



GREटना

Sandy Wang

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## *A Graph-theoretical Network Analysis Toolkit*

Sandy Wang

National Key Laboratory of Cognitive Neuroscience and Learning,  
Beijing Normal University, Beijing, China

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# OVERVIEW

## A Brief Introduction of GRETN

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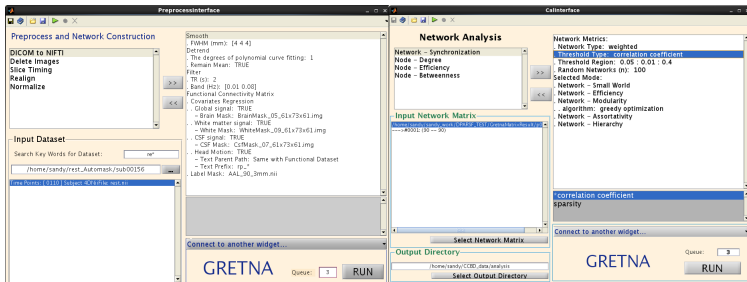
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- This toolkit, termed as GRETN, is designed to perform graph-theoretical network analysis of fMRI data. It can calculate most frequently used network metrics currently, e.g. small world parameters (Watts and Strogatz, 1998), network efficiency (Latora et al., 2001; Marchiori et al., 2003) and etc.



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The advantages of GRETNA

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- GRETNA has a simplified interface to calculate brain network metrics.
- GRETNA allows you to arrange the order of preprocess.
- GRETNA supports 3D/4D NIFTI-1 format.
- GRETNA use PSOM (<http://code.google.com/p/psom>) so you can run jobs in parallel as well as check and restart failed jobs.



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The contents of GRETNA

## Preprocess and Construction

- 1 DICOM to NIFTI
- 2 Delete Images
- 3 Slice Timing
- 4 Realign
- 5 Normalize
- 6 Smooth
- 7 Detrend
- 8 Filter
- 9 Covariates Regression
- 10 Functional Connectivity Matrix



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The contents of GRE<sup>T</sup>NA

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## Calculating Brain network metrics

- Network - Small World
- Network - Efficiency
- Network - Modularity
- Network - Assortativity
- Network - Hierarchy
- Network - Synchronization
- Node - Degree
- Node - Efficiency
- Node - Betweenness



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# GUIDE

## Install GRETNA in MATLAB

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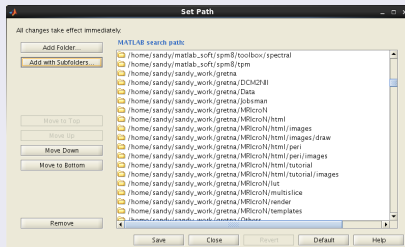
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## Add GRETNA to MATLAB search path and save it



- GRETNA support MATLAB(2010a) and above at Windows/Linux/Mac OS
- GRETNA call SPM8 to preprocess your fMRI data, so please ensure you have installed SPM8



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## Initiate Gretna

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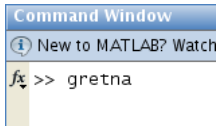
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- GRETNA includes two parts:
  - ① Network construction
  - ② Network metrics.



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## Network Construction Window

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**PreprocessInterface**

**Preprocess and Network Construction**

DICOM to NIFTI  
Filter  
Covariates Regression  
Functional Connectivity Matrix

>>  
<<

**Input Dataset**

Search Key Words for Dataset:

Time Points: [ 0230 ] Subject Directory: 0001/  
Time Points: [ 0230 ] Subject Directory: 0002/  
Time Points: [ 0230 ] Subject Directory: 0003/  
Time Points: [ 0230 ] Subject Directory: 0004/  
Time Points: [ 0230 ] Subject Directory: 0006/  
Time Points: [ 0230 ] Subject Directory: 0007/  
Time Points: [ 0230 ] Subject Directory: 0008/  
Time Points: [ 0230 ] Subject Directory: 0009/  
Time Points: [ 0230 ] Subject Directory: 0010/  
Time Points: [ 0230 ] Subject Directory: 0012/  
Time Points: [ 0230 ] Subject Directory: 0013/  
Time Points: [ 0230 ] Subject Directory: 0014/  
Time Points: [ 0230 ] Subject Directory: 0015/  
Time Points: [ 0230 ] Subject Directory: 0017/  
Time Points: [ 0230 ] Subject Directory: 0018/  
Time Points: [ 0230 ] Subject Directory: 0019/  
Time Points: [ 0230 ] Subject Directory: 0020/

