

LINE INSERTION IN A CONFORMING TETRAHEDRAL MESH

1. CONTEXT OF THE PROPOSAL

Motivation. Mesh update is an essential component to solve a number of numerical modeling problems such as the geometric optimization of structures to achieve some target properties. In this project, we wish to tackle problems commonly encountered in geological media where the geometry, the connectivity and sometimes even the number of the objects of interest are unknown. In particular, we aim to insert lines into a given mesh of the underground to test various scenarios. These lines may represent some features of interest (e.g., the limits of cracks/fractures, or drill holes for geothermal heat recovery), which need to be tested against some modeling objective, see Fig. 1.

Approach. In order to carry out the line insertion operation, we wish to rely on the mesh update philosophy proposed in the `mmg` library: local mesh operators are applied incrementally to preserve the mesh validity at all times. More precisely, each segment of the poly-line will be inserted iteratively into the mesh: for each line segment, one of the endpoints will be integrated into the mesh, then the intersection between the segment and the surrounding tetrahedra will be tracked and inserted iteratively, so that the segment restricted to the tetrahedron be always explicitly discretized in the updated mesh. As this step may significantly deteriorate the mesh quality, a local remeshing and resampling will be performed after the insertion to improve the mesh quality. In the whole process, care will be taken to preserve the input mesh conformity to pre-existing lines and interfaces.

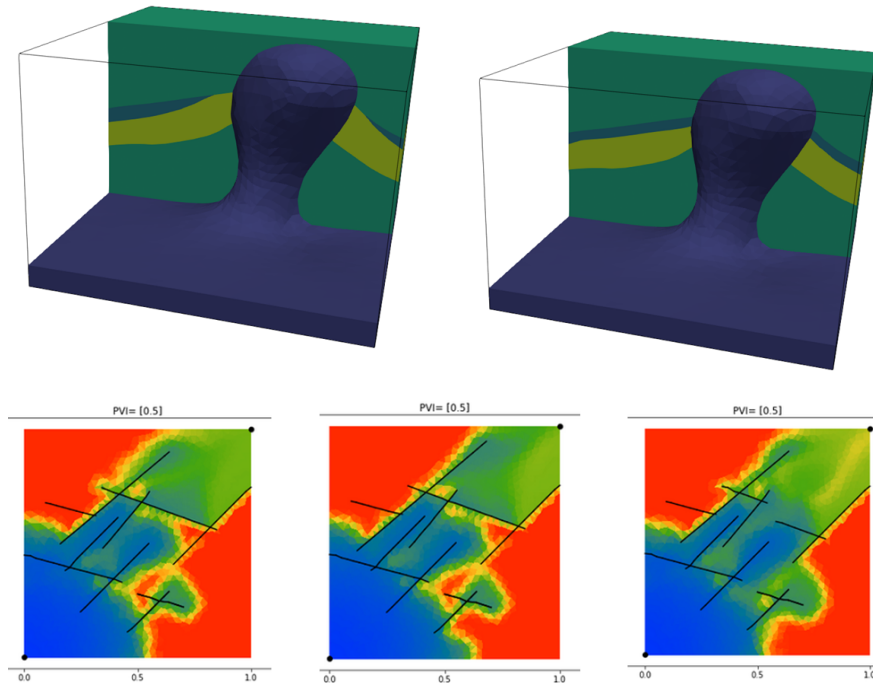


FIGURE 1. (Top) Offset of a geological interface in a tetrahedral mesh; (bottom) perturbation of a fracture network in a porous medium.

Context. This is a joint project between the `mmg` team, from Inria, Laboratoire Jacques-Louis Lions (Université Paris Sorbonne) and Laboratoire Jean Kuntzmann (Université Grenoble-Alpes) and the RING team (GeoRessources lab of Ecole Nationale Supérieure de Géologie at Université de Lorraine). This internship will be supported by RING and the candidate will be primarily be based in Nancy, with regular meetings with all stakeholders. The obtained results will be presented at the annual RING Meeting in Nancy in Sept 2023. This internship is expected to lead to a joint PhD project on the insertion of faults into multi-material models in 2023-2027. Overall, this project opens prospects both for the academic and industrial job markets. Indeed, `mmg`¹ and RING² are supported by a consortium of companies leading to significant industrial and academic contacts.

Duration. 4 to 6 months, spring and summer 2023

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¹www.mmgttools.org

²www.ring-team.org