

# BRAIN TUMOR SEGMENTATION

FROM T1-WEIGHTED CONTRAST-ENHANCED MRI

Using Analyze



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# Introduction

Segmentation and volume measurement of brain tumors allows visualization of the size and position of the tumor within the brain, and also provides for comparison of pre-operative and post-operative images or visualization of changes through a treatment time period.

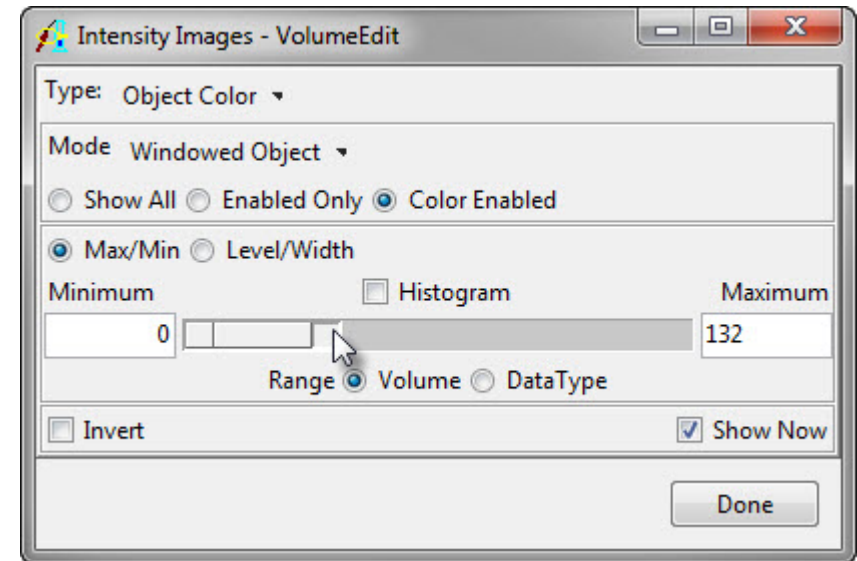
The gold standard of brain tumor segmentation has long been manual segmentation, which is time-consuming and labor-intensive, and thus unsuitable for large studies. Much research has been done to attempt to fully or partially automate the process of tumor segmentation<sup>1</sup>.


This guide outlines a semi-automated technique for segmentation of brain tumors from T1-weighted contrast-enhanced MR data in Analyze. The segmentation step requires a user-defined seed point and threshold range and uses an object extraction algorithm to define the tumor. The tumor volume can easily be measured once the segmentation step is complete.

# Tumor Segmentation

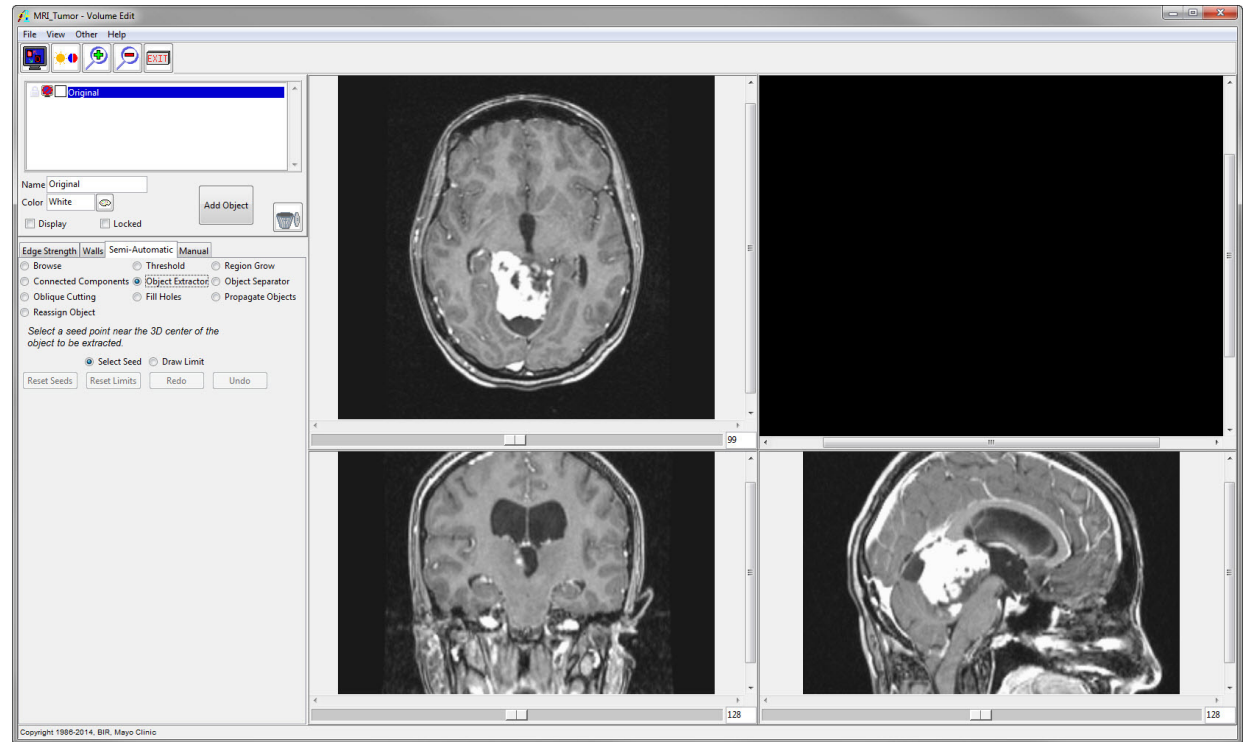
Load a T1 MRI brain tumor data set into Analyze using the Load module (**File > Load**). With the data set selected, open the Volume Edit module (**Segment > Volume Edit**).

