MULTIGRID PRECONDITIONERS FOR SPACE-FRACTIONAL DIFFUSION EQUATIONS

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In the last decade Fractional Diffusion Equations (FDEs) have gained a lot of attention in wide range of applicative fields like finance, biology, turbulent flow, image processing, and cardiac electrophysiology. The reason essentially relies on the fact that the so-called *fractional derivative order* can be tuned in order to model enhanced diffusivity.

Even with local discretization methods like finite differences, the nonlocal nature of the fractional operators leads to dense linear systems to be solved. Fortunately, the resulting matrices have a *Toeplitz-like structure*, in the sense that they are expressed as a sum of products between diagonal and dense Toeplitz matrices.

Our contribution in this field is twofold. From one side, we exploit the aforementioned Toeplitz-like structure in order to perform a spectral analysis of the resulting coefficient matrices. On the other hand, we use the obtained spectral information for designing effective multigrid preconditioners for Krylov methods and for studying their convergence properties [1]. Moreover, we propose a robust multigrid preconditioner for the anisotropic problems with application to a space-fractional model for cardiac electrophysiology [2].

References

[1] M. Dehghan, M. Donatelli, M. Mazza, H. Moghaderi, *Multigrid methods for two-dimensional space-fractional diffusion equations*, J. Comput. Phys., 350 (2017) 992–1011.

[2] M. Donatelli, R. Krause, M. Mazza, K. Trotti, *Multigrid preconditioned GMRES for anisotropic space-fractional diffusion equations*, submitted.