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Earthquake interevent time distributions reflect the proportion of dependent and independent events pairs and are therefore not universal

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Seismic activity is routinely quantified using event rates or their inverse, interevent times, which are more stable to extreme events [1].
It is common practice to model regional earthquake interevent times using a gamma distribution [2]. However, the use of this gamma distribution is empirically based, not physical. Our recent work has shown that the gamma distribution is an approximation that drops out of a physically based model after the commonly applied filtering of the raw data [3]. We show that in general, interevent time distributions have a fundamentally bimodal shape caused by the mixing of two contributions: correlated aftershocks, which have short interevent times and produce a gamma distribution; and independent events, which tend to be separated by longer intervals and are described by a Poisson distribution. The power-law segment of the gamma distribution arises at the cross over between these distributions. This physically based model is transferable to other fields to explain the form of cascading interevent time series with varying proportions of independent and dependent daughter events.
We have found that when the independent or background rate of earthquakes is high, as is the case for earthquake catalogues spanning large regions, significant overlapping of separate aftershock sequences within the time series "masks" the effects of these aftershock sequences on the temporal statistics. The time series qualitatively appears more random; this is confirmed in the interevent time distribution, in the convergence of the mean interevent time, and in the poor performance of temporal ETAS parameter inversions on synthetic catalogues within this regime [4]. The aftershock-triggering characteristics within the data are thus hidden from observation in the time series by a high independent rate of events; spatial information about event occurrence is needed in this case to uncover the triggering structure in the data.
We show that earthquake interevent time data from the Kilauea volcano can be explained by this physical model and demonstrate that the form of the interevent time distributions separated in space reflect the diversity of processes across the volcano [5].

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[5] A. Bell, S. Touati, M. Naylor and I. Main, (Submitted) The structure of earthquake interevent-time distributions at Kilauea volcano, Hawaii