Accepted Manuscript

Fractional-order derivatives defined by continuous kernels are too restrictive

Martin Stynes

PII: S0893-9659(18)30155-1
DOI: https://doi.org/10.1016/j.aml.2018.05.013
Reference: AML 5520

To appear in: *Applied Mathematics Letters*

Received date : 15 May 2018
Accepted date : 15 May 2018

Please cite this article as: M. Stynes, Fractional-order derivatives defined by continuous kernels are too restrictive, Appl. Math. Lett. (2018), https://doi.org/10.1016/j.aml.2018.05.013

Fractional-order derivatives defined by continuous kernels are too restrictive

Martin Stynes[a,1]

[a] *Applied and Computational Mathematics Division, Beijing Computational Science Research Center, Haidian District, Beijing 100193, China*

Abstract

Various new definitions of fractional-order derivatives seek to replace the singular kernel of the Caputo definition by some continuous function. It is shown here that the use of any continuous kernel often places a severe and unnatural restriction on the data that can be used in problems formulated using these new definitions.

Keywords: fractional derivative, continuous kernel, Caputo-Fabrizio derivative, Atangana-Baleanu derivative
2010 MSC: 35R11, 35B65

1. Introduction and summary

Fractional-order derivatives appear ever more frequently in the modelling of physical processes—see for example [1]. There is much debate about which variant of fractional derivative to incorporate into each model. The traditional choices of Caputo or Rieman-Liouville derivatives [2] have integral operators whose kernels are singular, i.e., they blow up at one limit of integration in the definition of the integral. These singularities can cause difficulties in analysing (and solving numerically) fractional-derivative problems. Consequently various authors have proposed alternative definitions of fractional derivatives with integral operators whose kernels are continuous over the domain of integration, in order to mitigate the analysis of fractional-derivative

*Corresponding author. The research for this paper was supported in part by the National Natural Science Foundation of China under grants 91430216 and NSAF-U1530401.
Email address: m.stynes@csrc.ac.cn (Martin Stynes)