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Spacetree-Based Adaptive Mesh Refinement for Hyperbolic Partial Differential Equations

Kristof Unterweger[1], Tobias Weinzierl[1], David Ketcheson[2] and Aron Ahmadia[2]

[1] *Technische Universität München, Boltzmann Str. 3*
85748 Garching b. München, Germany

[2] *King Abdullah University of Science and Technology, Thuwal 23955-6900, Kingdom of Saudi Arabia*

emails: `unterweg@in.tum.de`, `weinzier@in.tum.de`, `david.ketcheson@kaust.edu.sa`, `aron.ahmadia@kaust.edu.sa`

Abstract

Adaptive mesh refinement (AMR) is a state-of-the-art technique for the efficient numerical solution of partial differential equations (PDE) exhibiting multiple widely differing spatial scales. Recently, spacetree-based AMR has been established as a promising approach to structured AMR (see for example [1]).

In the talk the integration of the two software modules PyClaw [2] and Peano [4] is presented. PyClaw offers implementations of several hyperbolic conservation law solvers and works on logically quadrilateral grids. However, it lacks universally applicable AMR functionality. In contrast to this, Peano implements a parallel adaptive grid but without specific solvers [3].

The idea of the presented approach is to use the PyClaw solvers, dedicated for regular grids, on an adaptively refined mesh created by Peano to gain the benefits of both modules. The combination is minimal invasive to the PDE developer, i.e. operations written for regular Cartesian grids are used on adaptive meshes without changes to existing software, as the AMR code traverses the adaptive grid autonomously, calls back PDE-specific operations, and preserves the data consistency on the adaptive mesh. No code is altered, and only few additional PDE-specific code fragments are added. Furthermore, it comes along with a very simple programming interface to manipulate the adaptive mesh. Thus the implementation threshold for application specialists who want to extend existing code with AMR features is lowered.

Key words: adaptive mesh refinement; AMR; hyperbolic PDE.

References

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