

# UNIVERSITY of HOUSTON

Department of Mathematics

Scientific Computing Seminar

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## Multigrid and Acceleration Methods for PDEs and Nonsmooth Optimization

Thursday, September 11, 2025  
1 PM- 2 PM  
Room 646 PGH

### Abstract:

This talk explores advanced numerical techniques, “multigrid methods and acceleration strategies”, for solving partial differential equations (PDEs) and nonsmooth optimization problems.

**Part I: Advanced AMLI-Cycles with Momentum Acceleration** We begin with two improvements to the algebraic multilevel iteration (AMLI-cycle) method. First, we use Chebyshev polynomials to ensure uniform convergence, requiring only a two-grid convergence estimate–streamlining setup and reducing cost. Second, we present a momentum-accelerated AMLI-cycle that avoids eigenvalue and convergence rate estimates altogether, making it as easy to implement as standard multigrid methods. With quadratic momentum polynomials, it matches the performance of the Chebyshev-based approach. Numerical results confirm its robustness and efficiency across diverse problems.

**Part II: Acceleration Techniques for Fixed-Point Iteration** The second part focuses on acceleration methods, particularly Anderson acceleration (AA) and nonlinear GMRES (NGMRES), which enhance the convergence of fixed-point iterations. We apply AA to accelerate the alternating least squares method for canonical tensor decomposition and analyze its convergence properties. We propose a generalized alternating Anderson acceleration scheme—a periodic hybrid of fixed-point and AA steps with tunable window sizes—offering flexibility for both linear and nonlinear problems.

To demonstrate the applicability of our novel approach, we apply it to accelerate Jacobi iteration, Picard iteration, gradient descent and the alternating direction method of multipliers (ADMM) in solving nonsymmetric systems, PDEs, and nonlinear, nonsmooth optimization problems.

We also investigate NGMRES( $m$ ) applied to Richardson iteration for solving linear systems, establishing theoretical connections with classical Krylov subspace GMRES. We propose an alternating NGMRES, and provide convergence analysis of NGMRES applied to nonlinear systems.

This seminar is easily accessible to persons with disabilities. For more information or for assistance, please contact the Mathematics Department at 743-3500.