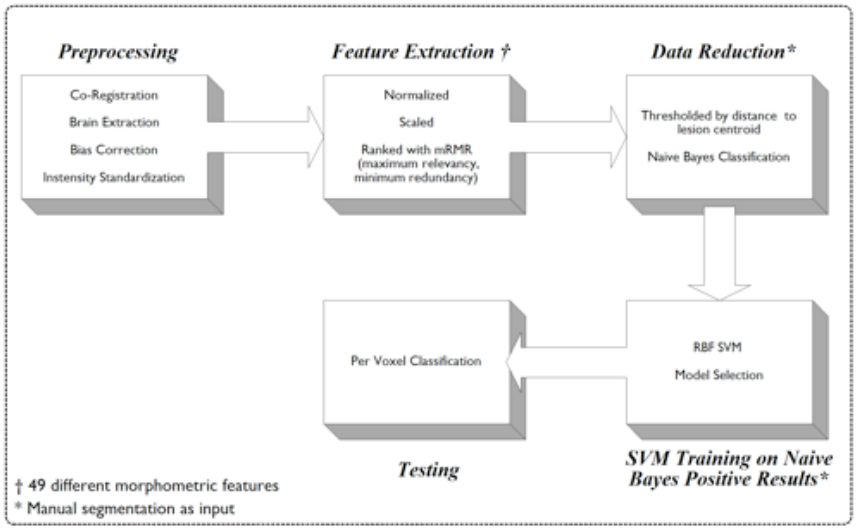
This course requires the following installation:

- The current version of Slicer 3.5.x Software which can be installed from:
  - http://www.slicer.org/pages/Downloads
- The White Matter Lesion module extension to Slicer 3
- The Lupus Lesion Tutorial Data, which can be downloaded from:
  - http://www.nitrc.org/frs/download.php/569/LesionSegmentationTutorialData.tgz
- n.b., a reliable internet connection will be required for downloading the data

Disclaimer

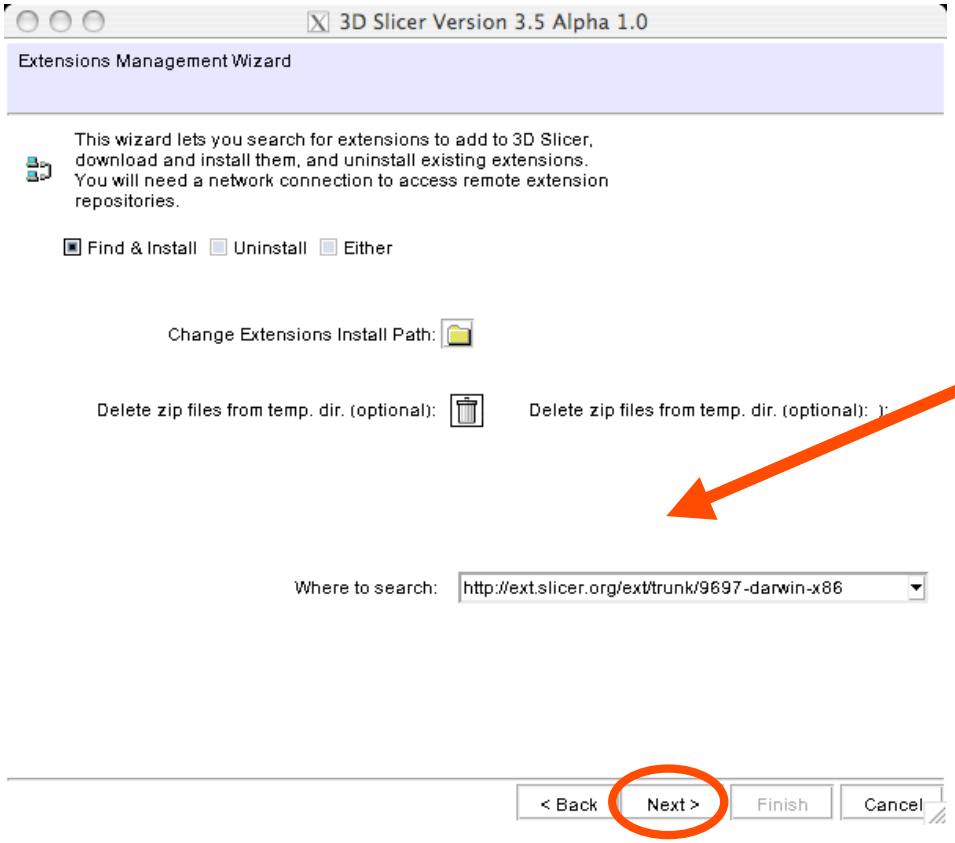
It is the responsibility of the user of 3DSlicer to comply with both the terms of the license and with the applicable laws, regulations and rules.

