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BRAINSCut General Tutorial

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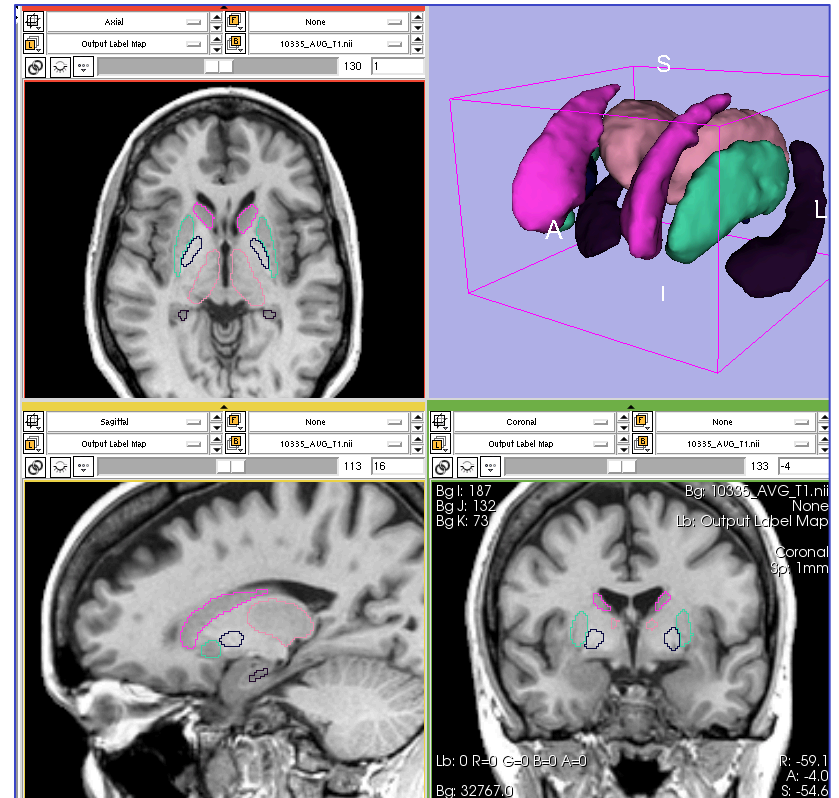
NA-MIC Tutorial Contest: Summer 2011



Learning Objective

BRAINSCut

- This tutorial shows how to segment *regions of interest (ROI)* by using BRAINSCut.
- The tutorial example includes sub-cortical structure segmentation from human MR brain Image.



BRAINSCut Output example for sub-cortical structures



Pre-requisite

- This is NOT mandatory but would be helpful when you run command line module for **BRAINSCut**
 - Tutorial Name: Programming in Slicer3 Tutorial
 - Author: Sonia Pujol, Ph.D
 - Tutorial Link: http://www.slicer.org/slicerWiki/images/c/ca/ProgrammingIntoSlicer3_SoniaPujol.pdf



Material

This tutorial requires the installation of the Slicer3.6 release or Slicer4 and the tutorial dataset. They are available at the following locations:

Slicer download page

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

Tutorial dataset: [name of dataset]

[\[Add a link to the tutorial dataset\]](#)



Platforms

- [Add the results of the tests on Linux, Mac and Windows]

