Automatic detection and classification of microseismic events from Super-Sauze landslide using convolutional neural networks

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The application of advanced signal processing techniques in the analysis of signals originating from surface and subsurface processes dates back to late 70s. But, it is within the last 5 years that it has become apparent that the volume of geophysical data being collected is ever increasing, while the time available for their analysis and interpretation has shrunk, especially for applications that require decision making in almost real-time, e.g., well stimulation processes, road traffic management prior to an imminent slope failure, etc.

Within the past 2 years, the number of studies on the potential of machine learning in deciphering the information contained within geophysical monitoring recordings has significantly increased. Machine learning algorithms for microseismic analysis have focused so far on classification of microseismic events, supported by various signal processing tools for denoising and detection of events. Most classification approaches have focused on well-known tools such as Support Vector Machine and Random Forests, with emerging approaches based on deep neural networks (DNNs).

	Local earthquake	**Distance slidequake**	Rock fall	**Undefined sinusoidal event**	**Calibration shot**
Local earthquake	**15**	0	0	0	0
Distance slidequake	0	**10**	1	0	0
Rock fall	0	2	**4**	0	0
Undefined sinusoidal event	1	0	0	**4**	0
Calibration shot	0	0	0	0	**4**

[redacted]

Our approach builds on the potential of DNNs through the implementation of a convolutional neural network (CNN) architecture that performs both detection and classification, and is trained on multi-channel data recordings to 'learn' the best feature representation for each event class of interest. We use the curated Super-Sauze landslide dataset with 8 stations that contains manually extracted 10 classes of events. Specifically, our CNN comprises 5 models, to automatically detect and classify 5 classes - local earthquake, distance slidequake, rock falls, undefined sinusoidal events and calibration events. The

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table below is a confusion matrix showing how many events of each type were correctly classified (on the diagonal) and how many events from the column labelled event are incorrectly classified as the row labelled event. For example, all 15 local earthquake events were correctly detected and classified, 10 out of 12 distance slidequake events were correctly detected and classified whereas the other two slidequake events were misclassified as multiple rock falls. In summary, all seismic events were detected, and clearly distinguished from the calibration shots.

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