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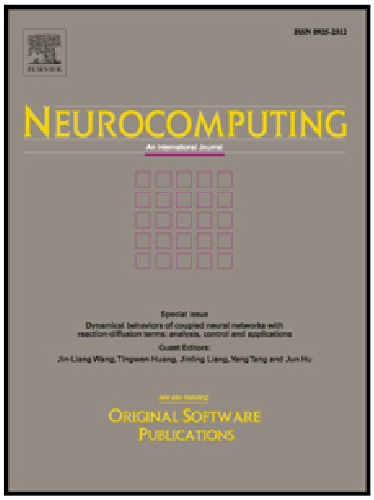

The Brain Dynamics Toolbox for Matlab

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The Brain Dynamics Toolbox for Matlab

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Abstract

Nonlinear dynamical systems are increasingly informing both theoretical and empirical branches of neuroscience. The Brain Dynamics Toolbox provides an interactive simulation platform for exploring such systems in MATLAB. It supports the major classes of differential equations that arise in computational neuroscience: Ordinary Differential Equations, Delay Differential Equations and Stochastic Differential Equations. The design of the graphical interface fosters intuitive exploration of the dynamics while still supporting scripted parameter explorations and large-scale simulations. Although the toolbox is intended for dynamical models in computational neuroscience, it can be applied to dynamical systems from any domain.

Keywords: initial-value problems, differential equations, numerical integration, visualization, brain dynamics

1. Introduction

Computational neuroscience relies heavily on numerical methods for simulating non-linear models of brain dynamics. Software toolkits are the manifestation of those endeavors. Each one represents an attempt to balance mathematical flexibility with computational convenience. Toolkits such as GENESIS [1], NEURON [2] and BRIAN[3] provide convenient methods to simulate conductance-based models of single neurons and networks thereof. The Virtual Brain [4] scales up that approach to the macroscopic dynamics of the whole brain by combining neural field models [5] with anatomical connectivity datasets [6]. Mathematical toolkits such as AUTO [7], XPPAUT [8], MATCONT [9], PyDSTool [10] and CoCo [11] are useful for analyzing non-linear dynamics but assume advanced mathematical theory.