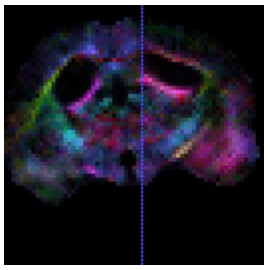
Sep 03, 2019

Creating Diffusion Tensor Images (DTI)



DOI
dx.doi.org/10.17504/protocols.io.6×2hfqe

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Protocol status: In development
We are still developing and optimizing this protocol

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Abstract

This procedure describes the steps required to create diffusion tensor images (DTI) from data from the MRI scanner.

The following programs are required to go through the protocol:

- MRtrix3
- TORTOISE
- ITKsnap

Note: If you are working from a Windows computer, you will need to follow X2Go Client Set-Up (dx.doi.org/10.17504/protocols.io.6tvhen6) before you can begin this protocol.

Troubleshooting

Set Up Directory with Required Files

1 Open a new terminal.

2 Confirm what directory you are currently in.

Command

pwd (0-58-generic #64-Ubuntu SMP)

pwd

```
pwd
```

3 Create a directory to place data. *(If not already created.)*

Command

Create directory. (0-58-generic #64-Ubuntu SMP)

mkdir

```
mkdir ~/Data/Projects/
```

4 Go to the directory that you plan to use.

Command

Go to a specified directory. (0-58-generic #64-Ubuntu SMP)

cd

```
cd
```

5 Copy directory where your raw data files that will be acquistioned, reside in.
You will need the following file types:

- Bvals
- Bvecs
- data.img
- data.hdr* - (*may not need this in all cases - used for FOV origin)*

5.1 Find where the files you plan to copy are located. *Make sure to use the original root i.e /home/... as you will get an error if you start from another location.*

Command

To list files in a specific directory. (0-58-generic #64-Ubuntu SMP)

ls

```
ls
```

5.2 Copy the specific files that you need. Alternatively, you can use **.** to specify the current directory you are in.

Command

Copy file or entire directory to a specified location. (0-58-generic #64-Ubuntu SMP)

cp

```
cp
```

6 Perform conversion between different file types.

Command

mrconvert (MRtrix3)

mrconvert

```
mrconvert
```

7 Import data from nifti format to TORTOISE list file format. A new directory will be created and the folder will be labeled **____proc**.
Example:

Command

ImportNIFTI (TORTOISE)

ImportNIFTI

```
ImportNIFTI
```

8 Go to the new directory that was created from the previous step.

9 Correct motion. Use **DIFFPREP** command. (*This is a command from TOROISE*). ***Note: This step is time & core consuming. Also, this step removes Gibbs ringing and noise***

Command

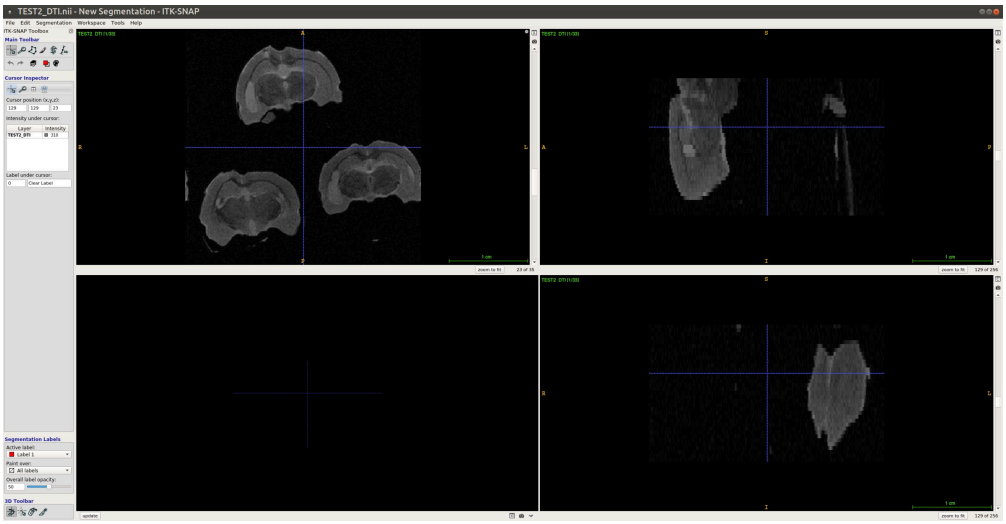
Corrects motion. (TORTOISE)

