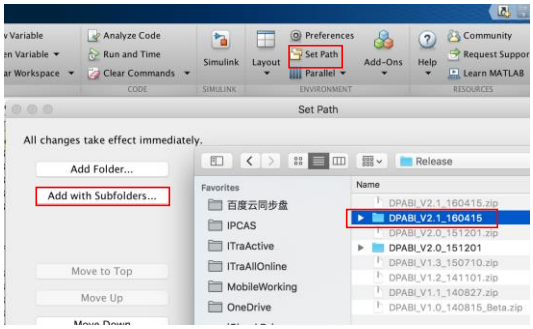
DPABISurf: A Surface-Based Resting-State fMRI Data Analysis Toolbox

Chao-Gan YAN, Ph.D.
严超赣
ycg.yan@gmail.com
http://rfmri.org
Institute of Psychology, Chinese Academy of Sciences

1

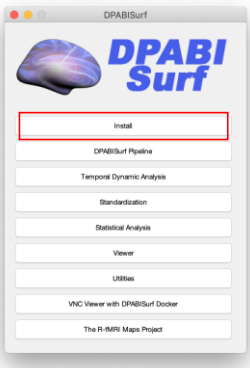


2

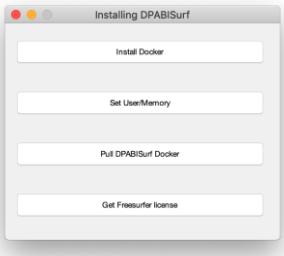
3

4

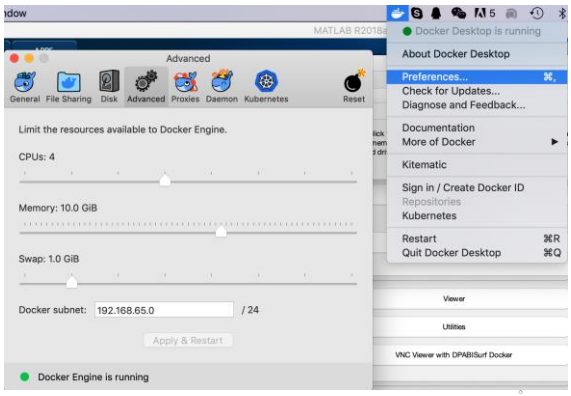
5



6



7

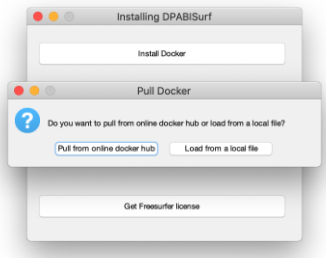


8

9

Linux: sudo groupadd docker
sudo usermod -aG docker $USER

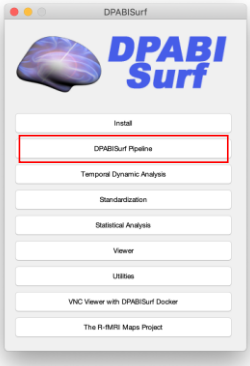
10



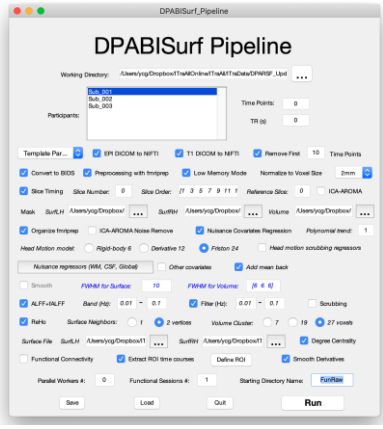
11

Please get Freesurfer license, and specify the license.txt you received in your email. Please visit:
https://surfer.nmr.mgh.harvard.edu/registration

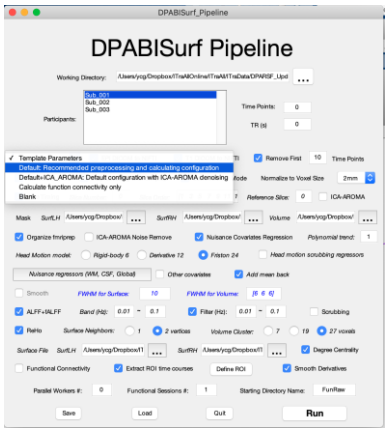
12



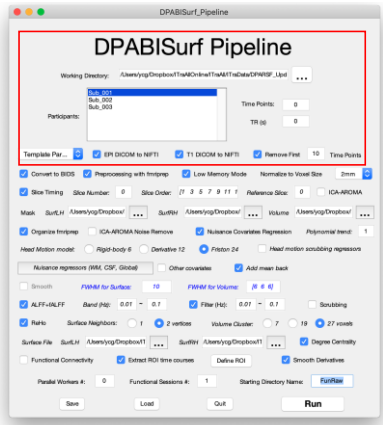
13



14



15



16

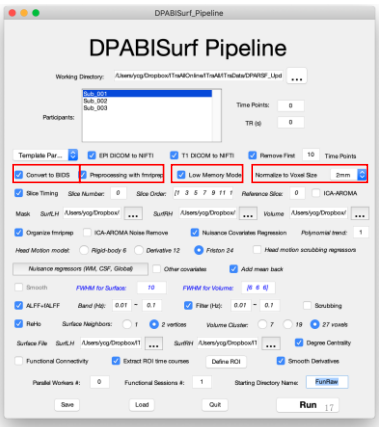
BIDS structure:

http://bids.neuroimaging.io

fMRIPrep
Esteban et al., 2018. Nat Methods.

