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Automatic seismic phase picking and weighting at national and regional scales

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The fast increasing size of seismogram databases creates an ever increasing need for reliable automatic picking methods in seismological projects involving medium- to large-size datasets. In order to improve the consistency of seismic phases at national and European scales, single-trace automatic picking methods can be used at some stage. It is however of paramount importance for high-quality studies such as those leading to Reference Models to appropriately address the quality-weighting of arrival times. Furthermore, since the true uncertainty on any arrival time is a time interval, arrival times should always be reported with picking weights clearly related to well-defined uncertainty intervals. Despite the abundant literature devoted to picking algorithms, the difficult problem of automatically estimating such true picking uncertainties has received very little attention until now.

MannekenPix (MPX) is a single-trace automatic picking system for events recorded at local, regional and teleseismic distances. Most automatic picks produced by the program are comparable to those of an expert seismologist. MPX includes also an advanced weighting engine rigorously calibrated on reference picks and true uncertainty classes provided by the user. For each automatic pick, the weighting engine of MPX attempts to predict the same true uncertainty class as the one that would be estimated by an expert seismologist. As such and as a whole, MPX acts as a consistent extension of manual picking and not as a totally new method possibly in conflict with the legacy.

The application of MPX to the very large database of seismograms recorded in Italy between 1988 and 2002 has yielded 81,256 P-picks and related picking uncertainties

from about 7,878 well-constrained events. With a hit rate of 78 percent with respect to shifts performing the INGV routine analysis, MPX arrival times, picking weights and polarities are very consistent and could substitute bulletin data. Results suggest that 1-D locations and in particular hypocentral depths derived from MPX arrival times are more accurate than those derived from INGV bulletin data. The use of MPX allowed also to enhance the resolution and the depth range of P-wave traveltime tomographic studies performed at the scale of the entire Italian peninsula.

Finally, we present automatic picking results derived from a large database of local earthquakes recorded by regional, national and temporary networks operating within the Alpine region. The main goal of this project is to improve the knowledge of Alpine lithosphere through 3-D traveltime tomography of S-waves. We present the automatic picking of P-waves by MPX for this dataset. The automatic picking of S-waves will be performed by MPX as the next step of the project.