Group ICA Toolbox: New features and developments

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June 11, 2020

GIFT Highlights

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

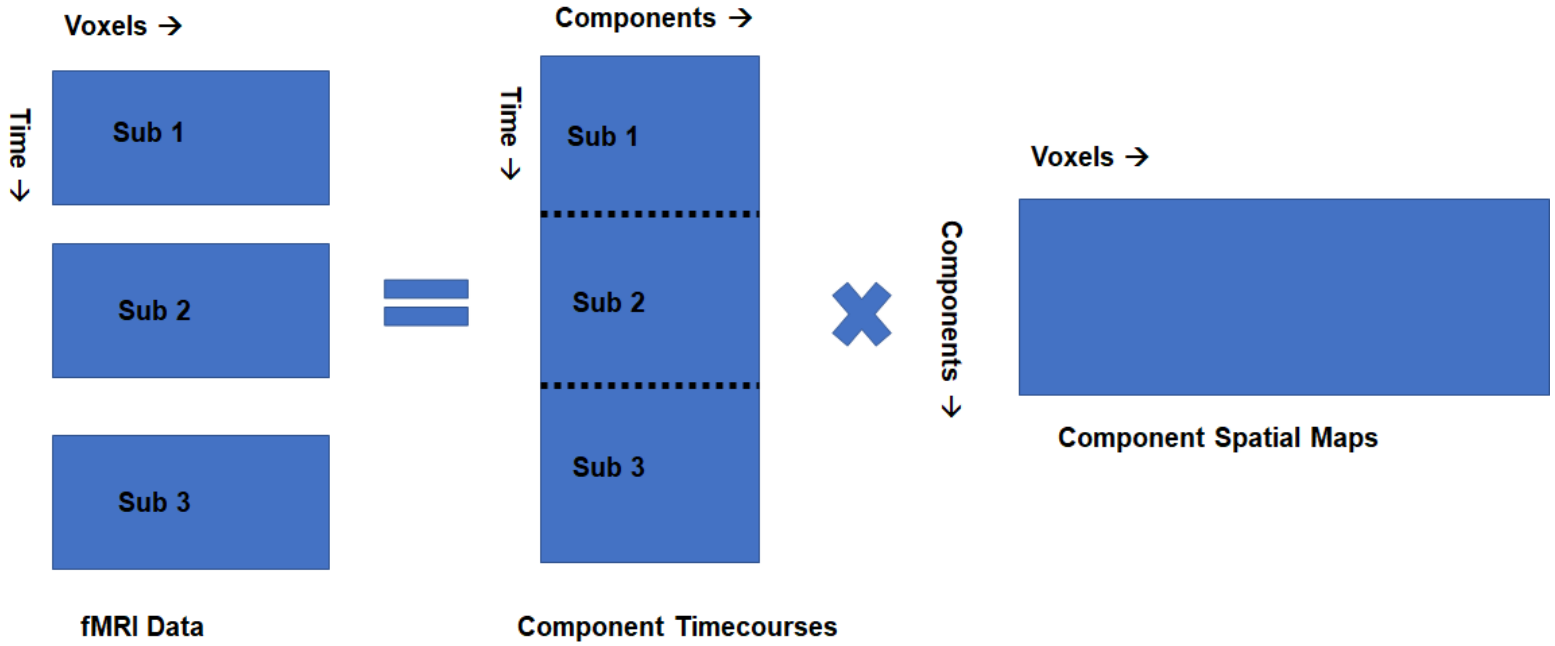
Introduction

- **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

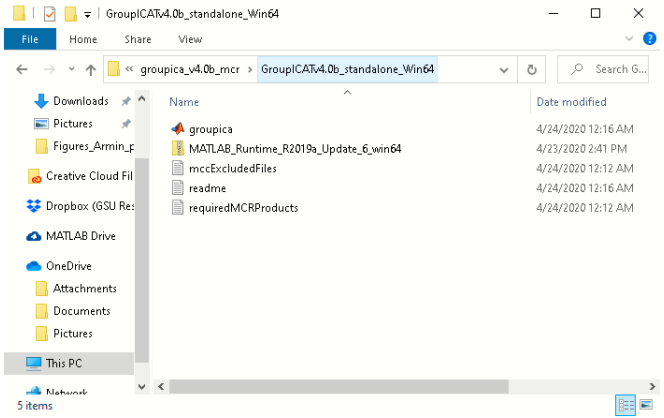


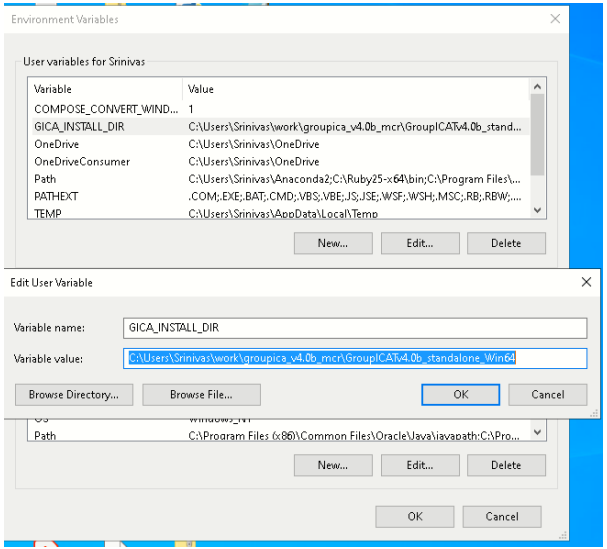
This is a simple example. In the software and group ica paper, PCA whitening and dewhitening matrices are used to achieve this transformation.

