DYNAMICAL LOW-RANK APPROXIMATION FOR RADIATION TRANSPORT

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ABSTRACT

Problems from radiation transport commonly exhibit a large phase space, leading to increased memory requirements and computational costs. One approach to cope with such high-dimensional phase spaces is dynamical low-rank approximation (DLRA). The main idea of DLRA is to represent the solution as a low-rank approximation, similar to a truncated singular value factorization. DLRA provides time evolution equations for the different factors. The method can be interpreted as a Galerkin method which picks basis functions adaptively. Deriving an efficient representation of the DLRA evolution equations significantly reduces memory and computational costs, as only the factors need to be computed and the costs of different dimensions decouple.

In this talk, we outline the DLRA method for radiation transport and present computational results for radiation therapy applications [?]. We present a stable collided-uncollided split for the DLRA scheme with an efficient treatment of scattering terms. Furthermore, a rank-adaptive DLRA integrator for radiation transport is presented according to [?]. This integrator picks the rank adaptively depending on the solution complexity. Besides its computational advantages, the method preserves and even adds favourable properties such as norm conservation up to a tolerance parameter.

The presented results have been developed in cooperation with Gianluca Ceruti, Lukas Einkemmer, Martin Frank, Chistian Lubich and Pia Stammer.

References

[1] G. Ceruti, J. Kusch, C. Lubich. *A rank-adaptive robust integrator for dynamical low-rank approximation*, BIT Numerical Mathematics (2022).

[2] J. Kusch, P. Stammer. *A robust collision source method for rank adaptive dynamical low-rank approximation in radiation therapy*, arXiv preprint arXiv:2111.07160 (2021).

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