Title:	Modelling Neurons and Their Col- lective Behaviour
Authors:	Bedi, Saurabh
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Abstract:	Electrical activity of a neuron is regulated by the unequal distribution of several ions across its membrane. The standard biophysical model of a neuron was given by Hodgkin and Huxley (HH), who used coupled differential equations involving the differential conduc- tances of the Sodium and Potassium ion channels and the input current as parameters. The model correctly describes the typical voltage impulse dynamics (Action Potential) across the neuronal membrane. This work probes various dynamic behaviour of single neurons at different parameter values through their long-term time course, different features of os- cillatory behaviour, and parameter space search for transition in stability that takes place upon changing these parameters. Subsequently, the dynamics of two HH neurons is stud- ied that share membrane voltages through gap junction coupling, for both unidirectional and bidirectional coupling. The dynamic behaviour is then probed for increased number of neurons for different boundary conditions, coupling types, and strengths of coupling. The two boundary conditions probed are - the ring (periodic boundary conditions) and the chain (fixed boundary conditions) of neurons, with bidirectional coupling implemented in the ring, and unidirectional coupling in the chain. The collective behaviour of these networks of neurons is studied for different coupling strengths and input currents. Synchronization in these neuronal networks is studied through Synchronization Order Parameter and Space Time plots. Preliminary studies on a reverse approach of estimating parameter values from neuronal voltage data are also reported. The results obtained in this work are discussed from a nonlinear dynamical systems view.
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