OPTIMIZATION OF POLYTOPAL MESHES FOR THE VIRTUAL ELEMENT METHOD

TOMMASO SORGENTE

IMATI, Pavia, Italy

We introduce an optimization procedure designed for generic polygonal or polyhedral meshes, specifically tailored for the Virtual Element Method (VEM). Upon evaluating the local quality of mesh elements using a VEM-specific quality indicator [1, 2], clusters of elements are agglomerated to optimize the global mesh quality. As a result, the discretization becomes significantly lighter, allowing for the removal of up to 80At the same time, the price to pay in terms of accuracy is negligible: the convergence rate of the VEM is maintained in optimized meshes, and the approximation errors remain comparable to those of the original meshes. Notably, the optimization process acts as a regularizer for low-quality meshes by eliminating the most pathological elements. This regularization effect becomes evident in cases where the original meshes cause VEM divergence, whereas the optimized meshes lead to convergence. We present applications of this approach to different types of planar and volumetric discretizations, ranging from classical simplicial meshes and grids to non-convex and low-quality polytopal meshes. We also show how the procedure can be effectively applied in the context of Discrete Fracture Networks [3] and in the simulation of time-dependent problems on real CAD models.

References

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[3] Sorgente, T., Vicini, F., Berrone, S., Biasotti, S., Manzini, G., Spagnuolo, M., Mesh Quality Agglomeration algorithm for the Virtual Element Method applied to Discrete Fracture Networks, *Calcolo*, 2023