



NA-MIC

*National Alliance for Medical Image Computing*

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# White Matter Lesion Segmentation

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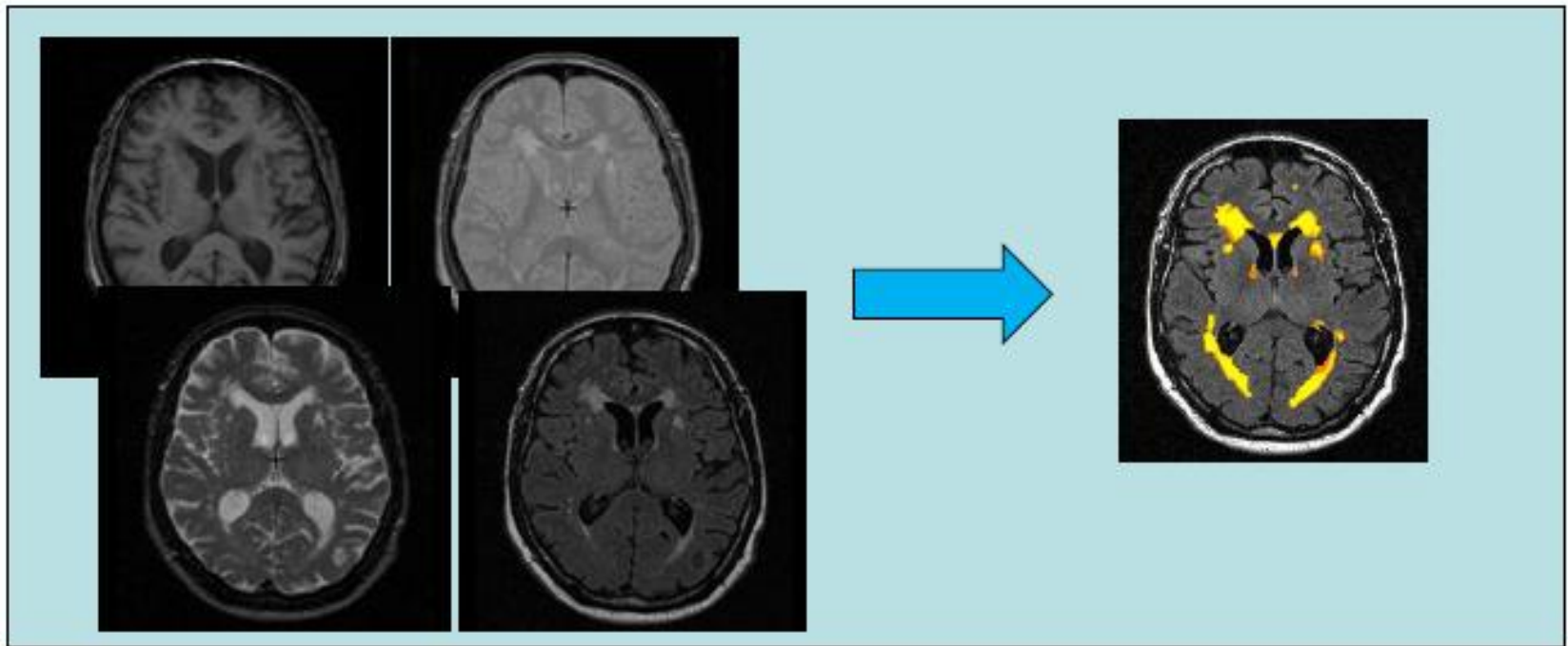
NA-MIC Tutorial Contest: Summer 2010

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# Learning Objective

Learn how to run “White Matter Lesion Segmentation” module in Slicer 3.





# Pre-requisite

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- Data Loading and Visualization (Sonia Pujol, Ph.D.)
  - <http://www.na-mic.org/Wiki/index.php/Slicer3.2:Training>



# Material

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- This tutorial requires **Slicer3.6 (release version)** and the tutorial dataset. They are available at the following locations:
- **Slicer3.6** download page  
<http://www.slicer.org/pages/Downloads/>
- **Tutorial dataset:**  
[http://wiki.na-mic.org/Wiki/index.php/File:White\\_Matter\\_Lesion\\_Segmentation\\_TutorialContestSummer2010.zip](http://wiki.na-mic.org/Wiki/index.php/File:White_Matter_Lesion_Segmentation_TutorialContestSummer2010.zip)

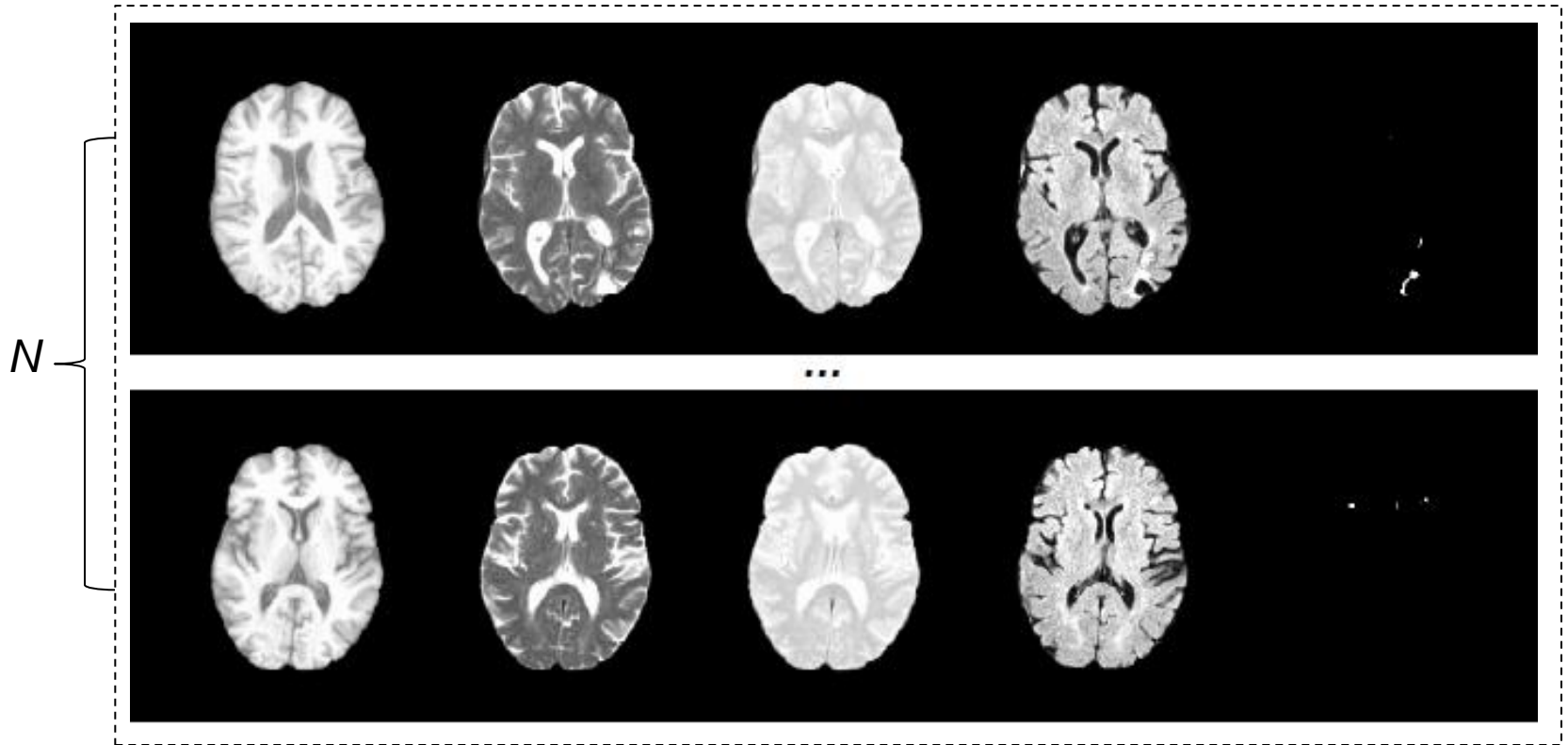
**Disclaimer:** *It is the responsibility of the user of Slicer to comply with both the terms of the license and with the applicable laws, regulations, and rules.*