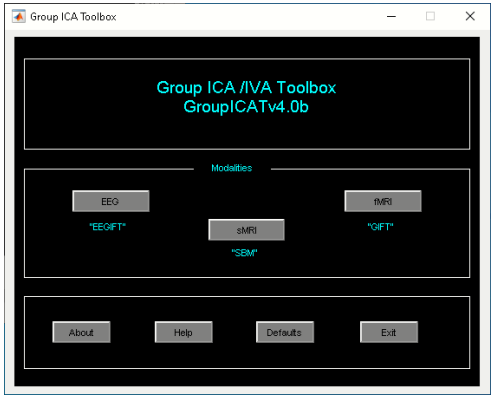
Stand-alone GIFT

- 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

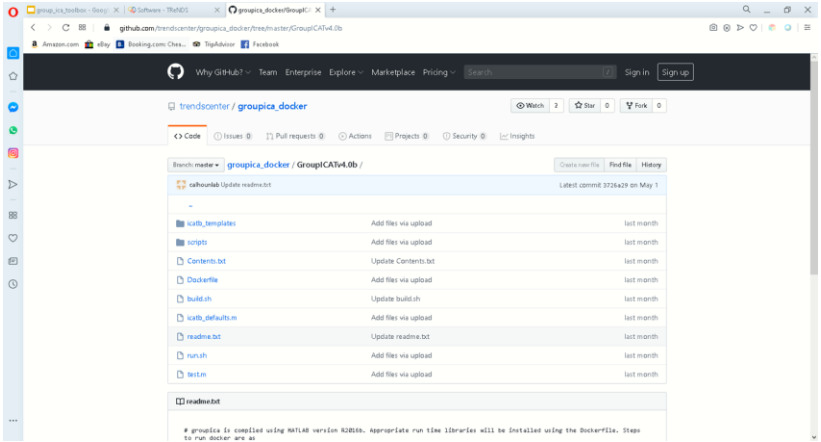


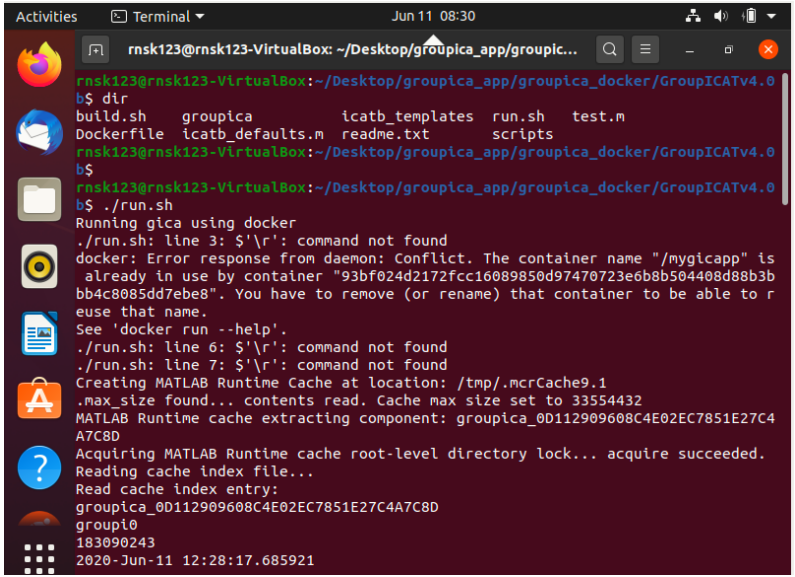




Set GICA_INSTALL_DIR variable to point to the group ica directory location

Docker





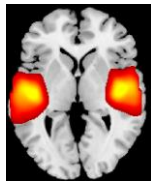
- Group ICA can be run inside a docker container.
- Github link contains information to clone/download the package
  - build.sh - Build docker image
  - run.sh - Inputs and outputs need to be mapped run the application

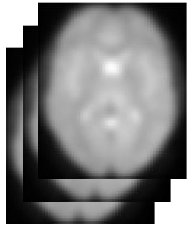
Nipype GIFT Interface

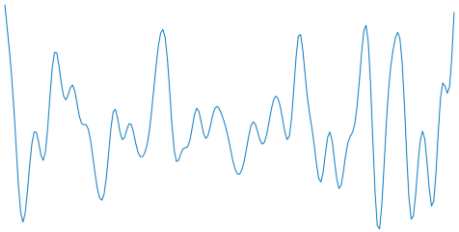
- GIFT can be run in a python setting using Nipype (https://nipype.readthedocs.io/en/latest/)
- Nipype software provides uniform interface to existing neuroimaging applications and built in python.
- Copy files from GroupICATv4.0b/icatb/nipype-0.10.0/nipype to existing nipype
- Use command pip install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

