

ShapeWorks Lab Walkthrough

1 System requirements

Hardware

Graphics Card

OpenGL 2.0 or higher (not available on older Intel embedded graphics cards), with at least 128 MB of memory, 256MB or more is recommended.

Operating System

Windows

Windows XP or later is supported.

Mac OS X

OS X 10.6 - 10.9 are supported.

2 Getting Started

2.1 ShapeWorks Installation

The command line tools used in this lab section is available on the flash drive provided to all participants in a ShapeWorks zip file. The ShapeWorks Client is available as a platform specific installer. Please copy the ShapeWorks tools to a convenient location on your filesystem.

2.1.1 Windows

Windows binaries are located under software → CS3_ShapeWorks → windows. Unpack the ShapeWorks.zip file in a convenient location, for example C:. Install the ShapeWorks Client GUI using the installer (ShapeWorksClient-1.1.0-win*.exe) provided on the flash drive.

2.1.2 Mac OS X

Mac OS X binaries are located under software → CS3_ShapeWorks → mac. Unpack the ShapeWorks.zip file in a convenient location, for example /Applications. Install the ShapeWorks Client GUI using the disk image (ShapeWorksClient-1.1.0-Darwin.dmg) provided on the flash drive.

2.2 ShapeWorks Broker

We will be running the ShapeWorksBroker locally. The directory used in the **broker_rootdir** parameter should not already exist. The ShapeWorksBroker will create this directory and populate it with project information.

Make a note of the password generated by ShapeWorksBroker. It will be required by the ShapeWorksClient application.

2.2.1 Windows

```
ShapeWorksBroker.exe broker_address=localhost \  
  broker_rootdir=c:\shapeworks_run
```

2.2.2 Mac OS X

```
./ShapeWorksBroker broker_address=localhost \  
  broker_rootdir=/Users/aylaxhan/shapeworks_run
```

2.3 ShapeWorks Server

We will be running the ShapeWorksServer locally.

2.3.1 Windows

This example assumes that the ShapeWorks command line tools have been installed in c:.

```
ShapeWorksServer.exe broker_address=localhost shapeworks_dir=c:\ShapeWorks
```

2.3.2 Mac OS X

This example assumes that the ShapeWorks command line tools have been installed in the Applications directory.

```
./ShapeWorksServer broker_address=localhost shapeworks_dir=/Applications/ShapeWorks
```

3 Example 1: Torus

The sample dataset software \rightarrow CS3_ShapeWorks \rightarrow data \rightarrow TorusExample contains a population of synthetically generated tori, parameterized by the small radius r and the large radius R . The shapes in this population resemble the ones in Figure 1.

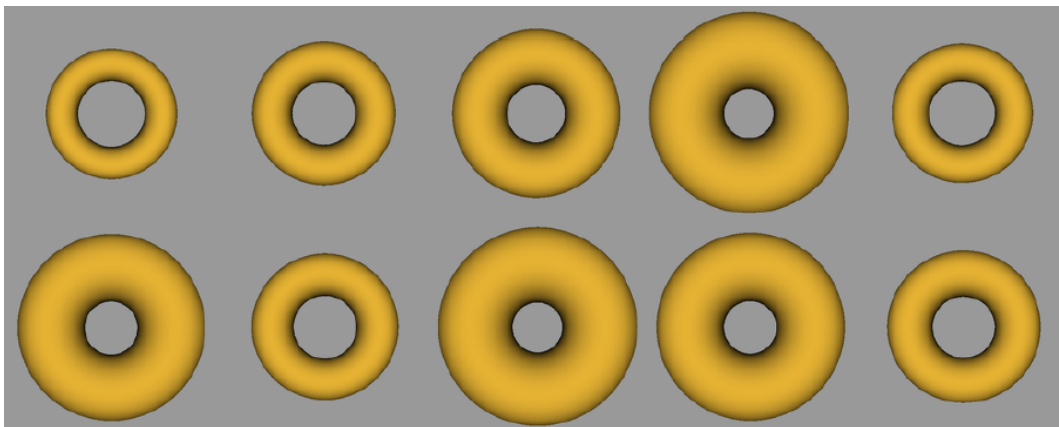


Figure 1: shapes from an example population of tori

We will initialize and optimize correspondences on these shapes to visualize and analyze the shape variation using the GUI tool.

