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Discrimination of quarry blasts from earthquakes using artificial neural networks

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- 1. Train a model that is able to separate earthquakes from quarry blasts, globally.
- 2. Separate the quarry blasts from earthquakes in Friuli-Venezia Giulia (FVG, NE Italy) region which has never been done before.
- 3. Compare the model with previous studies.

Data



Earthquakes: STEAD^[1]



Features:

Source Type: Local Earthquake Number of Events: 435,253 Number of Signals: 1,006,695 (3 channel) Maximum Epicentral Distance: 200km

Quarry Blasts: KOERI^[2] 30° 35° 40° 45° 40° 40° *Epicenter Station 35° 35° 30° 35° 40° 45°

Features:

Source Type: Quarry Blast Number of Events: 24,323 Number of Signals: 143,124 (3 channel) Maximum Epicentral Distance: 200km

Data



Preprocessing:

- 1. Resample to 100 Hz
- 2. Bandpass the signal between 1 Hz to 20 Hz
- 3. Tapering
- 4. Detrending
- 5. Fixing the length to 90s
- 6. Normalization

Data



Earthquake

Quarry Blast



Model



dropout: Dropout -		input:		(?, 278, 16)			
		output:		, 278, 16)			
flatton: Flatton	in	nput:	(?,	278, 16)			
Hattell, I lattell	ou	tput:	(?	9, 4448)			
dense: Dense	iı	input:		(?, 4448)			
	01	utput:	(1	?, 20)			
		,					
dense_1: Dense		input	: 0	(?, 20)			
		outpu	t:	(?, 10)			
dense_2: Dense		input:		(?, 10)			
		output:		(?, 1)			
			- 2				
linear: Activation		input:		(?, 1)			
		output:		(?, 1)			

.t. Dana aut		input:	((?, 278, 16)		
II: Dropout -		output:	1	(?, 278, 16)		
n: Flatten in		nput:	(?	9, 278, 16)		
		utput:		(?, 4448)		
		1				
ise: Dense o		nput:	(?, 4448)		
		utput: (?, 20)		(?, 20)		
		,		r. 8		
nse_1: Dense		input	;	(?, 20)		
		output:		(?, 10)		
nse_2: Dense		input		(?, 10)		
		output:		(?, 1)		



Model



<u>Training</u>

Loss: 0.0019 Binary Accuracy: 0.9995

Real	Negative	Positive
Predicted		
Negative	8382.5981	5.4902
Positive	6.5481	17030.3105

FPR: 0.0008 FNR: 0.0003

Validation

Loss: 0.0053 Binary Accuracy: 0.9987

Real	Negative	Positive
Predicted		
Negative	5721.0918	0.1154
Positive	24.4704	11204.1982

FPR: 0.0042 FNR: 0.00001

(Quarry Blast: Negative | Earthquake: Positive)

New Data



Earthquakes: Central Italy^[3,4]



Features:

Source Type: Local Earthquake Number of Events: 172 Number of Signals: 13,165 (3 channel)

<figure>

13°30′ 14°00′

Features:

Source Type: Quarry Blast Number of Events: 675 Number of Signals: 8707 (3 channel)

Results





FPR: 0.00379 FNR: 0.16301 (Quarry Blast: Negative | Earthquake: Positive)

Conclusion



- 1. Our model has a potential to separate the earthquakes from explosions.
- 2. The model is able to "learn" the features of the classes even though the data are coming from different part of the world and different type of sources.
- 3. It works well with the unseen data.
- 4. The model can be improved in terms of FNR.

Future Plans



- 1. Improving the accuracy of the model.
- 2. Compare the performance of our model with previous studies.
- 3. Including other features apart from the waveform itself to improve the model.
- 4. Detection of P and S wave arrival.

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