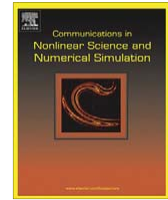




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Modified fractional Euler method for solving Fuzzy Fractional Initial Value Problem

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ABSTRACT

In this paper, the solution to Fuzzy Fractional Initial Value Problem [FFIVP] under Caputo-type fuzzy fractional derivatives by a modified fractional Euler method is presented. The Caputo-type fuzzy fractional derivatives are defined based on Hukuhara difference and strongly generalized fuzzy differentiability. The modified fractional Euler method based on a generalized Taylor's formula and a modified trapezoidal rule is used for solving initial value problem under fuzzy fractional differential equation of order $\beta \in (0, 1)$. Solving two examples of linear and nonlinear FFIVP illustrates the method.

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1. Introduction

The successful application of Fractional Differential Equations [FDEs] in modeling such as viscoelastic material [1], control [2], signal processing [3] and etc., has attracted lots of attention not only in mathematics researches, but also in other disciplines. Just as the application of fuzzy logic in differential equations of integer order has been used as an effective tool for considering uncertainty in modeling the processes, Fuzzy Fractional Differential Equations [FFDEs] can also offer a more comprehensive account of the process or phenomenon. This has recently captured much attention in FFDEs. As the derivative of a function is defined in the sense of Riemann–Liouville, Grünwald–Letnikov or Caputo in fractional calculus, the used derivative is to be specified and defined in FFDEs as well. FFDEs are examined in [4–7]. The Caputo-type fuzzy fractional derivatives are applied here.

The Caputo-type fuzzy fractional derivatives are defined based on Hukuhara difference and strongly generalized fuzzy differentiability. This definition enjoys the advantage of having initial conditions of integer order when modeling various processes by FFDEs under this type of derivative. On the other hand, in FFDEs under Riemann–Liouville derivative, the initial conditions are of fractional order that restricts the applications due to the lack of an appropriate physical meaningfulness. Since modeling many processes involves differential equations with initial conditions, solving initial value problems in a specified interval has crucial importance.

Following the definition of the Caputo-type fuzzy fractional derivatives, a generalized Taylor's formula is presented in this paper. Fuzzy Fractional Initial Value Problem [FFIVP] is then solved using a modified fractional Euler method. In the modified fractional Euler method, the solution in each step is predicted by the fractional Euler method and then corrected by a modified trapezoidal rule. As a result, the solutions are more precise than those obtained by the fractional Euler method.

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