3.1 ShapeWorks Client

Open the ShapeWorksClient application. Connect with the ShapeWorksServer by entering the password generated by the ShapeWorksBroker and pressing the **Connect** button (see Figure 2). The use of the ShapeWorksClient is described in detail in the ShapeWorksRemoteClient documentation.

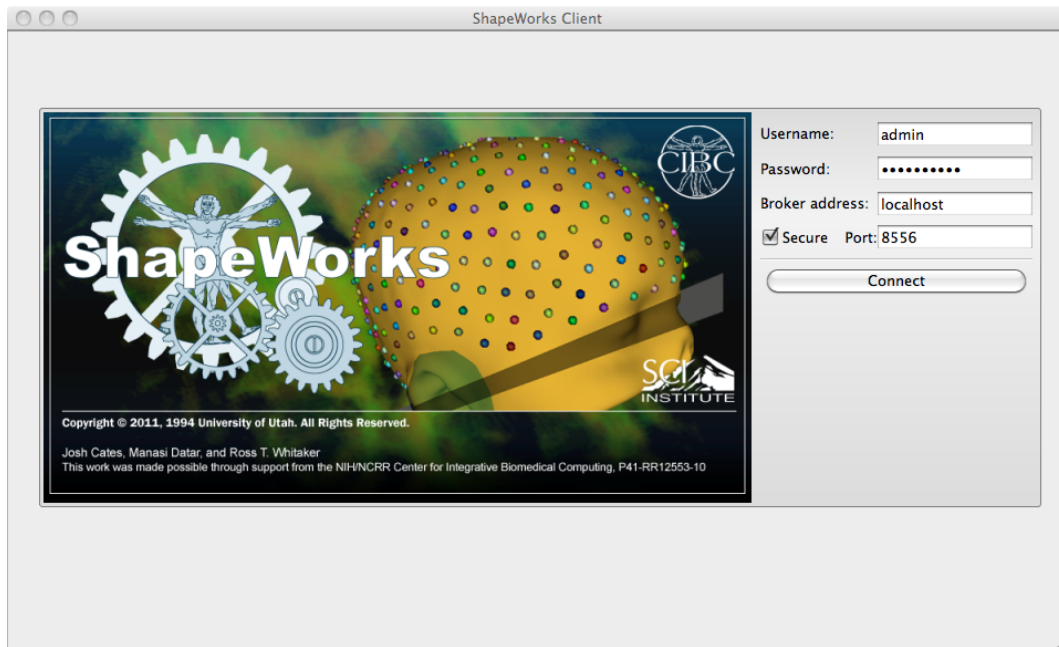


Figure 2: Starting the ShapeWorksClient (shown on Mac OS X).

3.1.1 Preferences

Make sure that the auto-detect Seg3D2 and ShapeWorksView locations are enabled (see Figure 3 for Mac OS X).

3.1.2 Mac OS X Security Settings

It may be necessary to temporarily change Mac OS X security settings on OS X versions 10.8+ to launch Seg3D and ShapeWorksView2 visualization tools from the **Analyze** buttons in the interface of each step.

If the visualization tools do not launch, try setting changing the **Security & Privacy** settings in **System Preferences** to allow any application to run (see Figure 5).

3.2 Preprocessing

Follow these steps to apply preprocessing filters to the input segmentation data in order to prepare it for the particle optimization process. The first preprocessing step cleans the segmentation by

