Fluid Mechanics Based DTI Tractography Module Tutorial

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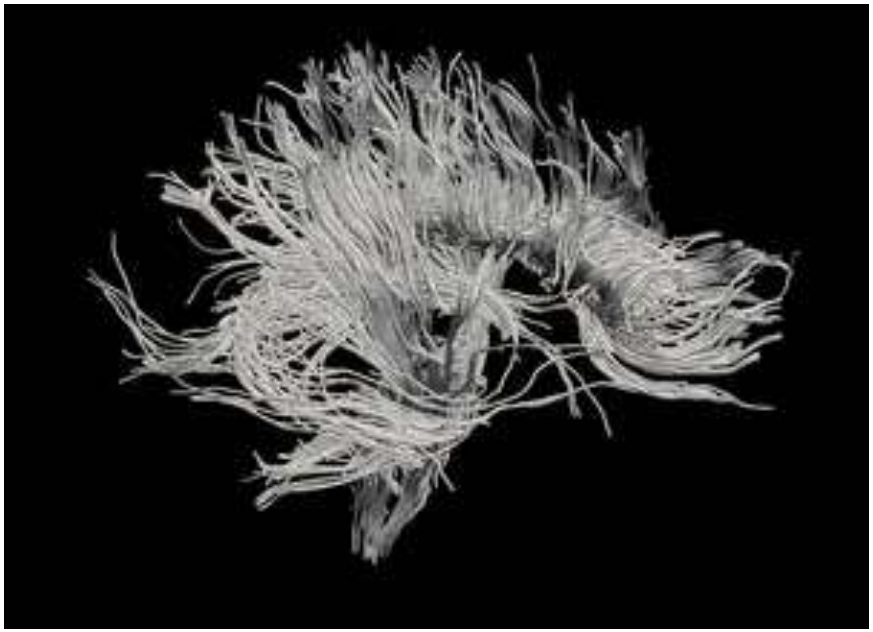
Learning Objective

The goal of this tutorial is to take you step-by-step through the process of using the fluid mechanics tractography module to do tractography on a sample tutorial dataset.



Pre-requisite

- The following tutorials are prerequisites to this tutorial:
  - Diffusion MRI Tutorial (Sonia Pujol) (http://www.slicer.org/slicerWiki/images/7/7f/DiffusionMRITutorial_Slicer3.6_SPujol.pdf)
  - Neurosurgical Planning Tutorial (Danielle Pace, Isaiah Norton, Haiying Liu)

Material

- This tutorial requires the installation of the **Slicer3.6 release** and the tutorial dataset. They are available at the following locations:

- **Slicer3.6** download page

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

- **Tutorial dataset**: Data from Neurosurgical planning tutorial

Disclaimer: *It is the responsibility of the user of Slicer to comply with both the terms of the license and with the applicable laws, regulations, and rules.*

Module Code

- This code is not currently available as part of the stable Slicer 3.6 release.
- To get the module code:
  - Download the experimental branch, Slicer3.6-hagemanFMTractography, from the Slicer 3 svn and run getbuildtest.tcl script (preferred) OR
  - Download the code from the NAMIC sandbox, branch – FluidMechanicsTractography/Source, and build using the instructions (BuildInstructions.txt) in the Documents directory.

Platform

- This tutorial has been developed and tested on a MacBook Pro (2.6 GHz Intel Core 2 Duo, 2 GB RAM), running OS X.

Dataset

- The dataset used is identical to the dataset used in the neurosurgical planning tutorial.
- Any other tensor dataset in the proper format should be acceptable.

Input

- Tensor volume dataset in NRRD format
- Fluid Source ROI: mask volume that specifies the fluid source and seeds the tract reconstruction.
- Tract Select ROI (optional): mask volumes that reconstruct only those tracts that intersect it.
- Fluid and tractography constants that influence the tract reconstruction.

Output

- vtk file of the reconstructed tracts that can be viewed within Slicer.
- series of ucf files (single ucf file = 1 tract) that can be visualized using LONI software (i.e. Brainsuite).

