

# BOrient Tutorial

Jonathan Merritt  
j.merritt@pgrad.unimelb.edu.au

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## 1 Objective

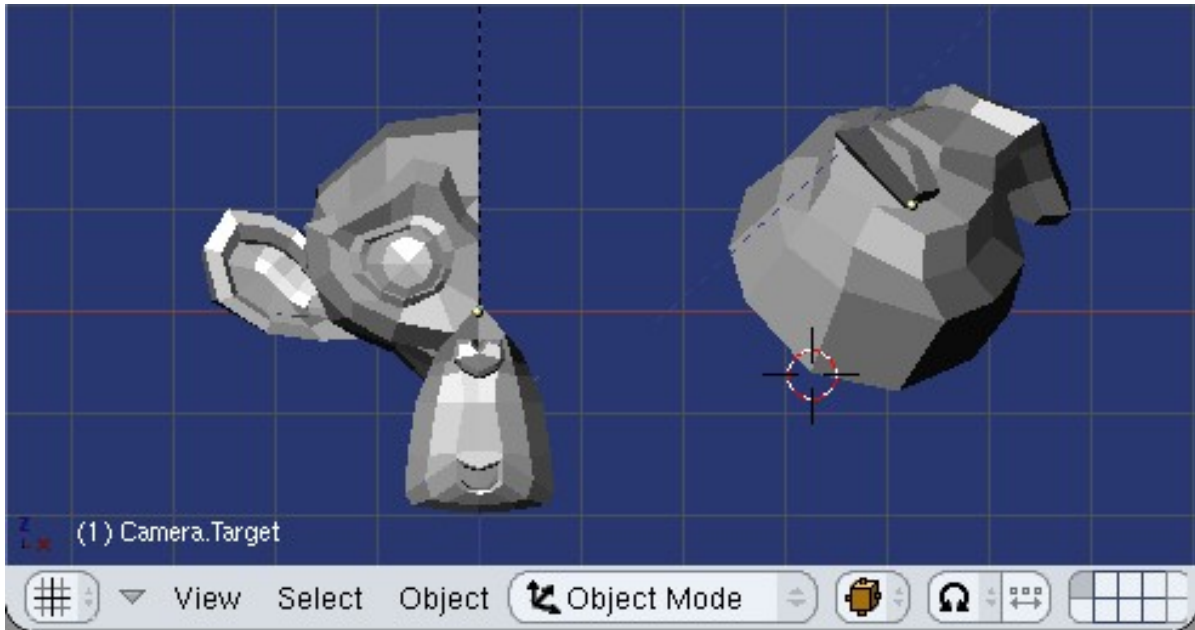
In this tutorial, we will be aligning a pair of objects. This may sound like a simple task, but I would encourage you to attempt to do some orientations manually. You will discover that the manual process takes several iterations, and you will have to inspect the aligned objects closely in order to be sure that your alignment is good. Figure 1 shows the pair of objects we will be aligning in this tutorial: two parts of the Blender monkey, called Suzanne.

The alternative to manual alignment is to use a mathematical procedure that can perform an alignment automatically. In the `BOrient.py` script, the method used was originally described by Challis (1995) [1]. This method finds a least-squares fit for the rigid body transformation between one object and the other. You need to specify *at least* three points that the two objects to be aligned have in common. More than three points can be used, and typically the more points you use the better your fit will be. The Challis method can also calculate a uniform scale factor between the two objects if they don't happen to be the same size.

## 2 Tutorial

### 2.1 Load and examine the tutorial file

Begin by loading the file `BOrient-tutorial.blend`. This file contains the two objects that we plan to orient. Also marked are some Empties, which specify the locations of common points on the two objects. In practice, if you are digitizing an object, it is not difficult to find common points provided that you spend a little time planning your digitizing. Notice that Empties on one object are all called “Source  $x$ ” and those on the other are all called “Target  $x$ ” where  $x$  is some number. This naming scheme has been adopted to simplify the process, but is not actually necessary - you can name the Empties any way you wish. We will be moving the



**Figure 1:** A pair of objects to orient. In this tutorial, the two objects are parts of the Blender monkey, Suzanne.

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“source” object so that it aligns with the “target” object. Take a few seconds to convince yourself that the source and target empties are actually placed at corresponding locations on the two meshes. Figure 2 shows the meshes with the source and target empties.

