A SOFTWARE FOR THE PROCESSING OF THE WAVEFORMS OF THE ITALIAN STRONG MOTION DATABASE

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It is important for users of strong-motion data to understand that digitized accelerograms are not the exact reproductions of the ground motion, as, for a variety of reasons, they contain noise at both high and low frequencies. Purpose of processing accelerograms is to estimate the level of noise present and the extent this may affect different parameters that are derived from the records for a particular application. Generally it is not possible to identify the 'best' processing for an individual record, as assumptions always need to be made and a certain degree of subjectivity is involved.

A processing procedure for strong motion data, that takes into account the outcomes of recent research (Boore and Akkar, 2003; Boore and Bommer, 2005; Boore, 2005; Boore et al, 2012) has been developed by Paolucci et al (2011) for the processing of the waveforms contained in the Italian strong motion database (ITACA, itaca.mi.ingv.it) and to ensure compatibility of corrected records, i.e., velocity and displacement traces obtained by the first and second integral of the corrected acceleration should not be affected by unrealistic trends.

This procedure includes:

- baseline correction (constant de-trending);
- application of a cosine taper (typically between 2% and 5% of the total record length) - records identified as late-triggered are not tapered at the beginning;
- visual inspection of the Fourier spectrum to select the band-pass frequency range; the same range is selected for the 3-components unless it is not feasible;
- adding of zero pads;
- application of a 2nd order two-pass time-domain a causal Butterworth filter to the acceleration time-series;
- double-integration to obtain displacement time series;
- zero-pads removal and subsequent tapering of displacement and velocity, in order to have zero initial conditions; for late-triggered records, no taper is applied and zero-pads are kept;
- linear de-trending of displacement;
- double-differentiation to get the corrected acceleration.

The Italian strong-motion database ITACA (Italian ACcelerometric Archive v. 2.0, http://itaca.mi.ingv.it) contains about 7500 processed waveforms and the database is growing at faster

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speed than previous years, as it collects accelerometric data of all the main seismic monitoring networks in Italy. Therefore there is the need of a centralized system for waveform processing that allows different ITACA operators to access waveforms directly from the database and to perform the processing from their workstation. Operators can now use a web-based Graphical User Interface (GUI) to process raw data and store the processed waveforms directly in the database together with the relevant strong motion parameters. The web GUI is a frontend to an underlying software (a command line tool written in Python) that has been developed to allow waveform processing according to the Paolucci et al (2011) procedure.

As several ITACA users employ waveforms for research, included numerical simulations, they might be interested in process by themselves the signals in order to constrain the frequency content in relation to the model in hand, extract portions of the signal, or resample it in order to limit the computational effort.

Therefore the web page for waveform processing, http://dyna.mi.ingv.it/processing/ (Figure 1), has become publicly accessible. External users should register in order to obtain an unprivileged account with the rights to access all waveforms in the database, select waveforms, do their own processing and save the processed waveforms on their own personal computer.
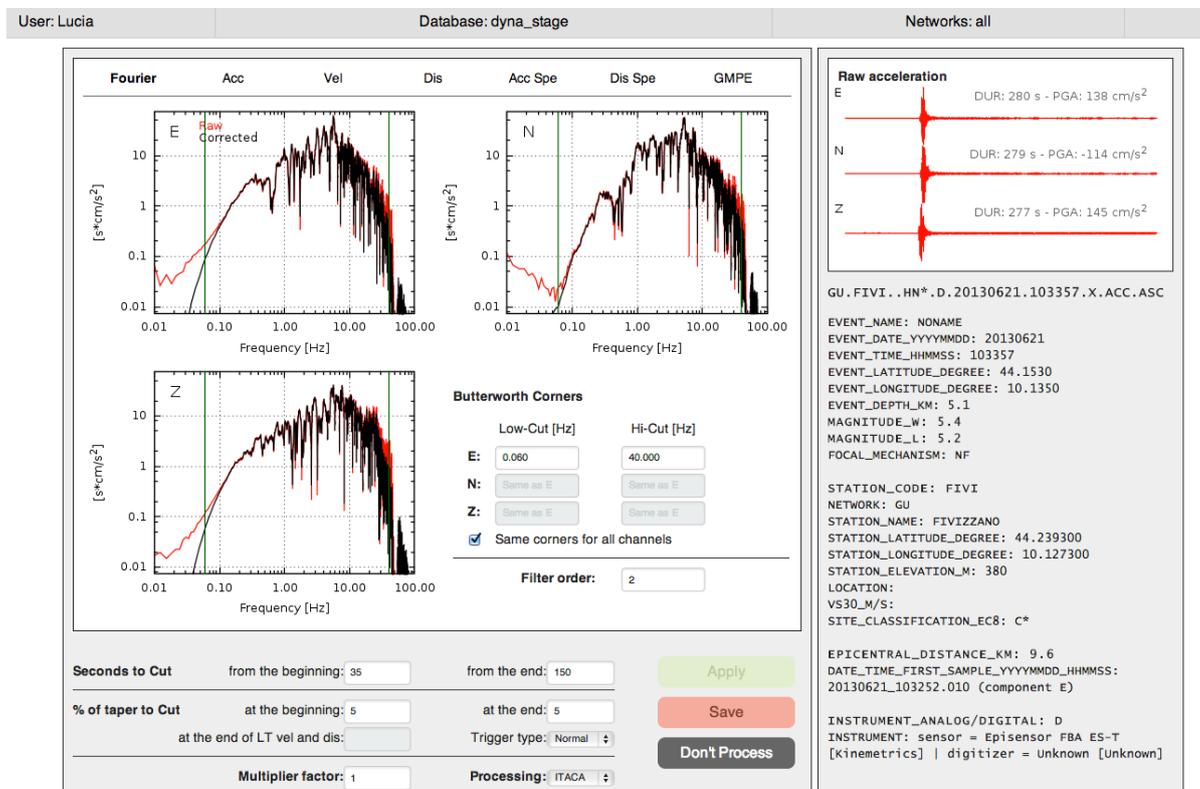

Figure 1. ITACA processing software interface

REFERENCES

Boore D M, and Akkar S. (2003) "Effect of causal and acausal filters on elastic and inelastic response spectra", *Earthquake Engng Struct. Dyn.*, 32(11), 1729–1748, doi:10.1002/eqe.299

Boore D M, and Bommer J J (2005) "Processing of strong-motion accelerograms: needs, options and consequences", *Soil Dynamics and Earthquake Engineering*, 25, 93–115, doi:10.1016/j.soildyn.2004.10.007

Boore D M (2005) "On Pads and Filters: Processing Strong-Motion Data", *Bull. Seism. Soc. Am.*, 95(2), 745–750

Boore D M, Azari Sisi A., Akkar S. (2012) "Using Pad-Stripped Acausally Filtered Strong-Motion Data", *Bull. Seism. Soc. Am.*, 102(2), 751–760, doi:10.1785/0120110222

Paolucci R , Pacor F, Puglia R, Ameri G, Cauzzi C, Massa M. (2011) "Record processing in ITACA, the new Italian strong-motion database". In: Akkar S, Gulkan P, Van Eck T (eds) Earthquake data in engineering seismology. Predictive models, data management and networks, Geotechnical, Geological and Earthquake Engineering series, Vol. 14, Chapter 8. Springer, 99–113