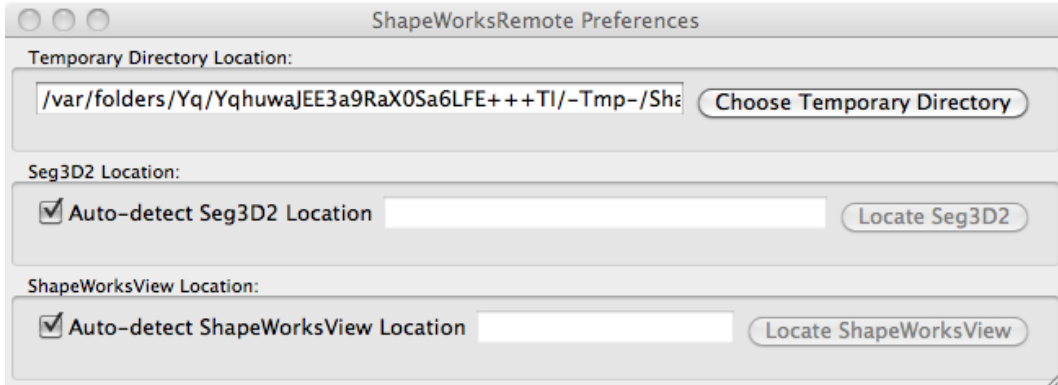


Figure 3: Set ShapeWorks Client preferences for visualization tools (shown on Mac OS X).

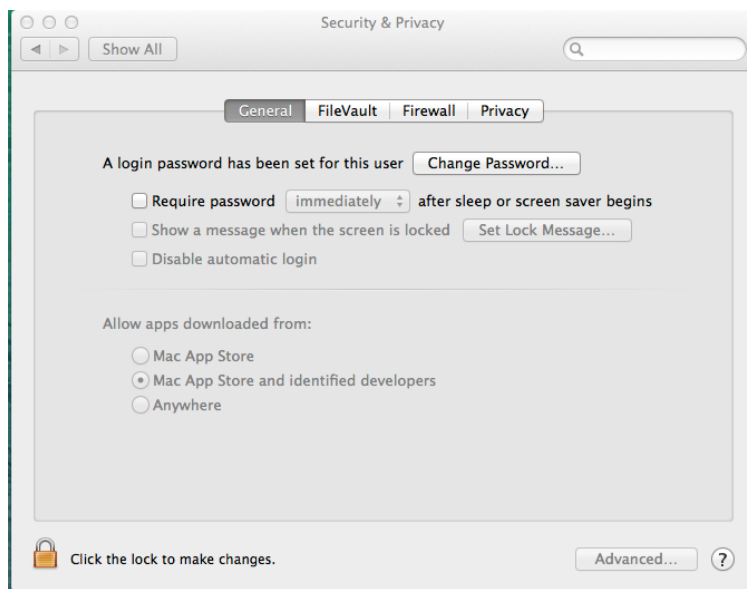


Figure 4: Default security settings for Mac OS X 10.8+.

isolating the largest connected component and centers every shape in a common bounding box. The second preprocessing step performs antialiasing and creates signed, smooth distance transforms for input into the optimization stage.

3.2.1 ROI

Runs ShapeWorksGroom with a set of parameters controlled through the ROI interface (see Figure 6). By default, ShapeworksGroom is run with the parameters **isolate**, **hole_fill** and **auto_crop**. Use the **Analyze** button to view the data produced by this stage in Seg3D.

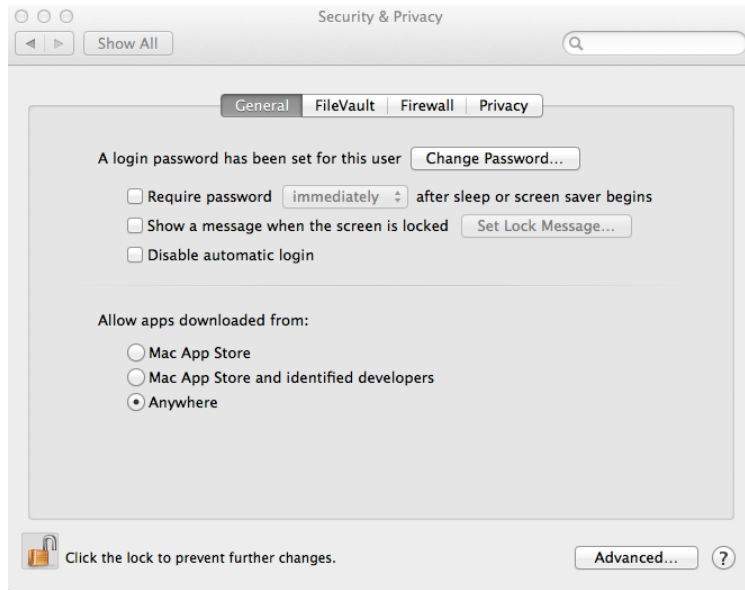


Figure 5: Most permissive security settings for Mac OS X 10.8+.

