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Automatic spectral collocation for integral, integro-differential, and integrally reformulated differential equations. (English) Zbl 1195.65225

Summary: Automatic Chebyshev spectral collocation methods for Fredholm and Volterra integral and integro-differential equations have been implemented as part of the chebfun software system. This system enables a symbolic syntax to be applied to numerical objects in order to pose and solve problems without explicit references to discretization. The same objects can be used in matrix-free iterative methods in linear algebra, in order to avoid very large dense matrices or allow application to problems with nonsmooth coefficients. As a further application of the ability to implement operator equations, a method of L. Greengard [SIAM J. Numer. Anal. 28, No. 4, 1071–1080 (1991; Zbl 0731.65064)] for the recasting of differential equations as integral equations is generalized to \( m \)th order boundary value and generalized eigenvalue problems. In the integral form, large condition numbers associated with differentiation matrices in high-order problems are avoided. The ability to implement the recasting process generally follows from implementation of the operator expressions in chebfun. The integral method also can be extended to first-order systems, although chebfun syntax does not currently allow easy implementation in this case.

MSC: 65R20 Numerical methods for integral equations

Keywords: chebfun; spectral collocation; integral equation; integro-differential equation; iterative method

Software: Chebfun; chebop; Matlab; ARPACK

Full Text: DOI

References:


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