CEREBELLUM SEGMENTATION
AND VOLUME MEASUREMENT
Using Analyze

Table of Contents

Introduction

The cerebellum is an active area of brain research. It has long been associated with motor coordination, but more recently it has been shown to play a role in cognition and learning as well[1]. Its structure, and thus its volume, has been shown to exhibit plasticity based on an individual's experiences and environmental stressors[2].

Cerebellar volume has been found to decrease with age, driven by loss of white matter[3]. Smaller cerebellar volume was associated with diabetes, low total cholesterol, high fasting glucose, low HDL cholesterol[3], major depressive disorder[4], and schizophrenia,[5] or schizophrenia combined with alcoholism[6]. The cerebella of children from multiplex alcohol dependence families[7] appear to have increased volume compared to controls, which may indicate a lower functional efficiency of this structure.

Interconnectivity between the cerebellum and the cerebrum has been demonstrated in different ways. Constrained spherical deconvolution analysis was used to show a pathway linking the cerebellum and limbic structures[8]. Supratentorial lacunar infarcts and white matter lesions in the cerebrum have been found to be associated with decreased cerebellar volume[3].

The cerebellum has a similar intensity to the rest of brain in MRI images. One way of separating it from other brain structures is by using three-dimensional walls to define boundaries, then using the object extractor algorithm to extract the cerebellum.

This guide will describe in detail how to segment the cerebellum from MRI brain data and measure its volume in Analyze.

Segmentation of the Cerebellum

Use the Load module **(File > Load)** to load the example MRI brain data set MRI_EGV_Brain.avw from **$:\BIR\images\TutorialData**, where $ is the drive where you have installed the TutorialData folder. This folder can also be downloaded from http://analyzedirect.com/data/

Select the data set in the Analyze workspace and open the Volume Edit module **(Segment > Volume Edit)**.

If detailed structures are hard to see, as in this data set, adjust the range of grayscale intensities displayed from the Intensity Images window **(View > Intensities)** by moving the sliders. In the case of the example data, the maximum value should be decreased until the brain structures become visible, around 80-100.

Select the **Walls tab** and check the **"Define walls to limit semi-automated operations"** checkbox. Choose the **Draw Wall** radio button and set the Wall Type to **Spline**.
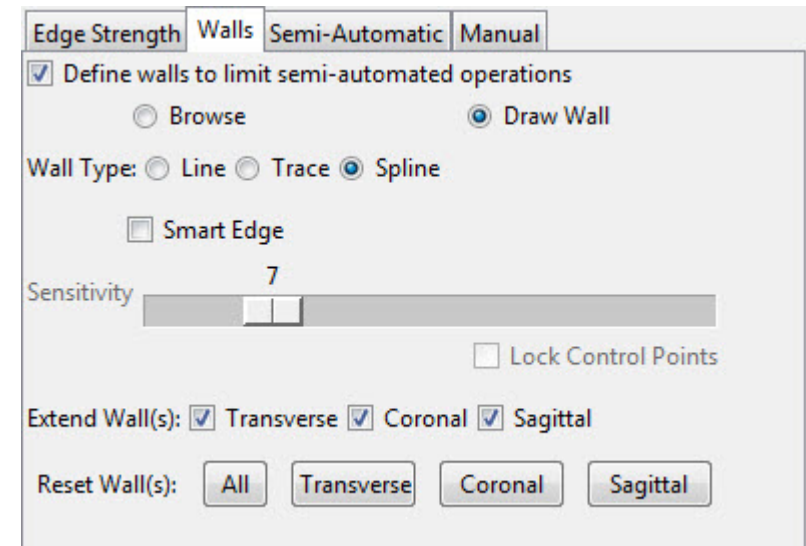
Navigate through the sagittal slices to find the first slice that includes tissue belonging to the cerebellum. In the example data set, this is slice 68. Draw a wall separating the cerebellum from the cerebrum on this slice. To draw a wall using the spline tool, left-click to set spline points which will connect into a smooth line. Double click when defining the last spline point to set the spline. The spline points can be adjusted by clicking and dragging them with the middle mouse button. Once you are happy with the spline, click the **Apply** button or hit the A key to apply the spline.

Tip: Draw walls that are not completed closed shapes. If the walls are closed, sometimes the interpolation will not stay around the shape of the cerebellum. Instead, draw an open U or C shape, letting natural intensity boundaries in the image define the open part of the wall.