Methods



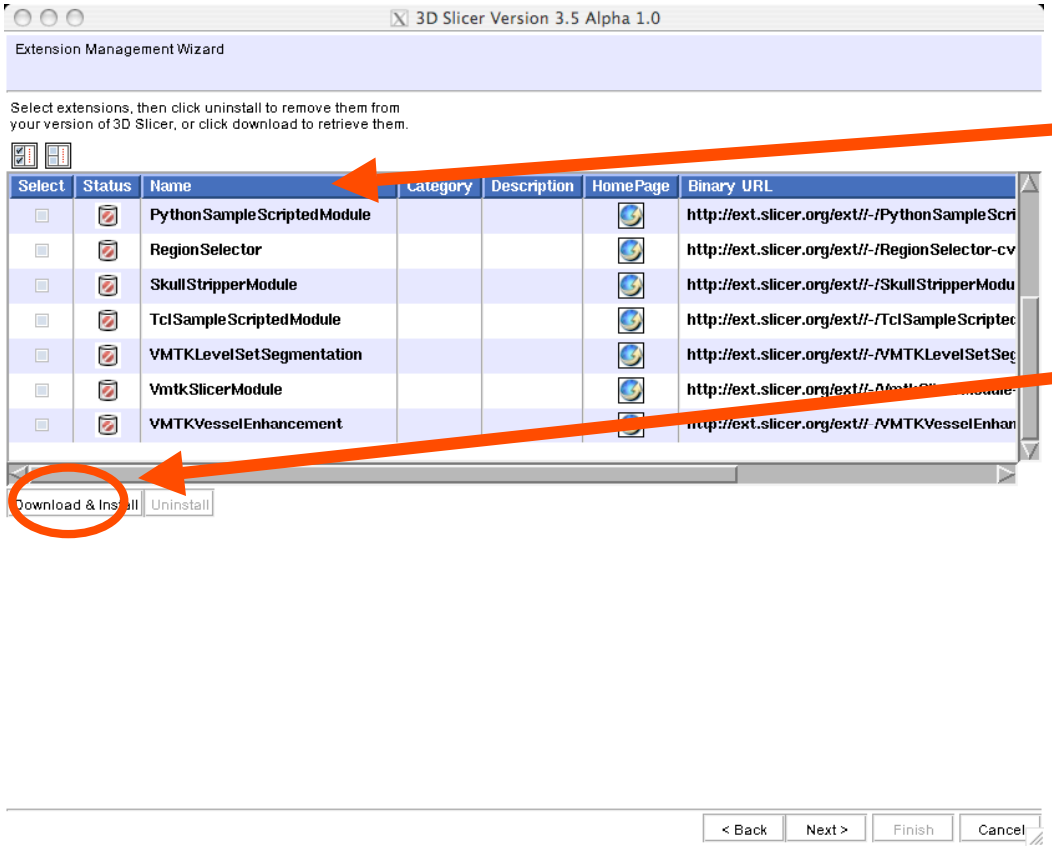
The method makes use of local morphometric features based on multiple MR sequences, including T1-weighted, T2-weighted, and Fluid Attenuated Recovery from ten subjects. After preprocessing, including co-registration, brain extraction, bias correction, and intensity standardization, 49 features were calculated for each brain voxel based on local morphometry. At each level of segmentation a supervised classifier takes advantage of a different subset of the features to conservatively segment lesion voxels, passing on more difficult voxels to the next classifier. This multi-level approach allows for a fast lesion classification method with tunable trade-off between sensitivity and specificity, with accuracy comparable to a human rater.

Getting the Module



- To add the external module, Select the Extensions Management Wizard from the View menu within Slicer. Click next to search the external site for the appropriate module to install.

Installing the Module



Select **LesionSegmentationApplications** from the list

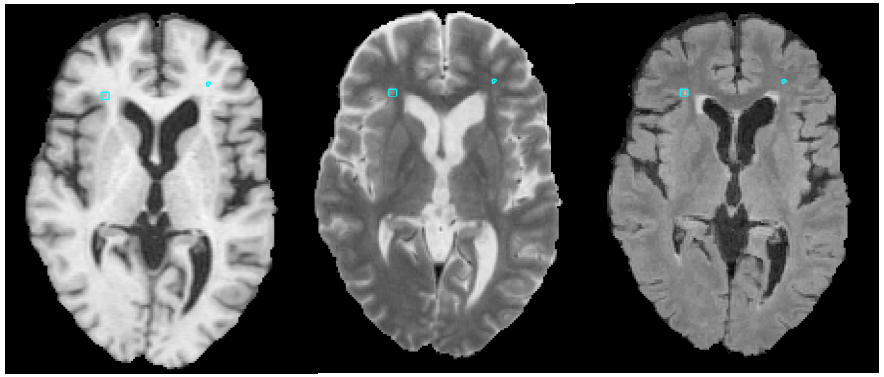
Click **Download & Install**.

Click **Finish** when download completes and restart Slicer to use the external module

Tutorial Data

This course is built upon two scans of patients with lupus that have T1, T2, and FLAIR images. These images have been co-registered and brain extracted.

The following summary shows the contents of the data/LesionSegmentationTutorial directory once download and uncompressed

