The Landmark Cookbook

August 24, 2011

This document gives step-by-step instructions for specific tasks using the "advanced features" of Landmark (beyond placing landmarks), in particular using a template to interpolate data sets along an evolutionary tree, looking for the best position for a fossil in a tree, and symmetrizing a fossil.

Here are a few background concepts. A template mesh is a .ply file which will be warped onto to multiple data files. If "projection" will be used, the template must be a clean manifold mesh (no holes, no dangling triangles, no boundaries). Projection tries to match the data more exactly than TPS warping, which just warps the template so that its landmarks match those of the data file.

A treemorph takes a tree as input, with landmarked warped copies of the same template representing all of the leaf nodes, and computes a warp for the template to represent any point in the interior of the tree. Also known in Landmark as a "blob".

Just as a general note, remember that on the Mac or other single-mouse-button system, right-click is control-click, and to zoom use control-option.

1 Moving a landmarked mesh from one .land file to another

Input: A landmarked mesh in a .land file
Output: Another new or old .land file, containing the landmarked mesh.

1. Open the source .land file.
2. Right-click the taxon in the left-hand column, choose export.
3. Select .ply file, click OK.
4. Select .cor file, click OK. Save to same folder as the .ply file.
5. Close the source .land file and open the target .land file
6. Menu "file", "into project", and browse for the .ply file

Both the file and its landmarks will be imported into the target .land file

2 Saving out an intermediate tree mesh as a new .ply file

Input: A tree with blob computed
Output: A .ply file containing the warped template mesh for an intermediate, without landmarks.

1. Open the tree window, choose preview, and click on the desired point on the tree. Depending on what kind of state Landmark is in, you'll see either the mesh with point landmarks, or just the point landmarks.

2. Right click on the tree itself (above the blob) and click on "Import from C." This will import the mesh that is being rendered in the C Window, as Mesh1.

3. Export Mesh1 as a .ply file (right-click, export).

Issue: It can be hard or impossible to get the dot to go where you want it on a crowded big tree.

3 Transferring landmarks to a warped template mesh

Input: A warped template mesh with no landmarks "target" and another one with landmarks "atlas"
Output: Transfers the landmarks from atlas to target

1. Select both atlas and target, by left-clicking one and then shift-right-clicking the other.

2. Right-click either one,→custom plugins→landmark transfer→landmark transfer for bijective meshes, select atlas as the Atlas, then click OK.

3. If you load target into A, should be able to see landmarks.

Bug: After this, it may not be possible to set correspondences between target and any other mesh. Workaround: save and reopen the land file.
Bug: This might fail to transfer landmarks correctly (it failed for me with target being template projected to Victoriapithecus, but worked for target begin TPS to Victoriapithecus). Workaround: ???

4 Project template mesh to possibly incomplete data

Input: Landmarked template mesh, landmarked .ply file of target mesh, possibly with missing landmarks indicated.

Output: Template mesh projected onto target.
Projecting the template to the target uses all of the vertices of the meshes to get as close a surface match as possible. If there are missing regions in the target, those regions are covered by a warped version of the template.

1. Check for missing landmarks on the target, by loading it into A and using the 1-2-3 toolbar button.

2. Load the template mesh into B.

3. Set up correspondences using the "A=B" button on the toolbar. You can use the "⟩⟩" button to set all the correspondences, and then go back and remove missing correspondences with the "⟨" button.

4. Select the two meshes, right click one of them, Custom Plugins→Landmark Transfer→Project template to target. This will project the template to the fossil, and save out a file named as "Template_Filename.ply"

5 TPS warp template mesh to incomplete data

Input: Landmarked template mesh, landmarked .ply file of target, possibly with missing landmarks indicated
Output: Template mesh projected onto target data
The TPS warp just uses the landmarks to produce a template mesh similar to the target.

1. Check for missing landmarks on the target, by loading it into A and using the 1-2-3 toolbar button.

2. Load the template mesh into B.

3. Set up correspondences using the "A=B" button on the toolbar. You can use the "⟩⟩" button to set all the correspondences, and then go back and remove missing correspondences with the "⟨" button.