If the data set appears very dark at first, the intensity display range can be adjusted in the Intensity Images window (**View > Intensities**). Lower the maximum intensity until the structures are lightened and easier to visualize.



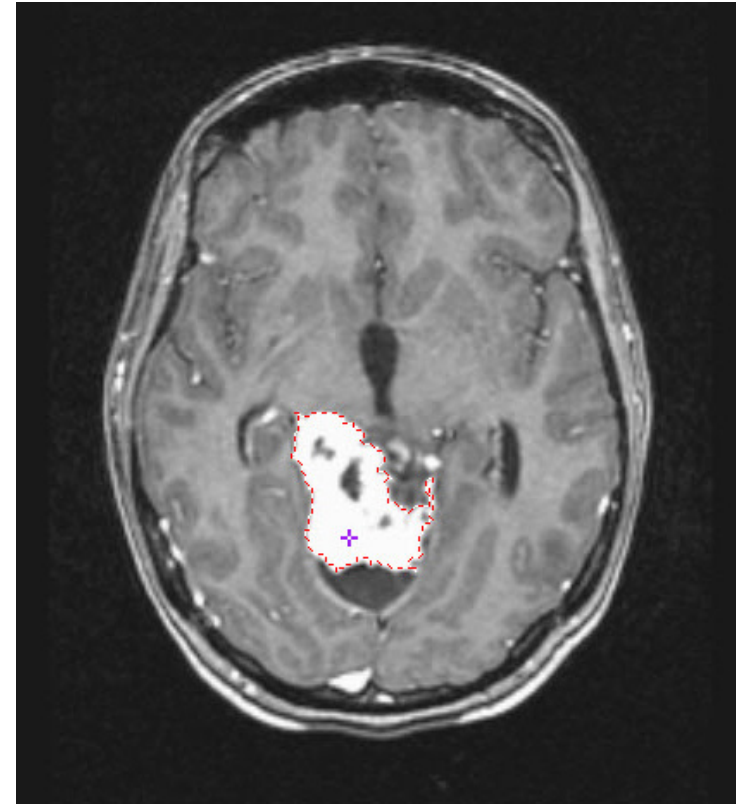
To increase the display size of the orthogonal views by a factor of two, click the Double Current Size button. 

Select the Semi-Automatic tab, and choose the **Object Extractor** radio button.



Navigate to a slice where the tumor is spatially connected and click in the tumor to set a seed point. In this example, the seed point was set on a transverse slice. Once the seed point has been chosen, a threshold bar will appear with the threshold set at the intensity value of the seed point.

In this contrast-enhanced data set, the tumor appears hyperintense, so the maximum threshold level should be set to the highest possible value. The minimum threshold value should be decreased until the tumor is defined by the dotted line.



