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MORRIS-LECAR NEURONAL NETWORKS TOPOLOGY AND SYNCHRONIZATION

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Abstract

As is well known, synchronization phenomena are important and pervasive in neuronal systems. Recently a lot of work about the synchronization of the neuronal networks has been done. In this work we used the results of Sheng, Huai and Wen [1] to study the effect of network topology on the synchronization of a special form of Morris-Lecar (ML) neuronal networks. We show that the synchronization of the neurons in this form can be enhanced by increasing the number of the shortcuts and obtain an optimal number of shortcuts at which neurons have best performance.

Keywords: Morris-Lecar neural network, synchronization, shortcuts, maple software

1 Introduction

Classical theories of the synchronization phenomenon are based on the notion of proximity of the frequencies or phases of the subsystems generating periodic oscillations. Using common language of dynamical systems with continuous time, synchronization of periodic oscillations may be represented as follows: while a stable limit cycle is a geometrical image of such oscillations, an attracting two-dimensional (or n-dimensional) torus is a geometrical image of the oscillations generated by two (or n) uncoupled oscillators in a common phase space. As the parameter of coupling is increased ($\varepsilon > 0$) , the motions of partial subsystems are no longer independent and a stable limit cycle is born on the torus that is still an attractor. This corresponds to the transition of the system to synchronisation.
Any coupled system can be viewed as a network consisting of a number of sites connected with a certain topology graph, where vertices represent the dynamic elements of the system and edges represent the interactions or couplings between them. It is known that a single neuron in the vertebrate cortex is connected to more than 10^4 postsynaptic neurons via synapses, forming complex networks. Therefore, adding a number of long range connections among them is reasonable. So far, most studies of synchronization are between neurons on completely local regular networks and completely random networks.