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Implementation of computation codes in geostructural surveys to evaluate rock mass stability aimed at the protection of cultural heritage

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Instability of rock masses is a frequent problem in Italy, which territory is naturally predisposed to a variety of geological hazards. Therefore, issues related to the study of rock masses have always been of primary importance, since their consequences directly affect human lives and the urbanized areas, causing severe losses to society. In order to identify the areas most susceptible to gravity-related phenomena in such settings, the traditional approaches are often not sufficient, and need to be integrated by new tools and techniques aimed at properly and quantitatively describe the structural arrangement of rock masses. These include the use of close range remote sensing techniques. It is now many years that various attempts have been made to standardize processes to extract volumetric shapes from digital data, in order to individuate geometrical features in point clouds and, eventually, to identify discontinuities on rock outcrops.
We present an attempt to develop and experimentally implement an application of computation codes and software control via command line, to carry out geomechanical investigations on rock masses, starting from 3D surveys. The final goal is to provide reliable results on the likely instability processes in surface and underground settings, as a contribution to the mitigation of the related risks. For this aim, a novel approach is proposed: in order to combine user observation made in situ and on digital results of scanning, our attention was focused on developing non-automatic methods, which could allow, giving a tolerance angle for both dip and dip direction, the extraction of discontinuities on well-structured datasets representing point clouds. This approach could be considered a fully supervised type of classification, because the user can specify the query by placing a numerical input representing an interval of tolerance in degrees; then, it has as output a cluster of planar surfaces belonging to the given interval for each set. The code, organized in a basic software called GEODS (alpha version), which runs on Windows operating systems, also utilizes the results to represent the rocky surfaces on charts and stereographic projections, and is able to calculate standard deviation and mean values of the classified clusters. It is useful to identify the density of each identified discontinuity and to evaluate potential kinematics as well, based on geometric relationships, through analyses carried by a skilled user. This approach was tested at the Cocceio cave, in Campania, southern Italy: this site has historical importance since the Roman age. Reused during World War II, it is now part of a redevelopment project of the Phlegraean Fields, an area renowned for its natural beauty, which includes

numerous archaeological sites. At the cave, with this new method, we were able to recognize an additional set, with minor frequency than the other sets, and which was not identified during previous studies.

As a final result, it is thus expected to contribute in an innovative way to the implementation of alternative and accurate methods in structural analysis and the geomechanical characterization of rock masses.

IMPLEMENTATION OF COMPUTATION CODES IN GEOSTRUCTURAL SURVEYS TO EVALUATE ROCK MASS STABILITY AIMED AT THE PROTECTION OF CULTURAL HERITAGE

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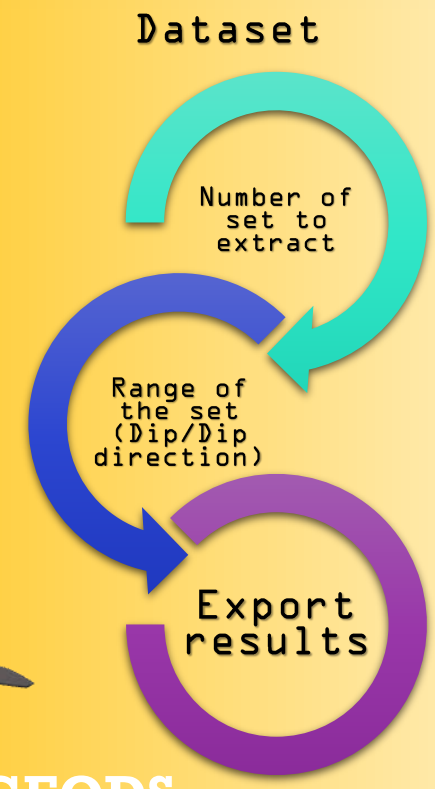
INTRODUCTION

Instability of rock masses is a frequent problem, therefore, issues related to the study of rock masses have always been of primary importance, since their consequences directly affect human lives, causing severe losses to society. In order to identify the areas most susceptible to gravity-related phenomena in such settings, the traditional approaches are often not sufficient, and need to be integrated by new tools and techniques aimed at properly and quantitatively describe the structural arrangement of rock masses. These include the use of close range remote sensing techniques. It is now many years that various attempts have been made to standardize processes to extract volumetric shapes from digital data, in order to individuate geometrical features in point clouds and, eventually, to identify discontinuities on rock outcrops.

AIM

Provide reliable results on the likely instability processes in surface and underground settings by combining observations made in situ with digital results of scanning.

