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A framework for implementing general higher order virtual element spaces

MS90: STRUCTURE PRESERVING AND ADAPTIVE POLYTOPAL METHODS

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First introduced to solve second order elliptic problems, the virtual element method has gained a lot of attention due to both the versatility of the method and its ability to easily handle general polygonal meshes. As such, it has been applied to a wide range of problems; for example, higher order continuity spaces have been developed for the approximation of polyharmonic problems as well as the construction of pointwise divergence-free spaces for the Stokes problem. However, the implementation of VEM is not so straightforward and we are yet to see many major software packages providing access to VEM spaces.

In this talk we focus on a generic implementation that fits easily into existing software frameworks and leads to beneficial additional structure within the VEM spaces. We implemented our approach within the open source DUNE framework [1]. The software is implemented in `C++` but since a user has access to a Python frontend, they can easily perform numerical experiments by describing mathematical models using the domain specific form language UFL.

In order to describe the generic VEM implementation, we define the projection operators, necessary for the virtual element discretization, in a way that; (a) does not depend on the variational form of the underlying problem, and (b) are computable using only the degrees of freedom. Following [2], we describe this general method and show how this leads to the construction of compatible VEM spaces.

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