CSE 512-16S: Interactive Brain Connectivity Network

Yan Jin, 1520010

Industrial Engineering Department, University of Washington

Introduction & Highlights

- This project is to provide an on-line interactive brain network visualization tool, which can help researchers to visualize structural and functional connectivity patterns from different levels in a quick, easy, and flexible way.
- Functional connectivity is defined as the temporal dependency of neuronal activation patterns of anatomically separated brain regions, by measuring the level of co-activation of resting-state fMRI time-series between brain regions.
- There are several methods to process resting-state fMRI data to construct the functional connections between brain regions:
  - seed method: correlation between brain regions.
  - PCA/ICA
  - graphical lasso: partial correlation between brain regions.

Mathematical Transformation: graphical lasso

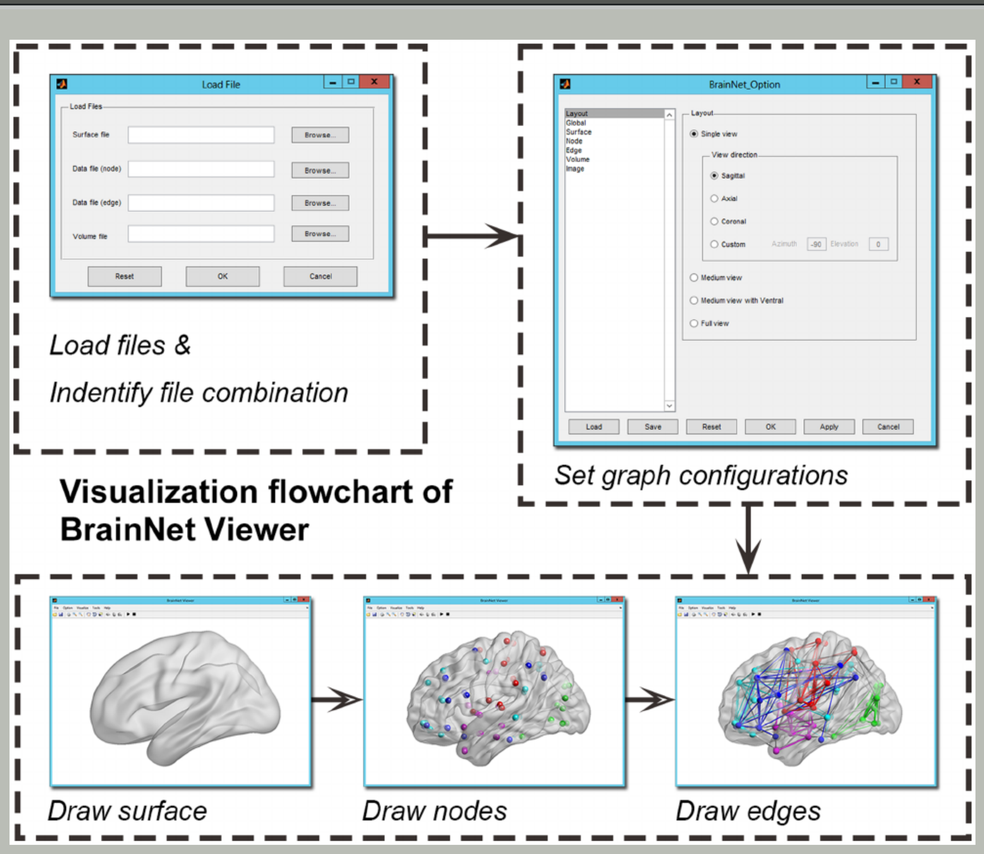
- Sparse inverse covariance estimation (graphical lasso) could be used for brain connectivity modeling.
- Inverse covariance matrix has a clear interpretation that the off-diagonal elements correspond to partial correlations.
- Graphical Lasso

$$\hat{\Theta} = \arg\max_{\Theta \succ 0} \left(\log(\det(\Theta)) - \mathrm{tr}(S\Theta) - \lambda \|\mathrm{vec}(\Theta)\|_1 \right)$$

where:

- $\Theta = \Sigma^{-1}$ is the inverse covariance matrix, which is to be estimated.
- S is the sample covariance matrix
- det, tr, $\|\mathrm{vec}(\cdot)\|_1$ denote the determinant, trace and sum of the absolute values of all elements of the matrix, respectively.