DIFFPREP

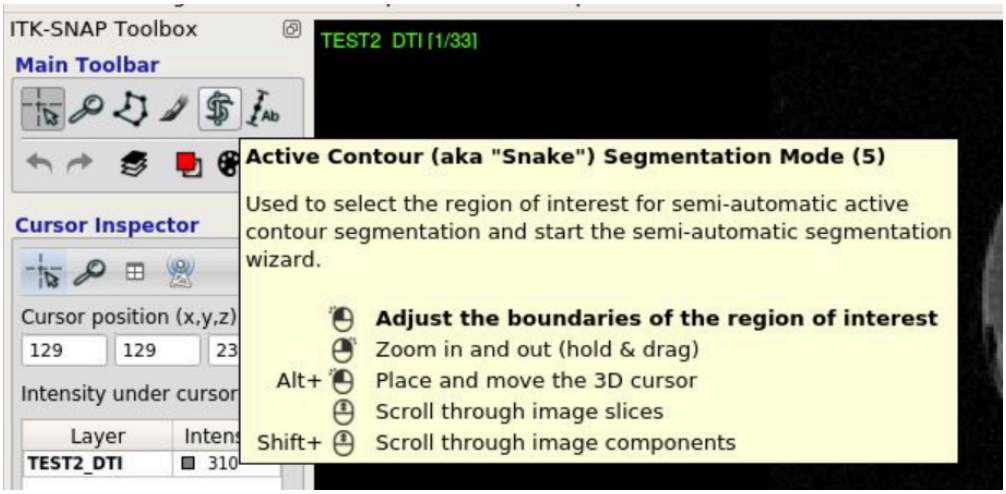
```
DIFFPREP
```

Create Mask and Segmentation

10 Open one of the populated files using ITKsnap.



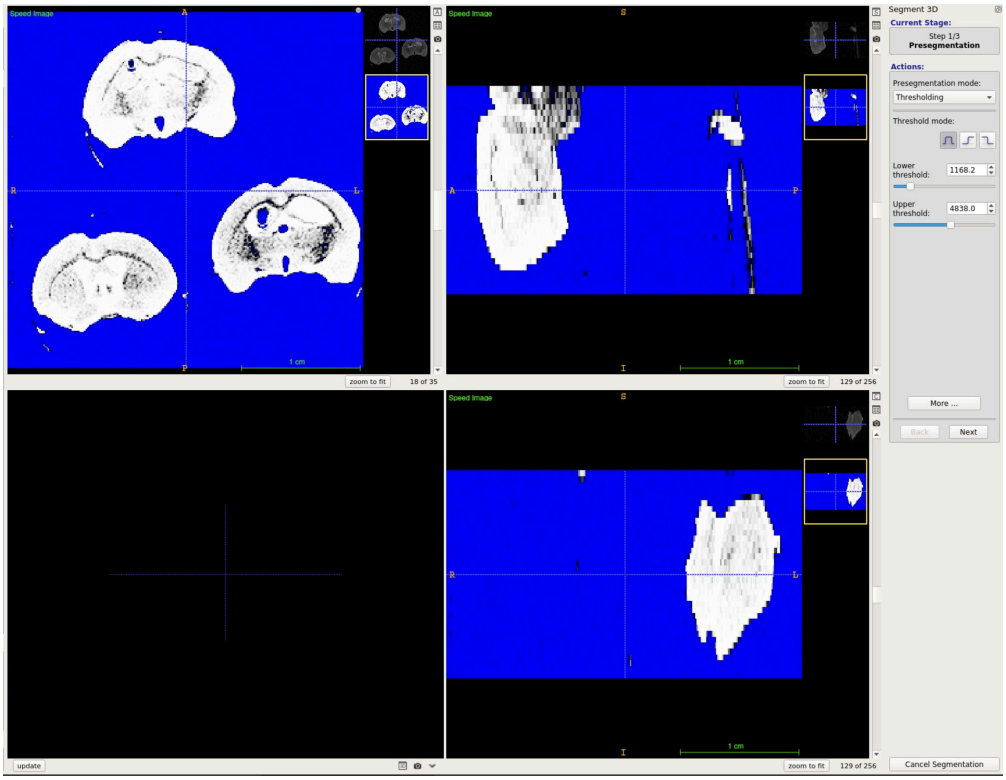
11 Within ITKsnap, select **Active Contour (aka Snake) Segmentation Mode** from the toolbar.



