Development of an adaptive multi-method algorithm for automatic picking of first arrival times: application to near surface seismic data

Amin Khalaf [1], Christian Camerlynck [1], Ana Schneider [1], Nicolas Florsch [1,2]

[1] Sorbonne Universités, UPMC, UMR 7619 METIS.
[2] Sorbonne Universités, UPMC, UMI 209 UMMISCO.

Contact: amin.khalaf@upmc.fr

Abstract:

Accurate picking of first arrival times plays an important role in many seismic studies, particularly in seismic tomography and reservoirs or aquifers monitoring. Many techniques have been developed for picking first arrivals automatically or semi-automatically, but most of them were developed for seismological purposes which does not attain the accuracy objectives due to the complexity of near surface structures, and to usual low signal-to-noise ratio. We propose a new adaptive algorithm for near surface data based on three picking methods, combining multi-nested windows (MNW), Higher Order Statistics (HOS), and Akaike Information Criterion (AIC). They exploit the benefits of integrating many properties, which reveal the presence of first arrivals, to provide an efficient and robust first arrivals picking. This strategy mimics the human first-break picking, where at the beginning the global trend is defined. Then the exact first-breaks are searched in the vicinity of the now defined trend. In a multistage algorithm, three successive phases are launched, where each of them characterize a specific signal property. Within each phase, the potential picks and their error range are automatically estimated, and then used sequentially as leader in the following phase picking. The accuracy and robustness of the implemented algorithm are successfully validated on synthetic and real data which have special challenges for automatic pickers. The comparison of resulting P-wave arrival times with those picked manually, and other algorithms of automatic picking, demonstrated the reliable performance of the new scheme under different noisy conditions. All parameters of our multi-method algorithm are auto-adaptive thanks to the integration in series of each sub-algorithm results in the flow. Hence, it is nearly a parameter-free algorithm, which is straightforward to implement and demands low computational resources.