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I) Background and Motivation

- Functional connectivity profiles exhibit organization and reconfiguration into modules that enable a diverse functional repertoire [1];
- A significant proportion of functional brain connectivity maps human brain sub-circuits (e.g. [2]);
- Not every estimated functional connectome (FC) is information-theoretically relevant for a prior set of functional communities.
- We explore this phenomenon from an FC thresholding perspective using Stochastic Block Modelling (SBM) framework.

II) FC Reconstruction Pipeline

- Step 1:** For each Schaefer granularity level and task, compute a binarized (masked) **group-average FC** (*based on individual FCs*) (M_t);
- Step 2:** For each threshold value τ , infer the Stochastic Block Model (SBM) parameters for the compute Signal-to-noise ratio (SNR) of M_t . Repeat this computation for all threshold values to determine the weak-recoverability threshold sub-interval (a_w, b_w) (*Vetting Step*);
- Step 3:** For a given **individual FC** and threshold value τ , compute the associated thresholded FC (FC_t); infer the Stochastic Block Model (SBM) parameters for FC_t . Use SNR as a mesoscopic prominence measure and compute $SNR[FC_t]$;
- Step 4:** Repeat steps 1-3 for all threshold values
- Step 5:** Obtain the threshold value that maximizes SNR of the thresholded FC and the corresponding optimally reconstructed whole-brain FC; check if τ_{opt} is in the weak-recoverability sub-interval (**Step2**)
$$FC_{recon} = FC_{\tau_{opt}}$$
 where $\tau_{opt} = \text{argmax}(SNR[FC_t])$

SBM Parameters

$$\begin{aligned} G &\sim SBM(n, p, \sigma, W) \\ n &= \text{number of brain ROIs}; k = \text{number of communities} \\ \Omega &= [\Omega_i] = \text{community } i \text{ cardinality}; i = 1, 2, \dots, k \\ p &= [p_i] = \frac{n}{C}; P = \text{diag}(p) \\ \sigma &= [k]^n: \text{a priori set of Functional Networks} \\ W &= \frac{C}{C_{max}}: \text{edge connecton propability matrix} \\ PQ &= nPW: \text{the expected number of neighbors between communities} \end{aligned}$$

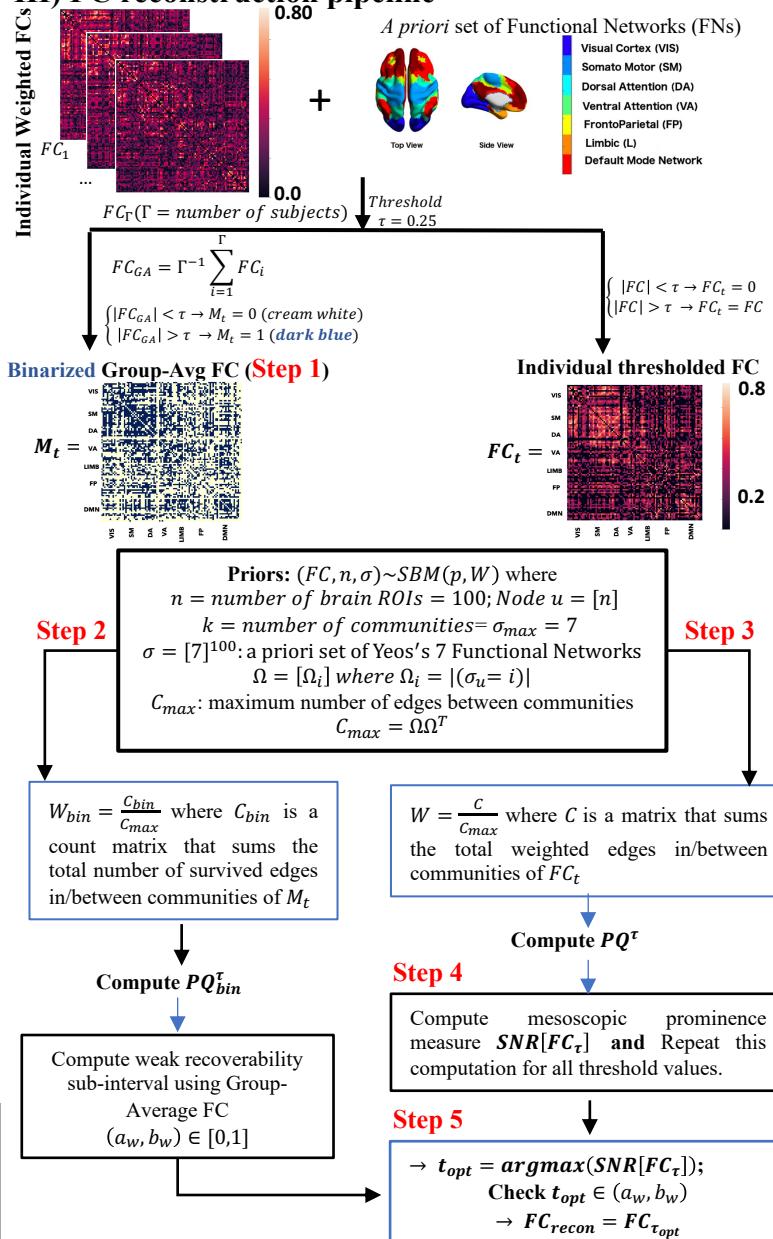
Weak Recovery Criteria Theorem for SBM [3]

