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Title:
A Neural Model for V1 That Incorporates Dendritic Nonlinearities and Backpropagating Action Potentials

Abstract: The work of Hubel and Wiesel has been instrumental in shaping our understanding of V1, leading to modeling neural responses as cascades of linear and nonlinear processes in what is known as the “standard model” of vision. Under this formulation, however, some dendritic properties cannot be represented in a practical manner, while evidence from both experimental and theoretical work indicates that dendritic processes are an indispensable element of key neural behaviors. As a result, current V1 models fail to explain neural responses in a number of scenarios. In this work, we propose an implicit model for V1 that considers nonlinear dendritic integration and backpropagation of action potentials from the soma to the dendrites. Our model can be viewed as an extension of the standard model that minimizes an energy function, allows for a better conceptual understanding of neural processes, and explains several neurophysiological phenomena that have challenged classical approaches.

Bio: Marcelo Bertalmío is a Senior Research Scientist with the Spanish National Research Council (CSIC), specializing in vision modeling. He is in Stanford’s list of the world’s top 2% scientists, has obtained an ERC Starting Grant, written two books, and among other honors he was awarded the SIAG/IS Prize. His current research interests include overcoming the critical limitations of artificial neural networks through vision science.