An original and useful approach to mesh a discrete fracture network

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Modeling mass and heat transfers in fractured media is a challenge. That is due to the geometrical complexity of the discrete fracture network (DFN) and the remaining input data uncertainties. As an illustration, in the field of CO2 sequestration or oil reservoir production, transfers have to be modeled at the scale of reservoirs (~ 10km x 10km 100m) using 100m x100m x 10m grid cell sizes, [1]. However, fractures are finely characterized on well logs and outcrops (at a scale of few meters). From this characterization a DFN can be built and may contain over 10^6 fractures. Analogous issues are to be adressed for hydrology and geothermal applications. Direct numerical simulations accounting for the DFN geometry remain still impossible at the reservoir scale. In practice, upscaling approaches are used to determine equivalent transfer parameters at the grid cell scale. The number of fractures belonging to a grid cell and respecting data from characterization scale may be close to 10^3 fractures. This number is more tractable and direct numerical simulation may be used at this step. Nevertheless, considering the complexity of the DFN geometry, it still remains to simplify the DFN mesh, considering assumptions about the details of the flow [2, 3, 4]. In order to test the accuracy of these assumptions, reference numerical simulations must be carried out using a mesh which accounts for the detailed DFN geometry [5]. The goal of this contribution is to present an original 3D DFN mesh approach allowing to get high fidelity reference simulations and allowing to test further simplifications required by applications.

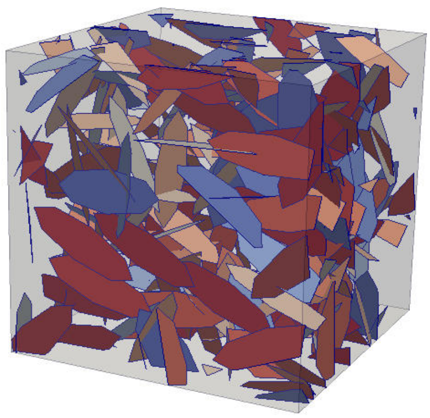

Figure 1: Local view of a Discrete Fracture Network.

The basic difficulty is to mesh each fracture accounting for the intersections with the others, especially if a conformal mesh is desired. The original idea is to decompose each DFN fractures into a set of connected closed outlines including each fracture intersection segments. Special focus is put on common outlines boundaries to generate a conforming Delaunay triangulation (COQ). Advantages of this mesh are to be conform and to closely respect the geometry of the DFN and the topology of the intersection network. These outlines are easy to mesh.

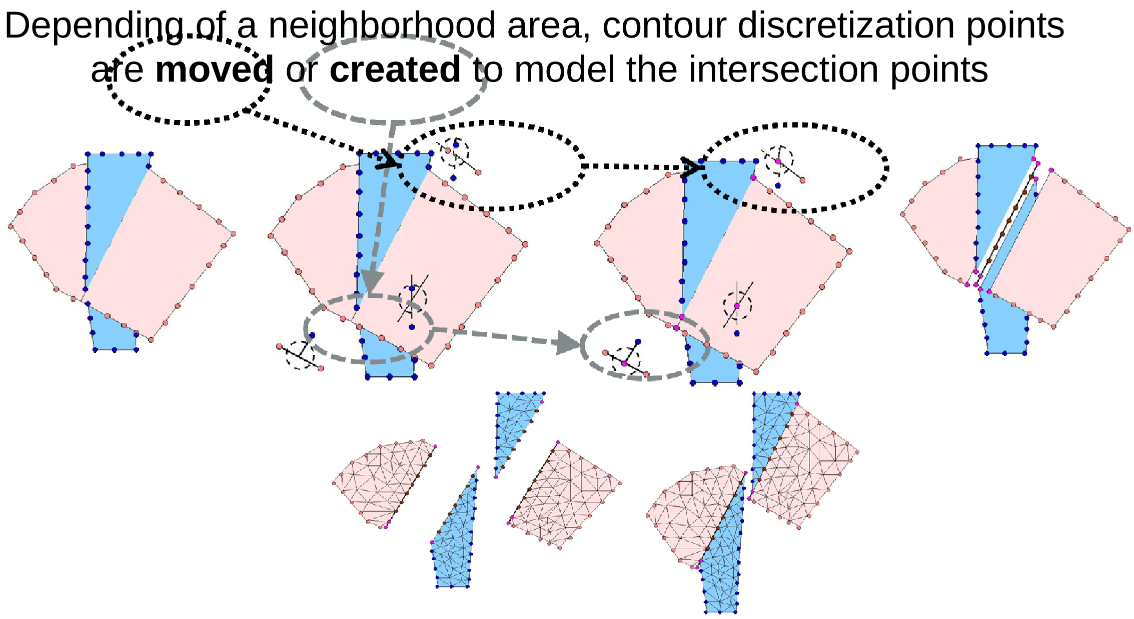

Figure 2: Fractures are “broken” into easy top mesh components that help to build a conformal mesh using standard meshing tools.

In a next step, using this mesh, some fluid flow simulations of interest can be performed.

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