Cleaver Lab Walkthrough

Cleaver 2.0 Beta Documentation

Center for Integrative Biomedical Computing
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Cleaver software download:

http://software.sci.utah.edu

Center for Integrative Biomedical Computing:

http://www.sci.utah.edu/cibc

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Chapter 1

Overview

This walkthrough was written for use in CIBC workshop as a guide for the allotted lab time. This document is meant to provide the information needed for the first time users to begin using Cleaver. It provides step by step instructions to install, setup, and run Cleaver with basic functionality. There are some example datasets and tutorials that will provide specific direction and training for using Cleaver; this walkthrough will provide the information needed setup your system, and to acquaint inexperienced users to Cleaver so that my begin exploring the provided tutorials or experimenting on their own.

1.1   Cleaver Description

Often for computer modeling and visualization, it is necessary to have geometry that represents different regions of homogeneous properties. An example of this is modeling white and gray matter in the brain together. Segmentations allow this type of demarcation of different regions using labels. Of course these segmentations must be based on real geometries to be useful, so they are often created from image data. Image data is taken from some kind of scanner and provides spatially dependent information about properties within a space. An example would be an MRI scan of the brain showing white and dark matter. Image data itself is often too varied for direct use into computer models, thus segmentations are used to generalize the regions in the space for easier computation.

Seg3D is a application that allows users to interactively visualize and segment image data. Using a slice and volume viewer, spacial visualization of the image data is very easy to manipulate and focus on important details. Many image processing tools are included in Seg3D that can modify the image volume and automatically and manually generate segmentations from the image data. Seg3D essentially puts many image processing and segmentation techniques into a very easy to use interface. The ease of use and power of the software makes Seg3D a critical tool in the generation of image based models.

System requirements

Hardware

CPU

Core Duo or higher, recommended i5 or i7.

Memory

At least 8GB, 32GB or more is recommended.

Graphics Card

OpenGL 2.0 or higher (Not available on older Intel embedded graphics cards), with at least 128 MB of memory, 1GB or more is recommended.

Operating System

Windows

Windows 7, 64-bit or later is supported.

Mac OS X

OS X 10.6, 64-bit or later is supported

Chapter 3

Getting Started

3.1 Installation

This lab uses Cleaver 2 Beta, which is not yet publically available. The installation files for Windows and Mac can be found on the workshop USB drive.

Please consider the system requirements (Ch. 2) before installing

3.1.1 Windows

The zipped installation files can be found at:
/workshop14/software/CS4_Cleaver/windows/Cleaver2Beta_x64.zip

Extract this file into an empty directory and run setup.exe to start the installer. The installer will guide you through the rest of the setup proecess.

3.1.2 Mac OS X

The zipped installation files can be found at:
/workshop14/software/CS4_Cleaver/mac/Cleaver2Beta_x64.zip

Extract this file into an empty directory. The application directory 'cleaver-gui.app' can then be dragged into the system Applications folder for install, or ran locally.

3.1.3 Cleaver2 Example Data

The main dataset for this lab is thee synthetic Mickey example. It comes in the form of a segmented label map image file: mickey4tDCS.nrrd. Additional datasets may also be provided at the workshop.

3.2 Starting Cleaver

When you start Cleaver, you will be presented with the main interface screen. (Figure 3.1). In this section, the various aspects of the this interface are outlined.

Figure 3.1. Starting interface for Cleaver

3.2.1   File Menu

From the 'File' menu at the top left, there are three types of data that can be loaded: a volume, a sizing field, or a tetrahedral mesh. (Figure 3.2). A sizing field cannot be loaded until a volume is already present, and so it is initially grayed out.

Figure 3.2. Loading Data

3.2.2   Data Manager

The Data Manager is located on the top right side of the interface. It contains a list of all currently loaded material fields, volumes, and generated meshes. (Figure 3.3). Pressing on the plus icon will expand any given data object to give a more detailed view. In addition, the various fields of a Volume object can be rearranged or swapped out by clicking and dragging other data objects into corresponding slots.
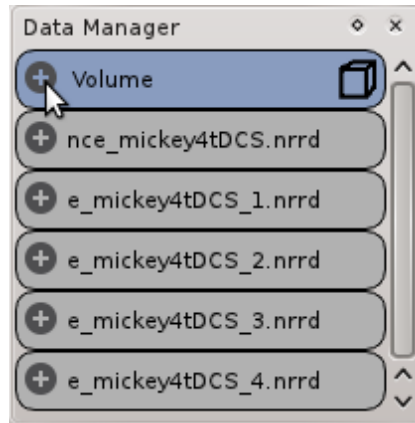
Figure 3.3. Data Manager

3.2.3 Sizing Field Creator

The Sizing Field creator is located on the top left side of the interface. The tool operates on the currently selected volume and is used to generate a field specifying the desired tetrahedron size for any given point in the domain. Various parameters can be set to tune how this field is created. (Figure 3.4).

