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High-Order Discontinuous Galerkin Method for Problems with Shocks

Solutions of nonlinear systems of conservation laws often contain both discontinuities and rich smooth structures. Resolving these simultaneously might be difficult. Discontinuous Galerkin methods are a promising approach to high resolution computations of compressible flows with shocks in general domains. However, solution or flux limiting strategies are needed to restrict or suppress oscillations near discontinuities. Unfortunately, such limiters frequently identify regions near smooth extrema as requiring limiting and this typically results in a reduction of the optimal high-order convergence rate.

We present a slope limiter for discontinuous Galerkin solutions of hyperbolic conservation laws designed to work with an arbitrary-order spatial approximation. It is problem independent and parameter free. The limiter limits not only the solution, but its derivatives as well, which is done adaptively. As a result, limiting of smooth extrema is avoided for quadratic and higher approximations. We show numerically that the $(p+1)$-st rate of convergence can be achieved in smooth regions, while stability is maintained near shocks. Two-dimensional examples on structured meshes will be presented.