THE MULTISCALE SELF-SIMILARITY OF THE WEIGHTED HUMAN BRAIN CONNECTOME

Laia Barjuan,[1] Muhua Zheng,[2] and M. Ángeles Serrano[1,3]

[1] *Universitat de Barcelona, E-08028 Barcelona, Spain*
[2] *Jiangsu University, Zhenjiang, Jiangsu, 212013, China*
[3] *ICREA, Passeig Lluís Companys 23, E-08010 Barcelona, Spain*

Anatomical connectivity between brain regions can be represented as a network –the connectome– where the intensities of the links, the weights, influence resilience and functional processes. However, many features associated with these weights are not fully understood, particularly their multiscale organization. In this paper, we investigate the architecture of connection weights in multiscale human brain connectomes. We uncover multiscale self-similarity in the weighted statistical properties of the connectomes, including the ordering of weak links, which remains consistent across the analyzed length scales. Additionally, we show that these observations are well explained by the weighted geometric soft configuration model WSD, which uses the same set of rules to model both weak and strong links, and supports the observed scale invariance through its renormalizability. This finding eliminates the need for separate generative connectivity rules for weak and strong connections at specific scales in brain connectomes. The observed symmetry suggests a signature of criticality in the weighted organization of the human brain and raises important questions for future research, such as the existence of symmetry breaking at some scale.

---

[1] L. Barjuan *et al.*, The multiscale self-similarity of the weighted human brain connectome, *PLoS Comput. Biol.* **21**(4), e1012848 (2025).
[2] A. Allard *et al.*, The geometric soft configuration model for weighted networks, *Nat. Commun.* **8**(1), 14103 (2017).