

Nicola Guglielmi (talk 8): A fast and memoryless numerical method for solving fractional differential equations

Wednesday, June 11, 2025 2:00 PM (45 minutes)

The numerical solution of implicit and stiff differential equations by implicit numerical integrators has been largely investigated and there exist many excellent efficient codes available in the scientific community, as Radau5 (based on a Runge-Kutta collocation method at Radau points) and Dassl, based on backward differentiation formulas, among the others. When solving fractional ordinary differential equations (ODEs), the derivative operator is replaced by a non-local one and the fractional ODE is reformulated as a Volterra integral equation, to which these codes cannot be directly applied.

This talk proposes a methodology which makes it possible to make use of such codes. In particular it presents an algorithm for the construction of an approximation of the fractional kernel by a sum of exponential functions, and it shows how the arising linear systems in a stiff time integrator can be solved efficiently. It is explained how the code Radau5 can be used for solving fractional differential equations. Numerical experiments, on both fractional ODEs and 1D PDEs, illustrate the accuracy and the efficiency of the proposed method. Driver examples are publicly available from the homepages of the authors.