Gisola: Real-Time Moment Tensor computation optimized for multicore and manycore architectures

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Automatic Moment Tensor (MT) determination for regional areas is essential for real-time seismological applications such as stress inversion, shakemap generation, and tsunami warning. In recent years, the combination of two powerful tools, SeisComP and ISOLA (Sokos and Zahradník, 2008), paved the way for the release of Scisola (Triantafyllis et al., 2016), an open-source Python-based software for automatic MT calculation of seismic events provided by SeisComP -a well-known software package-, in real-time. ISOLA is an extensively used manual MT retrieval utility, based on multiple-point source representation and iterative deconvolution, full wavefield is taken into consideration and Green's functions are calculated with the discrete wavenumber method as implemented in the Axitra Fortran code (Cotton and Coutant, 1997). MT of subevents is found by least-square minimization of misfit between observed and synthetic waveforms, while position and time of subevents is optimized through grid search. Scisola monitors SeisComP and passes the event information, the respective waveform data and the station information to the ISOLA software for the Green's Functions and MT computation. Gisola is a highly evolved version of Scisola software, oriented for High-Performance Computing. Unlike Scisola, the new program applies enhanced algorithms for waveform data filtering via quality metrics such as signal-to-noise ratio, waveform clipping, data and meta-data inconsistency, long-period ("mouse") disturbances, and current station evaluation based on comparison between its daily Power Spectral Density (PSD) and various reference metrics for the frequency bands of interest, featuring a CPU multiprocessing implementation for faster calculations. Concerning the Green's Functions computation, Gisola operates a newer version of the Axitra, highlighting the power of simultaneous processing in the CPU domain. Likewise, the inversion procedure code has been intensively improved by exploiting the performance efficiency of GPU-based multiprocessing implementation (with an automatic fallback to CPU-based multiprocessing in case of GPU hardware absence) and by unifying sub-programs to minimize I/O operations. In addition, a fine-grained 4D (space-time) adjustable source grid search is available for more accurate MT solutions.

Moreover, Gisola expands its seismic data input resources by interconnecting to the FDSN Web Services. Furthermore, the new software has the ability to export the results in the well-known QuakeML standard, and in this way, provide clients -such as SeisComP- with MT results attached to the seismic event information. Finally, the operator has full control of all calculation aspects, with an extensive and adapted to regional data, configuration. The program can be installed on any computer that operates a Linux OS and has access to the FDSN Web Services, while the source code will be open and free to the scientific community.

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Sokos, E. N., and J. Zahradník (2008). ISOLA a FORTRAN code and a MATLAB GUI to perform multiple-point source inversion of seismic data, Comp. Geosci. 34, no. 8, 967–977, doi: 10.1016/j.cageo.2007.07.005.

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