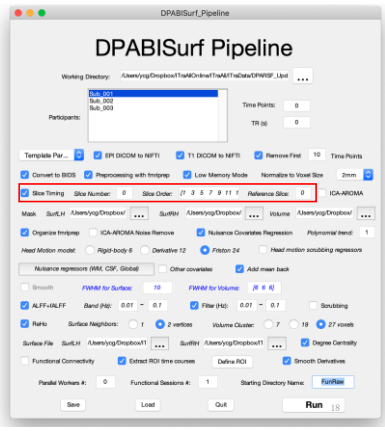
Low memory mode (fMRIPrep)

Voxel size (fMRIPrep)

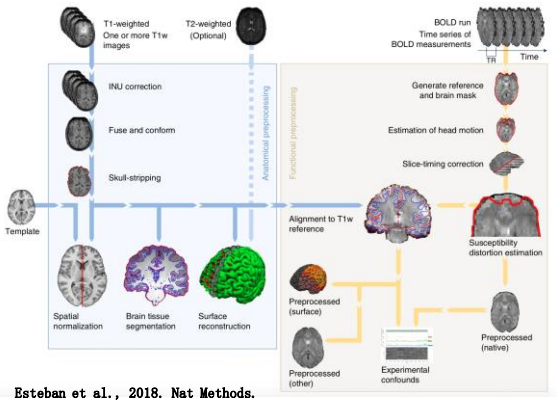


17

Slice timing (fMRIPrep)

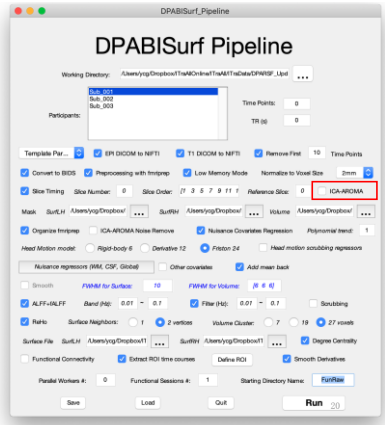


18

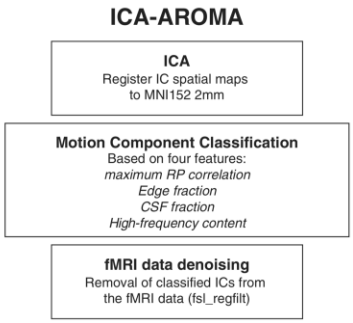


Esteban et al., 2018. Nat Methods.

ICA-AROMA (fMRIPrep)