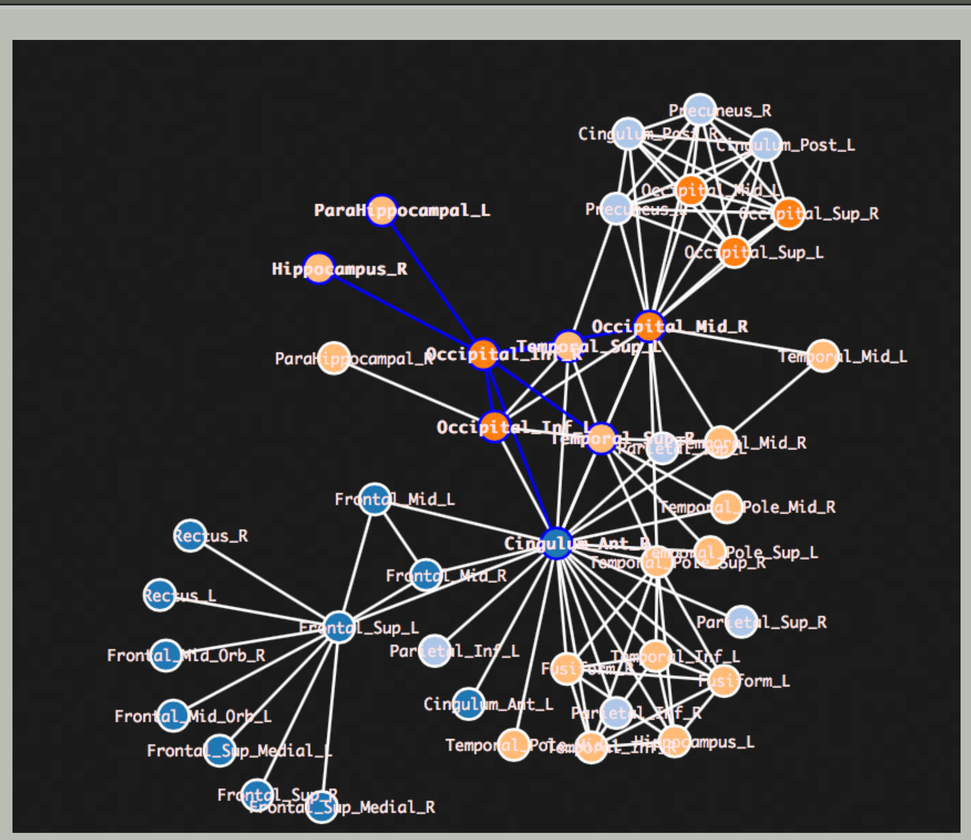
Literature Review: BrainNet Viewer



Drawbacks:

- Few interactions
- Matlab based, complicated operations

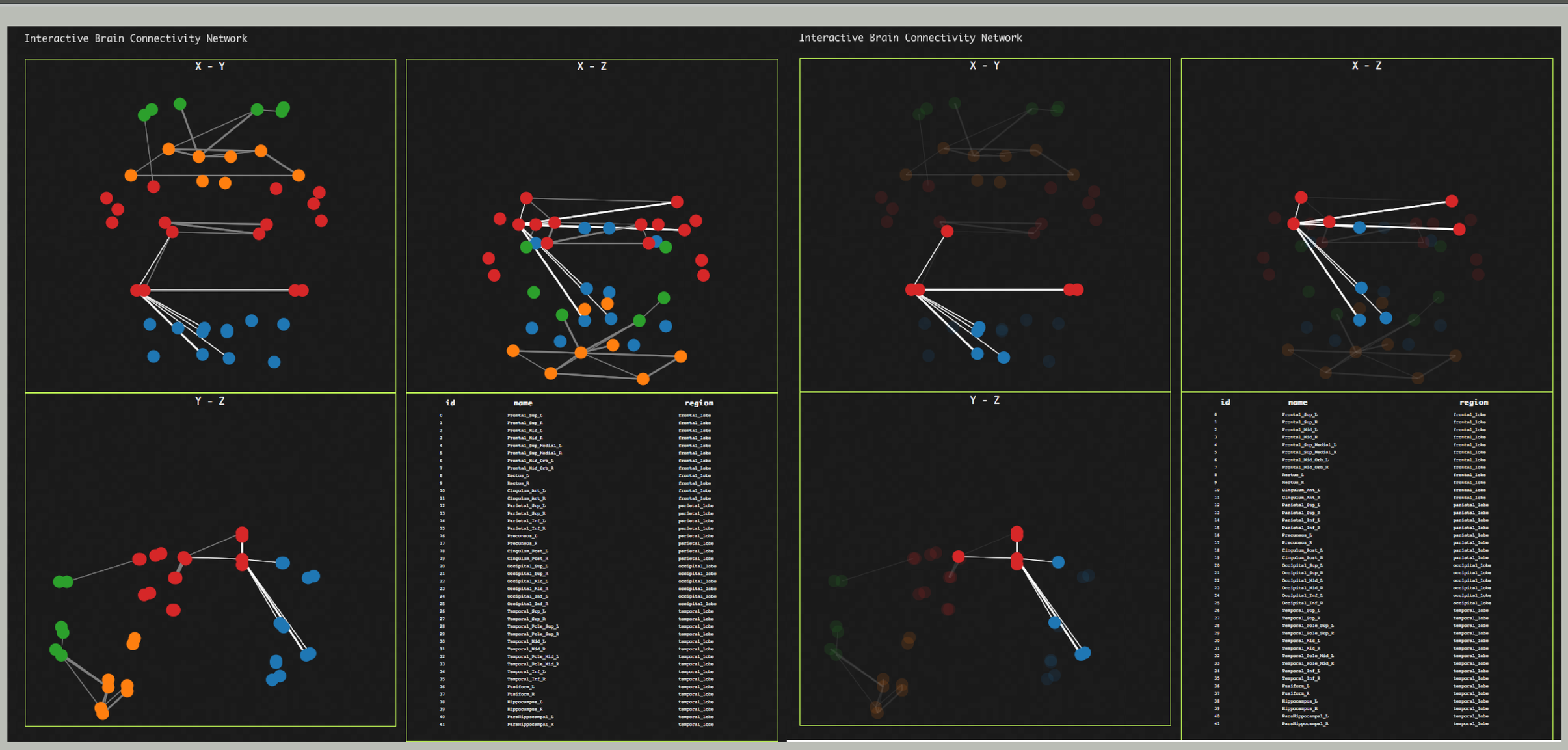
Previous Work: assignment 3 & brainconnecitivty.cc



Drawbacks:

- No proper 3D coordinates
- Messy

Current Visualization



Drawbacks:

- Difficult to identify the interested brain region, since the nodes are not labeled well.
- No proper brain shape images as background for all three sub-figures.
- Even the strength of connections could be reflected as the width of edges, the actual value cannot be shown.