MSc Project Title : Simulation of Brain Functional Connectivity on Empirical and Randomized Complex Networks

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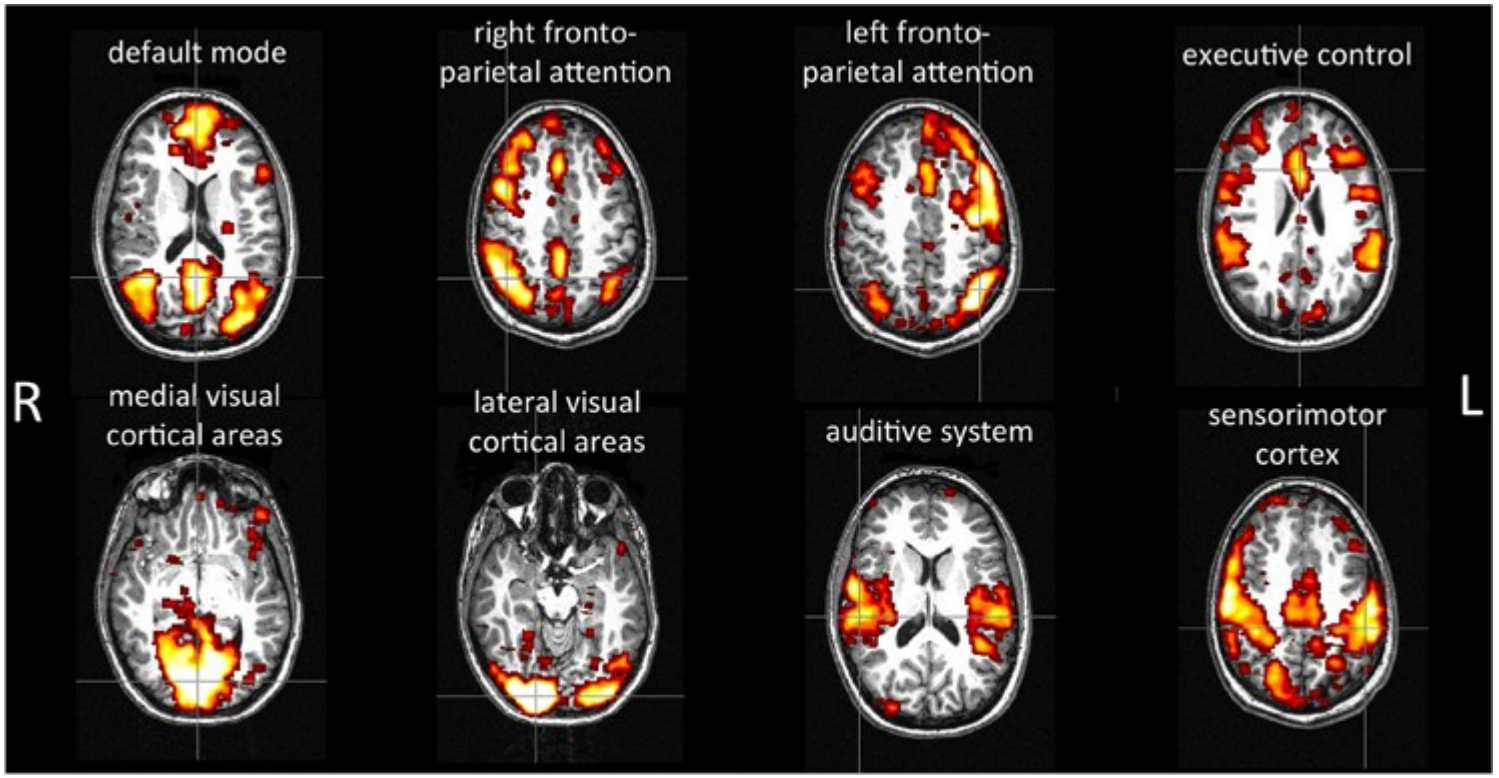
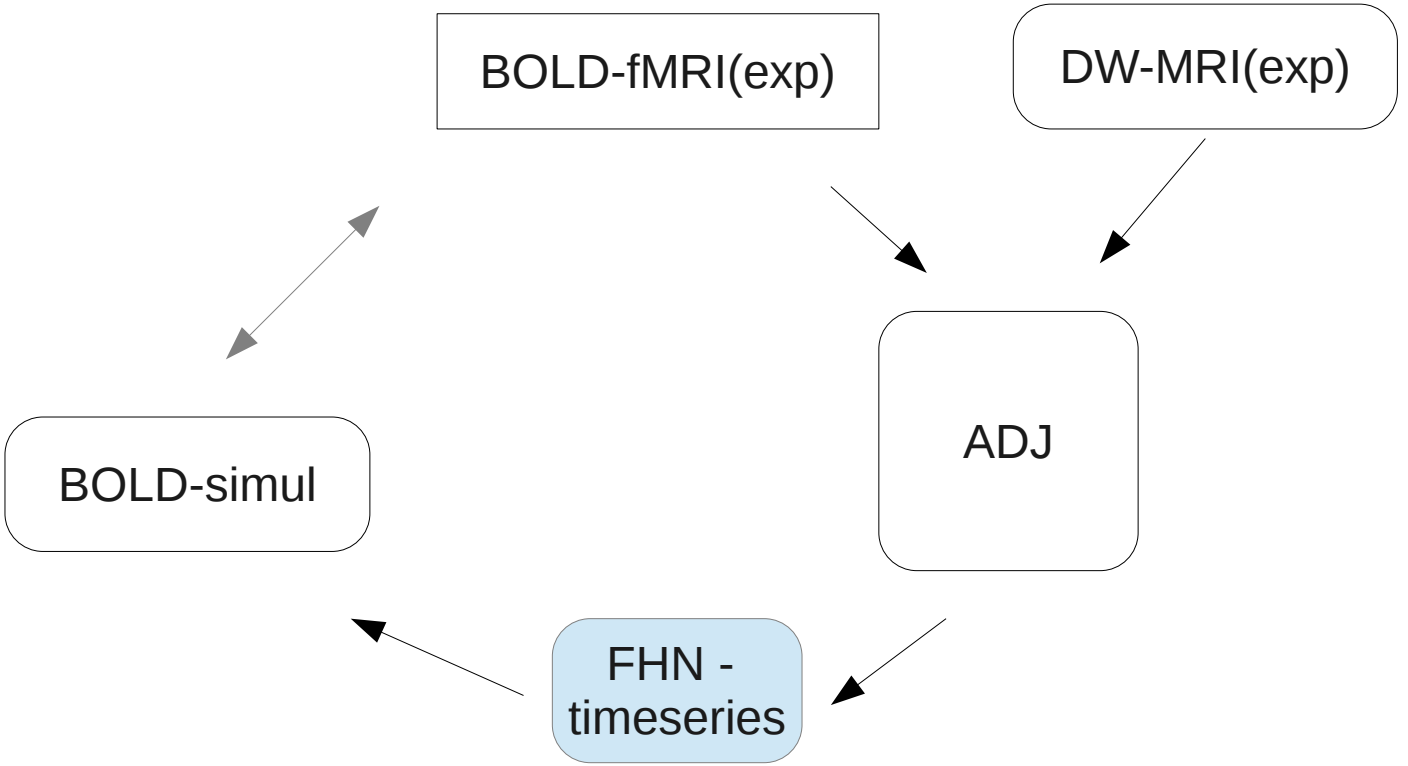
Supervisors: P. Hövel, V. Vuksanovic