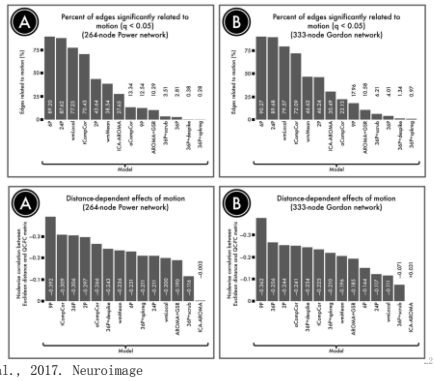


ICA-AROMA



Pruim et al., 2015. Neuroimage

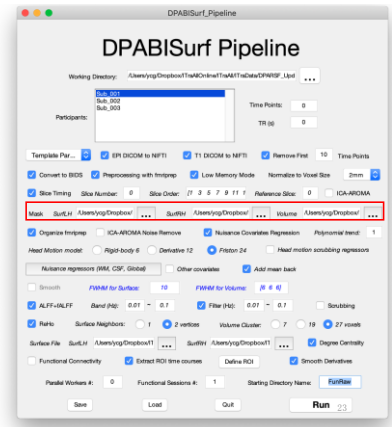
ICA-AROMA



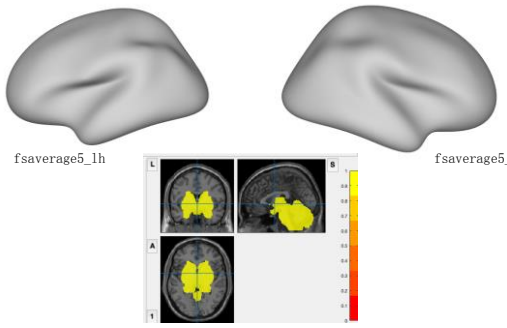
Ciric et al., 2017. Neuroimage

Mask

E.g. {DPABIPath}/DPABISurf/SurfTemplates/fsaverage5_lh_cortex.label.gii



Three Spaces

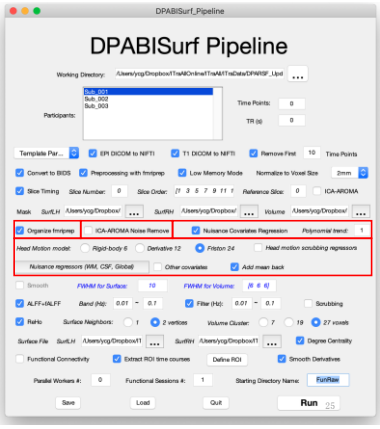


Volume space
can be restricted within freesurfer_subcortical_mask

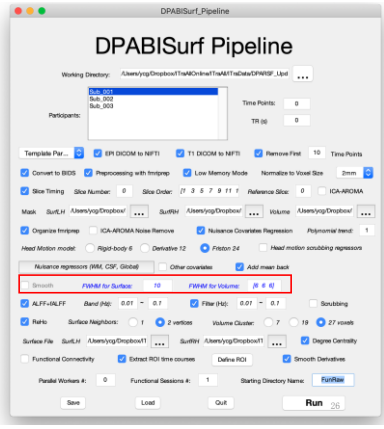
Organize the output files from fMRIPrep

Non-aggressively regressed out the covariates of ICA-AROMA noises.

Nuisance Regression Same as DPARSF



Smooth



Spatial Smoothing

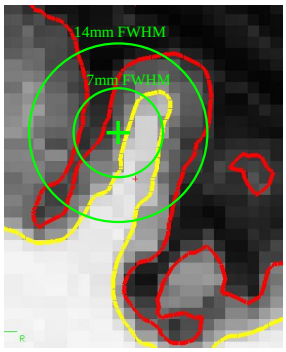
Why should you smooth?
- Might Improve CNR/SNR
- Improve intersubject registration

How much smoothing?
- Blob-size
- Typically 5-20 mm FWHM
- Surface smoothing more forgiving than volume-based

Based on Freesurfer Course

27

Volume-based Smoothing

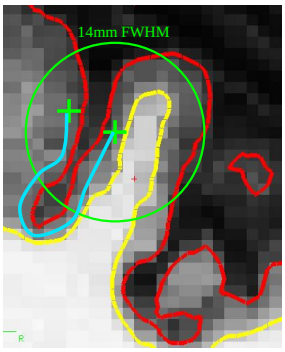


- Smoothing is averaging of "nearby" voxels

Based on Freesurfer Course

28

Volume-based Smoothing



- 5 mm apart in 3D
- 25 mm apart on surface!
- Kernel much larger
- Averaging with other tissue types (WM, CSF)
- Averaging with other functional areas

Based on Freesurfer Course

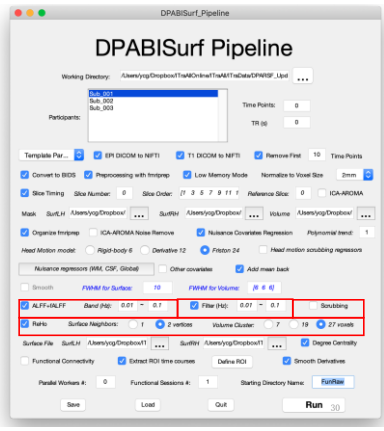
29

ALFF

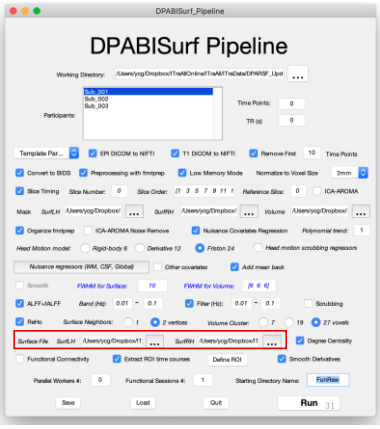
Filter

Scrubbing

ReHo



Provide surface file for 2d ReHo Calculation

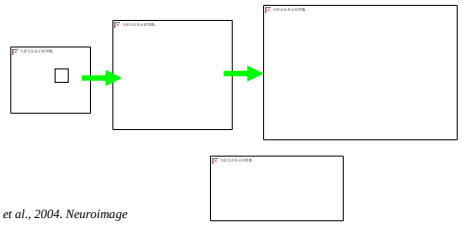


31

3D ReHo

Regional Homogeneity (ReHo)

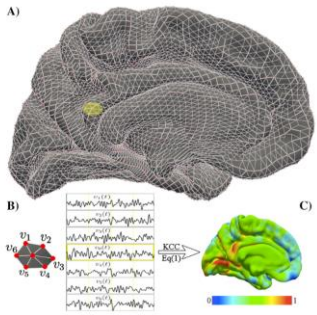
Similarity or coherence of the time courses within a functional cluster