The Size Multiplier is a scaling factor applied to the entire field after computing. The Sample Scale is the amount of refinement used on the input fields. The more the volume is refined, the smaller fine features can be detected. The memory and computational costs willa lso vary with this value. The Lipschitz parameter is a gradient limiting parameter. It specifies how quickly the sizing field may grow away from size-limiting features (like corners or curved interfaces). Padding simply adds a padding material around the exterior of the domain. Finally, you can specify the surface size to be Constant or Adaptive. Cleaver2 allows the sizing field to vary across interface surfaces, this is the Adaptive mode. Constant mode is provided to replicate the behavior of Cleaver1, should that form be desired.
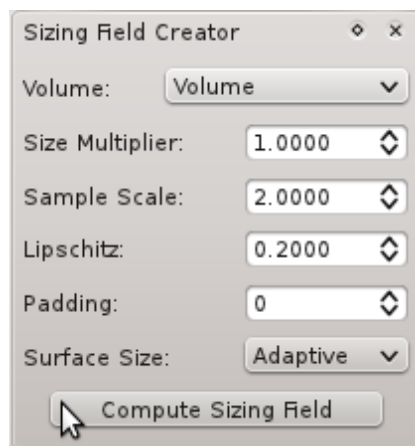

Figure 3.4. Sizing Field Creator

3.2.4 Cleaving Tool

The Cleaving Tool is located on the bottom left side of the interface. For the purposes of this lab, only the Construct Mesh button on the Basic tab is necessary. (Figure 3.5).
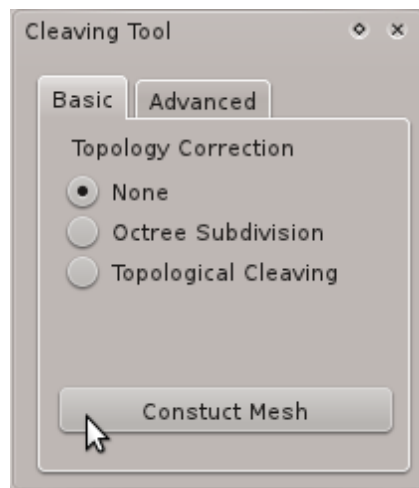

Figure 3.5. Cleaving Tool

3.2.5 Mesh View Options

Mesh View Options are located on the bottom right side of the interface. Various aspects of the mesh visualization can be toggled on and off using checkboxes. Mesh clipping is supported on the major axis. In addition, Material Visibility locks can be set for individual materials. These locks exclude the given material from being clipped by the clipping plane.
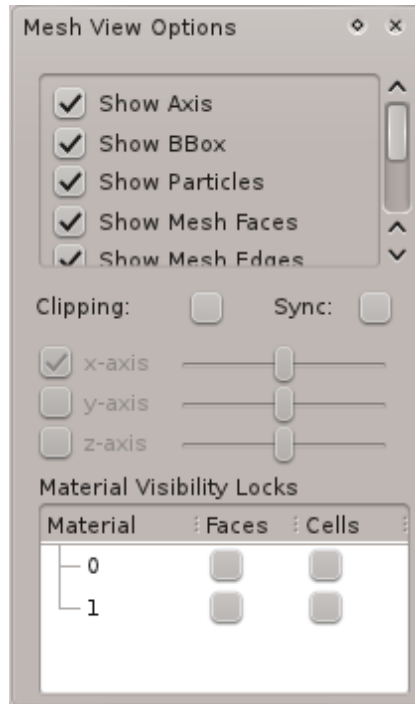
(Figure 3.6).

Figure 3.6. Mesh View Options

Example Dataset Walkthrough

In this section we will utilize the test 'Mickey' dataset and go through an entire use-case for Cleaver. Before beggining, make sure you have access to either the Mickey NRRD files, or alternatively, your own set of NRRD files.

