1st Women in Mathematics Meeting (WM^2) Contributed Talk

Title:

Efficient representation of high-order operators for the numerical solution of PDEs

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Abstract:

For decades, high-order numerical methods have been considered too computationally expensive and therefore have been rarely used in industrial applications, despite their favorable properties, such as high accuracy and fast convergence to solution. In particular, one of the challenges with high-order finite element and spectral element methods is the representation of the high-order linear or nonlinear operator as a global sparse matrix. Moreover, the Jacobian matrix of a nonlinear operator is known to rapidly lose sparsity as the order is increased, leading to time-to-solution and memory requirements that were unaffordable for years. Thus, high-order methods require a new operator description that still represents a linear or non-linear operator, but not through a sparse matrix. The goal of the libCEED library is to propose such a format, as well as supporting implementations and data structures that enable efficient operator evaluation on a variety of computational device types, such as CPUs, GPUs, etc. We introduce libCEED and its API and demonstrate its usage though a Navier-Stokes solver using libCEED and PETSc.