Performance Prediction of a Parallel-in-Time Solver based on MGRIT.

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Abstract

Here we consider MGRIT (MultiGrid-In-Time) algorithm, which is based on MultiGrid Reduction (MGR), and analyze its performance focusing on the benefits arising by introducing parallelism-in-time. Our ultimate aim is to develop a modular implementation of MGRIT in PETSc (the Portable, Extensible Toolkit for Scientific computing), which is equipped with a computable estimate of the performance gain, depending on the maximum number of levels and the number of processing elements.

1 Introduction and Motivations

Equations governing physical models contain time-stepping both in the mathematical model and in numerical approximation, but their implementations make little or no use of parallelism in the time dimension. Parallel-In-Time (PinT) methods have the potential to extract very large additional parallelism. To maximize the availability of PinT algorithms to science, the idea is to encapsulate their implementation in reusable libraries. The deployment of application codes by means of the use of scientific libraries, such as PETSc (the Portable, Extensible Toolkit for Scientific computing) [2], can be considered a good investment [4, 7]. We are developing a PETSc-based implementation of the MultiGrid-In-Time (MGRIT) algorithm [3], which is based on Multigrid Reduction (MGR) techniques [8]. Furthermore, our aim is to give the user the opportunity of predicting the performance gain that she/he can achieve when using the Multigrid-In-Time approach instead of a sequential Time Stepping integrator (TS) which is already available in PETSc - when parallelism in the space dimension is introduced or not.

In order to do it, in this work we analyze the performance of MGRIT algorithm with respect the parallelization in time dimension [10], using results presented in [1, 5, 6], intentionally overlooking the spacial parallelism.