4.1 Loading The Volume

Begin by clicking on the *File* menu at the top left of the window (on Mac this menu will be placed in the system toolbar.) and selecting *Import Volume*. (Figure 4.1).

Figure 4.1. Loading the Data

Navigate to the directory containing your indicator functions (NRRD files). For convenience, only files ending with acceptable extensions will be shown. Using Ctrl or Shift, select *all* material files that you wish to include in the volume. (Figure 4.2). Note, because indicator functions are typically interdependent for a given volume, leaving out materials may lead to unexpected output interfaces.
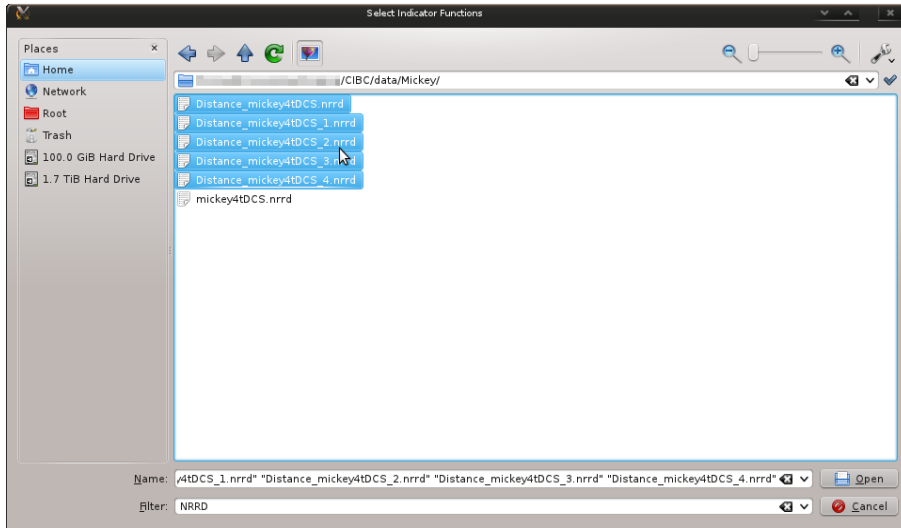
Figure 4.2. Select Material Indicator Functions

Press *enter* or left-click on the *open* button to initiate loading the indicator fields and create a volume group. If the load was successful, the Data Manager window will display all material fields and the new volume that contains them. (Figure 4.3).
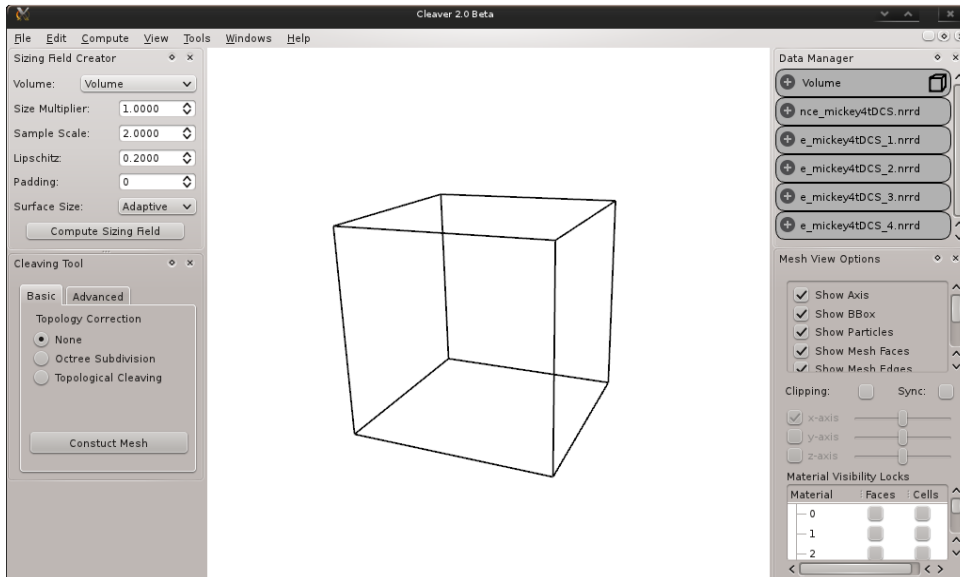

