A posteriori error analysis for a cut-cell finite-volume method

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Diffusive process with discontinuous coefficients provide significant computational challenges. We consider the solution of a diffusive process in a domain where the diffusion coefficient changes discontinuously across a curved interface. Rather than seeking to construct discretizations that match the interface, we consider the use of regularly-shaped meshes so that the interface "cuts" through the cells (elements or volumes). Consequently, the discontinuity in the diffusion coefficients has a strong impact on the accuracy and convergence of the numerical method. We develop an adjoint based *a posteriori* error analysis technique to estimate the error in a given quantity of interest (functional of the solution). In order to employ this method, we first construct a systematic approach to discretizing a cut-cell problem that handles complex geometry in the interface in a natural fashion yet reduces to the well-known Ghost Fluid Method in simple cases. We test the accuracy of the estimates in a series of examples.