Zang et al., 2004. Neuroimage

32

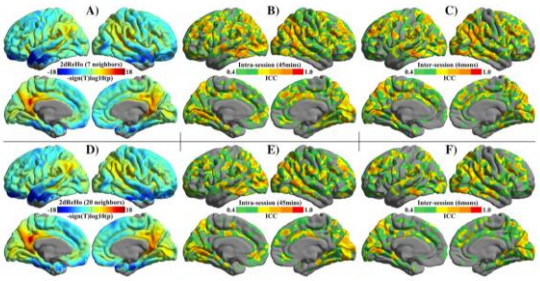
2D ReHo



Zuo et al., 2013. Neuroimage

33

2D ReHo



Zuo et al., 2013. Neuroimage

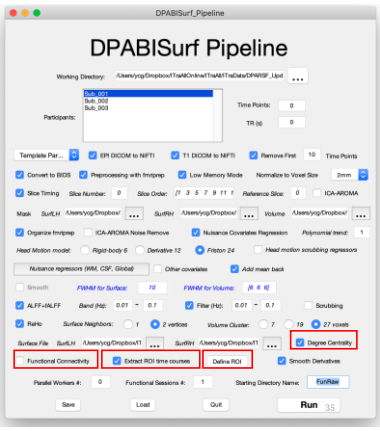
34

Degree Centrality

Functional Connectivity

Extract ROI Time Courses

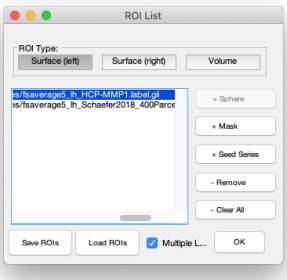
Define ROI



35

Define ROI

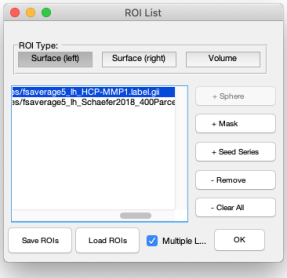
Left Surface
Right Surface
Volume



36

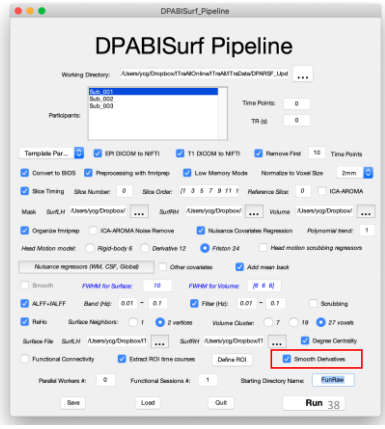
Define ROI

Left Surface
Right Surface
Volume



ROI order:
ROISignals_SurfLHSurfRHVolu_FunSurfWCF

37

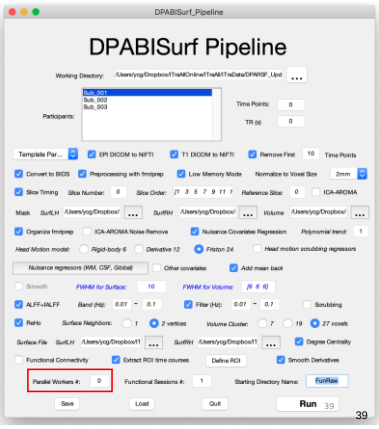


Smooth Derivatives

38

Parallel Workers (if parallel computing toolbox is installed)

Each subject is distributed into a different worker.
Do not be too much because of fMRIPrep processing.

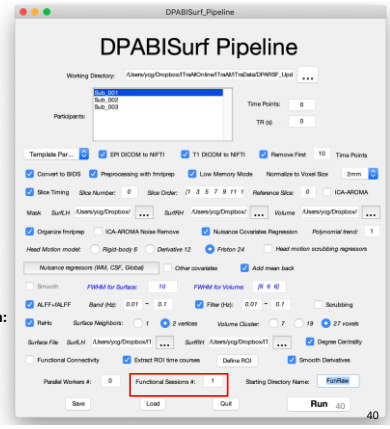


39

Multiple functional sessions

1st session: FunRaw
2nd session: S2_FunRaw
3rd session: S3_FunRaw
…

If also have multiple sessions of T1 image data:
1st session: T1Raw
2nd session: S2_T1Raw
3rd session: S3_T1Raw
…



40

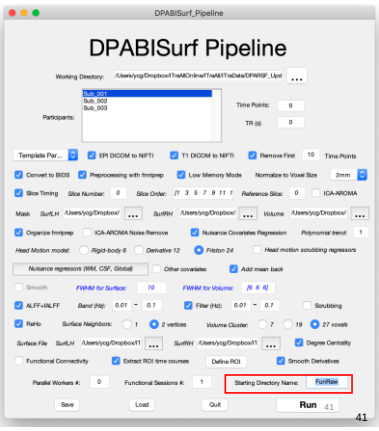
Starting Directory Name

If you do not start with raw DICOM images, you need to specify the Starting Directory Name.

E.g. "FunSurfWCF" means normalized, covariates regressed and filtered

Abbreviations:

- **W - Normalize**
- **I - ICA-AROMA Noise non-aggressively regressed**
- **C - Covariates Removed**
- **S - Smooth**
- **F - Filter**
- **B - ScruBBing**

