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

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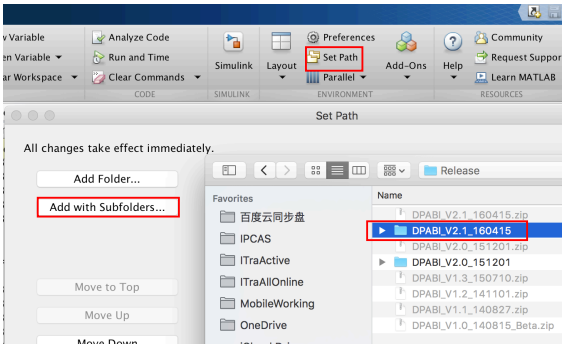
1



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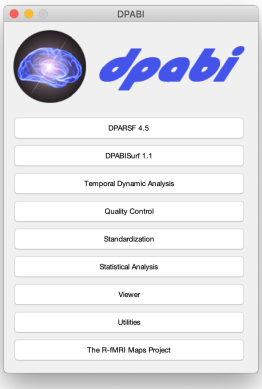

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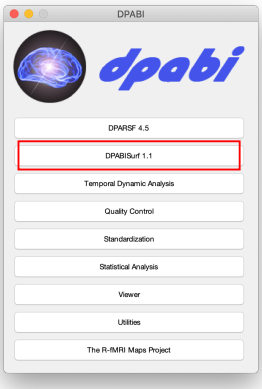

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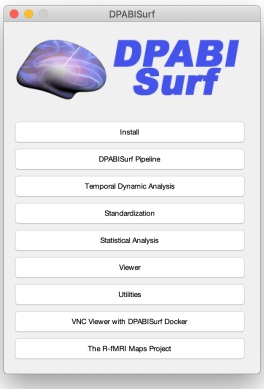

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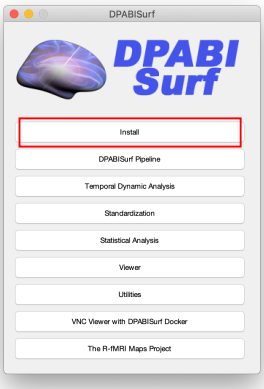

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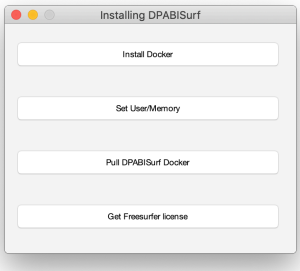

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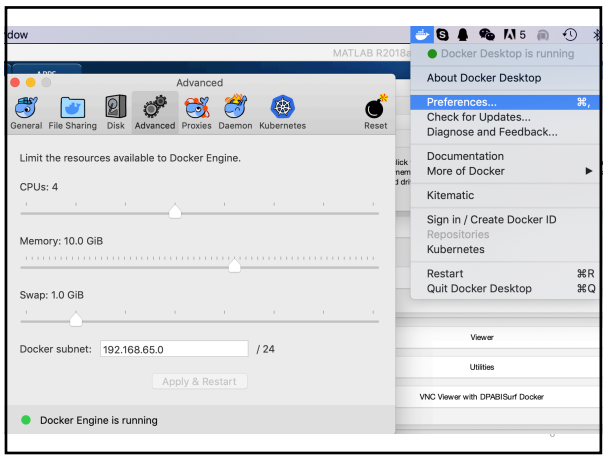

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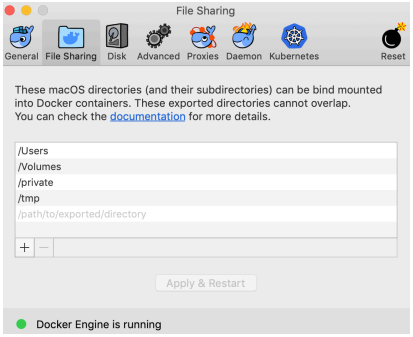

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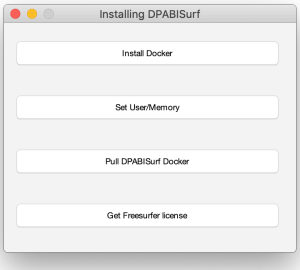

Linux: sudo groupadd docker
sudo usermod -aG docker $USER

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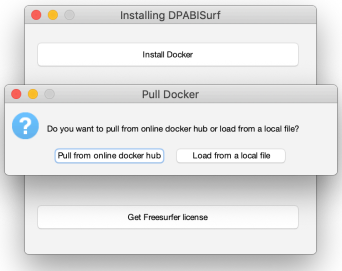

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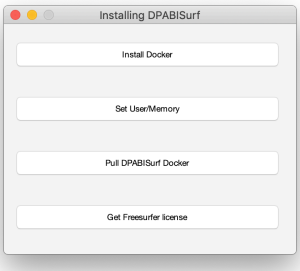

Please get Freesurfer license, and specify the license.txt
you received in your email. Please visit:
https://surfer.nmr.mgh.harvard.edu/registration.html

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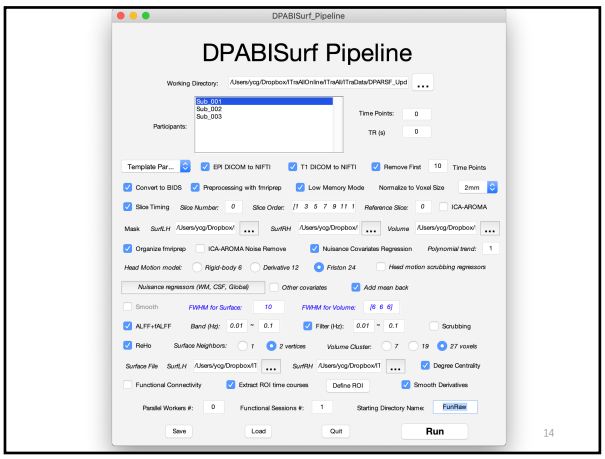

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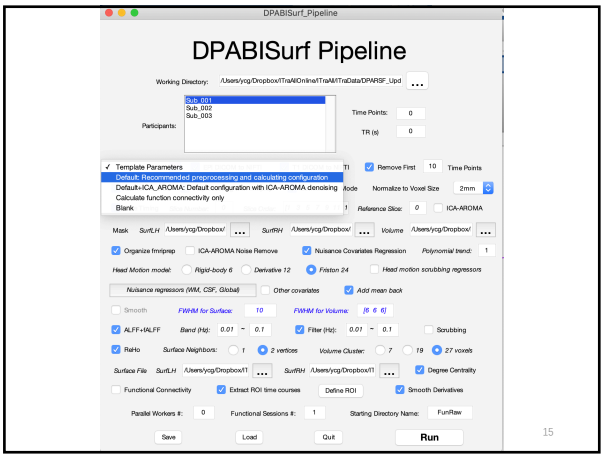

