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Short communication

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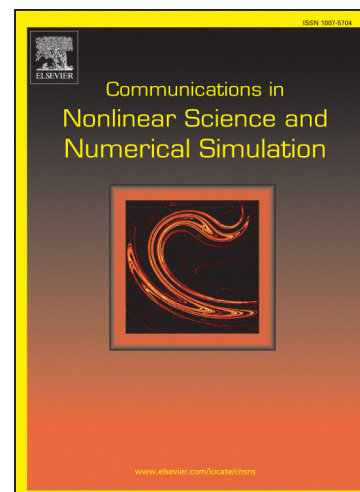
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Counterexamples on Jumarie's two basic fractional calculus formulae

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Abstract

Jumarie proposed a modified Riemann-Liouville derivative definition and gave two basic fractional calculus formulae $(u(t)v(t))^{(\alpha)} = u^{(\alpha)}(t)v(t) + u(t)v^{(\alpha)}(t)$ and $(f(u(t)))^{(\alpha)} = f'_u u^{(\alpha)}(t)$. We give two counterexamples to show that Jumarie's two formulae are not true. Respectively, all results obtained in references by using Jumarie's these two formulae are incorrect. In the end, we give the corresponding formulae.

Keywords: counterexample, fractional calculus, modified Riemann-Liouville's derivative

1 Introduction

Jumarie proposed the following modified Riemann-Liouville fractional derivative[1-5]:

$$f^{(\alpha)}(t) = \frac{1}{\Gamma(1-\alpha)} \frac{d}{dt} \int_0^t (t-x)^{-\alpha} (f(x) - f(0)) dx. \quad (1)$$

and gave some basic fractional calculus formulae, for example, formulae (4.12) and (4.13) in [4]:

$$(u(t)v(t))^{(\alpha)} = u^{(\alpha)}(t)v(t) + u(t)v^{(\alpha)}(t), \quad (2)$$

$$(f(u(t)))^{(\alpha)} = f'_u u^{(\alpha)}(t). \quad (3)$$

The last formula (3) has been applied to solve the exact solutions to some nonlinear fractional order differential equations[6-9]. If this formula were true, then we could take the transformation $\xi = x - \frac{kt^\alpha}{\Gamma(1+\alpha)}$, and reduce the partial derivative $\frac{\partial^\alpha U(x,t)}{\partial t^\alpha}$ to $U'(\xi)$. Therefore the corresponding fractional differential equations become the ordinary differential equations which are easy to study.

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