12 A new side window will appear. Select **Segment 3D**.

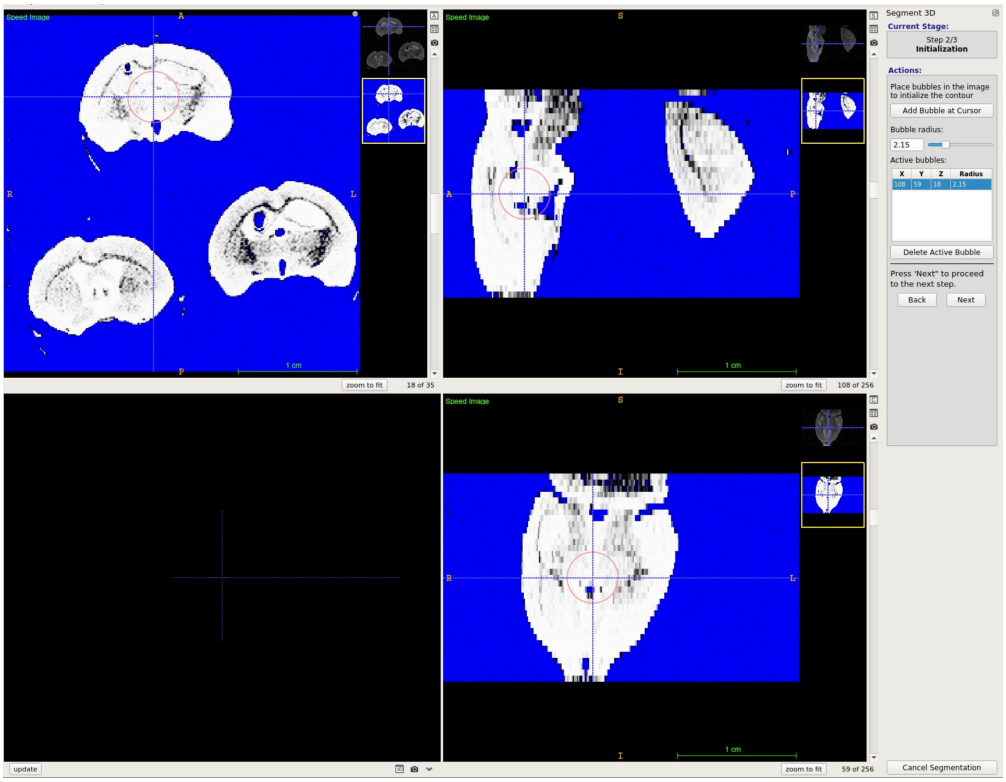

Snake Inspector
ROI for auto-segmentation:
Position (x,y,z):
1
1
1
Size (x,y,z):
256
256
35
Reset ROI
Resample ROI
Initialize with current segmentation
Segment 3D

13 Toggle the thresholds (lower & upper) so that the blue mask covers the region you want repelled. (*Regions that are empty space or not the brain of interest should have this mask*). ***Note: Try not to change the defaults.***



