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Euler's Method for Fractional Differential Equations

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Abstract:
This paper presents a numerical method for solving fractional differential equations in the Riemann-Liouville sense. The approach is based on the Euler's method. The main characteristic behind the approach is that Euler method has intuitive geometric meaning. The algorithm is presented and the convergence of the algorithm is proved. As applications of main results, three specific numerical examples are given.

Keywords: Fractional Differential Equations, Initial Value Problem, Solution, Existence, Euler's Method.

1 Introduction:

With the rapid development of high-tech, the fractional calculus gets involved in more and more areas, especially in control theory viscoelastic theory electronic chemicals fractal theory and so on. See reference [1]-[5]. The Existence and uniqueness for fractional differential equations has been investigated by many authors (see, e.g., [6]-[8]). Finding accurate and efficient methods for solving FDEs has been an active research undertaking. In the past few decades, many methods have been developed for solving FDEs from the numerical point of view, such as the Legendre wavelet method, the spectral method and quartered shifted Legendre method based on Gauss C.Lobatt. See reference [9]-[11]. Euler's method has been proven to be efficient solving ordinary differential equations (ODEs) and other kinds of equations. See reference [12, 13]. A question arise naturally: can we have Euler method to derive numerical solution of FDEs? This paper is concerned with the numerical solution of following initial value problem of FDE

$D^{\alpha}_{*} = f(x, y)$ Where $0 < \alpha < 1$ and fractional derivative is in Riemann-Liouville sense. In this paper, we give the Euler method for the fractional differential equations. This paper is organized as follows.

In section 2 we introduce some definitions and some relevant properties of Riemann-Liouville derivative and Caputo derivative. In section 3 we present the proof of convergence of the algorithm and error analysis of the algorithm. In section 4 improved algorithms are given. In