**Setting up the tutorial files**

1. Download the tutorial files

-Cat05\_refpose tutorial.ma (reference file for Maya scene)

-Cat05\_tutorial\_start.ma (skeletal animation file for Maya scene)

- expTransWS.mel (Maya script for exporting XYZ coordinates from Maya scene)

-expVolTransCat.mel (alternative Maya script for exporting XYZ coordinates from Maya scene)

-dynamicEndocastBeta.m (Matlab script for calculating alpha shape objects and volumes)

-impHulls.mel (Maya script for importing alpha shape objects into Maya scene)

1. Load Maya scripts

Windows: move the three .mel scripts into the following directory

C:\Documents and Settings\User\_Account\My Documents\maya\scripts

Mac OS: move the three .mel scripts into the following directory (you will have to hold down the Option key and click on the Go menu in the Finder to see the Library folder)

MacintoshHD/Users/User\_Account/Library/Preferences/Autodesk/maya/mayaVersion(e.g. 2018)/scripts

1. Load Matlab script

Move the .m script into whatever folder you use to keep your Matlab scripts, OR set a new path in Matlab to the folder where the .m script is currently (see below):

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**Open animated scene in Maya**

1. Open the scene “Cat05\_tutorial\_start.ma” in Maya
2. Re-associate the reference scene (if opening for the first time)

-When you open the scene, a window may pop up saying it can’t find “Cat05\_refpose tutorial.ma”. Check the ‘Make changes permanent’ box and then click “Browse” to navigate to the reference file.

**Create volume locators**

1. A set of locators has already been created on the bony surfaces surrounding the volume of interest, the mouth cavity of a catfish in this case. These are virtual landmarks that move with the animated bones. To see these locators, right-click on the “r:VolumeLocators” layer in the Channel Box/Layer Editor and choose “Select A screenshot of a computer

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2. If you want to make your own, create a locator (Create>Locator from main menu) and then position it wherever you want on the skeleton. You can use point constraints to position these locators (e.g., if you want a locator to be evenly spaced between two other locators or landmarks), but delete all constraints after the locator is in its final position. Parent each locator to its animated bone, so that locators move with the bones.

**Export coordinates of volume locators**

1. To export the translations (i.e., XYZ coordinates in world space) of all the volume locators…

Option 1: Select all the locators, the order doesn’t matter. You can do this using the Layer Editor as described above or manually (this gets tedious with large numbers of locators). Then export all locators over all frames of the animation using the MEL command expTransWS, saving the file wherever you want.

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Option 2: Use the MEL command exportVolTransCat, which will select all the volume locators and then export their translations.

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With either method, you’ll end up with a .csv file of locator coordinates as a function of time, with frame number in the first column and locator names in the first row (sample below).

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This file will contain coordinates for all 581 frames of the animation, but for the purpose of this tutorial, **I highly recommend** cropping it down--to frames 100-200 or even 120-140—by deleting rows.

**Calculate alpha shapes in Matlab**

1. Type script name into the command line and hit enter to run.
2. The first window to pop up is looking for your .csv file of locator coordinates; navigate to this file.A screenshot of a social media post

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3. The second window to pop up is looking for the folder where you want to save all the alpha shape (.obj) files. Navigate to or create a folder for these files. These shapes will be named automatically as “Alpha\_(frame number)\_Hull”, e.g., Alpha\_5\_Hull.obj

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1. The third window to pop up is for saving out a file with the alpha shape volume at each frame. This file isn’t necessary for any of the following steps, but may be useful for your analyses. Give the file a name and navigate to where you’d like it to be saved.A screenshot of a cell phone

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You can ignore and close the figures that pop up.

To adjust how tightly (or loosely) the apha shape “shrink wraps” your locator coordinates, you can adjust the maximum radius of curvature. Open the script in Matlab, go to line 34, and change the value of n. After you’ve changed n, save the script and re-run it.

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You should now have a folder containing one .obj file for each frame of your animation, and a .csv file with the alpha shape volume at each frame.

**Import alpha shape volumes back into Maya**

1. Go back to the animated Maya scene (“Cat05\_tutorial\_start.ma”) and type impHulls into the MEL command line.
2. A window will pop up, asking you to navigate to your folder of .obj files, and select the ones you want to import. If you select a lot of files (a few hundred or more) this may take a while. Again, for the purposes of this tutorial, **I highly recommend** importing no more than frames 100-200; even just 120-40 would be fine.
3. Maya will then run through your scene, setting the keys on each .obj (this may also take a while). When it's done, you should be able to play through and see the alpha shape at each frame. All the alpha shapes will be grouped (i.e., parented) under a single node called Hull: AlphaHulls. Select this node to change the visibility, color, etc. of all the alpha shapes.
4. There will also be a locator called "HullVolume", which has an attribute called Volume; this is the volume of the alpha shape at each frame. You can select the volume attribute and display it in the Graph Editor. **Currently you can only import one set of alpha shapes at a time.** If you try to import a second set of obj files with the impHulls script, **it will delete your first set and replace it with the second set.**

You should now have a skeletal animation with both the bone models and the alpha shapes forming a dynamic endocast.