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Solving PDEs on hypercubes using Chebyshev interpolation

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In this talk, we extend our work [2] on the approximation of trivariate functions in functional low-rank formats by combining tensorized Chebyshev interpolation and a low-rank approximation of the coefficient tensor. In the spirit of Chebfun [1], we want to perform numerical computations with these approximations. The application of a differential operator to an approximation in this format, can be evaluated by directly modifying the coefficient tensor. Following the ideas of Chebop2 [3] for two-dimensional domains, we develop a spectral method to solve PDEs on three-dimensional hypercubes by inverting the differential operator in combination with boundary conditions. This leads to a tensor equation, which for certain PDEs has a structure generalizing generalized Sylvester equations from matrices to tensors of order 3.

References

[1] T. A. Driscoll, N. Hale, L. N. Trefethen, *Chebfun Guide*, Pafnuty Publications, Oxford, 2014.

[2] S. Dolgov, D. Kressner, C. Strössner, *Functional Tucker approximation using Chebyshev interpolation*, arxiv e-prints, (2020) p. arXiv:2007.16126.

[3] A. Townsend, S. Olver, *The automatic solution of partial differential equations using a global spectral method*, J. Comput. Phys., 299 (2015) pp. 106-123.