VIRTUAL ELEMENT METHODS FOR LARGE-SCALE SIMULATIONS IN COMPLEX GEOMETRIES: POLYTOPAL MESH ADAPTIVITY

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Abstract. In this presentation, we will discuss key aspects of using Virtual Element Methods (VE methods) to simulate real-world problems. VE methods are gaining attention due to their flexibility in mesh generation for complex geometries. We will start by exploring a new approach that combines mesh generation and refinement from a basic geometric description, particularly focusing on polygonal mesh refinement to address quality preservation and improvement challenges in complex domains.

A novel refinement technique tailored for convex cells will be introduced, incorporating properties conducive to addressing convergence and optimality concerns within adaptive methods. Key aspects in refining general convex polygons encompass a cell refinement strategy contingent solely upon the marked cells for refinement at each step, a partial enhancement of mesh quality, or, at the very least, the maintenance of non-degenerate mesh quality throughout refinement iterations, and a constraint on the number of unknowns in the discrete problem relative to the number of cells in the mesh.

Lastly, our discussion will encompass the simulation of flux within fractured and porous-fractured media, a geological application characterized by exceedingly complex geometric features. Fractures are often modeled as polygons, intersecting within three-dimensional space, while fractured media models are typically stochastically generated, employing probabilistic distributions for fracture density, orientation, and size. The stochastic nature of fractures and their intersections naturally introduces geometric challenges within the simulation domains. Moreover, the large number of fractures and the demand for precise simulations on extensive domains pose mesh generation as a paramount challenge, where the incorporation of polygonal or polyhedral elements, including hanging nodes, greatly simplifies the process, albeit occasionally resulting in the inclusion of elements with suboptimal quality.

Keywords: Polygonal mesh generation

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