# Material: Sample Data

- Training data

*Input:  $N$  training images (T1, T2, PD, FLAIR, lesion ROI)*



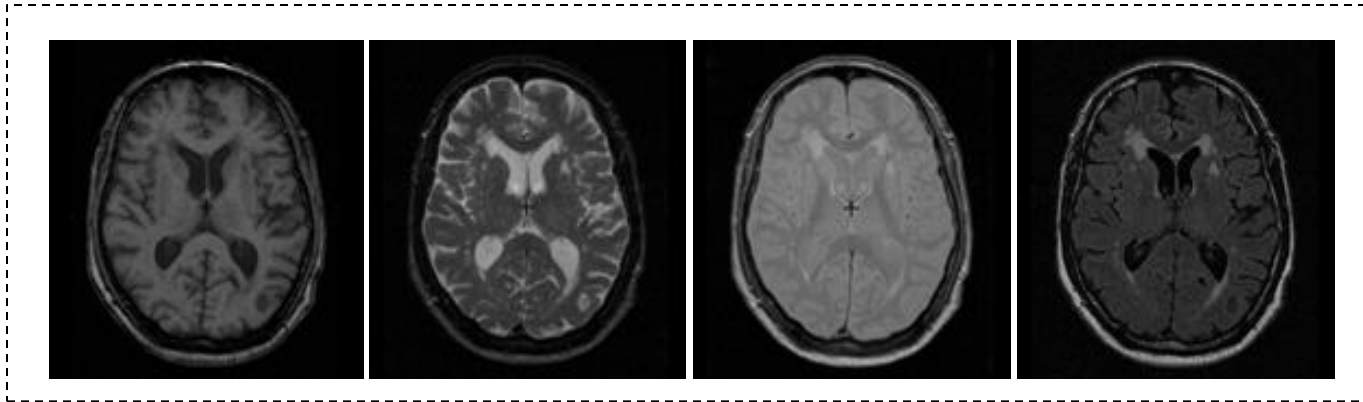


# Material: Sample Data

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- Testing data

*Input: testing image (T1, T2, PD, FLAIR)*





# Platform

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- This tutorial has tested on a Linux (64 bit) machine.



# Overview

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- **Introduction**
- Getting started
- Pipeline 1 - Training & Segmentation only
- Pipeline 2 - Preprocessing, Training, and Segmentation
- Conclusion

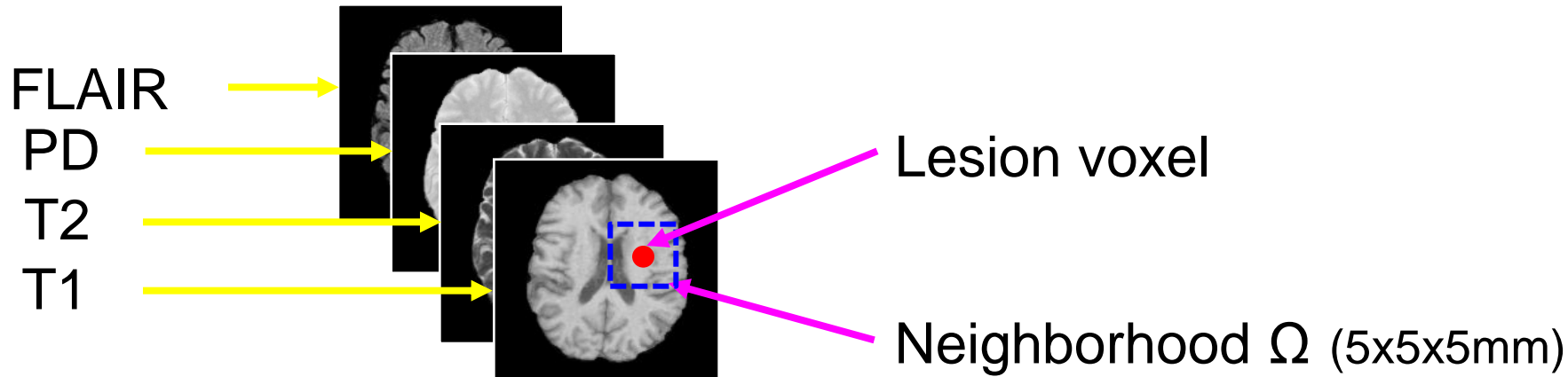




# Introduction

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- Learning based WML segmentation



$$F(v) = \{I(t_m) \mid t_m \in \Omega(v_m), m \in \{T_1, T_2, PD, FLAIR\}\}$$

- SVM → To train a WML segmentation classifier.
- Adaboost → To adaptively weight the training samples and improve the generalization of WML segmentation method.



# Overview

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- Introduction
- **Getting started**
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- Pipeline 2 - Preprocessing, Training, and Segmentation
- Conclusion



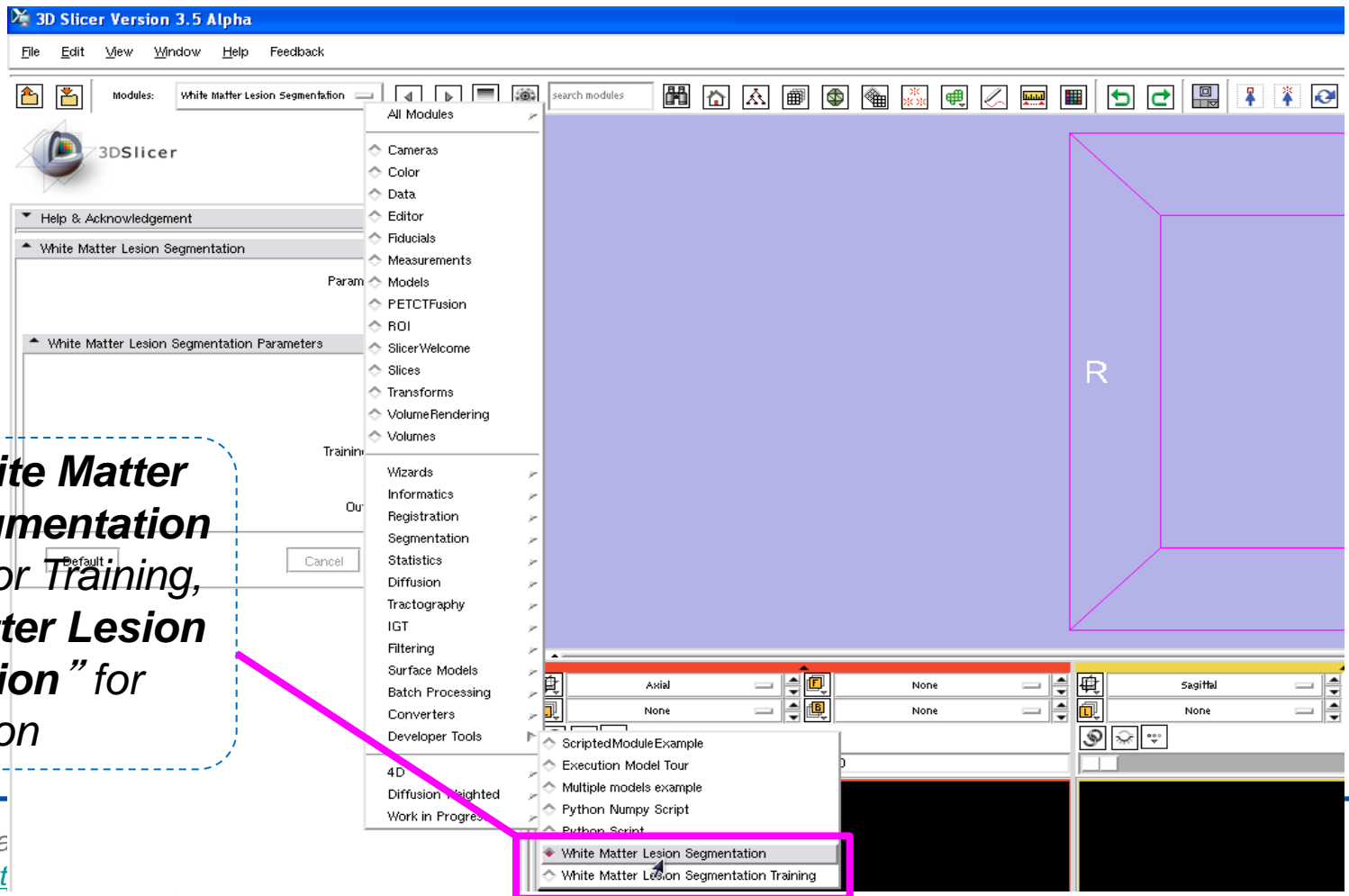
# Getting started

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- Module installation
  - Press F2 or go to View >> Application Settings >> Module Settings on the menu of Slicer3.
  - Click the “add a preset” button.
  - Select the location of the White Matter Lesion Segmentation modules (*wmlstrain* and *wmlstest*).
  - Close Slicer3 and restart.



