Parareal algorithm for multistep time schemes

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In the field of nuclear energy, computations of complex two-phase flows are required for the design and safety studies of nuclear reactors. System codes are dedicated to the thermal-hydraulic analysis of nuclear reactors at system scale by simulating the whole reactor. We are here interested in the Cathare code developed by CEA [1]. Typical cases involve up to a million of numerical time iterations, computing the approximate solution during long physical simulation times. A space domain decomposition method has already been implemented and to improve the response time, we will consider a strategy of time domain decomposition, based on the *parareal method* [3].
The Cathare time discretization is based on a multistep time scheme. In this work, we derive a strategy to adapt the parareal algorithm to multistep schemes that is not intrusive in the code. We propose a variant of the parareal algorithm for time dependent problems involving a multistep time scheme in the coarse and/or fine propagators. This choice can potentially bring higher approximation orders than plain one-step methods but the initialization of each time window needs to be appropriately chosen. Here, we explore some possible initializations and demonstrate their relevance on a Dahlquist test equation followed by numerical results on an advection-diffusion equation and on an industrial test case with an application on the Cathare code [2].

Références

[1] D. Bestion, *The physical closure laws in the CATHARE code*, Nuclear Engineering and Design, vol. 124, 1990.

[2] G.F. Hewitt, J.M. Delhaye, N. Zuber, *Multiphase science and technology*, vol. 6, 1991.

[3] J.-L. Lions, Y. Maday, G. Turinici, *Résolution par un schéma en temps "pararéel"*, C. R. Acad. Sci. Paris, 2001.

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