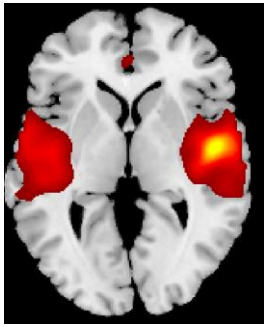
```
Python 2.7.16 |Anaconda, Inc.| (default, Mar 14 2019, 21:00:58)
[GCC 7.3.0] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> from nipype.interfaces import gift
>>> matlab_cmd = '/data/mialab/users/srinivas/GIFT_Stand_alone/Linux_x86_64/GroupICATv4.0b_standalone_aug_8_2019/run_gr
oupica.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/m
ialab/users/srinivas/Example_Subjects/Visuomotor_data/sub02_vis/sub002.nii', '/data/mialab/users/srinivas/Example_Subje
cts/Visuomotor_data/sub03_vis/sub003.nii']
>>> gc.inputs.dim = 16;
>>> gc.run()
```

Automated ICA Or Reference Based ICA









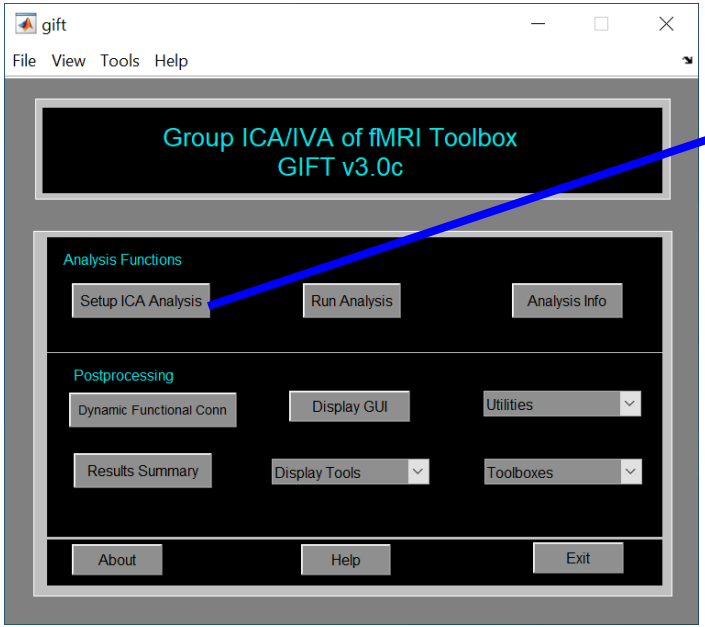
Spatial Priors

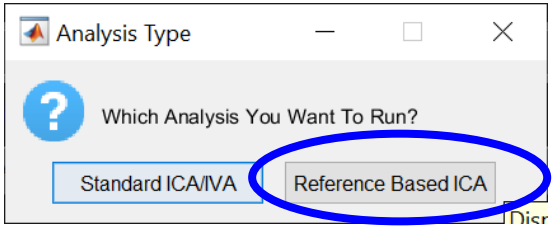
Subject Data

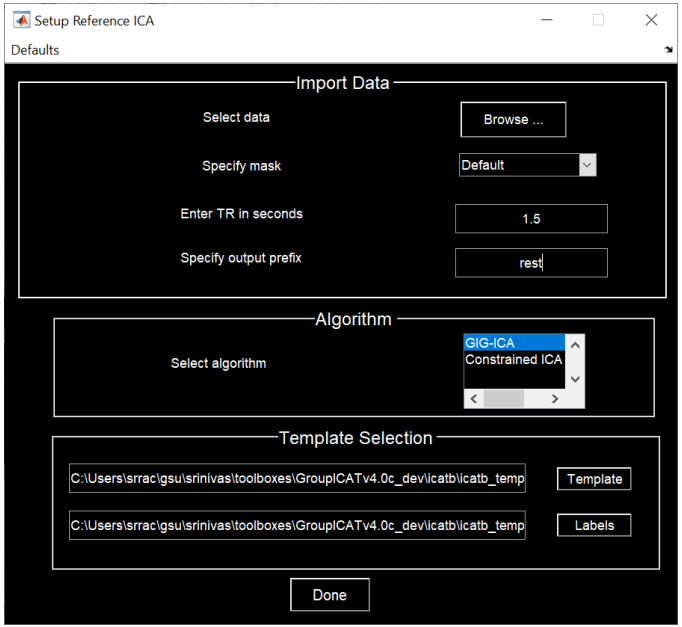
Subject ICA Timecourse

Subject ICA Map