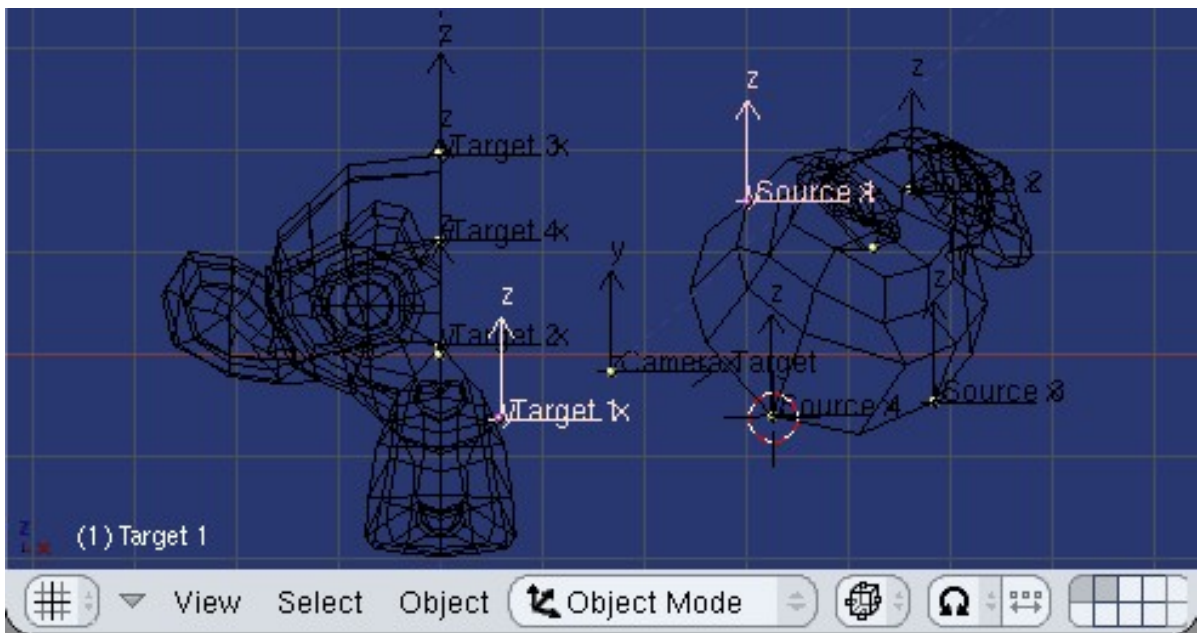
## 2.2 Load and execute the BOrient.py script

Open a script window, and load the BOrient.py script. Depending upon your installation, you may be able to select this script from the Scripts menu, or you may need to load it as a text file and execute it. Either method will suffice. Figure 3 shows the BOrient.py script as it will appear immediately after it has been started.

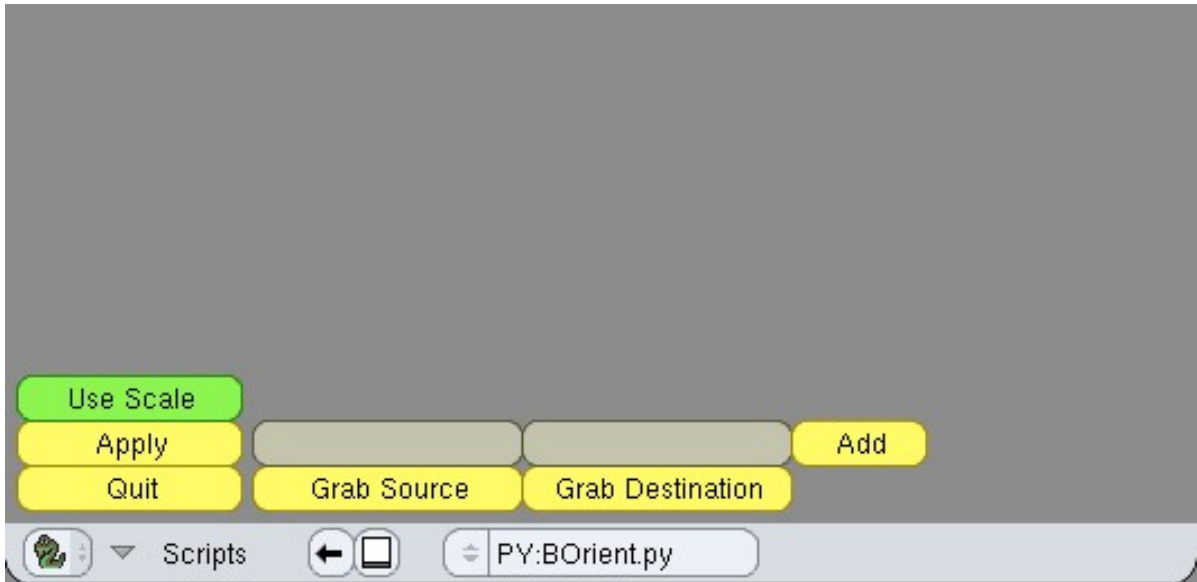
## 2.3 Establish corresponding points

We must now tell the script which empties associated with one mesh correspond to the empties pointing to the same locations on the other mesh. To achieve this, the following series of steps can be followed:

