Earthquake Early Warning Classification and Magnitude Prediction

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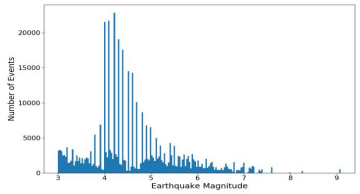
1. Introduction

Accurate and early detection of earthquakes is of critical importance in formulating an effective response. Generally, an earthquake of magnitude less than 4 does not constitute a danger. However, a higher magnitude earthquake demands an immediate response. The current detection system generally evaluates the earthquake magnitudes correctly in roughly 90% of the time.

The purpose of this project is to detect the presence of an earthquake, given a 4-second waveform signal, and to predict the magnitude of that earthquake.

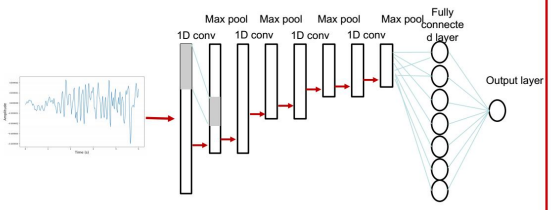
2. Data

Our data set consists of 373,731 different earthquake events and >600,000 non-earthquake events (noise). Below is a histogram of the magnitude of the earthquake data.



3. Method

1. 1-D CNN

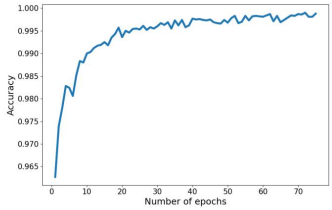


2. Fully connected neural network is used to predict the earthquake magnitude. We extracted 24 different features based on the waveform that formulated the input to the neural network.

4. Result

1D CNN

#Layers	Optimizer	Learning rate	Accuracy	test acc
4	SGD	0.001	52%	44%
4	SGD	0.01	55%	55%
4	Adam	0.001	99%	55%
4	Adam	0.01	99%	55%



Fully connected network

Binary classification:

Number of layers	3 layers	5 layers	10 layers
	98%	99%	99%

β (5 layers)	0.1	0.01	0.001
	96%	98%	99%

Softmax optimization (cuts at 3,4, and 5 magnitude):

	Number of non-earthquake data used		
# of Layers	50k	150k	300k
3 layers	82%	86%	86%
5 layers	83%	86%	89%
10 layers	84%	87%	89%

5. Future work

1. Gather more data
2. Investigate different number of layers in 1-D CNN
3. Explore the impact of bin size on the fully connected network results
4. Train on full dataset with different earthquakes (regional and teleseismic)

6. Acknowledgements

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