- Execution



Select **“White Matter Lesion Segmentation Training”** for Training, **“White Matter Lesion Segmentation”** for Segmentation



# Overview

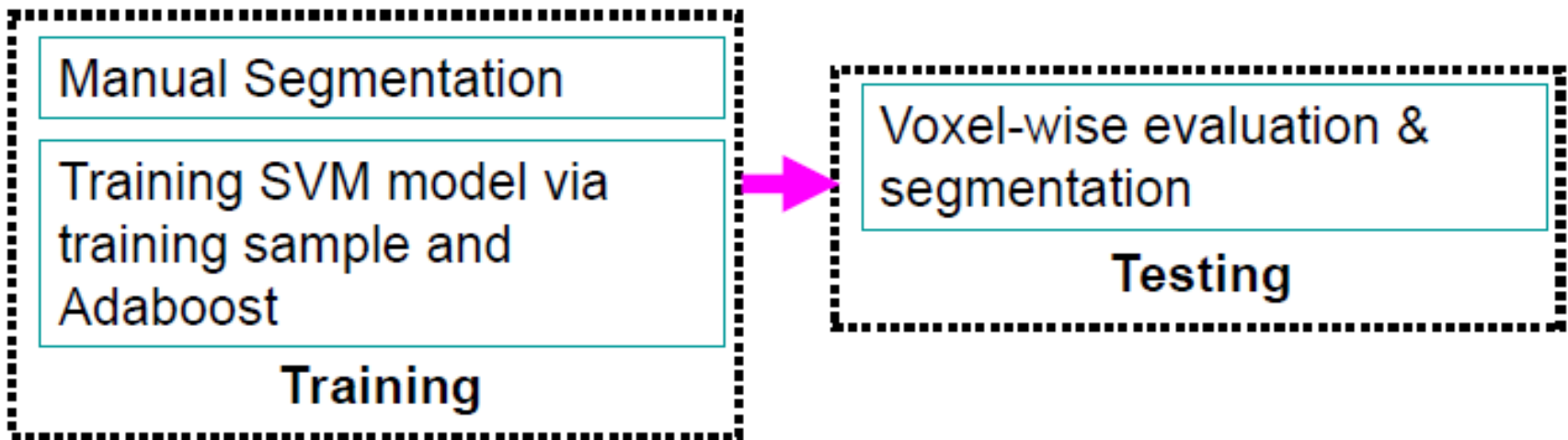
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- Introduction
- Getting started
- **Pipeline 1 - Training & Segmentation only**
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- Conclusion



# Pipeline 1 (w/o Preprocessing)

- In case your images are already preprocessed...



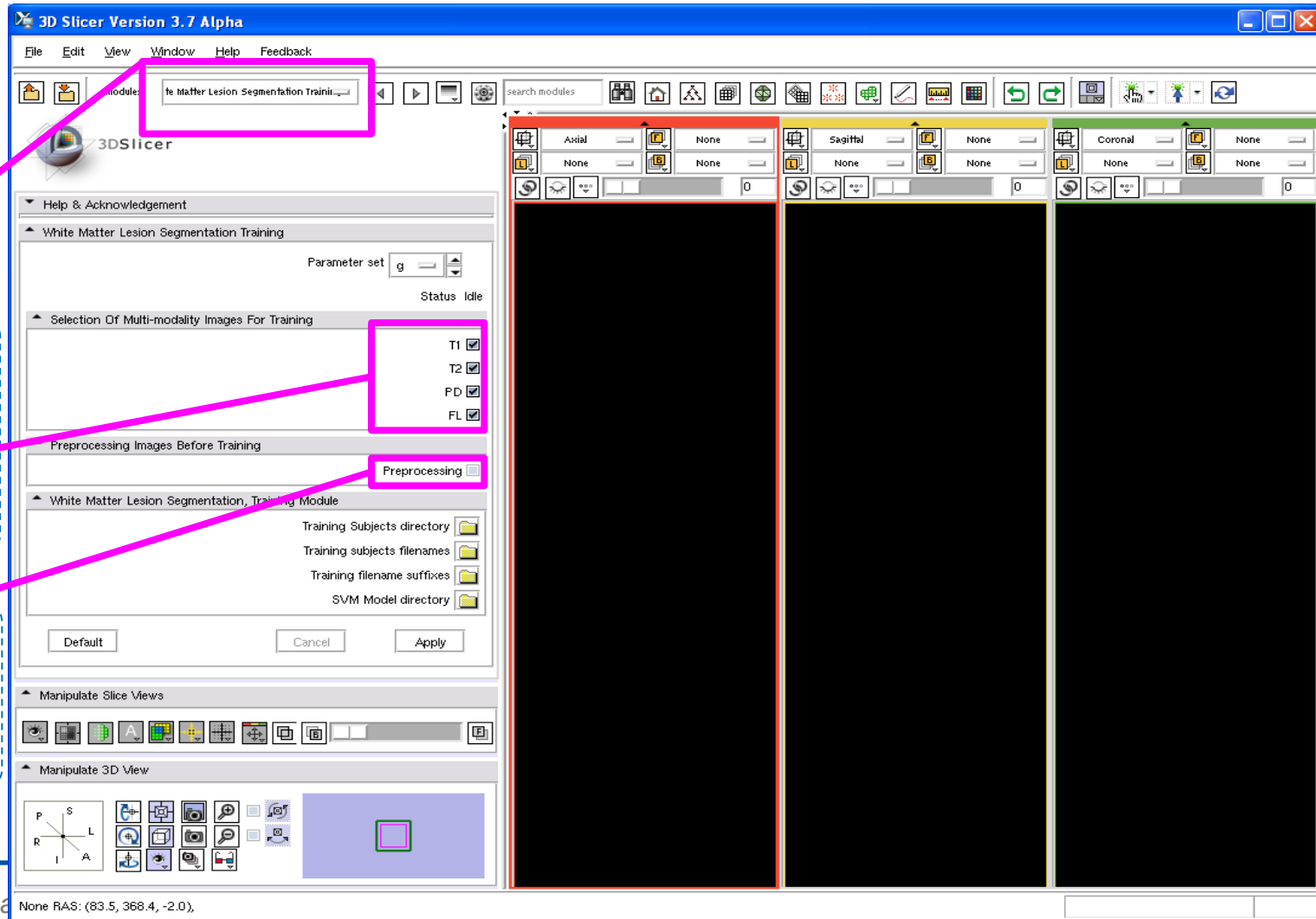


# Training

Select "White Matter Lesion Segmentation Training"

