Analytic Mesh Optimization for Discontinuous Galerkin Methods Using a Continuous Mesh Model

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Abstract

Many convection-diffusion systems exhibit strongly anisotropic features. Compressible flow is a prime example: Depending on the flow conditions, such as Mach number and Reynolds number, strong boundary layers, shear layers, and shocks may be present. In order to resolve these features efficiently in a numerical simulation, anisotropic meshes are advantageous. We present an anisotropic mesh adaptation and optimization method for high-order Discontinuous Galerkin schemes. Given the total number of degrees of freedom (DOFs), we propose a metric-based method, which aims to globally minimize the L^q norm of an error model associated with the approximation space. Advantages of using a metric based method in this context are several. Firstly, it facilitates changing and manipulating the mesh in a general non-isotropic way. Secondly, defining a suitable continuous interpolation operator allows us to use analytic optimization techniques, which operate on the metric field, rather than the discrete mesh. A mesh with very good approximation properties may then be generated from the quasi-optimal metric field, using a suitable mesh generator. We present numerical validation for convection-diffusion systems, and discuss extensions to adjoint-based adaptation methods.

References

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