

Group ICA Toolbox: New features and developments



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GIFT Highlights

- Stand-alone GIFT
- Automated ICA or Reference Based ICA
- Dynamic Functional Connectivity Highlights

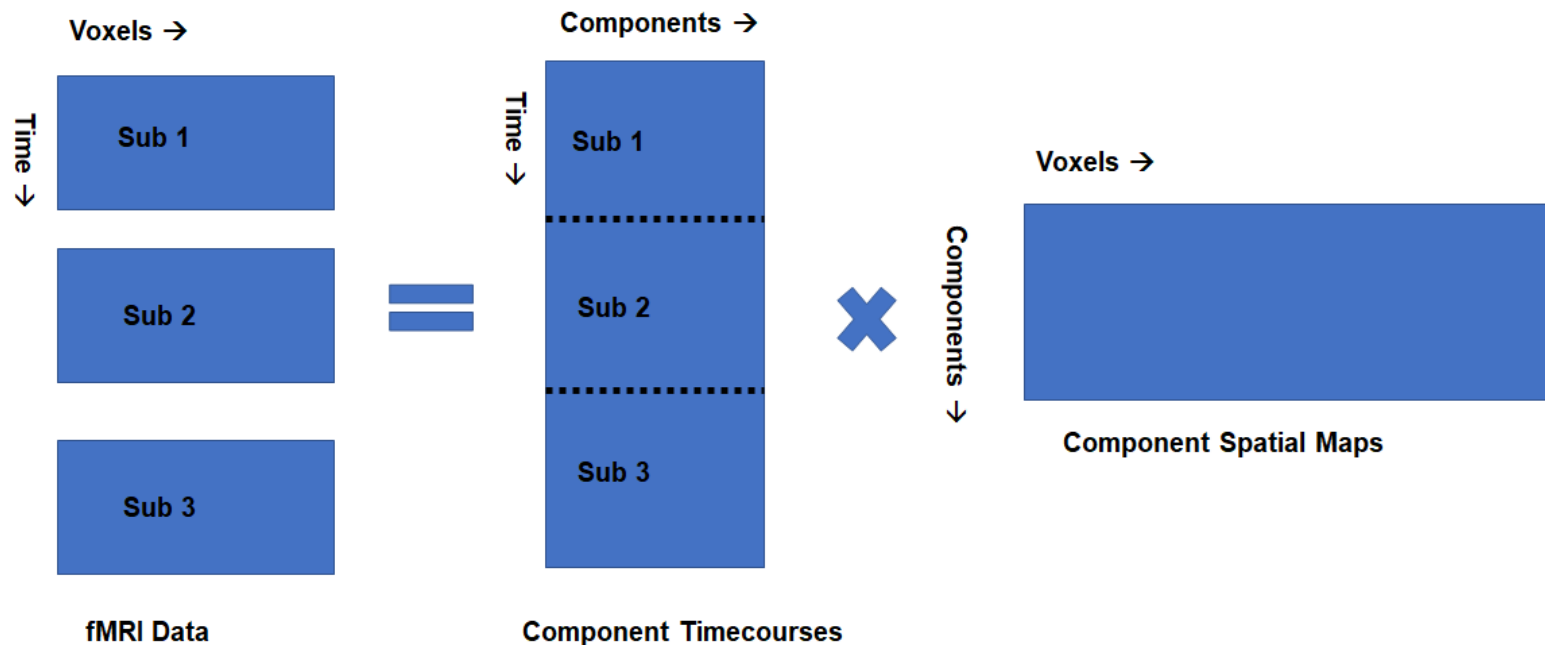
Introduction

- **GIFT toolbox** - Single subject and group ICA/IVA on fMRI data.
- Open source MATLAB Toolbox
- **19 ICA/IVA** algorithms are implemented such as Infomax, Fast ICA, etc.
- **Automated or Reference based ICA**
 - Use spatial templates as priors
 - Two algorithms are implemented like GIG-ICA and Constrained ICA (Spatial)
- GIFT can run **very large scale ICA analysis** using **MPOWIT** and **Subsampled Time PCA** algorithms.
- Tools in GIFT:
 - **Mancova** - Multivariate tests are performed on features like spectra, FNC to determine significant covariates. Univariate tests are performed using significant covariates.
 - **Dynamic Connectivity** - Temporal and spatial dynamics can be studied on the ICA/IVA components using a variety of methods.
 - **Noise cloud** - Uses logistic regression to detect noise or artifacts and networks using both ICA spatial maps and timecourses.

GIFT Introduction

- **Remove artifacts** - Components identified from ICA as artifacts can be removed from the original data. Useful in GLM analyses.
- **Outlier detection** - GIFT can detect bad or outlier subjects before analyzing data using generate mask tool.
- **Spatial-temporal regression** - GIFT uses prior ICA maps and subject's data to estimate subject spatial maps and timecourses.