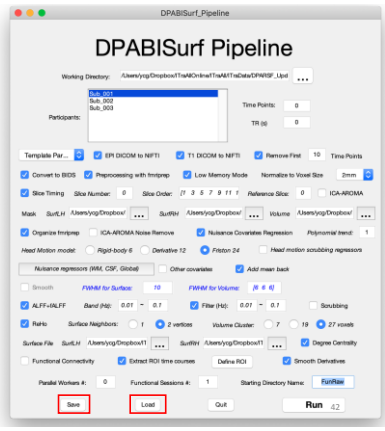


41

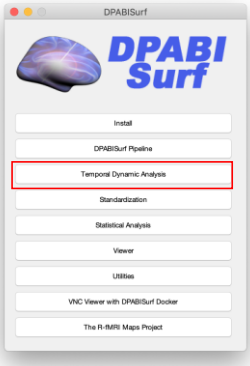
Save and Load Parameters

Save parameters to *.mat

Load parameters from *.mat

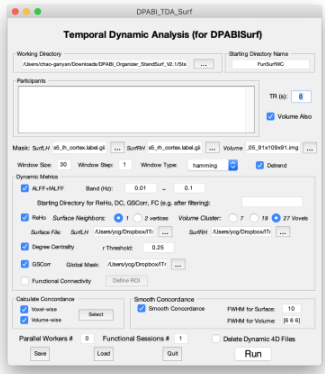


42



43

DPABI_TDA_Surf



52

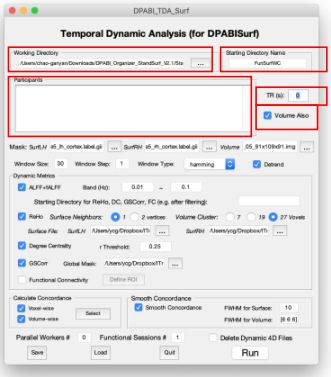
Based on DPABISurf Preprocessed Data

Starting Directory Name

Participants

TR

In addition to the surface-based data, also process the data in volume space processed by DPABISurf



45

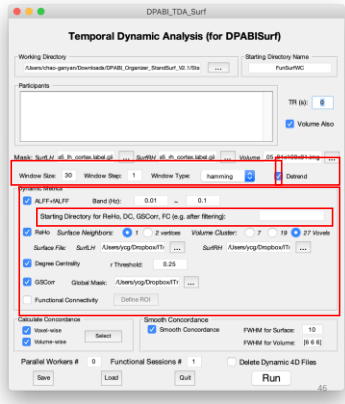
Based on DPARSF Preprocessed Data

Window Setup

Detrend

Dynamic Indices

If need filtering



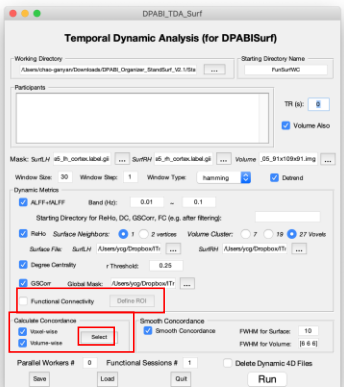
46

Based on DPARSF Preprocessed Data

Functional Connectivity

Concordance

Concordance Settings



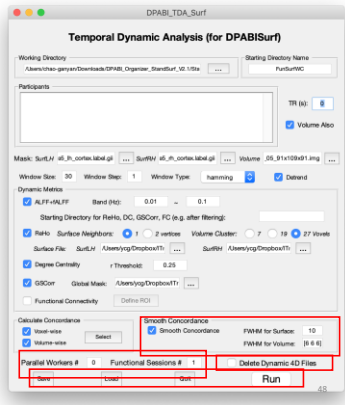
47

Smooth concordance maps

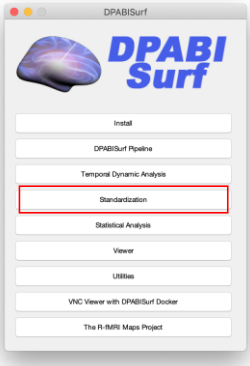
Parallel and Sessions setting

Delete Dynamic 4D Files to save space

Save/Load parameters and Run



48



49

Standardization across both hemispheres

Set data for both left hemisphere and right hemisphere

Masks for both hemispheres

Standardization methods

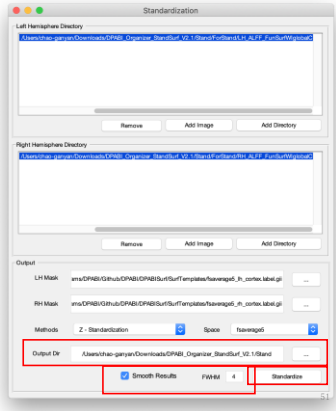
Space: fsaverage (anatomical) or fsaverage5 (functional)

50

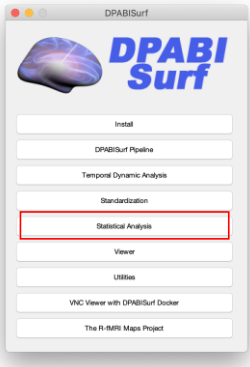
Output directory: left hemisphere and right hemisphere will be separated in different directories automacially

