Anderson Acceleration: Theory and Applications

Project title: Anderson Acceleration for Fixed-Point Iterations

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Abstract

Anderson acceleration is an acceleration method applicable to general fixed-point iterations. It originated in work of D. G. Anderson [J. Assoc. Comput. Mach., 12 (1965), pp. 547-560] but has been independently reinvented at least twice by others. In this presentation, we begin by reviewing the very close relationship between Anderson acceleration and GMRES on linear problems and a parallel relationship between the *Anderson Type 1* method of H. Fang and Y. Saad [Numer. Linear Algebra Appl., 16 (2009), pp. 197-221] and the Arnoldi (full orthogonalization) method. We then show results that illustrate its performance in a variety of applications. A particular focus is an extensive computational study conducted jointly with P. A. Lott, C. S. Woodward, and U. M. Yang at LLNL/CASC, in which we explored the effectiveness of Anderson acceleration applied to a modified Picard method for approximately solving the nonlinear systems arising in variably saturated flow problems. In this study, we found that, on steady-state problems in two spatial dimensions involving systems with over 1M unknowns, the accelerated modified Picard method was significantly more robust and efficient than both the modified Picard method without acceleration and a Newton-GMRES method globalized by backtracking.