Robust high-order low-rank BUG integrators based on explicit Runge-Kutta methods

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Abstract. In this talk, we present high-order basis-update & Galerkin (BUG) integrators based on explicit Runge-Kutta methods for large-scale matrix differential equations. These dynamical low-rank integrators are high-order extensions of the BUG integrator and are constructed by performing a BUG step at each stage of the Runge-Kutta method. In this way, the resulting Runge-Kutta BUG integrator is robust to the presence of small singular values and does not involve backward time-integration steps. We provide an error bound, which shows that the Runge-Kutta BUG integrator retains the order of convergence of the associated Runge-Kutta method until the error reaches a plateau corresponding to the low-rank truncation error and which vanishes as the rank becomes full. This error bound is finally validated experimentally on three numerical test cases. The results demonstrate the high-order convergence of the Runge-Kutta BUG integrator and its superior accuracy compared to other dynamical low-rank integrators proposed in the literature.