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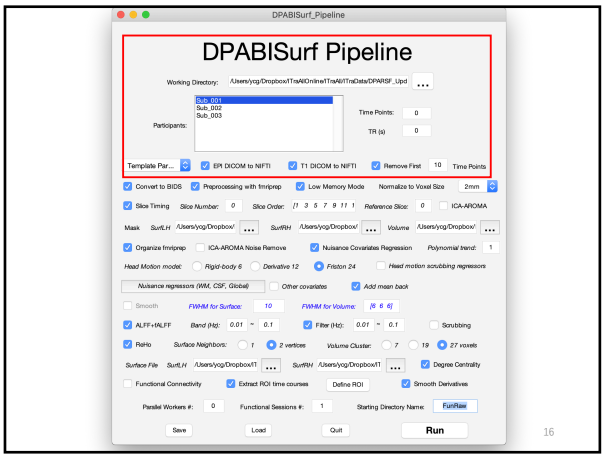

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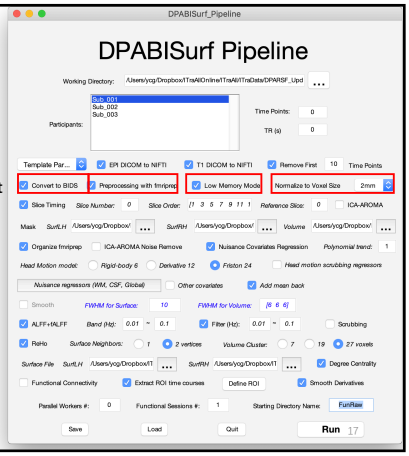
BIDS structure:

http://bids.neuroimaging.io

fMRIPrep
Esteban et al., 2018. Nat Methods.

Low memory mode (fMRIPrep)

Voxel size (fMRIPrep)



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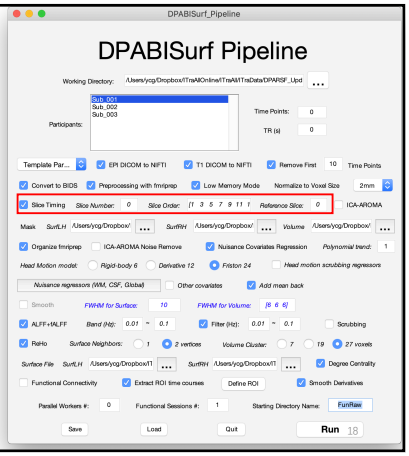
Slice timing (fMRIPrep)



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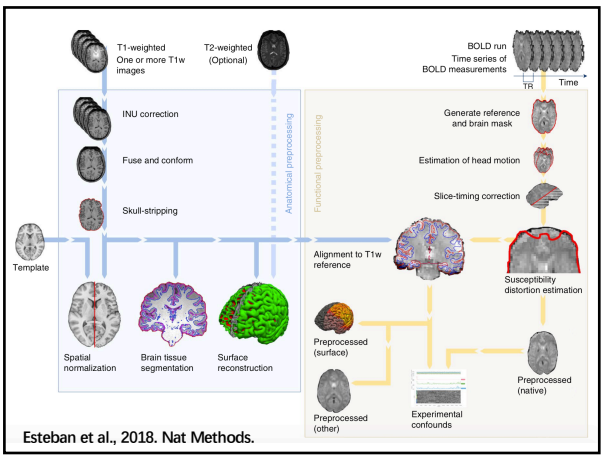

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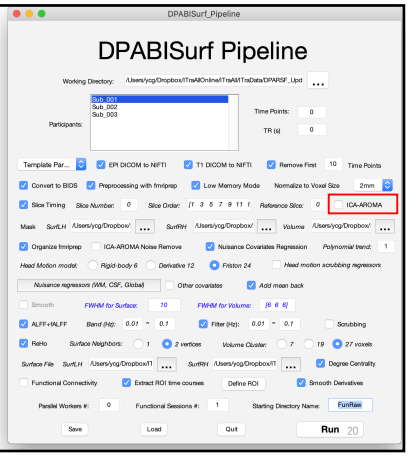
ICA-AROMA
(fMRIPrep)



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ICA-AROMA

ICA-AROMA

ICA
Register IC spatial maps
to MNI152 2mm

Motion Component Classification
Based on four features:
maximum RP correlation
Edge fraction
CSF fraction
High-frequency content

fMRI data denoising
Removal of classified ICs from
the fMRI data (fsl_regfilt)

Pruim et al., 2015. Neuroimage

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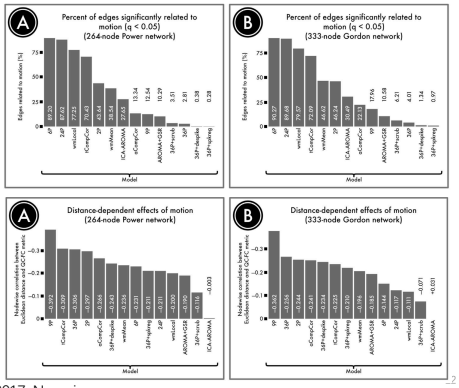
ICA-AROMA



Ciric et al., 2017. Neuroimage

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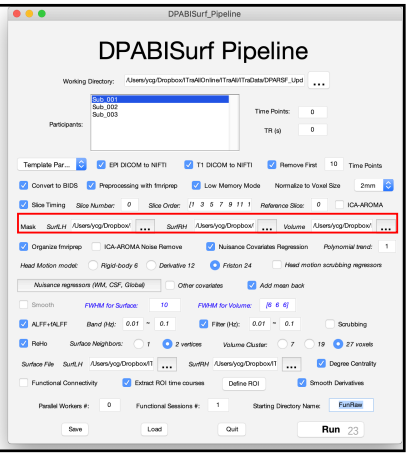
Mask

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



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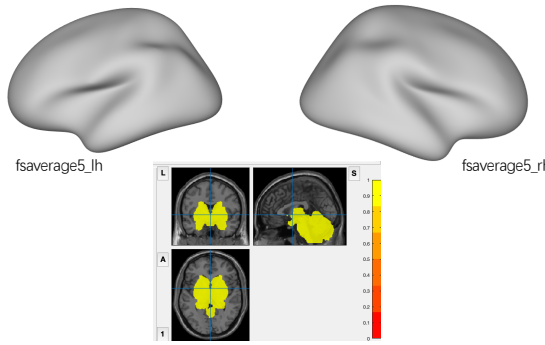
Three Spaces



Volume space
can be restricted within freesurfer_subcortical_mask

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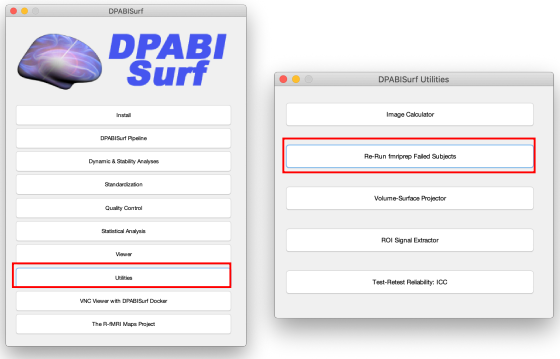
Re-Run fmriprep Failed Subjects