Group ICA Framework

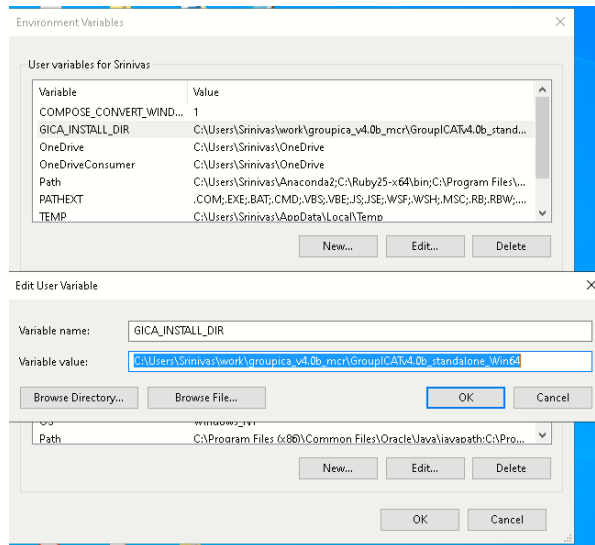
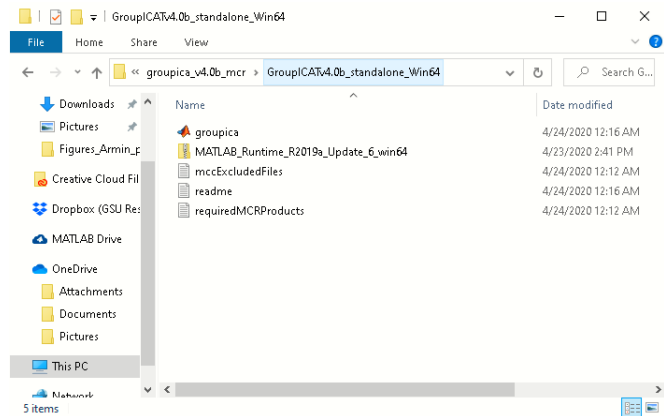


This is a simple example. In the software and group ica paper, PCA whitening and dewhitening matrices are used to achieve this transformation.

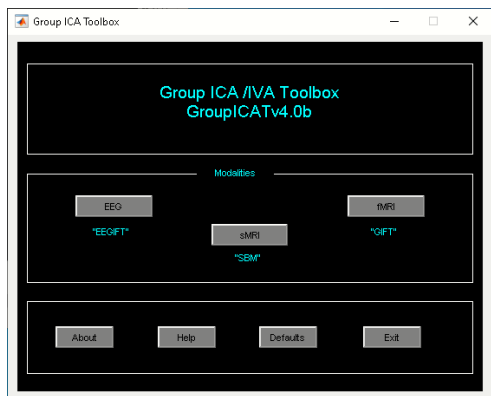
Stand-alone GIFT

- MATLAB code is compiled to stand alone application on Windows and Linux 64 bit OS.
- Docker for group ICA.
- Python wrappers through Nipype Interface.

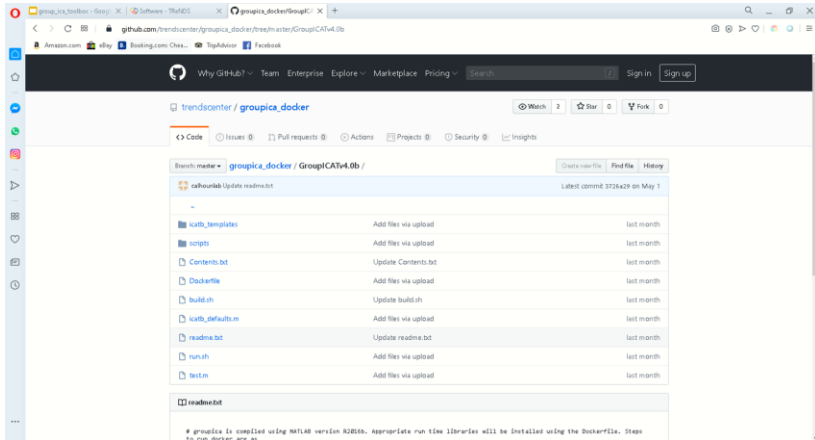
Stand-alone GIFT



Set GICA_INSTALL_DIR variable to point to the group ica directory location



Docker



```
Activities Terminal Jun 11 08:30
rnsk123@rnsk123-VirtualBox: ~/Desktop/groupica_app/groupica...
rnsk123@rnsk123-VirtualBox:~/Desktop/groupica_app/groupica_docker/GroupICATv4.0
b$ dir
build.sh groupica icab_templates run.sh test.m
Dockerfile icab_defaults.m readme.txt scripts
rnsk123@rnsk123-VirtualBox:~/Desktop/groupica_app/groupica_docker/GroupICATv4.0
b$
rnsk123@rnsk123-VirtualBox:~/Desktop/groupica_app/groupica_docker/GroupICATv4.0
b$ ./run.sh
Running gica using docker
./run.sh: line 3: '$\r': command not found
docker: Error response from daemon: Conflict. The container name "/mygicapp" is
already in use by container "93bf024d2172fcc16089850d97470723e6b504408d88b3b
bb4c8085dd7ebe8". You have to remove (or rename) that container to be able to r
euse that name.
See 'docker run --help'.
./run.sh: line 6: '$\r': command not found
./run.sh: line 7: '$\r': command not found
Creating MATLAB Runtime Cache at location: /tmp/.mcrCache9.1
.max_size found... contents read. Cache max size set to 33554432
MATLAB Runtime cache extracting component: groupica_0D112909608C4E02EC7851E27C4
A7C8D
Acquiring MATLAB Runtime cache root-level directory lock... acquire succeeded.
Reading cache index file...
Read cache index entry:
groupica_0D112909608C4E02EC7851E27C4A7C8D
groupi0
183090243
2020-Jun-11 12:28:17.685921
```