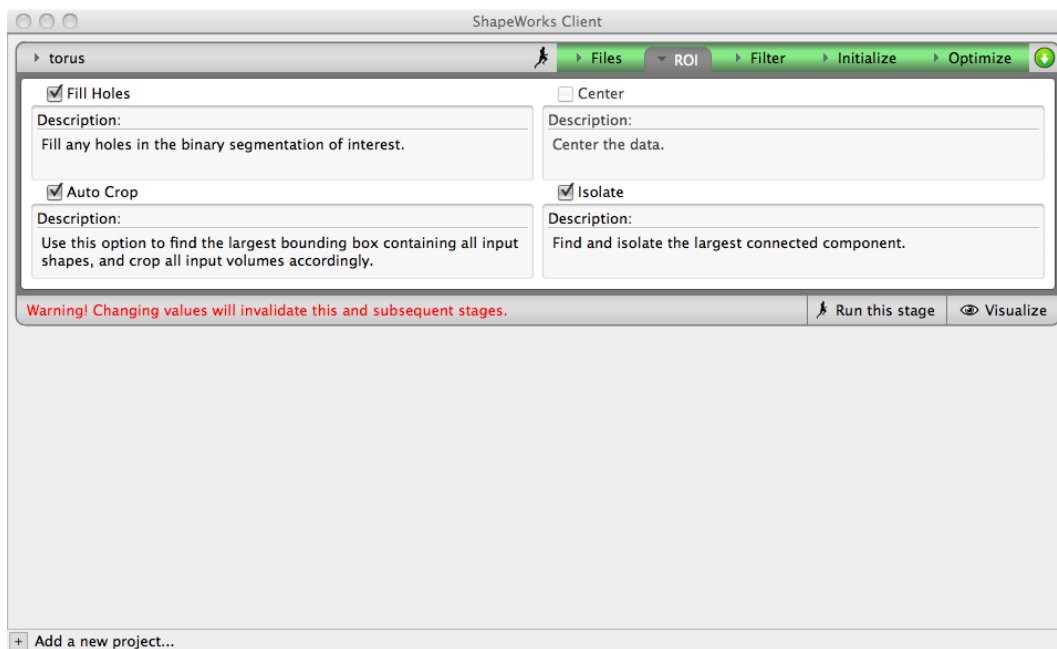


Figure 6: ROI interface (shown on Mac OS X).

3.2.2 Filter

Runs ShapeWorksGroom with a set of parameters controlled through the Filter interface (see Figure 7). By default, ShapeworksGroom is run with the parameters **antialias**, **fastmarching** and **blur**. Use the **Analyze** button to view the data produced by this stage in Seg3D.