- Resting state
- BOLD-fMRI & DW-MRI
- Purpose:

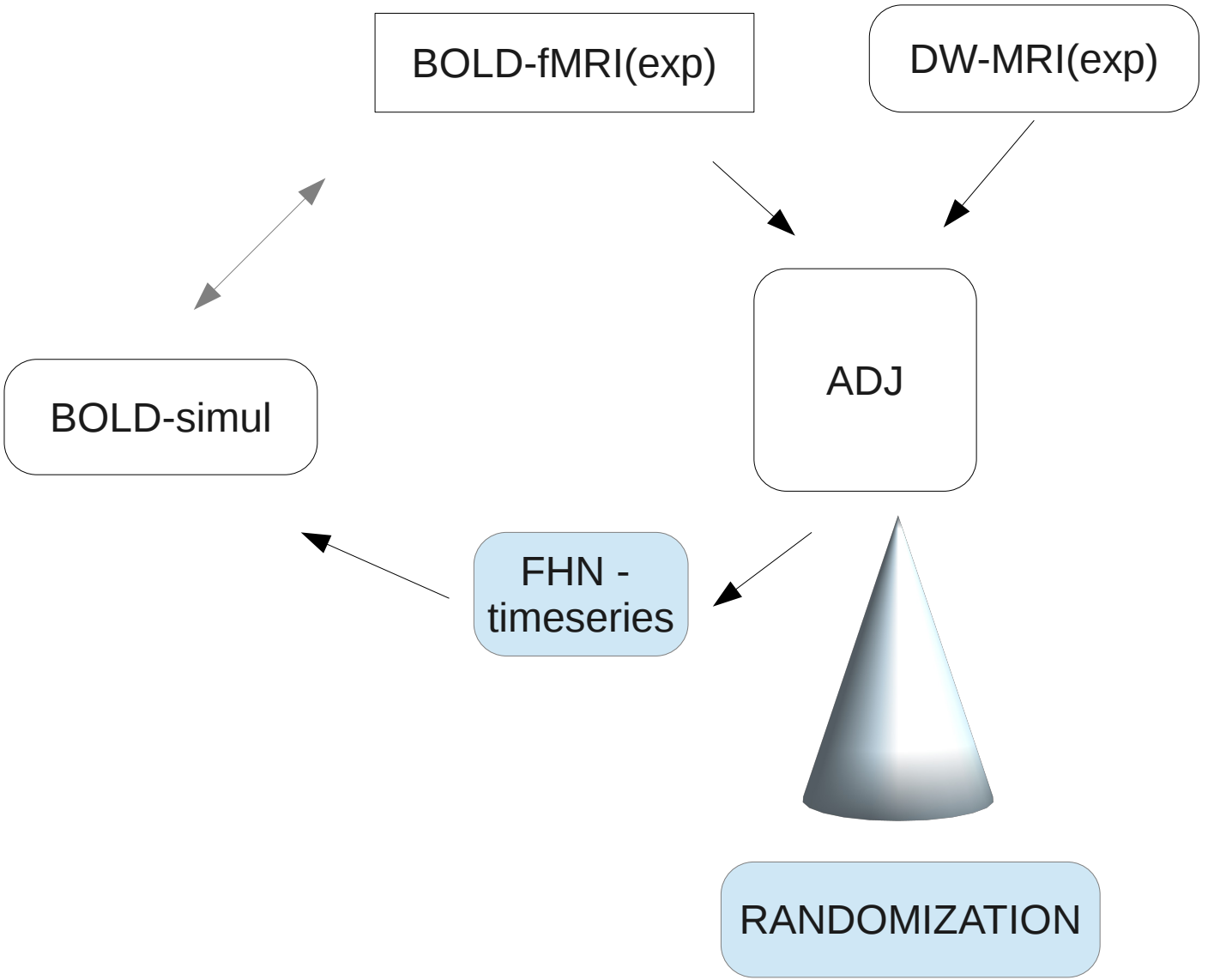
Resting state networks



- Storti et al. (2013)



[Vuksanovic and Hoevel, 2013]

