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Existence and uniqueness of the mild solution for fuzzy fractional semilinear initial value problems

Monir Mirvakili* Payame Noor University
Marziyeh Alinezhad Payame Noor University
Tofigh Allahviranloo Islamic Azad University

Abstract

In this paper we will study the existence and uniqueness of mild solution for the fuzzy fractional semilinear initial value problem:

$$\begin{cases} u^{\eta}(t) &= Au(t) + f(t, u(t), Gu(t), Su(t)), t > t_0, \eta \in (0, 1], \\ u(t_0) &= u_0, \end{cases}$$

where $f(t, u(t), Gu(t), Su(t))$ is a given function that is satisfied in Lipschitz condition and fuzziness in this fractional problem occurs as a result of fuzzy initial value. To this aim, we introduce Caputo-differentiability concept and purpose mild solution for fuzzy fractional differential equation.

Keywords: Fuzzy fractional differential equations, Existence and uniqueness, Caputo-differentiability, Fuzzy mild solution, Fuzzy-valued function
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1 Introduction

The importance and popularity of fractional differential equations have been increased during the recent decades, mainly due to its widespread use in numerous variety fields of science and engineering. The existence and uniqueness of the crisp mild solution for the fractional semilinear initial value functions have been studied before, [3], [4]. Since a little uncertainty in data such as uncertainty in the initial value or ambiguity in function as a result of vagueness in one of its constant elements, can change the crisp case of fractional differential equation to fuzzy one, recently fuzzy fractional differential equation has been also regarded, so the existence and uniqueness of solution for this type of equations must be considered. In this paper, we study the existence and uniqueness of mild solution for the fuzzy fractional semilinear initial value problem. To this regards, the uniqueness and existence of the mild solution for fuzzy fractional semilinear initial value problems is proved.
The fuzzy semilinear initial value problem of non-integer order which is considered here is

$$\begin{cases} u^{\eta}(t) &= Au(t) + f(t, u(t), Gu(t), Su(t)), t > t_0, \eta \in (0, 1], \\ u(t_0) &= u_0, \end{cases} \tag{1}$$

*Speaker