APPLIED MATHEMATICS COLLOQUIUM: A Multiplicative Formulation of GMRES

Stephen Thomas
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AMD and Denver University

Date:
9/30/2022

Time:
3:00 PM-5:20 PM

Location:
SSB 170

About The Speaker:

Throughout his career, Dr. Stephen Thomas has focused on the intersection of high-performance computing and scalable iterative solvers for large sparse linear systems with applications in climate (EnvCan, NCAR, ANL), geoscience (Schlumberger), and renewable energy (DOE NREL, LLNL). His projects at NREL were focused on solvers for wind turbine simulations (ExaWind), and combustion (PeleLM) as part of the U.S. Department of Energy (DOE) Exascale Computing Program (ECP). These solvers are based on the Hypre-BoomerAMG library from LLNL-CASC. His current interest is the development of iterative solvers and Algebraic multigrid (AMG) for GPU's.

Stephen is originally from Montreal and a dual Canada-USA citizen. He completed a Ph.D at the University of Montreal in computational math (french dissertation) and is fluent in french. He also has an M.Eng from McGill and B.Math from the University of Waterloo. He continues to collaborate on Krylov methods with Stephane Goudreault at the national weather center in Montreal.

Notable achievements include a 4000+ GPU wind turbine simulation on Summit, based on the LLNL Hypre library with novel solver contributions from Stephen. He was also on the NCAR team receiving a Gordon Bell award at SC-2001 in Denver for a spectral element climate model run at NERSC.
He is also one of the early users of the world's first Exascale supercomputer, Frontier at ORNL, running PeleLM solver studies.

Abstract:

The MGS-GMRES algorithm of Saad and Schultz (1986) is a well-known iterative method for approximately solving linear systems $Ax=b$. The algorithm employs the Arnoldi expansion of the Krylov basis vectors (columns of V_k) and was proven to be backward stable by Paige, et al. (2006). We present a multiplicative Gauss-Seidel formulation based on Ruhe (1983) and the low-synch algorithms of \'{S}wirydowicz et al. (2020). For a broad class of matrices, a significant loss of orthogonality does not occur and the Arnoldi relative residual no longer stagnates above machine precision. The Krylov vectors remain linearly independent and the smallest singular value of V_k remains close to one. The new Arnoldi-QR algorithm can also be employed to compute eigenvalues with the Krylov-Schur algorithm and shows promise for Krylov exponential integrators.

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