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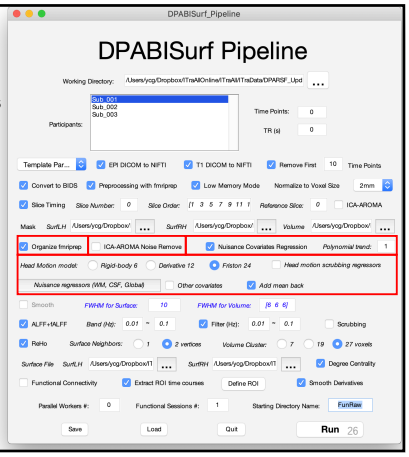
Organize the output files from fMRIPrep

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

Nuisance Regression Same as DPARSF



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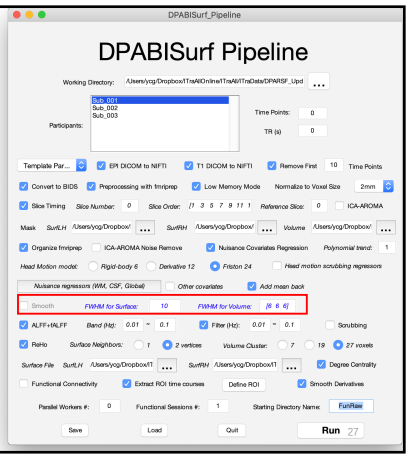
Smooth



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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

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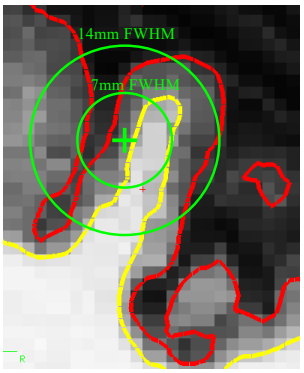
Volume-based Smoothing



- Smoothing is averaging of "nearby" voxels

Based on Freesurfer Course

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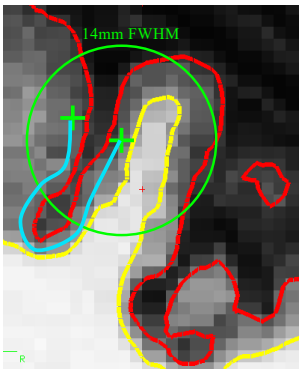
Volume-based Smoothing



- 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

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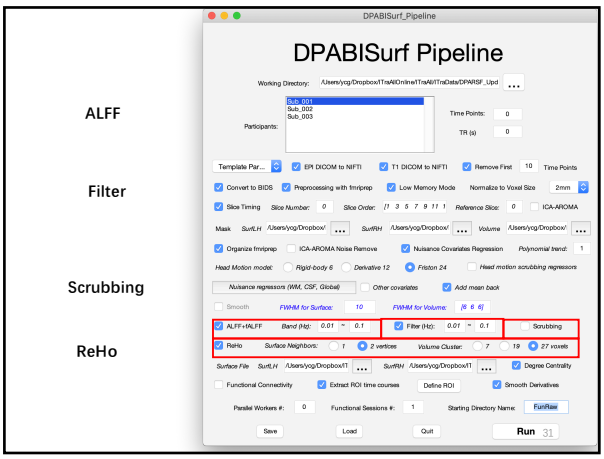

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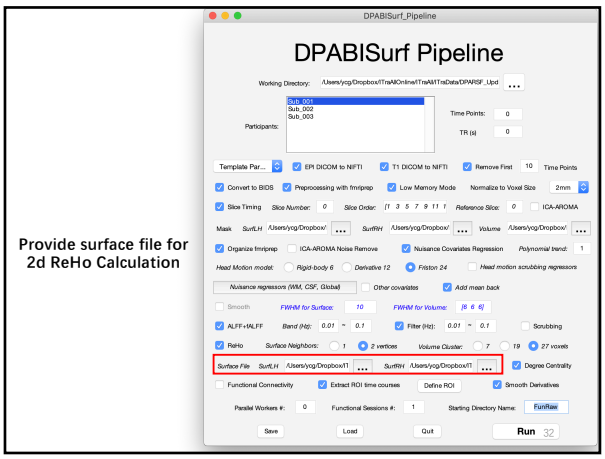

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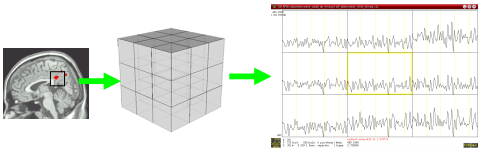
3D ReHo

Regional Homogeneity (ReHo)

Similarity or coherence of the time courses within a functional cluster



$$W = \frac{\Sigma(R_i)^2 - n(\bar{R})^2}{\frac{1}{12}K^2(n^3 - n)}$$

Zang et al., 2004. Neuroimage

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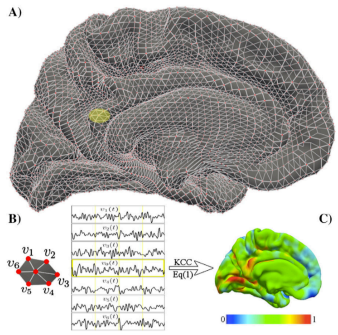
2D ReHo



Zuo et al., 2013. Neuroimage

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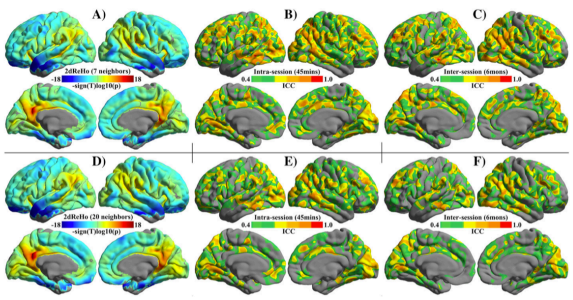
2D ReHo



Zuo et al., 2013. Neuroimage

35

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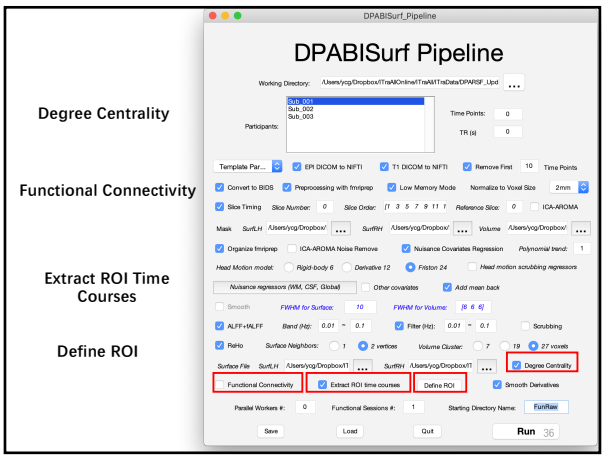

