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The Iterative Pole Density Estimation, a new approach to assess the stability of rock masses from 3D point clouds

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Assessment of the stability of rock masses is crucial in the process of risk mitigation. Among the many factors predisposing the Italian territory to geohazards, it has to be mentioned the geological and geomorphological setting, often characterized by karst processes and widespread presence of cavities, of both natural and anthropogenic origin, potentially leading to sinkholes and other instability mechanisms. For these reasons, the study of rock masses has always been of primary importance, as a primary tool to define the susceptibility to geological instability and to safeguard the environment.

To solve the problems related to traditional analyses, in many cases too expensive and difficult to carry out, over the last decade the implementation of new digitalized methods, such as close- and long-range remote sensing techniques, has become essential to quantitatively describe the structural arrangement of rock masses. This necessarily requires robust and reliable methods dedicated to extracting the primitive geometries representing the discontinuities on a rock outcrop. A novel approach, combining observations made in situ with digital results, has been recently proposed (Cardia et al., 2021). This method is able to extract discontinuities clusters in a fully supervised way, thus allowing the user to evaluate every situation by determining specified tolerance angle ranges for both dip/dip direction.

We provide here an ongoing development of the method, based on an algorithm that has been implemented in the software GeoDS. The algorithm takes as input a K value, representing a density threshold, from which it will start searching for coplanar points in a given range of 10° for both dip and dip direction, and a seed range value, that is the number of sample points that the system chooses randomly to evaluate each cluster. The greater this value is set, the more successful is going to be the result; however, this comes with a computation time cost, which extent depends on the computer capability.

This new algorithm, called IPDE (Iterative Pole Density Estimation) is then coupled with a KDE (Kernel Density Estimation), extremely useful to plot the graphic projection, on which the user can choose to manually select points or to evaluate the sets with two different automatic clustering techniques, K-means and Gaussian Mixture. The proposed method aims to improve the evaluation of discontinuities on a rock outcrop in a new and original way.

Cardia S., Palma B. & Parise M. (2021) - Implementation of computation codes in geostructural surveys to evaluate rock mass stability aimed at the protection of cultural heritage. EGU General Assembly 2021, EGU21-343.