

Documentation of How to Use the 4D Atlas Construction Software

1. Purpose of this Project:

The purpose of this project is to construct longitudinal atlases (i.e., 4D atlases) with different ages for elder subjects.

2. How to use the Toolbox:

The proposed algorithm has 2 major steps:

- (1) Patient specific growth model construction.
- (2) Longitudinal atlases construction in the atlas space.

In order to build the longitudinal atlas, please follow the following procedures in order. Except explicit mentioning, the running path is in the root directory where you place this package.

Running Environment: Currently this software package can only be used in the Linux environment

Preprocessing:

(1) Please make sure the images are with identical voxel resolution in X and Y dimensions (i.e., in-plane resolutions). Otherwise, you need to scale the data to make it fulfill this requirement before you use this software.

(2) All the images must be in analyze format with unsigned char type (i.e., 8 bit data representation for each voxel)

(3) Type in the following command in the root directory of this package:

Carry out in the following commands:

(a) If in C-shell:

```
vi ~/.cshrc
```

Inside the ~/.cshrc file, add the following two lines at the end of the file:

```
setenv PATH /PackageRootDirectoryPath/Programs:${PATH}  
setenv FSLOUTPUTTYPE ANALYZE
```

save the file, then type “source ~/.cshrc”

(b) If in Bash-shell:

```
vi ~/.bashrc
```

Inside the ~/.bashrc file, add the following two lines at the end of the file:

```
export PATH=$PATH: /PackageRootDirectoryPath/Programs  
export FSLOUTPUTTYPE=ANALYZE
```

save the file, then type “source ~/. bashrc”

Type in the following command to make all items in the package executable:

```
chmod 777 /PackageRootDirectoryPath/ -R
```

(Note: Regions highlighted in yellow needed to be adjusted to your own case where you place the software package)

(4) Close the current shell command window, and then reopen a new one.

Main Steps:

(a) In the root directory, create new folders, namely S1, S2, ..., SN, where N is the number of patient in your database. Place each patient's longitudinal image sequences in each corresponding folder. In the demo data contained in this toolbox, there are 4 patients, thus you can see S1, S2, S3 and S4 in the current directory.

(b) Rename patient i 's j th longitudinal data as $Si0j_cbq.img$, and also provide the age information of each patient in the file $SiAgeList.txt$ in folder Si for each patient i , with each row the age at which the longitudinal data is taken. Please see the demo data as examples. Also, you need to provide a file $SiNumImg.txt$ in folder Si specifying the number of longitudinal images of patient i .

(c) Open Matlab, and set the matlab working path the same as your root directory of the 4D package, then type "MyTestGUI" in the Matlab command window, the software GUI will prompt out.

(d) Run the growth model construction part for each subject:

1. In the first part of the GUI highlighted with title "Growth Model Construction", type in the information of number of subjects (e.g., 4 in the demo example), each image's XY Dimension (e.g., 204 in the demo example), Z Dimension (e.g., 162 in the demo example), and the iteration number to run the 4D HAMMER algorithm to build the growth model (usually 30 is enough, you can set this value higher to get more accurate results).

2. Then press the "Build Growth Model Button", the Matlab command window will prompt out running messages. Once this step is done, you can move to the atlases construction step.

Once this step is done, a message will prompt out in the command window:

"Growth Model Construction Done!"

(e) Run the atlases construction part:

1. In the root directory of the package, create a txt file which specifies the ages where you want to build the longitudinal atlases (e.g., in the demo example, it is the “AgeToBuild.txt” file, you can see that the ages of interests to build atlases are 71, 72, 73 and 74 specific in that file)

(Note: In this software, it is assumed that the ages of interest to build the 4D atlases are with constant age step. For instance, ages 71, 72, 73, 74 (i.e., with age step 1), or ages 72, 74, 76, 78 (i.e., with age step 2)).

2. Then fill in the fields in the “Longitudinal Atlas Builder” tag:

In the “Ages to Build Atlases” field, type in the txt file name created in Step 1.

In the “Kernel Bandwidth” field, specify the width of the Gaussian kernel to perform regression over the temporal domain, the higher the value, the smoother the longitudinal changes across atlases, the smaller the value, the more salient the longitudinal changes across atlases.

In the “Iteration Numbers to Refine” field, type in the number of iterations of the algorithm to perform 4D atlases construction, usually set it to 3 is enough to give you good results, you can set this value higher to get more accurate results.

3. Press the “Build 4D Atlases” button. The Matlab command window will prompt the running message. The final constructed atlases are named as: (Age 1)Atlas.img, (Age 2)Atlas.img,...,(Age c)Atlas.img

Once this step is done, a message will prompt out in the command window:

“Atlas Construction Done!”

3. Demo Data:

Demo data of 4 subjects are also given in the root directory. The final output of the demo data should be: 71Atlas.img, 72Atlas.img, 73Atlas.img, 74Atlas.img

4. Reference:

[1] Shu Liao, Hongjun Jia, Guorong Wu, Dinggang Shen: A Novel Longitudinal Atlas Construction Framework by Groupwise Registration of Subject Image Sequences. IPMI 2011: 283-295

[2] Shu Liao, Hongjun Jia, Guorong Wu, Dinggang Shen: A novel framework for longitudinal atlas construction with groupwise registration of subject image sequences. NeuroImage 59(2): 1275-1289 (2012)