Navigate through the sagittal images. A dotted line will indicate the position of the wall as you move through the slices. Once the cerebellum is no longer well defined by the wall, redefine the wall on that slice. The wall will be interpolated between all slices on which it is defined. When finished, scroll through the slices to ensure that the cerebellum is well defined by the wall.
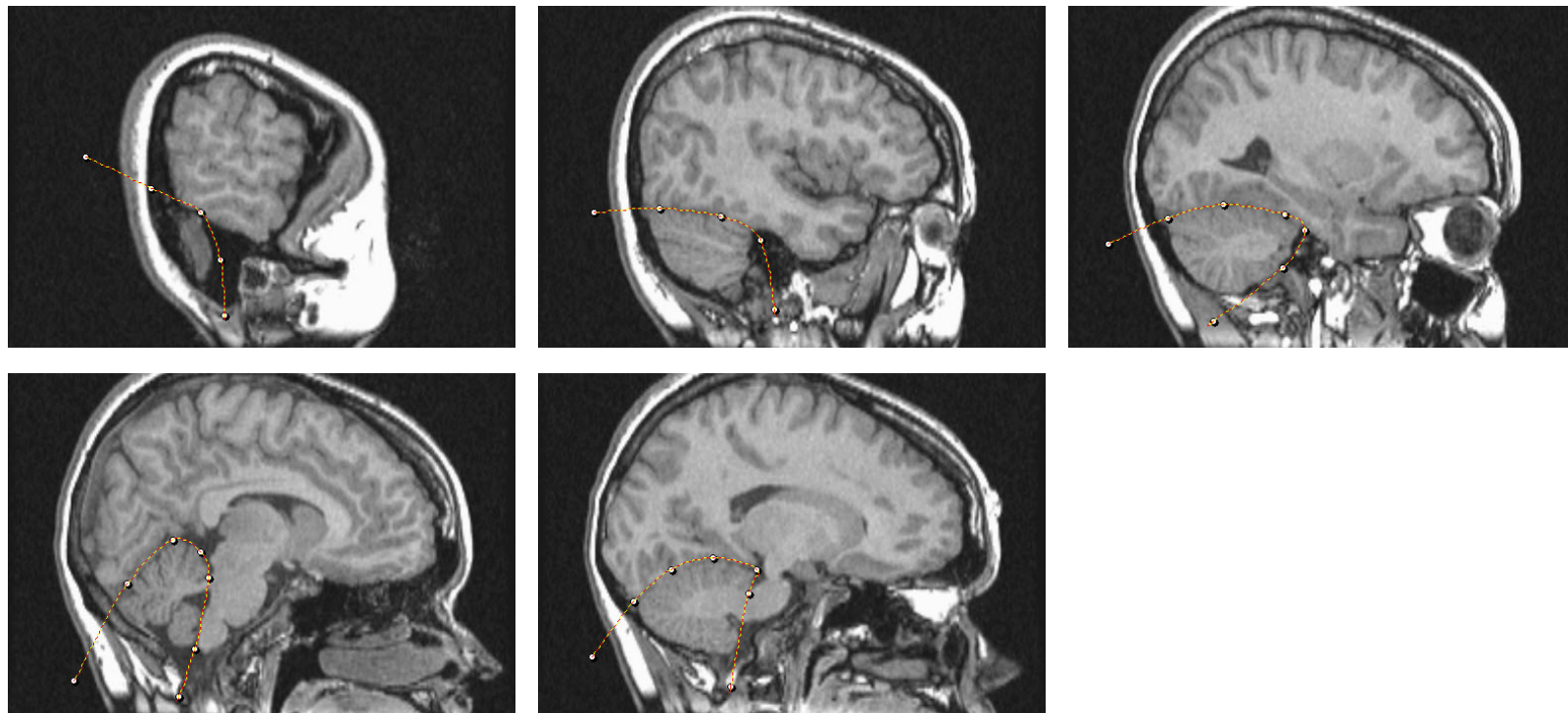
Now that the cerebellum boundary is defined in three dimensions by the wall, we will use the object extractor algorithm to segment the cerebellum. Select the Semi-Automatic tab and choose the **Object Extractor** radio button. Click in the cerebellum on a sagittal slice to set a seed point.

Select a threshold range that defines the brain tissue. For the example data set, the threshold range 30-69 works well.