http://wiki.na-mic.org/Wiki/index.php/Training:Summer_2011_Contest_Table



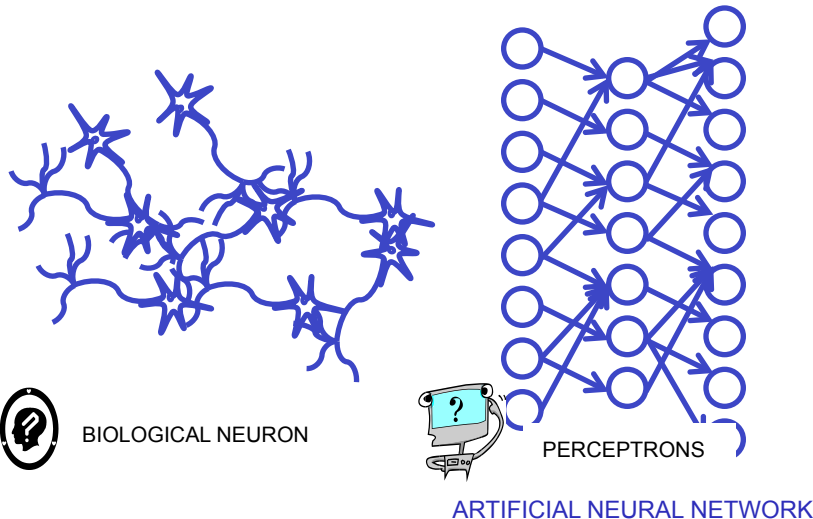
Overview

- The tutorial starts with brief background for **BRAINSCut** and followed by step-by-step instruction how to get sub-cortical volumetric segmentation.
- **BRAINSCut** Background
- **BRAINSCut** Process
 1. **BRAINSCut** I/O: *Understand and preparation*
 2. Train **BRAINSCut**: *Tell **BRAINSCut** what's your ROI*
 3. Apply **BRAINSCut**: *Get the actual volumetric segmentation*



BRAINSCut Background

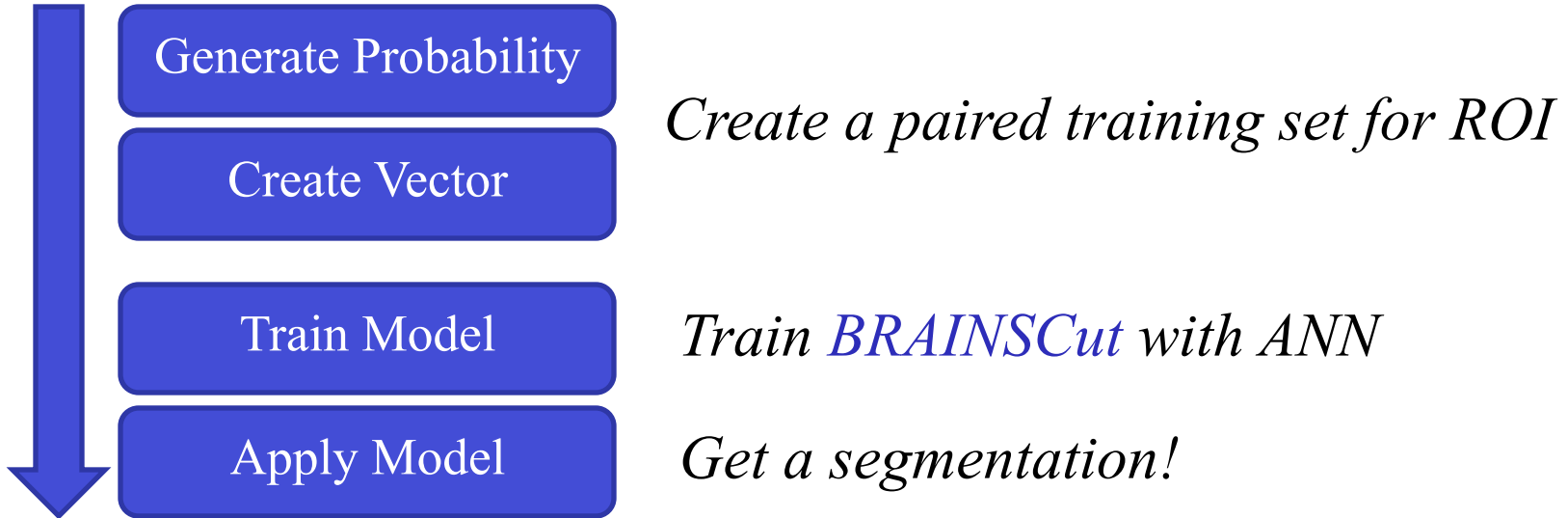
BRAINSCut uses *Artificial Neural Net(ANN)* learning mechanism in its segmentation process. Here briefly introduce how ANN works for image segmentation.



