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On magnitude dependence in earthquake clustering

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Abstract

Whether successive earthquake magnitudes are correlated—a putative magnitude dependence within clustered seismicity—remains a fundamental question with direct implications for forecasting frameworks such as ETAS. Addressing this, we deploy two complementary tests. First, we perform stochastic declustering under the ETAS model to reconstruct parent–offspring relationships and restrict inference to events above the magnitude of completeness. Second, we introduce an information-theoretic neural approach: a history-dependent modulated neural network (MNN) contrasted with a history-independent NN, and evaluate per-event information gain (PEIG); positive log-likelihood gains would indicate predictive value from past magnitudes.

Across both stochastic-declustering and neural network tests, we find no statistically significant evidence of magnitude dependence in clustered seismicity once catalog incompleteness is controlled, suggesting that forecast models need not assume such dependence.