Delete Images  
. The delete type: Delete  
. Delete first 10 time points  
Slice Timing  
. Number of Slices: 33  
. TR (s): 2  
. Slice order: 1:2:33,2:2:32  
. Reference Slice: 33  
Realign  
Normalize  
. Normalize Method: EPI  
. Source Image Path: Same with Functional Dataset  
. Source Image Prefix: mean\*  
. Voxel Sizes (mm): [ 3 3 3 ]  
. Bounding box: [-90, -126, -72 ; 90, 90, 108]  
Smooth  
. FWHM (mm): [ 4 4 4 ]  
Detrend  
. The degrees of polynomial curve fitting: 1  
. Remain Mean: TRUE

\*EPI  
T1

Connect to another widget...

**GRETNA** Queue:  **RUN**



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## Network Construction Window - Toolbar

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### Easy to use toolbar (from left to right)

- 1 Change Default Configure
- 2 GRETNA Manual
- 3 Load your Configure
- 4 Save current Configure
- 5 Run Jobs
- 6 Refresh Jobs Status
- 7 Stop current Jobs



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## Network construction Window - Procedure

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### Preprocess and Network Construction

DICOM to NIFTI  
Delete Images  
Slice Timing  
Realign  
Normalize  
Smooth  
Detrend  
Filter  
Covariates Regression  
Functional Connectivity Matrix



### Preprocess and Network Construction

DICOM to NIFTI  
Filter  
Covariates Regression  
Functional Connectivity Matrix



#### Delete Images

. The delete type: Delete  
. . Delete first 10 time points  
Slice Timing  
. Number of Slices: 33  
. TR (s): 2  
. Slice order: 1:2:33,2:2:32  
. Reference Slice: 33  
Realign  
Normalize  
. Normalize Method: EPI  
. Source Image Path: Same with Functional Dataset  
. Source Image Prefix: mean\*



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## Network construction Window - Input

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The figure displays three instances of the 'Input Dataset' window in the GRETNA software, illustrating different file selection paths and the resulting file lists.

- Top Left Window:** The 'Search Key Words for Dataset:' field is empty. The file path is `/home/sandy/sandy_work/DPARSF_TEST/Gretna_4`. The file list shows DICOM files: `DICOM File: [ 10320 ] DICOM Directory: p001` and `DICOM File: [ 10320 ] DICOM Directory: p002`.
- Top Right Window:** The 'Search Key Words for Dataset:' field contains the text `ra`. The file path is `/home/sandy/RSorSR/SR/ec/FunlmgAR`. The file list shows Time Points and Subject Directories: `Time Points: [ 0230 ] Subject Directory: 0001/`, `Time Points: [ 0230 ] Subject Directory: 0002/`, `Time Points: [ 0230 ] Subject Directory: 0003/`, `Time Points: [ 0230 ] Subject Directory: 0004/`, and `Time Points: [ 0230 ] Subject Directory: 0006/`.
- Bottom Left Window:** The 'Search Key Words for Dataset:' field is empty. The file path is `/home/sandy/Vesa/analysis/Funlmg`. The file list shows Time Points and Subject Directories: `Time Points: [ 0240 ] Subject Directory: sub01077/rest.nii`, `Time Points: [ 0240 ] Subject Directory: sub01241/rest.nii`, `Time Points: [ 0240 ] Subject Directory: sub01261/rest.nii`, `Time Points: [ 0240 ] Subject Directory: sub01679/rest.nii`, and `Time Points: [ 0240 ] Subject Directory: sub02036/rest.nii`.
- Bottom Right Window:** The 'Search Key Words for Dataset:' field is empty. The file path is `/home/sandy/sandy_work/DPARSF_TEST/4DNii/Fu`. The file list shows Time Points and Subject 4DNiiFiles: `Time Points: [ 0230 ] Subject 4DNiiFile: 20100514_140449gefund`, `Time Points: [ 0220 ] Subject 4DNiiFile: an20100514_140449gefund`, `Time Points: [ 0220 ] Subject 4DNiiFile: bdswwan20100514_140449gefund`, `Time Points: [ 0220 ] Subject 4DNiiFile: cbsdwwan20100514_140449gefund`, and `Time Points: [ 0220 ] Subject 4DNiiFile: dswwan20100514_140449gefund`.

