Theory for Macroscopic Neural Computation Based on Laplace Transform

The model The hypothesis is that the brain represents information by constructing functions over continua. In order to construct these representations, and to manipulate them, the brain maintains the Laplace transform of these continua and approximates the inverse transform to reconstruct the function itself. If this hypothesis is correct, it would endow the brain with powerful computational abilities to manipulate and compare functions (which we can understand using well-established mathematics), enabling us to build realistic and elegant models of cognitive computation describing the cooperative behavior of many millions of neurons in a few equations.

What is new inside? The major advance in the time since the award was made is the discovery that neurons in the entorhinal cortex have f ring properties that comport with predictions for the Laplace transform of time. Neurons in the hippocampus, referred to as ``time cells'' have f ring properties like those predicted for the inverse of the Laplace transform via the method we have proposed. Thus, we have observed a transform/inverse pair in connected brain regions, conf rming a fundamental prediction of this theory. We've also advanced the theory by working out a Laplace domain treatment of evidence accumulation, potentially unifying computational models for memory and decision-making.

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