Figure 4.3. Volume and Material Functions Loaded

To verify that the contents of the volume is what you expect, left-click on the Volume Data field's expansion icon (+). (Figure 4.4). Note that the slot for Sizing Field is initially empty. This field can be imported from file using the File menu, or computed using Cleaver as shown in the next step.
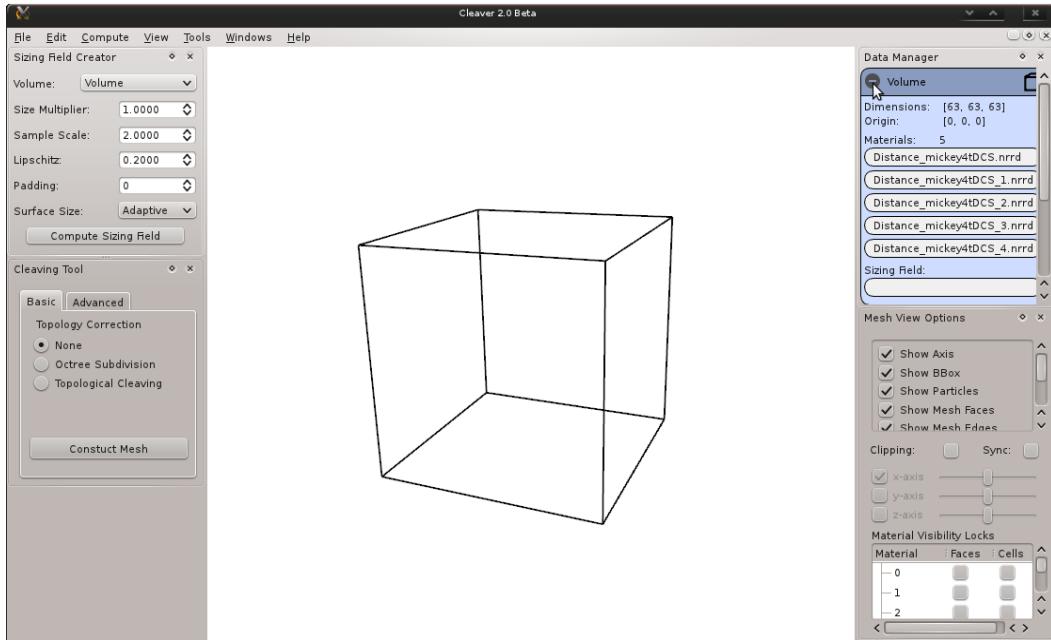
Figure 4.4. Expand Volume Data View

4.2   Computing A Sizing Field

The Sizing Field Creator widget allows you to select any loaded volume and compute a sizing field for it. This sizing field specifies the ideal element size for a tetrahedron at any point in the volume. The Size Multiplier is a scaling factor applied to the entire field after computing. The Sample Scale is the amount of refinement used on the input fields. The more the volume is refined, the smaller fine features can be detected. The memory and computational costs willa lso vary with this value. The Lipschitz parameter is a gradient limiting parameter. It specifies how quickly the sizing field may grow away from size-limiting features (like corners or curved interfaces). Padding simply adds a padding material around the exterior of the domain. Finally, you can specify the surface size to be Constant or Adaptive. Cleaver2 allows the sizing field to vary across interface surfaces, this is the Adaptive mode. Constant mode is provided to replicate the behavior of Cleaver1, should that form be desired.