Requirements

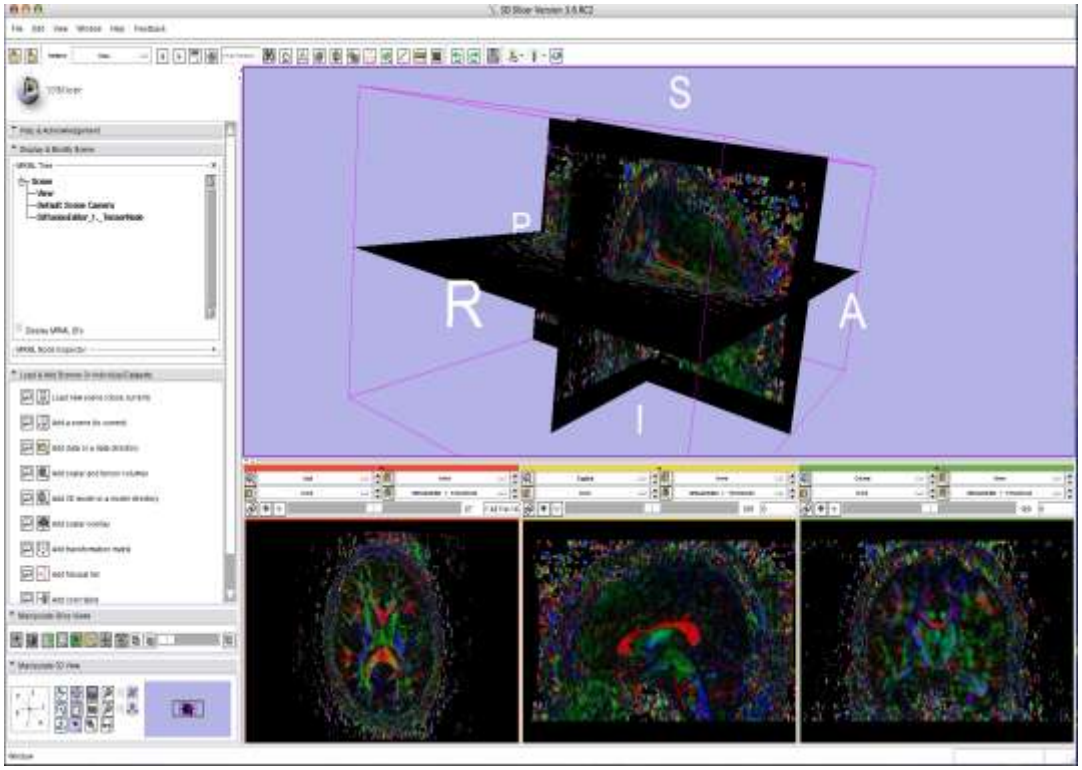
- All volumes (tensor and mask volumes) must be in NRRD format.
- Only a single fluid source ROI mask volume can be used.
- Only a single tract select ROI mask volume can be used

Overview

- Part 1: Load Data
- Part 2: Create Fluid Source and Sink Masks
- Part 3: Run Tractography
- Part 4: Load and Display Tract Data

