Numerical Solution of the Two-Dimensional Advection Equation on Unstructured Grids with Logarithmic Reconstruction

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There are numerous approaches for solving hyperbolic differential equations in context of finite volume methods. One popular approach is the limiter free Local-Double-Logarithmic-Reconstruction (LDLR) of Artebrant and Schroll. The aim of this work is to construct a two-dimensional reconstructing function based on the LDLR for solving the advection equation on unstructured grids. The new method should preserve the characteristics of the LDLR. That means in particular a reconstruction without use of limiters and with a small stencil of only the nearest neighbors of a particular cell. Also local extrema should be conserved while the local variation of the reconstruction within one cell should be under control.

We propose an ansatz which works on unstructured polygonal grids. To come up to this, an ansatz function with one logarithmic expression for each edge of the polygon is constructed. Required gradients at cell edge midpoints are determined by use of the Multi-Point-Flux-Approximation (MPFA) method. Further derivative information are obtained with help of special barycentric coordinates. All necessary integrals of the ansatz functions can be computed exactly. The new advection procedure is numerically evaluated with standard test cases from the literature on different unstructured quadrilateral grids.

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