İTÜ Matematik Seminerleri

Seeing inside the black box: Large deviation theory and its applications

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Abstract

Large deviation theory (LDT) studies the occurrence of rare events in complex stochastic systems, and has applications to physics, biology, computer science, statistics, operations research, and finance, among other fields. As a branch of probability theory involving convex analysis and dynamical systems, LDT not only enables the computation of probabilities of atypical phenomena — state transitions, conformational changes, accidents, system failures, defaults, etc. — but it also sheds light on the unobservable scenarios behind the occurrence of such rare but critical events. The latter feature is analogous to "seeing inside the black box" and needs to be appropriately interpreted in each context.

In the first half of the talk, I will introduce the main concepts of LDT by illustrating them in the case of repeatedly rolling a die. In the second half, I will give a survey of the large deviation results for random walk in random environment (RWRE) which is a classical model of diffusion in heterogeneous media. My main goal is to explain how the walk and the environment conspire in the realization of atypical velocities. The answer turns out to depend on the dimension of the ambient space, and gives rise to many interesting phase transition questions from statistical mechanics. All of these questions contribute to our understanding of what is inside the black box in the context of RWRE.

[Partially based on joint works with Firas Rassoul-Agha & Timo Seppalainen, and with Ofer Zeitouni.]

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