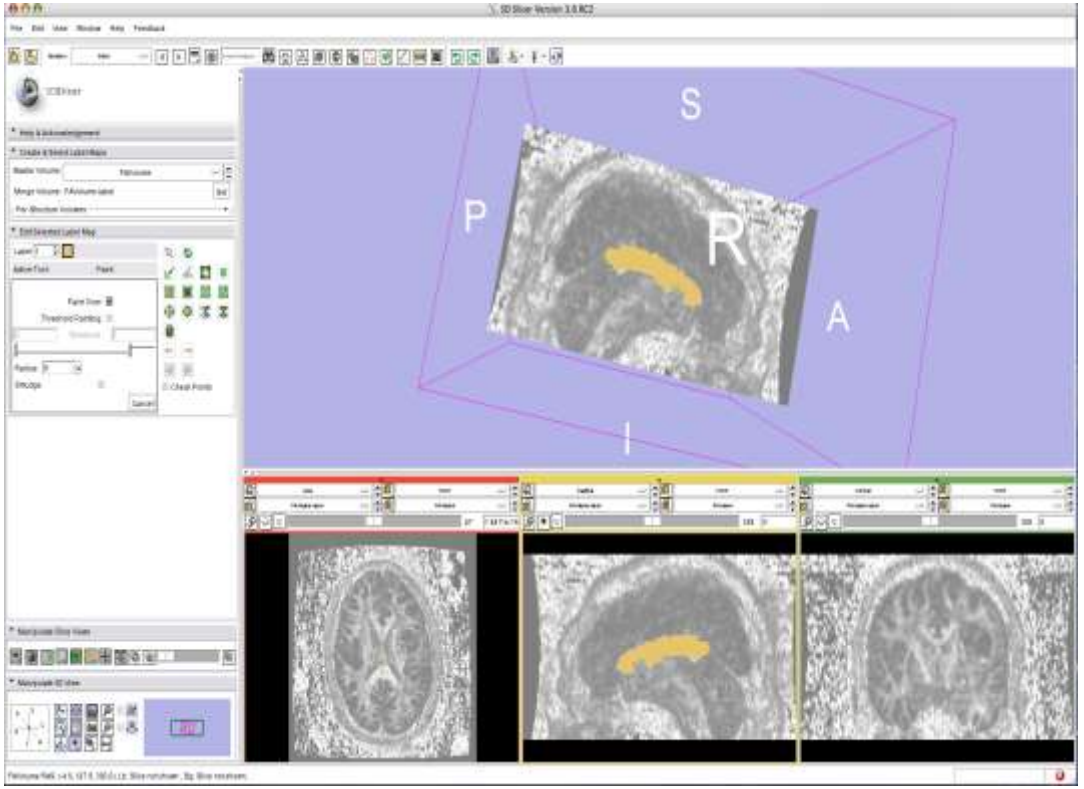
Part 1: Load Data

1. Open the Data Module
2. Click “Add scalar and tensor volumes”
3. Choose DiffusionEditor_1._TensorNode .nrrd [the tensor data volume]
4. Click “Add scalar and tensor volumes”
5. Choose FAVolume.nrrd [the FA volume]



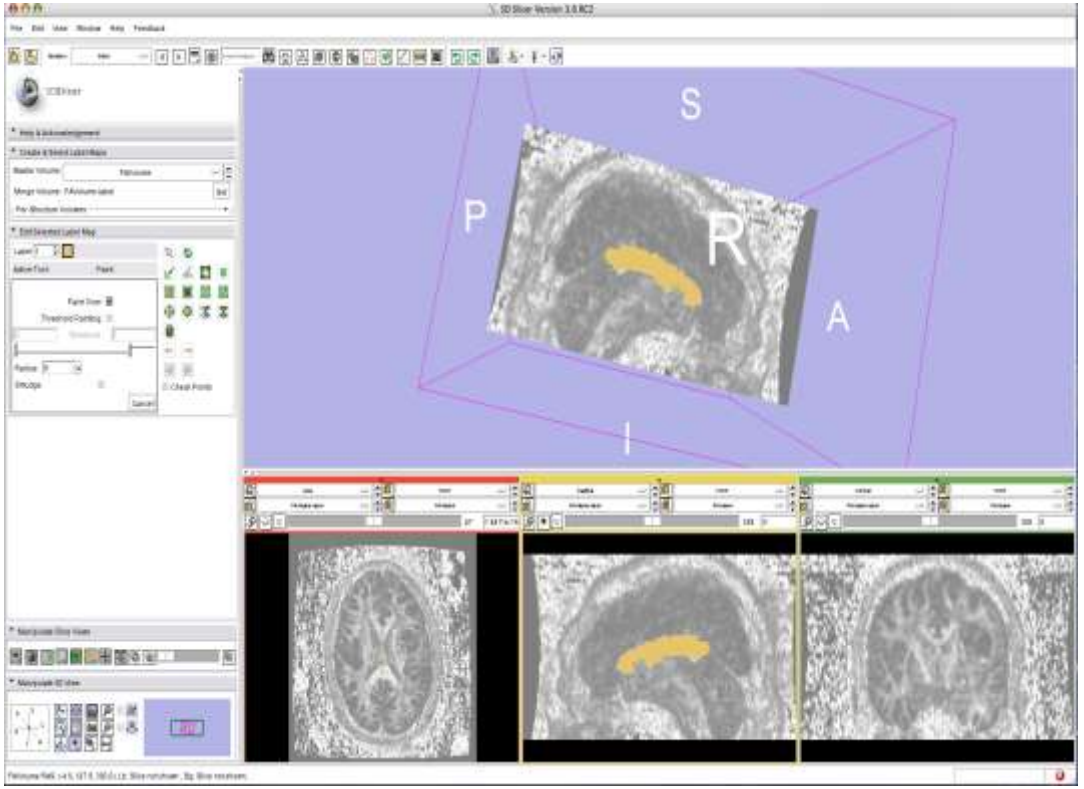
Part 2: Create Masks

1. Choose Editor Module.
2. Select the FA volume in the Master Volume field.
3. Choose an appropriate paint tool and label number.
4. Paint a region in the FA volume that you wish to pick as a fluid source [Hint: this region should be somewhere within the middle of the WM tract].
5. Save out the fluid source mask in NRRD format.
6. Erase current label.