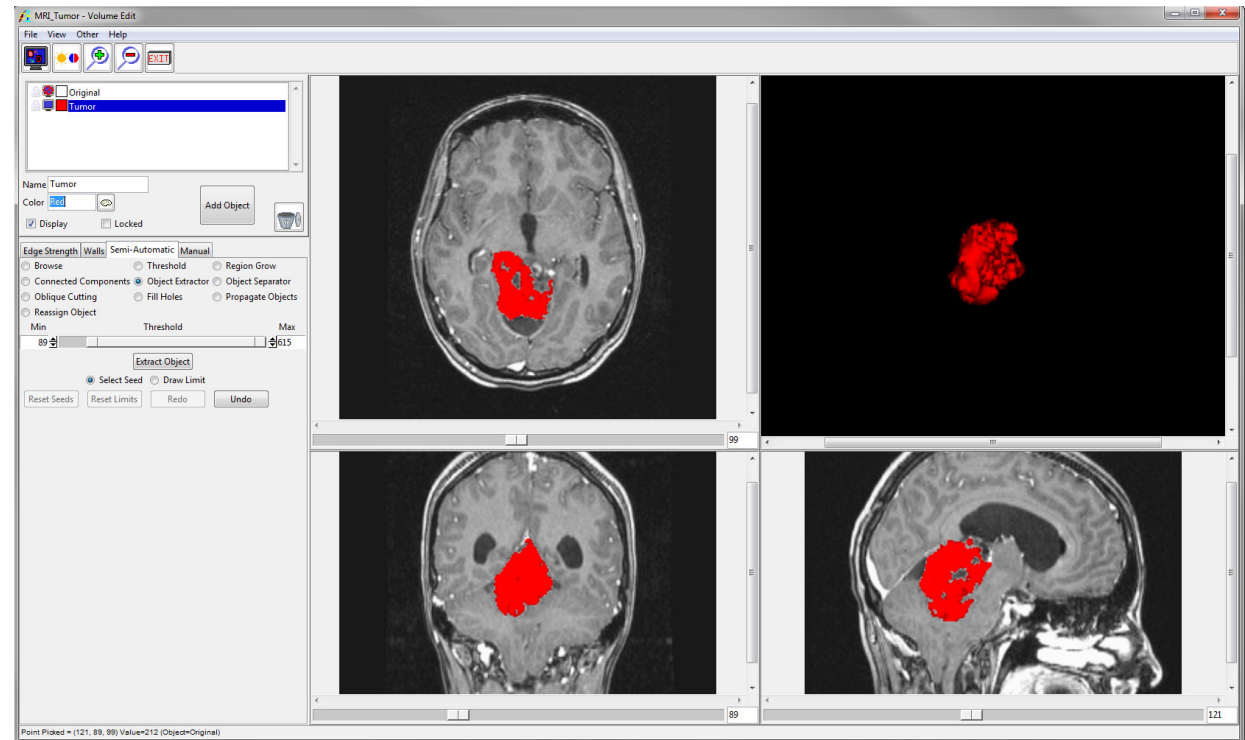
Once the threshold range has been set, click the **Extract Object** button to extract the tumor.

The tumor object will be defined in all three orthogonal orientations, as well as shown as a 3D rendering in the top right.

Save the object map to disk (**File > Save Object Map**) according to your naming conventions.

This object map will be imported into another module for measurement of the tumor volume.

