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Toda Lattice and Lotka Volterra Cellular Neural Network Models

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ABSTRACT

In this paper autonomous nonlinear cellular neural networks (CNNs) are used for modeling two well-known equations: Toda lattice and Lotka Volterra equations.

In general, one-dimensional lattices are described by a set of n structually identical ODE's (first or second order) with local coupling between the states:

$$\Delta x_k = f(x_{k-1}, x_k, x_{k+1}),$$

where Δ denotes the differential operator. Some prominent examples of such equations are discrete Korteweg-de-Vries equation, modified KdV equation, the self-dual network equation, etc. The Toda lattice equations can be obtained from KdV by a discretization process. Special spectral technique, related to a method known in control theory as Harmonic Balance Method, is applied for studying the dynamic behavior of our CNN model. Existence of solitary wave solutions of Toda lattice CNN is proved. Lotka-Volterra equation is transformed in the Toda lattice equation. Hence, the Lotka-Volterra equation can also be studied as an autonomous CNN. This example demonstrates the value of the CNN paradigm as a unifying framework for studying nonlinear differential equations.

Keywords: *cellular neural networks, Toda lattice equation, Lotka Volterra equation, Harmonic Balance Method, solitary wave solution*

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