4. Select the two meshes, right click one of them, Custom Plugins→Landmark Transfer→TPS warp template to target. This will warp the template to the fossil, and save out a file named as "Template_Filename.ply"

6 Computing a treemorph (blob)

Input: land file containing corresponding meshes
Ouput: the blob containing surfaces for all intermediate nodes, which allows you to click around the tree and compute intermediates.
As you click around on the tree, you should see the corresponding mesh in C.

1. Open the tree (right click on tree, open item → preview)

2. Click compute blob. Runs for a long time.

Bug: You cannot click on a node with a later date than the latest taxon in the tree. Workaround: Move all fossils to age 0 before clicking. DO NOT recompute the blob! Bug: On my Mac, right after computing the blob, I can click on nodes and see the meshes in C. But if I re-open a file with a computed blob, I just see the point landmarks when I click on a node. Workaround: Import mesh from C (as in Recipe **??**, then load Mesh1 into A and look at it.

7 Testing the position of a target

Input: A tree with computed blob, and a landmarked target, possibly with missing landmarks. Target need not be a warped template. The landmarks on the target should have been placed in correspondence with the landmarks on the specimens in the tree.
Output: Image of placement of fossil in the tree.

1. Open the tree (right click on tree, open item → preview)
2. Modify; click on any tree node, then compare mesh.
3. Runs for a long time, then produces a colored mesh.

Missing feature: does not put the answer - the nearest tree mesh - into C.

8 Entering a tree

Input: A land file containing a set of warped template meshes, all with corresponding landmarks.
Output: The same land file, now containing a tree.

1. From Trees button on control bar, choose enter new tree. Choose preview in the dialog box.
2. Start from the root of the tree and work down; it is impossible to add parents, only children.
3. Use add child to create new nodes; for internal nodes, fill in data. For leaves, select a mesh.
4. Deleting a node deletes all of its children.
5. Tree is automatically saved.

Missing feature: it would be much easier to use one of the many existing full-featured tree editor tools to define the tree, and let Landmark read in a standard evolutionary tree data format such as nexus.

9 Symmetrizing a .ply file

Input: A ply file containing a scanned specimen
Output: The ply file, warped so that selected landmarks are in symmetric positions.

1. Make a second copy of the .ply file to be symmetrized.
2. Make a new land file (File , New)
3. Import the file you want to symmetrize (File, Import, Into project)
4. Load that into A (right-click, Load into A)
5. Add landmark pairs to A, even numbered corresponding with odd numbered.
6. Export A with it's landmarks, as in Recipe 1
7. Rename the .ply file to something different, and give the .cor file you just exported the same name
8. Import them into the .land file, and load into B
9. Close Landmark and re-open it (bug prevents correspondences from working unless you do this)
10. Use A=B to indicate the correspondences; A1 $\leftrightarrow$ B2, A2 $\leftrightarrow$ B1, etc.
11. Select the two meshes in the right-hand column, right click, select custom plugins $\rightarrow$ FossilFixing $\rightarrow$ RetroDeform (Type 3, etc.)
12. Accept the default parameters, unless there is a good reason not to.
13. This saves out a bunch of files, and finally puts up a box saying "Plugin operation finished!"
14. The symmetrized model is in a file called SolvedMesh.ply. The other .comp files can be deleted.

10 Filling in by reflection

Input: A ply file containing a symmetrized specimen, with missing pieces
Output: A ply file with the missing portions on either side filled in by reflection from the other side.

1. Make a new land file and import the symmetrized specimen you want to fill in
2. Load that into A.
3. Create a reflected version (right click, Reflect, A)

4. The reflected mesh will be in the C window. Bring it into the project as an input (right click on the project folder in the right-hand column, import from C). This will add the reflected mesh to the project, as a mesh named "Model1".

5. Load Model1 into B.

6. Add corresponding landmarks on A and B...a few (10) will suffice.

7. Select the two meshes, right click, select custom plugins → FossilFixing → Fix missing regions in fossils

8. After a while, this will save our a file called FossilWFillerMesh.ply; other .comp files can be deleted