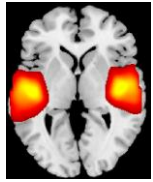
- Group ICA can be run inside a docker container.
- Github link contains information to clone/download the package
 - build.sh - Build docker image
 - run.sh - Inputs and outputs need to be mapped run the application

Nipype GIFT Interface

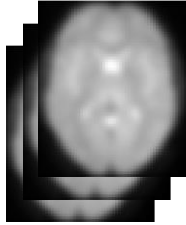
- GIFT can be run in a python setting using Nipype (<https://nipype.readthedocs.io/en/latest/>)
- Nipype software provides uniform interface to existing neuroimaging applications and built in python.
- Copy files from GroupICATv4.0b/icatb/nipype-0.10.0/nipype to existing nipype
- Use command `pip install -e /path/to/local/nipype` at the command prompt.

```
Python 2.7.16 [Anaconda, Inc.] (default, Mar 14 2019, 21:00:58)
[GCC 7.3.0] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> from nipype.interfaces import gift
>>> matlab_cmd = '/data/mialab/users/srinivas/GIFT_Stand_alone/Linux_x86_64/GroupICATv4.0b_standalone_aug_8_2019/run_groupica.sh /data/mialab/users/srinivas/GIFT_Stand_alone/Linux_x86_64/tmp_gica_stand_alone/v91/ '
>>> gift.GICACommand.set_mlab_paths(matlab_cmd=matlab_cmd,use_mcr=True)
>>> gc = gift.GICACommand()
>>> gc.inputs.in_files = ['/data/mialab/users/srinivas/Example_Subjects/Visuomotor_data/sub01_vis/sub001.nii', '/data/mialab/users/srinivas/Example_Subjects/Visuomotor_data/sub02_vis/sub002.nii', '/data/mialab/users/srinivas/Example_Subjects/Visuomotor_data/sub03_vis/sub003.nii']
>>> gc.inputs.dim = 16;
>>> gc.run()
```

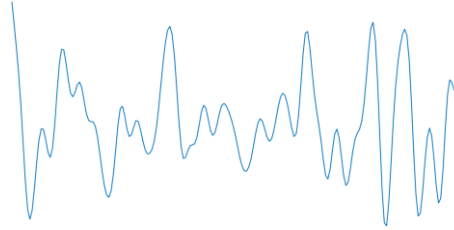
Automated ICA Or Reference Based ICA



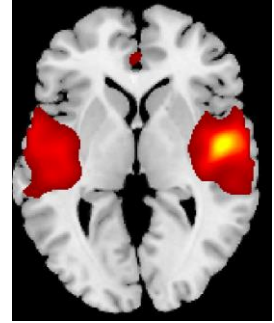
Spatial Priors



Subject Data

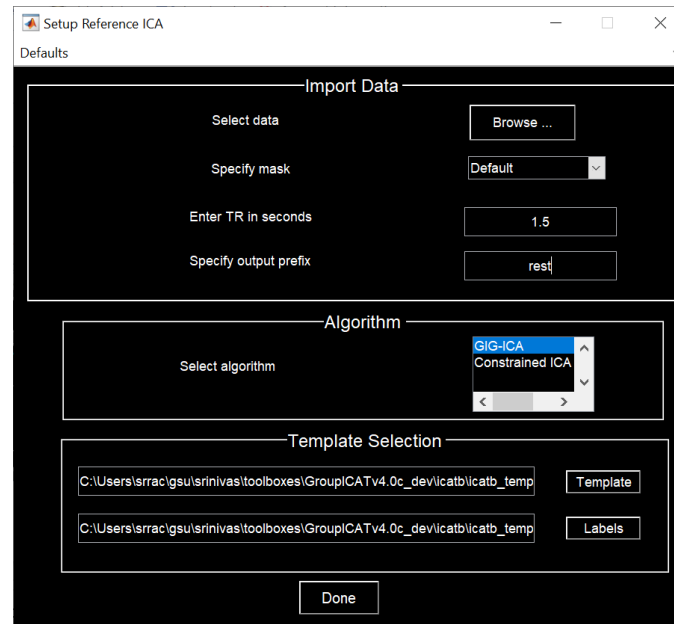
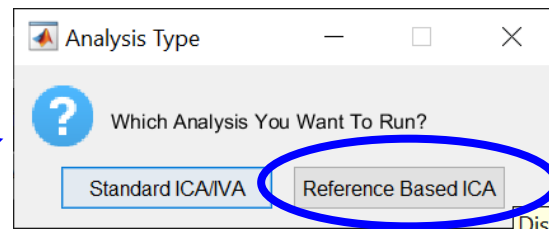
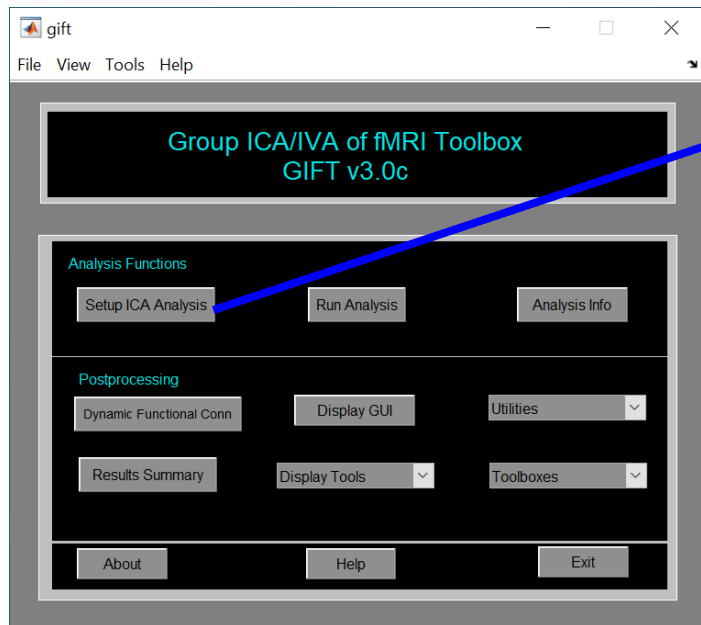


