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Domain of dependence stabilization for systems of conservation laws

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Abstract

The usage of cut cell meshes has become increasingly popular in recent years to guarantee an efficient and fast generation of accurate grids for complex geometries. One major drawback when solving hyperbolic conservation laws on cut cell meshes is the small cell problem: small cut cells lead to stability problems, if the time step for explicit time stepping schemes is chosen according to the larger background cells.

In [SIAM J. Sci. Comput., 42:A3677-A3703, 2020], Engwer, May, Nüßing and Streitbürger introduced the domain of dependence (DoD) stabilization to overcome the small cell problem for the linear advection equation in one and two space dimensions for discontinuous Galerkin schemes using piecewise linear polynomials. The DoD stabilization overcomes the small cell problem in an algebraic way by adding penalty terms to the standard discretization. These penalty terms are constructed to restore the correct domain of dependence in the neighborhood of the small cut cells by transporting information from the inflow neighbors to the outflow neighbors.

In this talk, we propose an extension of the DoD stabilization to systems of hyperbolic conservation laws for higher order polynomial degrees in one space dimension. For the scalar case, we show that the resulting stabilized scheme is monotone for piecewise constant polynomials. Moreover, we prove L2 stability for the stabilized scheme for the semi-discrete case for arbitrary polynomial degrees. We conclude the talk with numerical examples for Burgers equation and the Euler equations. These results confirm that the proposed method produces stable solutions while converging with the expected (high) order of convergence.

Remarks / Messages

Remark/Message from the Authors:
Please schedule this talk directly after the talk of Christian Engwer in Minisymposia 12.