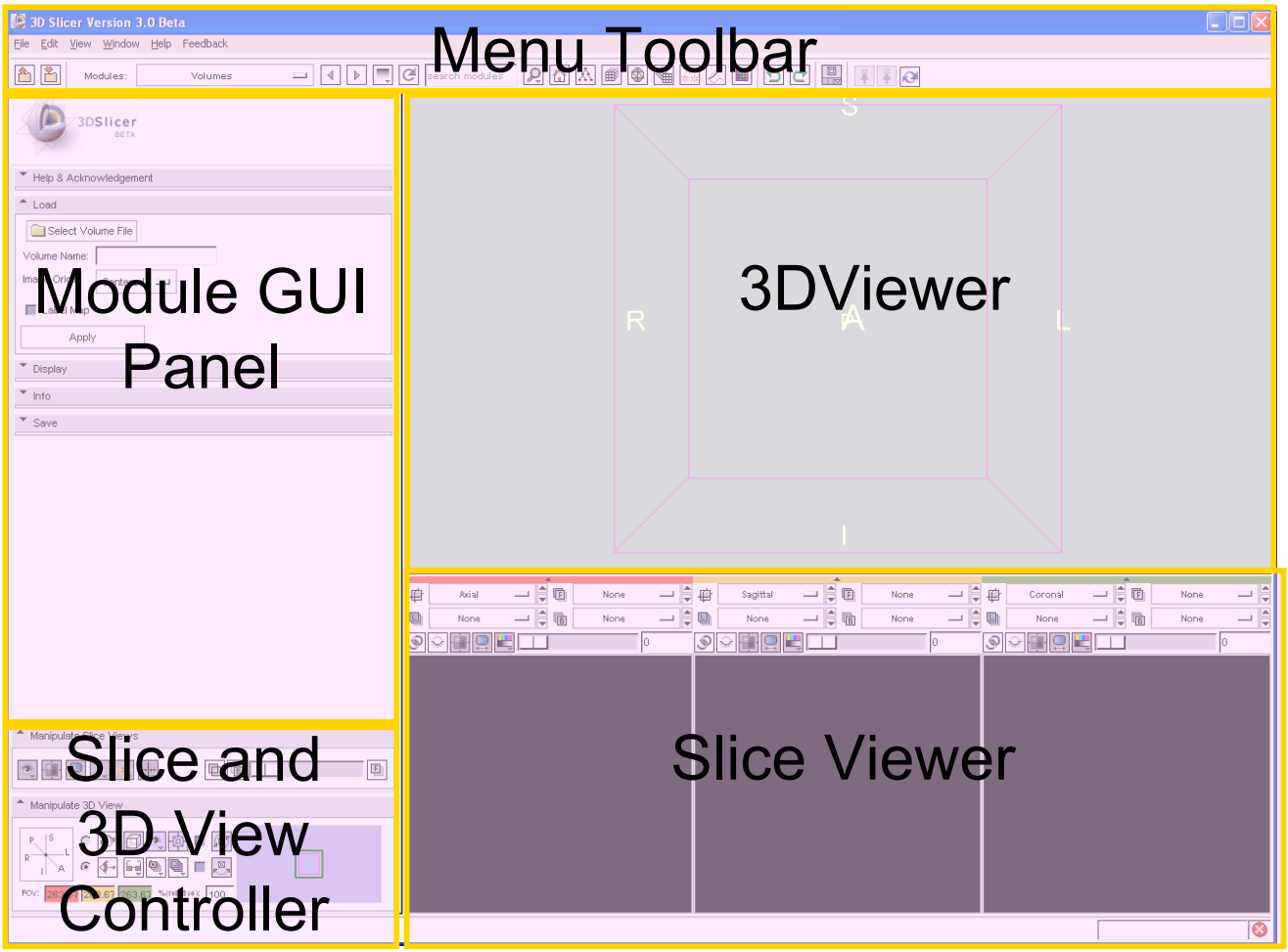


Joint Intensity Standardization Volume.nhdr
Joint Intensity Standardization Volume.raw.gz
Joint Intensity Standardization Volume1.nhdr
Joint Intensity Standardization Volume1.raw.gz
Joint Intensity Standardization Volume2.nhdr
Joint Intensity Standardization Volume2.raw.gz
LesionSegmentTutorial.mrml
Predict Lesions Volume.nhdr
Predict Lesions Volume.raw
Predict Lesions Volume1.nhdr
Predict Lesions Volume1.raw
lesionSegmentation.model
lupus002_FLAIR_reg+bias.nii.gz
lupus002_T1_reg+bias.nii.gz
lupus002_T2_reg+bias.nii.gz
lupus002_brain_mask.nii.gz
lupus003_FLAIR_reg+bias.nii.gz
lupus003_T1_reg+bias.nii.gz
lupus003_T2_reg+bias.nii.gz
lupus003_brain_mask.nii.gz
svm.model

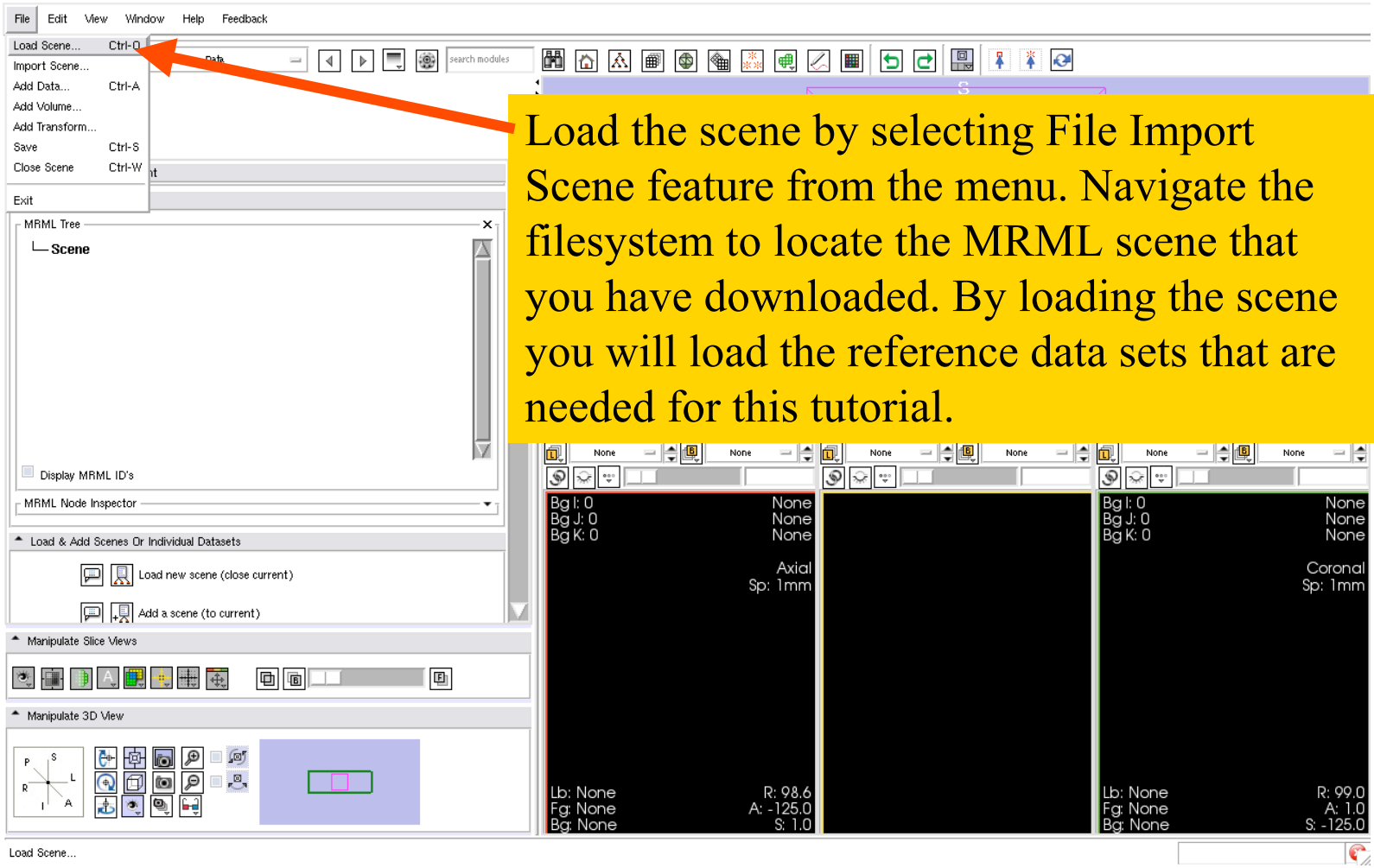
Slicer3 GUI

The Graphical User Interface (GUI) of Slicer3 integrates five components:

- the Menu Toolbar
- the Module GUI Panel
- the 3D Viewer
- the Slice Viewer
- the Slice and 3D View Controller