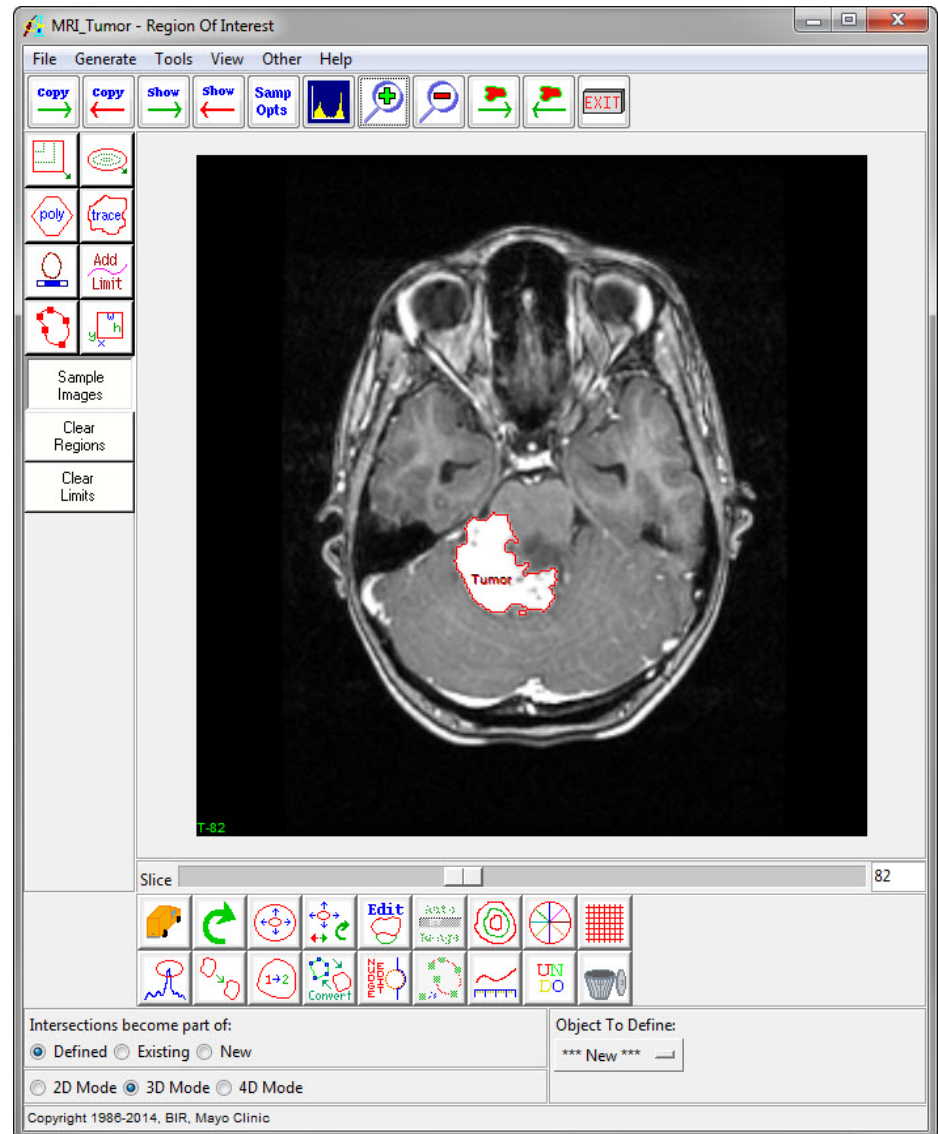
Close the Volume Edit module.



# Tumor Volume Measurement

With the tumor data set selected in the Analyze workspace, open the Region of Interest module (**Measure > Region of Interest**).

Load the object map created in the segmentation step (**File > Load Object Map**).





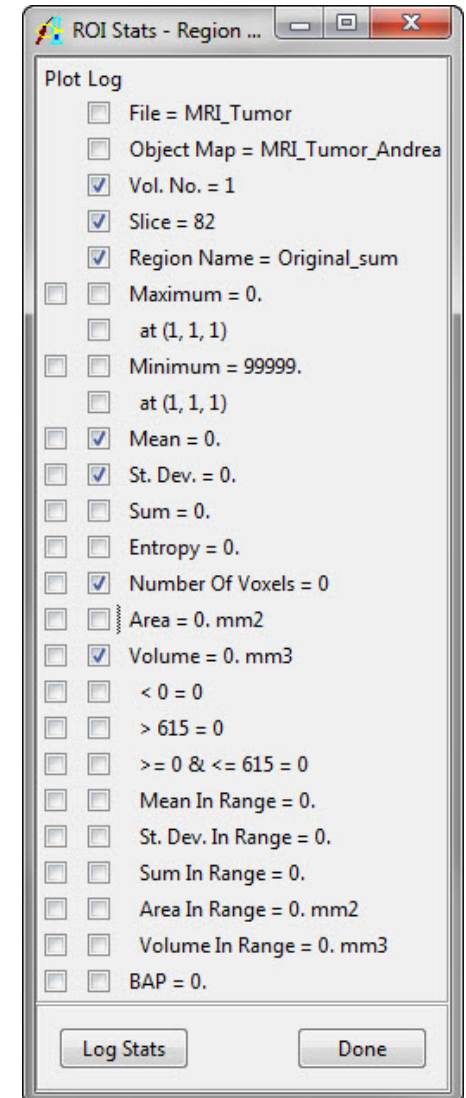
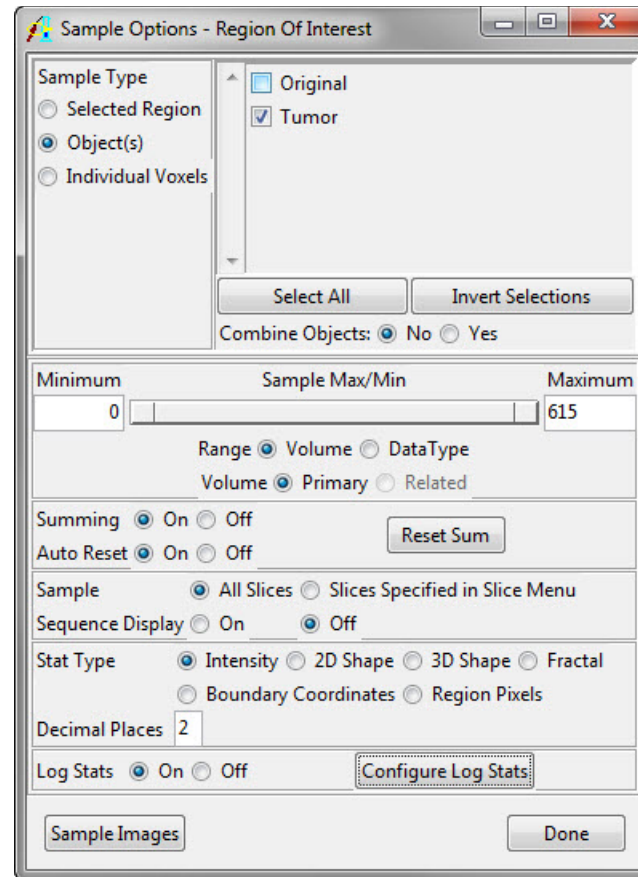
To measure the volume of the tumor, open the Sample Options window (**Generate > Sample Options**).

