AGU Fall Meeting 2009

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ID# NH53A-1076

Location: Poster Hall (Moscone South)

Time of Presentation: Dec 18 1:40 PM - 6:00 PM

A SOFTWARE PACKAGE FOR UNSUPERVISED PATTERN RECOGNITION AND SYNOPTIC REPRESENTATION OF RESULTS: APPLICATION TO VOLCANIC TREMOR DATA OF MT ETNA

H. K. Langer[1]; S. M. Falsaperla[1]; B. Behncke[1]; A. Messina[1, 2]; S. Spampinato[1]
1. Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Catania, Italy.
2. Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 2, Rome, Italy.

Artificial Intelligence (AI) has found broad applications in volcano observatories worldwide with the aim of reducing volcanic hazard. The need to process larger and larger quantity of data makes indeed AI techniques appealing for monitoring purposes. Tools based on Artificial Neural Networks and Support Vector Machine have proved to be particularly successful in the classification of seismic events and volcanic tremor changes heralding eruptive activity, such as paroxysmal explosions and lava fountaining at Stromboli and Mt Etna, Italy (e.g., Falsaperla et al., 1996; Langer et al., 2009). Moving on from the excellent results obtained from these applications, we present KKAnalysis, a MATLAB based software which combines several unsupervised pattern classification methods, exploiting routines of the SOM Toolbox 2 for MATLAB (http://www.cis.hut.fi/projects/somtoolbox). KKAnalysis is based on Self Organizing Maps (SOM) and clustering methods consisting of K-Means, Fuzzy C-Means, and a scheme based on a metrics accounting for correlation between components of the feature vector. We show examples of applications of this tool to volcanic tremor data recorded at Mt Etna between 2007 and 2009. This time span - during which Strombolian explosions, 7 episodes of lava fountaining and effusive activity occurred - is particularly interesting, as it encompassed different states of volcanic activity (i.e., non-eruptive, eruptive according to different styles) for the unsupervised classifier to identify, highlighting their development in time. Even subtle changes in the signal characteristics allow the unsupervised classifier to recognize features belonging to the different classes and stages of volcanic activity. A convenient color-code representation shows up the temporal development of the different classes of signal, making this method extremely helpful for monitoring purposes and surveillance. Though being developed for volcanic tremor classification, KKAnalysis is generally applicable to any type of physical or chemical pattern, provided that feature vectors are given in numerical form.

References:
Falsaperla, S., S. Graziani, G. Nunnari, and S. Spampinato (1996). Automatic classification of volcanic earthquakes by using multy-layered neural networks. Natural Hazard, 13, 205-228.
Langer, H., S. Falsaperla, M. Masotti, R. Campanini, S. Spampinato, and A. Messina (2008). Synopsis of supervised and unsupervised pattern classification techniques applied to volcanic tremor data at Mt Etna, Italy. Geophys. J. Int., doi:10.1111/j.1365-246X.2009.04179.x.

Contact Information
Susanna M. Falsaperla, Catania, Italy, 95123, click here to send an email