Click the **Extract Object** button to extract the cerebellum.
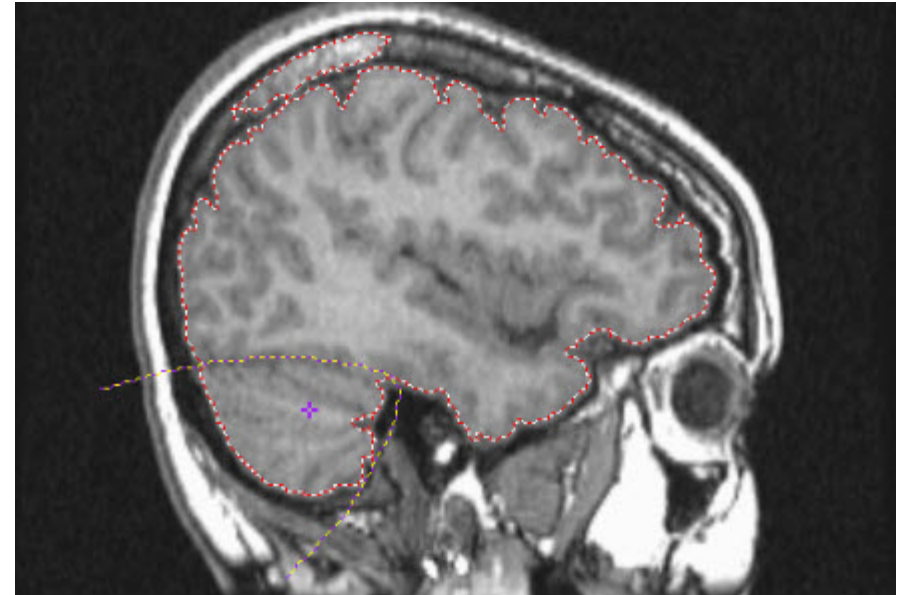
Note: If you wish to segment the cerebrum, lock the cerebellum object by clicking the padlock icon to the left of Object_2. Click the Add Object button to add a new object. Navigate through the transverse slices until the brain is spatially connected. Set a seed point in the brain on the spatially connected transverse slice. Click the Extract Object button to segment the cerebrum.

Save the object map to disk **(File > Save Object Map)** and close the Volume Edit module.
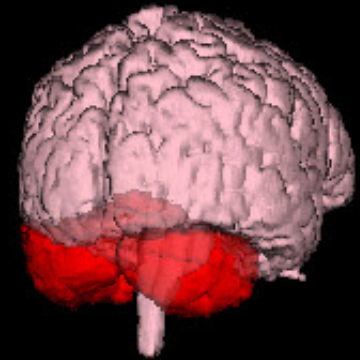
Measurement of Cerebellar Volume

Select the data set in the Analyze workspace and open the Region of Interest module **(Measure > Region of Interest)**. Load the object map created in the segmentation step **(File > Load Object Map)**.

To open the measurements tool, click **Generate > Sample Options**.