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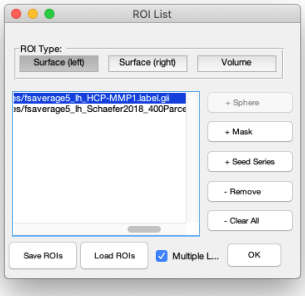
Define ROI

Left Surface
Right Surface
Volume



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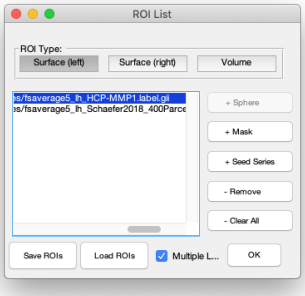
Define ROI

Left Surface
Right Surface
Volume



ROI order:
ROISignals_SurfLHSurfRHVolu_FunSurfWCF

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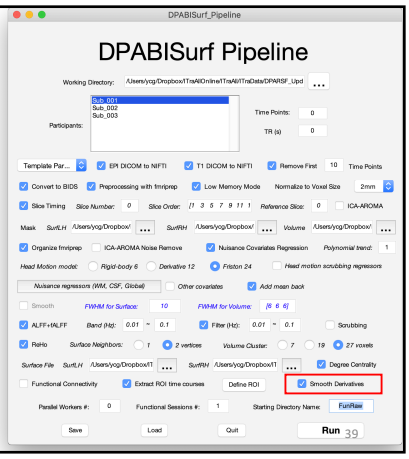
Smooth Derivatives



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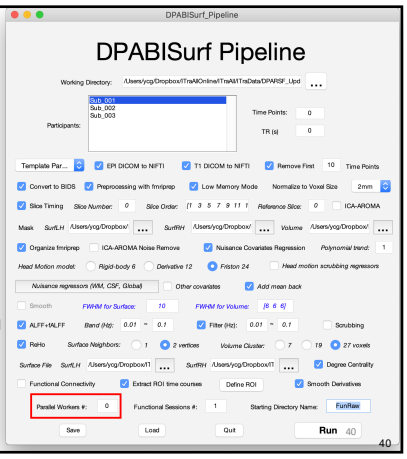
Parallel Workers (if parallel computing toolbox is installed)

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



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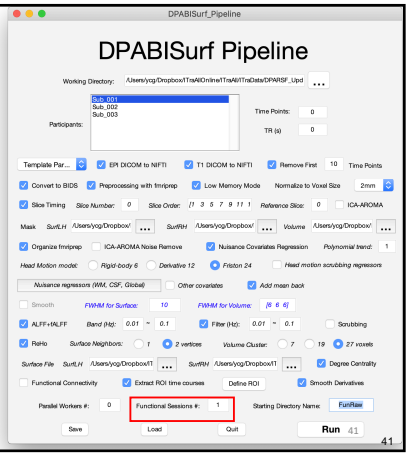
Multiple functional sessions

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
...



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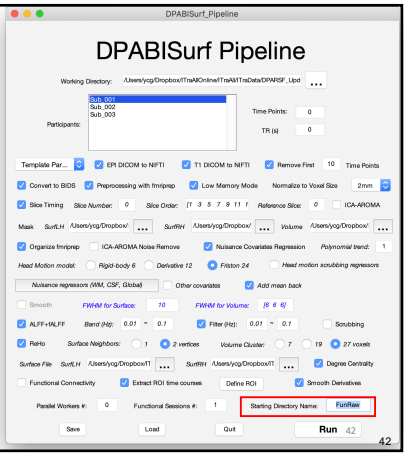
Starting Directory Name

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



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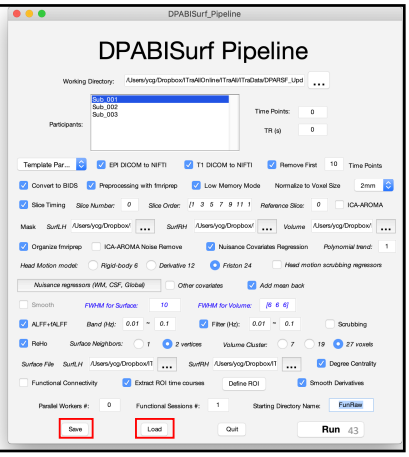
Save and Load Parameters

Save parameters to *.mat

Load parameters from *.mat



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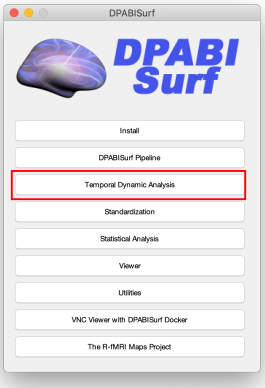

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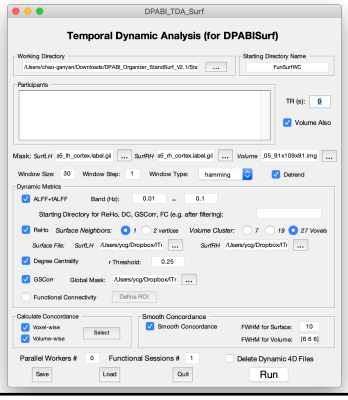
DPABI_TDA_Surf



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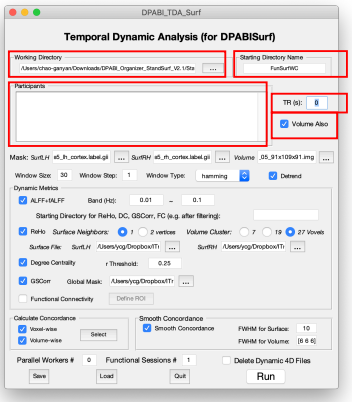
Based on DPABISurf Preprocessed Data

Starting Directory Name

Participants

TR

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



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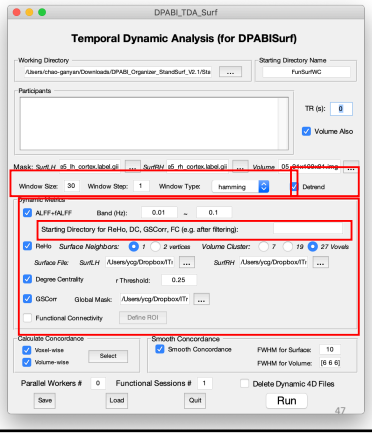
Based on DPARSF Preprocessed Data

Window Setup

Detrend

Dynamic Indices

If need filtering



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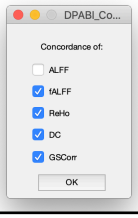
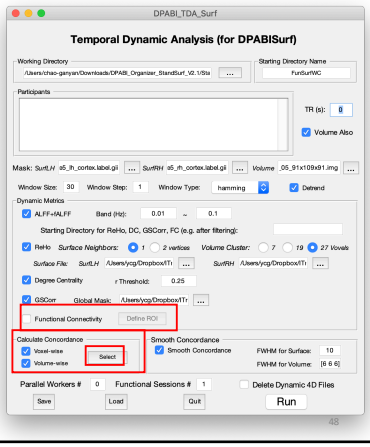
Based on DPARSF Preprocessed Data