Algorithm for supervised discontinuity extraction

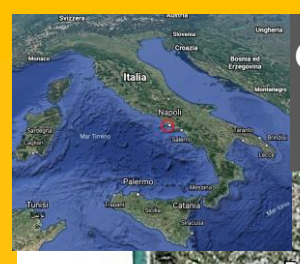


Software GEODS

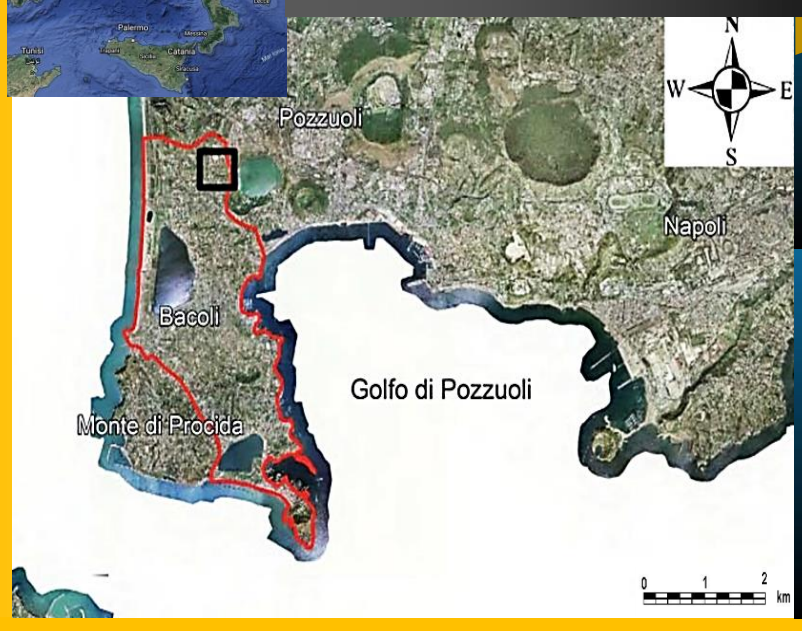
- utilizes the results to represent the rocky surfaces on charts and stereographic projections;
- is able to calculate standard deviation and mean values of the classified clusters.

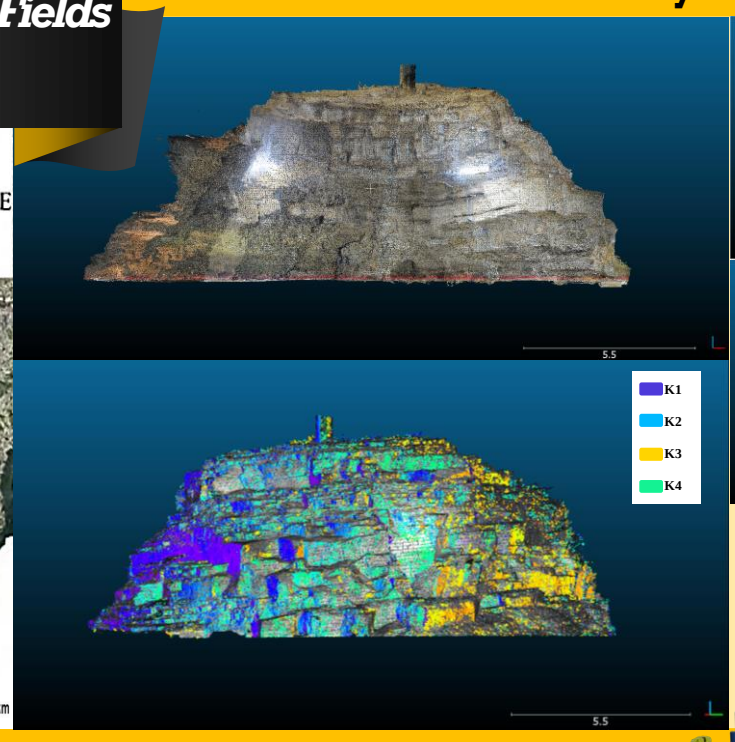
It is useful to identify the density of each identified discontinuity and to evaluate potential kinematics

