Abstract

Chapter-1 Connection topology is the key to controlling the spatio-temporal dynamics of coupled maps, and varying the fraction of random links can tune the system from spatio- temporal chaos to synchronized stable fixed points. Here we consider a network of chaotic maps, where the sites connect to nearest neighbours with probability (1−ps), and to random non-local sites with probability ps . Further we consider that the underlying links in the system can switch with probability pt, keeping the average fraction of random links the same. This implies that when pt is unity, the links in the network change at each iteration, with the new links being random with probability p. We study two kinds of variation of the links. We consider the scenario where the links change independently at the local level, namely, the coupling connections of every node is switched with probability pt . Our central result is that the probabilistic switching of links, at the local or global level, yields a sharply increasing range of synchronized fixed point, as one goes from a completely static network to completely dynamic one. Further, for small pt, we observe that different realizations of the connectivity matrix, with the same fraction of random links, synchronizes at different values of coupling strength, and so there is a spread in the values of the critical coupling strength necessary for synchronization. However, as we go towards the completely dynamic limit (pt = 1) there is rapid convergence to a specific critical coupling strength, indicating that dynamic rewiring acts like a self-averaging mechanism, as the network evolves under many different connection matrices drawn from an ensemble of matrices with the same p, over time. The enhanced spatio-temporal regularity obtained under dynamic links is also verified through linear stability analysis about the synchronization manifold. Lastly, for low probabilities of link change, we find that the system shows intermittency, and as the links switch more frequently, this intermittency gives way to perfect synchronization. Chapter-2 We investigate the emergent infection spreading patterns in a population on 2-Dimensional lattice based on a cellular automata model of the SIRS disease cycle. We observed that in a population consisting of randomly distributed refractory and susceptible individuals, an infection seed can lead to persistent infection in the population. Further, our results suggest that the size of the infected sub-population depends on the dynamical characteristics of the disease cycle, and on the heterogeneity of the population in which the disease spreads.