For this experiment, specify values of 1 for Size Multiplier, Sample Scale and Lipschitz and specify a Constant surface size. Then click *Compute Sizing Field*. (Figure 4.5). Verify that the Sizing Field slot of the Volume in the Data Manager now contains a field.
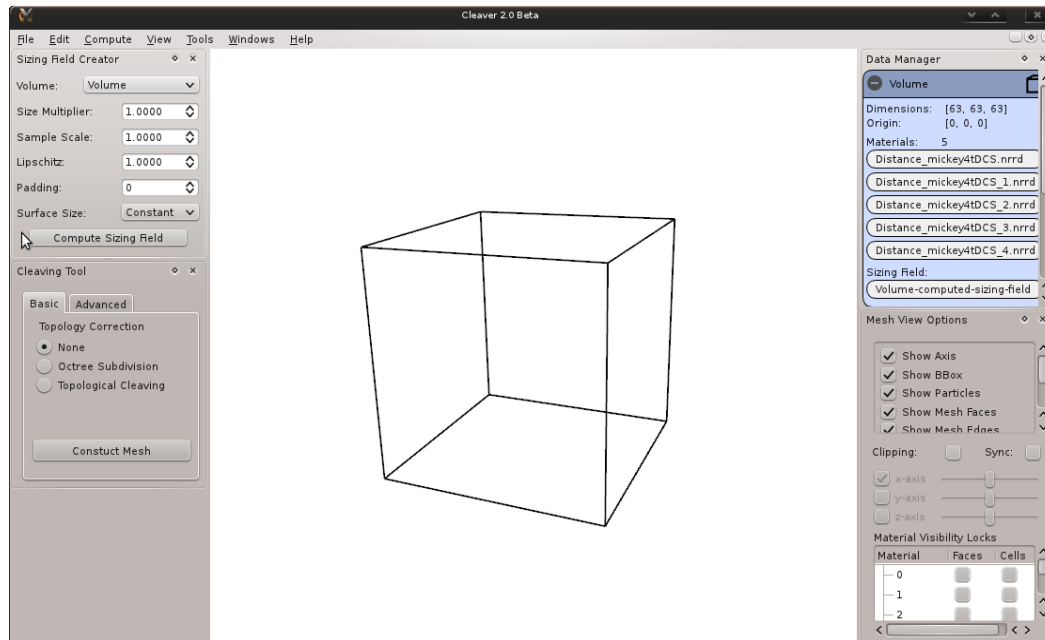
Figure 4.5. Compute Sizing Field

4.3 Generating The Mesh

With a loaded volume containing material fields and a sizing field, we can use the Cleaving tool to generate the tetrahedral mesh. The Cleaving tool contains two tabs: basic and advanced. The basic tab contains a single button to generate a mesh from the currrently loaded Volume. Click this button. (Figure 4.6)

If the volume does not yet contain a sizing field, this tool will automatically compute one with default parameters. This process may take some time complete. When it is complete, the compute button will gray out and the interface will become responsive again. The release version will be multithreaded and not suffer from this unresponsiveness. Alternatively, the advanced tab allows the user to slow down and go through each step of the cleaving process. This can be useful if the computation is taking a long time and you want to break it up into chunks.
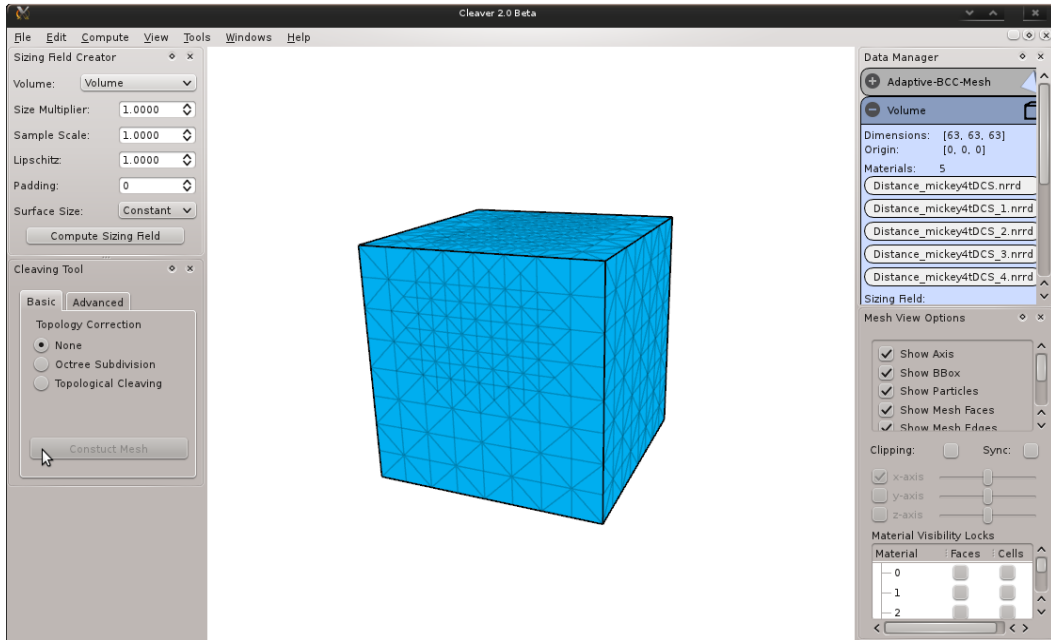
Figure 4.6. Construct Mesh

4.4   Visualization

With the mesh completed, you can now use the mouse and the Mesh View Options tool
to explore it in more depth. Left-Click and holding anywhere in the central mesh view
window will allow you to rotate the mesh. The Scroll-Wheel can be used to zoom in or
out of the mesh. Right-Click and holding allows you to pan the view camera horizontally
and vertically. At any time, you may press the *Space-Bar* to reset the camera and mesh
orientation to default.

