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Towards a new semi-automated consistent multiphase picking algorithm for local and regional seismic networks

Matteo Bagagli (1), Irene Molinari (1,3), Tobias Diehl (2), Edi Kissling (1), and AlpArray Working Group ()

(1) ETH-Zürich, Institute of Geophysics, D-ERDW, Zürich, Switzerland (matteo.bagagli@erdw.ethz.ch), (2) ETH-Zürich, Swiss Seismological Service (SED), Zürich, Switzerland, (3) Istituto Nazionale di Geofisica e Vulcanologia (INGV), Sezione di Bologna, Bologna, Italy

Recent passive seismological experiments like AlpArray (www.alparray.ethz.ch) will provide >15 Tb of data annually derived from more than 600 temporary and permanent broadband stations. Such big dataset opens new challenges to consistently asses P- and S- phases to establish a uniformly high quality regional seismic catalogue. Consistent earthquake catalogues are of crucial importance for many regional-scale seismic studies (i.e. traveltime-tomography, seismic hazard analysis) where a simple merging of several national earthquake bulletins often introduces mismatches of earthquakes and other inconsistencies.

The quality of a regional travel-time data primarily depends on consistency in arrival time picking, phase identification and their uncertainty estimates. While there exist several number of automated first arrival time pickers and just a few with timing uncertainty estimates, the phase identification is usually checked by hand. Here we propose a semi-automated procedure consisting of a precise timing onset definition algorithm, efficient phase identification decision making algorithm and consistent uncertainties estimation for the picked phase arrivals. In this work we approach this challenging task by creating a Python-based framework that includes a few well established picker algorithms and stable Python libraries for machine learning classification problems. The core of this procedure called QUAKE is represented by a MultiPicker class object where several pickers (i.e. Baer-Kradolfer, AIC, HOS) are applied to the waveforms with different slicing windows around a phase-prediction associated time. With this algorithm, we want to include a phase prediction analysis for a layered 1D velocity model with a multiple picking evaluation step, which is combined with machine learning classification algorithms to automatically assess phase-recognition and timing uncertainties.

The automated picking procedure QUAKE is tuned with the help of a representative reference data set hand-picked by an expert seismologist. Final automatic picking results (arrival times, phase identifications and respective uncertainty estimates) are compared with the reference information and statistical analysis is pursued to validate the algorithm efficiency. Preliminary results suggest that the proposed algorithm provides reliable first-arriving P- and S-phase arrivals information and aims to recover also the most prominent secondary crustal P-phases. Even though under development, the framework shows encouraging preliminary results that will contribute to improve automatic picking procedures at a regional scale. The QUAKE picking procedure is therefore suitable for processing the entire AlpArray data set, and will be used to produce the earthquake research catalog (see abstract of Molinari et al., 2019).