



Seismic Event Detection from Volcanic Regions using Feature Extraction and Deep Learning

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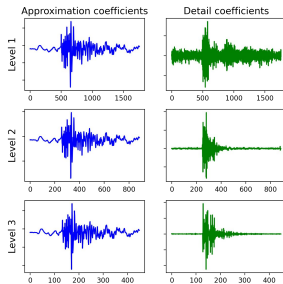
Background and Motivation

- ❖ Manual identification of the arrival times of P and S waves from seismometer data offers great precision but involves human bias and effort
- ❖ Deep-learning models can effectively automate this process, but they do not incorporate scientific knowledge, nor do they offer any understanding of the classification process
- ❖ By pre-processing the data into scientifically meaningful features and using them as input to deep-learning models, we hypothesize improved performance and understanding

Why Wavelet?

- ❖ Seismic events like earthquakes possess characteristic temporal signatures
- ❖ Templates [1] have been used to capture these signatures.
- ❖ Wavelets [2] are a good way to operationalize this for the purposes of feature engineering for ML methods.

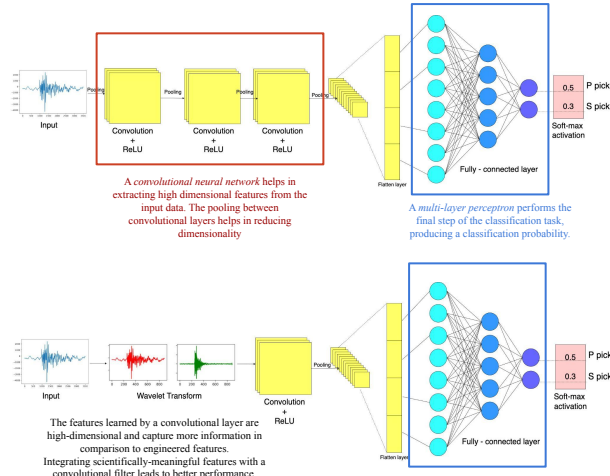
What a wavelet transform does!



The effect of this preprocessing step is not only to remove noise, but also more clearly expose the behavior of interest.

[1] Dawei Mu, En-Jui Lee, Po Chen, Rapid earthquake detection through GPU-Based template matching, Computers & Geosciences, Volume 109, 2017, Pages 305-314, ISSN 0098-3004, <https://doi.org/10.1016/j.cageo.2017.09.002>
 [2] Adhikari, B., Dahal, S., Karki, M. et al. Application of wavelet for seismic wave analysis in Kathmandu Valley after the 2015 Gorkha earthquake, Nepal. *Geoenviron Disasters* 7, 2 (2020). <https://doi.org/10.1186/s40677-019-0134-8>

A Comparative Analysis



Details: One year of seismic data from the southern Taupo Volcanic Zone, New Zealand collected using a short-period seismometer with three component sensor aligned to North. Split into training and testing sets in a 70:30 ratio.

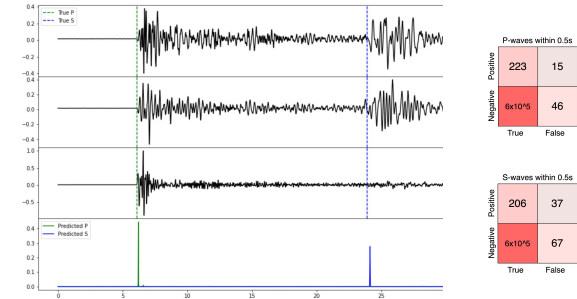
Future Work

- ❖ Explore more feature engineering mechanisms for the seismic waves such as continuous wavelet transform, fingerprints.
- ❖ Explore a neural network model that can retain memory such as Long Short Term Memory (LSTM).
- ❖ Build a model with the ability to classify the various kinds of earthquake events such as tremor and low-frequency earthquakes.

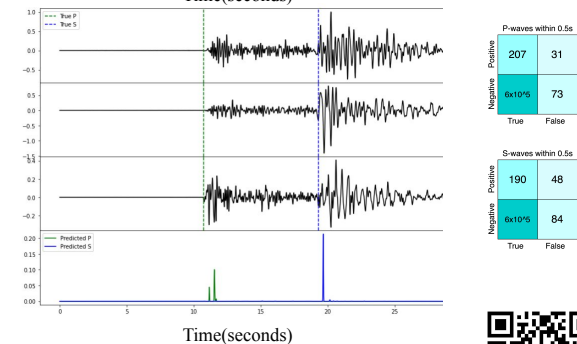
Results

- ❖ Model with featurized input exhibits better performance in terms of precision and proximity to the analyst-picked arrival times.
- ❖ Model with raw input is able to detect similar number of events but with lesser precision.

Wavelet transformed model prediction



Raw input model prediction



Scan the QR for more details!

