STRUCTURE, STABILITY, AND SENSITIVITY ANALYSIS FOR LÉVY-DRIVEN STOCHASTIC SYSTEMS: THE GENERALIZED COUPLING APPROACH

DESCRIPTION FOR THE GENERAL PUBLIC

Introduction: Many physical, biological and social phenomena are modelled mathematically as a Markov evolution, i.e. one in which the future configuration, or position, depends on the present and does not depend otherwise on past configurations. Such an abstract but flexible mathematical framework offers a simplifying perspective for complicated phenomena, since typically the main information about the complicated Markovian systems is contained in its (simpler) limiting or stationary regimes. The other source of simplification is provided by Stochastic Averaging paradigm, where a complicated multi-scale model is approximated by the (simpler) averaged one.

We will deal with evolutions with shocks, complicated local structure, and possible long memory effects. These effects are natural in realistic models for various physical and social phenomena, and provide new challenges for capturing the fundamental features of the dynamics because the associated Markov evolutions have to be considered in functional–and thus infinite-dimensional–state spaces. We develop new generalized coupling approach to study such systems, and combine classic probabilistic and analytic methods with the novel stochastic control ideas.

Project objectives. We want to study general stochastic equations with jump noise, including equations with delay and with full memory. For such complicated Markov models the standard tools of stochastic calculus and non-local partial differential equations have limited applicability. We will develop a new approach, based on the generalized coupling technique, for a unified study of the basic structural properties of such models, their long-term behavior, and sensitivities with respect to fluctuations of the position of the process and external parameters. Such a study will provide a solid background for future numerical approximations and statistical inference.

Significance. This research project belongs to the theory of stochastic processes and its main focus is on description and asymptotic properties of the multi- and infinite-dimensional Markov models for random dynamics with shocks. New methods for analysis of such systems will have great significance for the theory of stochastic processes and open new perspectives in Stochastic Averaging for multi-scale models with jumps. The outcome of the project will provide a solid mathematical background for future quantitative analysis of such models, their numerical approximations and statistical inference. This is likely to find applications in various realistic physical, biological and social models, where random shocks are combined with long memory (after-shock) effects.