Efficient Matrix-Free Discontinuous Galerkin Assembly: To Hand-Write Or to Generate?

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Abstract: Medium to high order Discontinuous Galerkin (DG) methods have received a fair bit of interest recently, as their their high computational intensity and structured memory access patterns are a good fit for current HPC architectures. However, implementations are rather complex and highly sensitive to small implementation details.

In this talk, we present and compare two different approaches to developing high-performance implementations of matrix-free DG: In our earlier efforts, we developed a C++ implementation for convection-diffustion problems and Navier-Stokes on top of the DUNE framework. More recently, our UFL-based code generation framework gained a sum-factorized DG back-end based on the earlier work, which allowed us to quickly add support for other types of problems and hardware architectures. There are tradeoffs between the two approaches, and we discuss how their strengths combine for a better framework than would be possible with either one alone.

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