EGU23-15180, updated on 23 Mar 2023
https://doi.org/10.5194/egusphere-egu23-15180
EGU General Assembly 2023

An automated earthquake detection algorithm by combining pair-input deep learning and migration location methods

Hamzeh Mohammadigheymasi[1], Nasrin Tavakolizadeh[2], Peidong Shi[3], Zhuowei Xiao[4], S. Mostafa Mousavi[5], and Rui Fernandes[1]

[1]Universidade da Beira Interior , Dom Luiz Institute, Computer sciences, Portugal (hamzeh@ubi.pt)
[2]Universidade da Beira Interior, Computer sciences Department, Portugal
[3]Swiss Seismological Service, ETH-Zurich, Zurich, Switzerland
[4]Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China
[5]Department of Geophysics, University of Stanford, California, United States

Modern seismology can benefit from a rapid and reliable earthquake catalog preparation process. In recent years Deep Learning (DL)-based methods attracted seismologists' attention to keep up with the constantly increasing seismic data for maximally processing and locating the recorded events. This study focuses on deploying an optimized workflow that integrates DL and waveform migration algorithms to achieve a comprehensive automated phase detection and earthquake location workflow. The goal is to deeply scan the seismic datasets for Pand S- phases, associate and locate the detected events, and improve the performance of DL algorithms in processing out-of-distribution and low signal-to-noise ratio data. The workflow consists of six steps, including the preparation of one-minute data segments by employing the framework of ObsPy, deep investigation of the recorded data for P- and S- phases by a low threshold EQTransformer (EQT), and a pair-input Siamese EQTransformer (S-EQT), phase association by Rapid Earthquake Association and Location (REAL) method, applying MIgration Location (MIL) to accurately locate the outputs of REAL, and calculating the local magnitude of the located earthquakes. Eighteen months of the Ghana Digital Seismic Network (GHDSN) dataset (2012-2014), is processed by this integrated and automatic workflow, and a catalog of 461 earthquakes is acquired. Although S-EQT and EQT, with the respective number of 758 and 423 earthquakes, show a figurative superiority in the number of detected events, they are scattered with inaccurate hypo-central depth. Conversely, the compiled catalog show high accordance with the previously interpreted seismogenic sources by Mohammadigheymasi et al. (2023), and a new seismogenic source is also delineated. This workflow significantly enhanced the seismic catalog compilation process and lowered the computational costs while increasing the accuracy of phase detection, association, and location processes. This work was supported by the European Union and the Instituto Dom Luiz(IDL) Project under Grant UIDB/50019/2020, and it uses computational resources provided by C4G (Collaboratory for Geosciences) (Ref. PINFRA/22151/2016). P. S. is supported by the DEEP project (http://deepgeothermal.org) funded through the ERANET CofundGEOTHERMICA (Project No. 200320-4001) from the European Commission. The DEEP project benefits from an exploration subsidy of the Swiss federal office of energy for the EGSgeothermal project in Haute-Sorne, canton of Jura (contract number MF-021-GEO-ERK), which is gratefully acknowledged.