Optimal Sequential Hypothesis Testing with Costly Information Acquisition

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We study the sequential testing problem of two alternative hypotheses when observations are costly. Mathematically, we frame this as an optimal stopping problem in which the decision-maker aims to minimize classification errors plus a running cost proportional to the duration of information acquisition. By formulating a value function that captures both the expected decision risk and the running cost, we derive a set of variational inequalities that govern the evolution of the optimal strategy. Our analysis encompasses two different informational regimes: Gaussian and Poisson. We characterize the continuation regions within which further information collection is optimal and derive monotonicity properties with respect to different parameters, including the noise level, running cost, difference between the two hypotheses, and the relative importance of false positive and false negative errors. For Poisson signals, we utilize a diffusion approximation to study the asymptotic regime of frequent small jumps. Overall, our model advances understanding of how observation costs reshape classical sequential hypothesis testing. It also offers practical guidelines for designing adaptive and non-adaptive testing schemes in medicine, engineering, and related fields under real-world resource constraints.

In Special Session 61 on Recent Advances in Mathematical Finance and Related Fields at the Mathematical Congress of the Americas 2025.

MCA 2025 internal code: SS61-T01