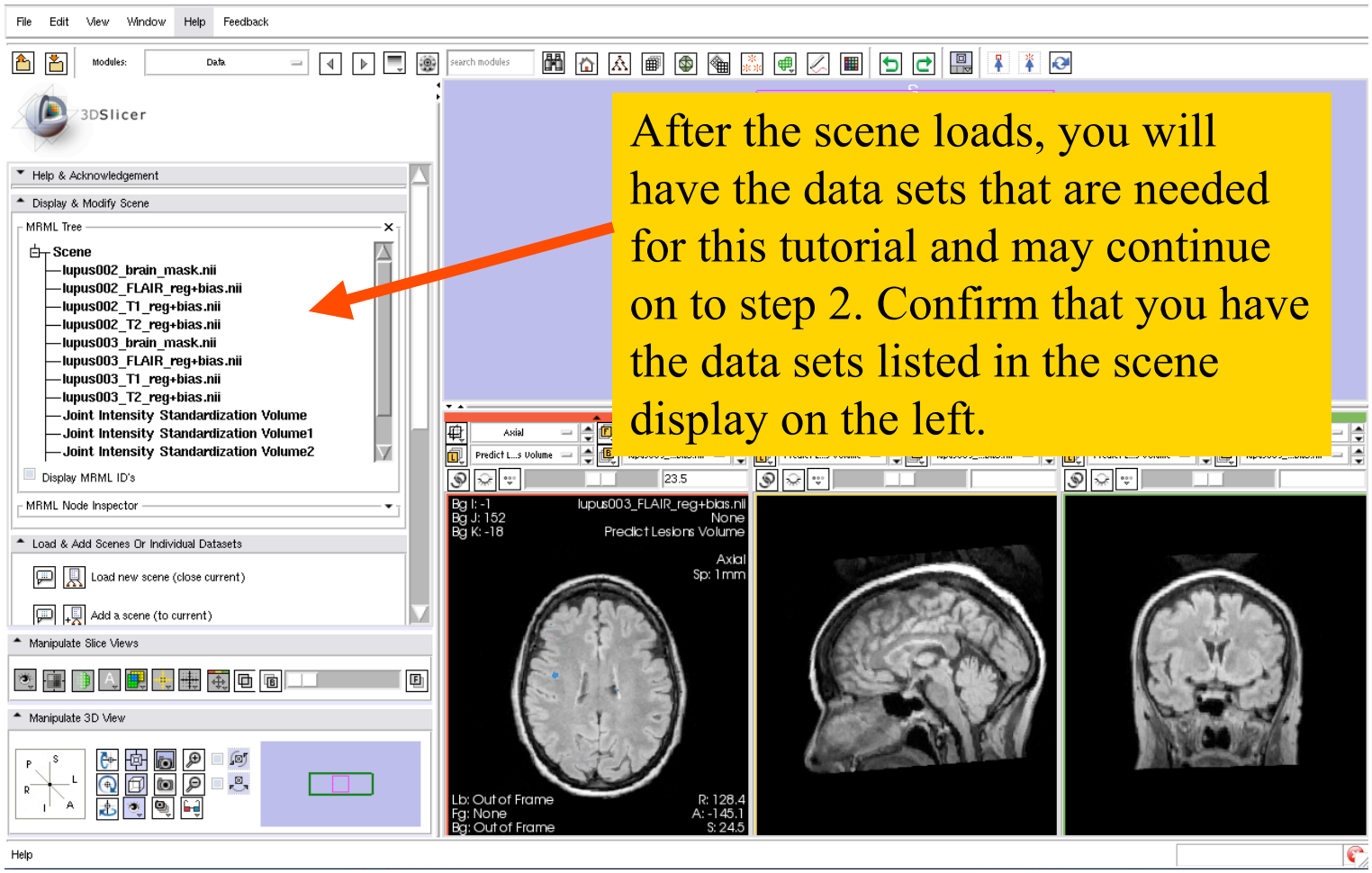


Step1: Setup



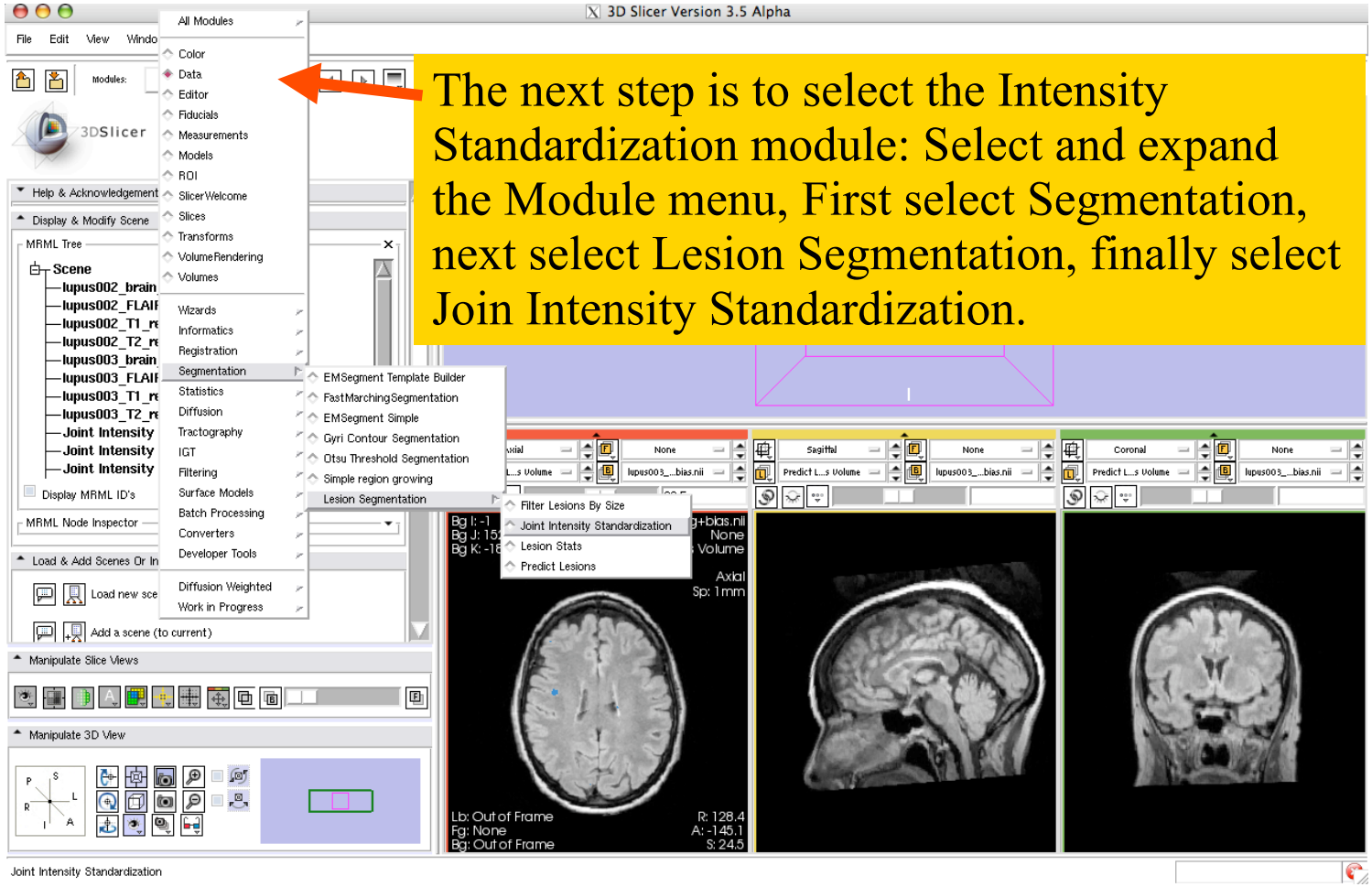
Load the scene by selecting File Import Scene feature from the menu. Navigate the filesystem to locate the MRML scene that you have downloaded. By loading the scene you will load the reference data sets that are needed for this tutorial.

