Applying the theory of random dynamical systems to compute the probabilistic distribution of the attractor of stochastic differential equations

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Abstract

Differential Equations with uncertainty are a powerful mathematical tool to describe real random phenomena. In the literature, there are two different approaches to consider uncertainty in differential equations: Stochastic Differential Equations (SDE) and Random Differential Equations (RDE). The difference between them is how uncertainty is included. While in SDE, a stochastic term is added in the right term of the differential equation, in the RDE the parameters of the equation are considered random variables instead deterministic values. Nowadays, huge efforts are being made for the study of the relationship between SDE and RDE.

Following this goal, in this work, we will compute the probabilistic distribution of the attractor of a SDE taking advantage of the random dynamical systems theory. Considering a specific transformation, we will transform the SDE into a RDE. This transformation preserves the statistical properties of the RDE in the SDE. Thus, we can compute the attractor of the RDE and its probabilistic properties, such as the mean, standard deviation, probability density function, etc. The theoretical findings are illustrated with specific examples.

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