Inspired by human brain signaling of neuron, *ANN* learns from training set, which is paired set of input and output. This training process is simply adjusting process of network, including size of network(e.g. number of perceptrons) and weights to match computed output from input as similar as possible to the paired output.



BRAINSCut Process



BRAINSCut process starts with preparation for learning/training for ROI. To train BRAINSCut, as stated in the previous slide, a paired input-output training set has to be provided. Processes of **Generating probability map** and **Creating Vector** together produces training data set for your ROI. **Train Model** process is followed by those step to learn about the structure and then completed with **Apply Model** step to get volumetric segmentation.



BRAINSCut Process

BRAINSCut I/O: Net Configuration File

: All the image volumes for BRAINSCut has to be indicated in the net configuration file(XML file format).

- Please download Tutorial Data File and see the following files.
 - File name: *BRAINSCutGeneralTutorialNetConfiguration.xml*

This file includes general setting for BRAINSCut with tutorial data set in it. After following the tutorial, you should be able to modify the net configuration file to fit your purpose.



BRAINSCut Process

BRAINSCut I/O: Net Configuration File

1. Open the net configuration file(*BRAINSCutGeneralTutorialNetConfiguration.xml*) with your favorite text editor
2. Here we need to change two variables for input and output directory name.
3. As shown in below figure, please change all [*BRAINSCutInputDir*] to your downloaded location.

```
34  =====
35  <DataSet Name="template" Type="Atlas" >
36    <Image Type="T1" Filename="[BRAINSCutInputDir]/BRAINSCutTutorialNetConfigurationFiles/template_t1.nii.gz"/>
37    <Image Type="T2" Filename="na" />
38  </DataSet>
39
40  <!-- =====
41  Probability Map Description
42  =====
43  BRAINSCutTutorialNetConfigurationFiles/BRAINSCutGeneralTutorialNetConfiguration.xml
44  =====
45  34  =====
46  35  <DataSet Name="template" Type="Atlas" >
47  36    <Image Type="T1" Filename="~/BRAINSCutTutorial/BRAINSCutTutorialNetConfigurationFiles/template_t1.nii.gz"/>
48  37    <Image Type="T2" Filename="na" />
49  38  </DataSet>
50  39
51  40  <!-- =====
52  41  Probability Map Description
53  =====
54  BRAINSCutTutorialNetConfigurationFiles/BRAINSCutGeneralTutorialNetConfigurationEditing.xml 34,1 24%
```

Original provided file

Modified file example



BRAINSCut Process

BRAINSCut I/O: Net Configuration File

4. In a same way, please change all `[BRAINSCutOutputDir]` to your preferred location to store BRAINSCut output.

```
46 StructureID="right_putamen"  
47 Gaussian="1.0"  
48 GenerateVector="true"  
49 Filename="[BRAINSCutOutputDir]//PutamenProbabilityMap.nii.gz"  
50 rho="[BRAINSCutOutputDir]/rho.nii.gz"  
51 phi="[BRAINSCutOutputDir]/phi.nii.gz"  
52 theta="[BRAINSCutOutputDir]/theta.nii.gz"  
53 />
```

Original provided file



```
BRAINSCutTutorialNetConfigurationFiles/BRAINSCutGeneralTutorialNetConfiguration.
```

```
46 StructureID="right_putamen"  
47 Gaussian="1.0"  
48 GenerateVector="true"  
49 Filename="-/BRAINSCutOutput/PutamenProbabilityMap.nii.gz"  
50 rho="-/BRAINSCutOutput/rho.nii.gz"  
51 phi="-/BRAINSCutOutput/phi.nii.gz"  
52 theta="-/BRAINSCutOutput/theta.nii.gz"  
53 />  
54
```