In the Sample Options window, set the following parameters:
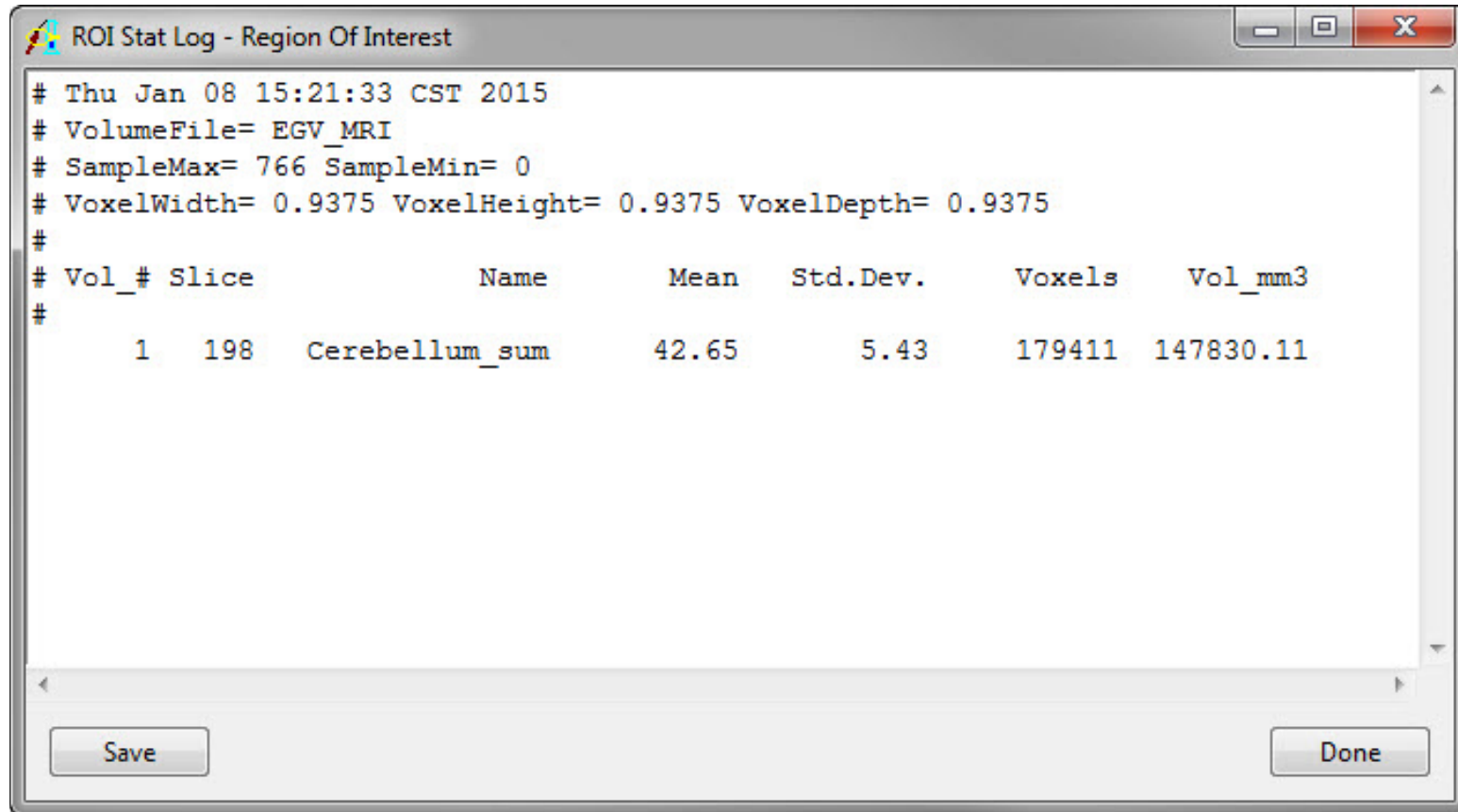
- **Sample Type** to Object(s)
- Select the Cerebellum Object
- **Summing** to **On**
- **Sample** to **All Slices**
- **Sequence Display** to **Off**
- **Log Stats** to **On**
- Specify number of decimal places

Click on the **Configure Log Stats** button. The ROI Stats window will open, showing the measurements that can be generated. Uncheck the Area measurement.
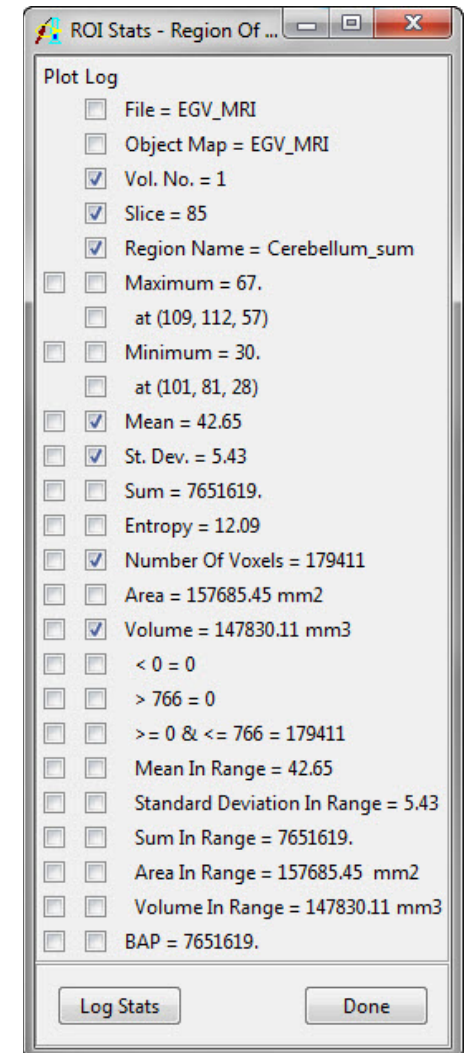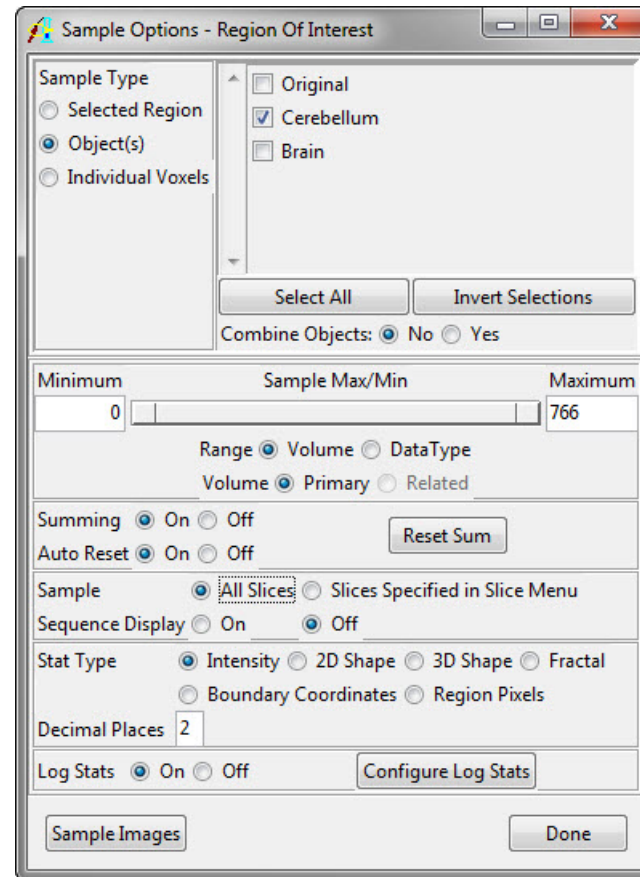
In the Sample Options window, click the **Sample Images** button to measure the volume of the cerebellum. The ROI Stat Log window will open and show the measured values. Save this data as a .stats file by clicking the Save button or right-clicking in the window and clicking Save Log or Save Log As.

