Central Limit Theorem, Moderate and Large Deviations for Nonlinear Stochastic Dynamical Systems

Dr. Haseena A

Assistant Professor, Department of Mathematics, Goverment College Chittur, Palakkad.

4 November 2020

Abstract

Nonlinear stochastic dynamical systems are a powerful research tool to study and analyse many real world phenomena as most systems in nature are nonlinear in behaviour and are subject to random fluctuations. Large deviation theory is a branch of probability theory which studies the exponential decay of probabilities of rare events. Freidlin and Wentzell investigated the large deviation behaviour of finite dimensional stochastic differential equations (SDEs) perturbed by small noise. Later the theory is extended to infinite dimensional diffusions and SPDEs. Moderate deviations is also concerned with probabilities of deviations, but of a smaller order than in large deviation theory.

In the first part of this talk, a Freidlin-Wentzell type large deviation principle (LDP) is discussed for some general class of nonlinear SDEs perturbed by Brownian motion and for a PDE epidemic model with Lèvy Noise. A central limit theorem (CLT) and moderate deviation principle (MDP) is also established for a stochastic tidal dynamics model. The second part concerns the work I propose to carry out for my post doctoral studies. It is planned to formulate a SIRI-PDE epidemic model and prove the global solvability results in both deterministic and stochastic framework. We then establish central CLT, MDP and LDP for the same. The main objective of the proposal is to predict the time to extinction of epidemics falling under SIRI category. If the size of the population remains under a given threshold, the CLT allows to predict the extinction of disease. The exit time will be studied applying the large deviation principle. This exit time is the time to extinction of the disease when the population is fairly large. Since MDP bridges the gap between the CLT and LDP, MDP can be used to predict the extinction time, if the population size lie in a range between that of CLT scale and LDP scale.

Keywords: SIRI epidemic model, central limit theorem, large deviation principle, moderate deviation principle, exit time.