

Cut Finite Element Methods for Mixed Dimensional Problems

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ABSTRACT

Mixed dimensional domains are unions of manifolds of different dimensions such that a d dimensional component always resides on the boundary of a $d + 1$ dimensional component. Mixed dimensional domains are common in applications such as modeling of flow in porous media with intersecting fractures.

We develop a cut finite element method (CutFEM) for a convection diffusion problem on a mixed dimensional domain. Each component of the domain has its own field variable and thus the convection diffusion problem is a coupled system of partial differential equations. The problem can be formulated in an abstract framework with natural directional and divergence operators suitable for analysis.

The CutFEM is based on embedding the mixed dimensional domain into a fixed background mesh that covers the domain and the manifolds are allowed to cut through the mesh in an arbitrary fashion. We consider a stabilized finite element formulation and present error estimates and numerical examples.

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