- You need select a parent folder which includes:
  - ① folders of DICOM files,
  - ② folders of 3D Analyze/Nifti files,
  - ③ folders of 4D Nifti files
  - ④ 4D Nifti files.



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## Network construction Window - Configure

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### DICOM to NIFTI

. Time Point: 240

Delete Images

. The delete type: Delete

. . Delete first 10 time points

Slice Timing

. Number of Slices: 33

. TR (s): 2

. Slice order: 1:2:33,2:2:32

. Reference Slice: 33

Realign

Normalize

. Normalize Method: EPI

. Source Image Path: Same with Functional Dataset

. Source Image Prefix: mean\*

. Voxel Sizes (mm): [3 3 3]

. Bounding box: [-90 , -126 , -72 ; 90 , 90 , 108]

Normalize

. Normalize Method: T1

. . T1 Path <-X

. . DICOM to Nifti: FALSE

. . Coregister: TRUE

. . Segment: TRUE

. - Source Image Path: Same with Functional Dataset

. - Source Image Prefix: mean\*

. - T1 Images Prefix: co\*

. - Affine Regularisation: mni

. . Mat Suffix: \*\_seg\_sn.mat

. Voxel Sizes (mm): [3 3 3]

. Bounding box: [-90 , -126 , -72 ; 90 , 90 , 108]

Smooth

. FWHM (mm): [4 4 4]

Detrend

. The degrees of polynomial curve fitting: 1

. Remain Mean: TRUE

### Filter

. TR (s): 2

. Band (Hz): [0.01 0.08]

Covariates Regression

. Brain Mask: BrainMask\_05\_61x73x61.img

. Global signal: TRUE

. . Brain Mask: BrainMask\_05\_61x73x61.img

. White matter signal: TRUE

. . White Mask: WhiteMask\_09\_61x73x61.img

. CSF signal: TRUE

. . CSF Mask: CsfMask\_07\_61x73x61.img

. Head Motion: TRUE

. . Text Parent Path: Same with Functional Dataset

. . Text Prefix: rp\_\*

Functional Connectivity Matrix

. Label Mask: AAL\_90\_3mm.nii

- Select parameters like SPM with double clicks.



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## Network construction Window - Logs

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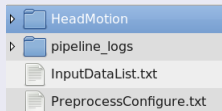
Step by Step

**Construction**

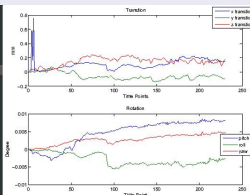
Metrics

Acknowledge

You can find logs in a folder named "GretnaLogs"



```
2013-1-18, 16:35:52
Time Points: [ 0230 ] Subject Directory: p001/
2013-1-18, 21:37:22
Time Points: [ 0230 ] Subject Directory: p001/
2013-1-18, 16:35:52
Covariates Regression
Brain Mask: BrainMask_05_61x73x61.img
Global signal: TRUE
Brain Mask: BrainMask_05_61x73x61.img
White matter signal: TRUE
White Mask: WhiteMask_09_61x73x61.img
CSF signal: TRUE
CSF Mask: CsfMask_07_61x73x61.img
Head Motion: TRUE
Text Parent Path: Same with Functional Dataset
Text Prefix: rp
Functional Connectivity Matrix
Label Mask: AAL_90_3mm.nii
```







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## Network construction Window - Run

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### Start Network Construction

Connect to another widget...

