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A HYBRID ITERATIVE APPROACH FOR SOLVING NONLINEAR TIME-FRACTIONAL DIFFERENTIAL EQUATIONS WITH APPLICATIONS TO FRACTIONAL REACTION-TRANSPORT MODELS

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Abstract: This paper proposes a novel hybrid iterative method for the numerical solution of nonlinear fractional differential equations (FDEs) in the Liouville-Caputo sense. The methodology integrates the Formable integral transform with a new algorithm based on the Daftardar-Gejji and Jafari iterative method to provide accurate approximations for complex FDEs. The efficacy of the approach is demonstrated through applications to the chemical Schnakenberg model and the coupled one-dimensional time-fractional Keller-Segel chemotaxis model. Numerical results confirm the convergence of fractional-order solutions towards their corresponding integer-order formulations, thereby validating the precision and reliability of the proposed technique. This study contributes significantly to the computational analysis of fractional reaction-transport phenomena and offers novel insights into the dynamic characteristics of nonlinear fractional models.

Keywords and Phrases: Fractional reaction-diffusion model, Chemotaxis, Series solution, Formable integral transform, Iterative technique.