Data Processing & Analysis for (Resting-State) Brain Imaging (DPABI): Utilities

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Outline

- **Standardization**
- **Utilities**

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Standardization

Table 1. Factors can introduce unintended variations in fMRI measurement.

Category	Factor
1. Acquisition-related variations	Scanner make and model (Friedman and Glover, 2006b), sequence type (spiral vs. echo planar; single-echo vs. multi-echo) (Klarhofer et al., 2002), parallel vs. conventional acquisition (Feinberg et al., 2010; Lin et al., 2005), coil type (surface vs. volume, number of channels, orientation), repetition time, number of repetitions, flip angle, echo time, and acquisition volume (field of view, voxel size, slice thickness/gaps, slice prescription) (Friedman and Glover, 2006a)
2. Experimental-related variations	Participant instructions (Hartstra et al., 2011), eyes-open/eyes-closed (Yan et al., 2009; Yang et al., 2007), visual displays, experiment duration (Fang et al., 2007; Van Dijk et al., 2010)
3. Environment-related variations	Sound attenuation measures (Cho et al., 1998; Elliott et al., 1999), attempts to improve participant comfort during scans (e.g., music, videos) (Cullen et al., 2009), head-motion restraint techniques (e.g., vacuum pad, foam pad, bite-bar, plaster cast head holder) (Edward et al., 2000; Menon et al., 1997), room temperature and moisture (Vanhoutte et al., 2006).
4. Participant-related variations	Circadian cycle (Shannon et al., 2012), prandial (Haase et al., 2009), caffeine (Rack-Gomer et al., 2009), and nicotine status (Tanabe et al., 2011), sleepiness / arousal (Horovitz et al., 2008), sleep deprivation (Samann et al., 2010), scanner anxiety (de Bie et al., 2010), and menstrual cycle status (for women) (Protopopescu et al., 2005).

Yan et al., 2013. Neuroimage

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Stand

	Analytic Method	Post-hoc Correction	Correction Level	Addresses Additive Noise	Addresses Multiplicative Noise	Can Introduce Artifact	Non-parametric
GSR	Regression of the mean brain signal during preprocessing		I			X	
Mean Subtraction	$V_{measure}$ - $Mean_{measure}$	X	I	X		X	
Mean Division	$V_{measure}$ / $Mean_{measure}$	X	I	X	X	X	
Z-Standardization	($V_{measure}$ - $Mean_{measure}$) / $SD_{measure}$	X	I	X	X	X	
Mean Regression	Regress out $Mean_{measure}$ from $V_{measure}$	X	G	X			
Mean regression and SD division	· Regress out $Mean_{measure}$ from $V_{measure,}$, resulting in y' · y' / $SD_{measure}$	X	M	X	X	X	
Mean regression and log SD regression	· Regress out $Mean_{measure}$ from $V_{measure,}$, resulting in y' · Regress out ln($SD_{measure}$) from ln(|y'|), resulting in y'' · Take the exponent of y'' and recover the sign, resulting in $e^{y''}$	X	G	X	X		
Median-IQR	($V_{measure}$ - $Median_{measure}$)/$IQR_{measure}$	X	I	X	X	X	X
Rank	Rank $V_{measure}$ relative to all voxels with the whole brain	X	I	X	X	X	X
Quantile Standardization	Rank $V_{measure}$ within subject. For each rank, calculate the mean across subjects and assign back	X	M	X	X	X	X
Gaussian Fit	($V_{measure}$ – E[$Mean_{measure}$]) / E[$SD_{measure}$]	X	I	X	X	X	

Yan et al., 2013. Neuroimage

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Table 4A. The site, motion, age, sex effects and R^2 on the whole brain **mean** of R-fMRI measures.

Effects on **mean**	ALFF	fALFF	ReHo	VMHC	PCC-iFC	DC
Site (F)	3073.71 (0.0000)	4305.97 (0.0000)	192.86 (0.0000)	46.57 (0.0000)	7.48 (0.0000)	27.61 (0.0000)
Motion (T)	3.77 (0.0002)	-0.72 (0.4741)	10.74 (0.0000)	11.51 (0.0000)	8.44 (0.0000)	9.93 (0.0000)
Age (T)	0.15 (0.8825)	-3.85 (0.0001)	-8.84 (0.0000)	-6.50 (0.0000)	-2.72 (0.0067)	-3.53 (0.0004)
Sex (T)	-0.25 (0.7993)	-0.31 (0.7532)	-0.36 (0.7172)	1.11 (0.2659)	0.75 (0.4548)	0.22 (0.8242)
R^2	0.99	0.99	0.82	0.58	0.21	0.45

Table 4B. The site, motion, age, sex effects and R^2 on the whole brain **standard deviation** of R-fMRI measures.

