DG = FEM + Flat Elements

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Abstract

The *tempered finite element method* (TFEM), [1], is a simple, easy to implement modification of vanilla finite elements (FEM) that allows computation on meshes containing nearly or completely degenerate (flattened, or zero-measure) elements. In the original paper [1], we showed how jump-penalization mortaring can be obtained by considering degenerate elements in a FEM triangulation. Here we go one step further and show how a simple modification of the computational mesh (by flattening certain 'edge' elements) allows one to trivially implement discontinuous Galerkin (DG) methods in any off-the-shelf FEM code. We demonstrate this on diffusion, as well as nonlinear evolutionary convection problems. We theoretically analyze the resulting DG scheme and demonstrate its performance on problems ranging from Poisson's problem to compressible Euler equations. Thus the TFEM framework not only fixes FEM by making it more robust to mesh degeneracy, but one can actively use TFEM to easily implement mortaring and/or DG schemes in ordinary FEM codes simply by collapsing chosen elements.

References

[1] Antoine Quiriny, Václav Kučera, Jonathan Lambrechts, Nicolas Moës and Jean-François Remacle. *The tempered finite element method*. Journal of Computational Physics, 549, 2026.