SECOND EUROPEAN CONFERENCE ON EARTHQUAKE ENGINEERING
AND SEISMOLOGY, ISTANBUL AUG. 25-29, 2014

STATISTICAL MODELLING FOR IDENTIFICATION OF EARTHQUAKE CLUSTERS

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It is widely recognized that earthquake clustering is a main feature of the seismicity and a seismic area can be affected by different types of earthquake clusters, such as aftershock sequences and swarms, due to its peculiar tectonic and volcanic environments. Different occurrence rates are expected to be observed in a sufficiently long period, each corresponding to and characterizing a different type of earthquake clusters.

In this study we propose a probabilistic approach to model different types of earthquake clusters, also named states of the system, in order to identify and quantify them. To this end, we assume a state-space model (X,Y) in which the states of the hidden (unobserved) process X drive different realizations of the observed process Y.

The earthquakes (observations) are first associated with a state and, conditioned on that state, follow an ETAS (Epidemic-Type Afetrshock-Sequence) point process. The hidden state process X is assumed to be a pure jump Markov process and the hazard function $\lambda(t|H_t)$ of the observed process Y is given by the following relation:

$$\lambda(t|H_t) = \sum_{s\in S} \lambda_s(t|H_t)\delta_s(X_t) \ . \qquad (1)$$

where $\delta_s(X_t)=1$ if $X_t = s$ and $\delta_s(X_t)=0$ otherwise.

The problem of the likelihood approximation is solved by particle filtering technique and parameter estimation is dealt with by Markov Chain Monte Carlo method in the Bayesian framework.

We analyse two earthquake sequences: the former occurred off the east coast of Izu Peninsula (Japan) in 1998 and the latter started in 2011, a week after the Tohoku-Oki earthquake, Northwest of Lake Inawashiro.

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