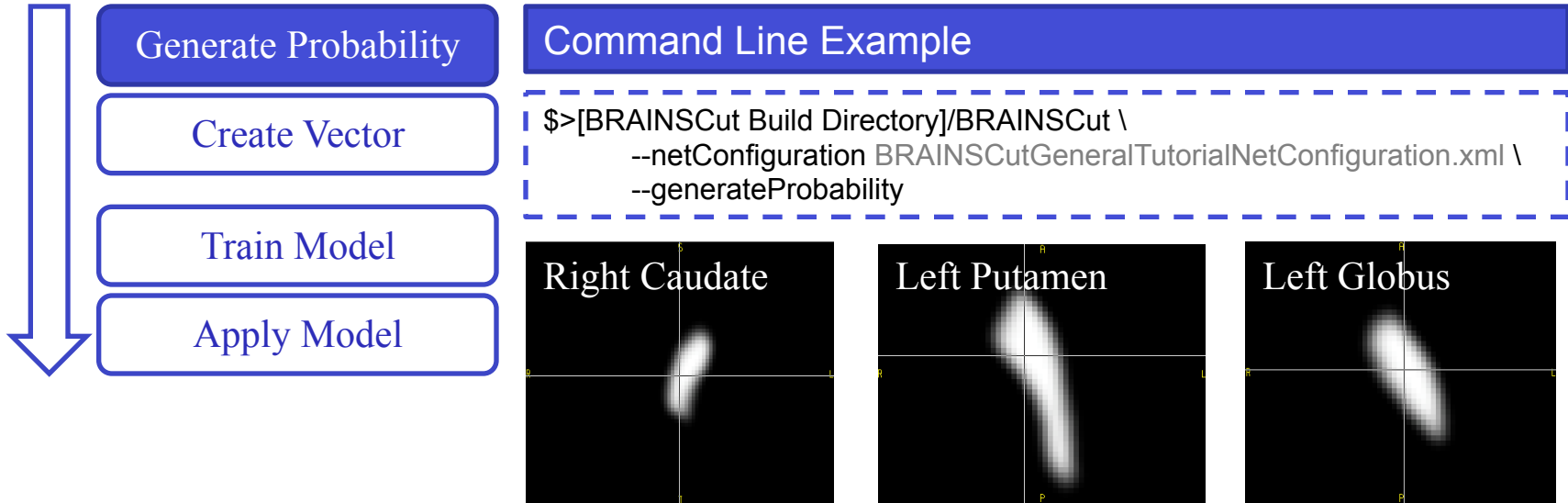
Modified file example

```
BRAINSCutTutorialNetConfigurationFiles/BRAINSCutGeneralTutorialNetConfigurationEditing.xml [+] 46,1 33%
```

Now, we are ready to go...



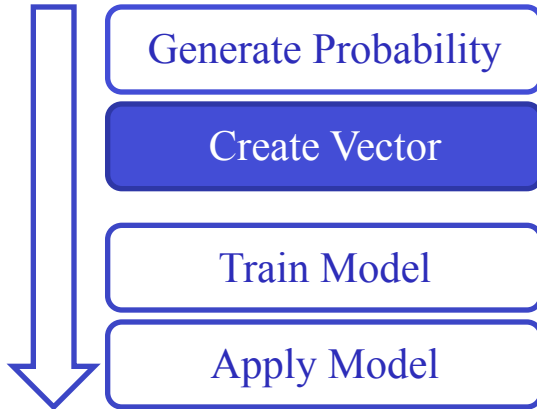
BRAINSCut Process



- Probability map is to identify rough region of segmentation. By registering each training data to the atlas data set, probability map(spatial prior) of each ROI could be created.
- ROI could be specified in the net configuration file in the *<ProbabilityMap... />* section.



