Inhomogeneous hidden semi-Markov models for incompletely observed point processes

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Abstract

A general class of inhomogeneous hidden semi-Markov models (IHSMMs) is proposed for modelling partially observed processes that do not necessarily behave in a stationary and memoryless manner. The key feature of the proposed model is that the sojourn times of the states in the semi-Markov chain are time-dependent, making it an inhomogeneous semi-Markov chain. Conjectured consistency of the parameter estimators is checked by simulation study using direct numerical optimization of the log-likelihood function. The proposed models are applied to a global volcanic eruption catalogue to investigate the time-dependent incompleteness of the record by introducing a particular case of IHSMMs with time-dependent shifted Poisson state durations and a renewal process as the observed process. The Akaike Information Criterion and residual analysis are used to choose the best model. The selected IHSMM provides useful insights into the completeness of the global record of volcanic eruptions, demonstrating the effectiveness of this method.

Keywords Time-dependent missing data for point processes · Inhomogeneous semi-Markov chain · Residual analysis · Viterbi path · Global volcanic eruption record · Hazard

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