Numerical Simulation of Fractional Riesz Space Nonlinear Reaction-Diffusion Models

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Abstract

Fractional differential equations have attracted considerable interest because of their ability to model anomalous transport phenomena. Fractional nonlinear reaction-diffusion models have found numerous applications in patten formation in biology, chemistry, physics and Engineering. Obtaining analytical solutions of fractional nonlinear reaction-diffusion models is difficult, generally numerical methods are used to simulate these models. Numerical methods and error analysis are very important fields in fractional calculus and its application.

In this paper, we consider two fractional Riesz space nonlinear reaction-diffusion models, i.e., Model-1: one-dimensional variable order fractional Riesz space nonlinear reaction-diffusion model and Model-2: two-dimensional fractional Riesz space nonlinear reaction-diffusion model. A implicit numerical method and an alternating direction implicit method are proposed for simulating the Model-1 and Model-2, respectively. The stability and convergence of the two implicit numerical methods are discussed, respectively. Some numerical examples are given to demonstrate the effectiveness of the methods. These methods and techniques can be extended in a straightforward method to simulate practical application problems in biology, chemistry, physics and engineering.