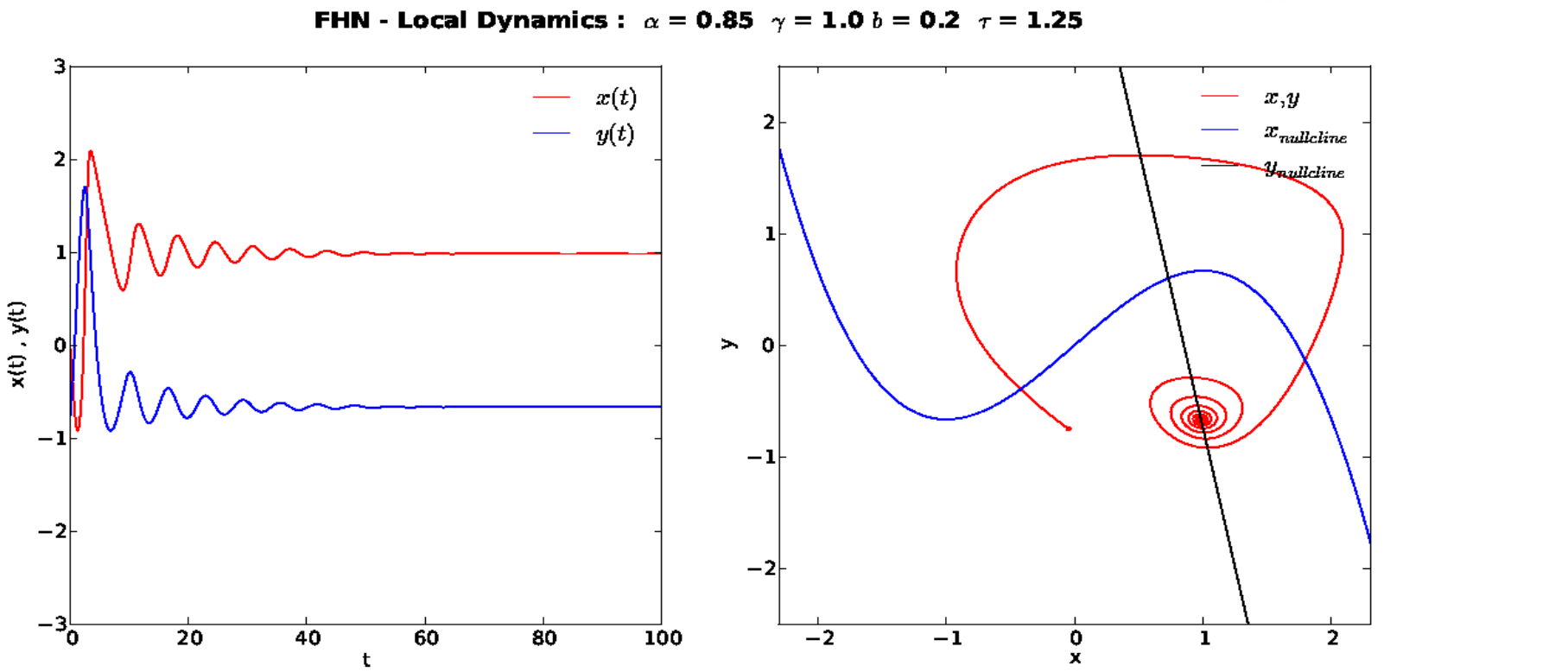

BOLD-fMRI(exp)
DW-MRI(exp)
BOLD-simul
ADJ
FHN - timeseries
RANDOMIZATION

FitzHugh-Nagumo Model

Local Dynamics

$$\dot{x} = \tau\left(x + \gamma u - \frac{x^3}{3}\right)$$

$$\dot{y} = -\frac{1}{\tau}(y - \alpha + bx)$$



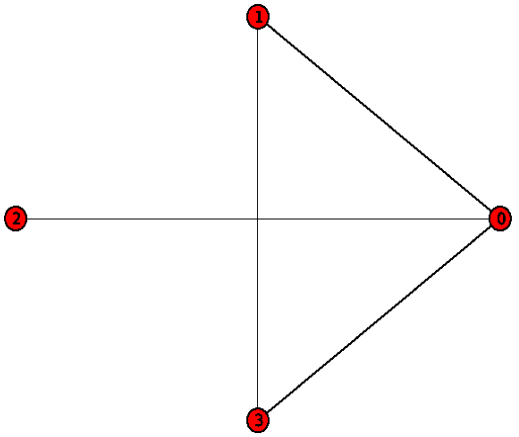
[Ghosh et al. 2008]

