UNIVERSITÀ DEGLI STUDI
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Dipartimento di Matematica

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Sharp large deviations in sequential inference

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In modern problems arising in probability and statistics, it is common to encounter sums of random variables sampled up to a stopping time T_u, namely S_{T_u} where $\lim_{u\to\infty} \frac{T_u}{u} = \tau$. When normalized by T_u,

$$\lim_{u\to\infty} \frac{S_{T_u}}{T_u} = \theta$$

in probability. We show that there exists a parameter τ_0 that describes the sharp expo- nential decay of $P(\frac{S_{T_u}}{T_u} \in B)$ for any Borel set B; namely,

$$P\left(\frac{S_{T_u}}{T_u} \in B\right) \sim u^{-\beta\tau_0} exp(-u\Gamma_{\tau_0}(B)) \quad \text{as} \quad u \to \infty,$$

for some large deviation rate function Γ_{τ_0}, where two different asymptotic regimes are possible depending on the value of τ_0. We use these results to derive the Gibbs conditioning principle, describing the evolutionary behavior of the random variables conditioned on these rare events. Our results can be applied to diverse problems in sequential inference, branching process, privacy, streaming data, and renewal processes arising in actuarial science. In sequential applications, these provide characterizations of the optimality properties of resulting confidence intervals and test statistics. (Joint work with Jeffrey Collamore.)

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