Functional Connectivity

Concordance

Concordance Settings





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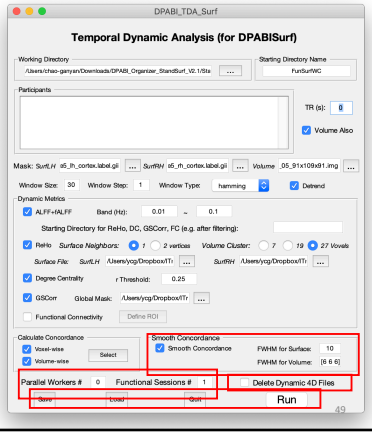
Smooth concordance maps

Parallel and Sessions setting

Delete Dynamic 4D Files to save space

Save/Load parameters and Run



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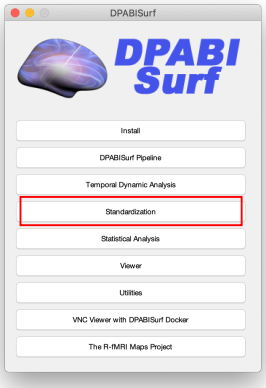

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Standardization across both hemispheres

Set data for both left hemisphere and right hemisphere

Masks for both hemispheres

Standardization methods

Space: fsaverage (anatomical) or fsaverage5 (functional)

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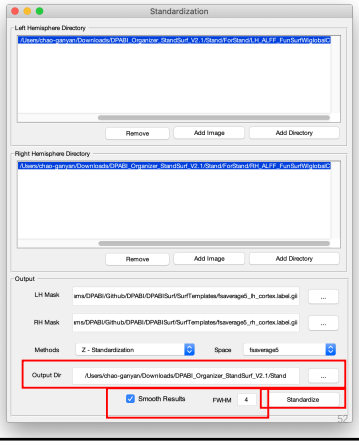
Output directory: left hemisphere and right hemisphere will be separated in different directories automacially

Smooth results: surface-based smoothing

Run



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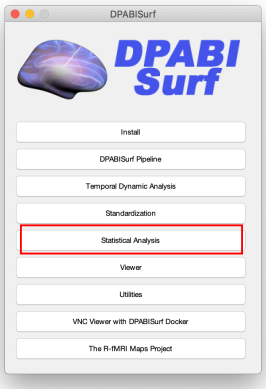

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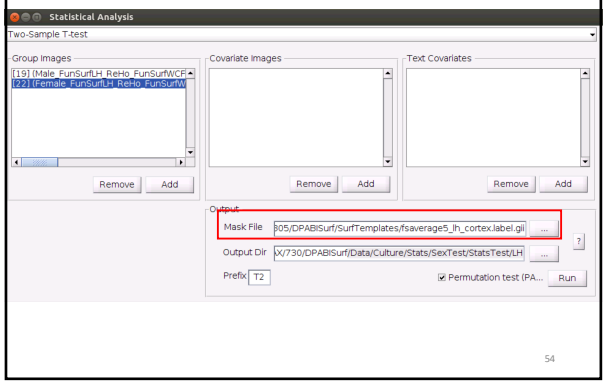

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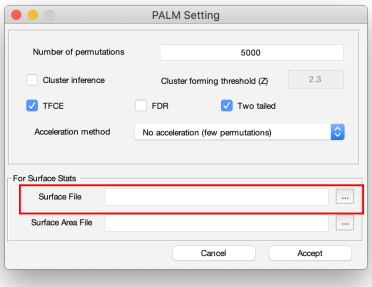
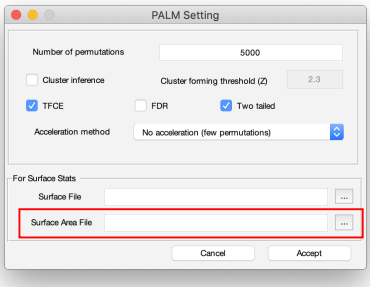


{DPABI}/DPABISurf/SurfTemplates/fsaverage5_lh_white.surf.gii

55

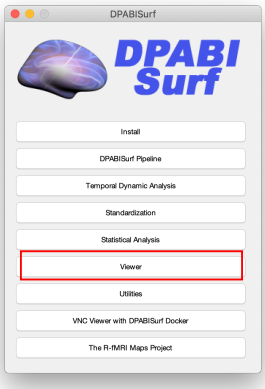
55



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

56

56



57

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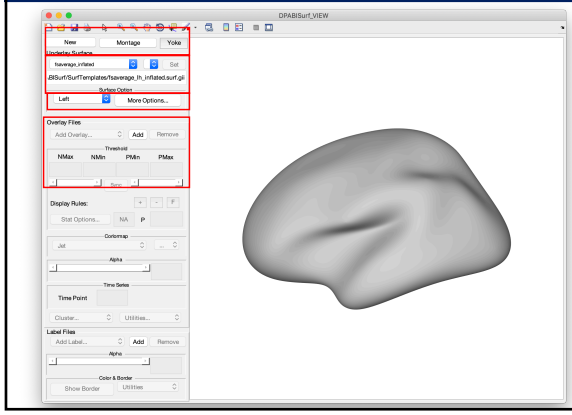
DPABISurf_VIEW



58

58

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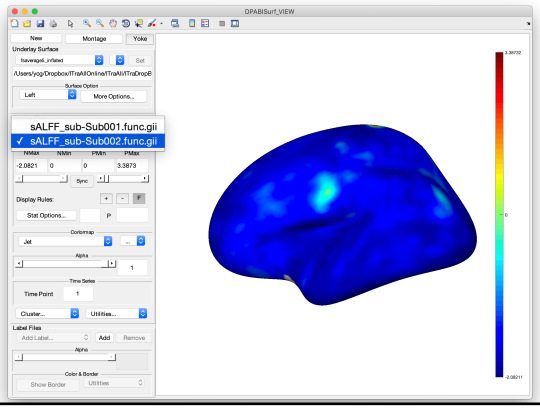

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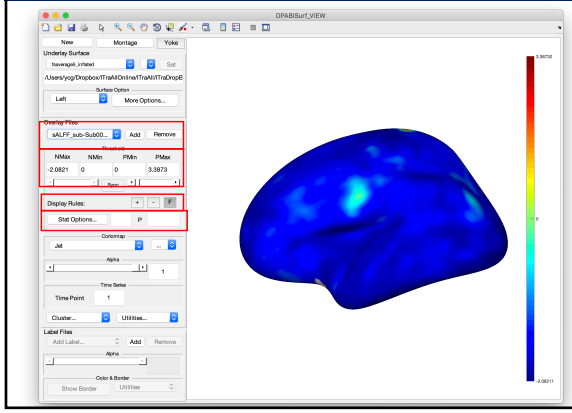