FitzHugh-Nagumo Model

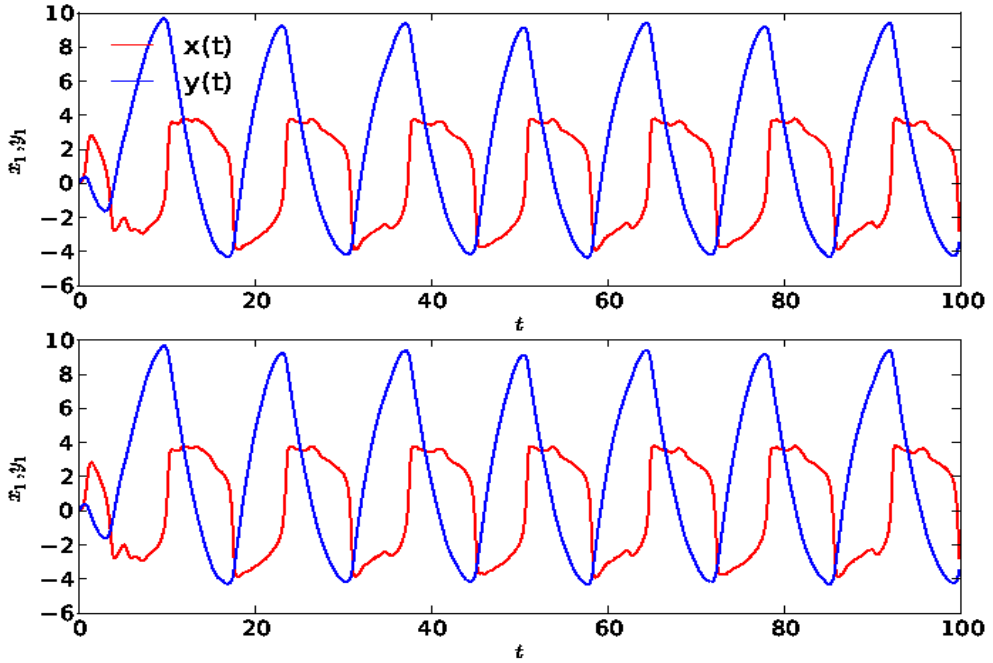
Global Dynamics

$$\dot{x}_i = \tau\left(y_i + +\gamma x_i - \frac{x_i^3}{3}\right) - c\sum_{j=1}^{N} a_{ij}x_j(t-\Delta t_{ij}) + n_x$$

$$\dot{y}_i = -\frac{1}{\tau}(x_i - \alpha + by_i - I) + n_y$$



FHN - time series : α **= 0.85** γ **= 1.0** b **= 0.2** τ **= 1.25** **C = 0.9** $\Delta\tau_{ij}=d_{ij}/v$



FitzHugh Nagumo Model

Time-series

$$\dot{x}_i = \tau\left(y_i + +\gamma x_i - \frac{x_i^3}{3}\right) - c\sum_{j=1}^{N} a_{ij}x_j(t-\Delta t_{ij}) + n_x$$

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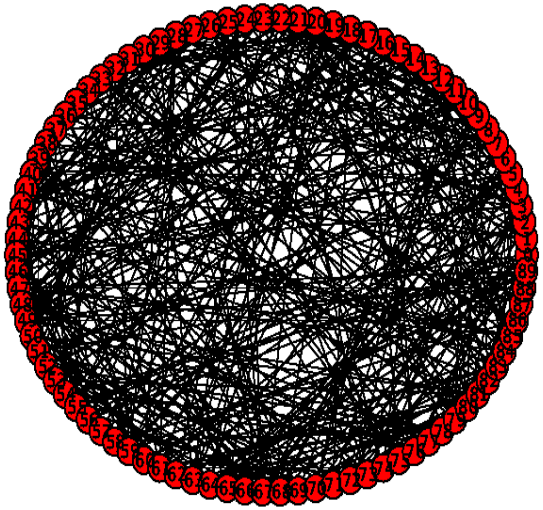

