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A parallel-in-time algorithm for variable stepsize multistep methods

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As the number of cores increases on current and future architectures, the natural sequential approach to time integration is becoming a more serious bottleneck for achieving high scalability. One alternative to overcome this problem is the use of multigrid-in-time algorithms such as MGRIT [1]. Although first designed for one-step methods, we apply the MGRIT algorithm to multistep BDF methods for the integration of fully implicit *Differential Algebraic Equations* (DAE) on variable timestep grids. Our step function solves the nonlinear problem

$$F\left(t_n, y_n, \dot{y}_n\right) = 0, \quad \dot{y}_n = \sum_{j=0}^{s} \alpha_{n,j}\, y_{n-j}, \tag{1}$$

where s is the order of the BDF method used, and the coefficients $\alpha_{n,j}$ depend on the order s and the previous timestep sizes. We will present one approach for implementing variable stepsize BDF methods in a parallel-in-time context based on the XBraid software library. Results on power grid applications will also be given.

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1 R. D. Falgout, S. Friedhoff, T. V. Kolev, S. P. MacLachlan, and J. B. Schroder, "Parallel time integration with multigrid", *SIAM J. Sci. Comput.*, vol. 36, no 6, pp. C635–C661, 2014, ILNL-JRNL-645325.