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Discretization of the Gamma Process: Structural Properties and Reliability Applications

The discretization of the gamma process plays an important role in both theoretical investigations and practical implementations of stochastic modeling. The gamma process is a continuous-time, non-decreasing Lévy process with independent increments and is widely used in applications such as reliability engineering, survival analysis, and degradation modeling.

In practice, however, observed degradation data are often collected in a categorized or discretized form. In many engineering applications, the data must also be categorized in order to apply decision-making frameworks such as Markov decision processes (MDPs). For this reason, studying the discretized gamma process becomes essential for linking theoretical models with real-world data.

Discretization enables the approximation of continuous-time dynamics while attempting to preserve the key probabilistic properties of the original process. In particular, it is important to examine whether fundamental characteristics—such as the Markov property, independent increments, stationarity of increments, and infinite divisibility—are maintained after discretization. Understanding the preservation or alteration of these properties is crucial for ensuring model validity and analytical consistency.

Furthermore, analyzing these structural properties provides insight into transition behavior, dependence structure, and long-term dynamics, all of which directly influence statistical inference and predictive performance. Therefore, a rigorous study of the discretized gamma process and its characteristic properties serves as an important bridge between continuous-time stochastic theory and practical modeling applications. Additionally, the impact of this discretization will be investigated in the context of maintenance and reliability analysis, where degradation modeling plays a central role.

Primary author: MOSAYEBI OMSHI, Elham (University of Technology of Troyes)

Co-author: GRALL, Antoine (Universite de technologie de Troyes)

Presenter: MOSAYEBI OMSHI, Elham (University of Technology of Troyes)

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