Intrinsic Stochastic Chaos and Reliability of Probabilistic Models

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Abstract

In chaos theory a deterministic chaotic system is highly sensitive to initial conditions, which renders the long-term predictions practically impossible, e.g. in weather forecast, molecular dynamics. Probably the only way to circumvent this extreme sensitivity, or computational impossibility, is to compromise with a probabilistic viewpoint by focusing our interest in the behaviors of an ensemble rather than a single system or a single trajectory. The strong discontinuities due to the extreme sensitivity therefore are smoothened out by the probabilistic averages. A deterministic chaos problem is thus transformed into a map between the probability information of the input and output. In this sense, we regain our predictability, though always attached with certain probability, dislike or not.

In this paper I want to discuss another type of chaos systems that even the above probabilistic approach might be not sufficient. For such a system, the probability information of the output is extremely sensitive to the probability information of the input, e.g. the mean or variance of an output is highly sensitive to a slight change of the probability density function of the input. This is doubly chaotic, and is completely different from the term "stochastic chaos" people normally use. It is therefore named as intrinsic stochastic chaos systems. Some formulation of these systems is developed in this study with possibly some examples provided. An important consequence for the possibility of such systems is that our probabilistic and reliability models, that all design codes/specifications based on, might need more rigorous certifications.