In the Sample Options window, set the following parameters:

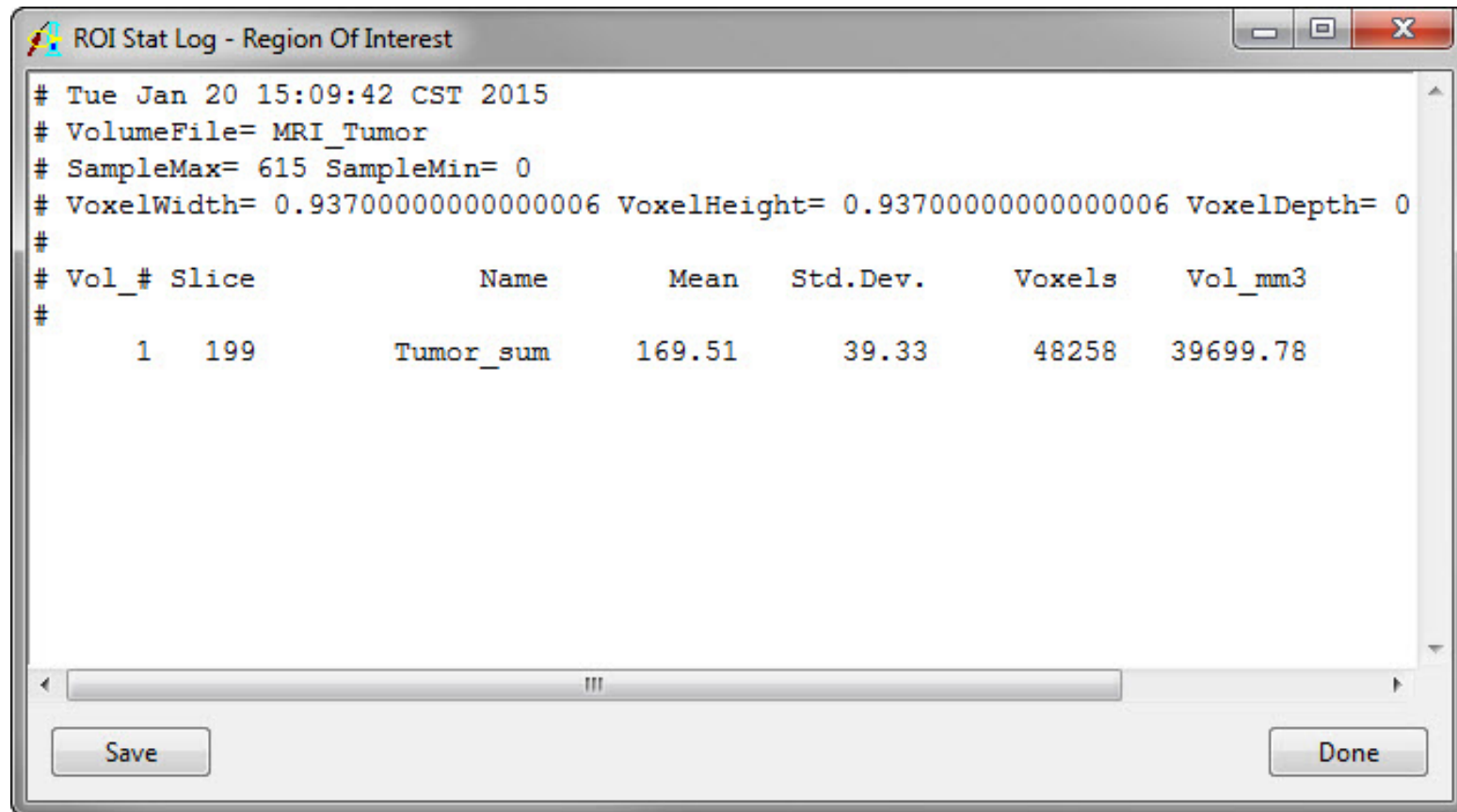
- **Sample Type** to Object(s)
- Select the tumor object
- **Summing** to On
- **Sample** to All Slices
- **Sequence Display** to Off
- **Log Stats** to On

