Chebyshev-like compression
of discrete integral operators

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Abstract

We show that the action of various linear and nonlinear integral operators, discretized by a suitable quadrature method, can be compressed and accelerated by means of Chebyshev interpolation or series expansion. Our approach is alternative to other well-known fast methods, such as sparse representation of linear operators using wavelets-based expansion of the kernel. As an additional feature of the method, we point out that in the case of non-smooth kernels, a posteriori Chebyshev approximation estimates may also provide an indicator of the underlying discretization error. We present here several numerical experiments, involving smooth as well as nonsmooth kernels, where we show the effectiveness of Chebyshev-like compression. If the integral operator is discretized by $n-$point composite integration (as the trapezoidal or Simpson's rule), and $m-$point (or $m-$term) Chebyshev-like compression is used, then the evaluation cost is reduced from the basic $\mathcal{O}(n^2)$ to $\mathcal{O}(mn)$ flops, with $m \ll n$.

Keywords: discrete linear and nonlinear operators, Chebyshev-like interpolation and approximation, compression, fast evaluation, error indicators.

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