Subject ICA Timecourse

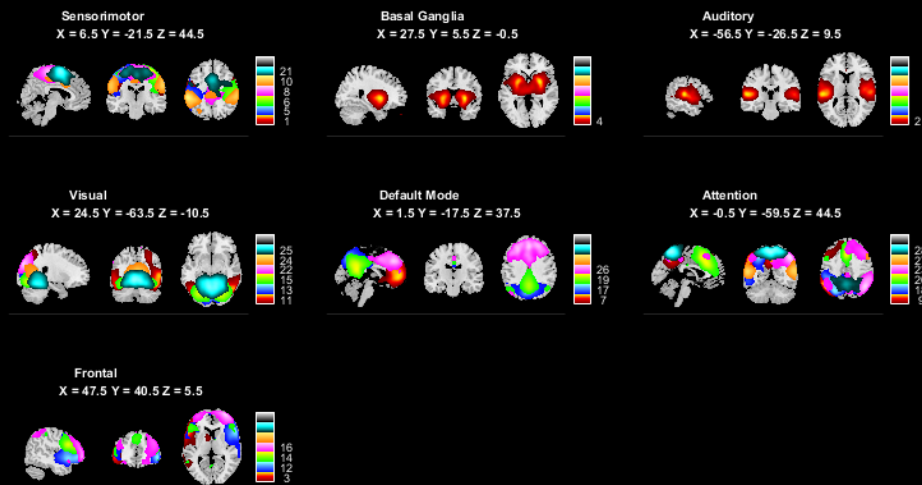


Subject ICA Map

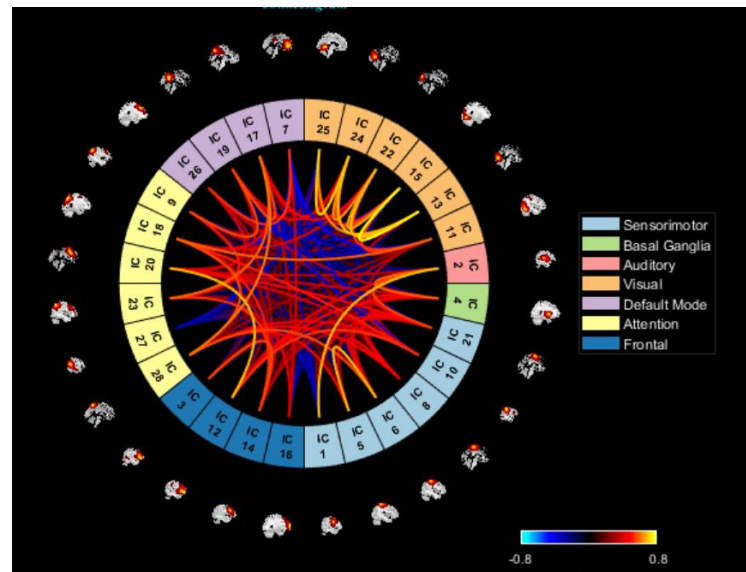
Automated ICA



Automated ICA

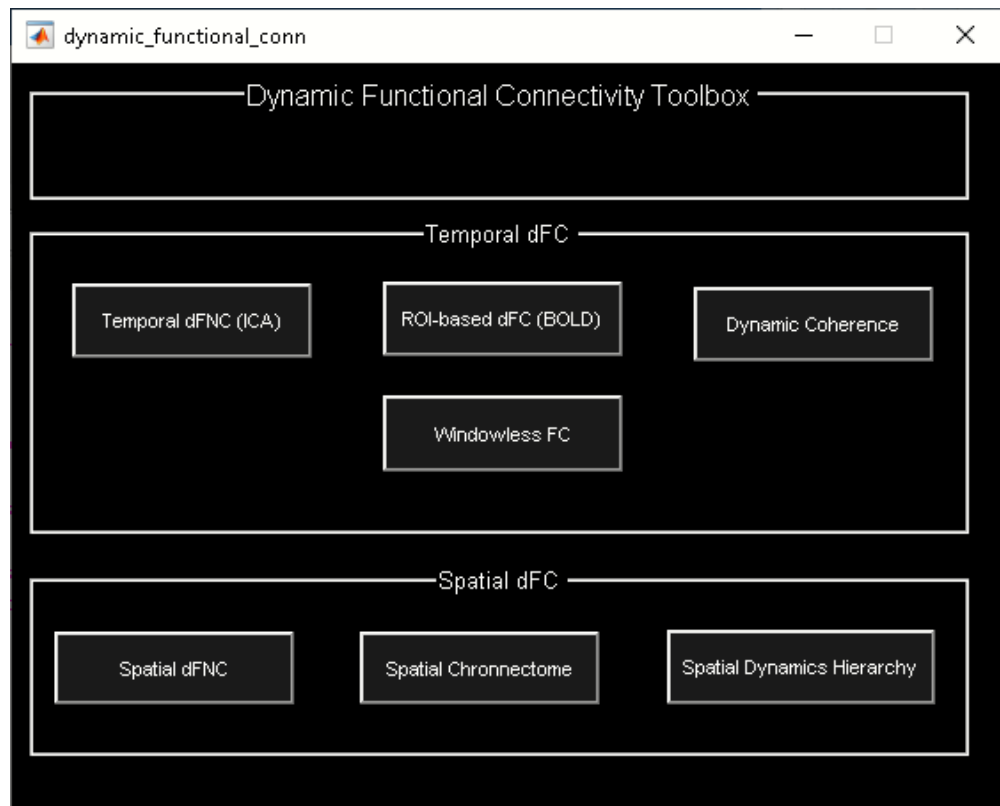
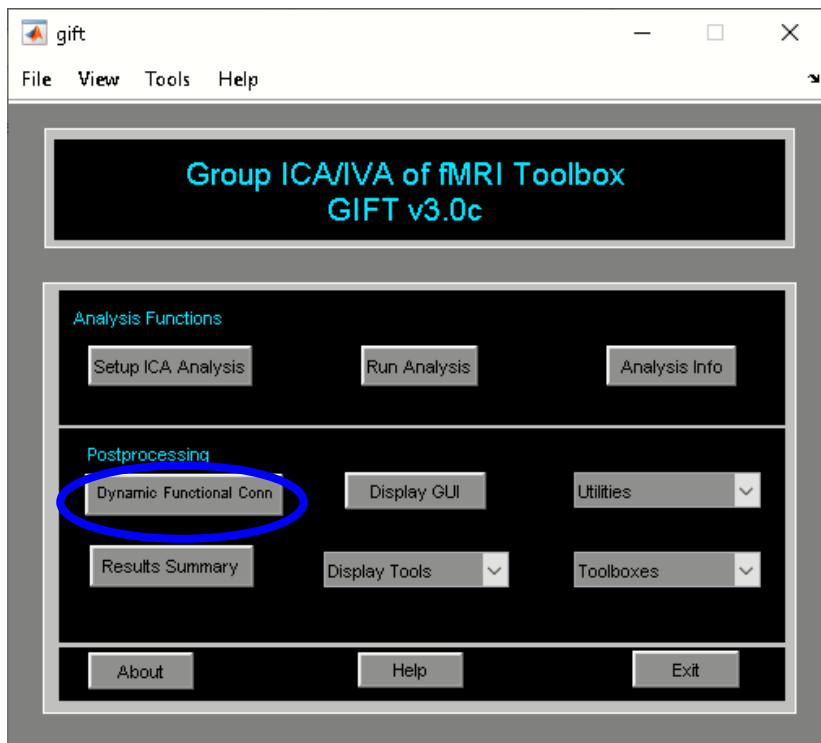