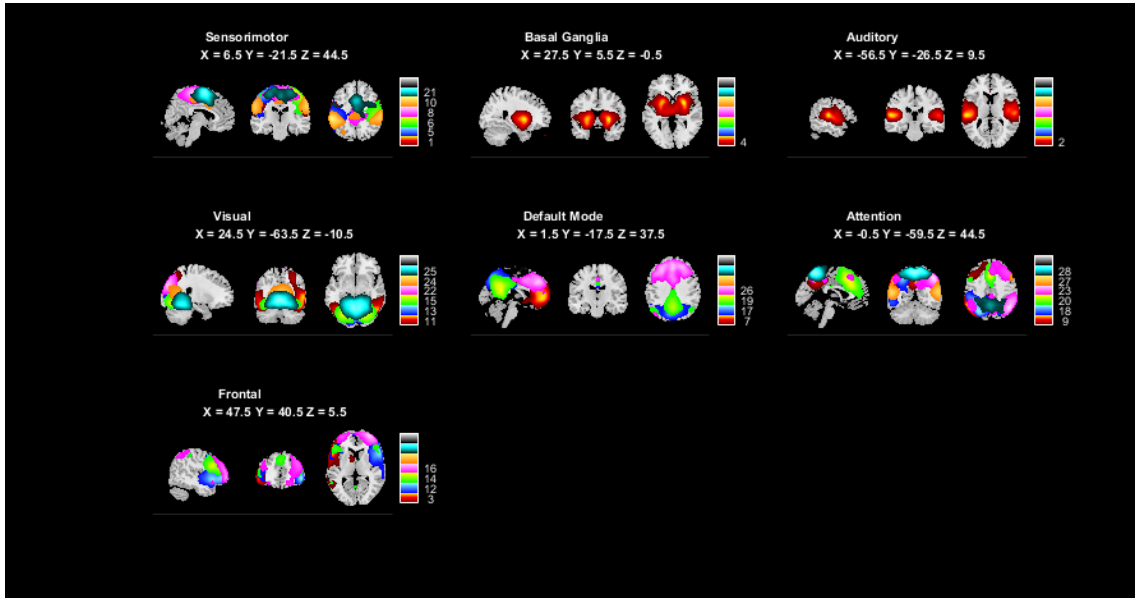
Automated ICA



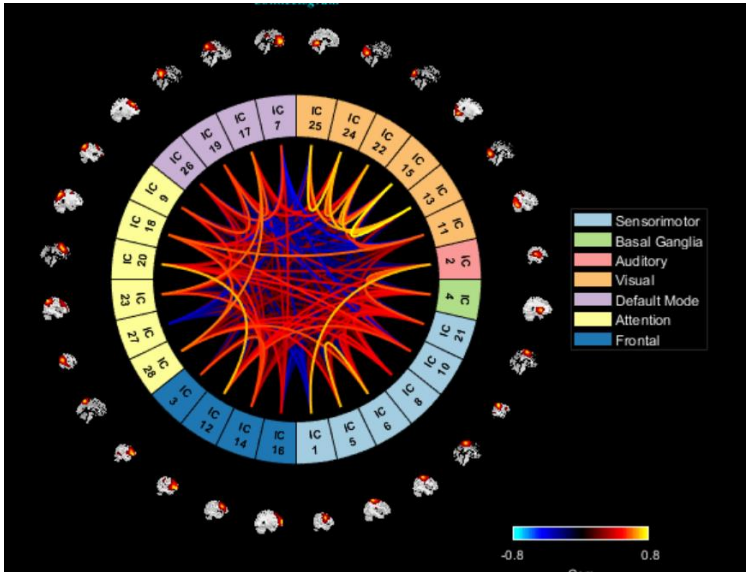




Automated ICA

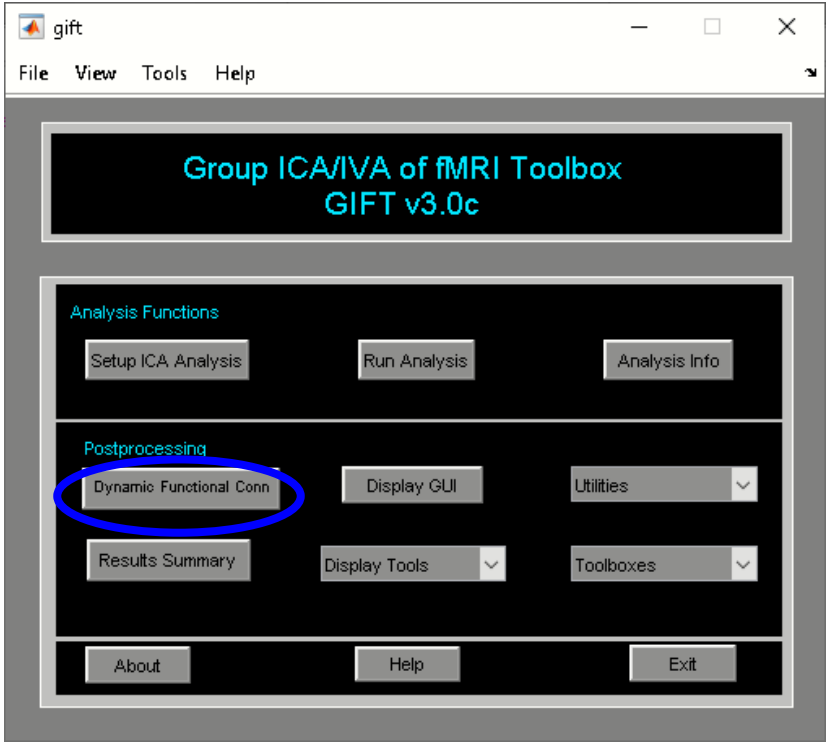


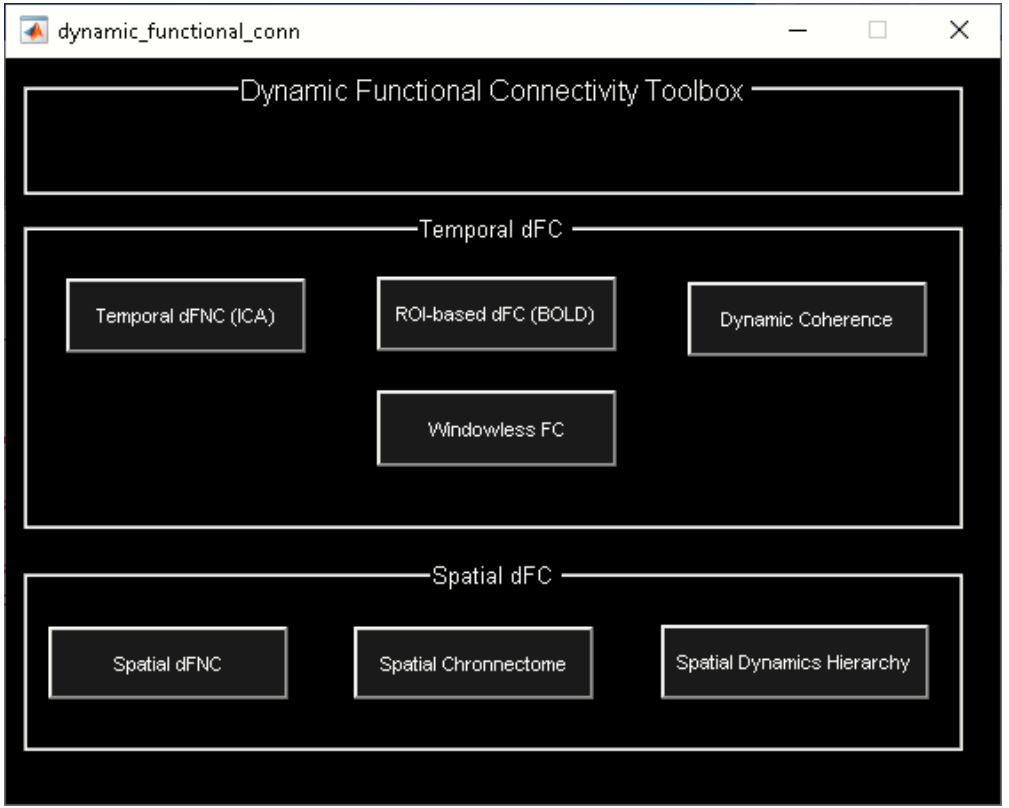
Composite ortho views



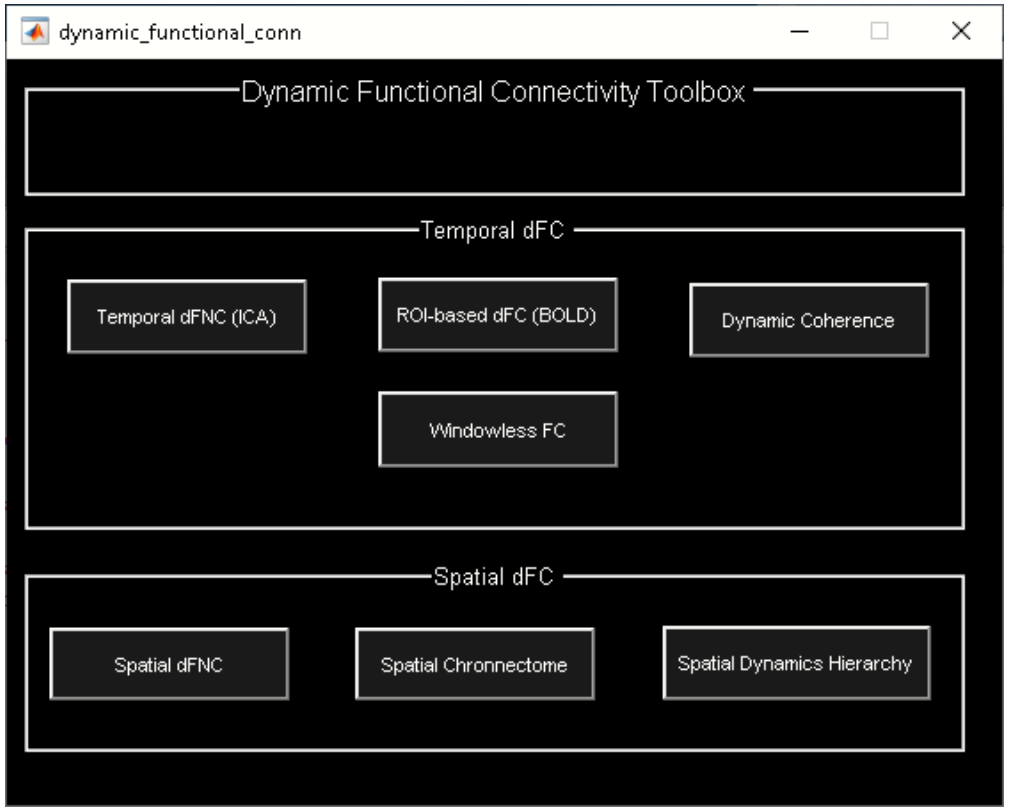
FNC Connectogram

Dynamic Connectivity Toolbox

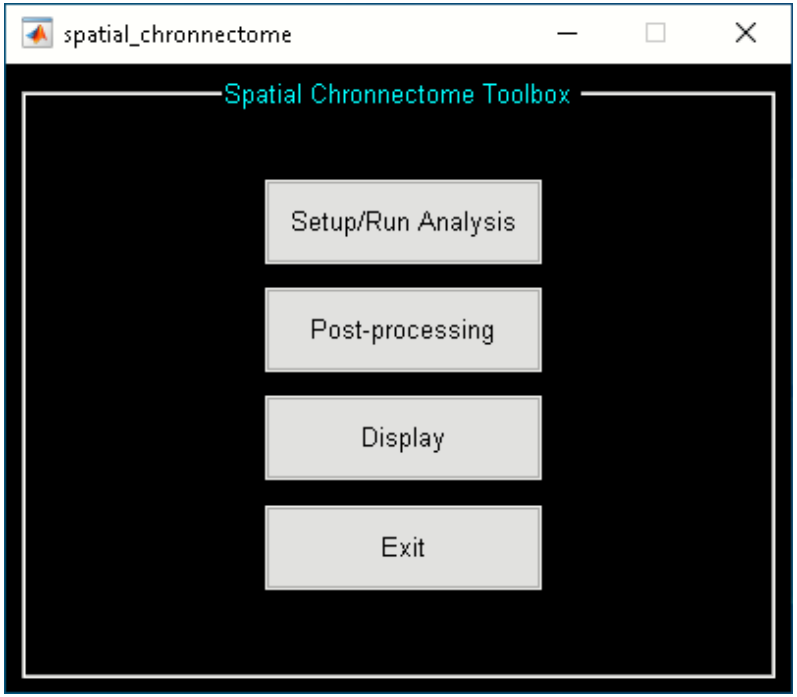


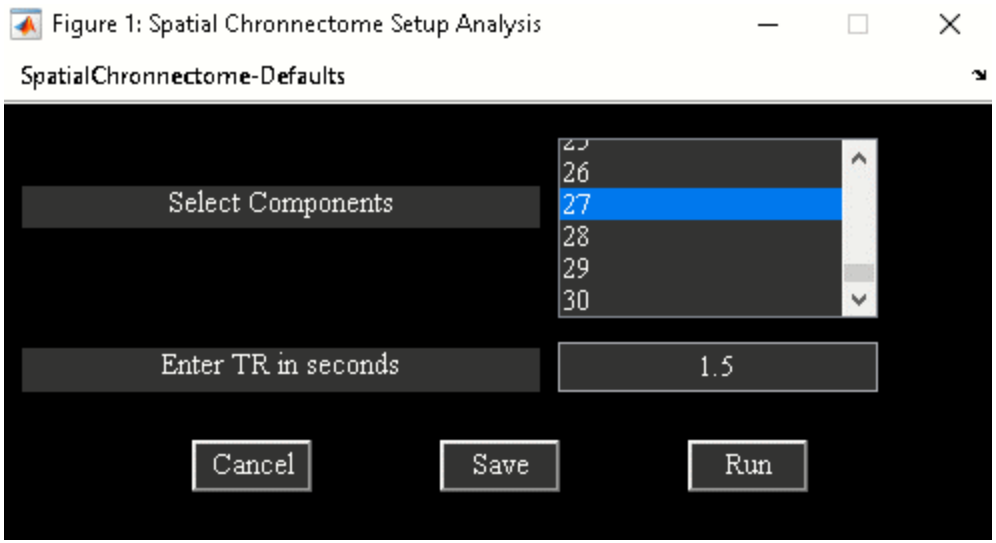


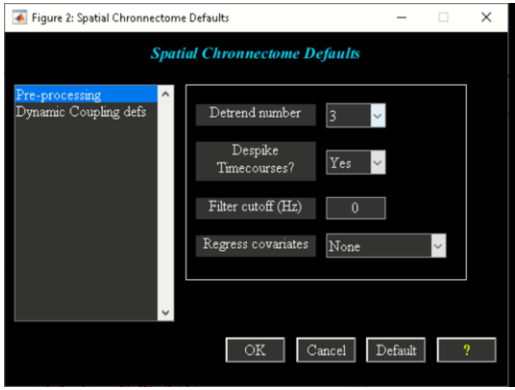
Dynamic Connectivity Toolbox

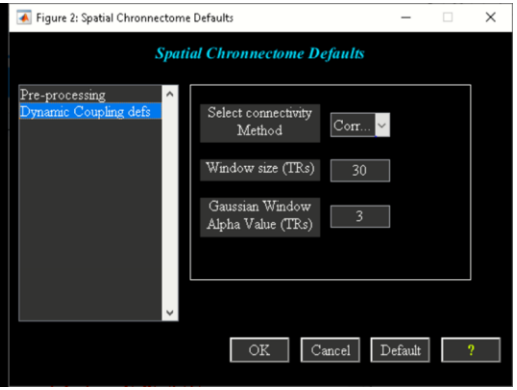


- **Temporal**
  - Temporal dFNC - Uses sliding window approach. Works on the ica output.
  - ROI-based dFC - Similar to Temporal dFNC. BOLD fMRI timecourses are used.
  - Windowless functional connectivity using KSVD
  - Dynamic Coherence using both time and frequency information.
- **Spatial**
  -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

