

A finite element method for fractional evolution problems

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Abstract

In this work we introduce and analyze a finite element scheme for fractional-in-time and in-space evolution problems. The left-sided fractional order derivative in time we consider is employed to represent memory effects, while a non-local differentiation operator in space accounts for long-range dispersion processes. We discuss well-posedness and obtain regularity estimates for the evolution problems under consideration. The discrete scheme we develop is based on piecewise linear elements for the space variable and a convolution quadrature for the time component. The numerical experiments that we have carried out show a good agreement with our theoretical estimates.

Key words: fractional Laplacian, Caputo derivative, evolution problems

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