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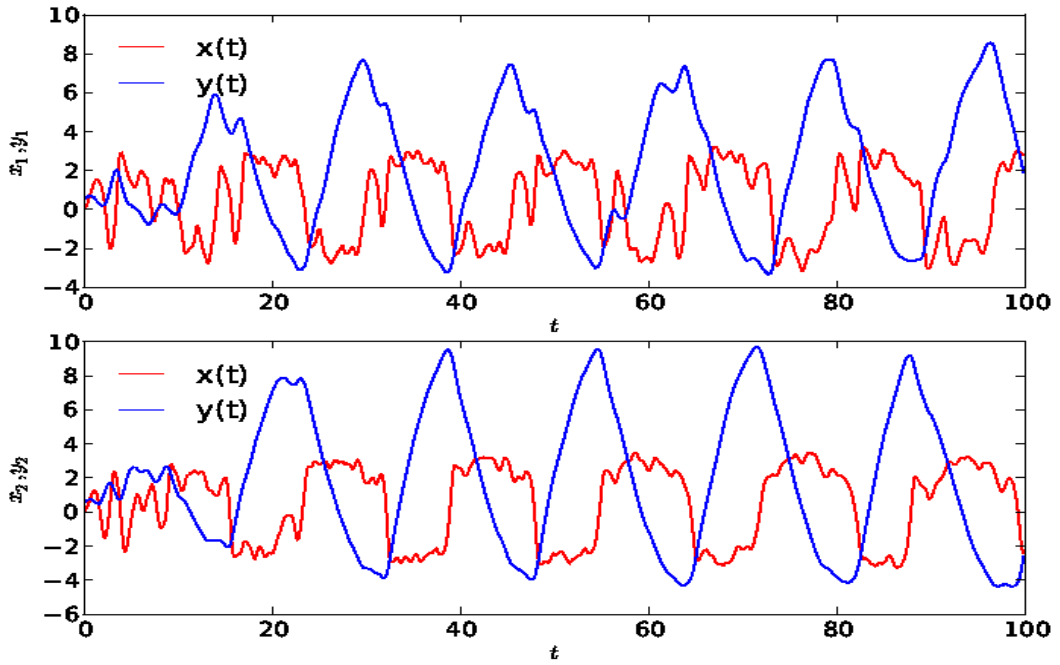

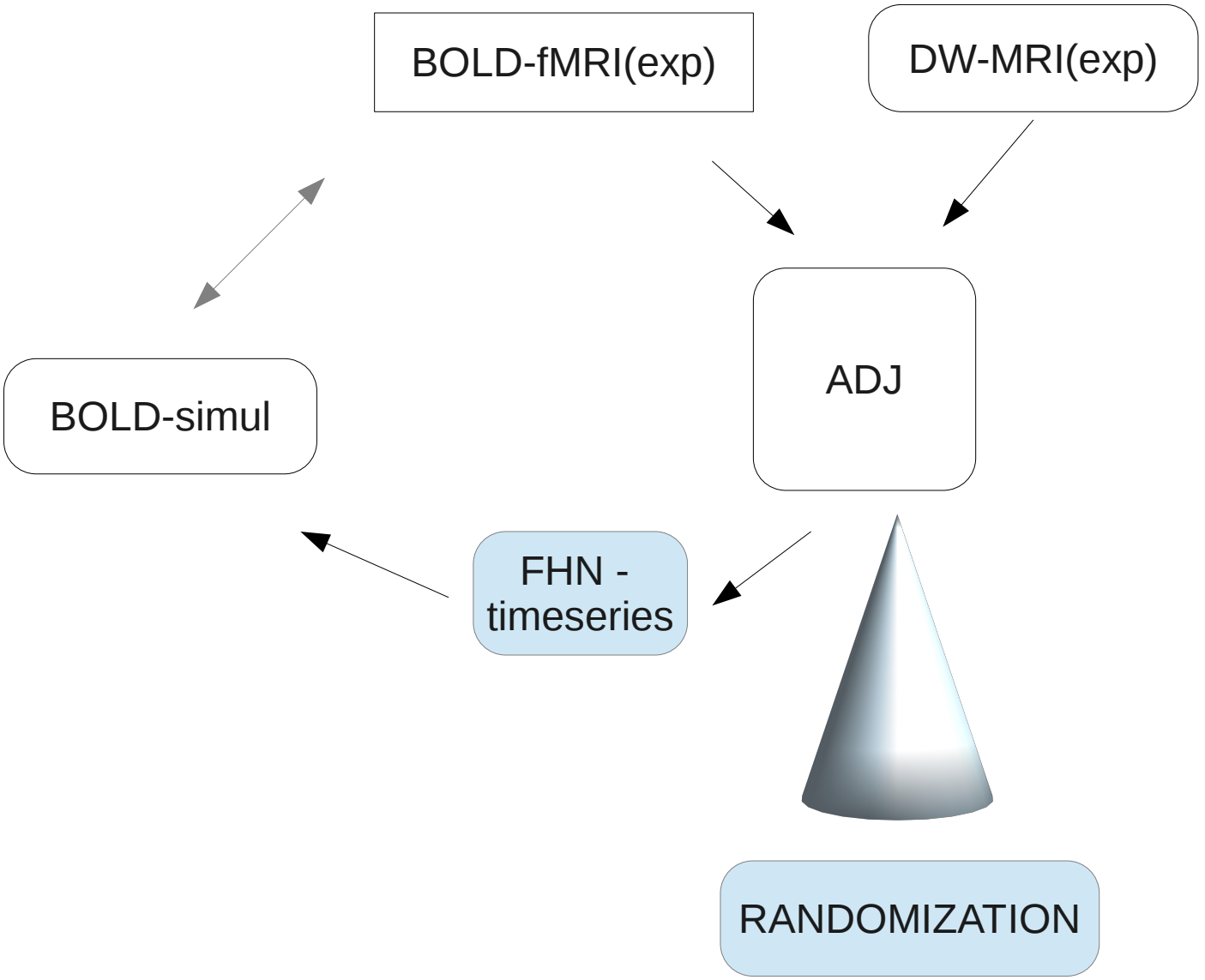
BOLD-fMRI(exp)
DW-MRI(exp)
BOLD-simul
ADJ
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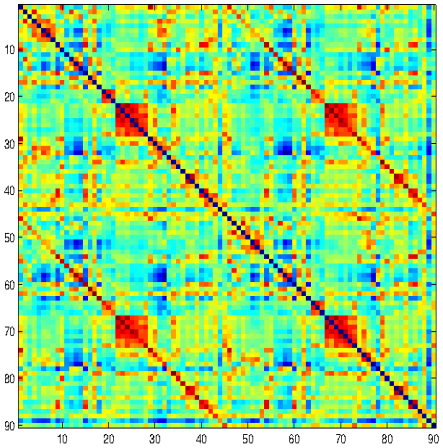
RANDOMIZATION

