A multi-level spectral deferred correction method

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Abstract

Spectral deferred correction methods (SDC) are iterative schemes for computing the numerical solution of initial value problems. SDC can be understood as applying an appropriate preconditioner to a Picard iteration to achieve faster and more robust convergence to a collocation solution. It has been shown that SDC can achieve arbitrary order of accuracy and possesses good stability properties. In this talk, we will examine the combination of multigrid and SDC, known as the multi-level spectral deferred correction (MLSDC) method, where sweeps are performed on a hierarchy of levels, and the FAS correction term couples solutions across different levels. We will examine various strategies to reduce the computational cost of correction sweeps on the coarser levels. I will present numerical examples to demonstrate the impact of multi-level coarsening on the convergence and cost of SDC integration.

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Multigrid preconditioners for the cardiac bidomain model: a performance analysis on HPC architectures

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Abstract

PETSc (Portable Extensible Toolkit for Scientific Computation) (1, 2), is a popular suite of data structures and routines for the numerical solution of partial differential equations. A feature of interest is the implementation of algebraic multigrid methods (3) as solvers and preconditioners, in order to provide fast, efficient, and scalable solutions to linear systems. Besides its own multigrid implementation, PETSc includes routines from HYPRE (4), a software library designed to solve large sparse linear equations on parallel computers and to run on the most modern architectures. This library has its cornerstone in the parallel implementation of the algebraic multigrid method known as BoomerAMG (Boomer Algebraic Multigrid (5)), suitable also for GPU computing. In this talk, we will explore the performances of these algorithms in preconditioning linear systems generated from the time and space finite element discretizations of the Bidomain cardiac model (6), a reaction-diffusion system of ordinary and partial differential equations describing the space-time evolution of cardiac potentials and ionic currents (7, 8). We will consider different settings for our Bidomain solvers and present scalability tests performed on structured and unstructured meshes, on both CPU and GPU parallel architectures.

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