Application of some high-order numerical formulae in solving time-fractional diffusion equations

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A time-fractional diffusion equation with the Caputo fractional derivative is considered and solved by using a numerical scheme based on finite element method and/or finite difference method in space. For the Caputo fractional derivative of order α, $0 < \alpha < 1$, some formulae such as L1, L1-2 and L1-2-3 had been constructed previously by using the piecewise Lagrange interpolation and some new formulae based on B-spline interpolations had been introduced and called S1, S2 and S3 with $2 - \alpha$, $3 - \alpha$ and $4 - \alpha$ order of convergence, respectively. The advantage of the B-spline based formulae lies in the fact that the form of these new formulae is as simple as L1 formula with fixed accuracy in the whole interval of integration while the previous formulae such as L1-2 have lower accuracy at the beginning of the interval. Finally, some numerical examples are tested in order to demonstrate the applicability and accuracy of the new formulae.

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