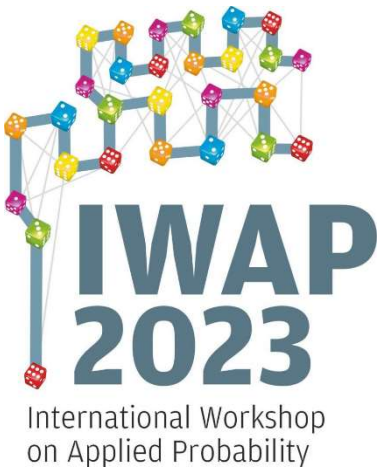
Book of Abstracts

10th International Workshop on Applied Probability

IWAP 2023



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7-10 June 2023

Thessaloniki, Greece

10th International Workshop on Applied Probability

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The Aristotle University of Thessaloniki

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Seismic sequences identification in Italy by local test of random labelling

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In this work, we present a study on a seismic spatial point pattern with functional marks provided by seismic waveforms.

Indeed, earthquakes can be characterized both by the spatio-temporal hypocentre locations and by the waveform associated with each event and the integration of these two sources of information is crucial to understand the nature of the generating seismic event.

However, despite the relatively long history of point process theory, few approaches to analyzing spatial or spatio-temporal point patterns where the features of interest are functions (i.e. curves) rather than qualitative or quantitative variables have been developed.

With this aims in mind, we present a family of local inhomogeneous mark-weighted summary statistics for general marked point processes, to capture various types of local dependence structures depending on the specified involved weight function.

We use such summary statistics to propose a local random labelling test. This procedure enables us to identify points and thus regions where the random labelling assumption does not hold, for example, when the functional marks (waveforms) are spatially dependent.

In particular, we analyse Italian earthquake data coming from the ISTANCE dataset, that is a sample dataset provided at http://www.pi.ingv.it/instance/, containing 10000 records of 300 events, together with the associated metadata.

The observed point pattern consists of 300 seismic events which occurred in a period ranging from 21st July 2012 to the 9th December 2016. The observation area is [6.729,18.002] x[36.64,46.46], including also seismic events occurring around Italy.

They tend to gather into two main clusters. The northernmost originated in May 2012, when two major earthquakes struck Northern Italy, causing 27 deaths and widespread damage. The events are known in Italy as the 2012 Emilia earthquakes, because they mainly affected the Emilia region. Then, Central Italy seismic sequence began in August 2016, and it is now defined by the INGV as the Amatrice-Norcia-Visso seismic sequence.

As a result of the application of our proposed local test, we are able to correctly identify seismic events belonging to important well known Italian seismic sequences. On the other hand, we find that the shocks related to these sequences are likely generated by different underlying processes, corresponding to different seismic sources. The significant events coincide with the aftershocks, triggered by some mainshocks previously occurred.

Founding

This work was supported by the PNRR project "Growing Resilient, INclusive and Sustainable - GRINS" Spoke 06: UNIPD "Low Carbon Policies".