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# Probabilistic Constraints on Structural Lineament Best Fit Plane Precision Obtained through Numerical Analysis

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Recent advances in geological trace extraction procedures now enable three dimensional representations of structural lineaments to be delineated from digital elevation models (DEMs), orthophotos and mesh based surface reconstructions. The principle advantage of obtaining higher dimensional representations of lineaments from remotely sensed data is that they allow best fit plane estimates to be made for their corresponding discontinuities which cannot be obtained from conventional bi-dimensional datasets. These orientation estimates yield deterministic constraints upon structural architecture and enable spatially dependent discontinuity network properties, such as volumetric intensity and connectivity, known to govern key rock mass physical properties (i.e. strength, elastic modulus and permeability) to be assessed.
However, the eigen characteristics of 3D structural lineaments mapped at decimetre to regional scales indicates that discontinuity plane estimates from such datasets tend to be unreliable. Here, we investigate the relationship between digitised lineament vertex geometry (coplanarity/collinearity) and the reliability of their estimated best fitting plane using Monte Carlo experiments. Lineaments are modelled as the intersection curve between two orthonormally oriented fractional Brownian surfaces representing the outcrop and discontinuity plane. Commensurate to increasing lineament vertex collinearity (K), systematic decay in estimated pole vector precision is observed from our experiments. Pole vector distributions are circumferentially constrained around the axis of rotation set by the end nodes of the synthetic lineaments, effectively reducing the rotational degrees of freedom of the vertex set from three to one. Vectors on the unit circle formed perpendicular to this arbitrary axis of rotation conform to von Mises (circular normal) distributions, only transforming to uniform at extreme values of K. This latter observation suggests that whilst intrinsically unreliable, confidence limits can be placed upon orientation estimates from most 3D structural lineaments digitised from remotely sensed data. We introduce a probabilistic framework which draws upon the statistical constraints obtained from our experiments to provide robust best fit plane estimates from digitised 3D structural lineaments.