4.4.1   Clipping

Clicking the *Clipping* checkbox of the Mesh View Options tool will enable the three clip-
ping planes. (Figure 4.7). The axis checkboxes can be used to change the current plane
orientation, and the respective sliders can be used to move the clipping plane forward and
backward.

   While the plane is being moved, a graphic displays the current position of the plane but
no updates to current visible elements are shown. Once you release the mouse button, the
view is updated. This improves responsiveness for large meshes or slower machines.

   Clicking on the *Sync* checkbox forces the visible elements to update in real-time as the
clipping plane is moved. This is more taxing on the hardware but can often provide a more
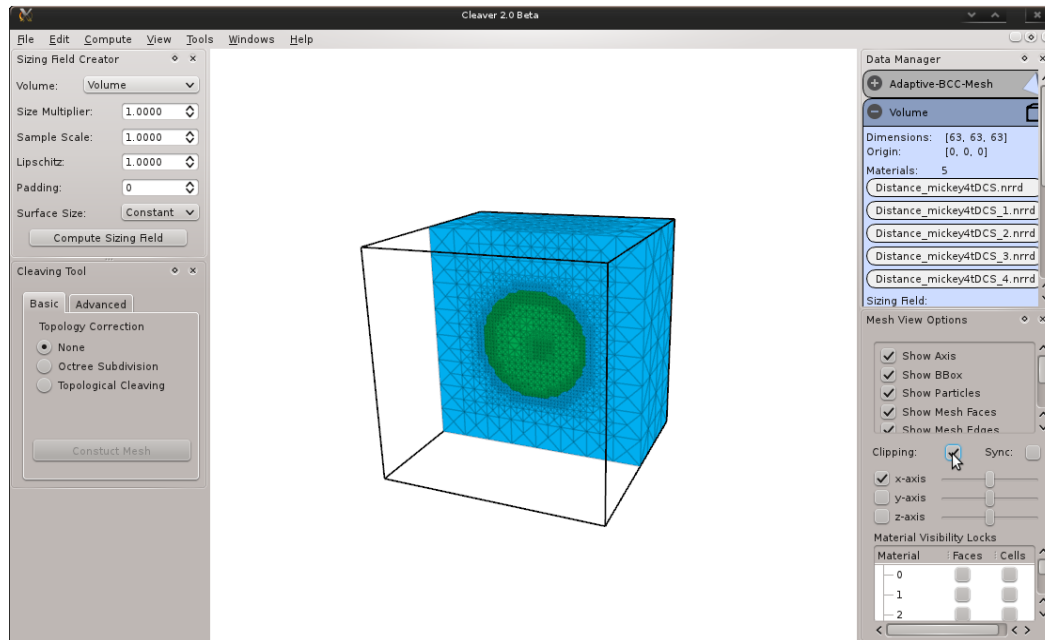intuitive understanding of the mesh.

Figure 4.7. Clipping Planes

Finally, you can force any material to remain unclipped by using the Material Visibility Locks. Select the *Faces* checkbox for the desired material and the clipping plane will ignore this material. The combination of clipping and face locks can be very beneficial for visualizing material embeddings.