Step 1: Results



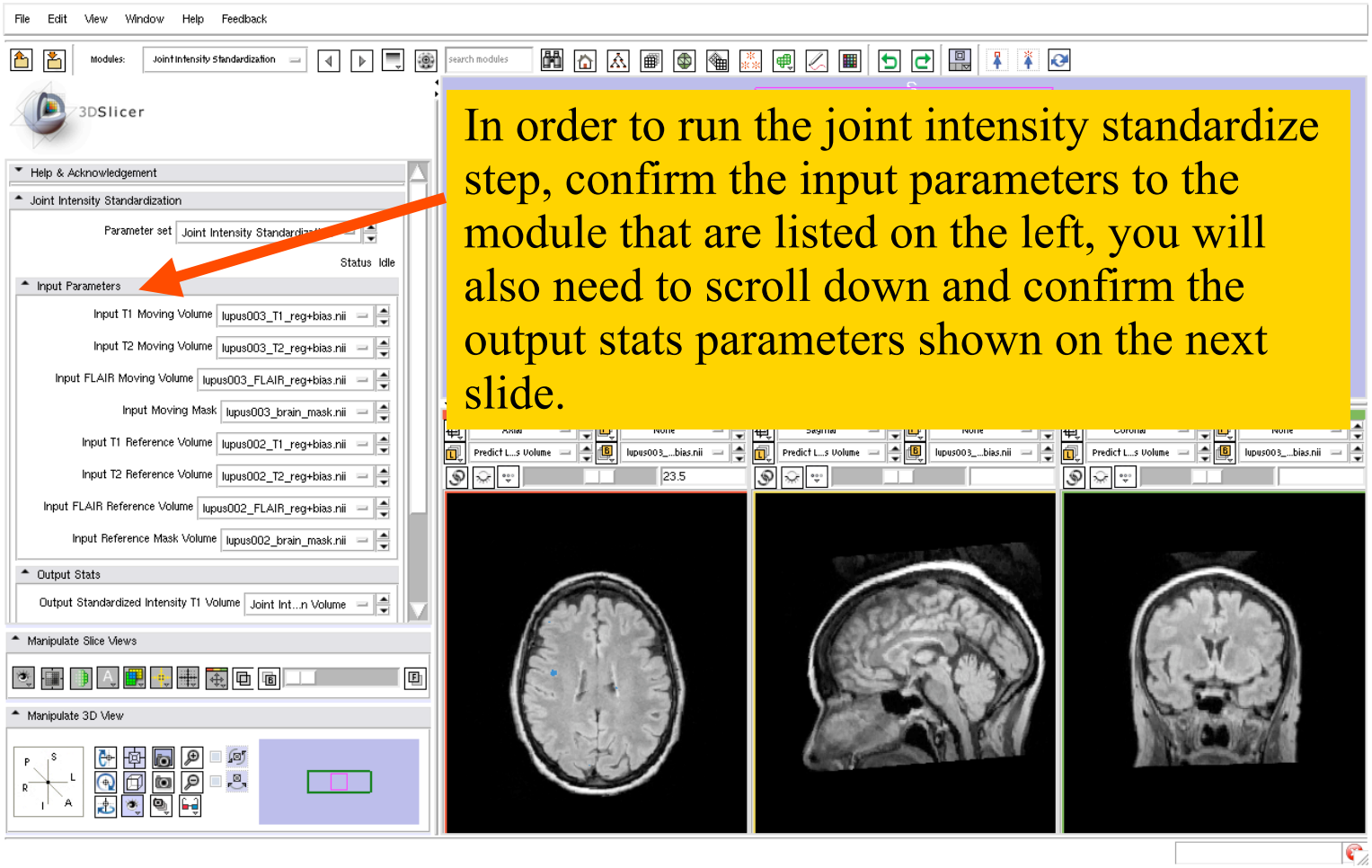
After the scene loads, you will have the data sets that are needed for this tutorial and may continue on to step 2. Confirm that you have the data sets listed in the scene display on the left.

