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Numerical solution of the time fractional nonlinear burgers equation using the quintic B-Spline method

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Abstract. This paper introduced a novel approach for resolving fractional partial differential equations. The time fractional nonlinear Burgers equation of order κ was solved to illustrate the efficacy of the technique, where $\kappa \in (0,1]$. The quintic B-spline method facilitated spatial partitioning, while the finite difference method addressed the fractional Caputo derivative, which simulates anomalous diffusion processes influenced by memory effects. The proposed methods stability is demonstrated utilizing the von Neumann technique; it has been shown to be unconditionally stable. Additionally, a convergence study is shown, demonstrating that the approach exhibits uniform convergence of $(\gamma h^4 + \sigma(\Delta\eta^2))$. We validated the methods correctness through numerical tests by comparing it with the exact solution and alternative numerical methods. Based on L^2 and L^∞ error norms, the quintic B-spline approach exhibits improved convergence rates and reduced computing costs.

Keywords: Quintic B-spline method, finite difference techniques, Caputo time-fractional derivative, Burgers equation.
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1 Introduction

Due to the fact that fractional differential operators have non-local properties while classical differential operators have local properties, the fractional calculus has grown significantly in recent years and is better able to describe real-life phenomena [31]. The significance of differential equations of fractional order has been demonstrated in recent years by researchers modeling scientific and engineering problems in a variety of demanding phenomena, such as the predator-prey food chain system [2], the unsteady fluid flow in a rotating annulus region, the non-linear oscillation of an earthquake, the unsteady rotational flow of a second-grade fluid, neutral differential systems with state-dependent delay [30], seepage flow in

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