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Title

Emergent elasticity in the neural code for space

Abstract

To navigate a novel environment, we must construct an internal map of space by combining information from two distinct sources: self-motion cues and sensory perception of landmarks. How do known aspects of neural circuit dynamics and synaptic plasticity conspire to construct such internal maps? We demonstrate analytically how a neural attractor model that combines path integration of self-motion with Hebbian plasticity in synaptic weights from landmark cells can self-organize a consistent internal map of space as the animal explores an environment. Intriguingly, the emergence of this map can be understood as an elastic relaxation process between landmark cells mediated by the attractor network. Moreover, we verify several experimentally testable predictions of our model, including: (1) systematic deformations grid cells in irregular environments, (2) path-dependent shifts in grid cells towards the most recently encountered landmark, (3) a dynamical phase transition in which grid cells can break free of landmarks in altered virtual reality environments and (4) the creation of topological defects in grid cells. Taken together, our results conceptually link known biophysical aspects of neurons and synapses to an emergent solution of a fundamental computational problem in navigation, while providing a unified account of disparate experimental observations.Dynamics across minds, brains and machines: from the retina to semantic cognition

Biography

Surya Ganguli triple majored in physics, mathematics, and electrical engineering and computer science at MIT, completed a PhD in string theory at Berkeley, and a postdoc in theoretical neuroscience at UCSF. He is now an assistant professor of Applied physics at Stanford where he leads the Neural Dynamics and Computation Lab, and is also a consulting professor at the Google Brain Research Team. His research spans the fields of neuroscience, machine learning and physics, focusing on understanding and improving how both biological and artificial neural networks learn striking emergent computations. He has been awarded a Swartz-Fellowship in computational neuroscience, a Burroughs-Wellcome Career Award at the Scientific Interface, a Terman Award, a NIPS Outstanding Paper Award, an Alfred P. Sloan foundation fellowship, a James S. McDonnell Foundation scholar award in human cognition, a McKnight Scholar award in Neuroscience, and a Simons Investigator Award in the mathematical modeling of living systems.