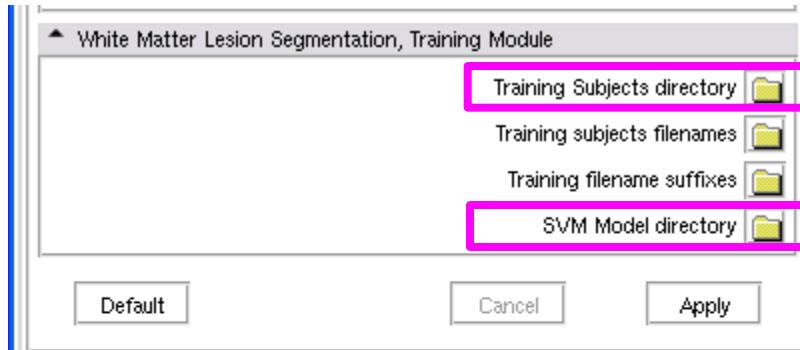
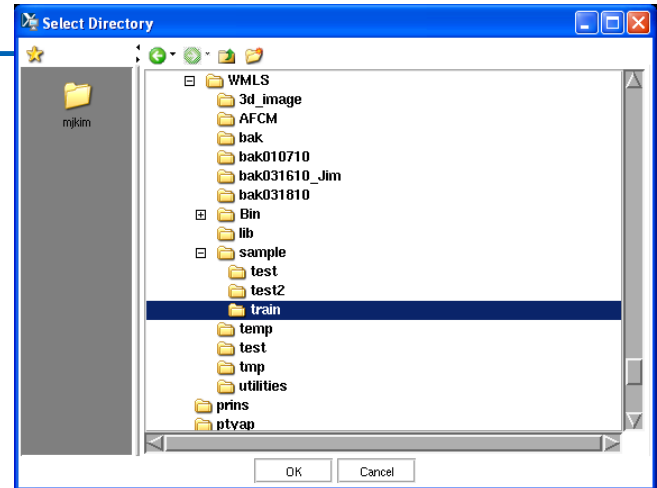
Check image modalities you want to train, e.g. T1, T2, PD, and FLAIR

DO NOT check this box to skip preprocessing

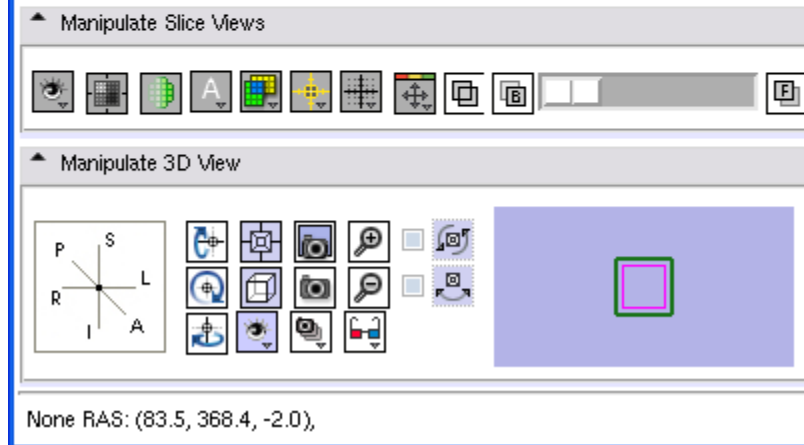
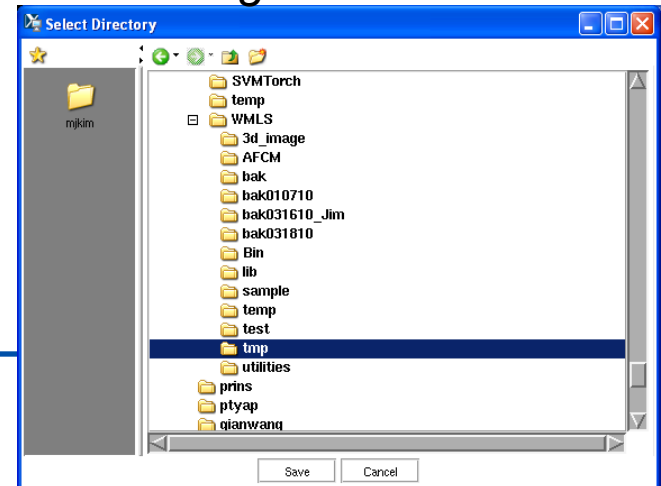




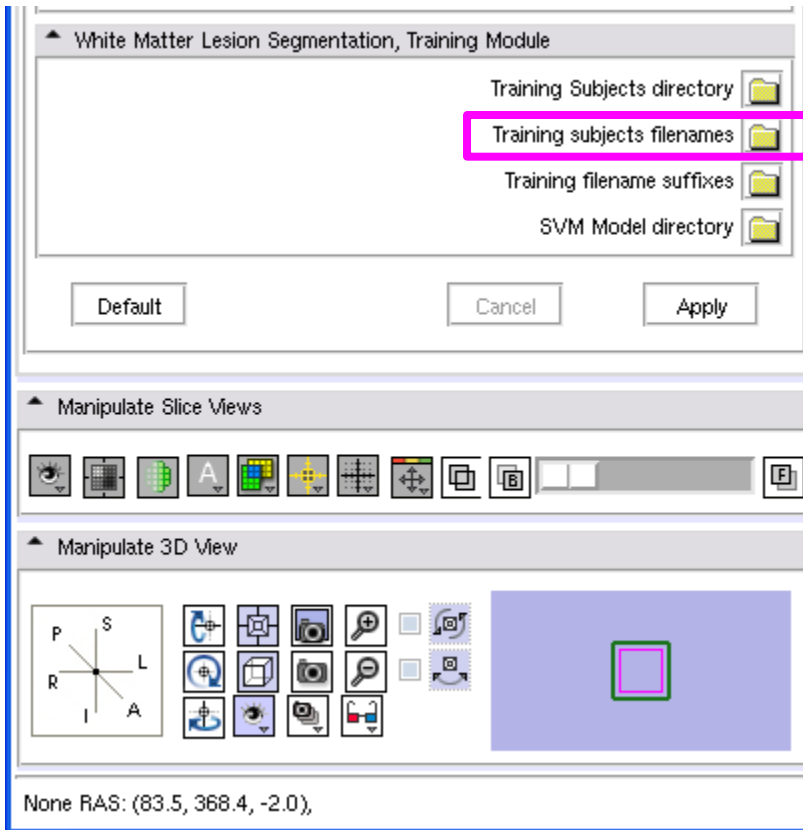
*Click and select the location containing training images*



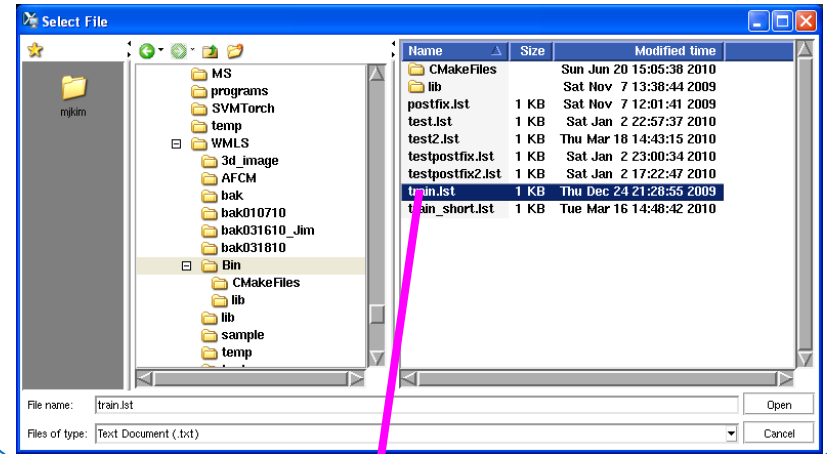
*Click and select the location where SVM model will be saved after training*







*Click and select the text file containing the list of filenames of training images*