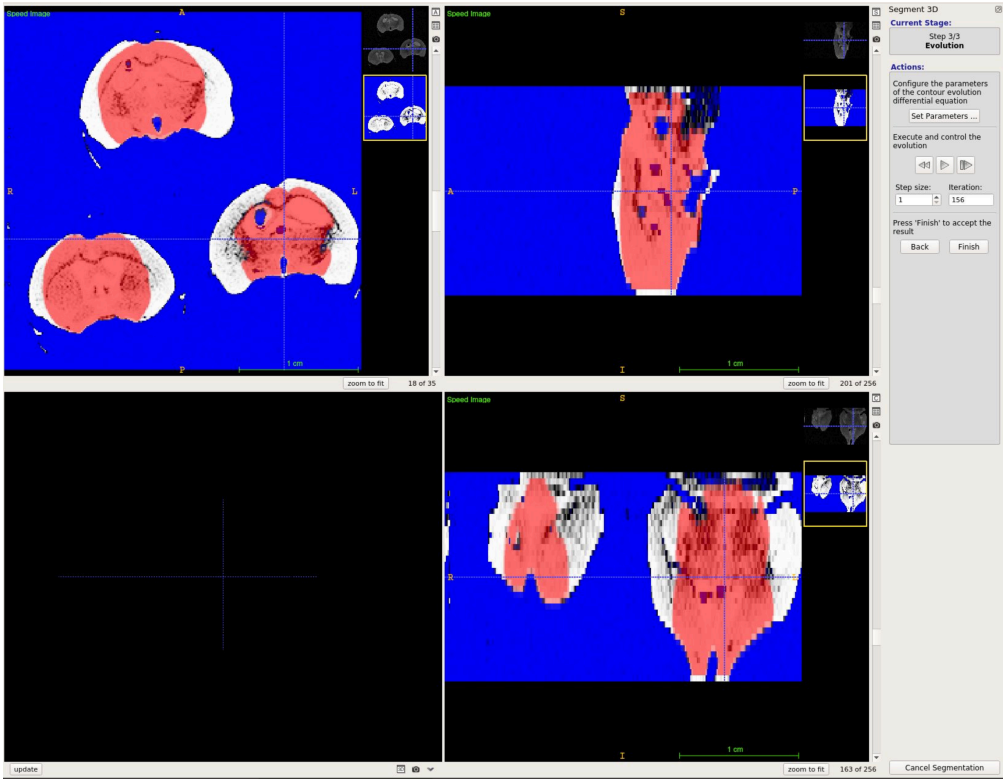
14 When the thresholds have been finalized, select **Next**.

15 Set the cursor in the relative center of your object of interest. Select **Add bubble at cursor**. A red circle(seed/bubble) will be placed at the location.
Note: You may need to repeat this if you have multiple objects of interest.