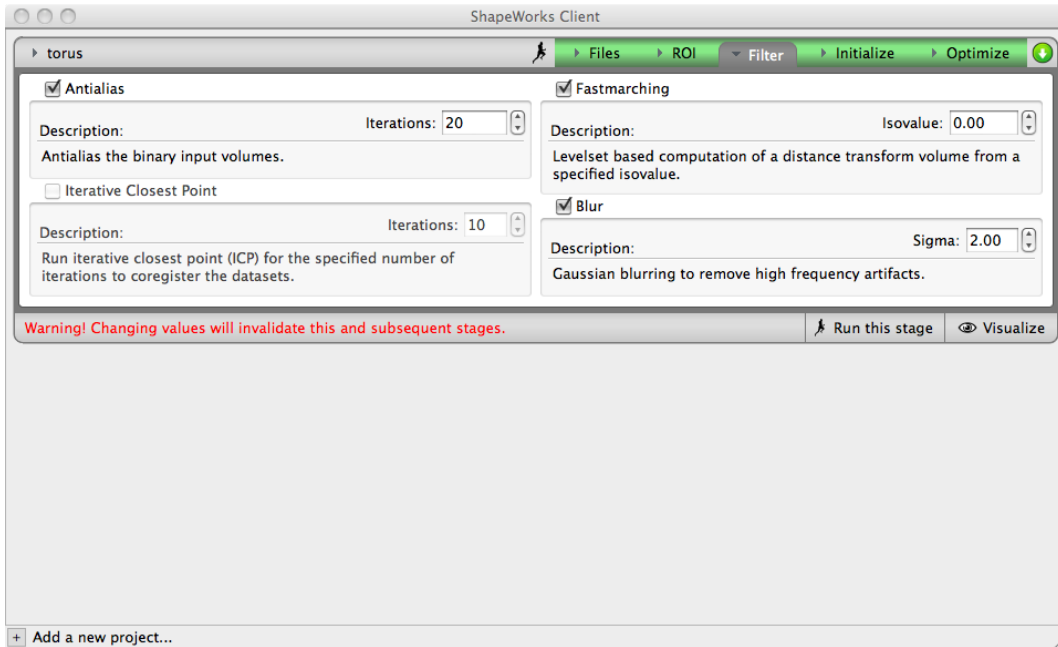


Figure 7: Filter interface (shown on Mac OS X).

3.3 Optimization

Next, we will initialize and optimize correspondences on the tori, using the distance transforms as input. Figure 10 displays example tori shapes with resulting correspondences overlaid as circular glyphs.

Execute the next two steps to perform this step and obtain a point-based representation of each shape in the population:

3.3.1 Initialize

Runs ShapeWorksRun with a set of parameters controlled through the Initialize interface (see Figure 8).

3.3.2 Optimize

Runs ShapeWorksRun with a set of parameters controlled through the Optimize interface (see Figure 9).

Once the correspondences are optimized, we can obtain a mean shape model and analyze the variation in the population using PCA. Figure 11 depicts the shape variation captured by the first two PCA modes in an example population of tori. The shapes are reconstructed from their respective point-based representations with point positions optimized in the earlier stage.

Use the **Analyze** button in the Initialize and Optimize interfaces to bring up the ShapeWorksView2 GUI for the analysis tool.

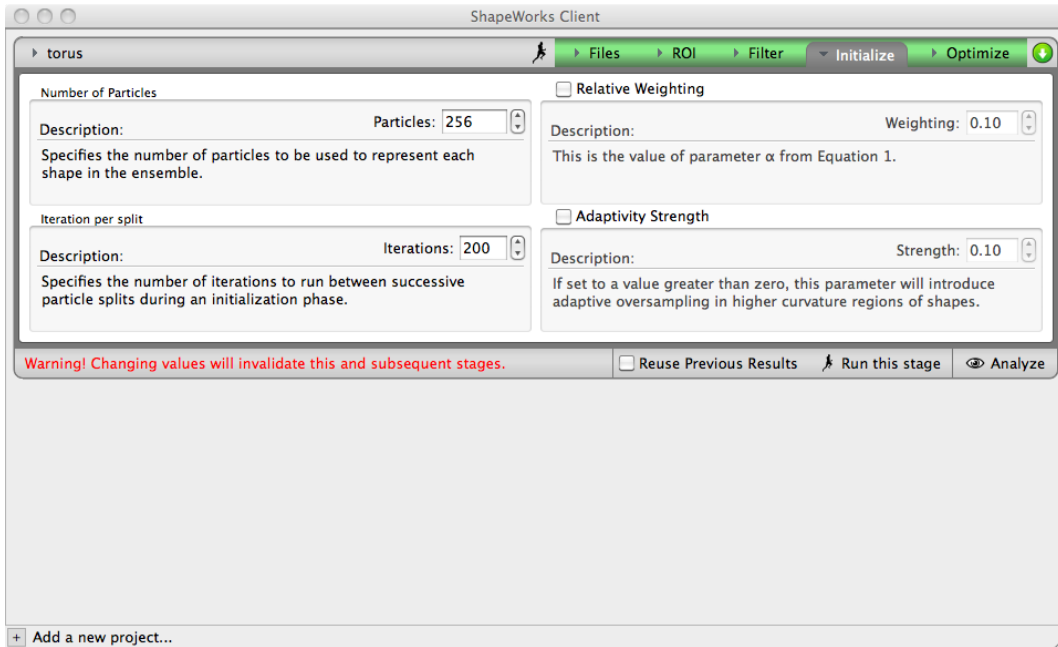


Figure 8: Initialize interface (shown on Mac OS X).

