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Toward accelerating landslide mapping with interactive machine learning techniques

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Despite important advances in the development of more automated methods for landslide mapping from optical remote sensing images, the elaboration of inventory maps after major triggering events still remains a tedious task. Image classification with expert defined rules typically still requires significant manual labour for the elaboration and adaption of rule sets for each particular case. Machine learning algorithm, on the contrary, have the ability to learn and identify complex image patterns from labelled examples but may require relatively large amounts of training data.

In order to reduce the amount of required training data active learning has evolved as key concept to guide the sampling for applications such as document classification, genetics and remote sensing. The general underlying idea of most active learning approaches is to initialize a machine learning model with a small training set, and to subsequently exploit the model state and/or the data structure to iteratively select the most valuable samples that should be labelled by the user and added in the training set. With relatively few queries and labelled samples, an active learning strategy should ideally yield at least the same accuracy than an equivalent classifier trained with many randomly selected samples.

Our study was dedicated to the development of an active learning approach for landslide mapping from VHR remote sensing images with special consideration of the spatial distribution of the samples. The developed approach is a region-based query heuristic that enables to guide the user attention towards few compact spatial batches rather than distributed points resulting in time savings of 50% and more compared to standard active learning techniques. The approach was tested with multi-temporal and multi-sensor satellite images capturing recent large scale triggering events in Brazil and China and demonstrated balanced user's and producer's accuracies between 74% and 80%. The assessment also included an experimental evaluation of the uncertainties of manual mappings from multiple experts and demonstrated strong relationships between the uncertainty of the experts and the machine learning model.