

Continuous variable stepsize explicit pseudo two-step RK methods

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Abstract: The aim of this paper is to apply a class of constant stepsize explicit pseudo two-step Runge-Kutta methods of arbitrarily high order to nonstiff problems for systems of first-order differential equations with variable stepsize strategy. Embedded formulas are provided for giving a cheap error estimate used in stepsize control. Continuous approximation formulas are also considered for use in an eventual implementation of the methods with dense output. By a few widely used test problems, we compare the efficiency of two pseudo two-step Runge-Kutta methods of orders 5 and 8 with the codes DOPRI5, DOP853 and PIRK8. This comparison shows that in terms of f-evaluations on a parallel computer, these two pseudo two-step Runge-Kutta methods are a factor ranging from 3 to 8 cheaper than DOPRI5, DOP853 and PIRK8. Even in a sequential implementation mode, fifth-order new method beats DOPRI5 by a factor more than 1.5 with stringent error tolerances. ?? 1999 Elsevier Science B.V. All rights reserved.

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References:

1. Abramowitz, M., Stegun, I.A., Handbook of mathematical functions (1970) National Bureau of Standards Applied Mathematics Series, 55. , Dover, New York
2. Burrage, K., Efficient block predictor-corrector methods with a small number of corrections (1993) J. Comput. Appl. Math., 45, pp. 139-150
3. Burrage, K., (1995) Parallel and Sequential Methods for Ordinary Differential Equations, , Clarendon Press, Oxford
4. Chu, M.T., Hamilton, H., Parallel solution of ODE's by multi-block methods (1987) SIAM J. Sci. Statist. Comput., 8, pp. 137-157
5. Cong, N.H., Parallel iteration of symmetric Runge-Kutta methods for nonstiff initial-value problems (1994) J. Comput. Appl. Math., 51, pp. 117-125
6. Cong, N.H., Explicit Pseudo Two-step Runge-Kutta Methods for Parallel Computers, , submitted for publication
7. Cong, N.H., Mitsui, T., Collocation-based two-step Runge-Kutta methods (1996) Japan J. Ind. Appl. Math., 13, pp. 171-183
8. Cong, N.H., Mitsui, T., A class of explicit parallel two-step Runge-Kutta methods (1997) Japan J. Ind. Appl. Math., 14, pp. 303-313
9. Cong, N.H., Podhaisky, H., Weiner, R., Numerical experiments with some explicit pseudo two-step RK methods on a shared memory parallel computer (1998) Math. Applic., 36 (2), pp. 107-116
10. Curtis, A.R., High-order explicit Runge-Kutta formulae, their uses, and limitations (1975) J. Inst. Math. Appl., 16, pp. 35-55
11. Hairer, E., A Runge-Kutta method of order 10 (1978) J. Inst. Math. Appl., 21, pp. 47-59
12. Hairer, E., Nørsett, S.P., Wanner, G., (1993) Solving Ordinary Differential Equations, I. Nonstiff Problems, , Springer, Berlin
13. Van Der Houwen, P.J., Cong, N.H., Parallel block predictor-corrector methods of Runge-Kutta type (1993) Appl. Numer. Math., 13, pp. 109-123
14. Van Der Houwen, P.J., Sommeijer, B.P., Parallel iteration of high-order Runge-Kutta methods with stepsize control (1990) J. Comput. Appl. Math., 29, pp. 111-127
15. Van Der Houwen, P.J., Sommeijer, B.P., Block Runge-Kutta methods on parallel computers (1992) Z. Angew. Math. Mech., 68, pp. 3-127
16. Hull, T.E., Enright, W.H., Fellen, B.M., Sedgwick, A.E., Comparing numerical methods for ordinary differential equations (1972) SIAM J. Numer. Anal., 9, pp. 603-637
17. Jackson, K.R., Nørsett, S.P., (1988) Parallel Runge-Kutta Methods, , Manuscript
18. Lie, I., (1987) Some Aspects of Parallel Runge-Kutta Methods, , Report No. 3/87, Division Numerical Mathematics, University of Trondheim, Norway
19. Nørsett, S.P., Simonsen, H.H., Aspects of parallel Runge-Kutta methods (1989) Lecture Notes in Mathematics, 1386. , A. Bellen, C.W. Gear, E. Russo (Eds.), Numerical Methods for Ordinary Differential Equations, Proceedings L'Aquila 1987, Springer, Berlin