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Markov modulated Poisson process associated with state-dependent marks and its applications to the deep earthquakes

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Abstract In this paper, we introduce one type of Markov-Modulated Poisson Process (MMPP) whose arrival times are associated with state-dependent marks. Statistical inference problems including the derivation of the likelihood, parameter estimation through EM algorithm and statistical inference on the state process and the observed point process are addressed. A goodness-of-fit test is proposed for MMPP with state-dependent marks by utilizing the theories of rescaling marked point process. We also perform some numerical simulations to indicate the effects of different marks on the efficiencies and accuracies of MLE. The effects of the attached marks on the estimation tend to be weakened for increasing data sizes. Then we apply these methods to characterize the occurrence patterns of New Zealand deep earthquakes through a second-order MMPP with state-dependent marks. In this model, the occurrence times and magnitudes of the deep earthquakes are associated with two levels of seismicity which evolves in terms of an unobservable two-state Markov chain.

Keywords MMPP · Hidden Markov model · EM algorithm · Exponential family · New Zealand deep earthquakes · Marked point process