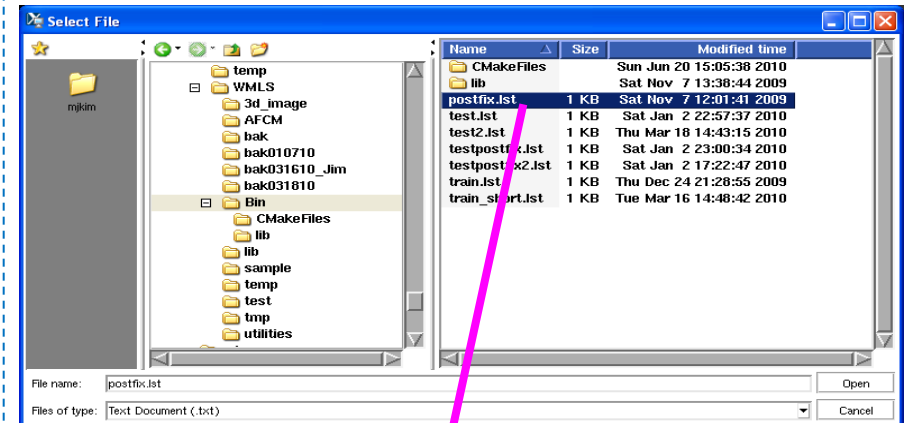
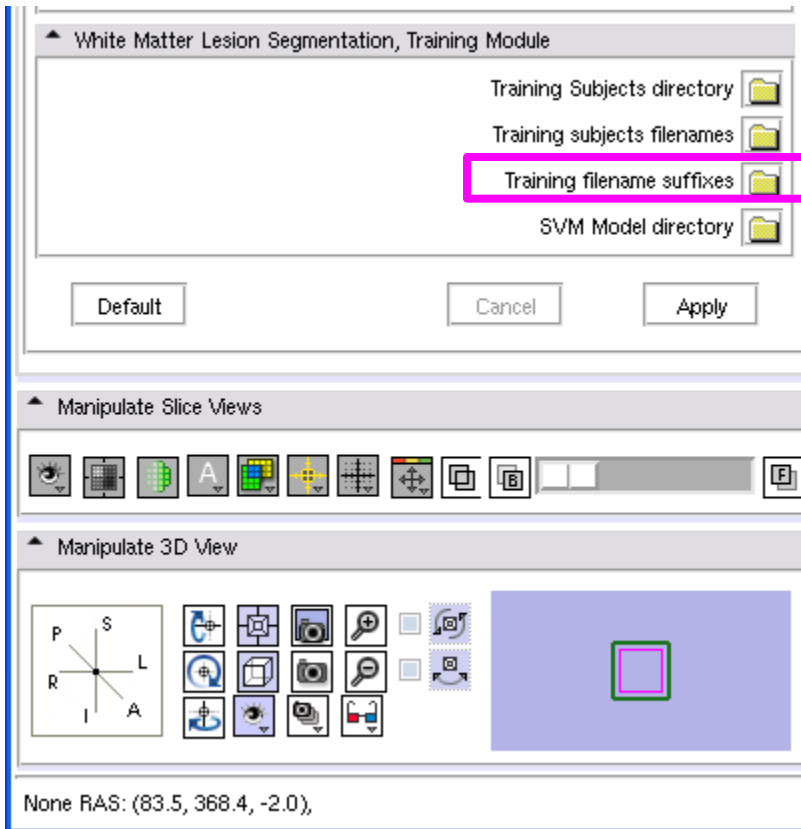


Example)

```
303D20268
305D40291
301D00368
303D20146
604H30067
303D20258
303D20153
302D10226
303D20114
```



Click and select the file containing the list of prefixes of training images



Example)

```
.T1.byte.cbq.match.smooth.hdr  
.T2.byte.cbq.match.smooth.hdr  
.PD.byte.cbq.match.smooth.hdr  
.FL.byte.cbq.match.smooth.hdr  
.lesion.mask.hdr  
.lesion.mask.open.hdr  
.lesion.premask.hdr
```



3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: White Matter Lesion Segmentation Training

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation Training

Parameter set: g

Status: Idle

Selection Of Multi-modality Images For Training

- T1
- T2
- PD
- FL

Preprocessing Images Before Training

Preprocessing:

White Matter Lesion Segmentation, Training Module

Training Subjects directory: train

Training subjects filenames: train.lst

Training filename suffixes: postfix.lst

SVM Model directory: tmp

Default Cancel Apply

Manipulate Slice Views

Manipulate 3D View

None RAS: (83.5, 371.5, -2.0)

*If all parameters are selected, press "Apply".*



# Testing (Segmentation)

Select “White Matter Lesion Segmentation Training”

DO NOT check this box to skip preprocessing

3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: White Matter Lesion Segmentation

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation

Parameter set: n

Status: Idle

Preprocessing Images Before Segmentation

Preprocessing

White Matter Lesion Segmentation Parameters

SVM Model: itktest2.mdl

Testing Subject directory: test

Testing Subject filename: test.list

Testing filename suffixes: testpostfix.list

Output Image: O...e

Default Cancel Apply

Manipulate Slice Views

Manipulate 3D View

None RAS: (-10.7, 1.0, -245.8)



Click and specify the location containing the saved SVM models in the “Training” stage.

3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: White Matter Lesion Segmentation

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation

Parameter set: n

Status: Idle

Preprocessing Images Before Segmentation

Preprocessing:

White Matter Lesion Segmentation Parameters

SVM Model: **itktest2.mcl**

Testing Subject directory: **test**

Testing Subject filename: test.lst

Testing filename suffixes: testpostfix.lst

Output Image: O...e

Default Cancel Apply

Manipulate Slice Views

Manipulate 3D View

None RAS: (-10.7, 1.0, -245.8)

Select File

Name	Size	Modified
302D10226.PD.byte.cbq.match.smooth.hdr	1 KB	Tue 1
302D10226.PD.byte.cbq.match.smooth.img	2,944 KB	Tue 1
AffineRegistration.xml	4 KB	Sat 1
AffineRegistration.CLP.h	15 KB	Sat 1
beforethreshold.hdr	1 KB	Sat 1
beforethreshold.img	11,776 KB	Sat 1
extractlesion0.hdr	1 KB	Thu 1
extractlesion0.img	5,888 KB	Thu 1
HistogramMatching.CLP.h	13 KB	Sat 1
itktest0.mcl	696 KB	Thu 1
itktest1.mcl	2,790 KB	Fri 1
<b>itktest2.mcl</b>	<b>3,043 KB</b>	Sat 1
lesion.vec.0	5,545 KB	Thu 1
maskout_input0.hdr	1 KB	Fri 1
maskout_input0.img	5,888 KB	Fri 1
maskout_input1.hdr	1 KB	Fri 1
maskout_input1.img	5,888 KB	Fri 1
maskout_time0_0.hdr	1 KB	Fri 1

File name: itktest2.mcl

Files of type: All Files (\*.\*)

Open Cancel

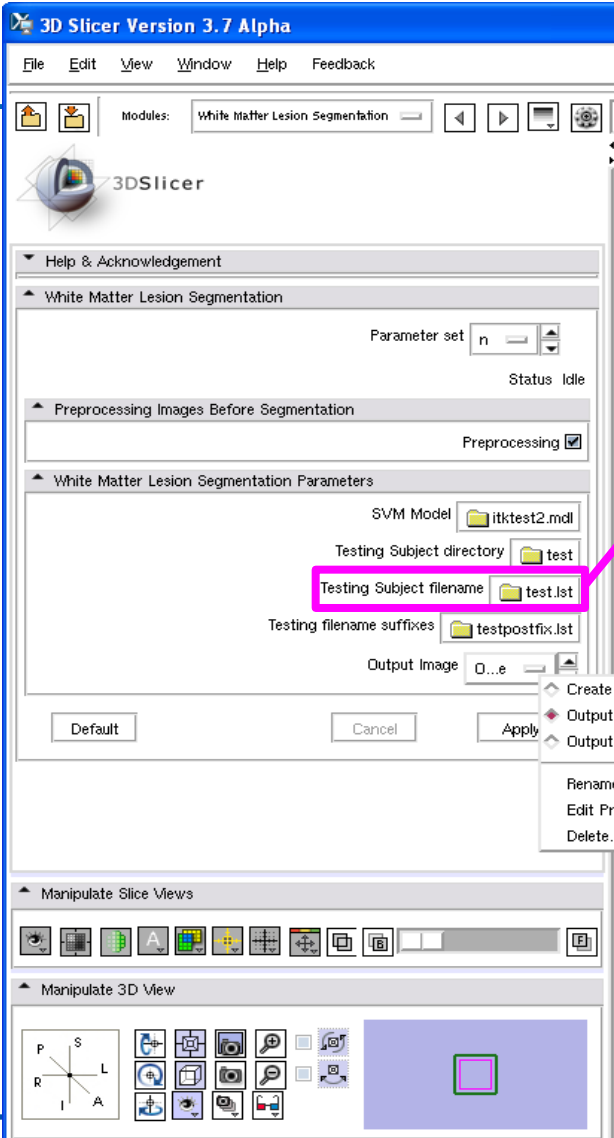
Click and select the location containing testing images.

