1 Eigen-reduction of Large Scale Neuronal Networks

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The modest pyramidal neuron has over 100 branches with tens of synapses per branch. Partitioning each branch into 3 compartments, with each compartment carrying say 3 membrane currents, yields at least 20 variables per branch and so, in total, a nonlinear dynamical system of roughly 2000 equations. We linearize this system to, x'=Ax+Bu, y=Cx, where B permits synaptic input into each compartment and C observes only the soma potential. We reduce this system by retaining the dominant singular directions of the associated controllability and observability Grammians. We evaluate the error in soma potential between the full and reduced models for a number of true morphologies over a broad (in space and time) class of synaptic input patterns, and find that reduced systems of dimension less then 10 accurately reflect the full quasi-active dynamics. This savings will permit, for the first time, one to simulate large networks of biophysically accurate cells over realistic time spans.