Understanding Rare But Catastrophic Events: Heavy-Tailed Large Deviations

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Abstract

Many rare events that arise in real-life applications exhibit heavy-tailed phenomena: for example, financial losses, delays in communication networks, and magnitudes of systemic events such as large-scale blackouts in power grids. While the theory of large deviations has been extremely successful in providing systematic tools for understanding rare events when the underlying uncertainties are light-tailed, the theory developed for the heavy-tailed counterparts has been mostly restricted to model-specific results or results pertaining to the events that are caused by a single big jump.

In this talk, I will discuss a new set of tools that go far beyond such restrictions. Our new large deviations results can deal with a very general class of rare events associated with heavy-tailed random walks and Levy processes. In particular, I will fully characterize the "catastrophe principle." I will illustrate the versatility of our approach with examples that arise in the context of mathematical finance, actuarial science, and queueing theory. Building on the sharp asymptotics provided by our new limit theorems, we will show how to construct simple, universal, and provably efficient rare-event simulation algorithms for heavy-tailed rare events, which has long been considered as one of the most challenging problems in the simulation literature.

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