60

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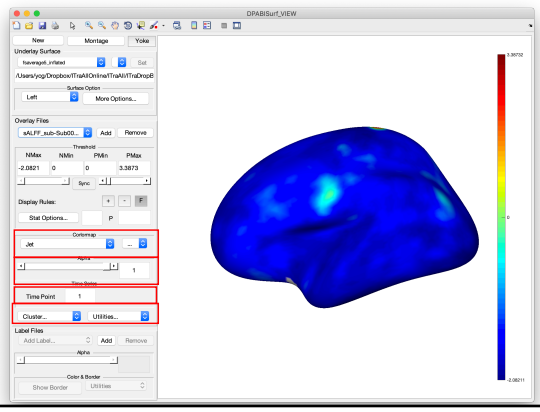

61

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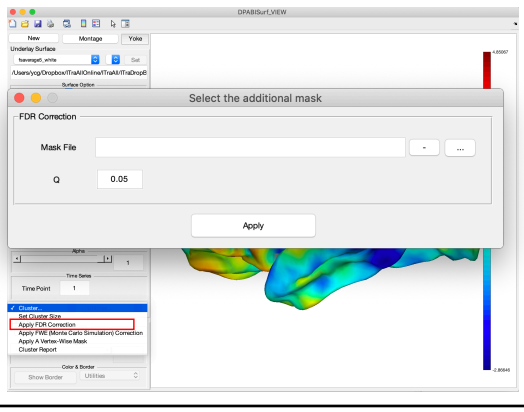

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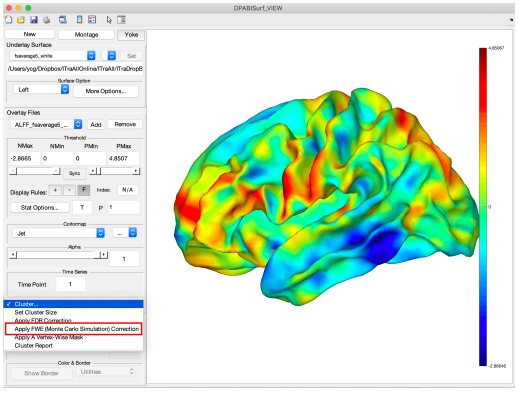

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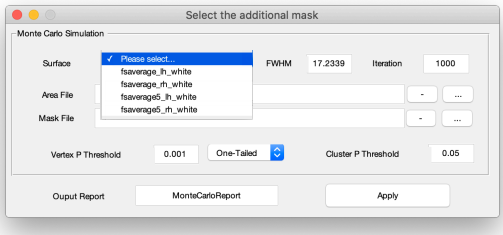

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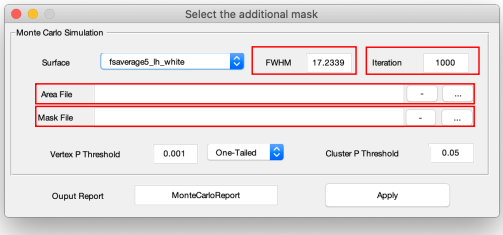


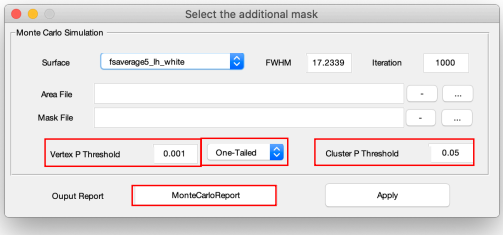
Estimated during DPABI Statistical Analysis (no PALM)

fsaverage5_lh_white_avg.area.gii

fsaverage5_lh_cortex.label.gii

65

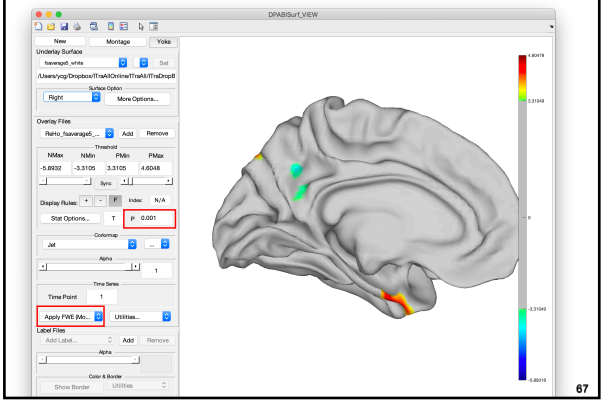
DPABISurf_VIEW



Two hemispheres, then 0.025

66

DPABISurf_VIEW



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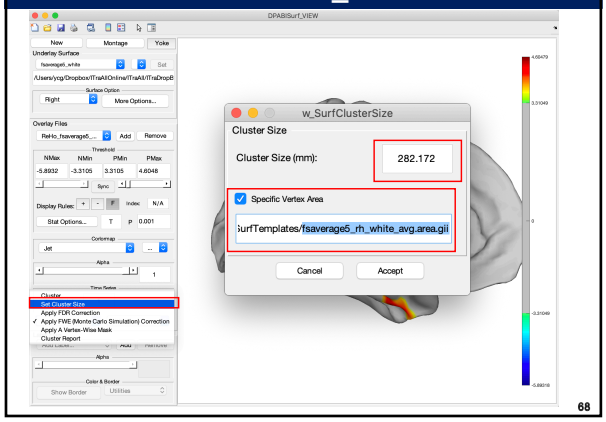
DPABISurf_VIEW



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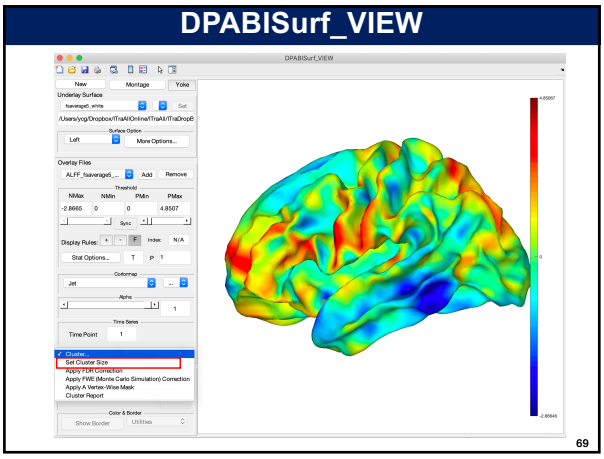

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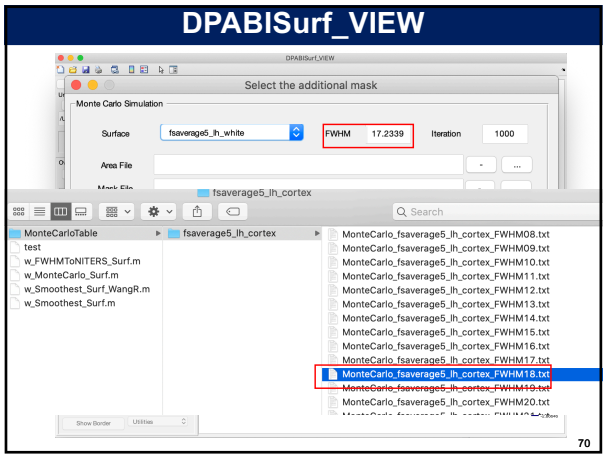