ROI Stat Log - Region Of Interest

```
# Thu Jan 08 15:21:33 CST 2015
# VolumeFile= EGV_MRI
# SampleMax= 766 SampleMin= 0
# VoxelWidth= 0.9375 VoxelHeight= 0.9375 VoxelDepth= 0.9375
#
# Vol_# Slice            Name      Mean    Std.Dev.    Voxels    Vol_mm3
#
    1    198   Cerebellum_sum      42.65       5.43    179411  147830.11
```

Save   Done
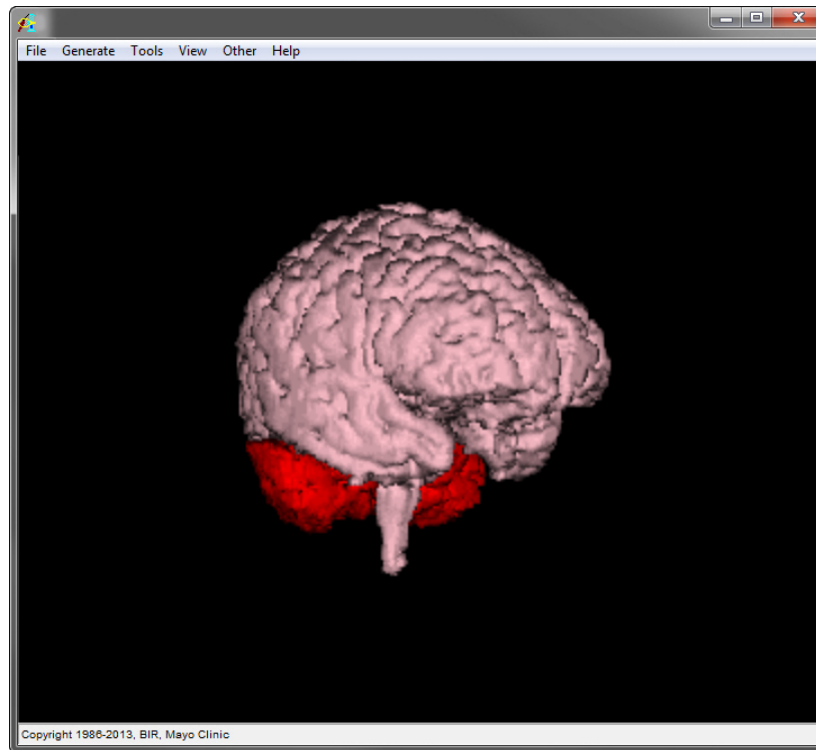
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