Part 2: Create Masks

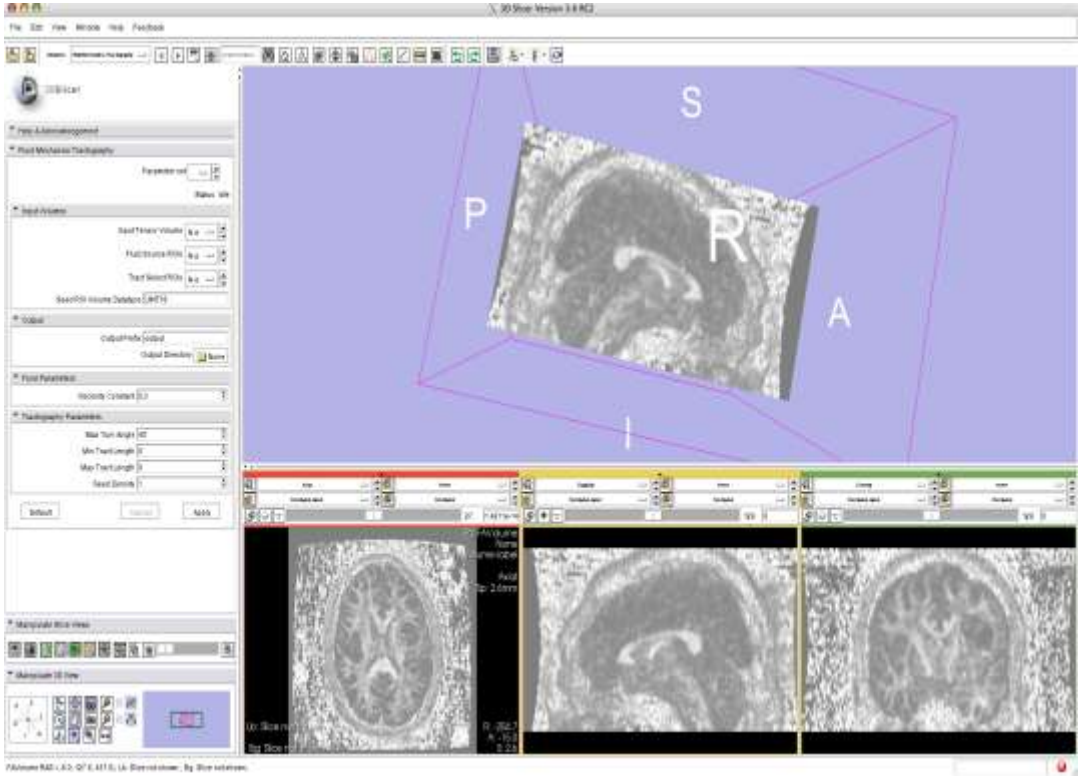
1. Choose Editor Module.
2. Choose an appropriate paint tool and label number.
3. Paint a region in the FA volume that you wish to pick as an ROI through which the tracts must pass. [Hint: this region should be some distance from the fluid source].
4. Save out the tract selection mask in NRRD format.
5. Erase current label.
6. Open the Data Module and load both the fluid source and tract select mask volumes.



Note: Creating a ROI for tract selection is an optional step.