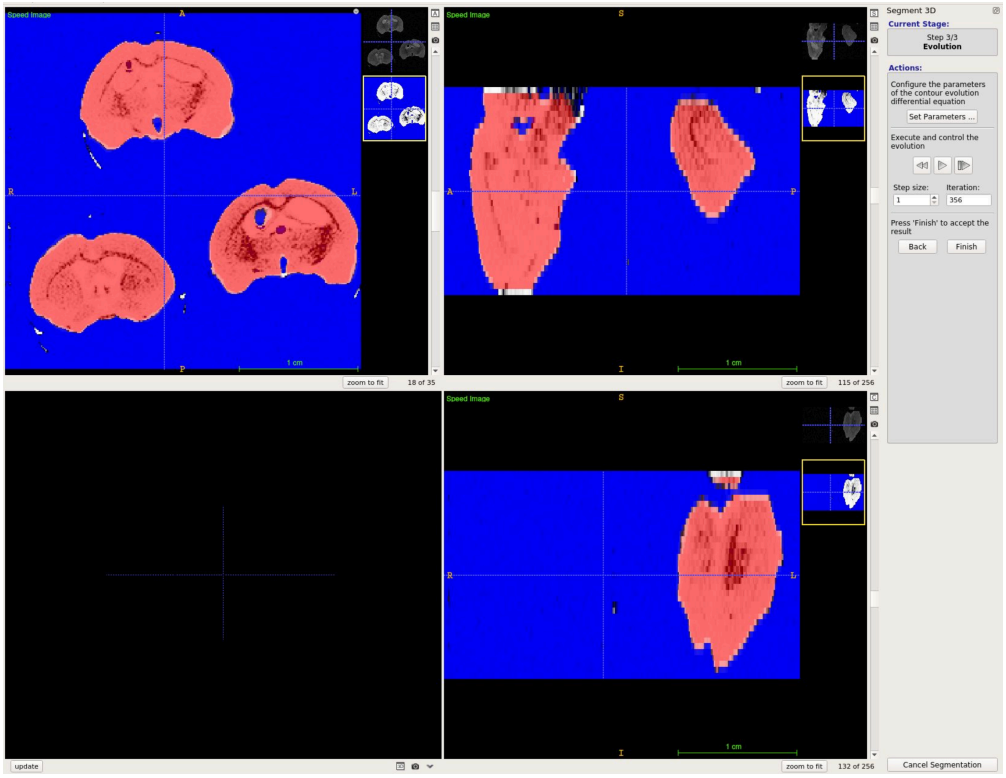


16 When the bubbles have been set and you have no more to add, select **Next**.

17 Press the play buton to have the seed grow within the mask that was set-up in a previous step. ***Note: Red should propagate and fill the entire region(s) of interest. This may require viewing the images from the different planes to confirm.***

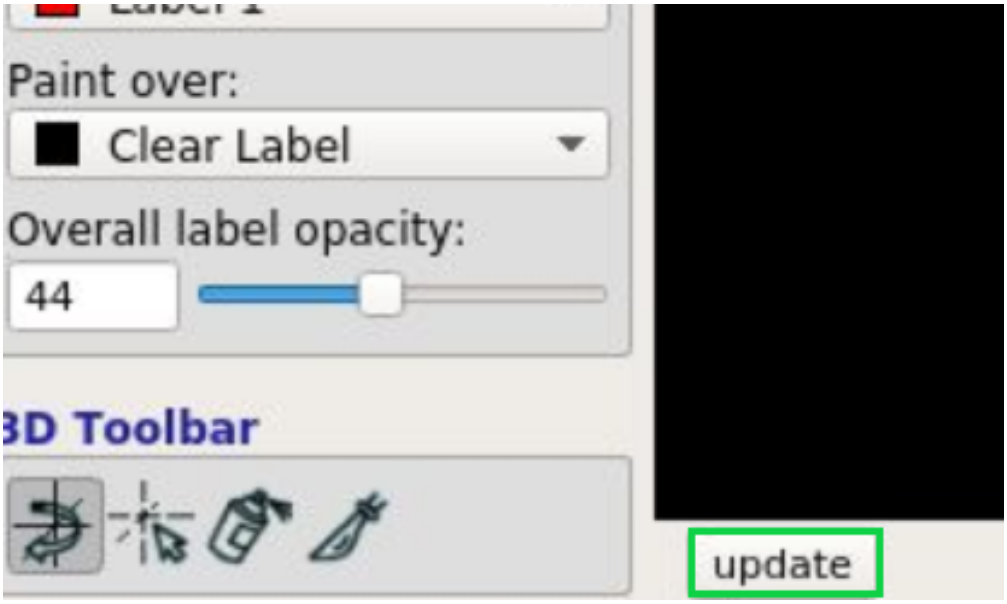

Speed Image
Segment 3D
Current Stage:
Step 3/3
Evolution
Actions:
Configure the parameters of the contour evolution differential equation
Set Parameters ...
Execute and control the evolution
Step size:
Iteration:
Press 'Finish' to accept the result
Back
Finish
Cancel Segmentation