Composite ortho views

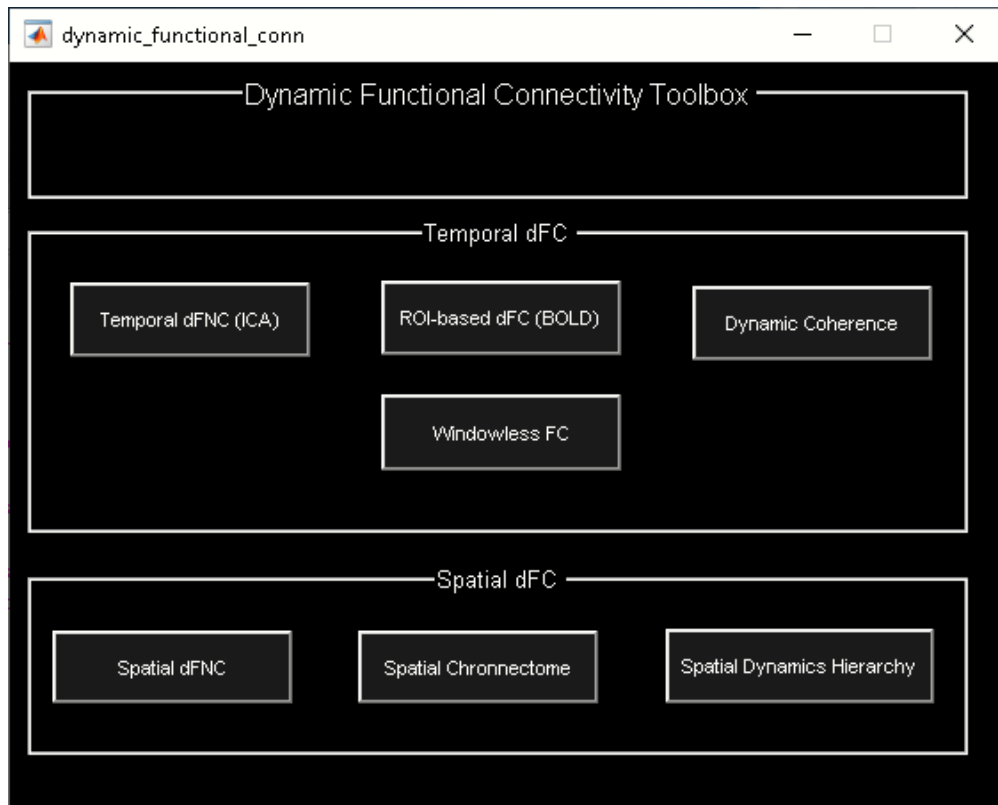


FNC Connectogram

Dynamic Connectivity Toolbox



Dynamic Connectivity Toolbox

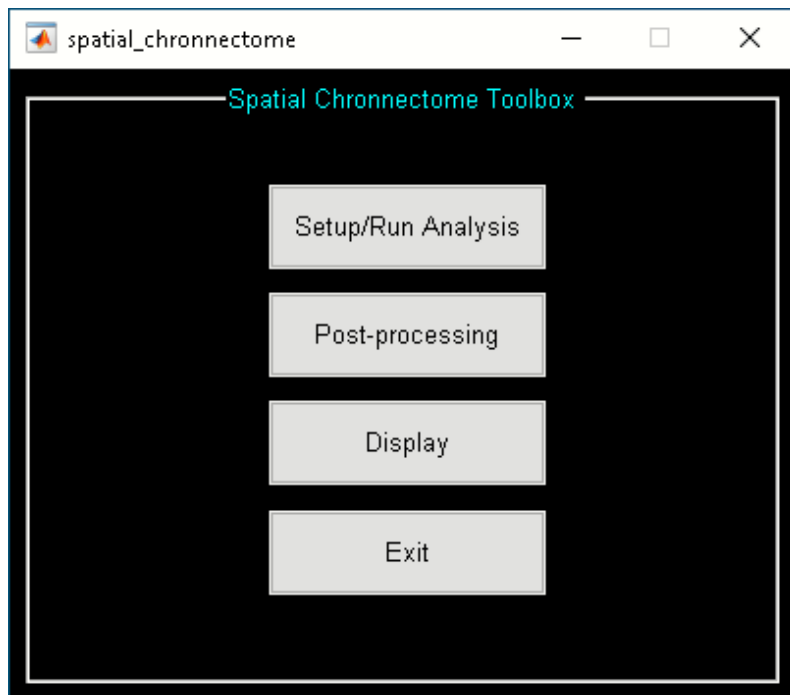


- **Temporal**

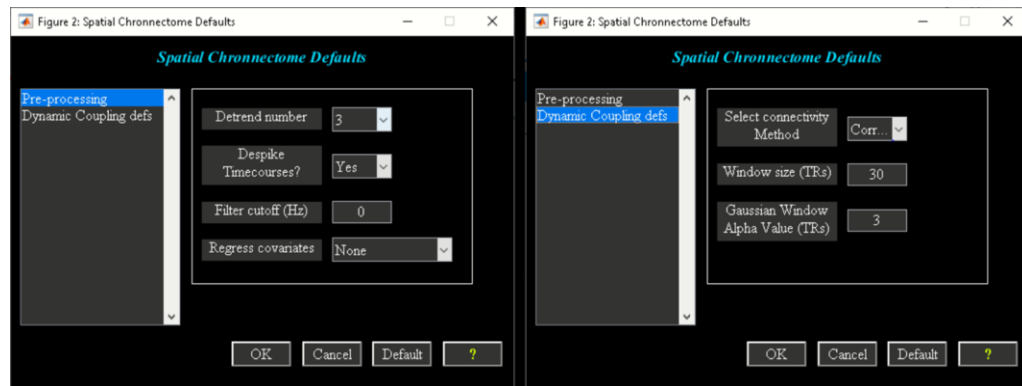
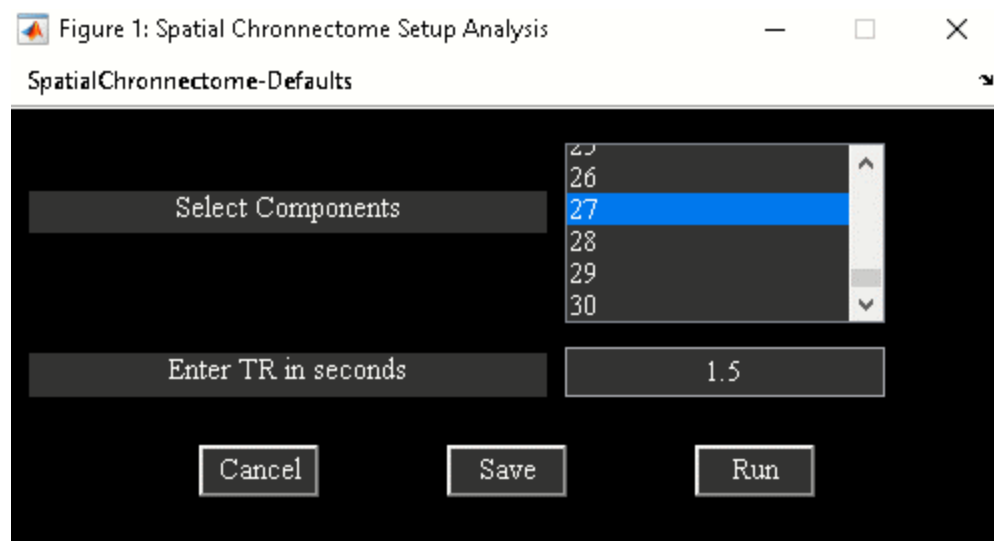
- Temporal dFNC - Uses sliding window approach. Works on the ica output.
- ROI-based dFC - Similar to Temporal dFNC. BOLD fMRI timecourses are used.
- Windowless functional connectivity using KSVD
- Dynamic Coherence using both time and frequency information.