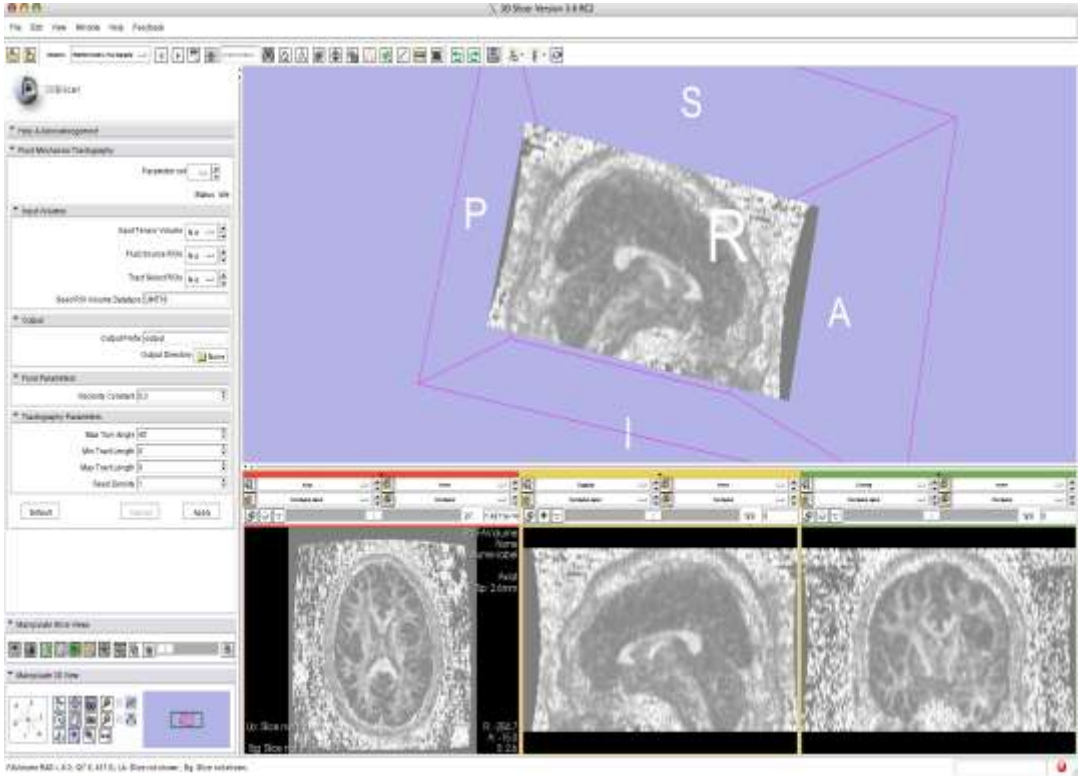
Part 3: Run Tractography

1. Open Diffusion -> Tractography -> Fluid Mechanics Tractography
2. Choose DiffusionEditor_1._TensorNode .nrrd as the Input Tensor Volume field.
3. Choose the appropriate mask volume for the Fluid Source ROI.
4. Choose the appropriate mask volume for the Tract Select ROI, if one is desired.
5. Choose the common datatype of the mask volumes.