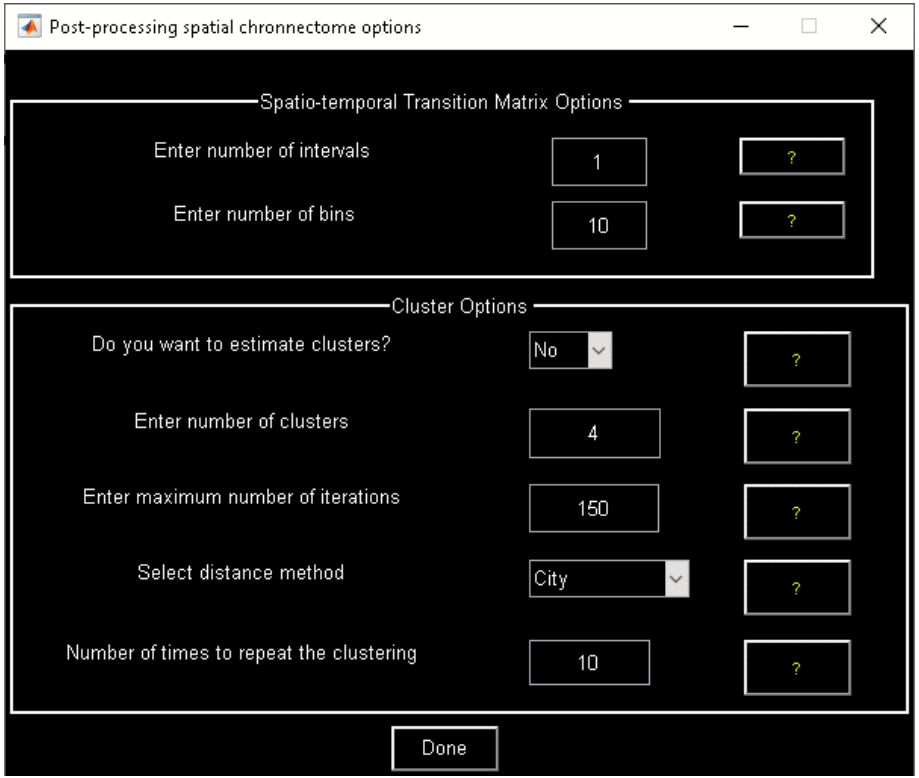




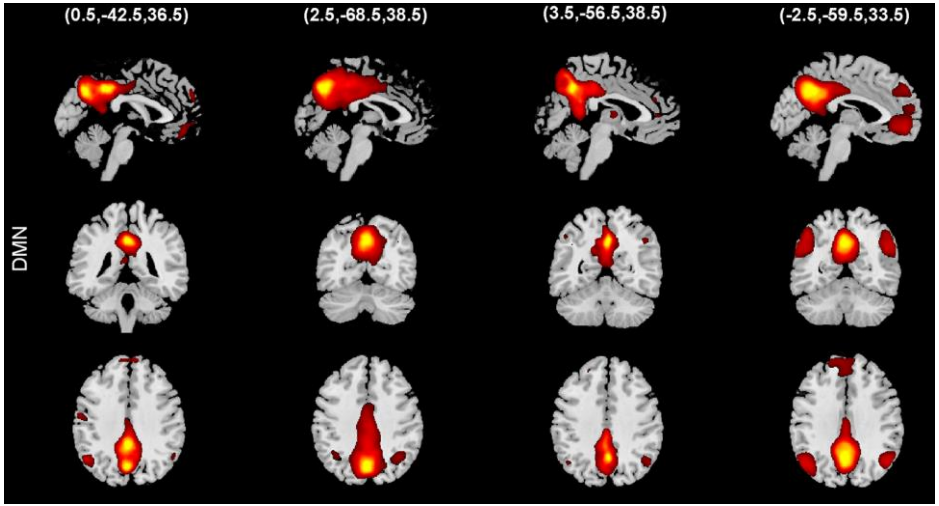




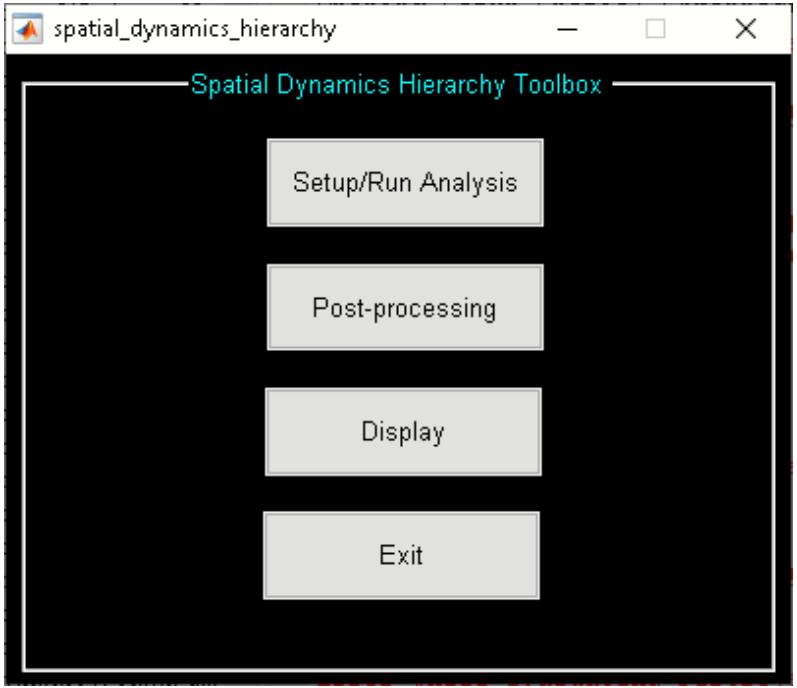
Spatial Chronnectome Toolbox

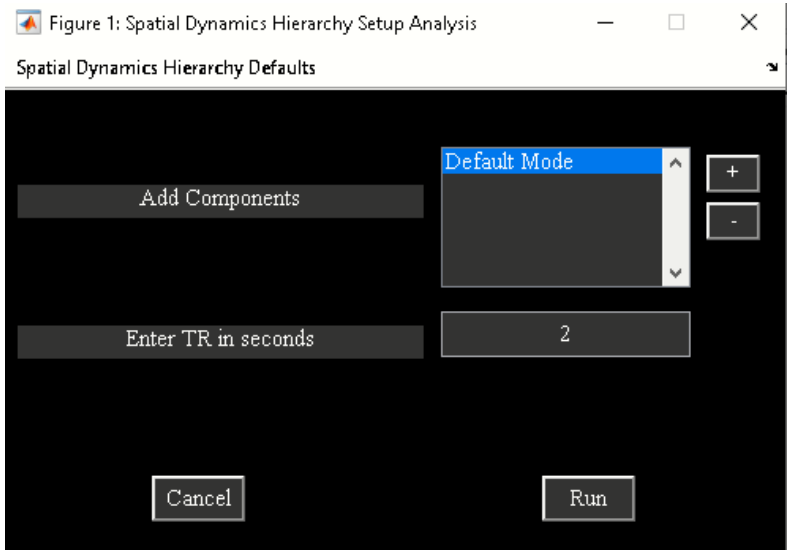