4.4.2   Surface View

To enable surface-only rendering, select the *Show Surfaces* checkbox. (Figure **??**). If this checkbox is not visible, scroll down the list of View Options. These surface views will also be clipped by any active clipping plane.
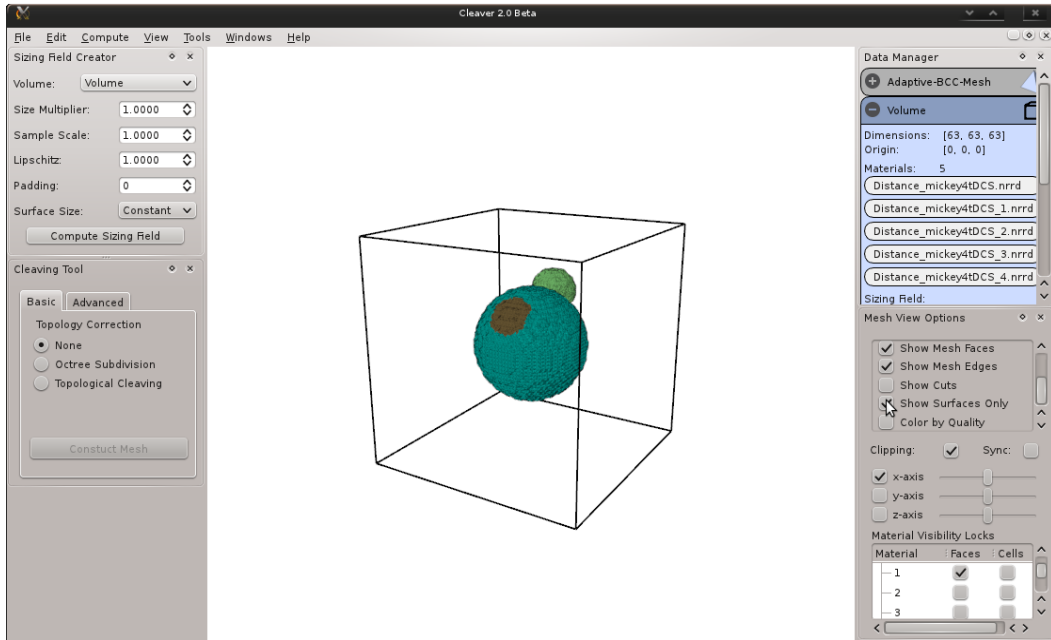
Figure 4.8. Surface View

4.5 Exporting A Mesh

To export the generated mesh, find the output mesh in the Data Manager. Right-Click on the Mesh object and select *Export Mesh*. (Figure 4.9). In the file selector that opens, you can rename the output mesh and select the desired format: TetGen tet mesh, PLY surface mesh, or Matlab binary tet mesh.
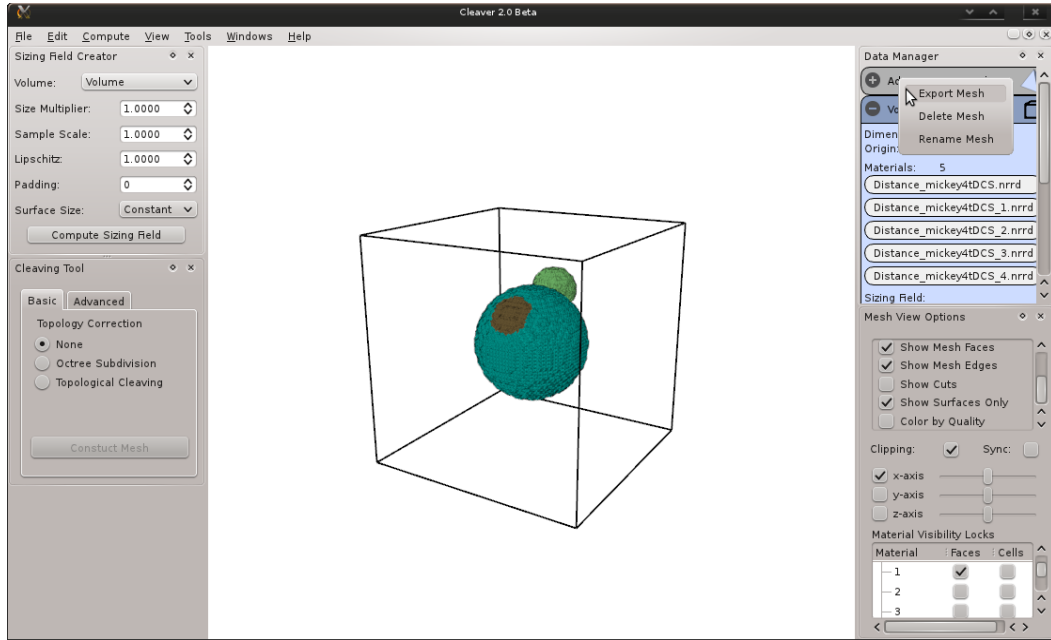
Figure 4.9. Export Mesh