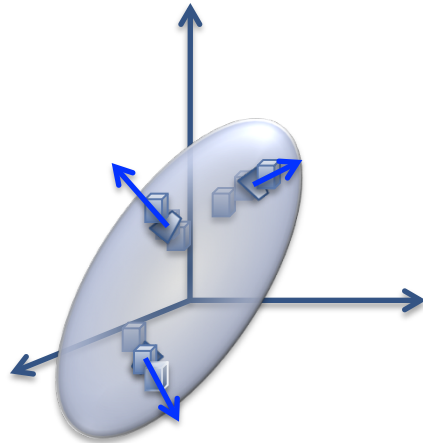
BRAINSCut Process



Command Line Example

```
[BRAINSCut Build Directory]/BRAINSCut \  
--netConfiguration BRAINSCutGeneralTutorialNetConfiguration.xml \  
--createVectors
```

Training data, input-output paired set, will be generated by above command. When creating training vector, BRAINSCut will use all image types specified in the Atlas Data Set



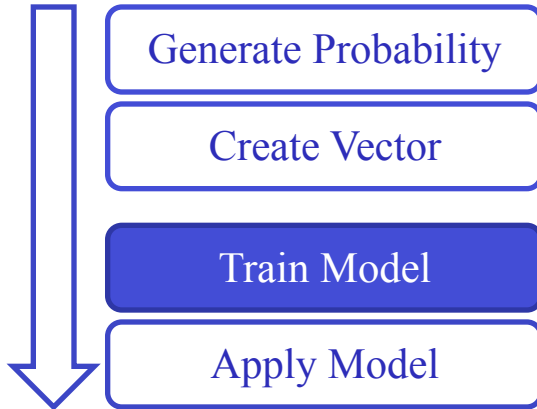
Neighbors along the Gradient Descents

```
<DataSet Name="template" Type="Train" >  
  <Image Type="T1" Filename="@BRAINSCut_SOURCE_DIR@/TestSuite/Atlas/Template/Template_T1.nii.gz" />  
  <Image Type="T2" Filename="@BRAINSCut_SOURCE_DIR@/TestSuite/Atlas/Template/Template_T2.nii.gz" />  
</DataSet>  
  
<DataSet Name="Scan2" Type="Train" >  
  <Image Type="T1" Filename="@BRAINSCut_SOURCE_DIR@/TestSuite/Atlas/Scan2/Scan2_T1.nii.gz" />  
  <Image Type="T2" Filename="@BRAINSCut_SOURCE_DIR@/TestSuite/Atlas/Scan2/Scan2_T2.nii.gz" />  
  <Mask Type="mask1" Filename="@BRAINSCut_SOURCE_DIR@/TestSuite/Atlas/Scan2/Scan2_mask1.nii.gz" />  
  <Registration  
    SubjToAtlasRegistrationFilename="[BRAINSCutOutputDir]/SubjToAtlasRegistration.nii.gz" />  
    AtlasToSubjRegistrationFilename="[BRAINSCutOutputDir]/AtlasToSubjRegistration.nii.gz" />  
    AtlasBinaryFilename="na" />  
    SubjectBinaryFilename="na" />  
    ID="BSpline" />  
  />  
</DataSet>
```

