CEBSIT / ION • Lab of Comparative Psychobiology • Technology Forum

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On Multi-Modality Data Integration from the Perspective of Representational Geometry in Abstraction Coding – Principals and Practices

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Abstract

When studying neural activity data, we are in the middle groundless of the infinite universe. How does our kind close the mind loop of the boundless natural world across evolution? What is the underlying principle of the neural information and computation operating in our little brain? The tuning property of neuronal responses naturally leads to a Boolean algebra that relies on all-or-none action potentials. While we can hardly achieve the adaptivity to diverse environmental challenges by merely relying on inorganic cooperation of the numerous distinct neurons, more elaborate neuronal organizational structures naturally lead to an algebra that is non-Boolean. The representational geometry derived from large populations of neurons drives toward a complementary non-Boolean-logically workable entity in the abstraction of mental codes, capturing decodable information both linearly and non-linearly. Thus, neural information and computation might rely on a combination of Boolean and non-Boolean logic, while the latter might be the grounded principled underlying mechanism. Such principle was evident in abstracting away differences that were entangled with the prime representational geometry from each data acquisition modality in neuroscience researches, such as fMRI, M/EEG, single neuron recordings, etc. Beyond linearity and non-linearity, the operational algorithms of prior constraints (or mental intuitions) in the transformation of representational geometry might be of great interest for future investigations in the convergence of brain science and intelligence technology.