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# Towards Real-Time Moment Tensor Inversions in a Data Rich Micro-Seismic Environment using Deep Learning

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Despite advanced seismological methods, source characterization for micro-seismic events remains challenging since current inversion and modelling of high-frequency waveforms are complex and time consuming. For a real-time application like induced-seismicity monitoring, these methods are slow for true real-time information because they require repeated evaluation of the often computationally expensive forward operation. Moreover, because of the low amplitude and high-frequency content of the recorded micro-seismic signals, routine inversion procedure can become unstable and manual parameter tuning is often required. Therefore, real-time and automatic source inversion procedures are difficult and not standard. A more promising alternative to the current inversion methods for rapid source parameter inversion is to use a deep-learning neural network model that is calibrated on a data set of past and/or possible future observations. Such data-driven model, once trained, offers the potential for rapid real-time information on seismic sources in a monitoring context.

In this study, we investigate how a supervised deep-learning model trained on a data set of synthetic seismograms can be used to rapidly invert for source parameters. The inversion is represented in compact form by a convolutional neural network which yields seismic moment tensor. In other words, a neural-network algorithm is trained to encapsulate the information about the relationship between observations and underlying point-source models. The learning-based model allows rapid inversion once seismic waveforms are available. Moreover, we find that the method is robust with respect to perturbations such as observational noise and missing data. In this study, we seek to demonstrate that this approach is viable for micro-seismicity real-time estimation of source parameters. As a demonstration test, we plan to apply the new approach to data collected at the geothermal field system in the Hengill area, Iceland, within the framework of the COSEISMIQ project funded through the EU GEOTHERMICA programme.