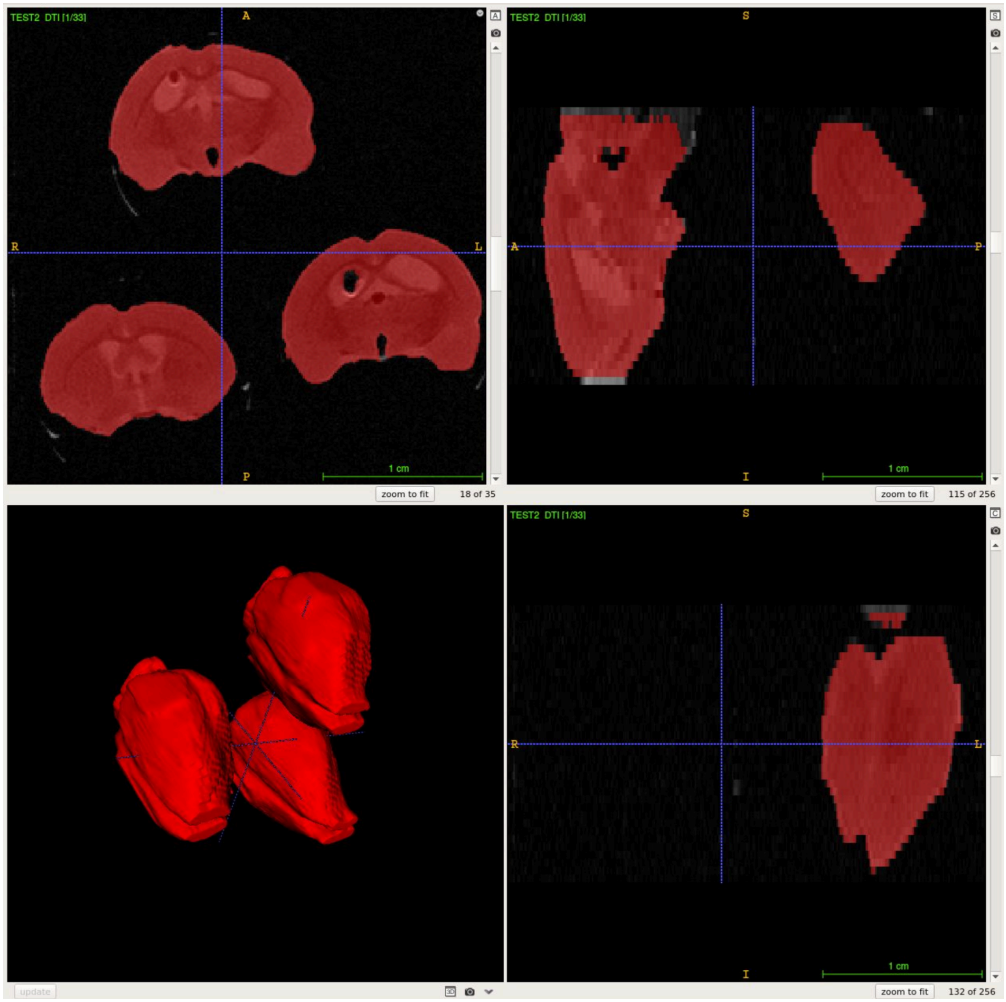
18


Speed Image
Segment 3D
Current Stage:
Step 3/3
Evolution
Actions:
Configure the parameters of the contour evolution differential equation
Set Parameters ...
Execute and control the evolution
Step size:
Iteration:
Press 'Finish' to accept the result
Back
Finish
Cancel Segmentation

