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A semi-automatic workflow for rock-fracture characterization with point clouds

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Characterizing the structure of a rock mass with traditional manned surveys can be extremely time-consuming and even unfeasible where the size and exposure of rock outcrops do not allow direct or safe access. In the last decade, increasingly available and powerful laser scanning and photogrammetric survey techniques, implemented on either ground or aerial platforms, have become able to provide high-resolution datasets describing the geometry of rock-slopes in the form of point clouds. At the same time, the cost and technical challenges of this kind of surveys is becoming very competitive. However, objective and reliable interpretation and extraction of common structural parameters that can be used to quantitatively characterize a rock mass (i.e. discontinuity orientation and clustering, fracture intensity and persistence, block size) remain a major bottleneck when analyzing these remote-sensing datasets. In fact, different biases influence the outcrop expression of fractures and thus the possibility to quantitatively characterize the before-mentioned parameters and their statistical distributions. Here we present a case study from the Aosta Valley (Italian Northwestern Alps), where we have applied an innovative yet simple workflow aimed at: (1) automatically extracting facets representing fracture surfaces exposed on the rock-slope, and (2) measuring orientation and spacing of fractures with a sound statistical support. Our automatic analysis workflow is tuned for outcrop-specific structural and geomorphological conditions and validated via a preliminary supervised mapping step. Due to its simplicity and modularity, our workflow is easy to apply in practice, and allows tracing and evaluating errors and biases affecting the different analysis steps and the reliability of output parameters. The results of our workflow provide basic inputs to further analyses including DFN modelling, empirical block size distribution, and kinematic stability analysis.