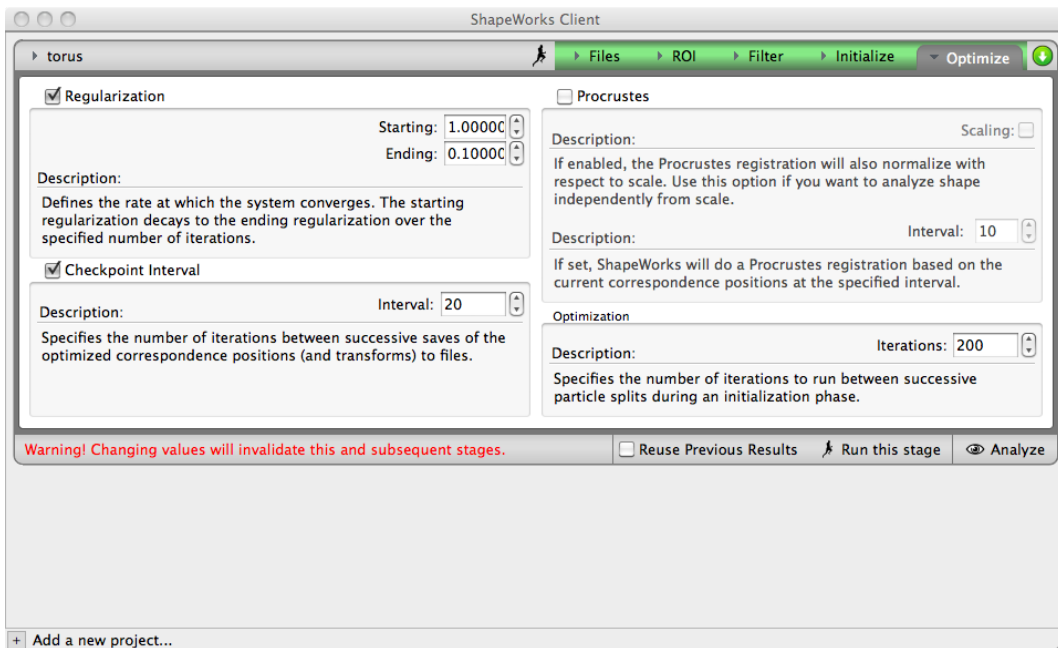


Figure 9: Optimize interface (shown on Mac OS X).

4 ShapeWorks Manual

More details about the various filters and parameters can be found in the ShapeWorks manual located in labs → CS3_ShapeWorks on the USB drive provided.



Figure 10: an illustration of correspondences on a few tori from example population

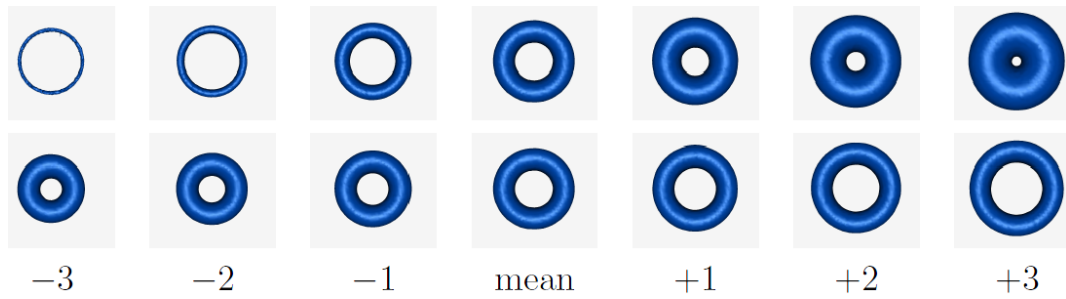


Figure 11: The top two PCA modes of variation for the torus shape model, shown in the first and second rows, respectively. These correspond to the shape changes from the generative model.