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Windows of opportunity for synchronization in stochastically coupled maps

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Abstract

Several complex systems across science and engineering display on-off intermittent coupling among their units. Most of the current understanding of synchronization in switching networks relies on the fast switching hypothesis, where the network dynamics evolves at a much faster time scale than the individual units. Recent numerical evidence has demonstrated the existence of windows of opportunity, where synchronization may be induced through non-fast switching. Here, we study synchronization of coupled maps whose coupling gains stochastically switch with an arbitrary switching period. We determine the role of the switching period on the synchronization through a detailed analytical treatment of the Lyapunov exponent of the stochastic dynamics. Through closed-form expressions and numerical findings, we demonstrate the emergence of windows of opportunity and elucidate their nontrivial relationship with the stability of synchronization under static coupling. Our results are expected to provide a rigorous basis for understanding the dynamic mechanisms underlying the emergence of windows of opportunity and leverage non-fast switching in the design of evolving networks.

Keywords: Networks; stochastic stability; switching; synchronization; windows of opportunity

1. Introduction

Dynamical systems with a network structure arise naturally as models in many fields, including physics, biology, engineering, and social sciences [4, 15, 22, 48, 69]. Significant attention has been devoted to understand the role of and interplay between node dynamics and network structure, specifically in regard to network synchronization, see, for example, [8, 10, 12, 14, 21, 51, 49, 53].

While most of the literature has focused on static networks, many examples of technological and natural networks are more accurately described through dynamic networks,

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