Scale-free behavior of weight distributions of connectomes

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To determine the precise link between anatomical structure and function, brain studies primarily concentrate on the anatomical wiring of the brain and its topological properties. In this work, we investigate the weighted degree and connection length distributions of the KKI-113 and KKI-18 human connectomes, the fruit fly, and the mouse retina. We find that the node strength (weighted degree) distribution behavior differs depending on the considered scale. On the global scale, the distributions are found to follow a power-law behavior, with a roughly universal exponent close to 3. However, this behavior breaks at the local scale as the node strength distributions of the KKI-18 follow a stretched exponential, and the fly and mouse retina follow the log-normal distribution, respectively, which are indicative of underlying random multiplicative processes and underpin the nonlocality of learning in a brain close to the critical state. However, for the case of the KKI-113 and the H01 human (1 mm^3) datasets, the local weighted degree distributions follow an exponentially truncated power law, which may hint at the fact that the critical learning mechanism may have manifested at the node level too.

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