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The Terracorrelator: a shared memory HPC facility for real-time seismological cross-correlation analyses

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Earthquakes and volcanic eruptions may in some instances be preceded or accompanied by changes in the geophysical properties of the Earth, such as seismic velocities or event rates. The development of reliable probabilistic forecasting methods for these hazards requires real-time analysis of seismic data and truly prospective forecasting and testing to reduce bias. However, potential forecasting techniques, including seismic interferometry and earthquake "repeater" analysis, require a large number of waveform cross-correlations; this is computationally intensive, and is particularly challenging in real-time.

Here we describe the "Terracorrelator", a new high performance computing facility at the University of Edinburgh designed for real-time cross-correlational analyses. The machine consists of two 2TB shared memory nodes for cross-correlation and post-processing, and two Intel Xeon Phi nodes for pre-processing. The Terracorrelator has been tested on a seismic interferometry case study using ObsPy for seismic operations and processing, and Dispel4Py for writing and executing the workflow. The workflow is distributed automatically for parallel processing in a shared memory multicore environment.

Preliminary results have demonstrated that data from 1000 seismic stations can be pre-processed, and each station cross-correlated with all others (499500 cross-correlations) in hourly or daily intervals sufficiently quickly to keep ahead of new data arriving, on one of the shared memory nodes. The second node is therefore free to perform interpretative analysis on the outputs, for example to look at changes in the resulting correlations.

These promising results suggest that it will be possible to undertake real-time interferometric analysis using Sure$\sim$1000 stations, and to test the predictive power of current seismic velocity changes for future hazard occurrence.