Effects on **STD**	ALFF	fALFF	ReHo	VMHC	PCC-iFC	DC
Site (F)	1659.00 (0.0000)	93.95 (0.0000)	61.78 (0.0000)	106.59 (0.0000)	84.07 (0.0000)	20.05 (0.0000)
Motion (T)	3.28 (0.0011)	-0.06 (0.9548)	5.66 (0.0000)	-4.27 (0.0000)	-0.12 (0.9040)	10.37 (0.0000)
Age (T)	-0.04 (0.9710)	0.19 (0.8479)	-7.29 (0.0000)	2.71 (0.0069)	-4.68 (0.0000)	-3.62 (0.0003)
Sex (T)	-0.24 (0.8111)	2.03 (0.0422)	1.26 (0.2072)	0.43 (0.6702)	-5.65 (0.0000)	0.93 (0.3549)
R^2	0.97	0.69	0.62	0.73	0.65	0.40

The first value in each cell is the F value or T value. The value in parentheses corresponds p value. A red number indicates significance after Bonferroni correction ($p<0.05$) across 6 measures.

Yan et al., 2013. Neuroimage

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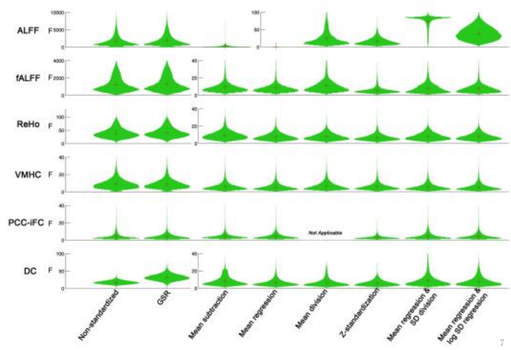
Standardization



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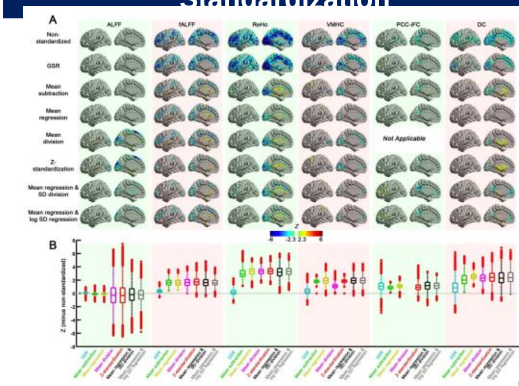
Standardization



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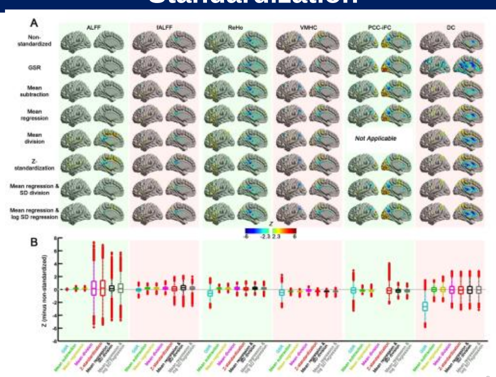
Standardization



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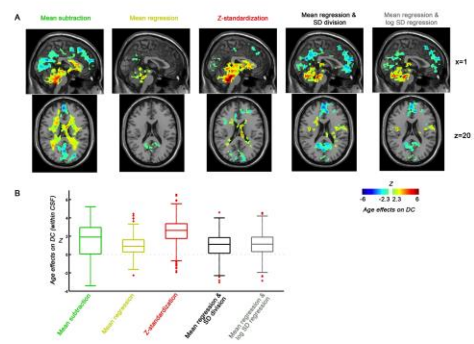
Standardization



Yan et al., 2013. Neuroimage

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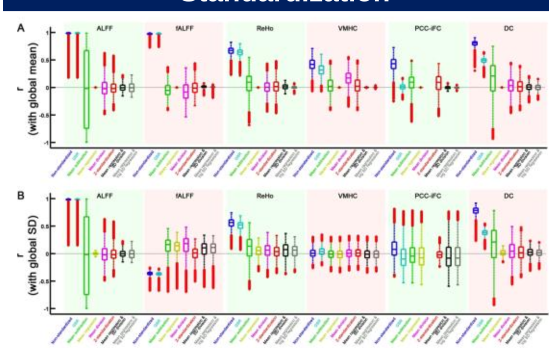
Standardization



Yan et al., 2013. Neuroimage

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Standardization

- Mean regression-based approach.
- Mean regression + SD division (for controlling mulplicative effects).

