Joint informational and topological signatures of individuality and age

Giovanni Petri[1,2,3,*]

[1] *Network Science Institute, Northeastern University London, London, UK*
[2] *CENTAI Institute, Turin, IT*
[3] *Networks Unit, IMT Lucca, Lucca, IT*
[*] giovanni.petri@nulondon.ac.uk

Network neuroscience is a dominant paradigm for understanding brain function. Functional Connectivity (FC) encodes neuroimaging signals in terms of the pairwise correlation patterns of coactivations between brain regions. However, FC is by construction limited such pairwise relations. In this work, we explore functional activations as a topological space via tools from topological data analysis. In particular, we analyze the resting fMRI data of populations of healthy subjects across ages, and demonstrate that algebraic-topological features extracted from brain activity are effective for brain fingerprinting. By computing persistent homology and constructing topological scaffolds, we show that these features outperform FC in discriminating between individuals and ages. That is, the topological structures are more similar for the same individual across different recording sessions than across individuals. Likewise we find that topological observables improve discrimination of individuals of different age. Finally, we show that the regions highlighted by our topological methods are characterized by characteristic patterns of information redundancy and synergy which are not share by regions that are topologically unimportant, hence estabilishing a first direct link between topology and information theory in neuroscience.