Expediting a stochastic search process with non-instantaneous resetting

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Target search processes arise ubiquitously across all disciplines of science e.g. search for extremum in a potential landscape, protein search for DNA binding site, and animals searching for food or home, etc. to name a few. A natural question that arises in such a context is: what would be an ideal search strategy so that the process is completed in a shorter period? Lately, the strategy of 'stochastic resetting' has garnered considerable attention as one of the useful strategies to expedite a stochastic search process. Here, one intermittently terminates the search and restarts it back from where it originally started. Despite being counterintuitive at first glance, stochastic resetting indeed aids in facilitating a search process. Notably, most of the studies till now assume resetting to be an instantaneous event such that the searcher returns to the starting position in zero time. Although such assumptions are easier to work with in theory, for experimental validations this becomes a major hindrance since no physical event can be instantaneous. In our work, we have considered resetting to be a non-instantaneous event and furthermore, the searcher can also find the target during the return process. After developing a unified renewal formalism to treat a general stochastic search process with non-instantaneous return, we show that it is not only significant for practical implications but also serves as a superior strategy in expediting a search process compared to the classical instantaneous return.