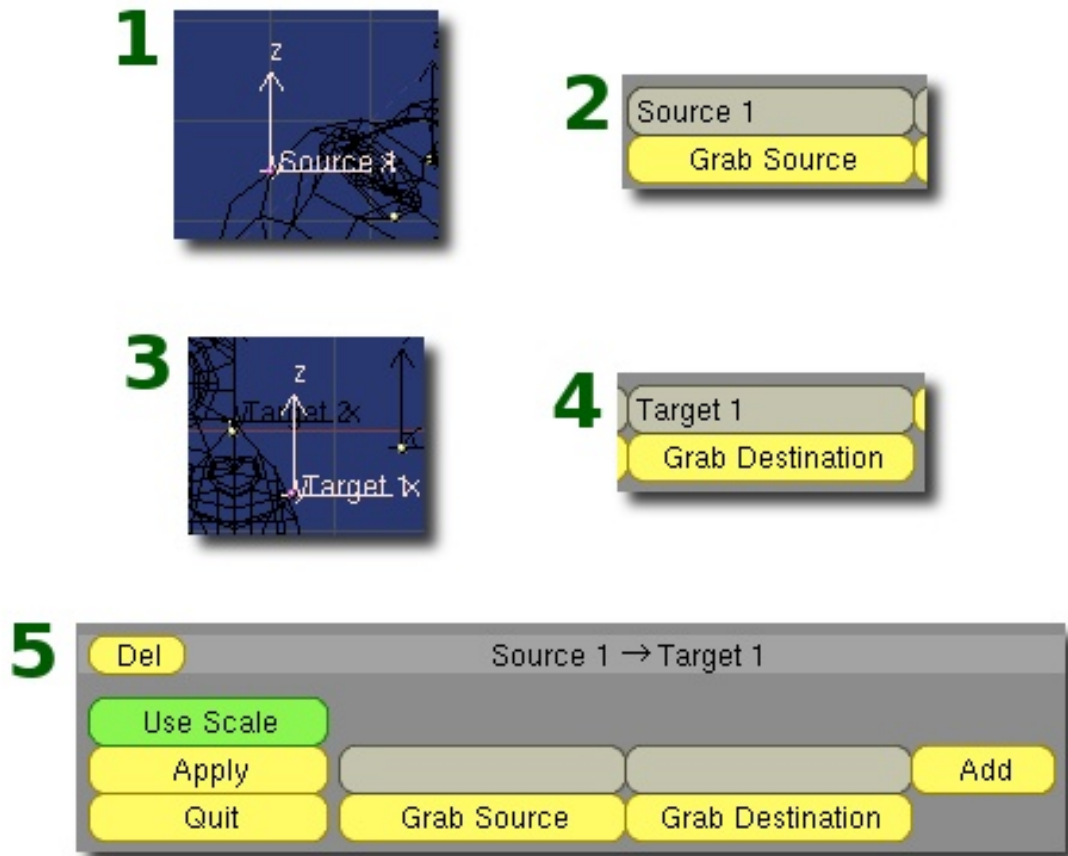
1. Select a “source” empty in the Blender 3D view.
2. Click the “Grab Source” button in the script window.