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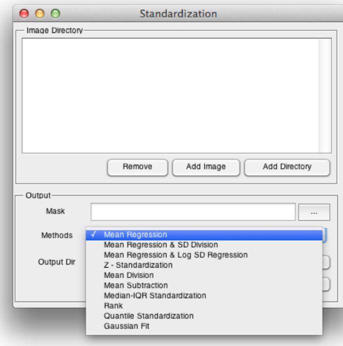
Standardization



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Outline

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- **Utilities**

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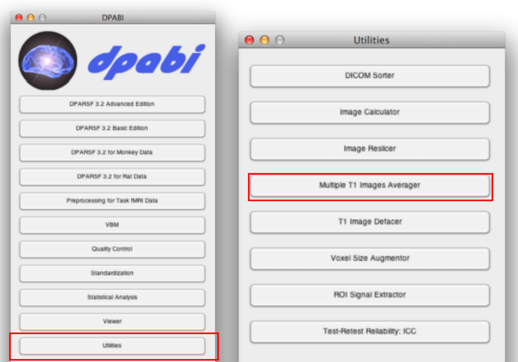

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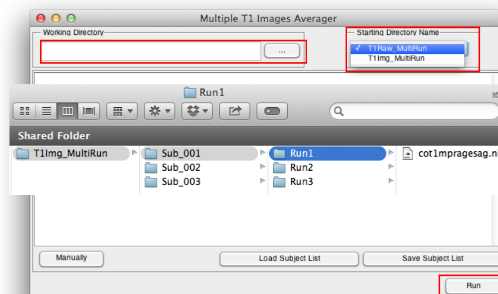
Utilities



Coregister and average

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Utilities

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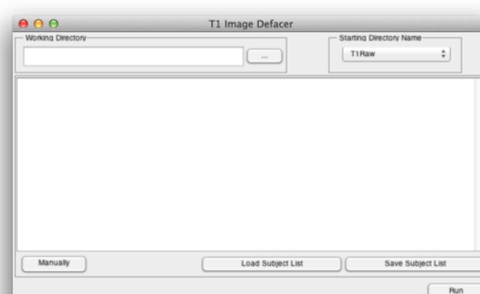
Utilities



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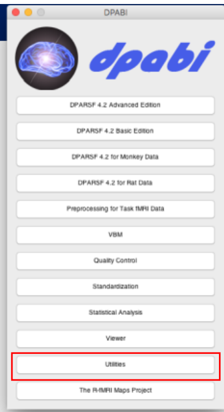

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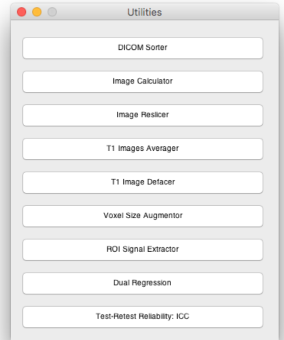
Utilities



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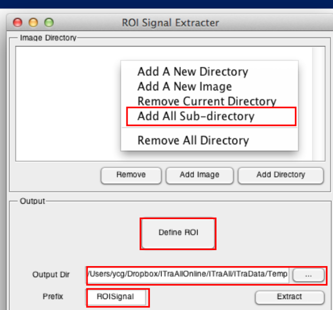

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Define ROI

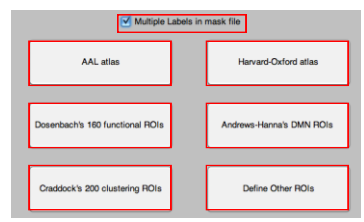
Multiple labels in mask file: each label is considered as one ROI

Dosenbach et al., 2010

Andrews-Hanna et al., 2010

Craddock et al., 2011

Define other ROIs



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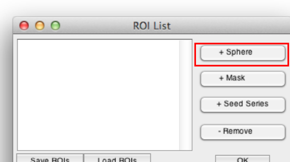
Utilities



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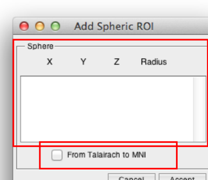

