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Iterative Strategies for Aftershock Classification in Automatic Seismic Processing Pipelines

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Aftershock sequences following very large earthquakes present enormous challenges to near-realtime generation of seismic bulletins. The increase in analyst resources needed to relocate an inflated number of events is compounded by failures of phase association algorithms and a significant deterioration in the quality of underlying fully automatic event bulletins. Current processing pipelines were designed a generation ago and, due to computational limitations of the time, are usually limited to single passes over the raw data. With current processing capability, multiple passes over the data are feasible. Processing the raw data at each station currently generates parametric data streams which are then scanned by a phase association algorithm to form event hypotheses. We consider the scenario where a large earthquake has occurred and propose to define a region of likely aftershock activity in which events are detected and accurately located using a separate specially targeted semi-automatic process. This effort may focus on so-called pattern detectors, but here we demonstrate a more general grid search algorithm which may cover wider source regions without requiring waveform similarity. Given many well-located aftershocks within our source region, we may remove all associated phases from the original detection lists prior to a new iteration of the phase association algorithm. We provide a proof-of-concept example for the 2015 Gorkha sequence, Nepal, recorded on seismic arrays of the International Monitoring System. Even with very conservative conditions for defining event hypotheses within the aftershock source region, we can automatically remove over half of the original detections which could have been generated by Nepal earthquakes and reduce the likelihood of false associations and spurious event hypotheses. Further reductions in the number of detections in the parametric data streams are likely using correlation and subspace detectors and/or empirical matched field processing.