Entropy Viscosity Method for Lagrangian Hydrodynamics

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Abstract. We use curvilinear finite elements to solve the Euler equations of compressible gas dynamics in a moving Lagrangian frame. First, the equations are regularized in a way that guarantees positivity of density, correct entropy inequality and minimum principle on the specific entropy. The amount of added diffusion is controlled by the entropy production which is large in shocks and almost none in smooth regions. Then, we derive a Lagrangian form of the regularized system and propose a weak formulation. All variables (position, density, velocity and internal energy) are discretized by continuous finite element basis functions of arbitrary polynomial degree. This requires the use of high-order mappings from a standard 2D/3D quadrilateral/hexahedral reference element. Finally, we use Runge-Kutta time stepping to derive a fully discrete algorithm. We show 2D and 3D numerical results for standard Lagrangian hydro test cases. Our code is developed by using the MFEM finite element library.