- **Spatial**

- Spatial dFNC - Each dataset are partitioned into windows and IVA is used to capture source variations across time
- Spatial Chronnectome captures voxel wise changes in the spatial patterns over time
- Spatial dynamics hierarchy - Study dynamic properties within brain hierarchy models.



Spatial Chronnectome Toolbox



Post-processing spatial chronnectome options

Spatio-temporal Transition Matrix Options

Enter number of intervals: 1 ?

Enter number of bins: 10 ?

Cluster Options

Do you want to estimate clusters? No ?

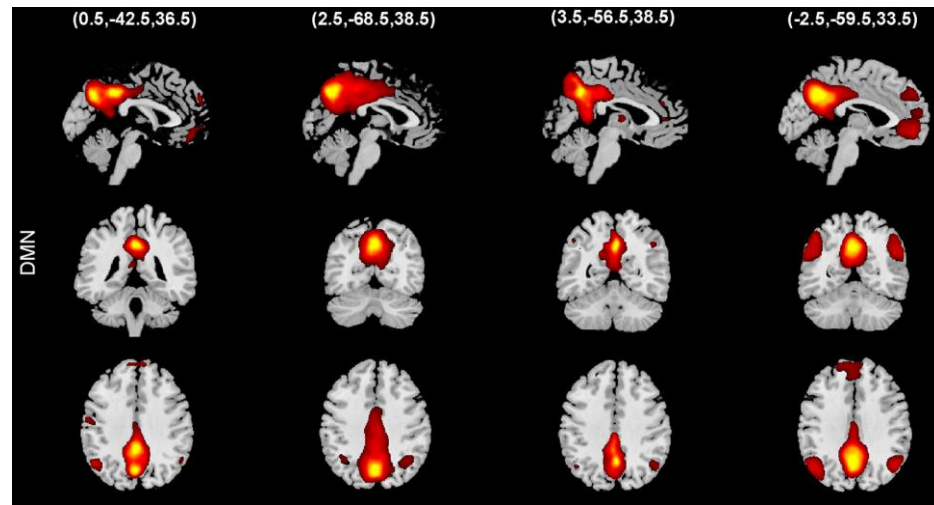
Enter number of clusters: 4 ?

Enter maximum number of iterations: 150 ?

Select distance method: City ?

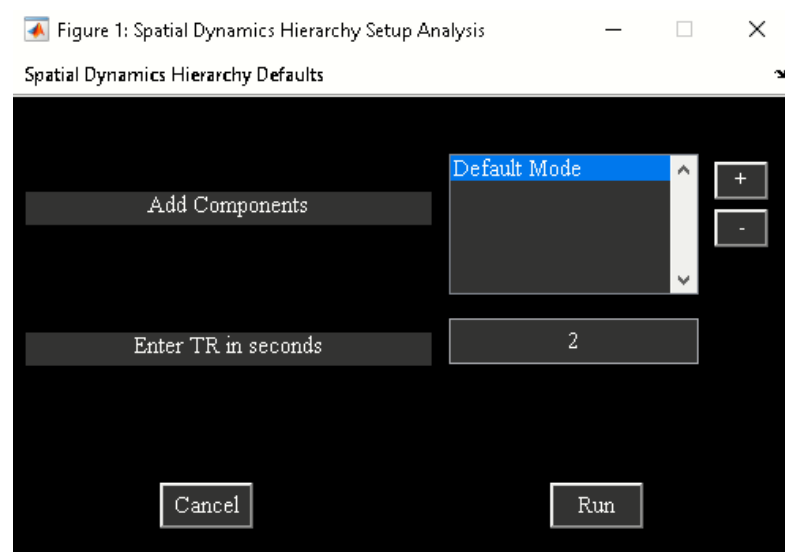
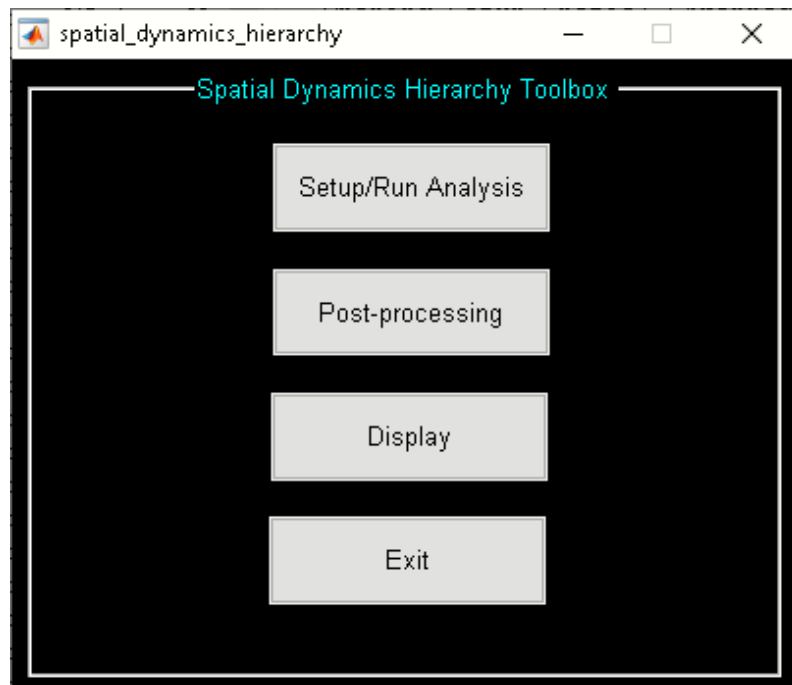
Number of times to repeat the clustering: 10 ?