**GRETNA** Queue:  **RUN**



**Input Dataset**

Search Key Words for Dataset:

...

(p001/Dcm2Nii): running  
(p002/Dcm2Nii): none



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## Network metrics Window

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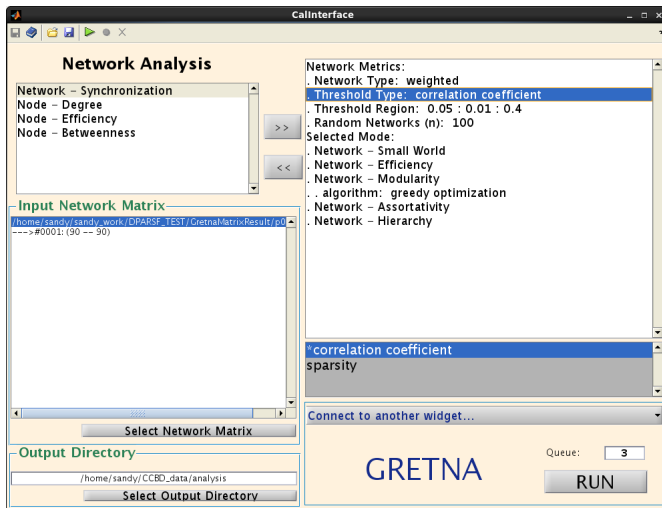
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**Network Analysis**

Network – Small World  
Network – Assortativity  
Network – Hierarchy  
Network – Synchronization  
Node – Degree  
Node – Efficiency  
Node – Betweenness

>>  
<<

Network Metrics:  
. Network Type: binarize  
. Threshold Type: sparsity  
. Threshold Region: 0.05 : 0.01 : 0.4  
. Random Networks (n): 100  
Selected Mode:  
. Network – Efficiency  
. Network – Modularity  
. algorithm: greedy optimization

*binarize	correlation coefficient	*greedy optimization
weighted	*sparsity	spectral optimization
0.050 0.060 0.070 0.080 0.090 0.100 0.110 0.120		100

- Select network metrics you need and parameters you want.

**Output Directory**

/home/sandy

Select Output Directory

- Select OUTPUT folder you want.



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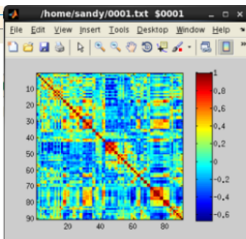
Construction

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### -Input Network Matrix-

```
/home/sandy/0001.txt  
-->#0001: (90 -- 90)  
/home/sandy/a.mat  
-->#0002: (90 -- 90)  
/home/sandy/b.mat  
-->#0003: (90 -- 90)  
-->#0004: (90 -- 90)  
-->#0005: (90 -- 90)  
-->#0006: (90 -- 90)  
-->#0007: (90 -- 90)  
-->#0008: (90 -- 90)  
-->#0009: (90 -- 90)  
-->#0010: (90 -- 90)  
-->#0011: (90 -- 90)  
-->#0012: (90 -- 90)
```



- You can select three format matrixes includes:
  - ① matrixes saved with \*.txt files
  - ② matrixes saved in a \*.mat files
  - ③ a cell of matrixes saved in a \*.mat files
- You can check inputed matrixes with double click



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- GRETNA call SPM8 and reference some functions in DPARSF.
- Yong He reserves the right of final interpretation for this toolkit.
- Thanks Jin-hui Wang, Ming-rui Xia, Zheng-jia Dai, Xun-hong Liao, Rui Hou, Xin-di Wang and others in He's group who develop this toolkit.
- You can get this toolkit at  
*[https : //github.com/sandywang/GRETNA](https://github.com/sandywang/GRETNA)*



# QUESTION AND ANSWER

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