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DPABISurf_VIEW

```
Surface File: /mnt/Data3/RfMRILab/Yan/YAN_Work/DPABIUpdating/MonteCarl
Program/DPABI-master/DPABISurf/SurfTemplates/fsaverage5_lh_white.surf.
Area File: /mnt/Data3/RfMRILab/Yan/YAN_Work/DPABIUpdating/MonteCarloTal
DPABI-master/DPABISurf/SurfTemplates/fsaverage5_lh_white_avg.area.gii
Mask File: /mnt/Data3/RfMRILab/Yan/YAN_Work/DPABIUpdating/MonteCarloTal
DPABI-master/DPABISurf/SurfTemplates/fsaverage5_lh_cortex.label.gii
FWHM=18.000000, NumOfSmoothIteration=14
NumOfSimulation=10000

One-Tailed Table
  pthr  | alpha = Prob(Cluster (mm^2) >= given size)
  ------ | 0.05000 0.02500 0.01667 0.01000 0.00500 0.00333
0.050000  1527.31 1741.74 1850.05 1988.63 2230.04 2338.35
0.010000   603.90  715.55  774.79  856.81  966.37 1052.41
0.005000   434.18  514.63  566.12  623.72  717.11  754.33
0.001000   203.64  250.88  282.63  319.04  379.76  408.66
0.000500   142.55  181.90  207.95  237.08  285.83  318.91
0.000100    43.37   72.29   90.38  117.84  152.39  169.02

Two-Tailed Table
  pthr  | alpha = Prob(Cluster (mm^2) >= given size)
  ------ | 0.05000 0.02500 0.01667 0.01000 0.00500 0.00333
0.050000  1242.97 1395.60 1502.38 1608.54 1791.32 1882.72
0.010000   547.16  640.99  686.92  753.74  882.51  913.00
0.005000   401.88  475.18  520.66  582.40  664.64  709.20
0.001000   201.04  251.27  280.26  323.62  369.22  411.38
0.000500   143.57  186.07  214.68  251.65  288.63  312.64
0.000100    52.31   83.57  105.27  126.69  163.39  180.46
```

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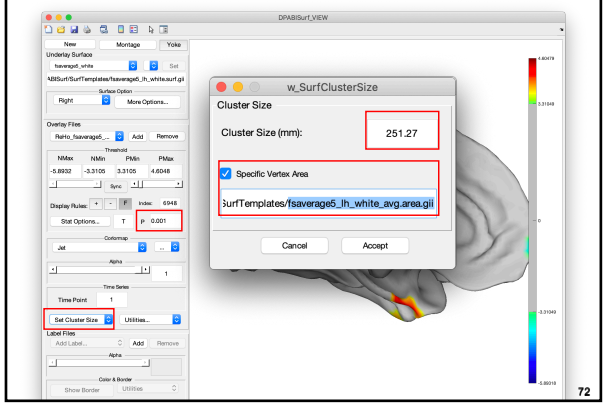
DPABISurf_VIEW



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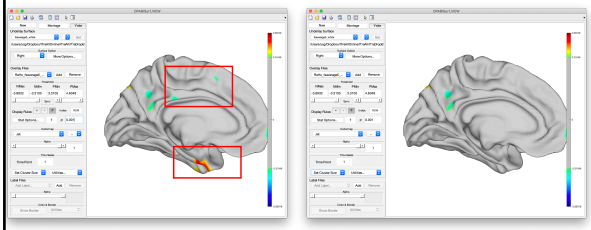
DPABISurf_VIEW



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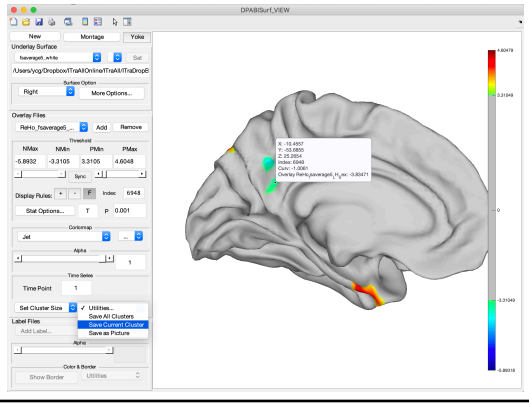

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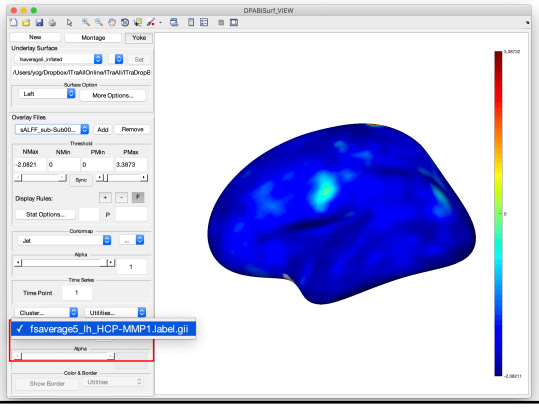

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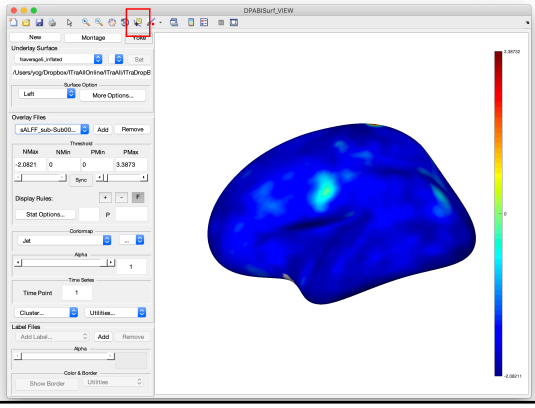

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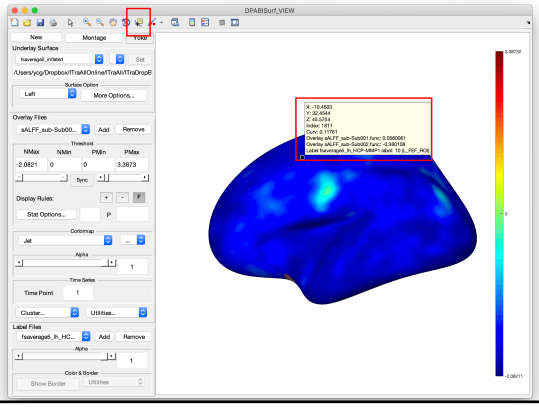

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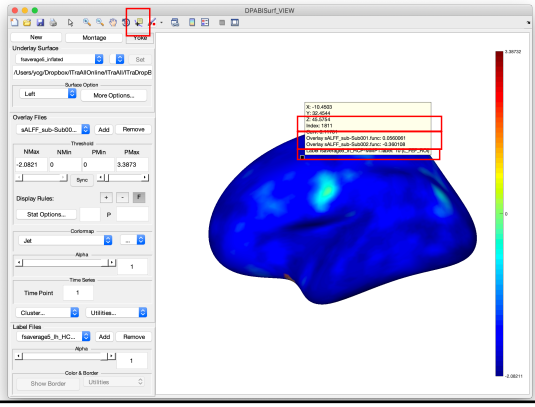

