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Toward a minimal model of a large spiking cell

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Experimentalists will soon be able to ascertain the highly nonuniform morphology and channel distributions of the large, pyramidal cells that populate the mammalian cortex. This advance is captured and quantified via tens of thousands of coupled nonlinear ordinary differential equations, per cell. The circuit modeler then asks, "How many of these equations must I keep in order to guarantee a fixed level of accuracy in the input-output map?" We demonstrate that the combined application of Balanced Truncation [1] to the weakly excitable portion of the tree and Principal Orthogonal Decomposition and the Discrete Empirical Interpolation Method [2] to the strongly excitable portion of the cell permit one to reduce the system size by more than one order of magnitude and decrease simulation time by a factor of 5 without sacrificing synaptic specificity in space or time.

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