Step 2: Setup

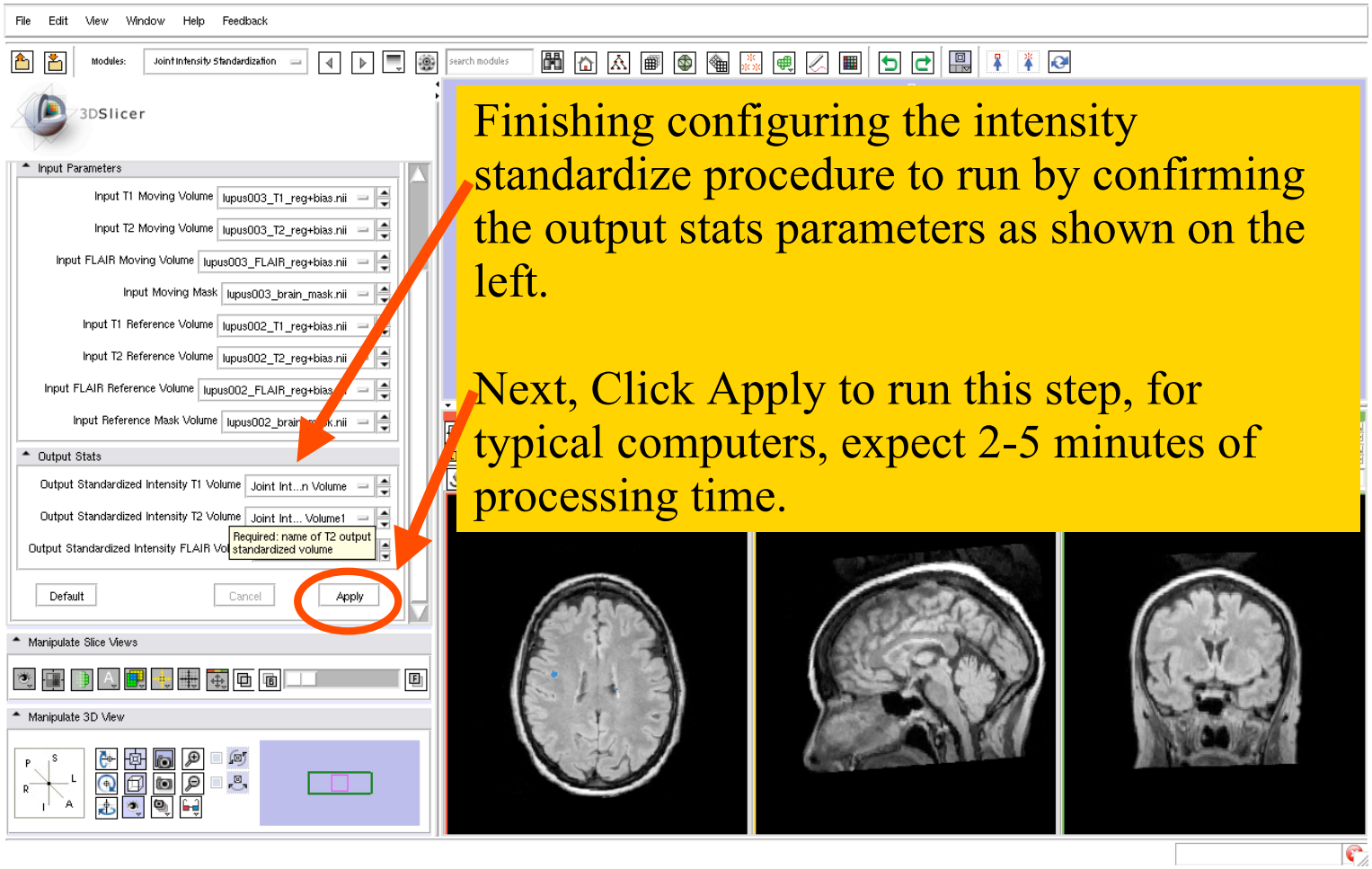


The next step is to select the Intensity Standardization module: Select and expand the Module menu, First select Segmentation, next select Lesion Segmentation, finally select Join Intensity Standardization.