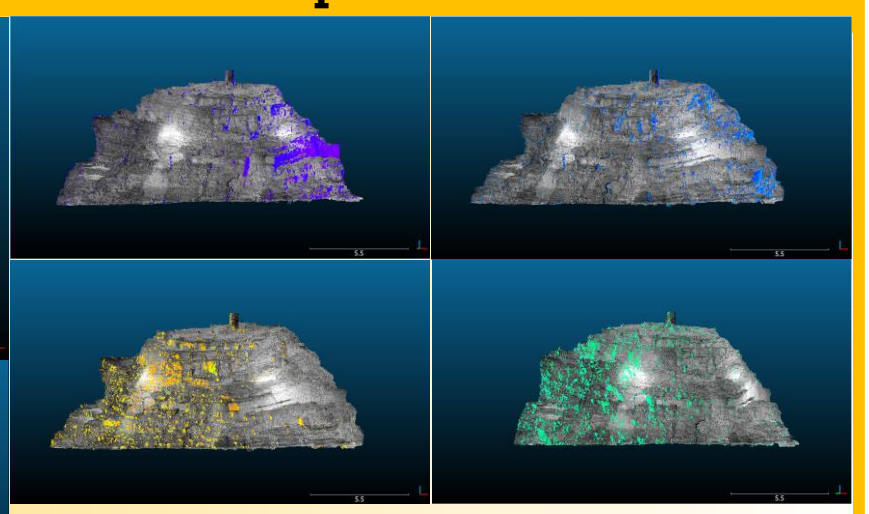
CASE STUDY

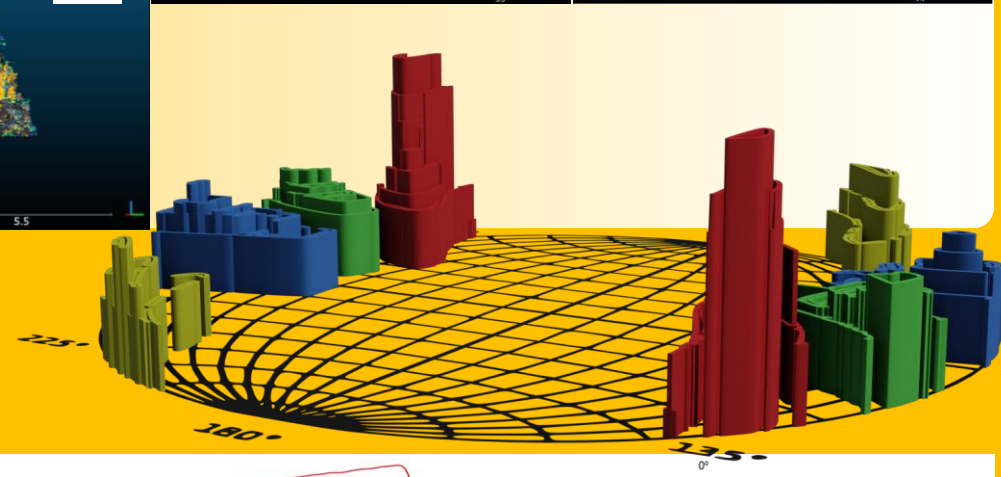


Cocceio cave - Phlegrean Fields Napoli, Italy

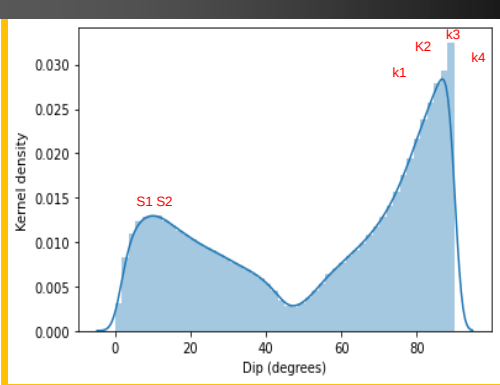


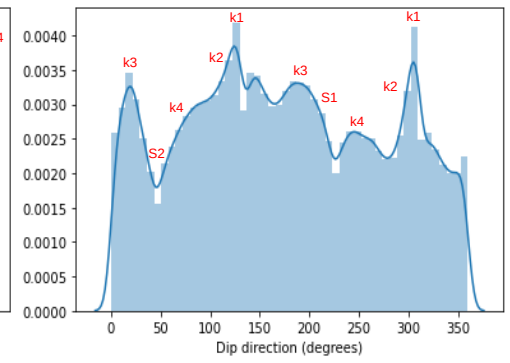


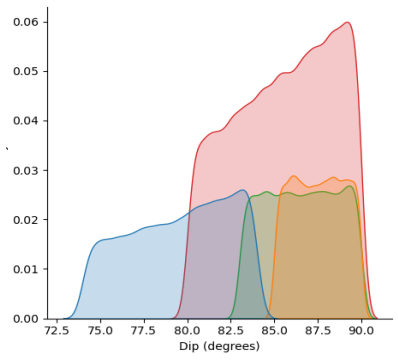


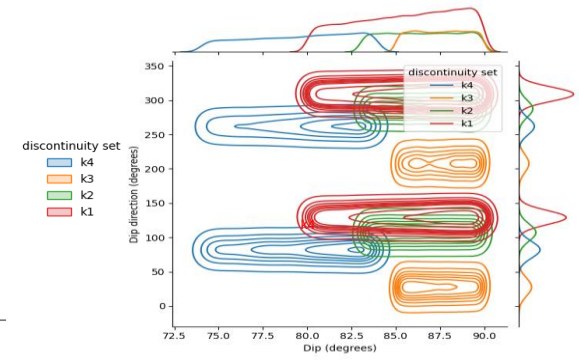


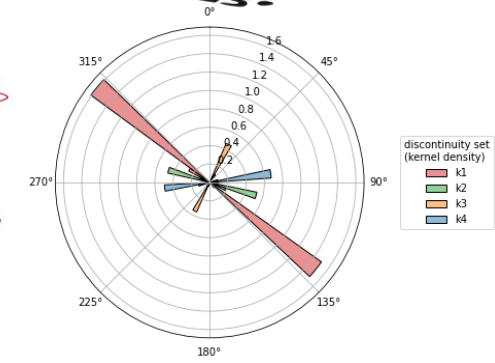
Graphic plot results











1 Density relative to dip

2 Density relative to dip direction

3 Density relative to the dip of the extracted sets

4 Density relative to the dip compared to dip direction of the extracted sets

5 Polar bar chart of the extracted sets

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