MS24: Numerical Approximation of Partial Differential Equations III

Time Domain Decomposition Methods for Forward-and-Backward PDEs

Zhu Wang, *University of South Carolina*

The forward-and-backward partial differential equation system always appears in the optimal control and optimization problems. It is appealing to solve such a system directly since a single solve suffices to determine the optimal states, adjoint states, and controls. However, this approach is computationally expensive. In this talk, we present several time domain decomposition methods, which are based on a decomposition of the time domain into smaller subdomains, and are suited for implementation on parallel computer architectures. The effectiveness of these algorithms are verified by numerical tests.

ANALYSIS OF QUASI-OPTIMAL POLYNOMIAL APPROXIMATIONS FOR PARAMETERIZED PDES WITH DETERMINISTIC AND STOCHASTIC COEFFICIENTS

Hoang Tran, *Oak Ridge National Laboratory*

We present a generalized methodology for analyzing the convergence of quasi-optimal Taylor and Legendre approximations, applicable to a wide class of parameterized elliptic PDEs with both deterministic and stochastic inputs. Such approximations construct an index set that corresponds to the best M-terms based on sharp estimates of the polynomial coefficients. Several types of isotropic and anisotropic (weighted) multi-index sets are explored and computational evidence shows the advantage of our methodology compared to previously developed estimates.

Recent Developments of Fast Methods for FPDEs

Jinhong Jia, *Shandong University*

Because of the nonlocal property of fractional differential operators, the numerical methods for FPDEs often generate dense coefficient matrices, which often requires computational work of $O(N^3)$ to invert per time step and memory of $O(N^2)$. Furthermore, fractional differential equations with smooth coefficients may generate solutions with strongly local behavior. We report our recent work on fast methods for FPDEs on local grid refinement.

A Fast Numerical Method for Nonlocal Models

Su Yang, *University of South Carolina*

The direct solvers for nonlocal models require $O(N3)$ computational complexity and $O(N2)$ memory for a N-size problem.This imposes significant computational and memory challenge in realistic applications. We present a fast numerical method for nonlocal models by exploiting the structure of the stiffness matrix. This method reduces the memory to optimal order and computational complexity to almost optimal order. The significant computational and memory reduction of the fast method is better reflected in numerical experiments