2nd ANNUAL DISTINGUISHED APPLIED MATHEMATICS GRADUATE ALUMNI SEMINAR

Two approaches to avoiding unnecessary work: Multirate time integration and dynamical low-rank approximation

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Date:
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Time:
3:00 PM-4:15 PM

Location:
COB2 170

About The Speaker:

John Loffeld has been at Lawrence Livermore National Lab since 2013, first as a postdoctoral researcher and then as a member of technical staff. At LLNL, he has worked on high-order finite-volume discretization, time integration, and methods for deterministic transport. He received a Ph.D. in Applied Mathematics from the University of California at Merced in 2013 (he was advised by Prof. Mayya Tokman) and a B.A. in Computer Science from the University of California at Berkeley in 1997. In the interim, he worked at Lawrence Berkeley National Lab as a software engineer.

Abstract:

This talk is in two parts. We begin by discussing multirate time stepping as a method for dealing with disparate time scales in multiphysics problems. Traditionally, such problems are commonly addressed with splitting and IMEX methods. Subcycling in splitting methods has been a common way for applications to deal with widely varying timescales in different processes, but these approaches are historically limited to second order. Basic IMEX methods deal well with varying stiffness in processes, even at high order, but use the same time resolution for all parts of the problem. In recent years, new multirate methods have emerged as a means of handling disparate timescales in multiphysics at higher order using methods tailored to each process, combining the benefits of both. We survey some design tradeoffs and demonstrate how these methods can give performance gains when applied to a flame combustion problem.

In the second part, we describe our early experience with using dynamical low-rank (DLR) approximation for combating the high-dimensionality of Boltzmann transport problems. Transport problems are of great importance to the DOE, being integral in flagship simulation problems such as for the National Ignition Facility inertial confinement fusion experiment. Unfortunately, their exorbitant cost dominates over other physics in multiphysics scenarios, which motivates seeking new ways to minimize it. We describe the structure of the DLR approach and how it can be mapped onto Boltzmann transport and show some promising early results on a thermal radiative transfer problem. We conclude by discussing possible future directions for using and improving DLR in our application space.

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