Once the region(s) of interest are completely filled, select **Finish.**

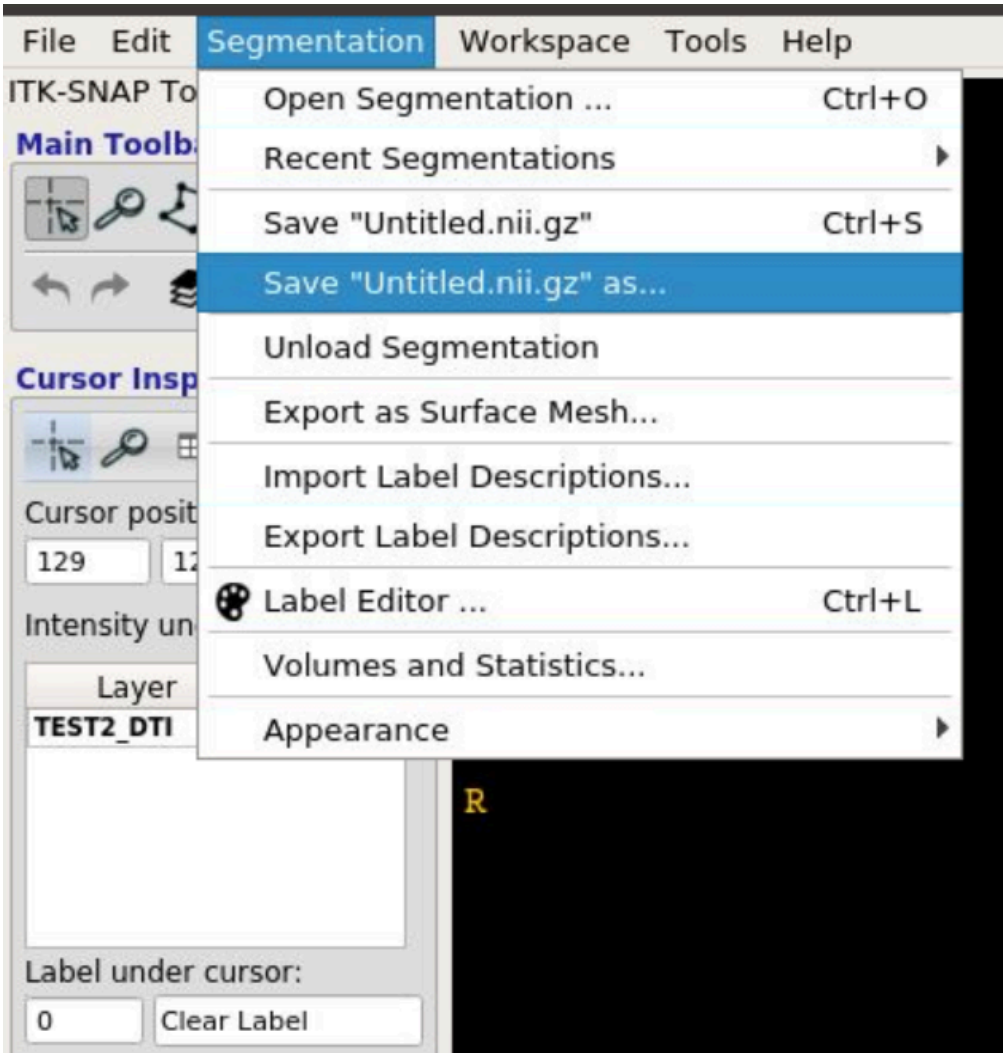
19 Press **Update** in the lower left corner of the ITKsnap interface to view the new 3D segmentation image.





20 Select **Segmentation** and **Save As** from the drop-down menu. You will be prompted to save your file as a **__.nii.gz** file type.

It is recommended you name your file __mask to clarify segmentation has already been performed.



21 Close out of ITKsnap.

22 In an open terminal, unzip the **___.nii.gz** file that was segmented in the previous step.

Command

Unzip file(s) of interest.

gunzip

```
gunzip  ___.nii.gz
```

23 Estimate diffusion tensor and Bo amplitude.

Command

Generates diffusion tensor and B0 amplitude. (TORTOISE)

EstimateTensorNLLS

```
EstimateTensorNLLS -i ___DTI_DMC.list -m ___mask.nii
```

This command will generate 2 files:

- **___N1_DT.nii** (diffusion tensor)
- **___DT_AM.nii** (B0 amplitude)

24 Compute all tensor maps on the **___N1_DTI.nii** output file from the previous step.

Command

Computer all tensor maps. (TORTOISE)

