Seismological stations around the world record 3 components particle motion – usually at 100Hz sampling rate.

An earthquake (EQ) radiates elastic waves in the earth that are picked on these seismometers. “P” / compressional waves arrive first, “S” / shear second. Surface waves (Rayleigh/ love) are also recorded.

Typically, arrival of EQ waves will be picked at several stations – and then inversion of the travel time is performed to locate the EQ and estimate its magnitude. Picking the wave arrival at one station is thus routine – this is performed automatically by a number of algorithm (from simple thresholding, to more complex STA/SLA algorithms ) . Usually, after seismologist do QC and sometimes/always re-pick some arrivals “manually” (when more in the noise).

Can ML help? i.e. harvest more EQ (of smaller size , buried in noise )

ML recent papers

[T. Perol, M. Gharbi, and M. Denolle. Convolutional neural network for earthquake detection and location*. Science Advances*, 4(2):e1700578, 2018.]

Kong, Q., Trugman, D. T., Ross, Z. E., Bianco, M. J., Meade, B. J., & Gerstoft, P. (2018). Machine learning in seismology: Turning data into insights. *Seismological Research Letters*, *90*(1), 3-14.

A general introduction /in depth textbook on seismology

S. Stein and M. Wysession. *An introduction to seismology, earthquakes, and earth structure*. John Wiley & Sons, 2009.

P. M. Shearer. *Introduction to seismology*. Cambridge University Press, 2009.

Note that EQ of multiple sizes occur – and obeys the Gutemberg-Richter law ,i.e. relation between Magnitude of an EQ and Occurrence. (<https://en.wikipedia.org/wiki/Gutenberg%E2%80%93Richter_law>)

MicroEQ also occurs in the lab – same physics / different frequencies – we are in the process of finalizing our acquisition system for such passive recording. -> we do not have a catalog yet -> hence we suggest to focus on seismological records following the approach developed in Perol et al.

**Access to seismological data**

Raw waveform of stations – mostly from fdsn.org but also

<https://service.iris.edu/irisws/fedcatalog/1/>

<http://www.orfeus-eu.org/data/eida/webservices/routing/>

<https://www.ncedc.org/index.html>

<https://scedc.caltech.edu/>

which probably redirect to fdsn.org

Oklahoma:

<https://www.fdsn.org/networks/detail/GS/> ( this is the temp network - then focus on OK for more stations)

<https://www.fdsn.org/networks/detail/OK/>

SED / CH network

<http://networks.seismo.ethz.ch/networks/ch/>

**EQ catalog (this is the classified data)**

usgs

<https://earthquake.usgs.gov/earthquakes/search/>

international big ones

<http://www.isc.ac.uk/iscgem/overview.php>

north cal

<https://www.ncedc.org/index.html>

south cal

<https://scedc.caltech.edu/>

Oklahoma

<http://www.ou.edu/ogs/research/earthquakes/catalogs>