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Pattern recognition of Seismic Activity in Indonesia through Deep Learning

Nishtha Srivastava[1], Kai Zhou[1,2], Jan Steinheimer[1,2], Johannes Faber[1,2], and Horst Stoecker[1,2,3]
[1]Frankfurt Institute for Advanced Studies, Germany (srivastava@fias.uni-frankfurt.de)
[2]Institute of Theoretical Physics, Goethe University
[3]GSI Darmstadt

Earthquakes have disastrously impacted communities by destructing the buildings and infrastructure and creating substantial setbacks in the socio-economic development of a region in addition to the huge human loss. They are inevitable and considered extremely difficult to predict. Earthquake prediction research is being carried out for more than 100 years with no well acknowledged model achieved till date. However, the analysis of past seismic stress history of an active fault may help in understanding the stress build up and the local breaking points of the faults. Yet, analysing and interpreting the abundant seismological dataset is most time consuming and is a herculean task.

The possibilities to solve big data, complex problems with Deep Learning are undeniable, however, it's usage in Seismology is still in its early stage. The implementation of Deep Learning algorithms has the potential to decipher the complex patterns and hidden information in past stress history that is nearly impossible for scientists. The careful implementation of various Deep Learning algorithms in the exponentially growing seismic data can significantly improve the Early Warning System. In the present study, we train a time efficient machine/deep learning algorithm to self-learn and decode the intricate stress accumulation and release pattern, to estimate the probability of local breakdowns of the fault.

The study region for the present research is Indonesia, which under the influence of the Eurasian, Indo-Australian, Philippine and Pacific plates, immensely suffers due to high seismic activity. The principal contributor in the seismicity of the region is Java-Sunda Trench which lies in the Pacific Ring of Fire (PROF). Owing to the high frequency of earthquakes striking every year from different epicentres, the region provides a huge database. The earthquakes triggering in the region from 1970-2018 is downloaded from the International Seismological Centre website (http://www.isc.ac.uk). These earthquake data comprised of ~270,000 events with the information of Latitude, Longitude, Time of the event and focal depth. To respect the bias which is unavoidable due to the change of the quality of the sensors and the data over the decades, the data is divided into subsets. We considered both small and large magnitude earthquakes along the subduction line to generate a localized time series of stress release to understand the seismic history of the region. By using different neural network models such as one dimensional Convolutional Neural

Network (CNN), Recurrent Neural Network (RNN), an optimized Deep Learning algorithm is trained to understand the intricate pattern associated with the seismic stress release in region. This specialized model is expected to empower seismologist by providing a time saving, automated process for the identification of the zone of failures.