Use these type image



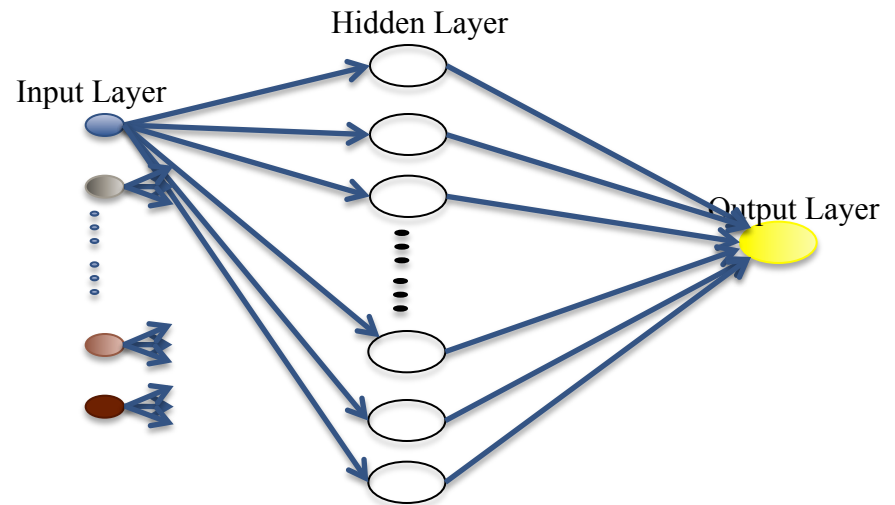
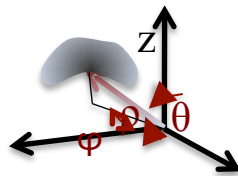
BRAINSCut Process



Command Line Example

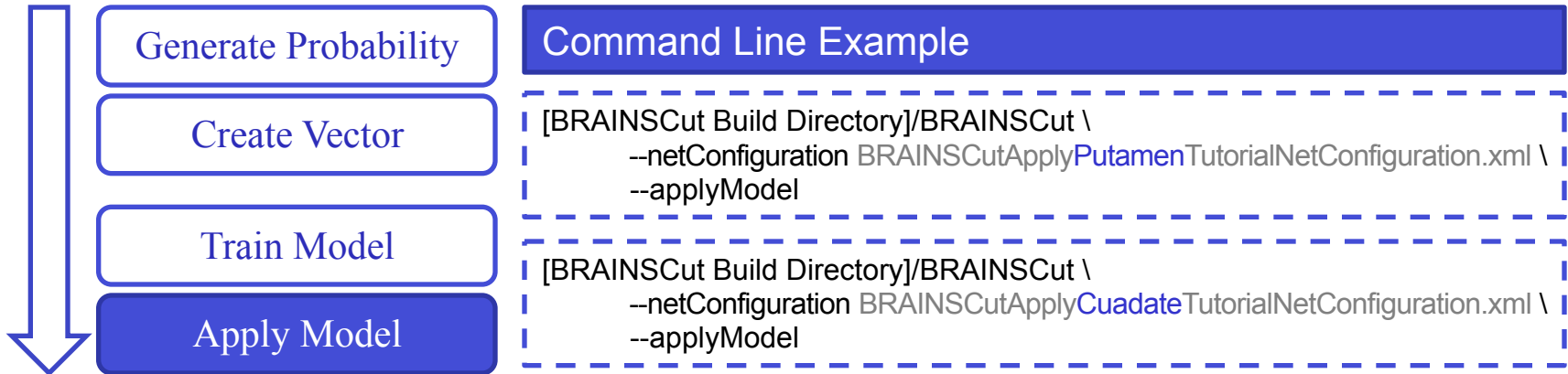
```
[BRAINSCut Build Directory]/BRAINSCut \  
--netConfiguration BRAINSCutGeneralTutorialNetConfiguration.xml \  
--trainModel
```

After creating training vector set, **BRAINSCut** will train for your ROI. The figure below shows the architecture of **BRAINSCut**.





BRAINSCut Process



Now, it is time to apply our trained data set. Since trained model from previous section could be quite ugly, please open up the `BRAINSCutApplyTutorialNetConfiguration.xml` file. The file includes finely trained ANN model for Caudate and Putamen for now. For other structures we are working on and will be updated as soon as we get.

By doing above line, segmentation output will be generated as in the directory specified at the net configuration file. In this tutorial example, the result file would go into the same directory as `BRAINSCutOutputDir`.



Conclusion



Acknowledgments



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[Other Acknowledgments]