Click on the Configure Log Stats button. The ROI Stats window will open, showing the measurements that can be generated.

Uncheck the Area measurement, as this would provide the sum of tumor area on all slices, which is not a useful measurement



Click Done to close the ROI Stats window, and in the Sample Options window click the Sample Images button to begin the measurement. The results will appear in a new window called ROI Stat Log. These results can be saved as a .stats file by clicking the Save button or right-clicking in the ROI Stat Log window and choosing Save Log or Save Log As. The .stats file can be imported into Excel or another spreadsheet software as a space-delimited file for further analysis.

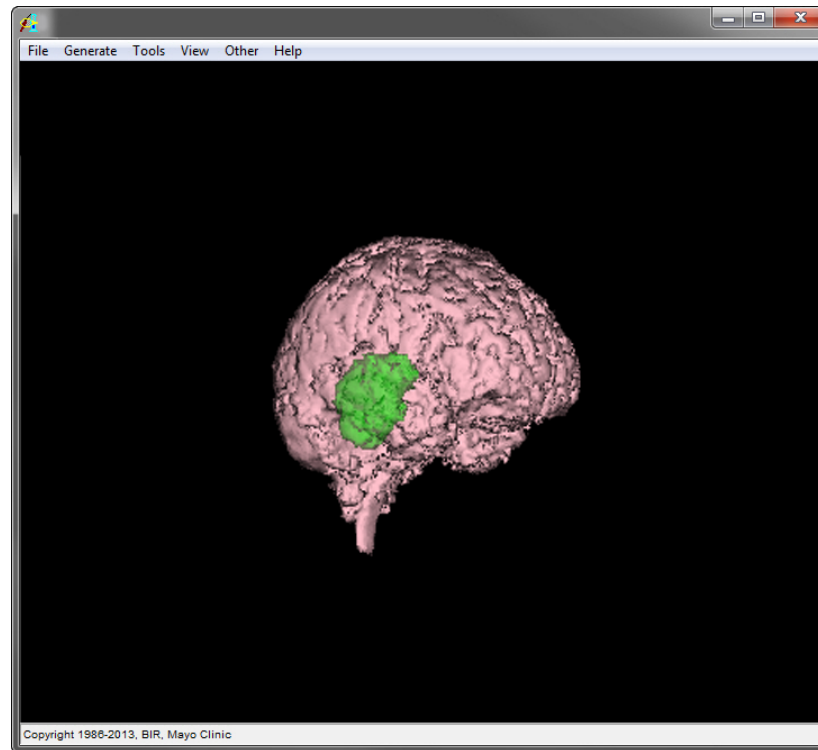


## References

1. Gordillo, N., Montseny, E. & Sobrevilla, P. State of the art survey on MRI brain tumor segmentation. *Magn. Reson. Imaging* 31, 1426–1438 (2013).

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