Smooth results: surface-based smoothing

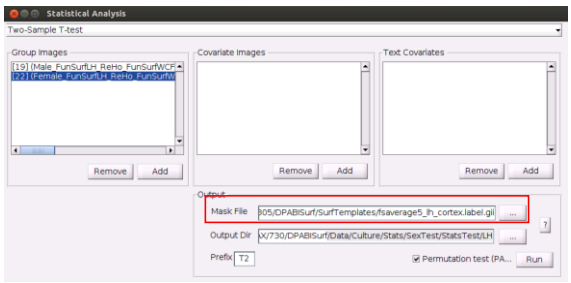
Run



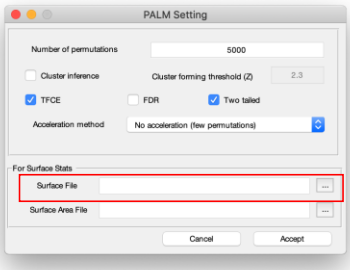
51



52

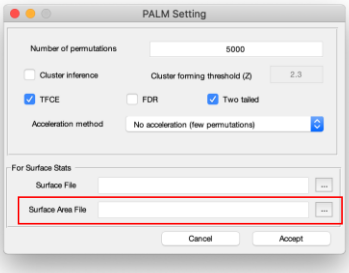


53



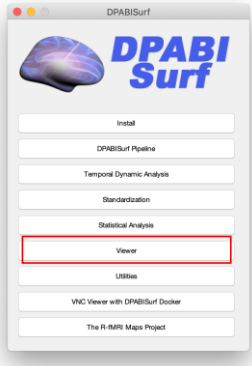
{DPABI}/DPABISurf/SurfTemplates/fsaverage5_lh_white.surf.gii

54



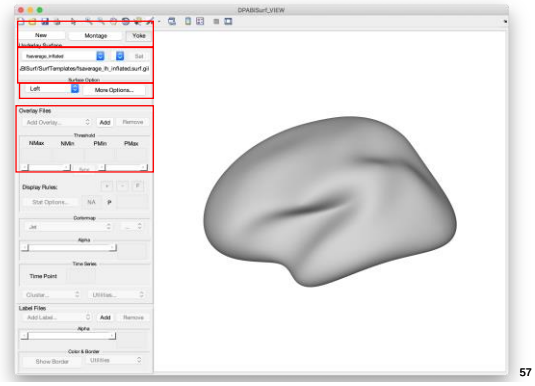
Optional: {DPABI}/DPABISurf/SurfTemplates/fsaverage5_lh_white_avg.area.gii