Post-processing step

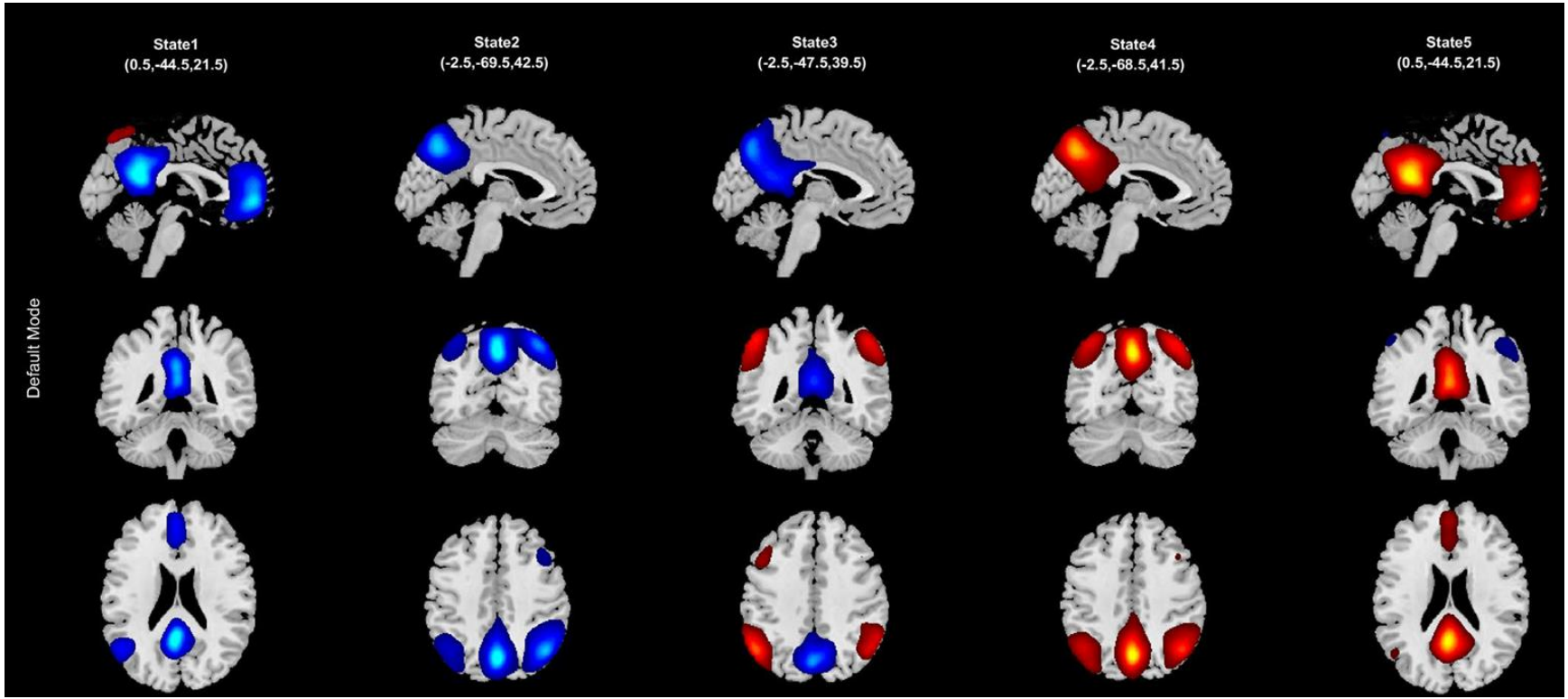


Cluster States





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/
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Thank You