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The Stability of Boolean Network with Transmission Sensitivity

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Abstract

Boolean network has been widely used in modelling biological systems and one of the key problems is its stability in response to small perturbations. Based on the hypothesis that the states of all nodes are homogenously updated, great progress has been made in previous works. In real biological networks, however, the updates of genes typically show much heterogeneity. To address such conditions, we introduce transmission sensitivity into Boolean network model. By the method of semi-annealed approximation, we illustrate that in a homogenous network, the critical condition of stability has no connection with its transmission sensitivity. As for heterogeneous networks, it reveals that correlations between network topology and transmission sensitivity can have profound effects on the its stability. This result shows a new mechanism that affects the stability of Boolean network, which could be used to control the dynamics in real biological systems.

Keywords: Boolean network, stability, transmission sensitivity

1. Introduction

Boolean network was first proposed as a model of genetic regulatory network by Kauffman [1] in 1969. Since then, it has been widely used to describe the behavior of a series of complex systems such as biochemical networks [2, 3, 4, 5], the spread of infectious disease and rumour [6, 7, 8]. A typical Boolean network consists of N nodes, each can take one of the following two

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