

**Almeida, Ricardo; Torres, Delfim F. M.**

**A discrete method to solve fractional optimal control problems.** (English) Zbl 1345.49022  
Nonlinear Dyn. 80, No. 4, 1811-1816 (2015).

**Summary:** We present a method to solve fractional optimal control problems, where the dynamic control system depends on integer order and Caputo fractional derivatives. Our approach consists in approximating the initial fractional order problem with a new one that involves integer order derivatives only. The latter problem is then discretized, by application of finite differences, and solved numerically. We illustrate the effectiveness of the procedure with an example.

**MSC:**

- [49K15](#) Optimality conditions for problems involving ordinary differential equations
- [34A08](#) Fractional ordinary differential equations and fractional differential inclusions
- [65L10](#) Numerical solution of boundary value problems involving ordinary differential equations

Cited in **1** Review  
Cited in **28** Documents

**Keywords:**

[fractional calculus](#); [fractional optimal control](#); [direct methods](#)

**Software:**

[AMPL](#); [Ipopt](#)

**Full Text:** [DOI](#) [arXiv](#)

**References:**

- [1] Aoun, M; Malti, R; Levron, F; Oustaloup, A, Numerical simulations of fractional systems: an overview of existing methods and improvements, Nonlinear Dyn., 38, 117-131, (2004) · [Zbl 1134.65300](#)
- [2] Atanackovic, TM; Stankovic, B, On a numerical scheme for solving differential equations of fractional order, Mech. Res. Commun., 35, 429-438, (2008) · [Zbl 1258.65103](#)
- [3] Benson, D.A., Meerschaert, M.M., Revielle, J.: Fractional calculus in hydrologic modeling: a numerical perspective. Adv. Water Res.  $\{51\}$ , 479-497 (2013) · [Zbl 1350.49033](#)
- [4] Ford, NJ; Morgado, ML, Fractional boundary value problems: analysis and numerical methods, Fract. Calc. Appl. Anal., 14, 554-567, (2011) · [Zbl 1273.65098](#)
- [5] Ford, NJ; Morgado, ML, Distributed order equations as boundary value problems, Comput. Math. Appl., 64, 2973-2981, (2012) · [Zbl 1268.45005](#)
- [6] Fourer, R., Gay, D.M., Kernighan, B.W.: AMPL: A Modeling Language for Mathematical Programming. Duxbury Press, Brooks/Cole Publishing Company, Belmont (2002) · [Zbl 0701.90062](#)
- [7] Kilbas, A.A., Srivastava, H.M., Trujillo, J.J.: Theory and Applications of Fractional Differential Equations, North-Holland Mathematics Studies, 204. Elsevier, Amsterdam (2006)
- [8] Lotfi, A; Dehghan, M; Yousefi, SA, A numerical technique for solving fractional optimal control problems, Comput. Math. Appl., 62, 1055-1067, (2011) · [Zbl 1228.65109](#)
- [9] Malinowska, A.B., Torres, D.F.M.: Introduction to the fractional calculus of variations. Imperial College Press, London (2012) · [Zbl 1258.49001](#)
- [10] Podlubny, I.: Fractional Differential Equations, Mathematics in Science and Engineering, 198. Academic Press, San Diego (1999) · [Zbl 0924.34008](#)
- [11] Pontryagin, L.S., Boltyanskii, V.G., Gamkrelidze, R.V., Mishchenko, E.F.: The Mathematical Theory of Optimal Processes. Translated from the Russian by K. N. Trifonoff; Neustadt, L.W. (ed.) Wiley, New York (1962) · [Zbl 0102.32001](#)
- [12] Pooseh, S; Almeida, R; Torres, DFM, Numerical approximations of fractional derivatives with applications, Asian J. Control, 15, 698-712, (2013) · [Zbl 1327.93165](#)
- [13] Pooseh, S; Almeida, R; Torres, DFM, Discrete direct methods in the fractional calculus of variations, Comput. Math. Appl.,

66, 668-676, (2013) · [Zbl 1350.49033](#)

- [14] Pooseh, S; Almeida, R; Torres, DFM, Fractional order optimal control problems with free terminal time, *J. Ind. Manag. Optim.*, 10, 363-381, (2014) · [Zbl 1278.26013](#)
- [15] Samko, S.G., Kilbas, A.A., Marichev, O.I.: *Fractional Integrals and Derivatives*, Translated from the 1987 Russian Original. Gordon and Breach, Yverdon (1993) · [Zbl 0818.26003](#)
- [16] Wächter, A., Biegler, L.T.: On the implementation of an interior-point filter line-search algorithm for large-scale nonlinear programming. *Math. Program. Ser. A.* \textit{106}(1), 25-57 (2006) · [Zbl 1134.90542](#)

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