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Hyperbolic Model Captures Temporal Small Worldness of Brain Dynamics

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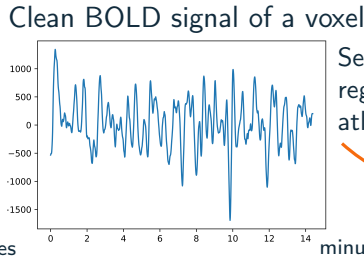
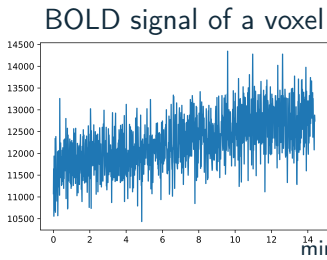
Brain activity can be represented as a complex network

- **Small Worldness:** combination of high clustering coefficient (*local property*) and short temporal path length (*global reachability property*)
- **Scale Freeness:** small number of nodes have a degree that exceeds the average one

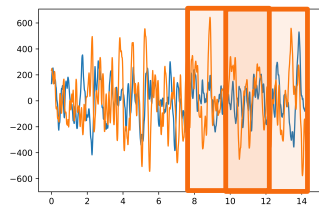
What is the best model that simulates the functional connectivity of the brain and can be used as a null model?

Pipeline

Linear Regression and Bandpass Filtering to remove patient, respiratory and cardiac movements



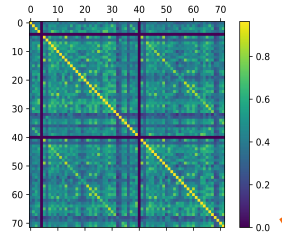
BOLD signal of two regions



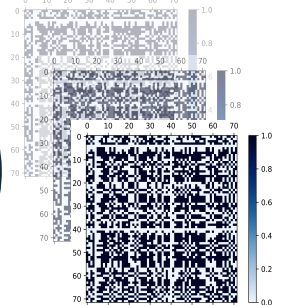
Sliding windows method

Computing correlation coefficient within each window

Adjacency matrix

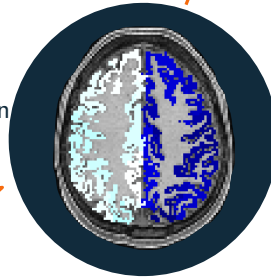


Thresholding

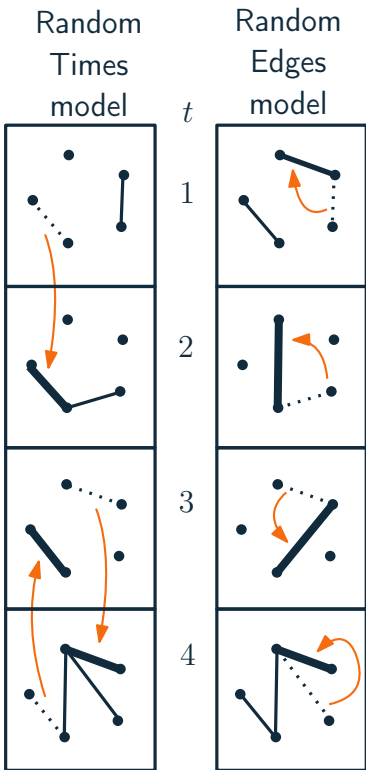


Temporal Brain Network

Selecting brain regions using an atlas



Popular models



REFERENCES

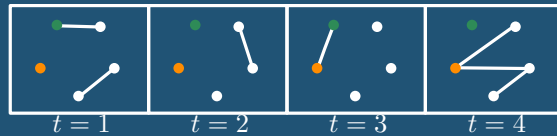
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2. Humphries, M. D. & Gurney, K. Network 'Small-World-Ness': A Quantitative Method for Determining Canonical Network Equivalence. *PLoS ONE* 3, 11 (2008).
3. Sizemore, A. E. & Bassett, D. S. Dynamic graph metrics: Tutorial, toolbox, and tale. *NeuroImage* 180, 417–427 (2018).
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Measures

- **clustering coefficient:** average over all the nodes of the local clustering coefficient, measures the tendency of the neighbors of a node to form a clique

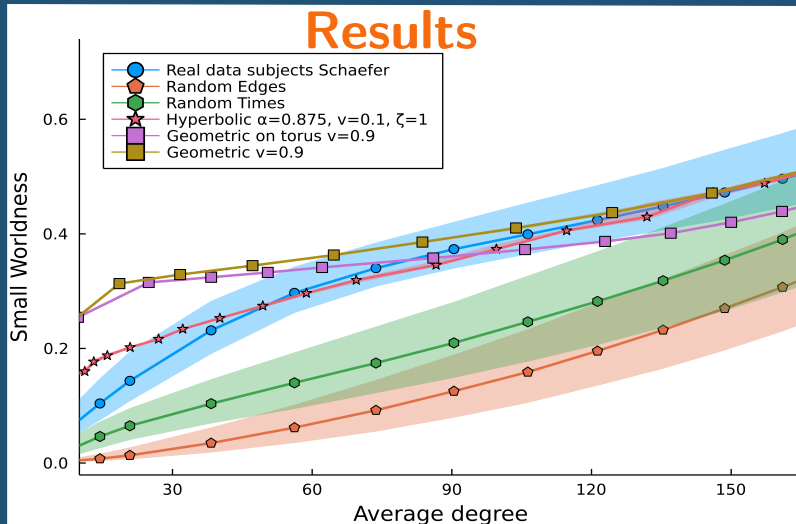


- **temporal path length:** average of the fastest paths between all pairs of nodes

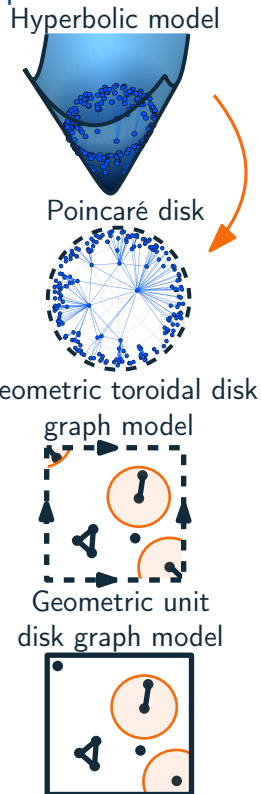


fastest path length from the green to the orange nodes = 3

Results



Proposed models



The Hyperbolic model not only is close to real data but it has the same behaviour