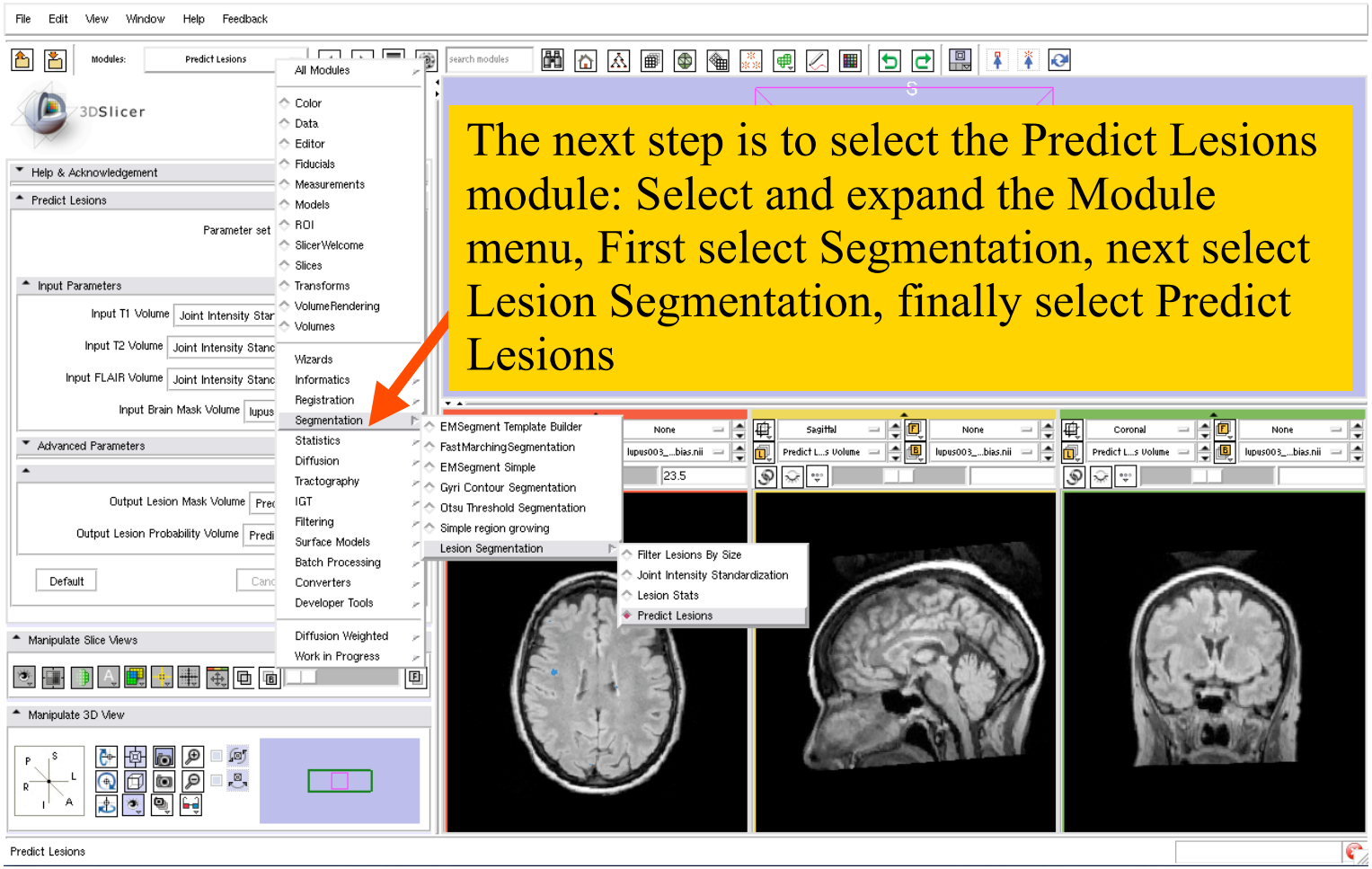
Step 2: Setup


File Edit View Window Help Feedback
Modules: Joint Intensity Standardization
search modules
3DSlicer
Help & Acknowledgement
Joint Intensity Standardization
Parameter set
Status Idle
Input Parameters
Input T1 Moving Volume lupus003_T1_reg+bias.nii
Input T2 Moving Volume lupus003_T2_reg+bias.nii
Input FLAIR Moving Volume lupus003_FLAIR_reg+bias.nii
Input Moving Mask lupus003_brain_mask.nii
Input T1 Reference Volume lupus002_T1_reg+bias.nii
Input T2 Reference Volume lupus002_T2_reg+bias.nii
Input FLAIR Reference Volume lupus002_FLAIR_reg+bias.nii
Input Reference Mask Volume lupus002_brain_mask.nii
Output Stats
Output Standardized Intensity T1 Volume Joint Int...n Volume
Manipulate Slice Views
Manipulate 3D View
In order to run the joint intensity standardize step, confirm the input parameters to the module that are listed on the left, you will also need to scroll down and confirm the output stats parameters shown on the next slide.

