

# Segmentation Filters in 3D Slicer

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## 1 Introduction

3D Slicer is an open-source software platform for medical image processing and two and three-dimensional visualisation. This document focuses on segmentation filters within 3D Slicer and aims to guide users in using them effectively.

## 2 Segmentation in 3D Slicer

Segmentation is the process of partitioning an image into meaningful structures. In 3D Slicer, segmentations are managed through the Segment Editor module. Each segmentation contains one or more segments associated with a segmentation node in the MRML scene.

If segmentations of different structures are required, this can be done separately or in the same segmentation node.

When performed in the same node, if different structures share voxels the intersecting voxels will be removed from all but one of the structures.

In Figure: 1 we can see the 3D slicer menus to manage segmentations, to go into this menu open the drop-down menu in the red box and select "Segment Editor". To create or select a different segmentation use the "Segmentation" drop-down menu in blue. Filters can be added to each segmentation using the add command in green.

## 3 Segmentation Filters Overview

Segmentation filters in 3D Slicer are tools that help modify, refine, or analyse segmentations. They are accessed through the Segment Editor and include operations such as thresholding, scissors, smoothing, and island analysis.

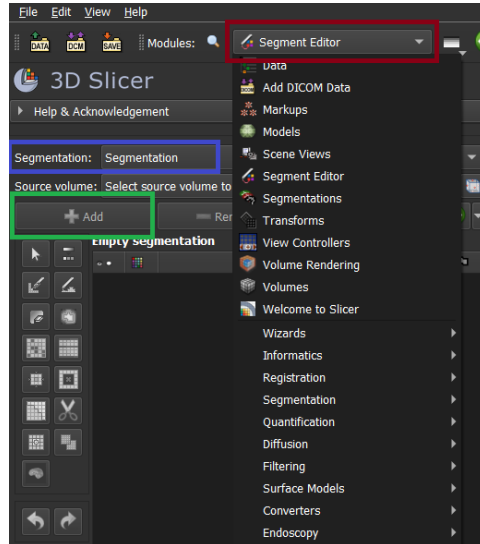


Figure 1: 3d slicer GUI to create, select and change segmentations.

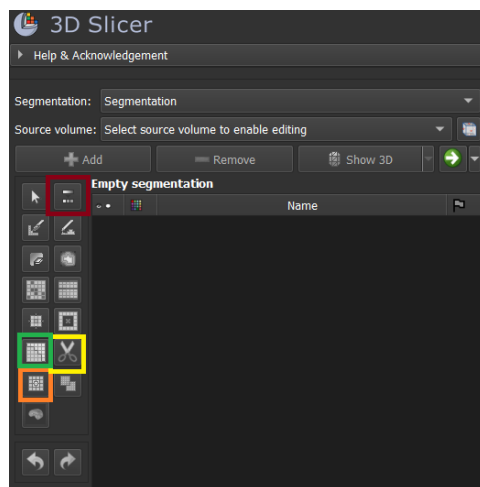


Figure 2: 3d slicer GUI to create, select and change segmentations. With the threshold tool in red, smoothing in green, cut in yellow and islands in orange.

## 4 Thresholding

The threshold tool (Figure: 2 in red) allows the user to create or refine a segment based on intensity values. It is useful for quickly isolating structures with known intensity ranges and high contrast to surrounding structures.

## 5 Scissors

The scissors tool (Figure: 2 in yellow) enables manual cutting of segments in 2D or 3D views. It can add or remove regions within defined shapes.

By drawing a curved line the concave part will be cut. By adjusting the camera to expose the area to be removed most segmentation artifacts can be removed.

## 6 Islands

The **Islands** tool (Figure 2, highlighted in orange) in 3D Slicer is designed for analysing and manipulating connected components, or "islands", within a single segment. This is particularly useful when a segmentation contains multiple disjoint regions, either due to noise or because the target structure itself is fragmented or too similar to in intensity to other structures.

The tool provides several functions:

- **Keep Largest Island**

This operation retains only the largest connected region within the selected segment and discards all smaller islands. It is commonly used to clean up noise after thresholding or automatic segmentation steps.

- **Remove Small Islands**

This function removes all islands below a user-defined size threshold. It provides more control than "Keep Largest Island" by allowing you to preserve multiple large regions while eliminating small, likely spurious ones.

- **Keep Selected Island**

This interactive operation allows the user to manually click on one island in the viewer to keep. All unselected islands will be removed. It's useful when the structure of interest is not the largest.

- **Remove Selected Island**

The inverse of "Keep Selected Island", this lets users manually remove one unwanted island by selecting it in the viewer.

- **Split Islands to Segments**

This powerful operation separates all islands into individual segments. Each connected component becomes its own segment within the same segmentation node. This is especially useful for labeling or quantifying multiple objects

These tools provide both automatic and manual ways to refine segmentations, making them essential for producing clean and accurate models for visualisation, analysis, or 3D printing.

## 7 Smoothing

The smoothing tool (Figure: 2 in green) helps refine the appearance of segments. Filters include median, Gaussian, and joint smoothing, each useful in different contexts.

When hovering the mouse in the 2D image with this tool selected a disk will appear in the 3D image, even when no smoothing is intended, this feature can be useful to help map the 2D image to the model.