A sample-path large deviation principle for dynamic Erdös-Rényi random graphs

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Abstract

In this talk, we consider dynamic Erdős-Rényi random graphs on n vertices in which each edge switches on at rate λ and switches off at rate μ independently of other edges. We work in the space of graphons, where our focus is on the evolution of the associated empirical graphon in the limit as $n \to \infty$. Our main result is a large deviation principle (LDP) for the sample path of the empirical graphon observed until a fixed time horizon. The rate of the LDP is $n(n-1)/2$ and the rate function is a specific action integral on the space of graphon trajectories. We apply the LDP to identify (i) the most likely path from a typical outcome of an Erdős-Rényi random graph at time 0 to a graph with an atypically large density of d-regular subgraphs at time T, and (ii) the most likely path between two given graphons. It turns out that the addition of dynamics leads to new phenomena which are caused by bifurcations that occur in the solutions of associated variational problems. The talk does not assume any prior knowledge of graphons or large deviation theory.