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PYFR: AN OPEN SOURCE FRAMEWORK FOR HIGH-ORDER COMPUTATIONAL FLUID DYNAMICS ON STREAMING ARCHITECTURES

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High-order numerical methods for unstructured grids combine the superior accuracy of high-order spectral or finite difference methods with the geometric flexibility of low-order finite volume or finite element schemes [1]. The Flux Reconstruction (FR) approach unifies various high-order schemes for unstructured grids within a single framework [2]. Additionally, the FR approach exhibits a significant degree of element locality, and is thus able to run efficiently on modern streaming architectures, such as Graphical Processing Units (GPUs). The aforementioned properties of FR mean it offers a promising route to performing affordable, and hence industrially relevant, scale-resolving simulations of hitherto intractable unsteady flows within the vicinity of real-world engineering geometries. In this talk we will present PyFR (www.pyfr.org), an open-source Python based framework for solving advection-diffusion type problems on streaming architectures using the FR approach. The framework is designed to solve a range of governing systems on mixed unstructured grids containing various element types. It is also designed to target a range of hardware platforms via use of our own custom domain specific language. The current release of PyFR (v0.1.0) is able to solve the compressible Euler and Navier-Stokes equations on grids of quadrilateral and triangular elements in two dimensions, and hexahedral elements in three dimensions, targeting clusters of CPUs, and NVIDIA GPUs. Results will be presented for various benchmark and 'real-world' flow problems, and scalability of the code will demonstrated on in excess of 100 NVIDIA M2090 GPUs.

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