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On the time dependent δ-shock model

One of the most popular ways to model an impact of a random environment on system's performance characteristics is via the external shocks that either cause certain damages or immediately result in failures. There is vast literature on this topic with respect to the relevant theoretical properties of the corresponding lifetime models as well as to the various practical applications. One of the widely discussed in the literature and relevant in practice shock models is the δ-shock model that is described by the constant time of a system's recovery after a shock. However, in practice, as time progresses and due to the deterioration of a system, this recovery time is gradually increasing. This important phenomenon was not discussed in the literature so far. Therefore, in this study, we are considering a time-dependent δ-shock model, i.e., the recovery time becomes an increasing function of time. Furthermore, in all studies, it is also assumed that shocks occur according to the HPP or NHPP processes, which is a rather stringent assumption in applications. This is because these stochastic processes are characterized by independent increments, whereas in reality, it is often not the case. Therefore, this assumption is made just for simplicity and mathematical tractability, which can result in substantial errors in assessing the impact of shocks on systems. To remove this limitation, we assume that shocks occur according to the generalized Polya process that contains the homogeneous Poisson process, the non-homogeneous Poisson process and the Polya process as particular cases. For the defined survival model, we derive the corresponding survival function and the mean lifetime and study the related optimal replacement policy along with some relevant stochastic properties.

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