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A new tool for rapid and automatic estimation of earthquake source parameters and generation of seismic bulletins

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RISS S.r.l. is a Spin-off company recently born from the initiative of the research group constituting the Seismology Laboratory of the Department of Physics of the University of Naples Federico II. RISS is an innovative start-up, based on the decade-long experience in earthquake monitoring systems and seismic data analysis of its members and has the major goal to transform the most recent innovations of the scientific research into technological products and prototypes. With this aim, RISS has recently started the development of a new software, which is an elegant solution to manage and analyse seismic data and to create automatic earthquake bulletins. The software has been initially developed to manage data recorded at the ISNet network (Irpinia Seismic Network), which is a network of seismic stations deployed in Southern Apennines along the active fault system responsible for the 1980, November 23, MS 6.9 Irpinia earthquake. The software, however, is fully exportable and can be used to manage data from different networks, with any kind of station geometry or network configuration and is able to provide reliable estimates of earthquake source parameters, whichever is the background seismicity level of the area of interest.

Here we present the real-time automated procedures and the analyses performed by the software package, which is essentially a chain of different modules, each of them aimed at the automatic computation of a specific source parameter. The P-wave arrival times are first detected on the real-time streaming of data and then the software performs the phase association and earthquake binding. As soon as an event is automatically detected by the binder, the earthquake location coordinates and the origin time are rapidly estimated, using a probabilistic, non-linear, exploration algorithm. Then, the software is able to automatically provide three different magnitude estimates. First, the local magnitude (Ml) is computed, using the peak-to-peak amplitude of the equivalent Wood-Anderson displacement recordings. The moment magnitude (Mw) is then estimated from the inversion of displacement spectra. The duration magnitude (Md) is rapidly computed, based on a simple and automatic measurement of the seismic wave coda duration. Starting from the magnitude estimates, other relevant pieces of information are also computed, such as the corner frequency, the seismic moment, the source radius and the seismic energy. The ground-shaking maps on a Google map are produced, for peak ground acceleration (PGA), peak ground velocity (PGV) and instrumental intensity (in SHAKEMAP® format), or a plot of the measured peak ground values. Furthermore, based on a specific decisional scheme, the automatic discrimination between local earthquakes occurred within the network and regional/teleseismic events occurred outside the network is performed. Finally, for largest events, if a consistent number of P-wave polarity reading are available, the focal mechanism is also computed.
For each event, all of the available pieces of information are stored in a local database and the results of the automatic analyses are published on an interactive web page. “The Bulletin” shows a map with event location and stations, as well as a table listing all the events, with the associated parameters. The catalogue fields are the event ID, the origin date and time, latitude, longitude, depth, Ml, Mw, Md, the number of triggered stations, the S-displacement spectra, and shaking maps. Some of these entries also provide additional information, such as the focal mechanism (when available). The picked traces are uploaded in the database and from the web interface of the Bulletin the traces can be download for more specific analysis.

This innovative software represents a smart solution, with a friendly and interactive interface, for high-level analysis of seismic data analysis and it may represent a relevant tool not only for seismologists, but also for non-expert external users who are interested in the seismological data. The software is a valid tool for the automatic analysis of the background seismicity at different time scales and can be a relevant tool for the monitoring of both natural and induced seismicity.