Randomized low-rank Runge-Kutta methods

Daniel Kressner (EPFL), Hysan Lam

Low-rank integrators, such as dynamical and projected low-rank methods, have been developed to efficiently address differential equations with matrix or tensor valued solutions. Application areas that have benefitted from these developments include plasma physics, quantum systems and, most recently, machine learning. During the last decade, randomized methods, such as the randomized SVD, have shown their benefits when performing low-rank approximations of (constant) matrices, to the extent that they are now considered a state-of-the-art approach. The purpose of this talk is to carry over these randomized techniques to time-dependent problems. In particular, we will present and analyze a new class of randomized low-rank Runge-Kutta methods. Building mainly on random sketches, these methods are efficient and flexible to exploit different types of sparsity in the data. Theoretical results suggest and numerical experiments validate that these methods can attain arbitrarily high order, which is not always the case for existing low-rank integrators, and perform well for typical benchmark examples of dynamical low-rank methods.

[link to pdf] [back to Numdiff-17]