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The reliability/efficiency trade-off for a class of interpolation schemes for ODE *solvers*

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Abstract

In the numerical solution of ODEs, it is now possible to develop efficient techniques that will deliver approximate solutions that are piecewise polynomials. The resulting methods can be designed so that the piecewise polynomial will satisfy a perturbed ODE with an associated defect (or residual) that is directly controlled in a consistent fashion.

We will discuss the reliability/efficiency trade off that one faces when implementing and using such methods. In particular we will identify a new class of continuous Runge–Kutta methods with a reliable defect estimator and a validity check that reflects the credibility of the estimate. These more reliable and robust piecewise polynomials are well suited for use in delay differential equation solvers.

Numerical results on a wide selection of problems will be presented for methods of order four through eight. It will be shown that a modest increase in the cost per step will lead to significant improvements in the reliability of the method.