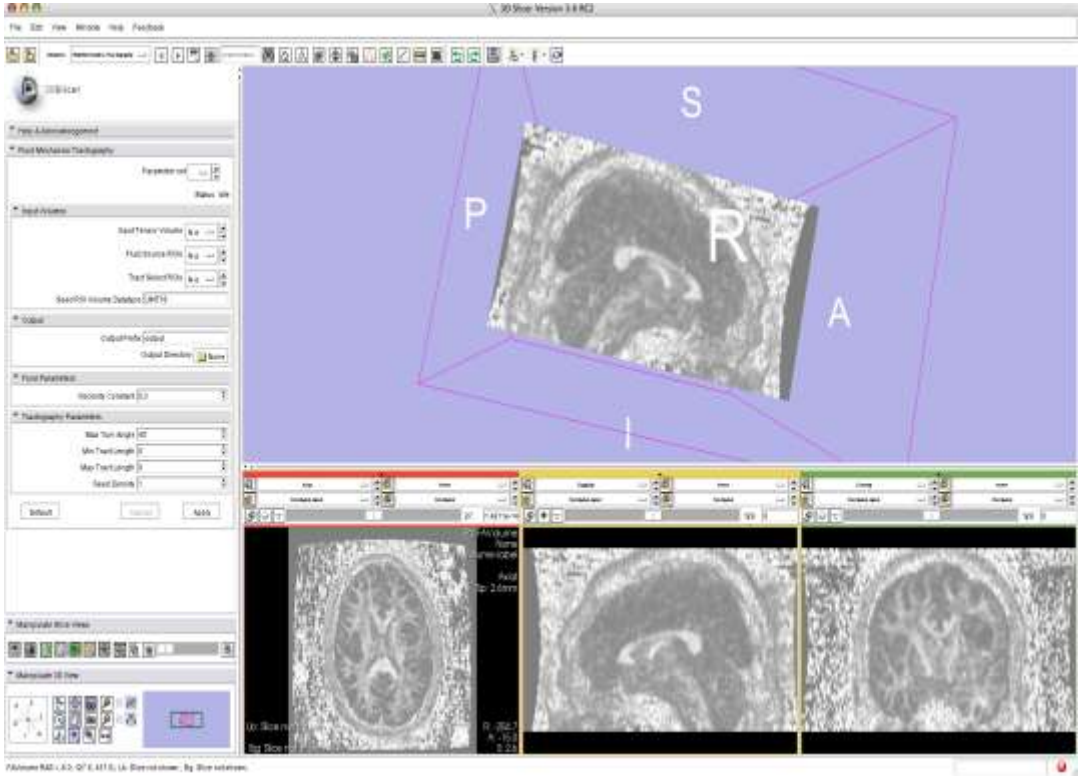
Part 3: Run Tractography

1. Choose an appropriate filename prefix for the tracts that would be generated [this prefix will be prepended to all UCFs and the vtk file generated].
2. Choose a directory to which to output the tracts.
3. Choose a constant that will control the magnitude of the fluid viscosity that flows from the source from 0 (no viscosity) to 1 (maximum viscosity/minimal flow) [Hint: the default (0.3) is a good starting point. Then, adjust if necessary].



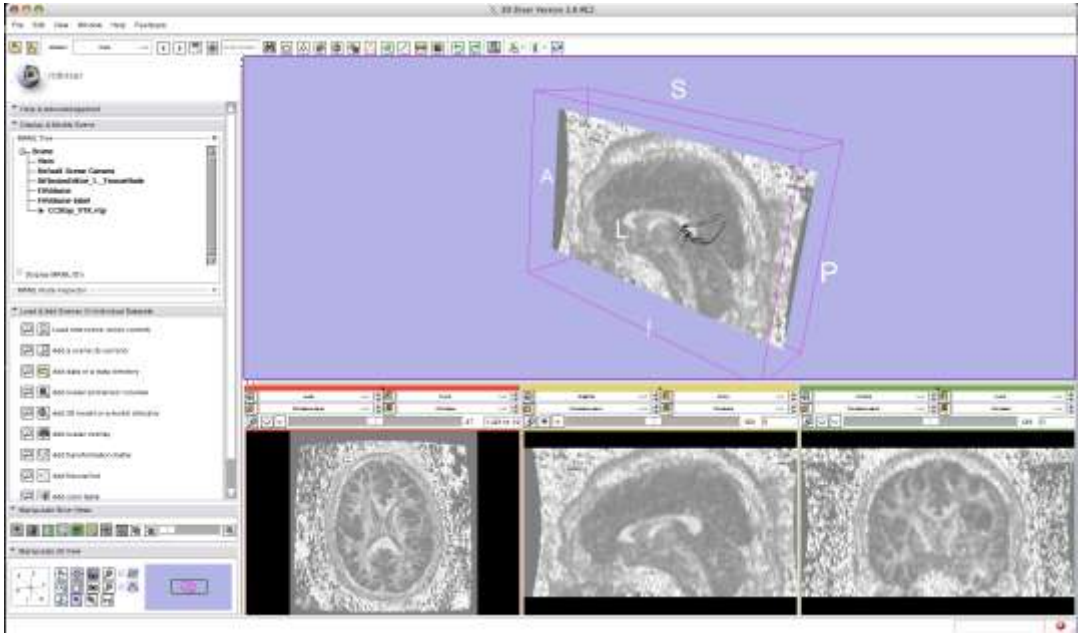
Part 3: Run Tractography

1. Choose the tractography parameters to put constraints on the geometry of the tracts generated from the fluid velocity vector field.
2. Choose a maximum turn angle (from 0 - 180 degrees) to limit the local bending of the fiber tracts.
3. Choose a maximum and minimum tract length to control the length of the tracts generated.
4. Specify the density of seed points that will be chosen randomly from the fluid source ROI to generate tracts (must be greater than 1).
5. Click Apply to run the module.



Part 4: Display Tracts

1. Open Data Module
2. Choose “Add data or a data directory.”
3. Choose appropriate vtp file.
4. Check Fiber Bundle box.



The UCF files generated can be used with the LONI tools.

Conclusion

We have demonstrated how we can use the fluid mechanics tractography module on a sample dataset to generate specific WM tracts. The steps in this tutorial can be repeated to do tractography in any WM region simply by using different masks.

Acknowledgments

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