Select Directory

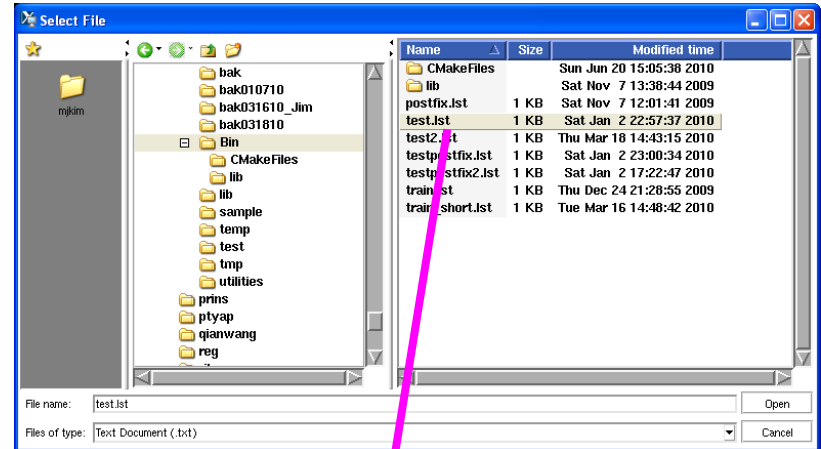
WMLS

- 3d\_image
- AFCM
- bak
- bak010710
- bak031610\_Jim
- bak031810
- Bin
- lib
- sample
- test**
- test2
- train
- temp
- test
- tmp
- utilities
- prins
- ptyap

OK Cancel

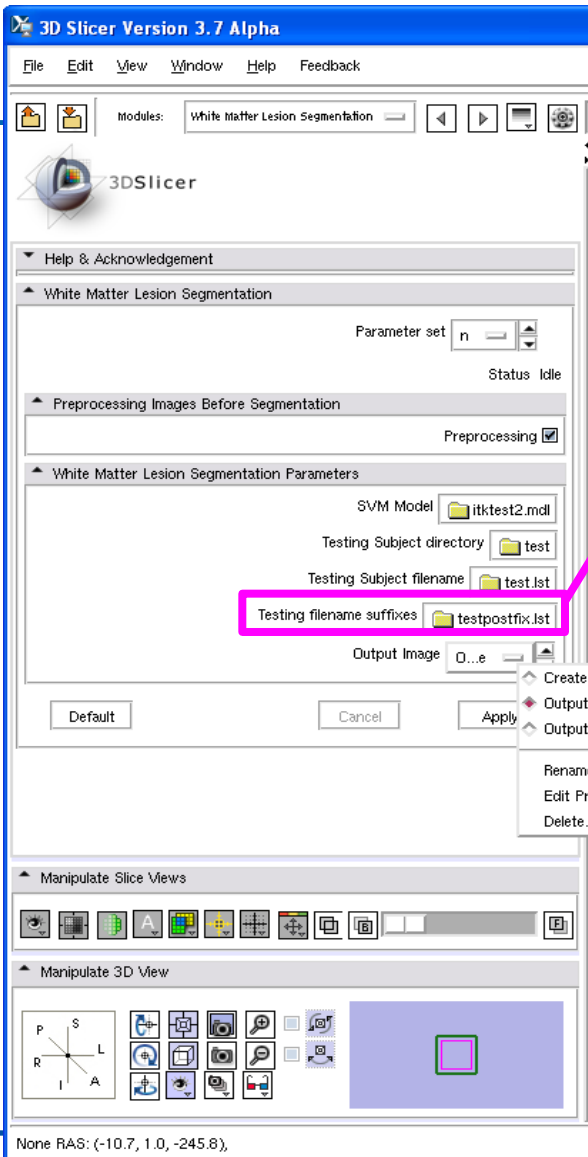


Click and select the file containing the list of filename of testing image.

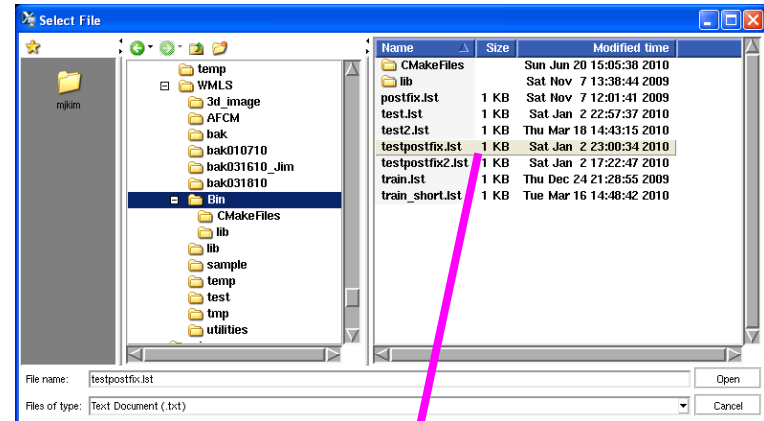


Example:

601H03166



Click and select the file containing the list of prefixes of testing image.



Example:

```
.T1.byte.cbq.match.smooth.hdr  
.T2.byte.cbq.match.smooth.hdr  
.PD.byte.cbq.match.smooth.hdr  
.FL.byte.cbq.match.smooth.hdr
```



3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: White Matter Lesion Segmentation

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation

Parameter set: n

Status: Idle

Preprocessing Images Before Segmentation

Preprocessing:

White Matter Lesion Segmentation Parameters

SVM Model: itktest2.mdl

Testing Subject directory: test

Testing Subject filename: test.lst

Testing filename suffixes: testpostfix.lst

Output Image: O...e

Apply

None RAS: (-10.7, 1.0, -245.8)

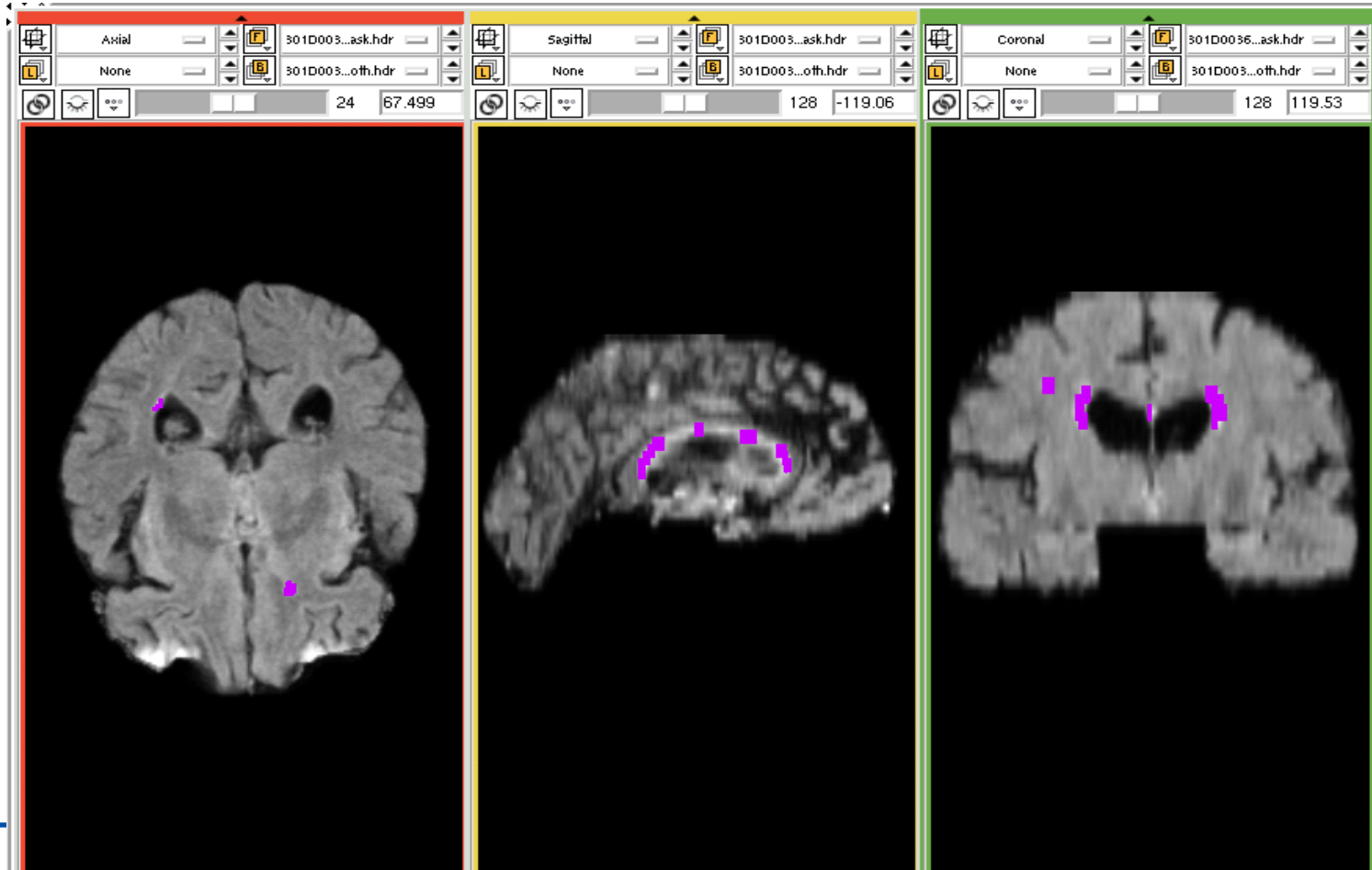
*Set the filename to save the segmented lesion volume in the end of "Testing" stage.*

