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GENERALIZATIONS OF FINITE ELEMENTS TO POLYGONAL AND POLYHEDRAL MESHES

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Very recently, work has begun on the development of the generalization of Finite Element methods to general polygonal meshes, dubbed Virtual Element (VE) methods [1]. This approach has been formulated for diffusion-reaction problems.

We compare the construction of the VE methods with Mimetic Finite Difference (MFD) methods, which also operate on general polygonal meshes. The two approaches utilize different tools in their construction. The VE methods are based on two projection operators acting on the approximation space, defined for the stiffness and for the mass matrices. These projection operators allow separation of two parts of the stiffness and the mass matrices. One part is defined uniquely, and is responsible for the convergence order of the numerical scheme. The remaining part must satisfy a number of constraints in order to yield a stable numerical scheme but, otherwise, allows for a wide range of flexibility. The MFD construction is based on the algebraic system of consistency conditions.

The constructions are demonstrated to be equivalent for the stiffness matrix, but there are some differences for the mass matrix. These differences will be illustrated by the examples of wave problems, where the MFD construction has more flexibility for the mass matrix. This flexibility, combined with the m-adaptation process (selection of the optimal member of the MFD family to improve the performance of the numerical scheme), ultimately can lead to a more accurate scheme.

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