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HULK - Simple and fast generation of structured hexahedral meshes for improved subsurface simulations

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Short for Hexahedra from Unique Location in (K)convex Polyhedra – HULK is a simple and efficient algorithm to generate hexahedral meshes from generic STL files describing a geological model to be used in simulation tools based on the finite difference, finite volume or finite element methods. Using binary space partitioning of the input geometry and octree refinement on the grid, a successive increase in accuracy of the mesh is achieved. HULK generates high accuracy discretizations with cell counts suitable for state-of-the-art subsurface simulators and provides a new method for hexahedral mesh generation in geological settings.

A geological model should incorporate structural information and rock properties for any kind of subsurface simulation because simulation accuracy strongly depends on the relevant rock properties and their distribution in space. Therefore, reliable results can only be expected when well-constrained structural and lithological information is used in the simulation. Due to complexities in both the geological modeling and subsurface simulation, an integrated approach of modeling the geology and the physics of the subsurface (e.g. flow, deformation, etc.) is in many cases not available. We address this problem for simulators using hexahedral grids by proposing an efficient mesh generation method. The method is based on octree refinement and provides for direct transfer of structural geological information to the numerical simulator of the underlying physics.

Accounting for structures in the subsurface using a geological model efficiently helps increase the accuracy of any kind of numerical subsurface simulation. We developed and implemented a fast and efficient hexahedral mesh generator for subsurface simulations. The simple structure of the algorithm makes it also possible to implement the algorithm directly in the discretization part of other simulation software. However, it can also be used as a stand-alone preprocessing unit. Simulators that use adaptive mesh refinement based on the physics can utilize our method within their simulations to dynamically resolve only those parts of the input geometry that are of interest in the current state of the simulation.