SOLVING THE TIME DIMENSION IN MULTIPHYSICS MULTISCALE PDE SIMULATIONS

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Abstract. Many applications involve large scale simulations of systems modeled by time dependent partial differential equations (PDEs). These systems are typically driven by multiple physical processes and their dynamics is characterized by multiple scales.

The time discretization defines the overall data dependencies in a simulation, as well as the way the simulation progresses across the nodes of a distributed platform. No single time stepping method can effectively solve multiphysics multiscale applications, where different physical processes have different dynamical characteristics (e.g., stiff and non-stiff), and different variables evolve at vastly different time scales (e.g., from milliseconds for reactive chemical species to decades for temperature averages in a climate application).

We discuss multi-methods where different processes are treated with different numerical discretizations (e.g., implicit-explicit) and different time steps are used for different components (multirate). Specifically, the focus of the talk is on our recent work partitioned general linear methods [5, 4, 1, 6] and on Generalized-structure Additive Runge-Kutta (GARK) methods [3, 2], two new frameworks for developing multi-methods.

Keywords: Multiscale multiphysics PDEs, General Linear Methods, Generalized-structure Additive Runge-Kutta methods.

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