55



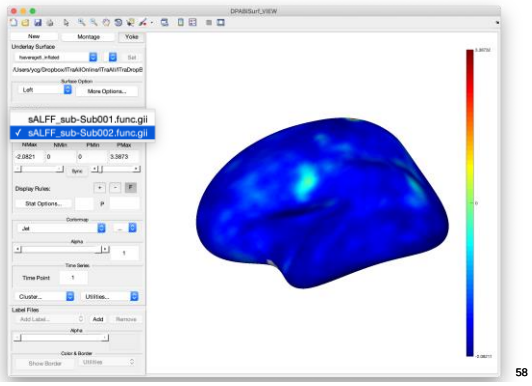
56

DPABISurf_VIEW



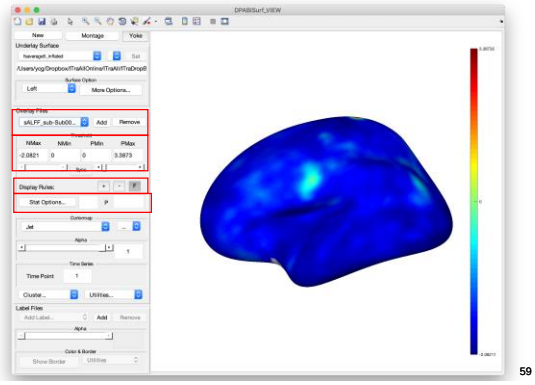
57

DPABISurf_VIEW



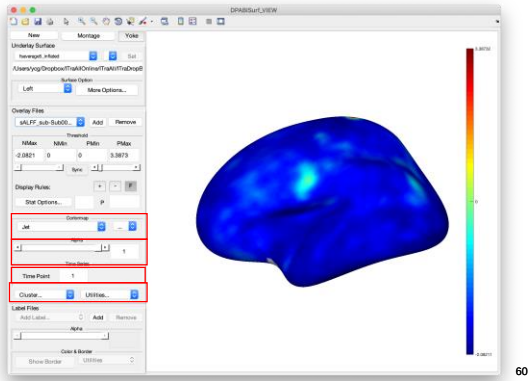
58

DPABISurf_VIEW



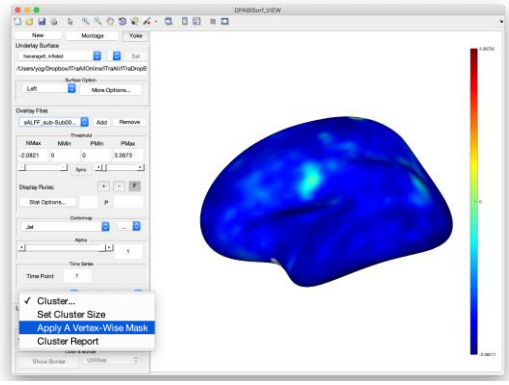
59

DPABISurf_VIEW



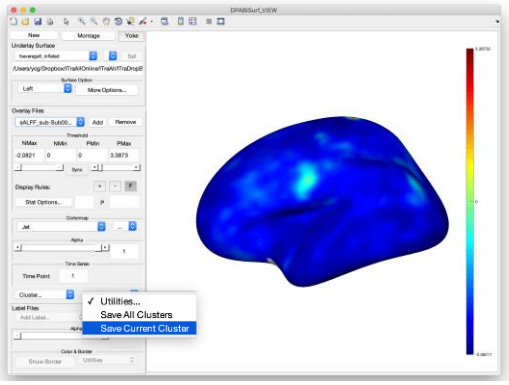
60

DPABISurf_VIEW



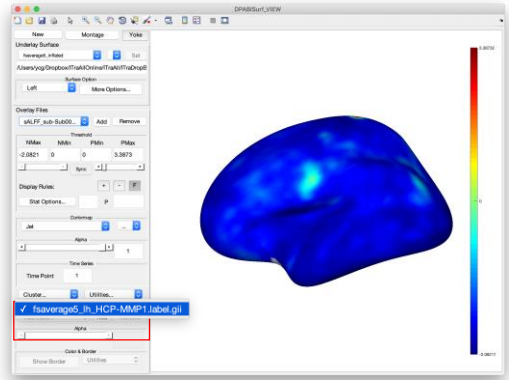
61

DPABISurf_VIEW



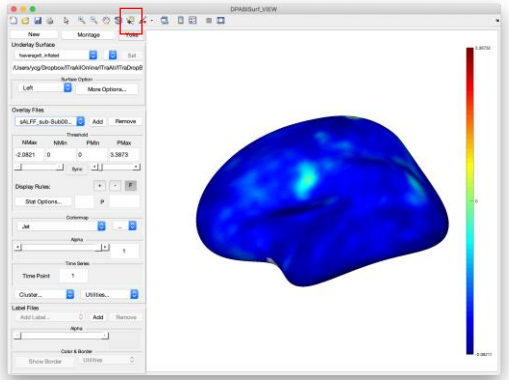
62

DPABISurf_VIEW



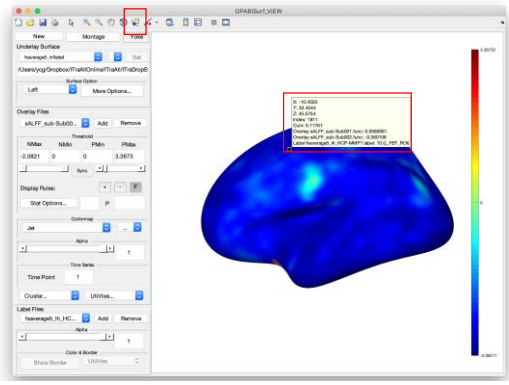
63

DPABISurf_VIEW



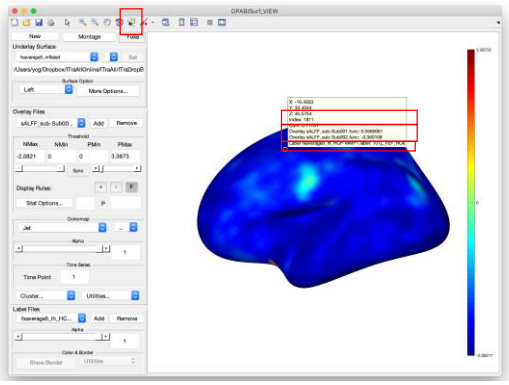
64

DPABISurf_VIEW



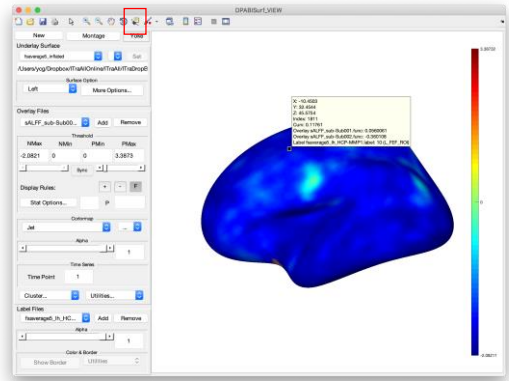
65

DPABISurf_VIEW



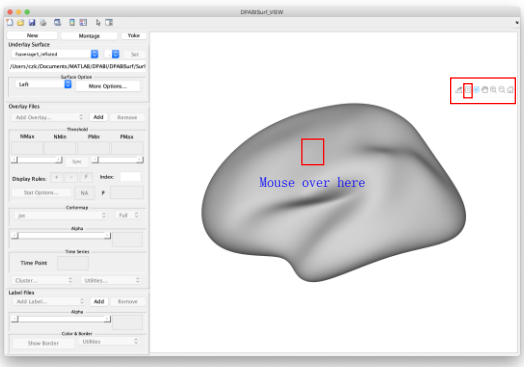
66

DPABISurf_VIEW



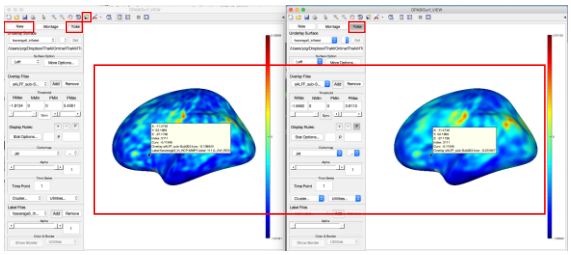
67

DPABISurf_VIEW

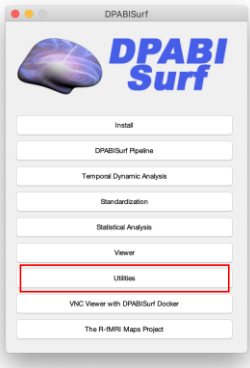


68

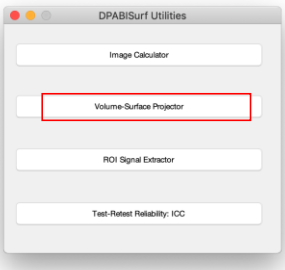
DPABISurf_VIEW



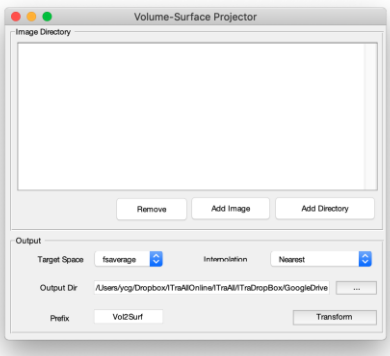
69



70



71



72

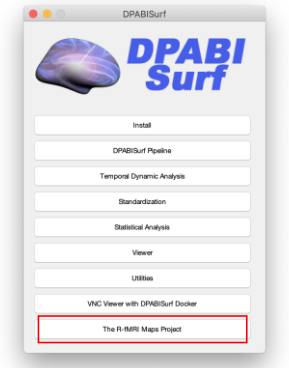
73

Use DPABISurf Docker

```
mri_convert.bin subcort.mask.1mm.mgz freesurfer_subcortical_mask_1mm.nii
$Id: mri_convert.c,v 1.226 2016/02/26 16:15:24 mreuter Exp $
reading from subcort.mask.1mm.mgz...
TR=0.00, TE=0.00, TI=0.00, flip angle=0.00
i_ras = (-1, 0, 0)
j_ras = (0, 0, -1)
k_ras = (0, 1, 0)
writing to freesurfer_subcortical_mask_1mm.nii...
root@506ad169e63c:/opt/freesurfer/subjects/fsaverage/mri# ls
T1.mgz                          orig
aparc+aseg.mgz                  orig.mgz
aparc.a2005s+aseg.mgz           p.aseg.mgz
aparc.a2009s+aseg.mgz           rh.ribbon.mgz
aseg.mgz                        ribbon.mgz
