MATH CCES Center for Computational Engineering Science

RWTH AACHEN UNIVERSITY

Bachelor/Master Thesis, CES Seminar

Asynchronous finite-difference schemes for PDEs

Course of study: CES, Mathematics
Kind of thesis: Numerical Analysis
Start: anytime

Problem

One of the main challenges for grid-based discretization schemes on massively parallel computer architectures is that processors have to wait in order to synchronize, for example when they exchange information over neighboring grid points. This leads to a loss of efficiency. Current research investigates the behavior of numerical schemes when no synchronization is enforced, i.e. the algorithm keeps computing even if necessary information is not yet available. The message arrivals are then modeled as random variables, which brings stochasticity into the analysis.
In this thesis, based on the paper (Donzis & Aditya, 2014), standard finite-difference schemes for the heat and advection equation are analyzed, and numerical experiments are performed. The hypothesis is that average errors drop to first-order accuracy, independent of the order of the scheme. The project is an ideal continuation of Mathematics IV (CES) or Numerical Analysis IV (Mathematics).

Literature

D.A. Donzis, K. Aditya: *Asynchronous finite-difference schemes for partial differential equations*, J. Comput. Phys. 274 (2014) 370-392.

Task

- Apply the analysis of the above paper to the case of the linear advection equation
- Implement the method in some parallel framework and make experiments. MathCCES has several compute servers available (shared memory CPUs, Xeon Phi, nVidia K20 GPUs)
- Depending on scope and progress, try to extend the results to non-linear PDEs, e.g. Lax-Friedrichs scheme for the Burgers equation

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