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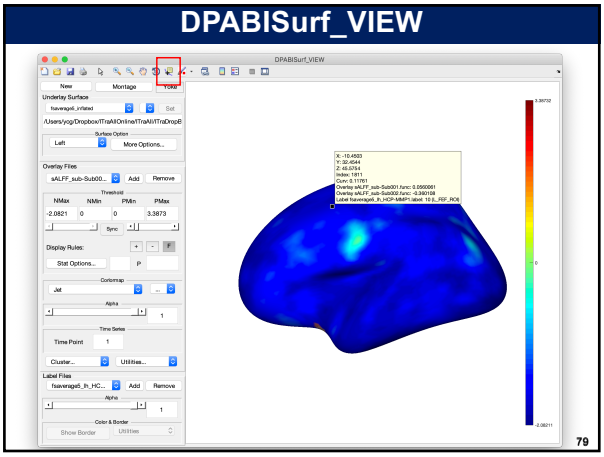

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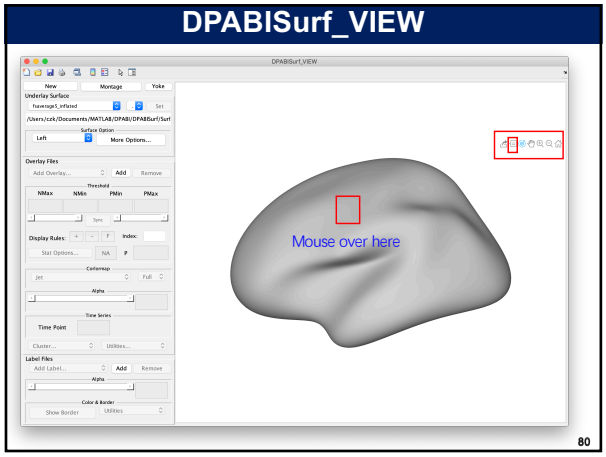

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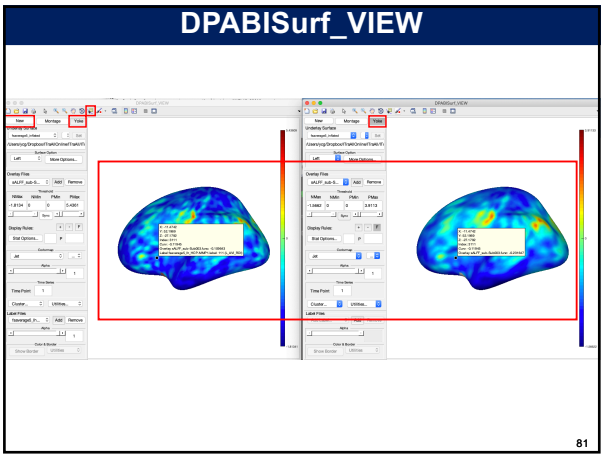

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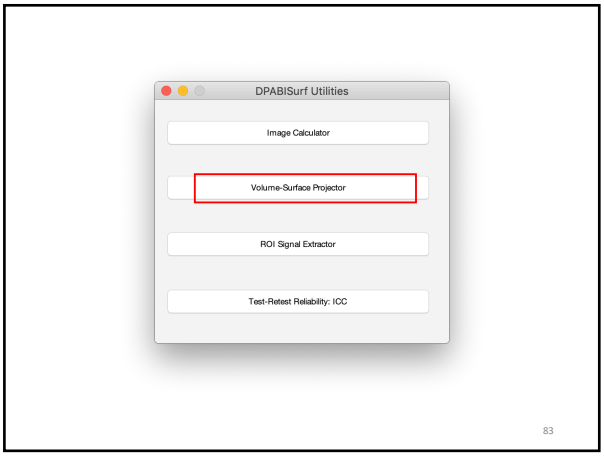

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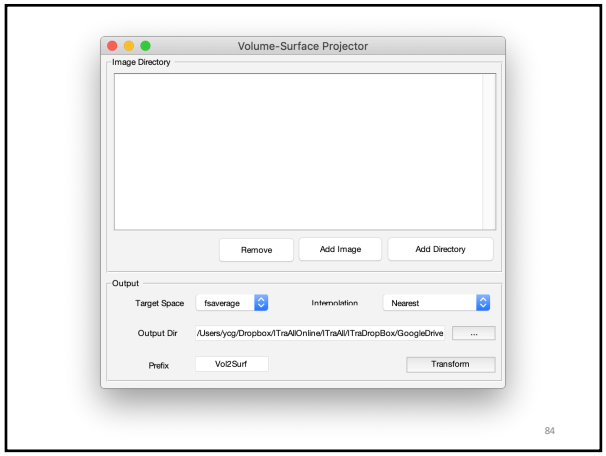

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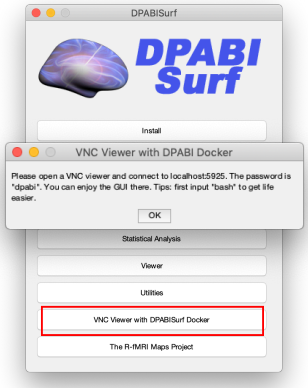

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Use DPABISurf Docker

```
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}

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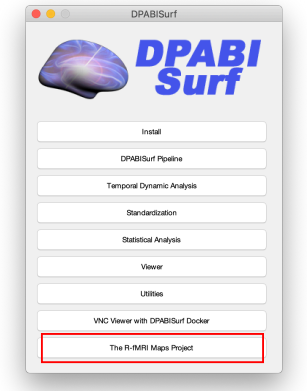

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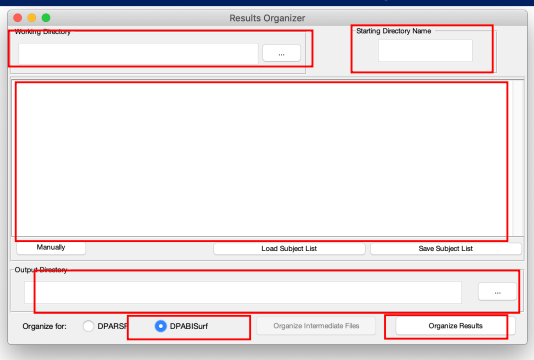
The R-fMRI Maps Project



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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');

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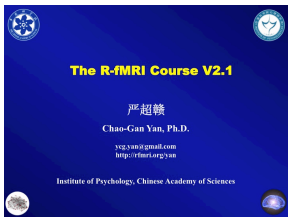
Further Help



http://rfmri.org/Course

http://wiki.rfmri.org

The R-fMRI Journal Club

Official Account: RFMRILab

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Acknowledgments

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Xi-Nian Zuo

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NYU Child Study Center
F. Xavier Castellanos

Child Mind Institute
Michael P. Milham

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- Chinese Academy of Sciences

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Thanks for your attention!

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