brain.mgz                       subcort.mask.1mm.README
brainmask.mgz                   subcort.mask.1mm.mgz
freesurfer_subcortical_mask_1mm.nii  subcort.prob.log
freesurfer_subcortical_prob_1mm.nii  subcort.prob.mgz
lh.ribbon.mgz                   transforms
mni305.cor.mgz
root@506ad169e63c:/opt/freesurfer/subjects/fsaverage/mri# ls *.nii
freesurfer_subcortical_mask_1mm.nii  freesurfer_subcortical_prob_1mm.nii
root@506ad169e63c:/opt/freesurfer/subjects/fsaverage/mri# mv *.nii /data
root@506ad169e63c:/opt/freesurfer/subjects/fsaverage/mri#
```

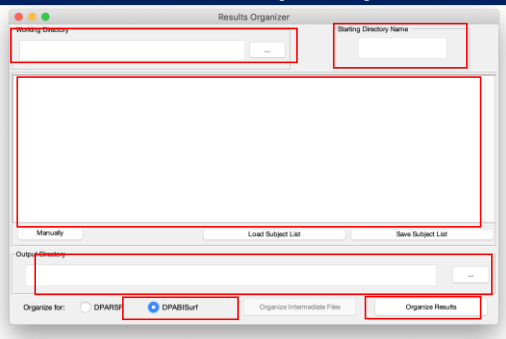
Call DPABI StandAlone:
/opt/DPABI/DPABI_StandAlone/run_DPABI_StandAlone.sh ${MCRPath}

74



75

The R-fMRI Maps Project



Reading and Writing functions

Reading:

```
[Data,VoxelSize,FileList, Header] = y_ReadAll('XX.func.gii');
        Data  -  10242*230 single
        Header  -  GIfTI Structure
```

Processing:

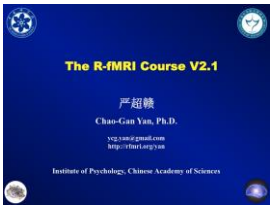
```
MeanData = mean(Data,2);
```

Writing:

```
y_Write(MeanData , Header, 'MeanData.gii');
```

77

Further Help



http://rfmri.org/Course

http://wiki.rfmri.org

The R-fMRI Journal Club

Official Account: RFMRILa

78

Acknowledgments

Chinese Academy of Sciences
Xi-Nian Zuo

Hangzhou Normal University
Yu-Feng Zang

Beijing Normal University
Yong He
Xin-Di Wang

Peking University
Jia-Hong Gao
Wei-Wei Men

NYU Child Study Center
F. Xavier Castellanos

Child Mind Institute
Michael P. Milham

Funding
- National Natural Science Foundation of China
- Chinese Academy of Sciences

79

Thanks for your attention!

80