*If all parameters are selected, press "Apply".*





- Visualization of the segmented lesion volume





# Overview

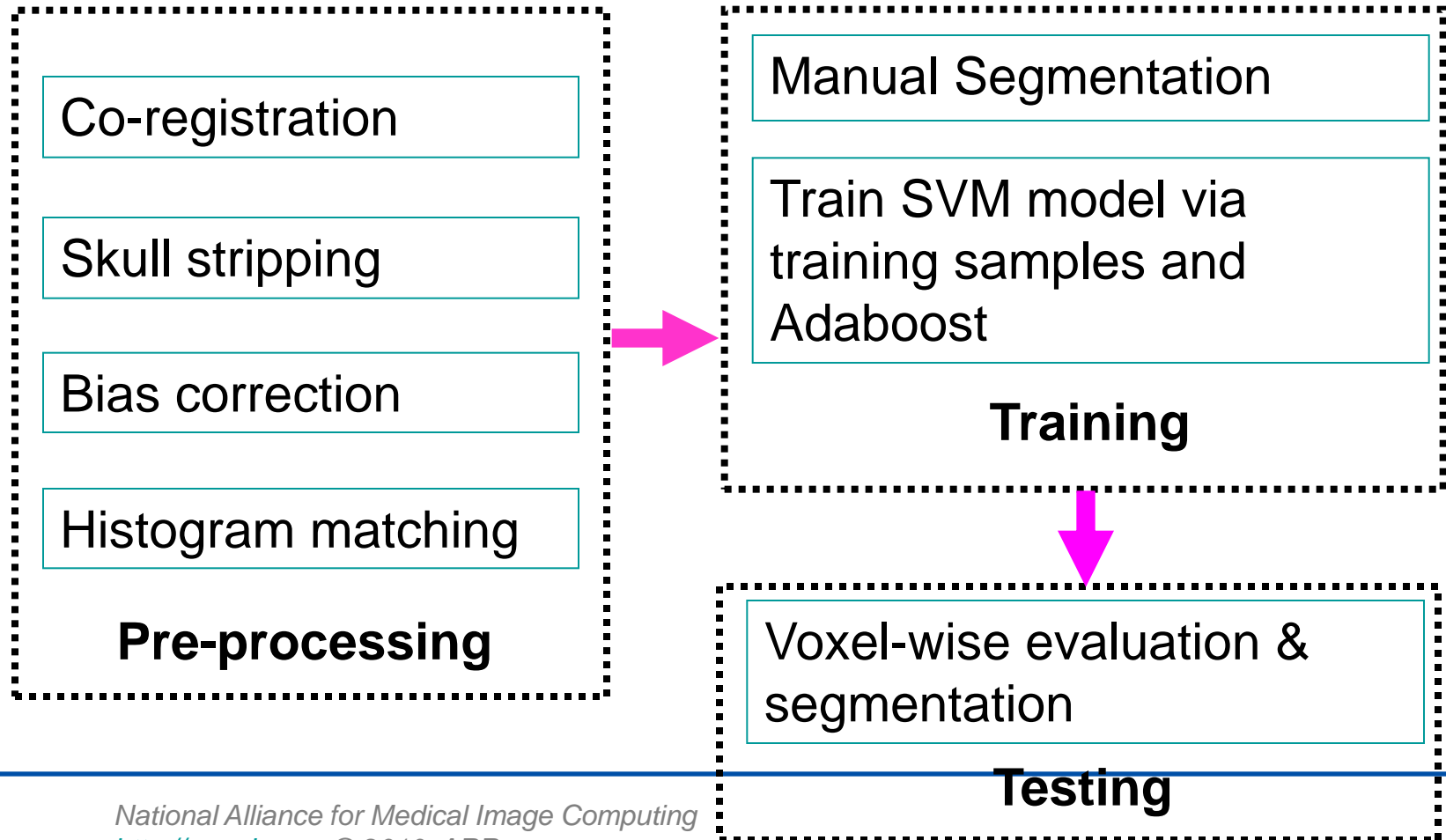
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- Introduction
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# Pipeline (w/ Preprocessing)

- If your images are unprocessed...





# Training/Testing w/ Preprocessing

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- In the training or testing menu, check the “Preprocessing” option.
- Intermediate files by processing steps are saved in the directory you specified in the training/testing menu.
- For other training and testing options, see page 12-24.



3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: te Matter Lesion Segmentation Traini...

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation Training

Parameter set g

Status Idle

Selection Of Multi-modality Images For Training

T1

T2

PD

FL

Preprocessing Images Before Training

Preprocessing

White Matter Lesion Segmentation, Training Module

Training Subjects directory

Training subjects filenames

Training filename suffixes

SVM Model directory

Default Cancel Apply

Manipulate Slice Views

Manipulate 3D View

None RAS: (83.5, 368.4, -2.0)

Check this box for preprocessing before "training". Do same thing for "testing".



- Example of preprocessing – coregistration (FLAIR)

The screenshot displays the 3D Slicer Version 3.7 Alpha interface. The main window is divided into three vertical panels for different slice views: Axial (left), Sagittal (middle), and Coronal (right). Each panel shows a grayscale MRI slice with a red overlay indicating the coregistration process. The Axial view shows a slice at z=128, the Sagittal view at z=128, and the Coronal view at z=24. The interface includes a menu bar (File, Edit, View, Window, Help, Feedback), a toolbar with various icons, and a sidebar on the left with several panels: 'Help & Acknowledgement', 'White Matter Lesion Segmentation' (with a parameter set 'n' and 'Preprocessing' checked), 'Manipulate Slice Views', and 'Manipulate 3D View'. The status bar at the bottom indicates the coordinates for the 'afterreg\_FL' RAS volume: (-119.5, -39.1, 363.2).

3D Slicer Version 3.7 Alpha

File Edit View Window Help Feedback

Modules: White Matter Lesion Segmentation

3DSlicer

Help & Acknowledgement

White Matter Lesion Segmentation

Parameter set: n

Status: Idle

Preprocessing Images Before Segmentation

Preprocessing:

White Matter Lesion Segmentation Parameters

SVM Model

Testing Subject directory

Testing Subject filename

Testing filename suffixes

Output Image

Default Cancel Apply

Manipulate Slice Views

Manipulate 3D View

afterreg\_FL RAS: (-119.5, -39.1, 363.2), Bg IJK: (127, 387, -13), Bg: Out of Frame,

