Numerical and theoretical treatment based on the compact finite difference and Spectral collocation algorithms of the space fractional-order Fisher's equation

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Abstract

This paper present an accurate numerical algorithm to solve the space fractional-order Fisher's equation where the derivative operator is described in the Caputo derivative sense. In the presented discretization process, first we use the compact nite difference (CFD) to occur a semi-discrete in time derivative, and implement the Chebyshev spectral collocation method (CSCM) of the third-kind to discretize the spatial fractional derivative. The presented method converts the studied problem to be a system of algebraic equations which can be easily solved. To study the convergence and stability analysis, some theorems are given with their profs. A numerical simulation is given to test the accuracy and the applicability of our presented algorithm.

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(b)

(a)

(b)

Exact−solution: Red

Approx.−solution: Blue

(a)

$\nu=2.0$:   Red
$\nu=1.8$:   Blue
$\nu=1.6$:   Green
$\nu=1.4$:   Brown
$\nu=1.2$:   Black

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(b)

ν=2.0:   Red
ν=1.8:   Blue
ν=1.6:   Green
ν=1.4:   Brown
ν=1.2:   Black

(a)

α=1.0:   Red
α=0.75:   Blue
α=0.50:   Black
α=0.25:   Brown

(b)

β=1.0:   Red
β=0.75: Blue
β=0.50: Black
β=0.25: Brown