Multiplex Brain Networks

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Neural systems consist of large numbers of interdependent components (i.e. neurons, cortical columns, etc.) that interact in qualitatively different ways across a range of different scales [1]. They are therefore naturally described using a multilayer or multiplex network approach [2, 3], in favour of the more standard single-layer network analyses [4] that have historically been widely applied to such systems. In this work we consider brain network models consisting of three layers: an anatomical layer describing the large-scale connectivity of the Macaque monkey, and a pair of functional layers that are derived by measuring pairwise correlations between time series of simulated excitatory and inhibitory neural activity. We investigate and characterize correlations between structural and functional layers, as system parameters controlling simulated neural activity are varied, by employing a range of multiplex measures [2, 3], as well as a recently forwarded structure-function clustering coefficient [5], which quantifies the emergence of functional connections that arise between structurally unconnected regions. Moreover, we demonstrate that such a simultaneous analysis of structure-function networks is better placed to capture emergent features and capabilities of neural systems than standard single-layer analyses.

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