Universal Computing in Networks in State Space: Guided Heteroclinic Switching

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ABSTRACT

Complex network dynamics commonly refer to the dynamics of units interconnected to form a network. Here we suggest a complementary, more abstract view and consider networks of (saddle) states in state space and the switching dynamics among them. More specifically, it has been shown that complex networks of dynamically connected saddle states persistently emerge in a broad range of high-dimensional systems and that they may reliably encode inputs as specific switching trajectories. Their computational capabilities, however, were far from being understood. Here, we analyze how symmetry-breaking inhomogeneities (high-dimensional external signals) naturally induce predictable persistent switching dynamics across such networks in terms of heteroclinic cycles. We show that such systems are capable of computing arbitrary logic operations by entering into switching sequences in a controlled way. This dynamics thus offers a highly flexible new kind of computation based on switching along complex networks of states.

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