For a specific Schaefer parcellation, threshold value and a subject rest or fMRI task FC, compute Signal-to-noise ratio (SNR)

$$SNR = \frac{\lambda_2^2}{\lambda_1}$$

of the community profile matrix PQ (λ_i : i^{th} eigen value of PQ). *A priori* set of FNs is **weakly recoverable** if and only if $SNR > 1$.

III) FC reconstruction pipeline

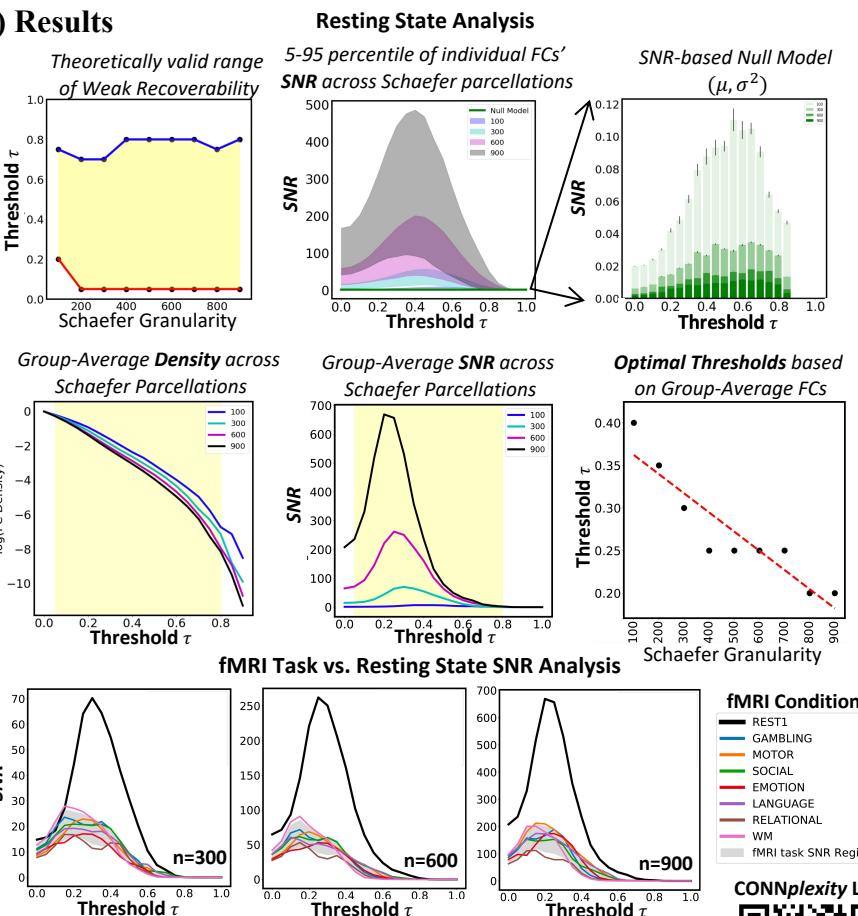


IV) Dataset and Parcellation

Dataset: The Human Connectome Project 410 Unrelated subjects (Q3 Release) parcellated by the Schaefer Atlas with 9 distinct granularity levels (from 100 to 900 cortical nodes). The dataset includes Resting state and 7 fMRI tasks: gambling, relational, social, working memory, language, motor, and emotion.

Parcellation (*a priori* set of Functional networks): Yeo's parcellation [2] which parcellates the cortical regions in to 7 distinct FNs: Visual, Somatomotor, Dorsal Attention, Ventral Attention, Limbic, Frontoparietal, Default Mode Network.

V) Results



References:

- Betzel, R. F., Medaglia, J. D., & Bassett, D. S. (2018). Diversity of meso-scale architecture in human and non-human connectomes. *Nature communications*, 9(1), 1-14.
- Buckner, R. L., Krienen, F. M., Castellanos, A., Diaz, J. C., & Yeo, B. T. (2011). The organization of the human cerebellum estimated by intrinsic functional connectivity. *Journal of neurophysiology*, 106(5), 2322-2345.
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