Abstract Submitted
for the 4CS19 Meeting of
The American Physical Society

Exploring the Behavior Space of the Hodgkin-Huxley Model
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— The Hodgkin Huxley model is a set of nonlinear, ordinary differential equations that describes electrical signals in neurons. In their simplest form, the equations include twenty-five parameters that correspond to different physical attributes of the neuron, such as membrane capacitance or conductance of sodium ions. The value of these parameters may vary depending on physical or chemical conditions, such as the structure of an ion channel or the concentration of an ion. There is a vast range of available behaviors that neurons can exhibit depending on the parameters' values. These behaviors are explored over evolutionary timescales by random genetic variation in the parameter values. Evolutionarily favorable behaviors and their corresponding parameters are selected for. We consider the problem of exploring the behavior space of the Hodgkin-Huxley model for different parameter values. As a first step, we have used model reduction techniques to remove irrelevant parameters, i.e., parameters whose variation are unnecessary to explain a specific behavior. We then ask whether the reduced models can accurately mimic behaviors exhibited by the full model. In this way, we begin to map out the behavior space accessible by real neurons.

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Date submitted: 12 Sep 2019 Electronic form version 1.4