Axial: None, afterreg\_FL, 128, 119.53

Sagittal: None, afterreg\_FL, 128, -119.53

Coronal: None, afterreg\_FL, 24, 67.499

Bg I: 41, Bg J: 145, Bg K: 22

Bg: afterreg\_FL, None, None

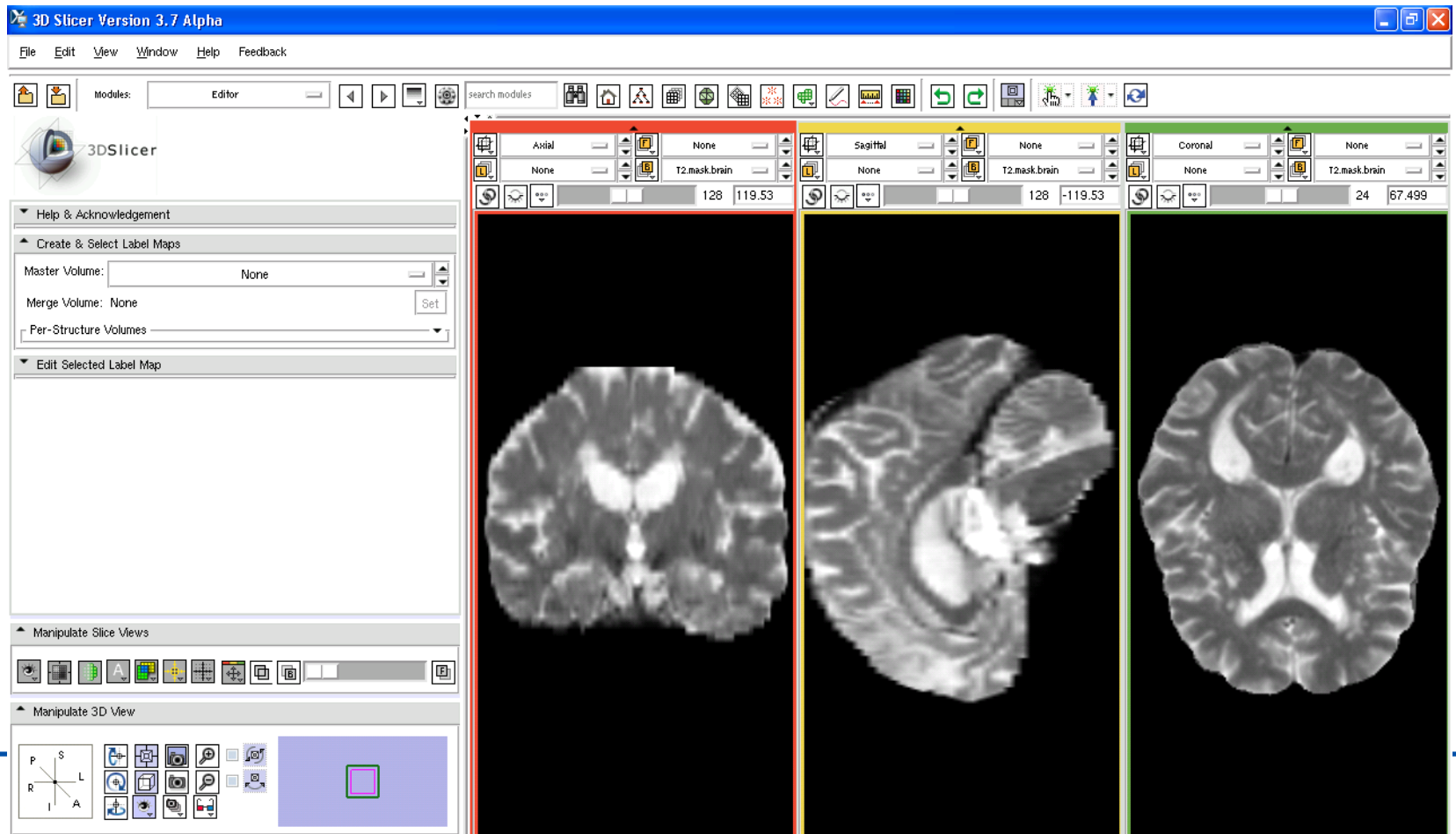
Coronal Sp: 3mm

Lb: None, R: -38.2, A: 64.5, S: 135.7

Bg: 13.0



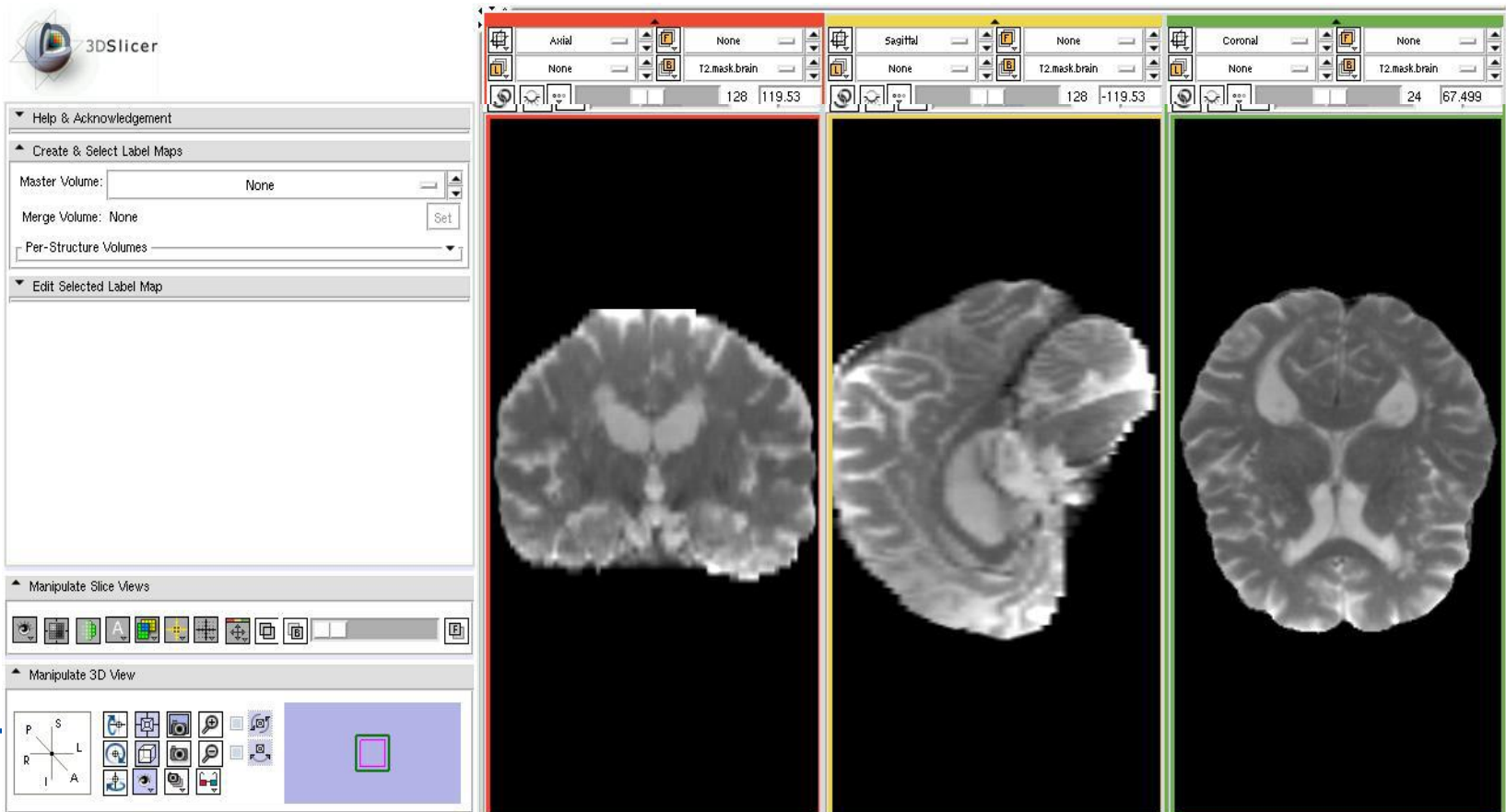
- Example of preprocessing – skull stripping



T2.mask.brain RAS: (-362.0, 283.2, 120.5), Bg: Slice not shown,



- Example of preprocessing – bias correction and histogram matching







# Overview

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- Introduction
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- **Conclusion**



# Conclusion

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- A Slicer3 module for automatic segmentation of white matter lesions has been developed.
    - Preprocessing
      - Coregistration, skull stripping, bias correction, and histogram matching
    - Training
      - Build SVM model using multi-protocol MRIs (T1, T2, PD, and FLAIR)
    - Segmentation
      - Test new subject images using the SVM model built in the training stage
-



# Acknowledgments

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