

ABSTRACT

This thesis describes a deep learning-based method for automatically classifying and characterizing seismic data that uses both Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks. The basic goals are to reliably detect earthquake events from noise and estimate critical earthquake characteristics like magnitude and seismic wave arrival timings. The research makes use of a large dataset of raw seismic waveforms and related information, with spectrogram pictures provided as input for the CNN and processed signal envelopes for the LSTM.

The CNN model, trained on spectrogram representations, performed well in the classification job, with an accuracy of more than 98% and precision and recall of more than 97% on the test set. For regression, the CNN displayed trustworthy magnitude estimation, with a mean absolute error (MAE) of 0.12, as well as exact wave arrival predictions with MAE values less than 10 samples. The LSTM model, which was trained on temporal signal envelopes, also performed well, with classification accuracy and F1-scores above 95% and good regression results, but somewhat less accurate than the CNN.

Overall, this study shows that deep learning models, particularly CNNs, may considerably increase the automation and accuracy of seismic signal processing. The methodology and results presented provide a solid platform for future study and practical application in operational earthquake monitoring systems, with the potential to improve seismic hazard assessment and early warning capabilities. Furthermore, the study demonstrates the benefits of incorporating sophisticated neural network designs into geophysical operations, which reduces reliance on manual interpretation and allows for faster, data-driven decision-making. Continued work in this area, such as the incorporation of more diversified datasets, hybrid model designs, and real-time system integration, promises to enhance the field of automated seismic analysis and improve our capacity to respond to seismic hazards.