Adjacency Matrix



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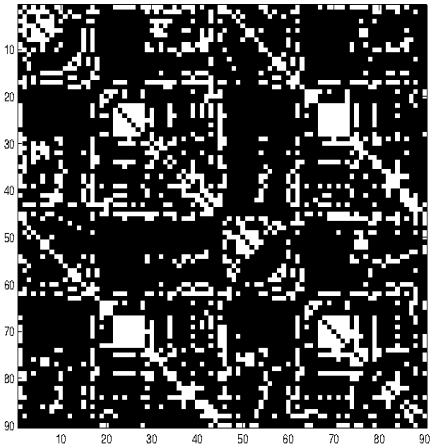
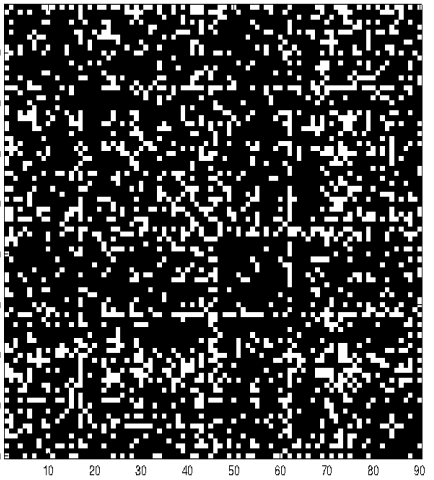