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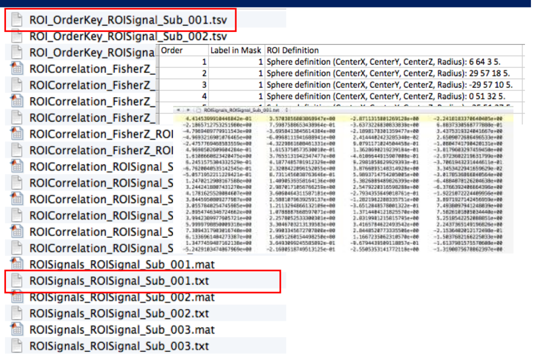

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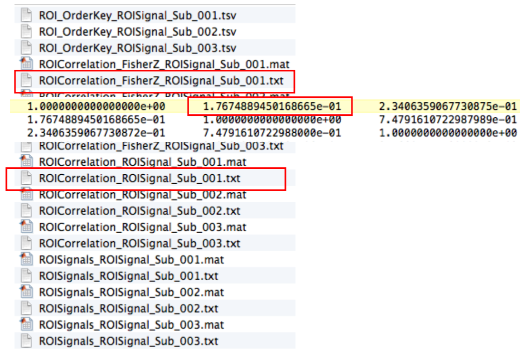
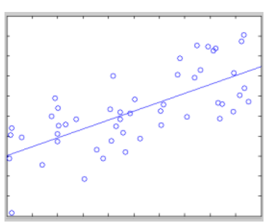


Utilities

Scatter Plot

```
[r p]=corrcoef(ALFF,MMSE)
plot(ALFF,MMSE,’o’)
lsline
```



Utilities

Image Reslicer

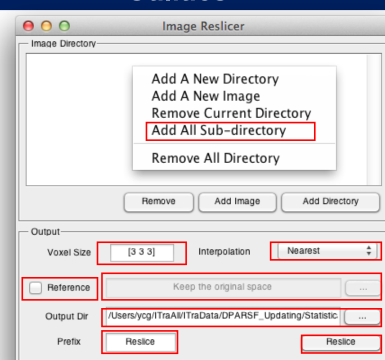


Image Calculator

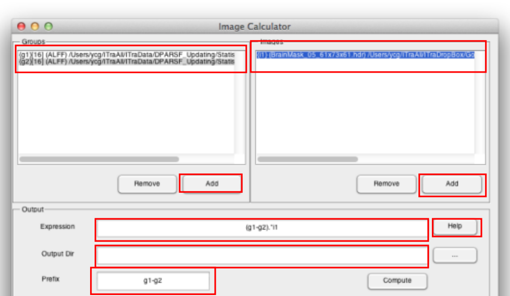


Image Calculator

Example expressions:

(a) g1-1 Subtract 1 from each image in group 1

(b) g1-g2 Subtract each image in group 2 from each corresponding image in group1

(c) i1-i2 Subtract image 2 from image 1

(d) i1>100 Make a binary mask image at threshold of 100

(e) g1.*To4D((i1>2.3),100) Make a mask (threshold at 2.3 on i1) and then apply to each image in group 1 (group 1 has 100 images)

(f) mean(g1) Calculate the mean image of group 1

(g) (i1-mean(g1))./std(g1) Calculate the z value of i1 related to group 1

(h) corr(g1,g2,"temporal") Calculate the temporal correlation between two groups, i.e. one correlation coefficient between two "time courses" for each voxel.

(i) corr(g1,g2,"spatial") Calculate the spatial correlation between two groups, i.e. one correlation coefficient between two images for each "time point".

Reading and Writing functions

Reading:

```
[Data Header] = y_Read('brodmann.nii');
    Data - 181*217*181 double
    Header - Structure
```

Processing:

```
BA20Data = (Data==20);
```

y_ReadRPI
y_ReadAll

Writing:

```
Header.pinfo = [1;0;0]; Header.dt =[16,0];
y_Write(BA20Data, Header, 'BA20.img');
```

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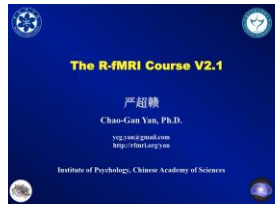
Further Help



http://rfmri.org/Course

http://wiki.rfmri.org

The R-fMRI Journal Club

Official Account: RFMRILa

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Acknowledgments

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Thanks for your attention!

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