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An Expert System for Computer-aided Volcano Monitoring on Mt. Etna

Flavio Cannavo' (1), Andrea Cannata (1,2), Carmelo Cassisi (1), Giuseppe Di Grazia (1), Placido Montalto (1), Michele Prestifilippo (1), Eugenio Privitera (1), Salvatore Gambino (1), and Mauro Coltelli (1)

(1) INGV - Istituto Nazionale di Geofisica e Vulcanologia, Catania, Catania, Italy (flavio.cannavo@ingv.it), (2) Università degli Studi di Perugia, Dipartimento di Fisica e Geologia, Perugia, Italy.

Constant estimation of the state of potentially hazardous volcanos plays a crucial role for civil protection purposes. In particular, the importance of monitoring volcanic activity, especially for paroxysms that usually come with tephra emissions, is crucial not only for hazards to the local population but also for airline traffic. Indeed,
At present, real-time surveillance of most volcanoes worldwide is essentially deputized to one or more human experts in volcanology, who interpret data coming from different kind of monitoring networks.
Unfavourably, the coupling of highly nonlinear and complex volcanic dynamic processes leads to measurable effects that can show a large variety of different behaviours. Moreover, due to intrinsic uncertainties and possible failures in some recorded data, the volcano state needs to be expressed in probabilistic terms, thus making the fast volcano state assessment sometimes impracticable for the personnel on duty at the control rooms. With the aim of aiding the personnel on duty in volcano surveillance, we present an expert system based on a probabilistic graphical model to estimate automatically the ongoing volcano state from all the available different kind of measurements. The system consists of a decision network able to represent a set of variables and their conditional dependencies via a directed acyclic graph. The model variables are both the measurements and the possible states of the volcano through the time. The model output is the most likely volcanic state. We tested the expert system on the Mt. Etna (Italy) case study by considering a long record of multivariate data from 2011 to 2015 and cross-validated it. Results indicate that the proposed model is effective and of great power for decision making purposes.