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A novel solver for fractional diffusion equations

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Abstract

In recent years, there are many applications of the fractional derivative and fractional Laplacian in different areas. The fractional order differential operators can be seen as an essential tool for developing more sophisticated mathematical models that can accurately describe complex anomalous systems. Since the fractional order differential operators are nonlocal, the corresponding linear system involves a dense, structured Toeplitz matrix. Many research activities are devoted to developing robust and efficient solvers for such linear systems. In this talk, we will introduce some common used definition and discretization of fractional derivative, then propose a numerical method for the fractional diffusion equations based on a new preconditioner that can be used to develop direct and iterative solvers for fractional diffusion equations with total $O(N \log N)$ operations per time step. Numerical results confirms that the new approach is a competitive alternative to existing methods.