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True high-order limiting for conservation laws based on Total Variation Denoising

Abstract: The major flaw of high-order in space methods is their inability to capture shocks or discontinuities without generating oscillations: a consequence of the Gibbs phenomena. We present a non-linear local filter based on ideas from image processing. The Rudin-Osher-Fatemi (ROF) denoising model introduces a cost functional based in part on the total variation (TV) semi-norm. The associated Euler-Lagrange equation yields a stiff nonlinear partial differential equation. The latter is discretized in space using the discontinuous Galerkin approach and solved to steady state using pseudo-time stepping. A BDF-1 scheme or a Rosenbrock Runge-Kutta time-discretization are employed. Results of this high-order limiting procedure for, simple one and two dimensional functions, one dimensional advection and preliminary results for the two dimensional compressible Euler equations are presented.