Low-rank techniques for integrating large Sylvester-like equations with Parareal

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Abstract

In this talk, we apply Parareal to evolution problems that admit good low-rank approximations that can be obtained from the dynamical low-rank approximation (DLRA) algorithm. In this context, the cost and accuracy of each time step are dominated by the rank chosen for the approximation. We use these properties in a new method, which we call low-rank Parareal, to obtain a time-parallel DLRA solver for evolution problems. Low-rank Parareal is shown, both experimentally and theoretically, to work well on parabolic problems. Furthermore, we present a new method to efficiently integrate the time steps in the fine and coarse levels of low-rank Parareal. The idea is to apply a projected exponential Runge–Kutta integrator, specific to Sylvester-like equations, in an extended Krylov subspace. The method is robust to stiffness and keeps all computations in a low-rank format. Numerical experiments show that it is superior compared to other low-rank methods for stiff problems.