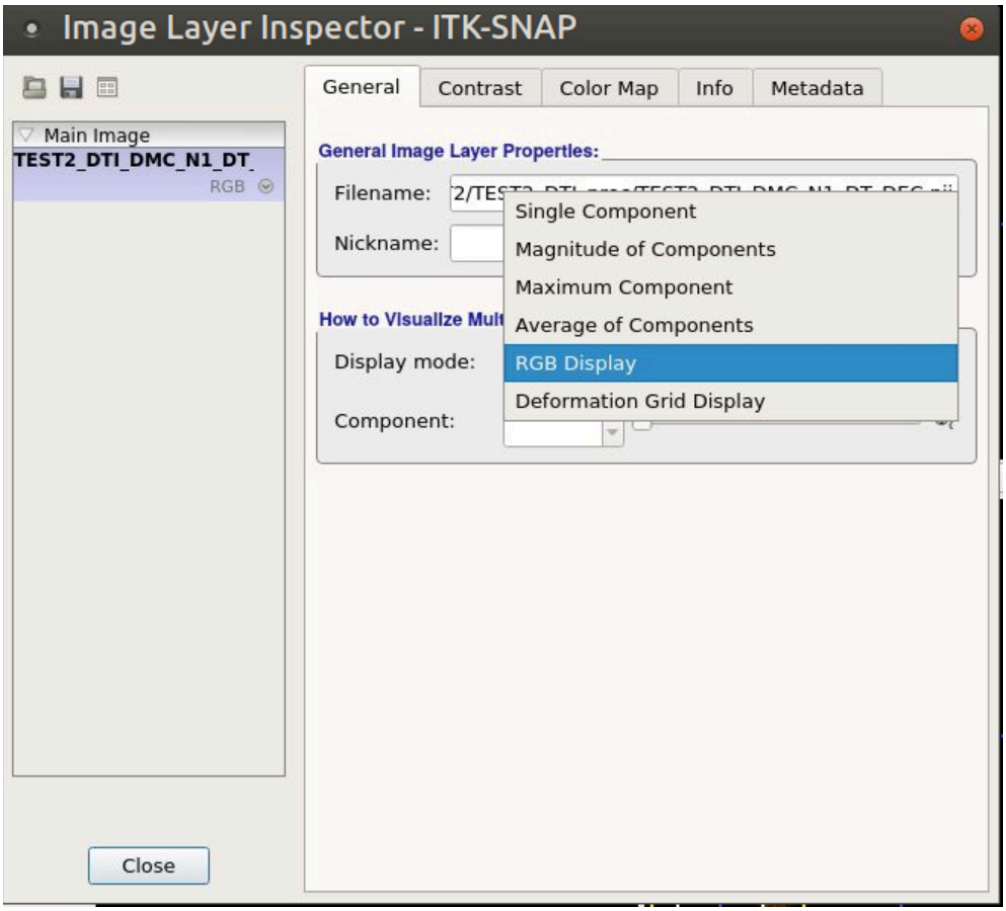
ComputeAllTensorMaps.bash

```
ComputeAllTensorMaps.bash  ___N1_DT.nii
```

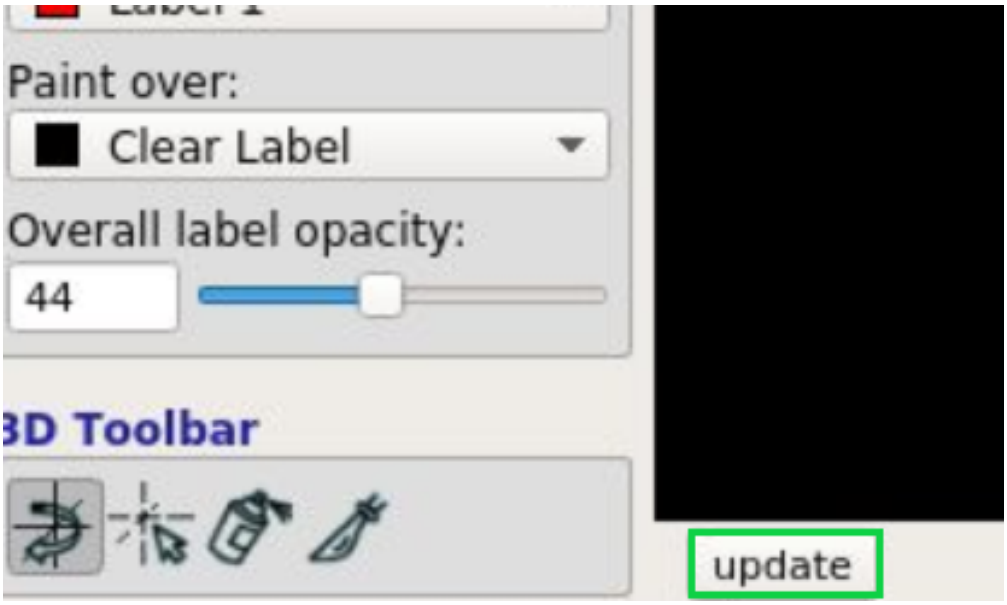
25 Open the **___DEC.nii** output file in ITKsnap to view the primary eigenvector map.

26 Within ITKsnap, select **Layer Inspector**.

27 From the **Layer Inspector** window, select the **Display mode** drop-down menu and select **RGB Display**.



28 Press **Update** in the lower left corner of the ITKsnap interface to view the image in the new display mode.



29 The final result will show a colorized image of your region of interest that allows a visual guide that estimates location, orientation, and anisotropy of the brain's white matter tracts based on the diffusion of water molecules.