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Title :

Contribution to the study of stochastic models for large interacting systems: synchronism, synchronisation and other collective phenomena

Abstract :

This report deals mainly with theoretical and numerical study of interacting random dynamics. These are formally stochastic processes whose state space is a highly dimensional or infinite product of spaces. The questions addressed are related different asymptotic like space and time. Stationary states are distribution of random fields which may be characterised as Gibbs measures, concept arising in statistical mechanics and associated with spatial correlations. Several collective phenomena are proved: phase transition/non ergodicity coming from the interaction of infinitely many dynamics, synchronisation phenomenon in systems where the interaction is through a reinforcement mechanism. In the stochastic systems considered, the elementary updating mechanisms are synchronous: probabilistic cellular automata (discrete time, finite spin space, markovian dynamics), monotone coupling of many markovian continuous time dynamics, interacting Pólya urns (discrete time, continuous spin space). Random fields naturally associated present various spatial structures. In particular, we study a non trivial phase diagram for a family of positive rates reversible probabilistic cellular automata: a non trivial chessboard-like structure emerges. Another case where concentration holds in sub-spaces in order to maintain an order structure. Finally, the synchronisation phenomenon may be considered as a mass' concentration on the diagonal.

Keywords :

- Interacting stochastic processes, high dimensional state space, discrete and continuous time, Markov processes, reinforced processes, interacting Pólya urns, time and space asymptotic, (non) ergodicity, coupling, synchronisation, collective behaviour, synchronous/sequential updating
- Spin systems, interacting particle systems, probabilistic cellular automata, interacting Markov chains, multicomponent systems
- Mathematical and probabilistic aspects of statistical mechanics, Gibbs measures, phase transition, mean field numerical aspects, cluster variational method
- stochastic algorithms, MCMC, perfect simulation, random dynamical systems
- stochastic simulations, sampling
- stochastic models for large interacting stochastic systems, in particular for physics and biology ; emergence and collective phenomena