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Numerics of delay differential equations

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Abstract

Systems of implicit delay differential equations, mainly including state dependent problems, neutral and differential-algebraic equations, singularly perturbed problems, with small or vanishing delays are considered. As is well-known the solution of such problems has a much more complicated dynamics than that for ordinary differential equations (lack of smoothness in the solution, possibility of non-existence or non-uniqueness), and it is rarely possible to find an analytic expression for the solution. This motivates the need for reliable and efficient numerical integrators for such problems. In turn the numerical integration of general delay differential equations presents several additional difficulties with respect to ODEs.

We mainly focus our attention on the stiffness of delay equations, on the computation of breaking points in the solution, on the numerical treatment of small delays, on suitable error control strategies and on the detection of situations where the solution ceases to exist or also bifurcates. We also consider some possible ways of extending the solution of problems where the solution terminates.

Several illustrative examples will be presented in order to clarify the discussion.

A numerical code designed to the numerical integration of the considered class of problems is available at the web-page <http://www.unige.ch/~hairer/software.html>.

This is a joint work with Alfredo Bellen (Trieste) and Ernst Hairer (Geneva).