random



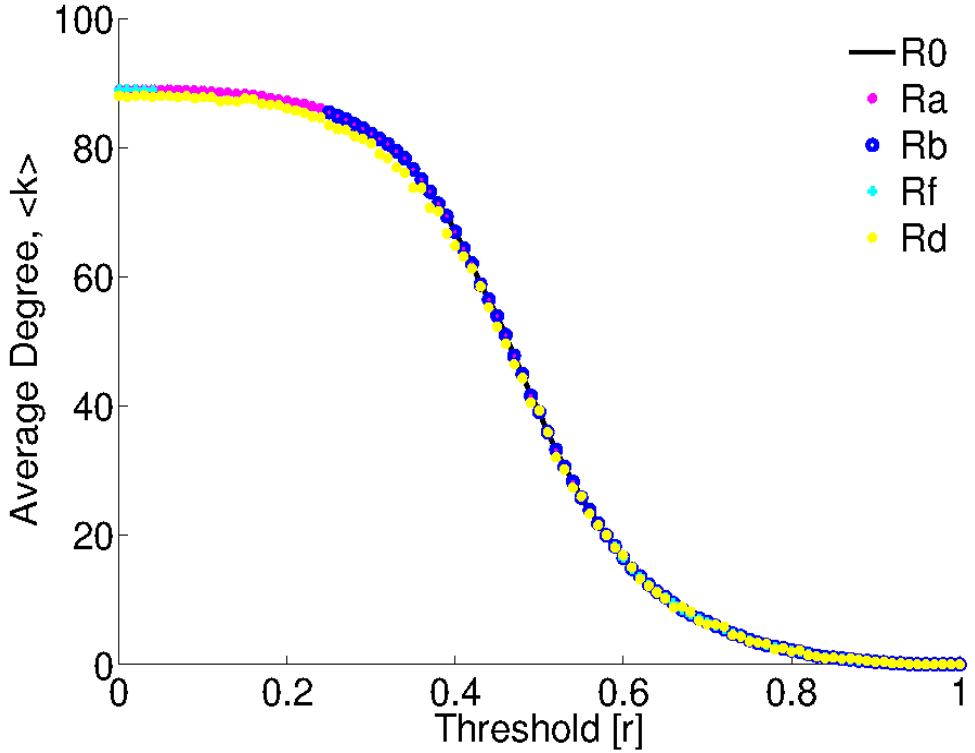
Adj. Matrix → Randomized Adj. Matrix

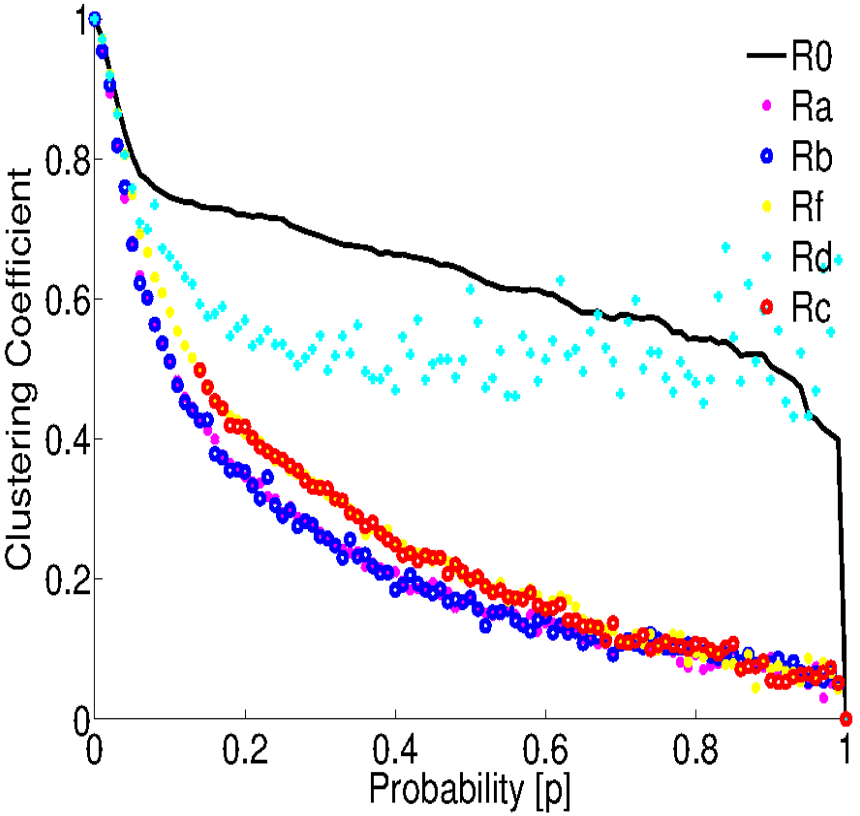
How to generate randomized network ?

* Erdos-Renyi graph (N, L)
* swapping double edges
* degree sequence preserved graph
* degree distribution preserved graph
* partially randomized graph

Tools : networkx and BCT

Network Measures





FUTURE DIRECTION

* Simulate neuronal and BOLD signal on randomized networks

* Compare simulations and experimental data

* Parameter Analysis

Questions ?