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A Bayesian Neural Network approach for the classification of volcano-seismic events.

Angel Bueno Rodriguez (1), Manuel Titos Luzon (1), Luz Garcia Martinez (1), Carmen Benitez Ortuzar (1), Alejandro Diaz Moreno (2), Silvio De Angelis (2), and Jesus Ibañez Godoy (3)

(1) University of Granada, Signal Theory, Telematic and Communications, Granada, Spain (angelbueno@ugr.es), (2) University of Liverpool, Department of Earth, Ocean and Ecological Sciences, Liverpool, UK, (3) University of Granada, Instituto Andaluz de Geofísica, Granada, Spain

Recent advances in the field of artificial neural networks (ANNs) could be applied to monitor volcanoes. However, direct applications of ANNs remain a challenge as obtaining high-quality labelled data is time-consuming and expensive. In addition, volcanoes are nonlinear dynamical systems and uncertainty quantification is essential to build highly-adaptable and effective monitoring systems. This work explores the practical implementation of Bayesian neural networks (BNNs) as probabilistic classifiers for volcano-seismic data. BNNs are defined as multilayer perceptrons (MLPs) with probability prior distributions over its parameters (weights). We evaluate classification performance on seven different seismic events registered at "Volcán de Fuego" (Colima, México). Uncertainty is estimated using approximate variational inference. Each volcano-seismic event is segmented into three non-overlapping segments, and 5 Linear Prediction Coefficients (LPC) are computed for each segment in order to capture spectral envelop information. Obtained results are compared with multilayer perceptron (MLP). These results empirically show that BNNs can classify a wide range of volcano-seismic signals, attaining similar accuracy to its non-Bayesian counterpart. However, BNNs can reliably detect long-period (LPE) and volcano-tectonic events (VTE), and provide an uncertainty estimation. In addition, uncertainty is higher with data from different seismic campaigns, which can be explained by signal variations due to attenuation and soil effects.
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