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Entropy Stable Galerkin Projection Reduced Order Model for the Discontinous Galerkin Method

Tyson Ofstie[1*], Siva Nadarajah[1]

[1]Mechanical Engineering, McGill University, Montreal, Canada
[*]e-mail address if desired

Abstract

Reduced order models are desired due to the fewer number of variables required to solve for a full order solution. This theoretically reduces the number of computations required to achieve similar results. A projection based model assumes that the solution lies on a lower order subspace. Two approaches, the Galerkin or Petrov-Galerkin, are commonly used due to their simplicity. These methods can be modified to prove the conservation of a conservative quantity (Kalashnikova et al., 2013), however they are not guaranteed to be stable. Yet projection based models have be altered to be stable (Carlberg, 2017).

Entropy-stable Galerkin reduced-order models have been developed for finite volume methods (Chan, 2020). This approach is then expanded to a discontinuous Galerkin (DG) model. The model adjusts the typical entropy conservative DG projection operator to account for the projection into the reduced-order space. This method also works with flux reconstruction schemes. To further reduce the size of the problem, a hyper-reduction using an empirical cubature for point selection and weighting. Results are shown for test cases for the Euler equations in multiple dimensions that display that the convective entropy is stable.