**Figure 2:** Empties placed at corresponding locations on the “source” and “target” objects.



**Figure 3:** The BOrient.py script immediately after startup.

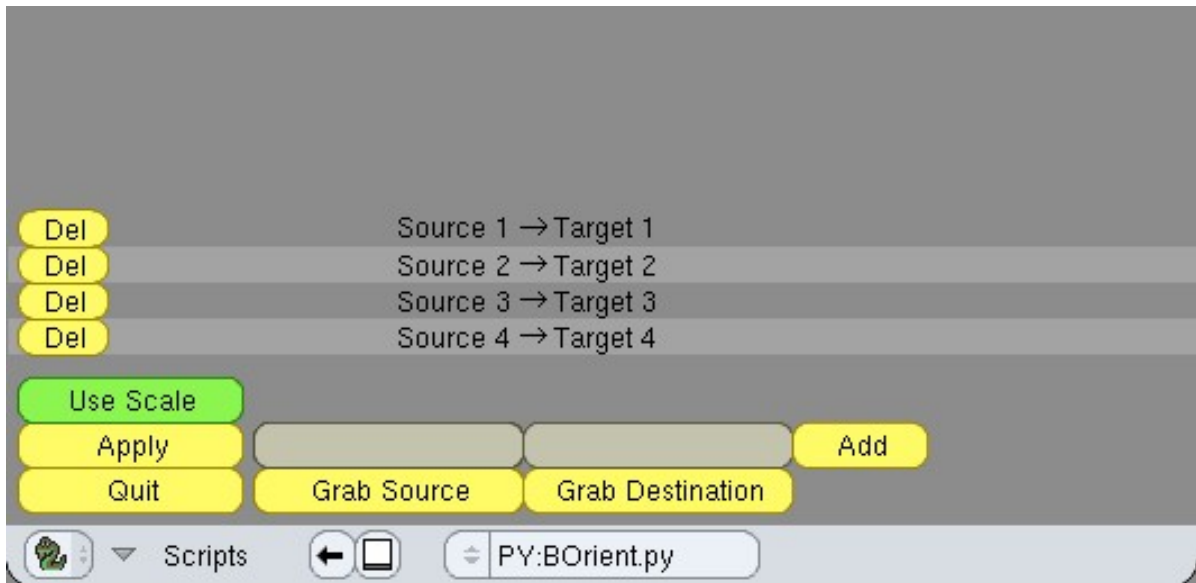


**Figure 4:** Establishing a correspondence between source and destination (target) points within the BOrient.py script.

3. Select a “destination” (target) empty in the Blender 3D view.
4. Click the “Grab Destination” button in the script window.
5. Click the “Add” button in the script window.

Figure 4 shows the result of each of the five steps graphically. If necessary, you can delete a correspondence using the “Del” button adjacent to it. The source and destination text boxes can also be edited manually.

Finish establishing correspondences between the source and destination points until you have registered all four pairs of Empties. The status of the script window once all four correspondences have been established is shown in Figure 5.



**Figure 5:** The view of the script window after all four correspondences have been established.

## 2.4 Transform the source object to the target object

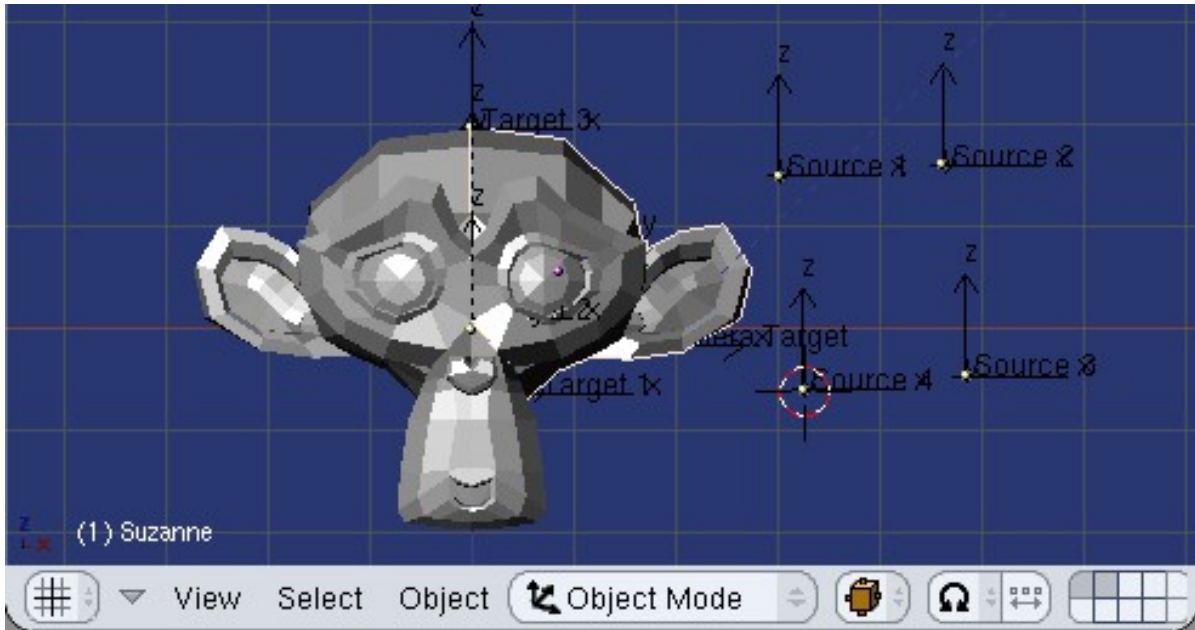
Once all of our corresponding points have been marked and registered with the script, we can then transform the source object to the target object. To achieve this, do the following:

1. Select the source Suzanne mesh (called “Suzanne”) in the Blender 3D view.
2. In the script window, click the “Apply” button.

If all has gone to planned, the source mesh should be properly aligned with the target mesh, as shown in Figure 6.

## 3 Conclusion

In this tutorial, you have seen how to perform full 3D alignment of a pair of objects based upon point correspondences. This can be useful when digitizing an object because it is often not possible to view all parts of an object during a single digitizing session. There are numerous other applications. Bear in mind that the technique is robust and resilient in the face of small errors in the point locations, especially when more than three points are used.



**Figure 6:** Alignment of the meshes after orientation has been completed.

### References

[1] J.H. Challis. A procedure for determining rigid body transformation parameters. *J. Biomech*, 28(6):733–737, 1995.