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A NEW TYPE OF HIGH-ORDER METHOD

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A variation on the finite-volume method is to consider the interface fluxes as independent degrees of freedom, rather than as quantities to be interpolated from the cell averages. This automaticaly doubles the resolving power of the schemes, and raises the order of accuracy by one. The methods are one-step, and fully discrete. Their semi-discrete versions, at least for one-dimensional advection, are the Discontinuous Galerkin methods, but the fully discrete methods, which have been named as the Active Flux methods, are substantially more efficient. No reliance is placed on superconvergence.

To create a method of order p, it is neccessary to create an interpolant of order $p-1$ and to use this, in a compact upwind manner to derive interface values of order $p-1$, with nonlinear effects accounted for to order $p-2$. These interface values do not have to be the fluxes, or to possess any conservation properties. They can be any quantities from which the flux could be derived, and good choices for the Euler equations appear to be the velocities, the sound speed and the entropy. Because of this freedom, a great variety of physical arguments can be used to provide physics-based schemes.

Multidimensional versions can be naturally based on simplices. Degrees of freedom located at the boundary of each cell are shared between neighbors, which leads to economical storage. Because the reconstruction in any cell does not depend on the geometry of any other cell, the method tolerates poor meshes.

A fully multidimensional treatment of acoustic waves makes use of the explicit Kirchoff solution to the initial-value problem for acoustic pressure, modified to include the velocities. A novel type of limiting, which appeals to the past history of the cell under consideration, is able to maintain feull accuracy close to smooth extrema.

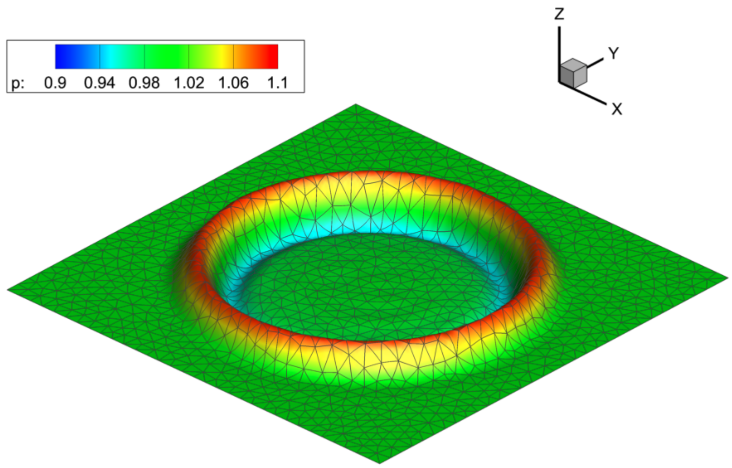

Figure 1: Evolution of a narrow Gaussian pulse on a coarse unstructured grid.

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