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The black-box fast multipole method. (English) Zbl 1177.65009

Summary: A new $O(N)$ fast multipole formulation is proposed for non-oscillatory kernels. This algorithm is applicable to kernels $K(x; y)$ which are only known numerically, that is their numerical value can be obtained for any $(x, y)$. This is quite different from many fast multipole methods which depend on analytical expansions of the far-field behavior of $K$, for $|x - y|$ large. Other “black-box” or “kernel-independent” fast multipole methods have been devised. Our approach has the advantage of requiring a small pre-computation time even for very large systems, and uses the minimal number of coefficients to represent the far-field, for a given $L^2$ tolerance error in the approximation. This technique can be very useful for problems where the kernel is known analytically but is quite complicated, or for kernels which are defined purely numerically.

MSC:
65B10 Numerical summation of series
65D05 Numerical interpolation
65F20 Numerical solutions to overdetermined systems, pseudoinverses

Keywords:
fast multipole method; interpolation; Chebyshev polynomials; singular value decomposition; numerical examples; fast summation method; non-oscillatory kernels; algorithm

Full Text: DOI

References: