**Medial Demons Shape Analysis Quick Guide**

This tool takes FreeSurfer aseg.mgz files and generates homologous mesh representations of subcortical ROI boundaries and vertex-wise shape features for statistical analysis. Please cite the following work when using this tool:

1. Gutman, B.A., Madsen, S.K., Toga, A.W., Thompson, P.M.: A Family of Fast Spherical Registration Algorithms for Cortical Shapes. In: Multimodal Brain Image Analysis, vol. 8159, pp. 246-257. Springer International Publishing (2013)

2. Gutman, B.A., Wang, Y., Rajagopalan, P., Toga, A.W., Thompson, P.M.: Shape matching with medial curves and 1-D group-wise registration. In: Biomedical Imaging (ISBI), 2012 9th IEEE International Symposium on, pp. 716-719. (2012)

**Requirements:**

1. FreeSurfer “-recon\_all” results, particularly the aseg.mgz files
2. Matlab installation (Versions 2011a and up known to work)
3. A comma-separated file with subject id’s in the first column, exactly as they appear in the FreeSurfer output paths. The csv file MUST BE SAVE IN PC or UNIX format. (due to a quirk, at least 2 additional columns are needed)

**Setting up ENIGMA Shape package:**

1. **Download and upzip ENIGMA\_Shape.zip file to a path of your liking**

In our example commands below, we assume it is:*/path/to/ENIGMA\_Shape/*

1. **Open permissions to Enigma shape package:**

*$ chmod –R 777 /path/to/ENIGMA\_Shape/*

1. **Set environment variables in shape script**

Open */path/to/ENIGMA\_Shape/*shape\_group\_run.sh in a text editor. Find ‘Path to Freesurfer.’

1. Change ‘FS’ variable (approximately line 22) to your local FreeSurfer installation. For example:

FS=/home/common/applications/freesurfer/freesurfer/ (yours will likely be different)

1. Change ‘runDirectory’ (approximately line 26) to you ENIGMA\_Shape directory. Following our example:

runDirectory=*/path/to/ENIGMA\_Shape/*

Save the shape\_group\_run.sh file.

1. **Set environment variables in AutoQA script**

Open */path/to/ENIGMA\_Shape/AutoQA\_prep/AutoQA*.sh in a text editor. Find ‘MatlabPath.’

1. Change ‘MatlabPath’ variable to your local Matlab binary (approximately line 14). Note that your entry must contain the binary file ‘matlab’ at the end, so that if copied and pasted into your terminal, it opens the Matlab environment:

MatlabPath=/home/common/applications/MATLAB/matlab/bin/matlab (yours will likely be different)

1. Change the FREESURFER\_HOME variable, as done previously in shape\_group\_run.sh (approximately line 24):

FREESURFER\_HOME=/home/common/applications/freesurfer/freesurfer/ (this must be exactly the same as in step 3a)

Save the *AutoQA*.sh file. You are now ready to use the ENIGMA shape package!

**Stage 1 – Computing Shape Measures (Serially)**

1. **Open write permissions to your FreeSurfer output mri folder**:

*$ chmod –R 777 /path/to/FreeSurfer/Output/\*/mri,*

where we assume that the path to a subject with subject ID {$SUBJ\_ID} in the .csv file is:

*/path/to/FreeSurfer/Output/{$SUBJ\_ID}*

1. **Run shape\_group\_run.sh script as follows:**

*$ /path/to/ENIGMA\_Shape/shape\_group\_run.sh* */path/to/Subject/Info/File/file.csv*  */path/to/FreeSurfer/Output* */path/to/MedialDemons/Output*

It is assumed that if the .csv file has headers, the subject Id header is exactly either “id” or “SubjID”. Note: if you already have a .csv file of clinical covariates that includes a header like above, there is no need to create a new one. The computational time is about 1 hour per subject. Note that to speed up the computational time without distributed computing, you may simply separate your .csv file into several smaller lists of subjects, and manually submit each job to a separate node. Two additional files will be created in */path/to/MedialDemons/Output: ${file}\_LogJacs.csv and ${file}\_thick.csv.* These files contain all the vertex-wise shape data for all subjects in *${file}.csv.* These files can potentially be shared or statistically analyzed. If splitting the group file into several smaller files, make sure to give each smaller file a unique name – the base name for the shape csv files is the same as in the *${file}.csv* file*.*

1. **(Optional, but recommended) Disconnecting the process from the terminal (can continue running after logging off):**

1. Press CTRL-Z 2. $ disown -h %1 3. $ bg 1

**Stage 2 – Generating Snapshots for Quality Control of Shape Results (Serially)**

The AutoQA.sh script generates snapshot .png images of surface models and their slice overlay onto the original MR image. These can be found in the “quickcheck” subfolder of the QA output folder you designate. This greatly speeds up visual quality checking of the outputs. In addition, the script generates a QA\_status.csv file, meant to be edited by the user to indicate subjects for which medial demons failed to generate reasonable results. Where the mesh models were not generated for a particular ROI, the entry will be 0. Please refer to the Shape QC manual for our ranking system (1, 2, or 3) to fill in the rest of the QA\_status.csv file. This format is expected by the R scripts for shape statistics (see full manual).

IMPORTANT!!! Because this script does some low-level computing on your local machine, you should:

1. Keep it logged in while the script is running
2. Log in with –XY flag, for example: $ ssh –XY [your\_username@your.server.institution.edu](mailto:your_username@your.server.institution.edu)
3. This script seems to run more reliably when logged in from a MAC than a PC, particularly if your server is running a pre-2014b version of MATLAB

The following arguments must be set when executing the AutoQA.sh script:

* **Mandatory flags:**

**-s** [ Mesh file directory ending with "SUBJID/resliced\_mesh\_ROI.m" ]

**-f** [ FreeSurfer Output Directory ]

**-g**  [ Path to the .csv file with subject info ]

**-o** [ QA (this script’s) Output directory ]

**-n** [ List of ROI region comma separated; e.g. '17,49'. You can also enter 'All'

to selected all of the ROIs ]

**-r** [ Redo option, enter either '0' or '1'; redoing will only delete and regenerate

the ".byu" files, the QC images will always get updated. ]

* **Optional flags:**

**-m** [ If using Matlab version 2014b and above, you MUST use this flag for the script to function. ]

**-e** [ Do not overwrite previously generated CSV files. ]

**-h** [ This will print out the script guide. ]

EXAMPLE (yes, you have to literally type SUBJID/resliced\_mesh\_ROI.m):

*/path/to/ENIGMA\_Shape/AutoQA\_prep/AutoQA.sh* -s */path/to/MedialDemons/Output*/SUBJID/resliced\_mesh\_ROI.m -f */path/to/FreeSurfer/Output* -g */path/to/Subject/Info/File/file.csv* -o */path/to/QA/Output* -n All -r 0