Done

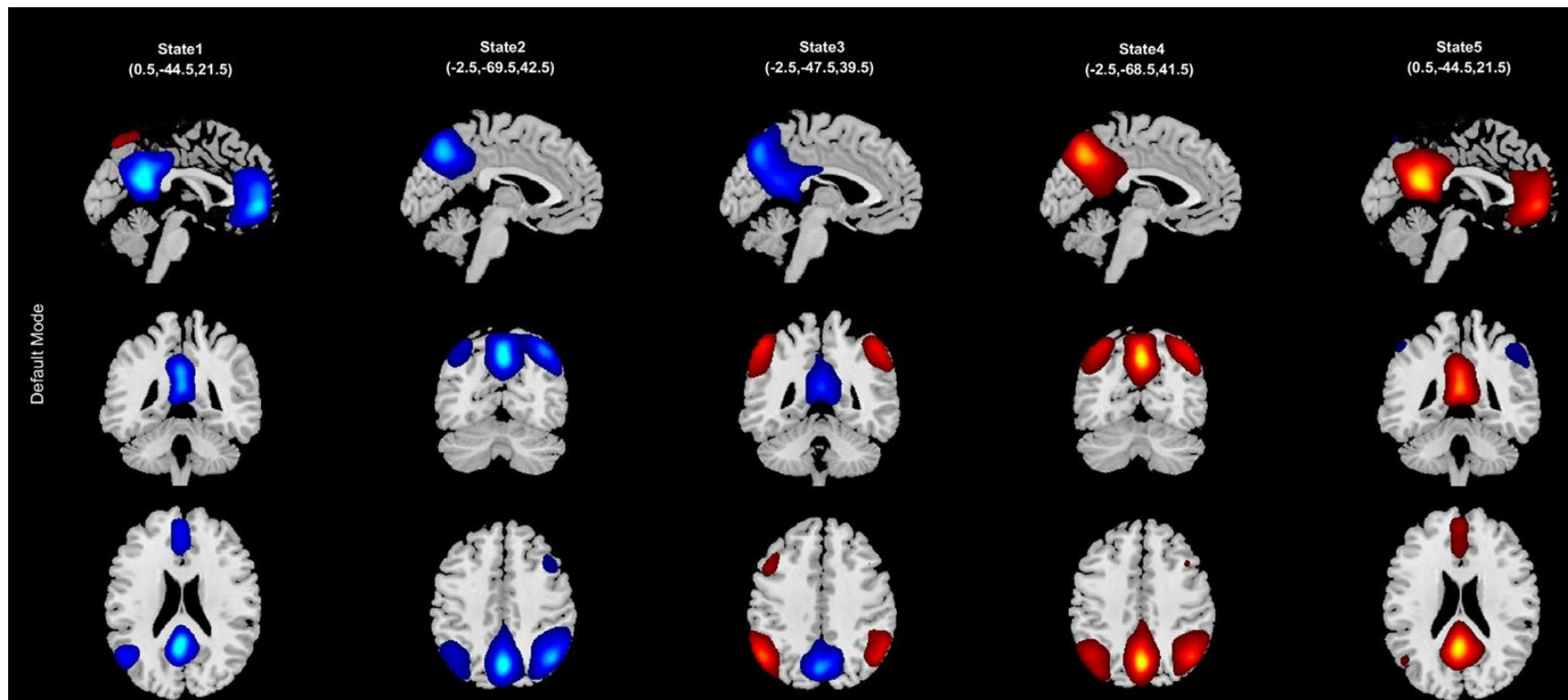


Cluster States

Post-processing step



Spatial Dynamics Hierarchy Toolbox



Cluster states of Default mode

References

- GIFT Toolbox Link: <https://trendscenter.org/software/gift/>
- GIFT Docker: https://github.com/trendscenter/groupica_docker
- Toolbox Videos: <https://trendscenter.org/software/gift/videos/>
- Templates: <https://trendscenter.org/data/>
- Nipype: <https://nipype.readthedocs.io/en/latest/>
- V.D. Calhoun et al. (2001). A Method for Making Group Inferences From Functional MRI Data Using Independent Component Analysis. HBM, 14, 140-151.
- E. Allen, et al, "A baseline for the multivariate comparison of resting state networks," Frontiers in Systems Neuroscience, vol. 5, p. 12, 2011.
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- Iraj, A. et al. (2019a) 'The spatial chronnectome reveals a dynamic interplay between functional segregation and integration', Hum Brain Mapp, 40(10), pp. 3058-3077.
- Iraj, A et al. (2019b) 'Spatial dynamics within and between brain functional domains: A hierarchical approach to study time-varying brain function', Hum Brain Mapp, 40(6), pp. 1969-1986.
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Thank You