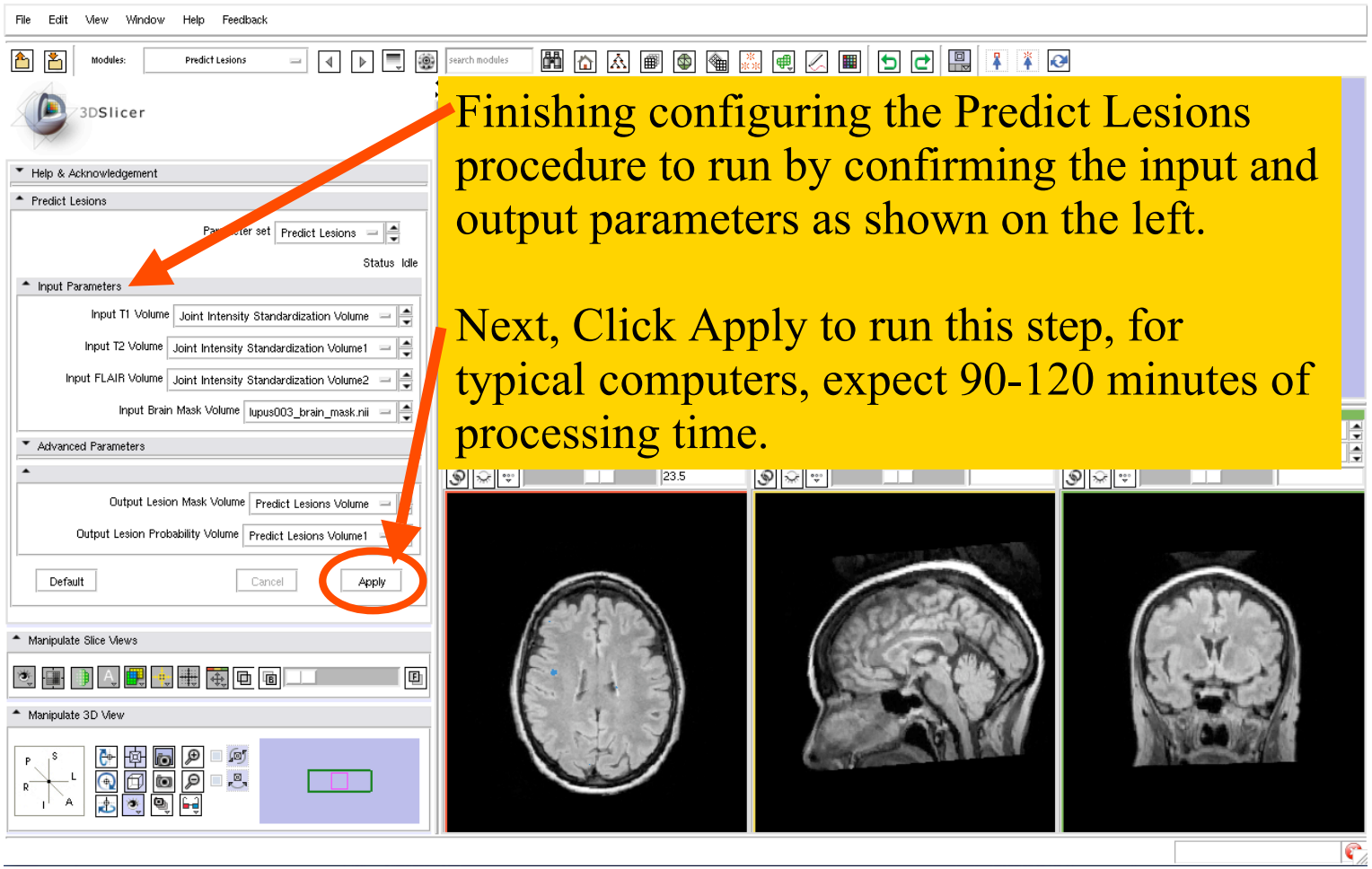
Step 2: Running



Step 3: Setup


The next step is to select the Predict Lesions module: Select and expand the Module menu, First select Segmentation, next select Lesion Segmentation, finally select Predict Lesions
File Edit View Window Help Feedback
Modules: Predict Lesions
All Modules
Color
Data
Editor
Fiducials
Measurements
Models
ROI
SlicerWelcome
Slices
Transforms
VolumeRendering
Volumes
Wizards
Informatics
Registration
Segmentation
Statistics
Diffusion
Tractography
IGT
Filtering
Surface Models
Batch Processing
Converters
Developer Tools
Diffusion Weighted
Work in Progress
EMSegment Template Builder
FastMarchingSegmentation
EMSegment Simple
Gyri Contour Segmentation
Otsu Threshold Segmentation
Simple region growing
Lesion Segmentation
Filter Lesions By Size
Joint Intensity Standardization
Lesion Stats
Predict Lesions
Help & Acknowledgement
Predict Lesions
Parameter set
Input Parameters
Input T1 Volume
Input T2 Volume
Input FLAIR Volume
Input Brain Mask Volume
Advanced Parameters
Output Lesion Mask Volume
Output Lesion Probability Volume
Default
Manipulate Slice Views
Manipulate 3D View
Predict Lesions

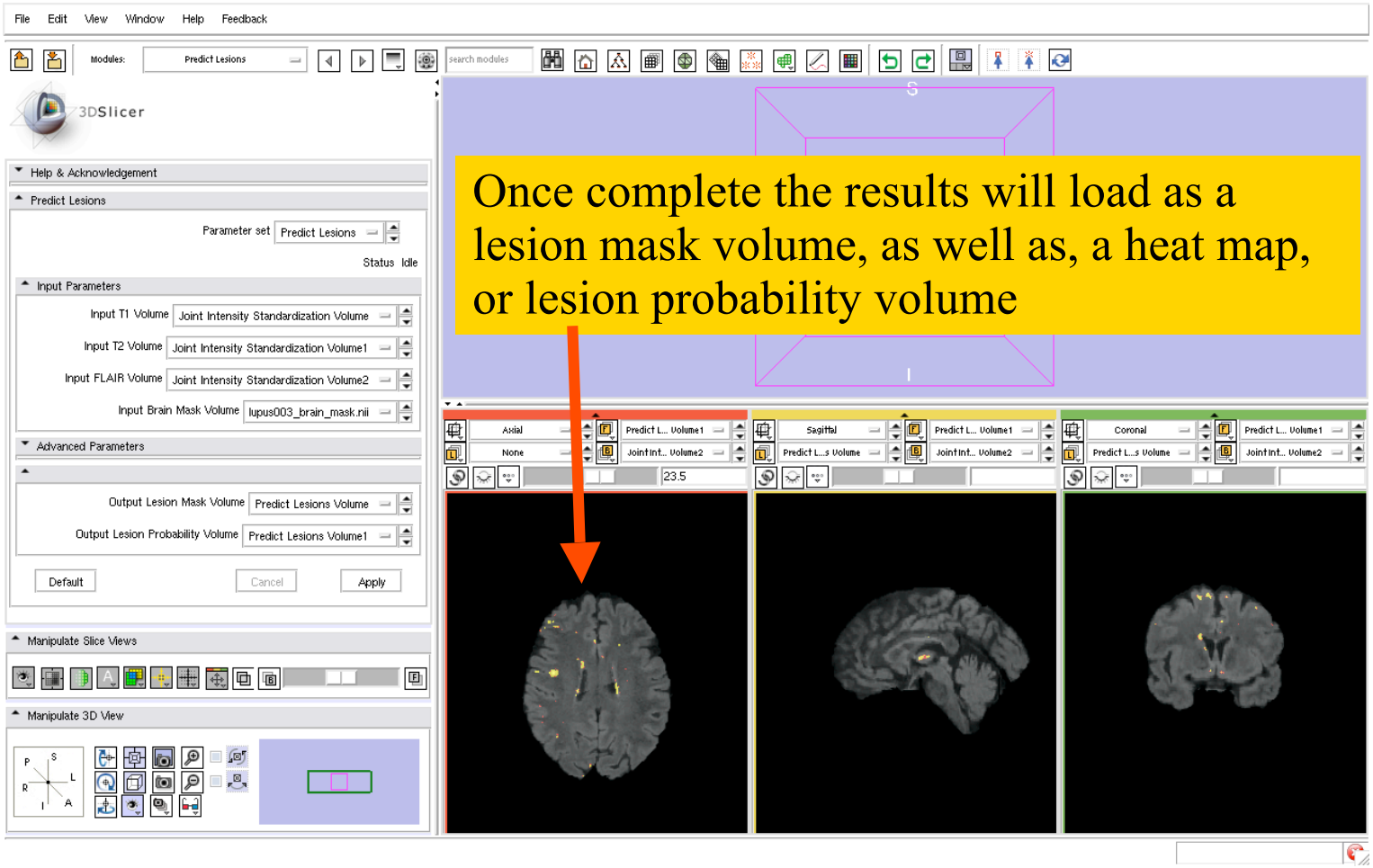
Step 3: Running



Finishing configuring the Predict Lesions procedure to run by confirming the input and output parameters as shown on the left.

Next, Click Apply to run this step, for typical computers, expect 90-120 minutes of processing time.

Step 3: Results



Discussion

- Since the tool has produced a label map, you may now measure the volumes of the automatically labeled lesion tissue or summarize the anatomical location of lesions. The lesion load is associated with symptom severity and can be used to guide treatment and care.
- You may use the lesion label maps as input to the change tracker capability in Slicer to assess time course of the illness (change in lesion size, number over time).
- You may use the label maps to assess either perfusion or diffusion deficits through co-registration of the lesion maps with pMR, ASL, or DTI.

Conclusion

- This capability provides an intuitive graphical user interface to interact with the data
- The tool has been built in an open-source environment and is readily available to the scientific community

For More Information

- Register as a user of this 3dSlicer Module using the NITRC resource to keep updated on any changes or additions to either the capability or tutorial
  - http://www.nitrc.org/projects/lupuslesion/

- You may also send e-mail message with any questions or concerns to Jeremy Bockholt (jbockholt@mrn.org)

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NIH U24-RR021992